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Editors

Clinical Cases in Early Orthodontic Treatment

An Atlas of When, How and Why to Treat
Second Edition

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Contents

1 Introduction	1
Julia Harfin	
2 Digital Technology as an Aid to Early Orthodontic Treatment	19
Bryce Lee	
3 The Treatment of Class II Division 1 Malocclusion in Stages	33
Kurt Faltin Jr	
4 Is Early Class II Treatment Worth the Effort?	73
Amit Bhardwaj	
5 Early Treatment of Cover-Bite and Class II Division 2 Malocclusion	115
Bernd G. Lapatki	
6 Early Treatment of Class III Malocclusions	203
Somchai Satravaha	
7 Early Treatment of Open Bite Problems	265
Julia Harfin	
8 Correction of the Transverse Problems	295
Julia Harfin	
9 Management of Dental Asymmetries	311
Julia Harfin	
10 Mandibular Incisor Agenesis	339
Julia Harfin	
11 Impacted Central Incisors: Different Options for Treatment	357
Julia Harfin	
12 How Orthodontic Movement Can Avoid Future Periodontal Problems in Children	369
Julia Harfin	
13 Early Orthodontic Treatment in Cleft Lip / Palate Patients	381
Somchai Satravaha	
14 Diabetes in Childhood and Adolescents	435
Olga Ramos	
15 Orthodontics in Hemophilia Patients	443
Eduardo Rey	
16 How to Avoid Long Term Relapse in Early Orthodontic Treatment	451
Julia Harfin	

17	Controversies in Cleft Lip / Palate Patients	469
	Julia Harfin	
18	Controversies Concerning Early Treatment.	475
	Julia Harfin and Kurt Faltin Jr	

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Bernd G. Lapatki received the degree in dentistry from the University of Freiburg, Germany, in 1994. He defended his thesis leading to the Dr. med. dent. degree in 1998, and his Habilitation Thesis on the pathogenesis and treatment stability of cover-bite and Class II Division 2 malocclusion in 2007. He also received a Ph.D. degree in neurophysiology from Radboud University Nijmegen (NL) in 2010 for the electrophysiological characterization of the facial motor system at a motor unit level. He started his clinical career in 1995 practicing as a general dentist for 2 years before he began his postgraduate study at the Department of Orthodontics, Freiburg University Medical Center. During his clinical work at this department as Specialist in Orthodontics from 2000 to 2009, he was also a Research Fellow at the Department of Clinical

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Introduction

1

Julia Harfin

This atlas was written taking into consideration the most common problems that are frequently encountered in young children.

Interceptive treatment is intervening in the developing dentition to allow it to achieve the best occlusion possible, or to make subsequent treatment as simple and short as possible (DiBiase 2002).

There is no doubt that early treatment can be justified if it provides additional benefits to the patient.

The question of when, how, and why is answered in depth in all the clinical cases contained in this atlas. The goal is to focus on functional and skeletal rather than dental correction.

Knowing the diagnosis criteria and which type of cases should be treated early will permit the clinician to offer the most efficient solution for each individual patient. In general, the first phase of treatment in the early mixed dentition has to be followed by the second phase in the permanent dentition.

When and how much growth will occur is unpredictable in some patients, but the direction of growth can be managed (Suresh et al. 2015). However, it is important for the clinician to be able to diagnose and intercept certain developing problems through early treatment.

Many other cases should be supervised, but not treated until the permanent teeth are in place. We must base our decision on a correct diagnosis taking into account that the correction of functional and skeletal imbalances are fundamental before the eruption of all the permanent teeth.

One of the most important advantages to begin the treatment early is to take advantage that in early mixed dentition, the skeletal growth pattern can be modified to a certain point. Other doctors with different protocols suggest that the treatment has to begin after the eruption of the second molars

(Behrents 2006). At this time, growth modification will be limited.

Specific indications for early treatment include Class II or Class III malocclusion, with maxillary midface deficiency anterior and posterior crossbite (unilateral and bilateral), midline discrepancies due to early loss of deciduous teeth with a midline shift, severe anterior open-bite, severe deep-bite with palatal impingement, finger-sucking habits, crowding resulting in ectopic positioning of permanent teeth, etc. (Dugoni 1998; Dugoni et al. 2006).

But not all the circumstances are black or white, each patient is unique. For example, the most appropriate timing for the treatment of Class II malocclusion is controversial (Cozzani et al. 2013). Some clinicians advocate starting the first phase in mixed or temporary dentition, but others prefer to wait until the second molars have erupted.

Also, the timing of treatment interventions can be influenced by the severity of the malocclusion, the age, and maturity of the patient at the time the treatment begins.

It is important to emphasize that different types of brackets and wires were used by the authors to treat the patients since there isn't a single type of bracket or wire that performs a correct diagnosis in each clinical case, until now.

The role of the orthodontist is to manage the problem in the most efficient way for a better diagnosis. It is fully recognized that some malocclusions are best treated early for biological, functional, and social reasons.

Different alternatives for each malocclusion will be described step by step in each chapter.

It is evident that to design an efficient treatment plan, the clinician must understand the growth and development process very clearly.

It is well-known that the difference in the response of patients with the same orthodontic treatment is the result of variability in the direction and rate of craniofacial growth.

It is impossible to decide the best time to begin the treatment based solely on the chronological age since the majority of the malocclusions that have to be treated during mixed dentition are the result of multiple factors.

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In general, mixed dentition is the best time to start treatment when the correction of habits with or without anterior or lateral transverse crossbite are indicated.

A panoramic radiograph is mandatory at age 8–10 years to confirm the presence or absence of agenesis, supernumerary teeth, cysts, mesiodens, etc.

The last chapter (Chap. 18) analyzes the most main controversies regarding early treatment in depth.

The following examples show the importance of the timing of treatment according to the initial pathology, direction of growth, and the normalization of the functional problems such as nasal breathing and tongue posture at rest or during swallowing. Although they were skeletal and dental Class III at the beginning of the treatment with a similar biotype, the results that were achieved in the long term were completely different.

The parents of this 6-year-old patient asked for a second opinion about the best time to begin his treatment. They were very interested in having him treated very early and avoid the orthognathic procedure that was suggested. The front photographs confirmed a significant negative overjet and overbite that was present in the anterior region (Fig. 1.1a, b).

From the etiological point of view it is important to consider that his two older sisters had Class I molar and canine but two of his seven cousins were Class III and were treated with orthognathic surgery.

The dental front and lateral photographs showed that the lower incisors were in contact with the upper labial gingival tissues and until then and for unknown reasons, he only ate soft meals.

The lateral radiograph confirmed the negative anterior position of the front teeth. Ricketts analysis demonstrated normal convexity with a retruded upper lip and everted lower lip. An increased facial axis was present (95°), along with a short lower anterior height (41°) (Fig. 1.2a, b).

The real question is when would be the best treatment time to begin the correction of this Class III malocclusion? Is

it advisable to begin now or to wait until 11–12 or 18 years of age?

There is no doubt that the normalization of the anterior negative crossbite should take place as early as possible since it will help achieve a normal development of the maxilla and to improve the soft tissue profile.

These were the results after 26 months with a functional appliance (Fig. 1.3a, b). Overjet and overbite were improved and midlines were almost normal. The objectives of Phase I of treatment were accomplished. It was important to improve the anterior position of the tongue.

However, the most important question is if the treatment results will remain stable over the long term.

These were the photos 9 years after treatment. The results were maintained or even improved even though some gingival retractions were seen in the upper canine area (Fig. 1.4a, b). Fortunately, in this particular clinical case the second phase of treatment was not necessary.

The comparison between the smile photos at the beginning and 9 years after treatment was the best proof that the results were maintained throughout his whole childhood and adolescence (Fig. 1.5a, b).

As a conclusion, it is possible to affirm that the treatment of very young Class III patients with a significant anterior deep-overbite is more reliable than when the Class III is in combination with a significant open-bite, as it is observed in the second patient.

The next case is very different from the first. It was very clear that early treatment would be beneficial for him, although the success was questionable due to the unfavorable type and direction of growth. She was only 4 years, 9 months of age. Her dental history showed that her parents were skeletal Class III but not her young sister.

The front photographs showed an important dentoalveolar Class III with a significant open bite in the anterior region and crossbite in the lateral areas.

As a consequence of the lower and anterior position of the tongue, significant diastemas were present in the lower arch

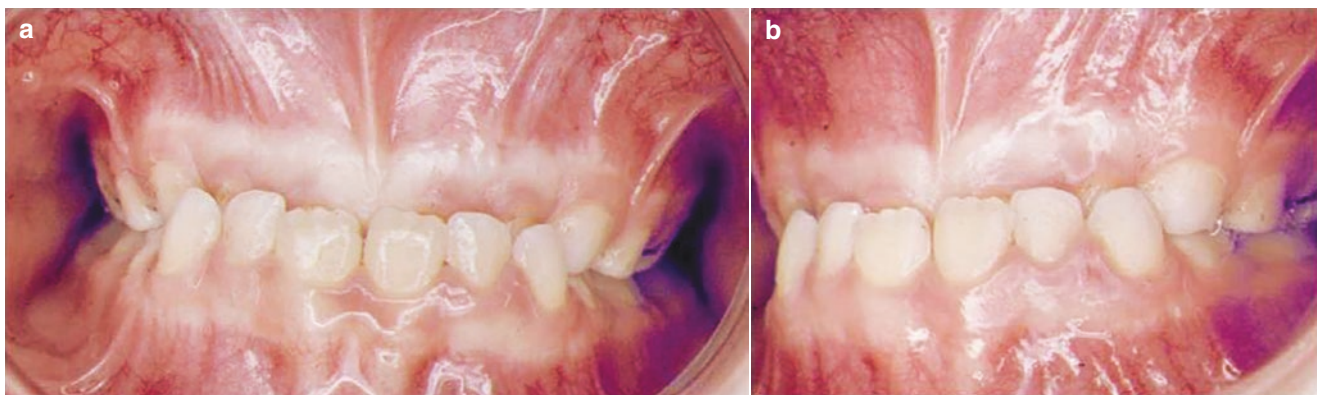


Fig. 1.1 (a, b) Frontal and lateral pre-treatment photographs. A significant negative overbite was present

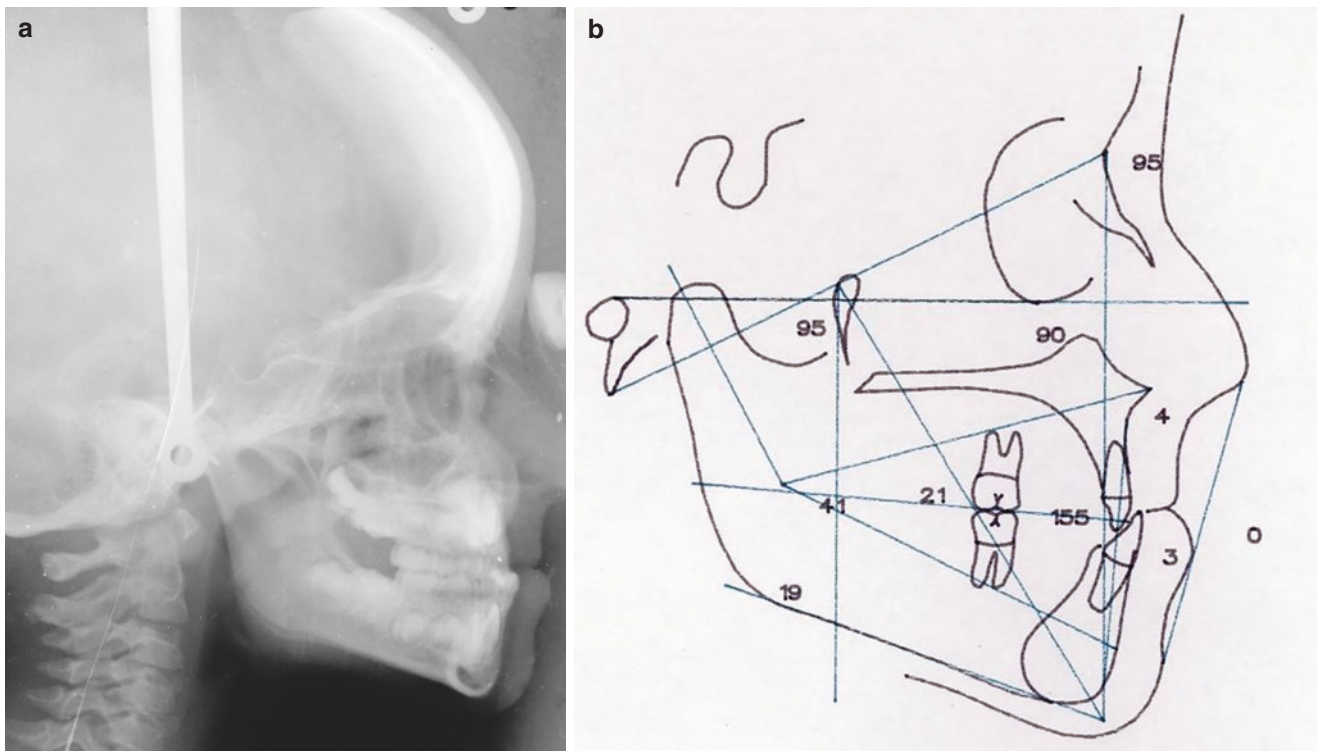


Fig. 1.2 (a, b) Pre-treatment lateral radiograph and Ricketts analysis

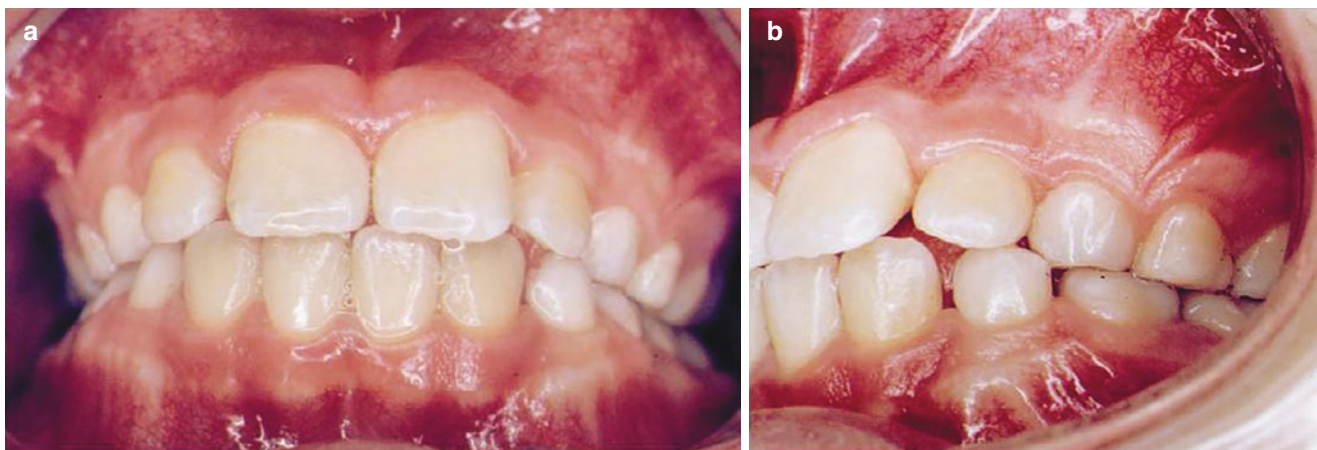


Fig. 1.3 (a, b) Frontal and lateral post-treatment photographs at the end of Phase I of treatment

(Fig. 1.6a, b). The normalization of the position of the tongue is one of the most difficult issues and requires a lot of time and effort for the patients and their parents.

Although Ricketts analysis was developed for 9-year-old patients, the lateral radiograph confirmed that the patient had a dental and skeletal open-bite—Class III with brachyfacial bio-type. This combination has the poorest long-term prognosis.

It is very important to take into account that patients with Class III and open-bite are harder to treat than those with

Class III and deepbite. The normalization of the tongue posture at rest and in function is mandatory to avoid relapse (Fig. 1.7a, b).

The real question is until when it is possible to redirect growth in these Class III patients and how to know, at an early age, how the mandible will develop.

Evaluation of the overall treatment and post-treatment changes confirm that overcorrection in this first phase of treatment is recommendable (Baccetti and Franchi 2006).

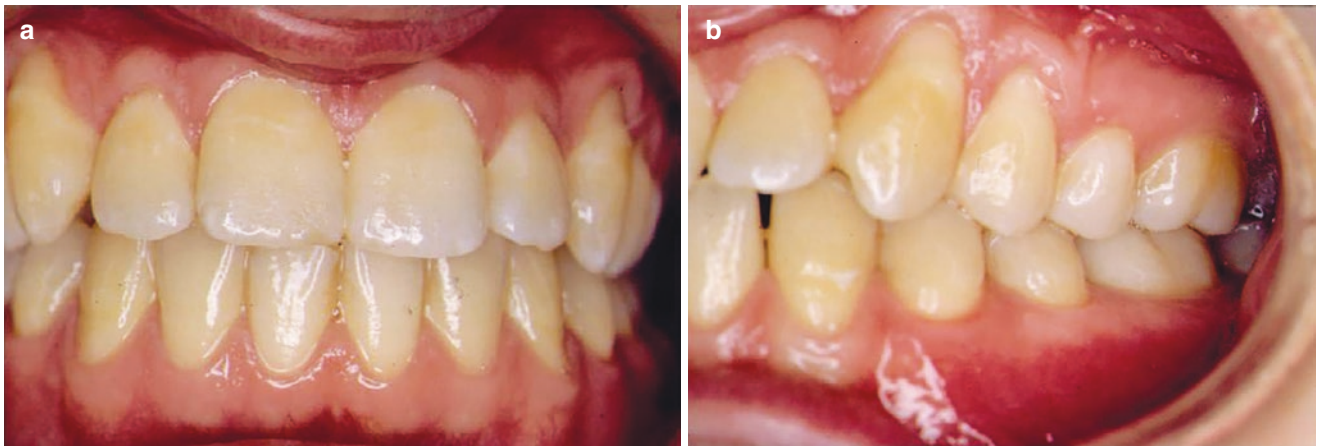


Fig. 1.4 (a, b) Control 9 years after treatment. The results were maintained. Overjet, overbite, and midlines were improved



Fig. 1.5 (a, b) Comparison of the smile photographs pre- and 9 years after treatment

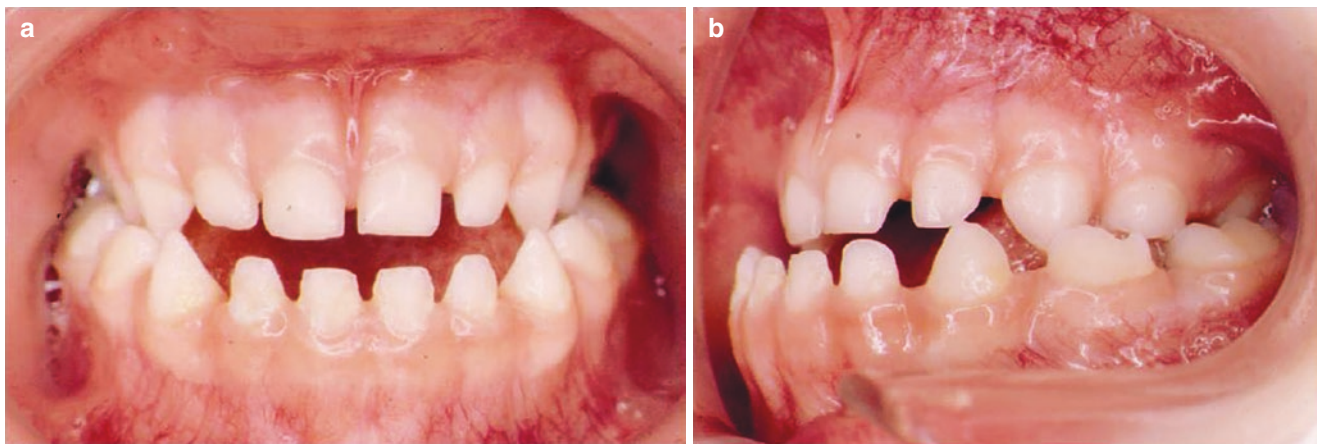


Fig. 1.6 (a, b) Frontal and lateral pre-treatment photographs. A significant skeletal and dental Class III with a considerable open-bite was present in this 4-year, 9-month girl

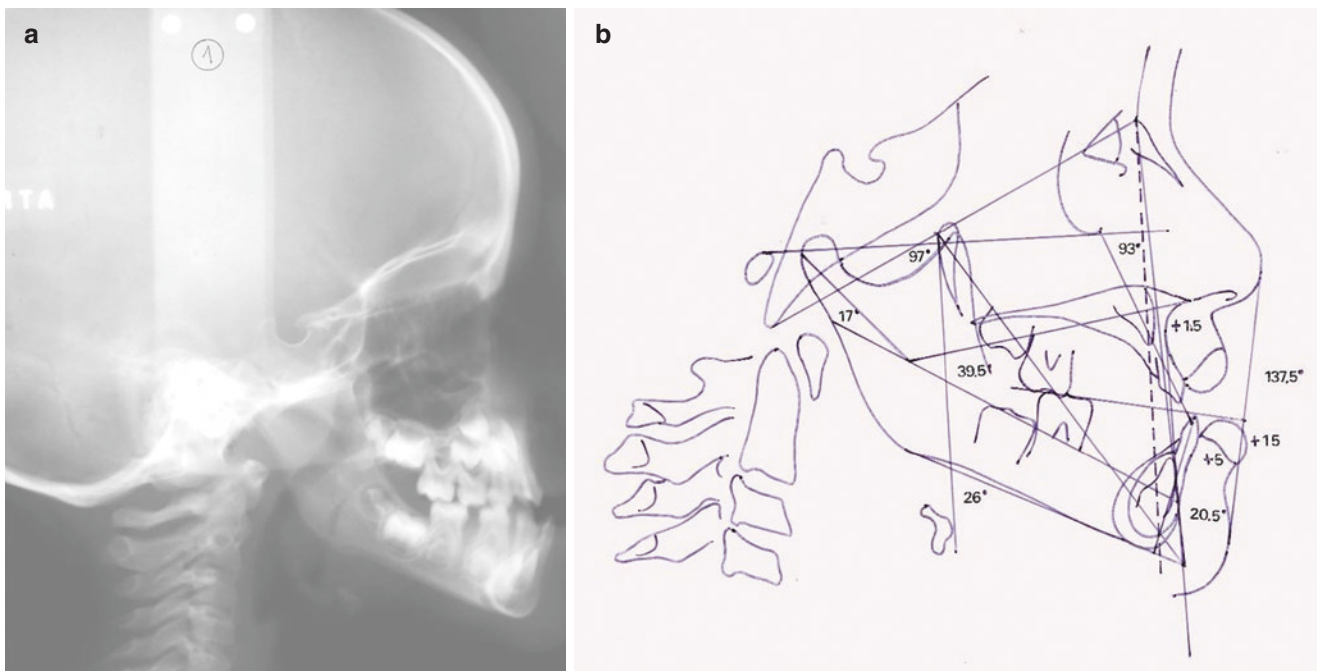


Fig. 1.7 (a, b) Lateral radiograph and Ricketts analysis at the beginning of the treatment Class III with a significant open-bite was confirmed

The Figs. 1.8 and 1.9 show the results after 3 years of treatment with a rapid maxillary expander in conjunction with a face mask. Although most of the treatment objectives were achieved, it would have been better to finish this first phase of treatment with more overjet and overbite, but the patient and her parents decided to conclude this phase for personal reasons. No speech therapy treatment was recorded.

At the end of this first phase, the posterior crossbite was not totally corrected and midlines were not coincident. The change of color of the right upper central incisor was the result of trauma produced while riding her bicycle (Fig. 1.8a, b).

The lateral radiograph at the end of the first phase of treatment confirmed the clinical results (Fig. 1.9a, b).

The patient returned after 5 years without any previous follow-up. The parents admitted that due to some personal problems they neglected her treatment. She also discontinued the treatment with the speech therapist and never used the retainers. The results were totally unexpected.

The clinical photos clearly showed that the open-bite in conjunction with Class III molar and canine worsened more than expected (Fig. 1.10a, b).

The cephalometric radiograph and Ricketts analysis confirmed the skeletal open-bite—Class III. The treatment plan

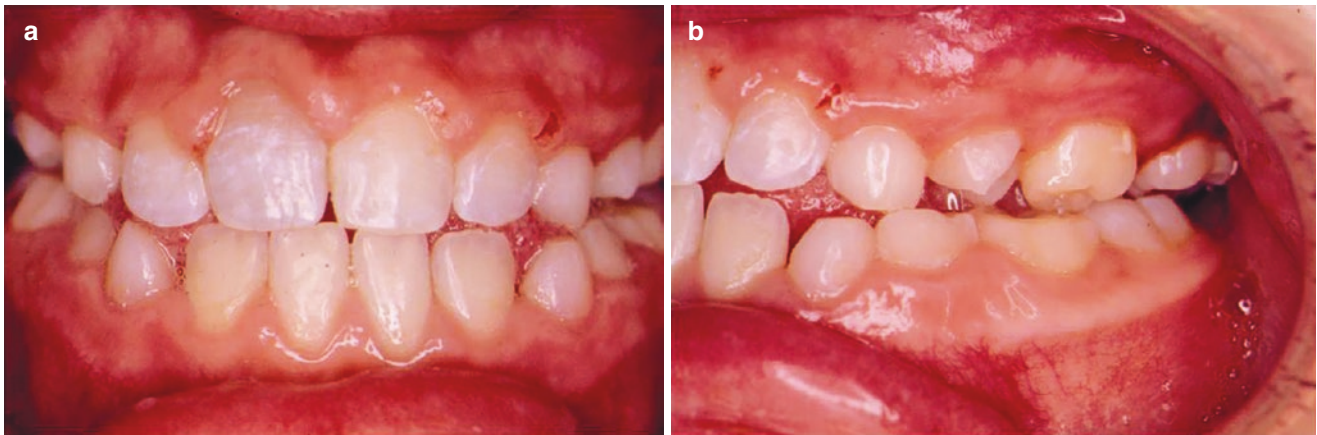


Fig. 1.8 (a, b) Frontal and lateral photos at the end of this phase of treatment. Not all the objectives for Phase 1 were completed

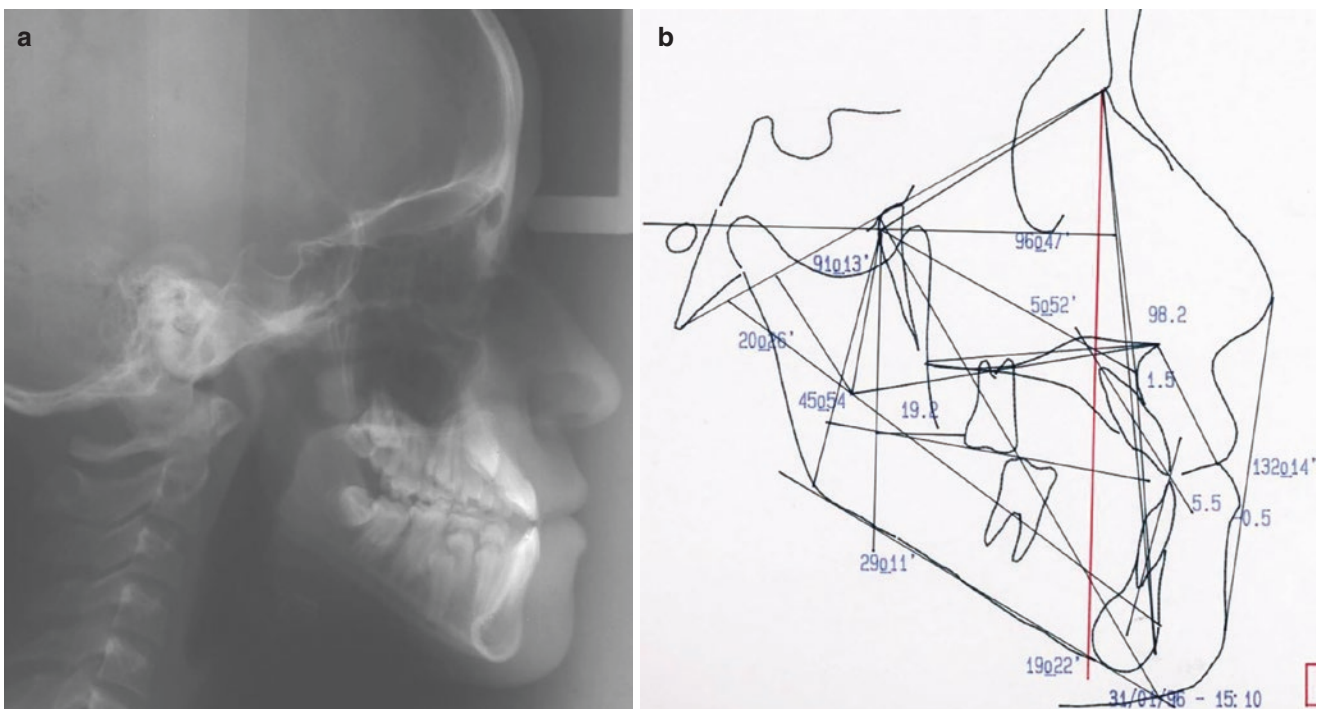


Fig. 1.9 (a, b) Lateral radiographs and Ricketts cephalogram at the end of the Phase I of treatment. Most of the objectives were fulfilled

at that time had to include an orthognathic surgical procedure when the patient was almost 20 years old (Fig. 1.11a, b).

These two clinical cases clearly demonstrated the importance of the normalization of the function and that the possibility to redirect growth is one of the major goals in this phase of treatment.

The difference in the response of patients with a similar orthodontic treatment protocol is the result of variability in the direction and rate of craniofacial growth as it was demonstrated with these two young Class III patients.

Integrated diagnosis is the basis that will allow us to determine the best treatment plan while considering the direction and quantity of growth.

It is important to take into consideration that maintaining the results for a long term depends on a number of factors: facial biotype, direction of growth, heredity, control of habits, etc.

The early treatment of the following patient was mandatory not only because of his profile but also due to the position and protrusion of the upper incisors (Figs. 1.12, 1.13 and 1.14).

The objectives of the first phase of treatment included the normalization of the position and inclination of the upper incisors to prevent any type of dental or dentoalveolar fracture as a consequence of an accident at home or at school. At the same time, the improvement of the position of the lower lip was necessary (Franchi et al. 2011).

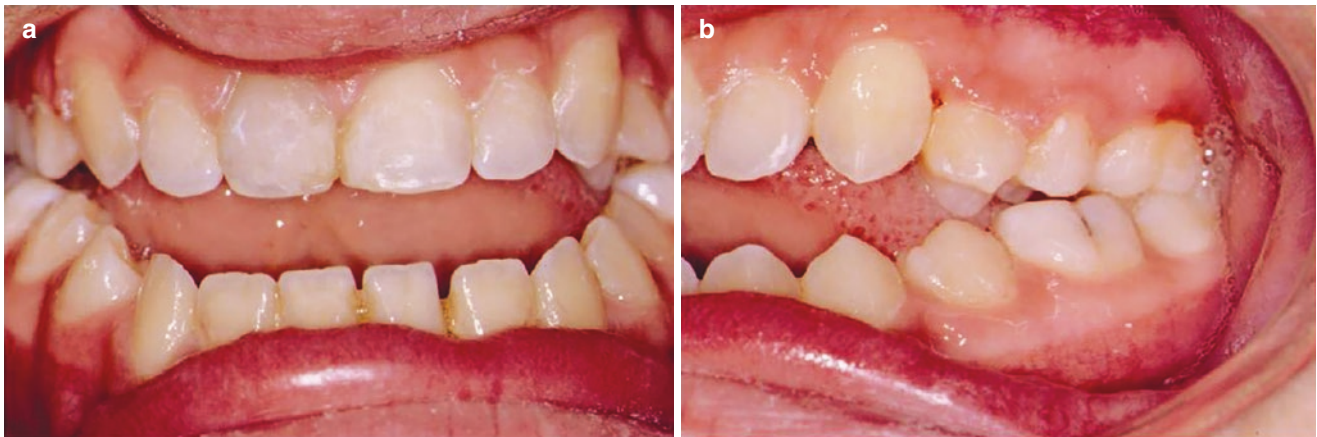


Fig. 1.10 (a, b) Frontal and lateral photographs 5 years without follow-up. The results were worse than expected

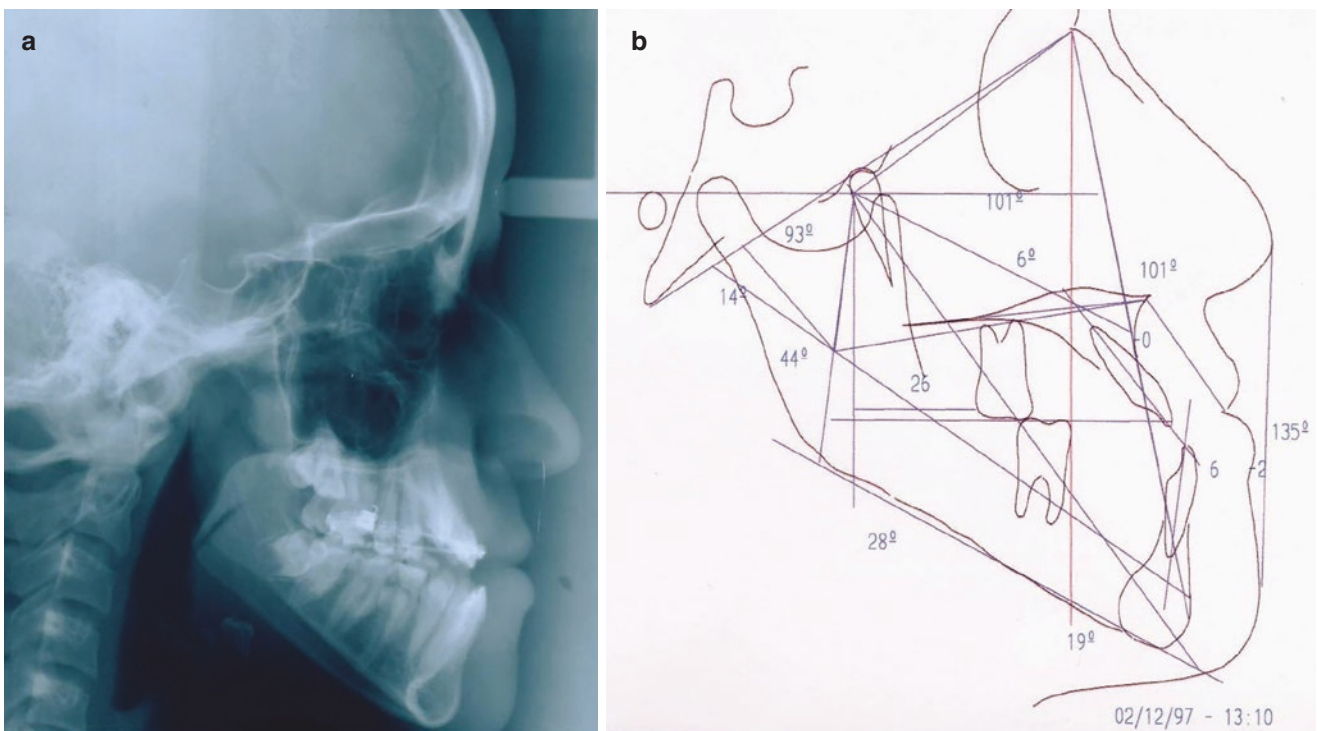


Fig. 1.11 (a, b) Lateral radiographs and Ricketts analysis 5 years later. The results clearly showed the adverse direction of growth

The consultation with the otorhinolaryngologist was also mandatory because it was necessary for the patient to be able to breathe without any problems in order to re-educate the position of the lips and the tongue.

The real question is what the best orthodontic treatment approach for this specific patient with prominent upper front teeth is. The answer can vary from beginning at that time or waiting until all the permanent teeth erupt.

Since one of the treatment objectives was to avoid the fracture of the anterior upper incisors, there is no doubt that the treatment had to begin at that moment.

A consultation with the otorhinolaryngologist was fundamental since the patient had to learn how to start breathing through his nose.

Before selecting the best treatment plan for this patient, it was necessary to determine which type of Class II he had.

Without knowing the etiology, it is very difficult to determine the correct, individualized treatment plan.

It is well-known that functional matrix facilitates the lower third development in the three directions thus in early mixed dentition the normalization of habits is fundamental to facilitate tooth eruption in normal position.

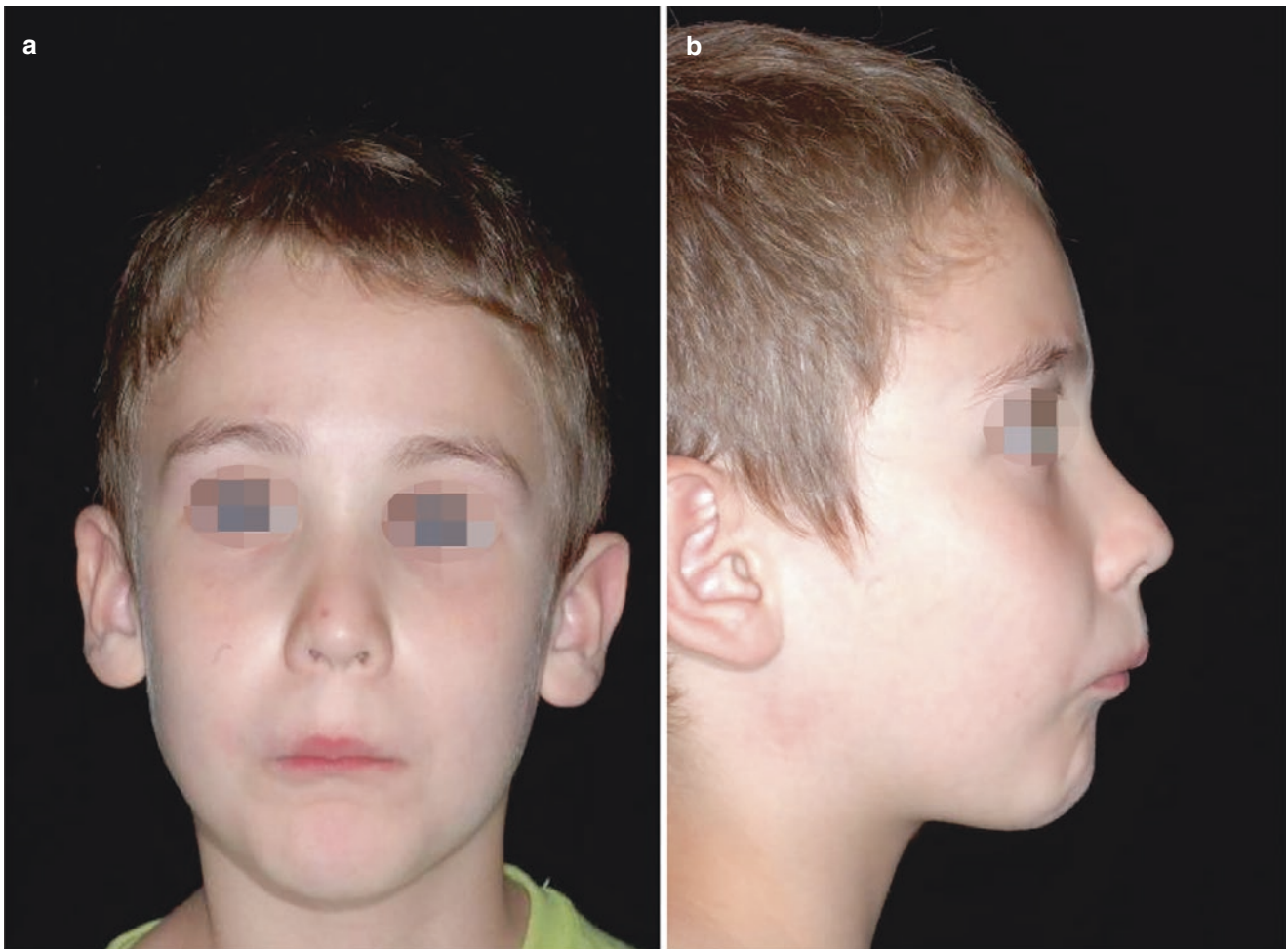


Fig. 1.12 (a, b) Frontal and lateral facial pre-treatment photographs. Difficulties in closing his mouth were clearly visible

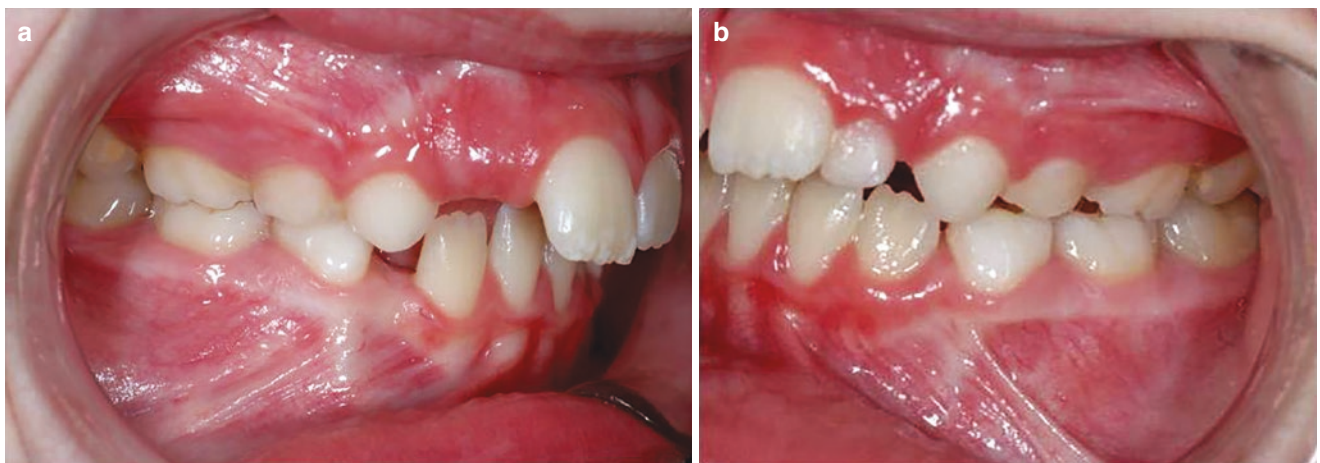


Fig. 1.13 (a, b) Pre-treatment right and left sides. Total lack of space for the left lower canine was confirmed along with the retroinclination of the lower incisors

To complete the diagnosis protocol, the patient was sent to his pediatrician because he snored loudly at night. He had a convex profile with a closed naso-labial angle in conjunc-

tion with difficulties to close his mouth. Also, he had some respiratory problems along with thumb sucking and lower lip interposition (Fig. 1.12a, b).

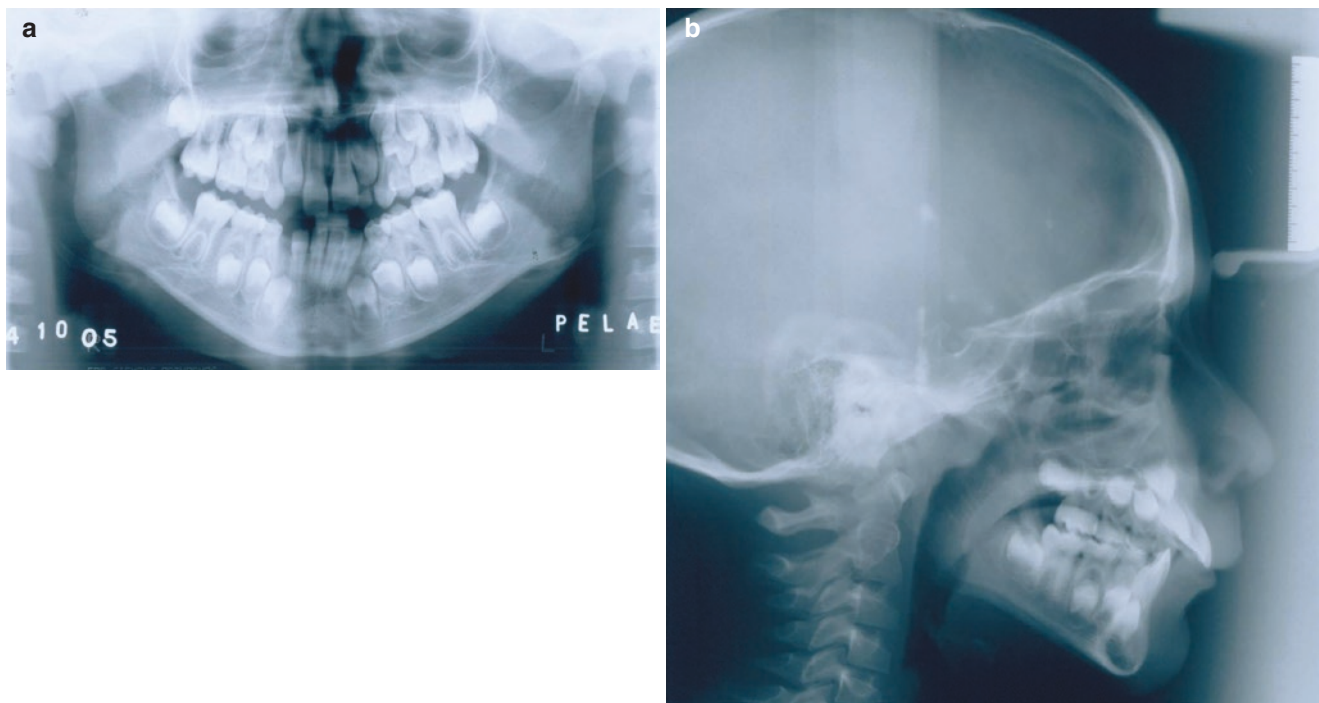


Fig. 1.14 (a, b) Pre-treatment panoramic and lateral radiograph. The anterior position of the upper incisors was confirmed

In order to determine the best and most efficient treatment protocol, it is necessary to consider if it is only an antero-posterior problem or if it is combined with a transversal one. In this situation, it is highly recommended to treat the transversal discrepancy first (Subtelny 2000). Also, it is advisable to restrain the forward displacement of the maxillary dentition and its alveolar process and at the same time allow the normal development of the mandible.

As a consequence of all the functional problems, the mandibular dentition was retro-positioned with retroinclined mandibular incisors and total lack of space for the lower left canine (Fig. 1.13a, b).

The panoramic radiograph confirmed the normal path of eruption of the other permanent teeth. The lateral radiograph showed the important frontal displacement of the upper incisors. He had a meso-facial biotype with a convexity of 9 mm.

The interincisal angle was 135° and his facial axis 85° (Fig. 1.14a, b).

The evidence suggests that providing early orthodontic treatment for children with prominent upper front teeth is more effective in reducing the incidence of incisal trauma than providing one course of orthodontic treatment when the child is in his adolescence (Thiruvengkatachari et al. 2014).

A myo-functional appliance (Trainer) was suggested in order to normalize nasal breathing and the position of the oral muscles.

The mother and the patient were very enthusiastic about the treatment since another colleague suggested to wait until 18 years of age and then correct the malocclusion with the help of an orthognathic procedure.

The patient was controlled by the orthodontist every 2 months, but he went to the speech therapist twice a week during the first year and then only once a week.

It is advisable that the patient uses the appliance 2 h during the day and all night.

These are the results after 3 years of treatment with a functional appliance that helped to normalized function and as a consequence redirected the position of the erupting teeth (Fig. 1.15a, b).

The patient continued using the appliance every night with a 3 months control. No brackets were bonded until that moment of the treatment, and the mother confirmed that the snoring disappeared.

His profile improved more than expected. No brackets were used during the entire second phase of treatment.

Since he was able to breathe normally, his behavior improved not only at school but also at home with his brothers too (Fig. 1.16a, b). There was an important improvement in his profile and in his dental anterior position.

A control 6 months later confirmed that the results were maintained. The incisors are normally positioned with good overjet and overbite. The gingival line and the occlusal plane were parallel (Fig. 1.17a, b).

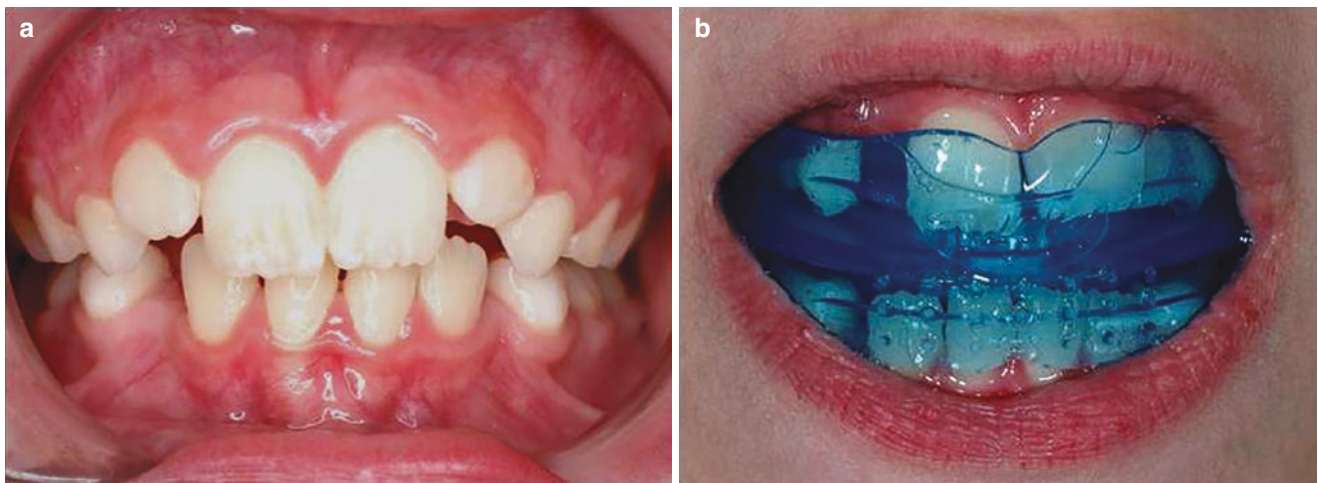


Fig. 1.15 (a, b) Frontal view with and without the appliance in place after 3 years of treatment

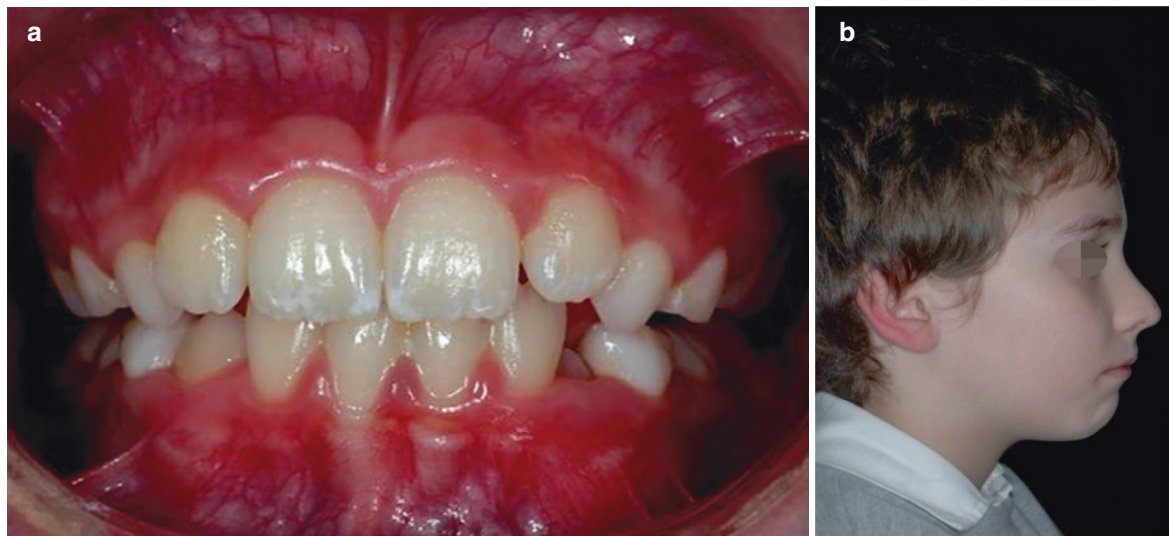


Fig. 1.16 (a, b) Frontal and profile photograph at this moment of the treatment. The normalization of the anterior occlusion and the position of the lips was remarkable

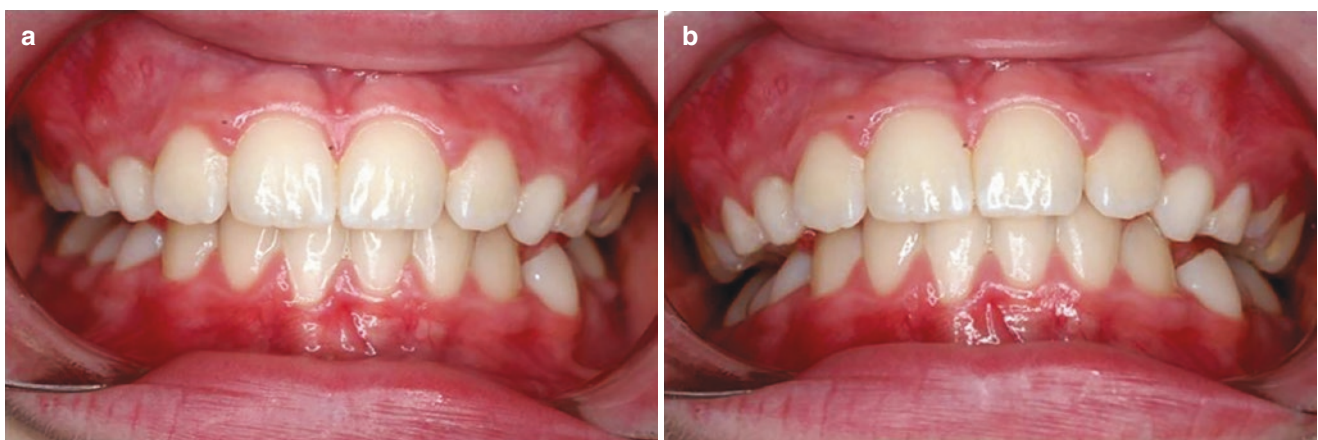


Fig. 1.17 (a, b) Control 6 months after treatment. Midlines, overjet and overbite were pretty normal

The lateral views confirmed that the lower canines erupted normally although they didn't have sufficient space at the beginning of the treatment (Fig. 1.18a, b).

The normalization of the upper and lower arch was the result of the new function of the oral muscles. Now they were rounded with space for all the permanent teeth (Fig. 1.19a, b).

In order to maintain the results and to control the position of the tongue and the width of the upper and lower arches, a new, more rigid (Phase II) Trainer was recommended (Fig. 1.20a, b).

After analyzing this type of patient, the conclusions would be that the early transitional dentition period seems to be the best time to correct these functional alterations in a very controlled and efficient manner.

The final photographs clearly demonstrated the normalization not only of the frontal teeth but also of the soft tissues. At that point, he could close his mouth without any muscle tension and the naso-labial angle was within normal ranges (Fig. 1.21a, b).

Front and occlusal photographs 1 year after treatment. All the teeth erupted in normal position. Class I canine and molar were achieved and maintained with perfect alignment. The patient had good oral hygiene during the whole treatment (Fig. 1.22a, b).

The comparison between the two profile photographs is the best demonstration of the results that were achieved when the function is recovered. No extractions were performed in the upper arch (Fig. 1.23a, b). The change in the naso-labial angle was better than expected as a consequence of the normalization of the stomatognathic system.

This clinical case strongly supports the benefits of the protocol that include second or third phase treatment. An early and accurate diagnosis is the most important issue, no matter the number of phases that the patient requires to achieve the best result in a more conservative manner with fewer orthognathic procedures.

Another malocclusion that has to be treated very early is the anterior deepbite since the musculature plays an important role before, during, and after treatment during the long

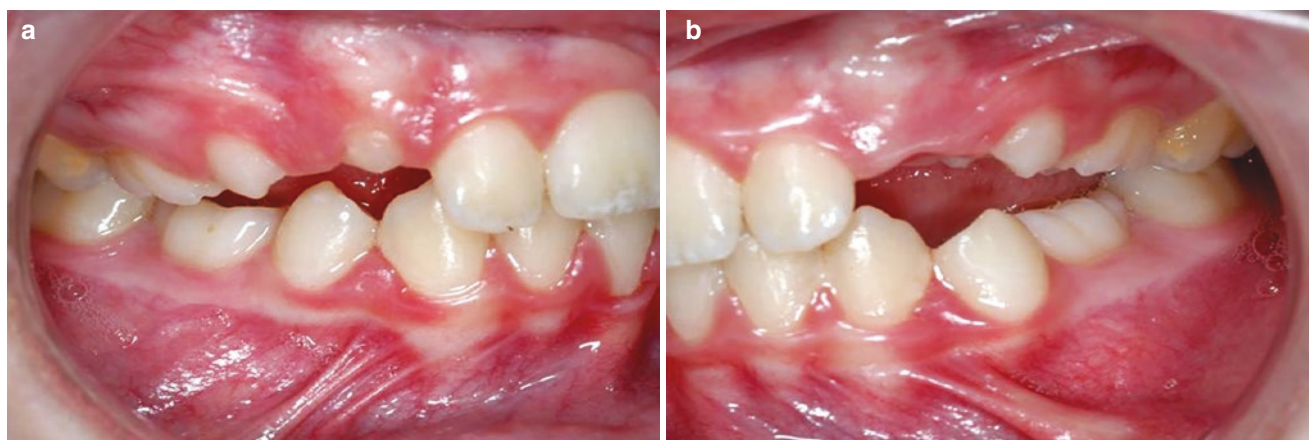


Fig. 1.18 (a, b) Right and left lateral views. Class I molar was maintained and at this moment the right and left canine had enough space to erupt

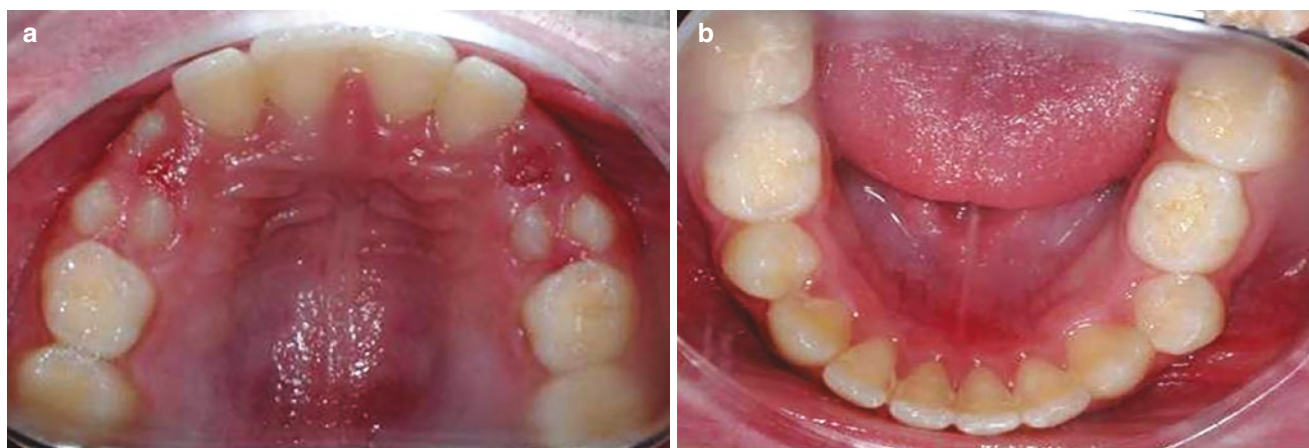


Fig. 1.19 (a, b) Upper and lower arch at this moment of the treatment. They had normal transverse and antero-posterior dimension

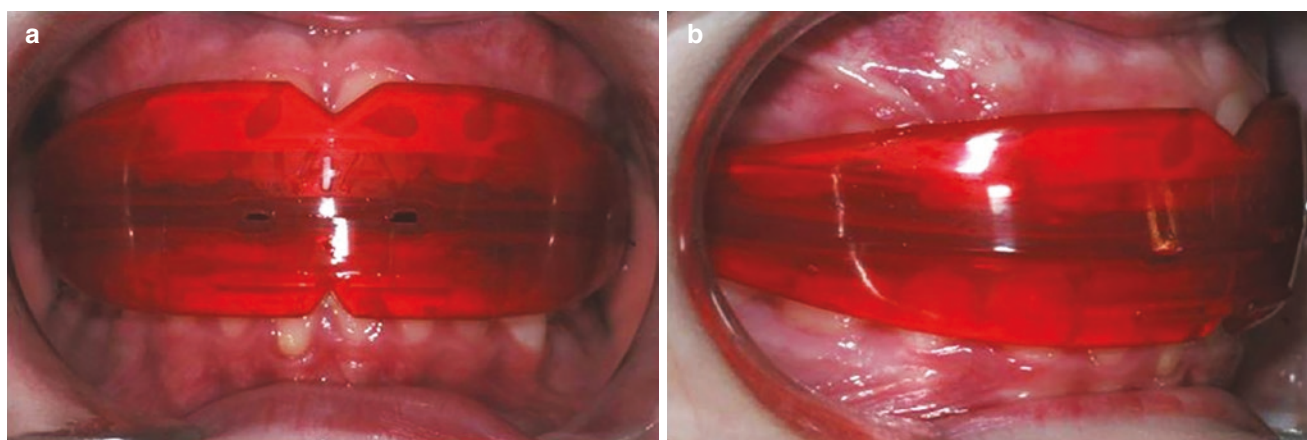


Fig. 1.20 (a, b) Phase II. Trainer was recommended in order to maintain the excellent results that were achieved



Fig. 1.21 (a, b) Post-treatment front and profile photographs. The lips closed without any muscular tension and the naso-labial angle was totally normal

retention period. The early treatment protocol to correct the anterior deepbite can be divided into three big groups: intrusion of the anterior teeth, extrusion of the posterior ones, or a combination of both.

To design the best treatment plan, a careful analysis of the smile at rest and during function is fundamental. The position of the upper incisors during the smile determines if the upper incisors have to be intruded or not.

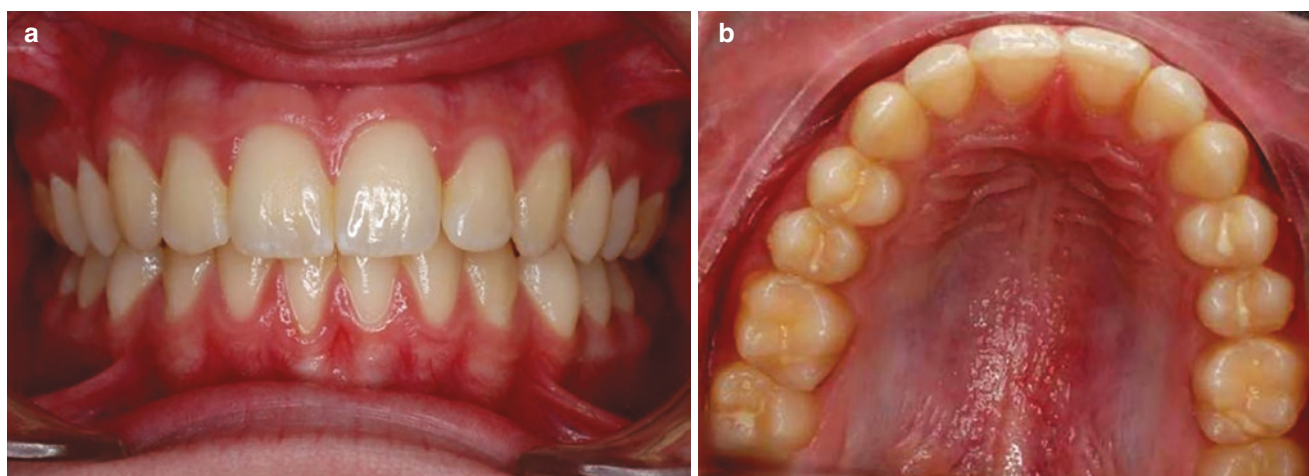


Fig. 1.22 (a, b) Frontal and occlusal view 1 year after treatment. The results improved with good oral hygiene. Midlines, overjet, and overbite were maintained

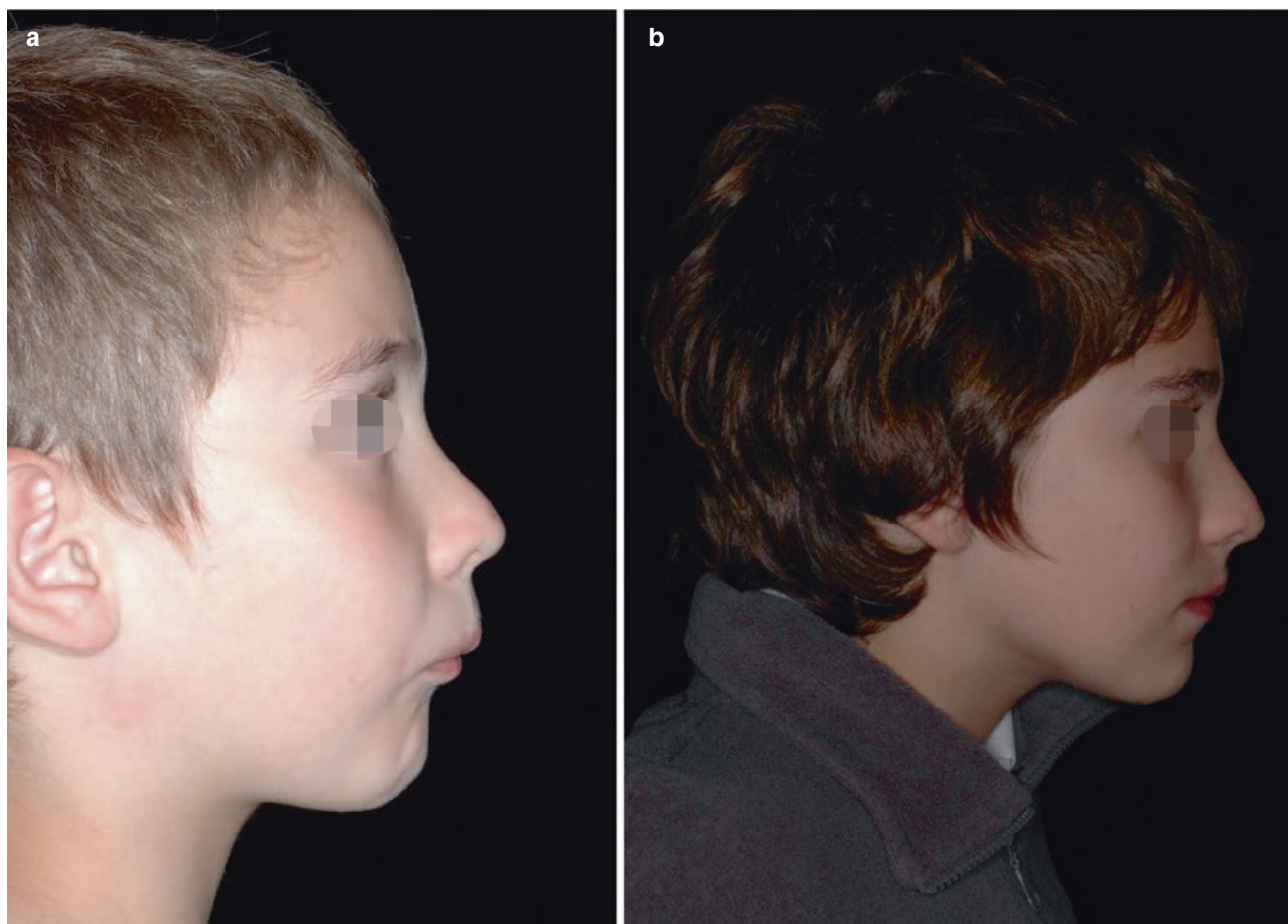


Fig. 1.23 (a, b) Comparison of pre- and post-treatment profiles. A significant improvement in the soft tissues was achieved and maintained

The next patient is a clear example. She was 9 years, 6 months of age. Her mother, a well-known odontopediatric, was very disappointed since her daughter never used any removable functional appliances in order to correct the considerable anterior deepbite.

The front photograph confirmed an overbite of 100% in the central incisor region that was confirmed in the lateral radiograph. Dental midlines were coincident and the upper lateral left incisor was more extruded than the right one. The lower anterior height was clearly diminished (41°) (Fig. 1.24a, b).

The lateral views confirmed the significant overbite and the retroclination of the upper incisors. The first upper and lower molars were not fully erupted (Fig. 1.25a, b). The occlusal plane wasn't parallel to the gingival line.

Taking into consideration that in this specific patient the first priority was the normalization of the anterior vertical dimension four lingual brackets were bonded on the palatal surface of the central and lateral incisors along with a coaxial arch. An indirect method with an individualized setup was fully recommended to bond the brackets correctly. No bands or tubes were placed on the molars to allow their physiological eruption and achieve a normal overbite (Fig. 1.26a, b).

As a consequence, an expected lateral open-bite was present in the posterior region (Fig. 1.27a, b). Bearing in mind that when the molars erupt slowly they erupt with bone, no other appliance was used in this phase.

A follow-up 4 months later showed a significant improvement of the anterior overbite only with this fixed appliance. The lower incisors were clearly visible (Fig. 1.28a, b).

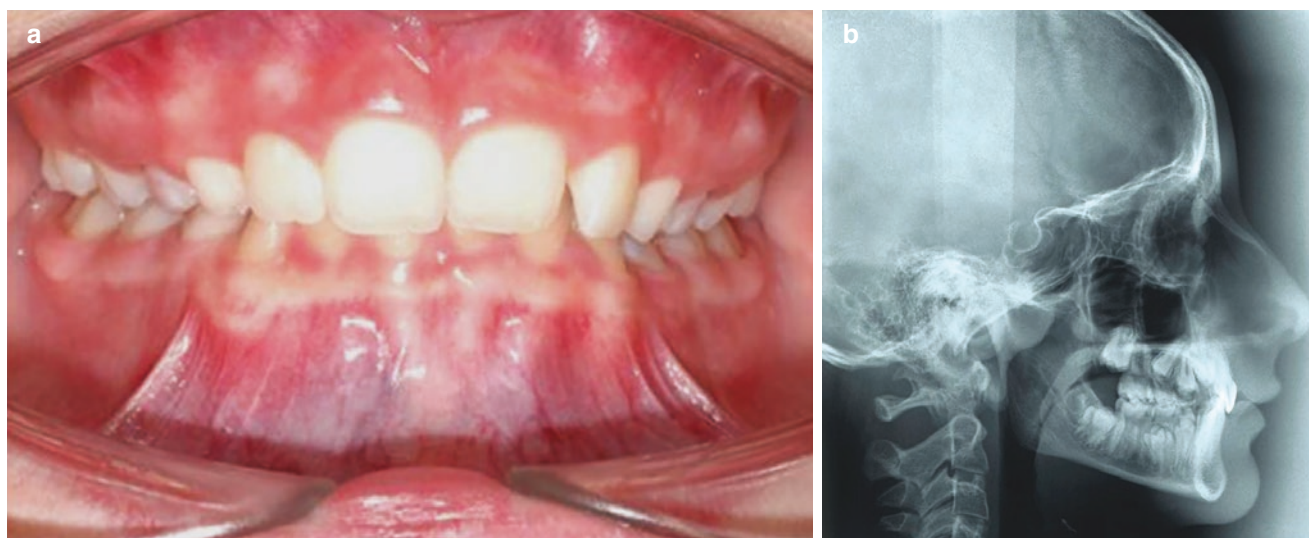


Fig. 1.24 (a, b) Frontal view and lateral radiograph showing the significant deep frontal overbite

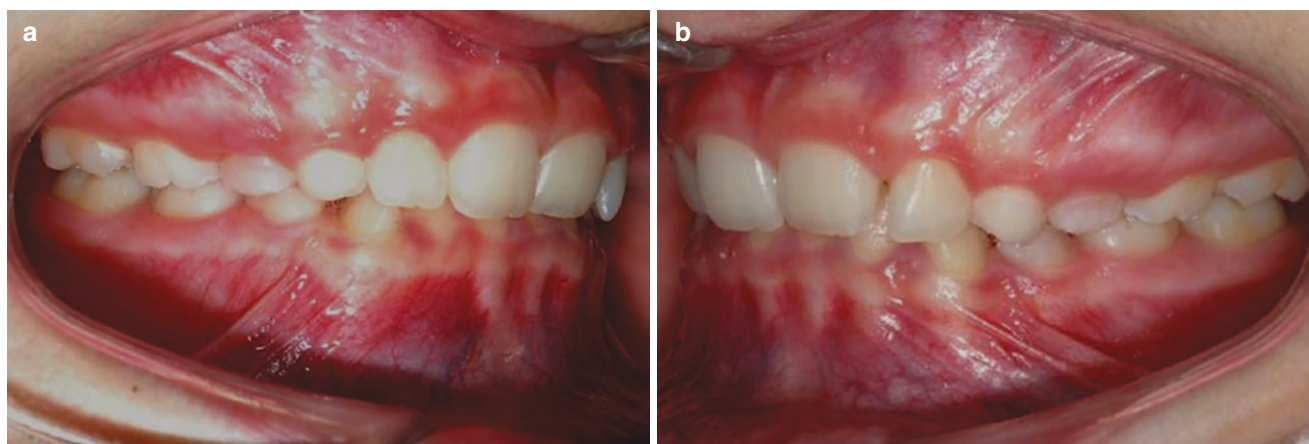


Fig. 1.25 (a, b) Class I right and left molar and canine was observed. The anterior overbite was almost 100% and the retroinclination of the upper incisors was confirmed

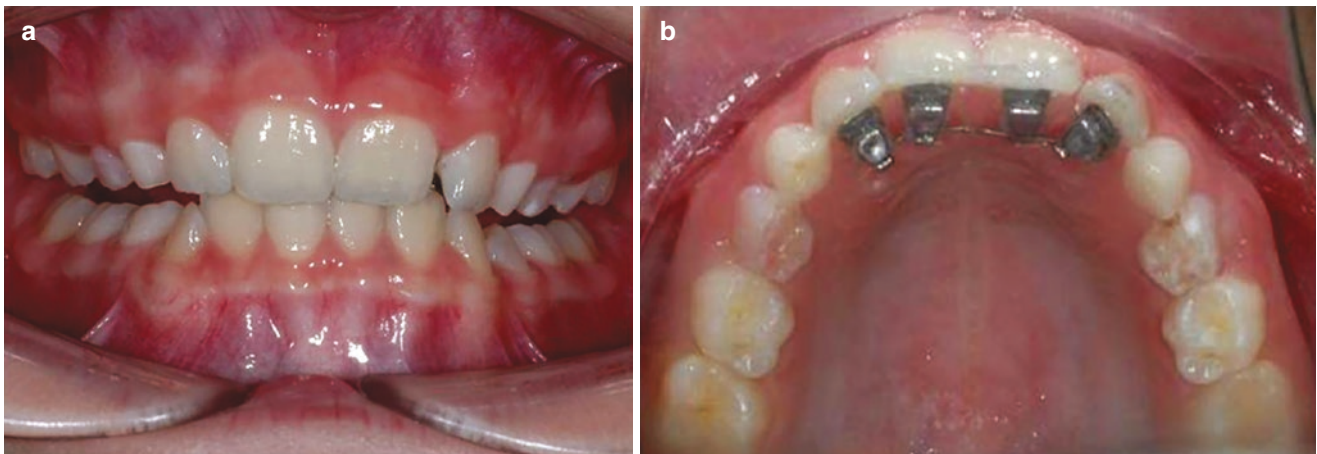


Fig. 1.26 (a, b) Lingual brackets were bonded on the palatal surface of the upper incisors with a partial coaxial arch

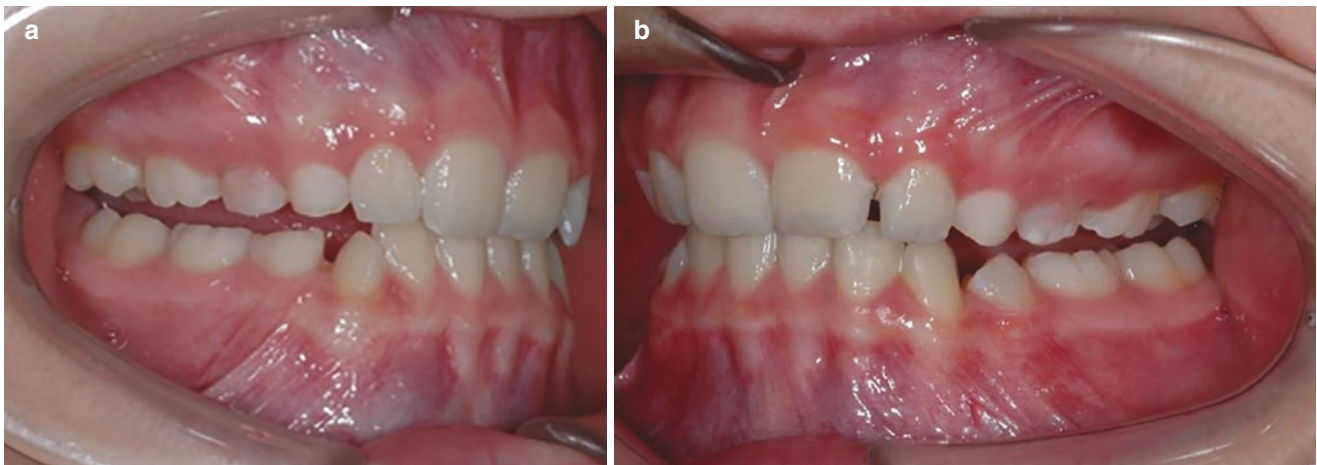


Fig. 1.27 (a, b) Lateral views after the indirect placement of the lingual brackets with an expected transitional lateral open-bite

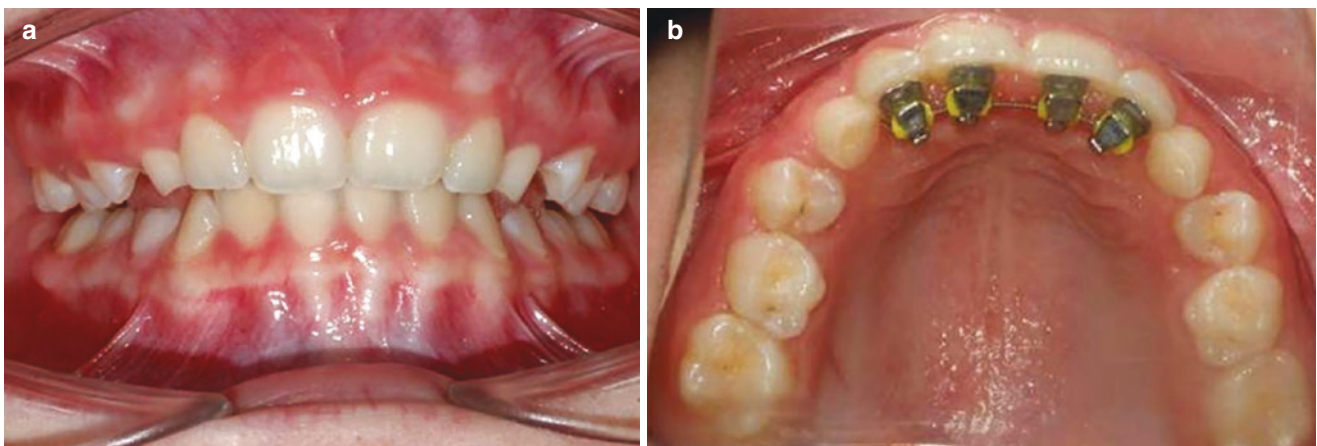


Fig. 1.28 (a, b) Frontal and occlusal photos after 4 months of treatment

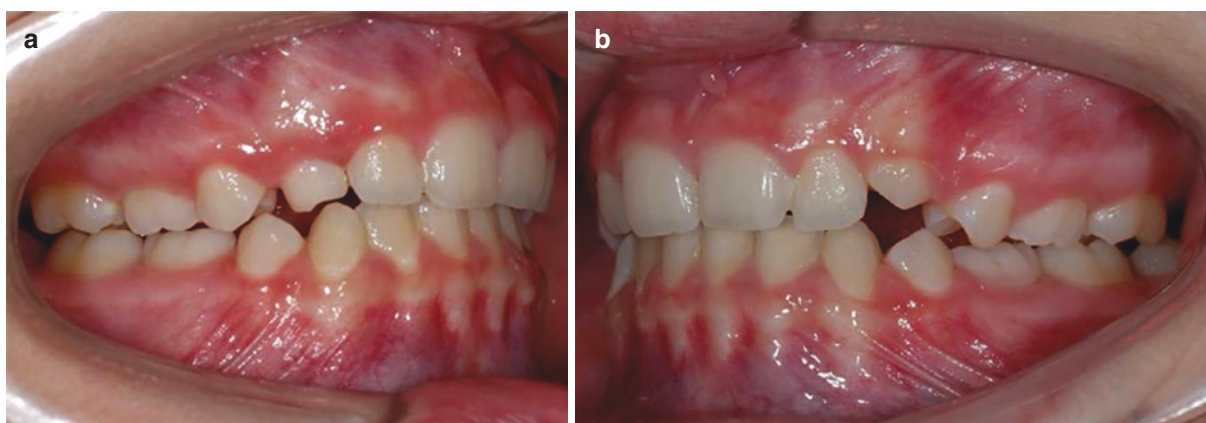


Fig. 1.29 (a, b) The extrusion in the temporary and first permanent molar region can be recognized



Fig. 1.30 (a, b) Comparison of pre- and after 6 months of treatment with a partial fixed lingual appliance acting as anterior bite planes

The extrusion on the right and left region was remarkable. Since this extrusion was performed very slowly, the jaw closing muscles could adapt and consequently relapse would be not expected (Fig. 1.29a, b).

The comparison pre- and post-treatment (6 months) confirmed that the treatment plan that was suggested was efficient. Phase I was very important since the adaptation of the musculature system is very predictable. It is possible that the second phase of treatment would be necessary when all the permanent teeth erupted. Although a significant posterior extrusion was performed, the midlines were stable (Fig. 1.30a, b).

The key was that the patient use this fixed anterior bite planes 24 h a day, and in this way the whole stomatologic system would adapt to the new vertical dimension and a normal functional occlusion would be achieved. The retention plan has to include a functional appliance until all the permanent teeth were erupted to maintain the achieved results.

There is no doubt regarding all the benefits of the early orthodontic treatment, no matter if more than one phase of treatment (Bowman 1998) is necessary.

The focus has to be placed on the treatment response since each patient is unique.

1.1 Conclusions

One of the benefits of the early orthodontic treatment is the improvement of the self-esteem of the patients since personal interactions at school are very significant at this age. It is important to emphasize that different types of brackets and wires were used since there is no intelligent bracket that performs a correct diagnosis in each patient.

The early normalization of the neuro-muscular behavior is more important than simply the position of some teeth and as a result early treatment has a real advantage to avoid adverse effects.

The role of the orthodontist is to manage in the most efficient way for a better diagnosis, prognosis, treatment, and retention plan.

It was totally demonstrated that there is no appliance that fits all the patients even with a similar age and malocclusion.

In general, the treatment plan was divided into one, two, or more phases: the first phase has to be undertaken only on the primary teeth or early mixed dentition to correct habits and alleviate functional problems before the second or third phase of treatment with fixed appliances in the permanent dentition.

The key question is: diagnosis, timing, and efficacy of treatment.

The selection of the best therapy has to be based on available evidence.

It is important to remember that an early treatment phase cannot avoid the second phase of treatment but does reduce its length and complications.

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Digital Technology as an Aid to Early Orthodontic Treatment

2

Bryce Lee

2.1 Introduction

The use of digital technology has had great impact on our lives. Its influence in the management of an orthodontic patient is no different.

The chapter has been divided into three sections:

1. The digital workflow in an orthodontic office.
2. Clinical indications and applications for early orthodontic treatment aided with digital technology.
3. Concluding remarks including a discussion on the pitfalls and an overreliance of digital technology.

The following are certain definitions of terms to be used in this chapter which may be helpful:

- **Digital technology** – this is an all-encompassing term used nowadays. But its roots lie in the fact that such technology is able to convert information into numbers (a binary format of zero and one) for machines to assimilate and use this information (Fig. 2.1).
- **Artificial Intelligence (AI)** – this uses algorithms and digitized patterns to mimic the cognitive function of the human mind to “learn” and “solve problems” (Fig. 2.2).
- **CAD-CAM** (computer-aided design-computer-aided manufacturing) – introduced to dentistry in the 1970s, the use of CAD-CAM in orthodontics has exponentially increased in the last 20 years with changes in treatment philosophies and modalities. For example, the use of appliances from 3-D printed models. Figure 2.3 illustrates such an example.



Fig. 2.1 The computer’s ability to use the numerical binary format (circuits being turned on/off) enables the assimilation of information by machines

2.2 The Digital Workflow in an Orthodontic Clinic

Emerging technology has improved the digital workflow, resulting in increased patient engagement, time efficiency, and better data acquisition, within the orthodontic office (Christensen 2017) (Fig. 2.4).

Logs of staff, patients, and visitors are kept in a central computer (Fig. 2.5) to monitor attendance and body temperature (a new requirement at our office, ever since the COVID-19 pandemic).

Digital records and attendance keep a log of patient’s information and treatment progress. Patients’ attendance (including time in and out) is an important tool nowadays as well.

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Fig. 2.2 Artificial Intelligence uses this information in an attempt to replicate the cognitive functions of the human mind

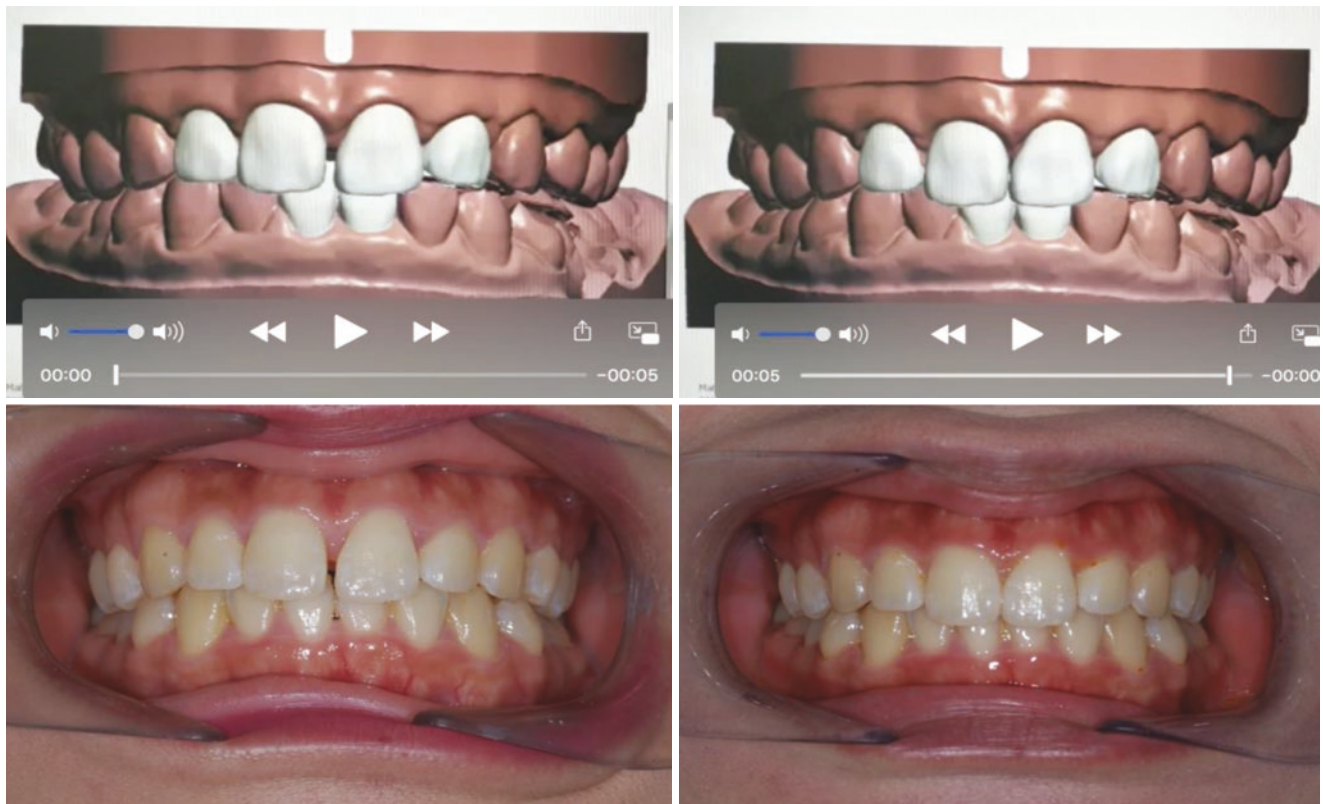


Fig. 2.3 A simple orthodontic example of CAD-CAM is the simulated movement of teeth, the subsequent manufacturing of appliances, and the resultant movement of the teeth

Having the ability to view patient records remotely gives flexibility (Fig. 2.6).

Digital data acquisition has enabled efficient means of accessing information. Radiographs and CBCTs can be remotely accessed (Fig. 2.7).

Digital scanners, both intraorally and extraorally, are convenient and a clinically acceptable way for record-keeping

and transmitting information. Cloud-based information can be accessed easily and saves on physical storage space (Fig. 2.8).

Digital scans and subsequent simulations, when properly executed, can be used to engage patients, manage expectations, and aid in treatment planning. An example of such a simulation is shown in Fig. 2.9.

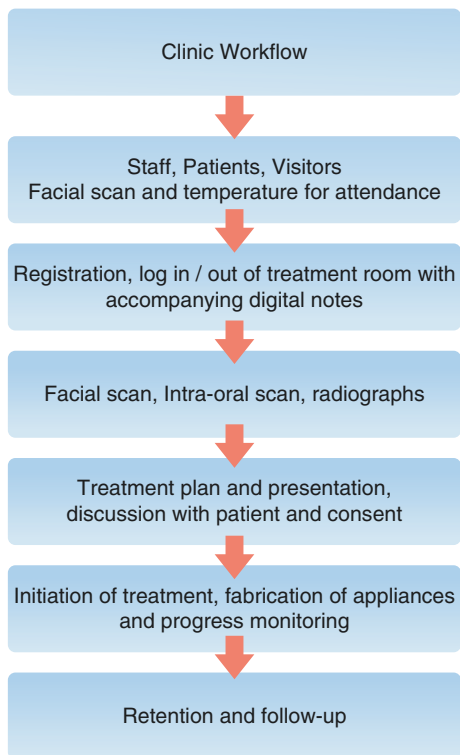


Fig. 2.4 An illustration of the digital workflow in an orthodontic office

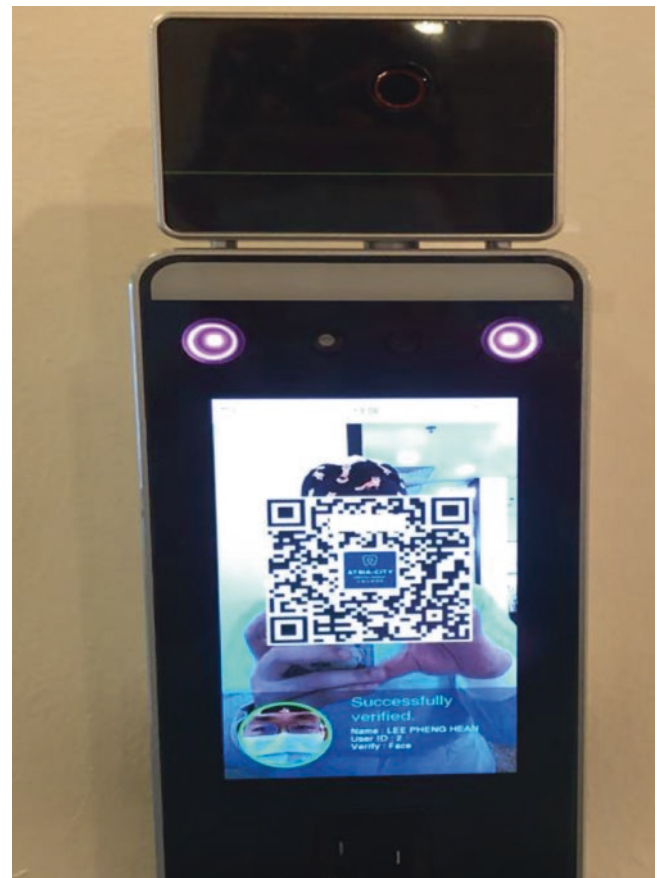


Fig. 2.5 A facial recognition scanner with clinic's Quick Reader (QR) code (for contact tracing by patients) along with an infrared temperature scanner

#	Date	Ref	Notes	Amount	Balance	Payment	Payment Method
2	11/4/2019	899/	1 Renew Development	37.45	37.45	0.00	0.00
2	11/4/2019	PNOTE	1 Patient Notes	0.00	0.00	0.00	0.00 Y
2	16/4/2019	899B	1 Orthodontic Records	160.50	160.50	0.00	0.00
2	16/4/2019	8340	1 Lateral Skull X-Ray (Digital)	107.00	107.00	0.00	0.00
2	16/4/2019	PNOTE	1 Patient Notes	0.00	0.00	0.00	0.00 Y
2	16/4/2019	PNOTE	1 Patient Notes	0.00	0.00	0.00	0.00 Y
2	17/4/2019	82200	1 Fixed Appliance - Bond Innovation	1605.00	1605.00	0.00	0.00
2	17/4/2019	PNOTE	1 Patient Notes	0.00	0.00	0.00	0.00 Y
2	24/4/2019	82200	1 Fixed Appliance - Bond Innovation	1605.00	1605.00	0.00	0.00
2	24/4/2019	PNOTE	1 Patient Notes	0.00	0.00	0.00	0.00 Y
2	30/5/2019	8999A	1 Orthodontic Adjustment	160.50	160.50	0.00	0.00
2	30/5/2019	PNOTE	1 Patient Notes	0.00	0.00	0.00	0.00 Y
2	27/7/2019	8999A	1 Orthodontic Adjustment	160.50	160.50	0.00	0.00
2	27/7/2019	PNOTE	1 Patient Notes	0.00	0.00	0.00	0.00 Y
2	8/8/2019	8999A	1 Orthodontic Adjustment	160.50	160.50	0.00	0.00
2	8/8/2019	PNOTE	1 Patient Notes	0.00	0.00	0.00	0.00 Y
2	14/9/2019	8999A	1 Orthodontic Adjustment	160.50	160.50	0.00	0.00
2	14/9/2019	PNOTE	1 Patient Notes	0.00	0.00	0.00	0.00 Y
2	19/10/2019	8999A	1 Orthodontic Adjustment	160.50	160.50	0.00	0.00
2	19/10/2019	PNOTE	1 Patient Notes	0.00	0.00	0.00	0.00 Y
1	23/11/2019	0140	1 Consultation	42.80	42.80	0.00	0.00
1	23/11/2019	11105	1 Scale And Polish	101.85	101.85	0.00	0.00
1	23/11/2019	PNOTE	1 Patient Notes	0.00	0.00	0.00	0.00 Y
2	23/11/2019	8999A	1 Orthodontic Adjustment	160.50	160.50	0.00	0.00
2	23/11/2019	PNOTE	1 Patient Notes	0.00	0.00	0.00	0.00 Y
2	18/12/2019	8999A	1 Orthodontic Adjustment	160.50	160.50	0.00	0.00
2	28/12/2019	PNOTE	1 Patient Notes	0.00	0.00	0.00	0.00 Y
2	1/2/2020	8999A	1 Orthodontic Adjustment	160.50	160.50	0.00	0.00
2	1/2/2020	PNOTE	1 Patient Notes	0.00	0.00	0.00	0.00 Y
2	29/2/2020	8999A	1 Orthodontic Adjustment	160.50	160.50	0.00	0.00
2	29/2/2020	PNOTE	1 Patient Notes	0.00	0.00	0.00	0.00 Y

Clinical Treatment Notes (A4 paper)				Printed: 15/12/2020 13:48	Page 1 of 4
Date	Prv	Items	Notes		
12 Dec 2020	2	8999A, PNOTE	Aug 16		
			U - IPR 21/22 in view of black gingival triangle, ref'd		
			L - ref'd, bond 37 aux. 014 Q3		
			Q3 fit same as per L/V. Left side triangular pattern 36 to 22 to 33 - both BLUE		
27 Nov 2020	2	8999A, PNOTE	Aug 15		
			U - ref'd		
			L - ref'd		
			Q3 fit same as per L/V. Left side triangular pattern 36 to 22 to 33 - both BLUE		
03 Oct 2020	2	8999A, PNOTE	Aug 14		
			U - ref'd		
			L - 17x25 nTMA ref'd. BCT more on 47		
			cont C3 fit (blue) stat. FIT to hooks d to upper 2s		
29 Aug 2020	2	8999A, PNOTE	Aug 13		
			U - ref'd		
			L - 17x25 nTMA ref'd		
			restart C3 fit (blue) stat. FIT to hooks d to upper 2s		
26 Jul 2020	2	8999A, PNOTE	Aug 12		
			U - ref'd		
			L - 17x25 nTMA - torque control for 47		
			restart C3 fit (blue) stat. n/a		
18 Jun 2020	2	8999A, PNOTE	Aug 11		
			U - ref'd		
			L - 17x25 n/a		
			restart C3 fit (blue) stat. n/a		
			Aug 10		

Fig. 2.6 Notes and patient's payment log can be stored digitally

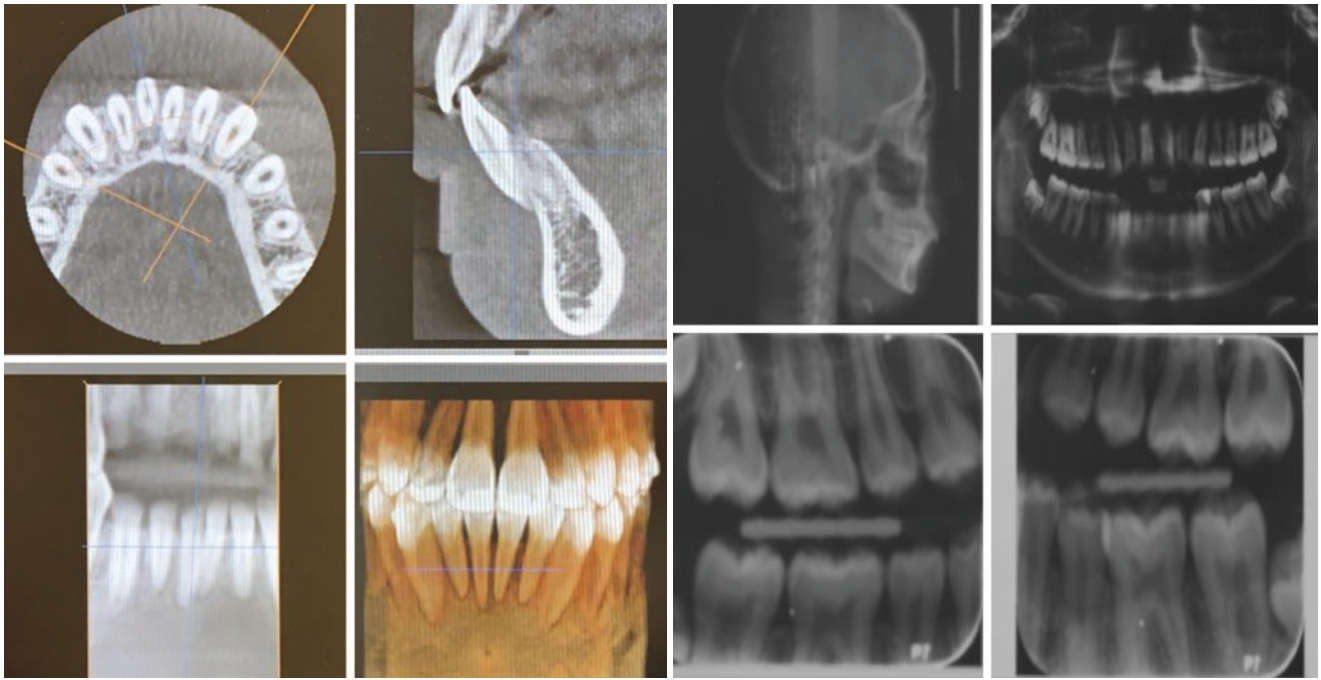


Fig. 2.7 Digital radiographs (of varying types) have enabled easy processing of films and access and transfer of data



Fig. 2.8 Digital extraoral scan. Good for integration with CBCTs when planning dentofacial corrections. Picture courtesy of Professor Dhirawat Jotikasthira

Radiograph algorithms can be used to predict certain conditions (Hunter 1966). An example of this is the study of determining the growth and development of an individual using the stages of the cervical vertebra (Bacetti et al. 2002) (Fig. 2.10).

The integration of scans can be used to give a more predictive treatment outcome. Surgical cases especially benefit from such outcomes. An example of this is shown in Fig. 2.11.

Monitoring the progress of cases will increase in demand. The use of phone apps along with highly innovative phone cameras enable orthodontists to monitor their patients remotely (Fig. 2.12). In view of the COVID-19 pandemic, the demand for tele-dentistry and distance diagnosis has become a need more than a luxury (Barenghi et al. 2020). Apps can be used to monitor patient compliance, progress, and oral conditions and hygiene.



Fig. 2.9 An example of dental simulation (TRIOS treatment simulator) using 3-Shape TRIOS scanning software with actual before and after scans of same patient. Note the scissor bite correction on the patient's right and the mandibular displacement



Fig. 2.10 Cervical vertebra stage determination in order to predict growth. For instance, in these two cases of skeletal class III patients both aged 12 but with very different skeletal maturity. Researchers are looking at algorithms (Kok et al. 2019), with the aid of landmarks, to help determine this

Transfer portals and storage of data are important in today's digital setting. Cloud-based portals enable safer storage and management of data as well as good accessibility of such data. Storage and transfer of such data is far more

hygienic as well. These scans can also be transferred via such portals to laboratories and coworkers reducing physical material handling and improving infection control (Figs. 2.13 and 2.14).

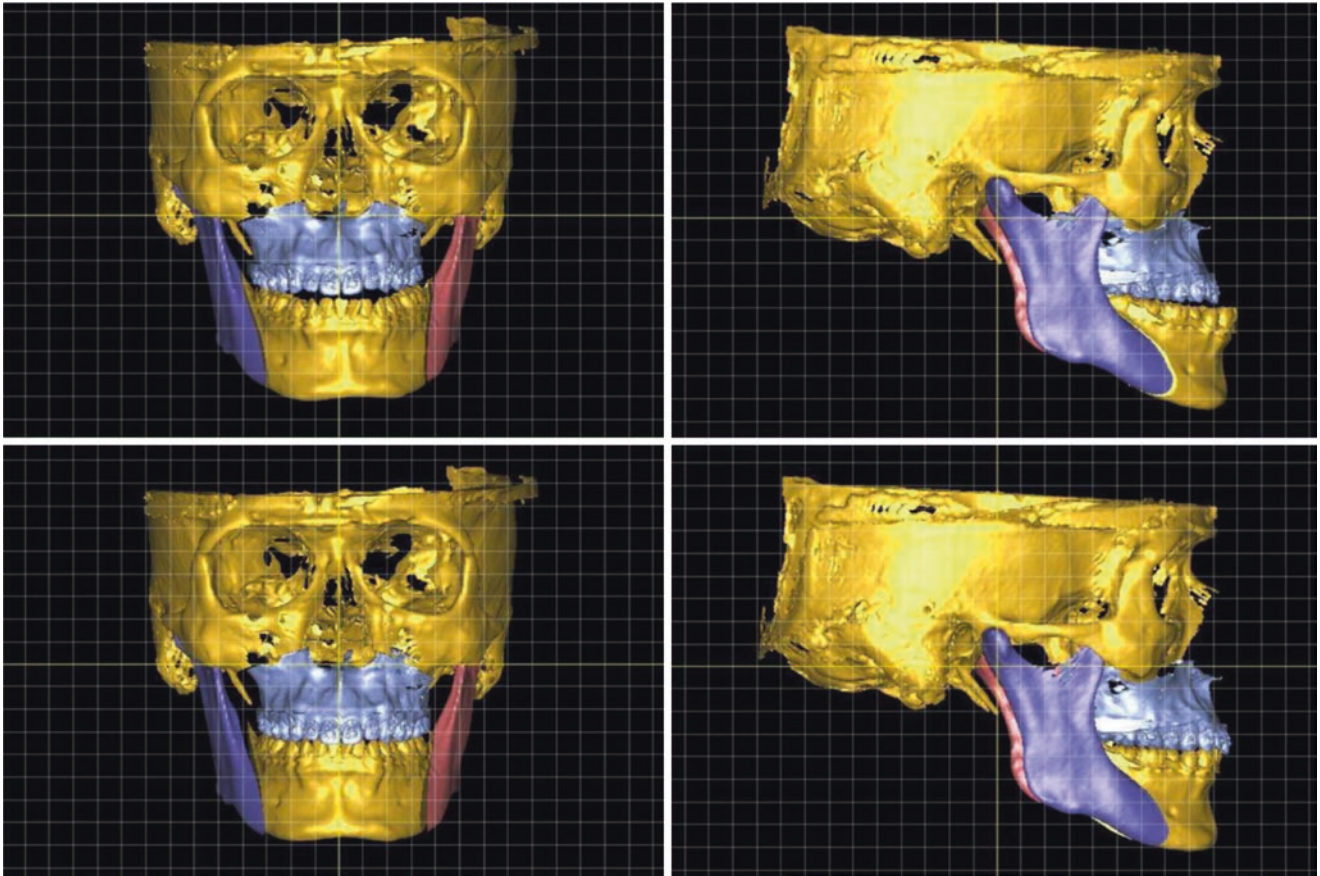


Fig. 2.11 CBCT/dental scan integration for a more predictive outcome. It also aids in the fabrication of both the intermediate and final surgical splints. Images courtesy of Dr. Andrew Ow

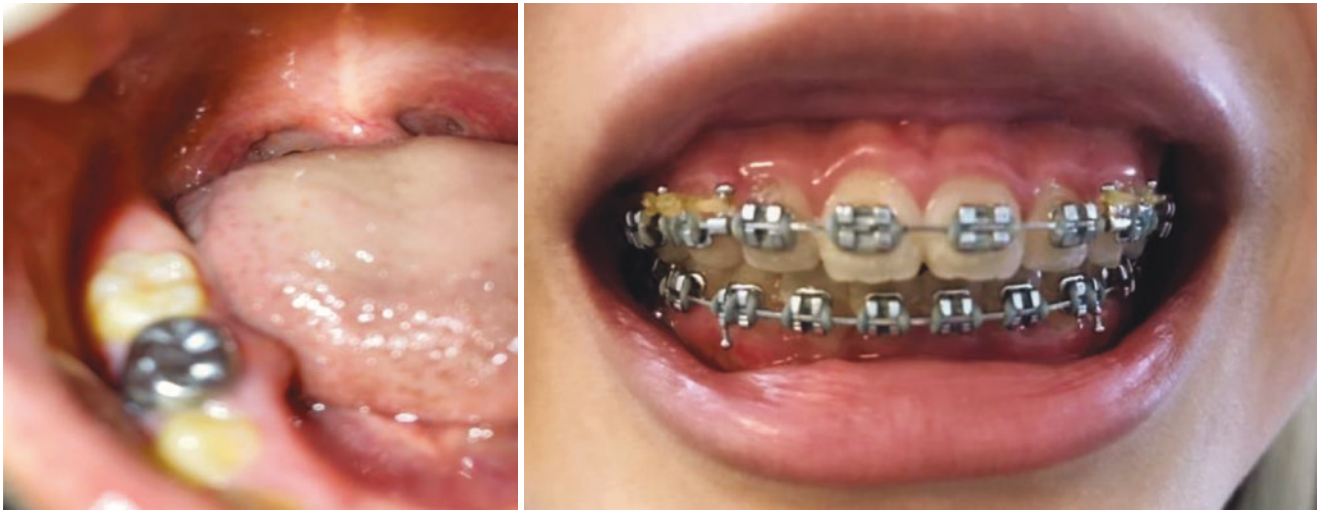
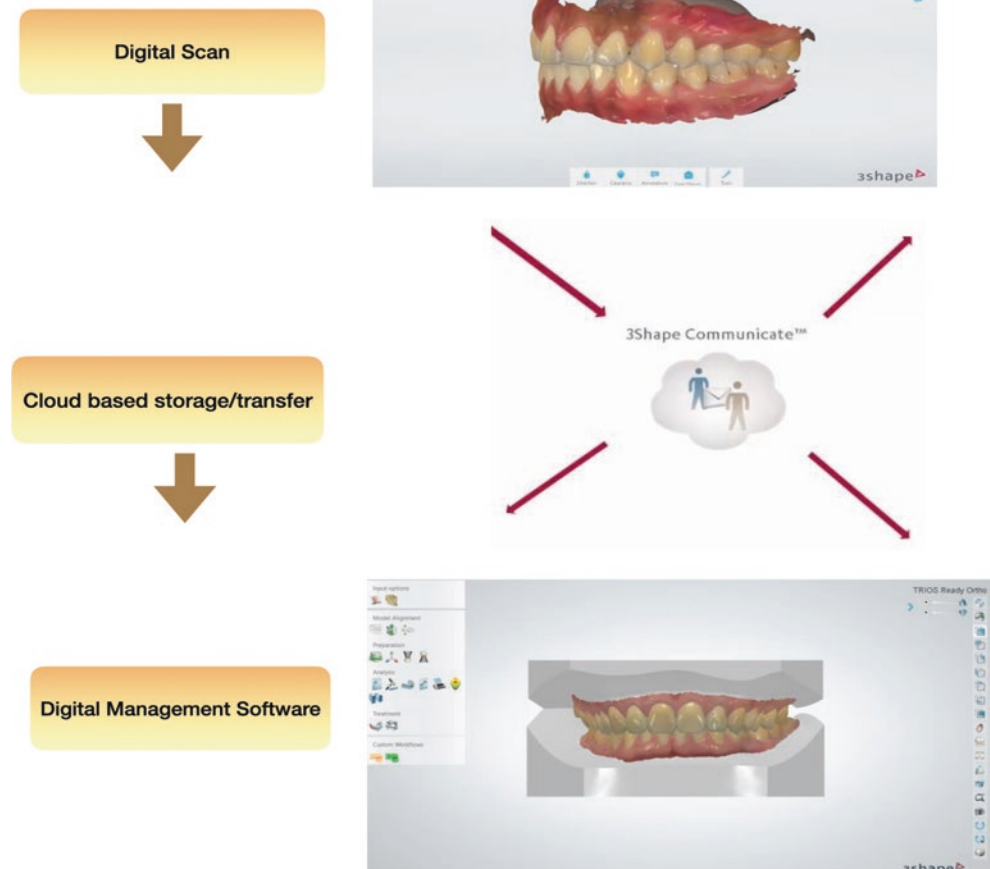


Fig. 2.12 Monitoring the progress of patients has become more urgent (Hansa et al. 2020). Actual pictures taken during the COVID-19 pandemic enquiring about dental infection and orthodontic progress

Fig. 2.13 Transfer of scans between software for management of cases are made convenient by secure cloud-based portals. An example using the 3-shape communicate platform



2.3 Clinical Indications and Application for Early Orthodontic Treatment-Aided Digital Technology

Intraoral scanning has made many processes much easier and safer (Chalmers et al. 2016) than impression materials including applications beyond the original scope of the device use such as scanning infants and young patients (Fig. 2.15).

Removable appliances—design and production have benefited greatly from digital technology (Fig. 2.16). Dedicated laboratory software has enabled in-house and lab-based manufacture of simple to custom-made appliances with a faster turnaround time.

Fixed appliances—prescription brackets and wires along with jig placement could change the way we manage our fixed appliance cases (Fig. 2.17).

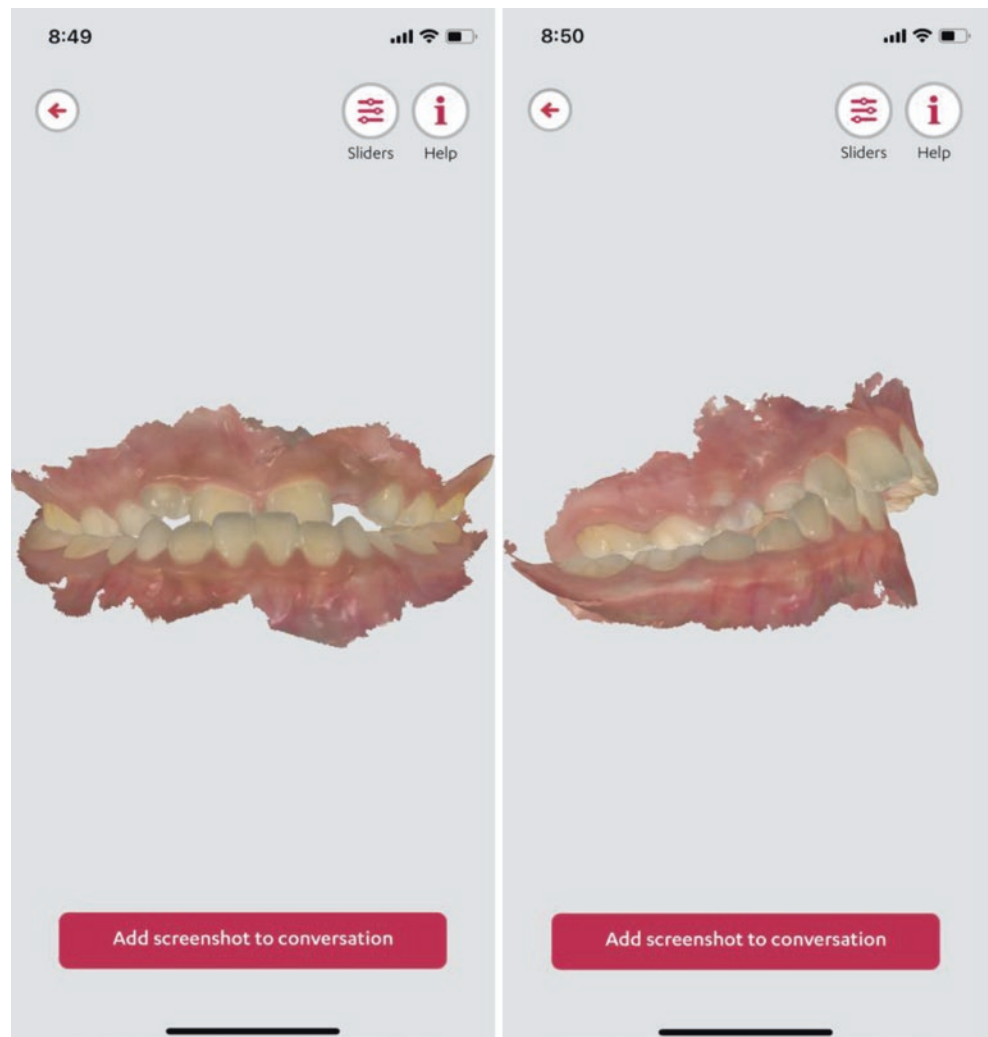
Customized appliance fabrication can result in personalized tailor-fitted appliances. Force delivery and application can be more precise (Fig. 2.18).

Functional appliances—the augmentation of clear aligners to include mandibular advancement components (Giancotti et al. 2020) is a very interesting avenue to be explored (Fig. 2.19).

Clear aligners have been one of the two technologies (the other being temporary anchorage devices) in orthodontics that have revolutionized the way we approach the management of our patients (Fig. 2.20).

Retainers have been another avenue where digital technology can improve. More accurate retainers and shorter manufacturing time would greatly improve retention protocols (Fig. 2.21 and 2.22).

Fig. 2.14 Easy access (e.g., via mobile apps) to cases for review and discussion is also a huge advantage (phone screen shots taken from the 3-shape communicate mobile app)



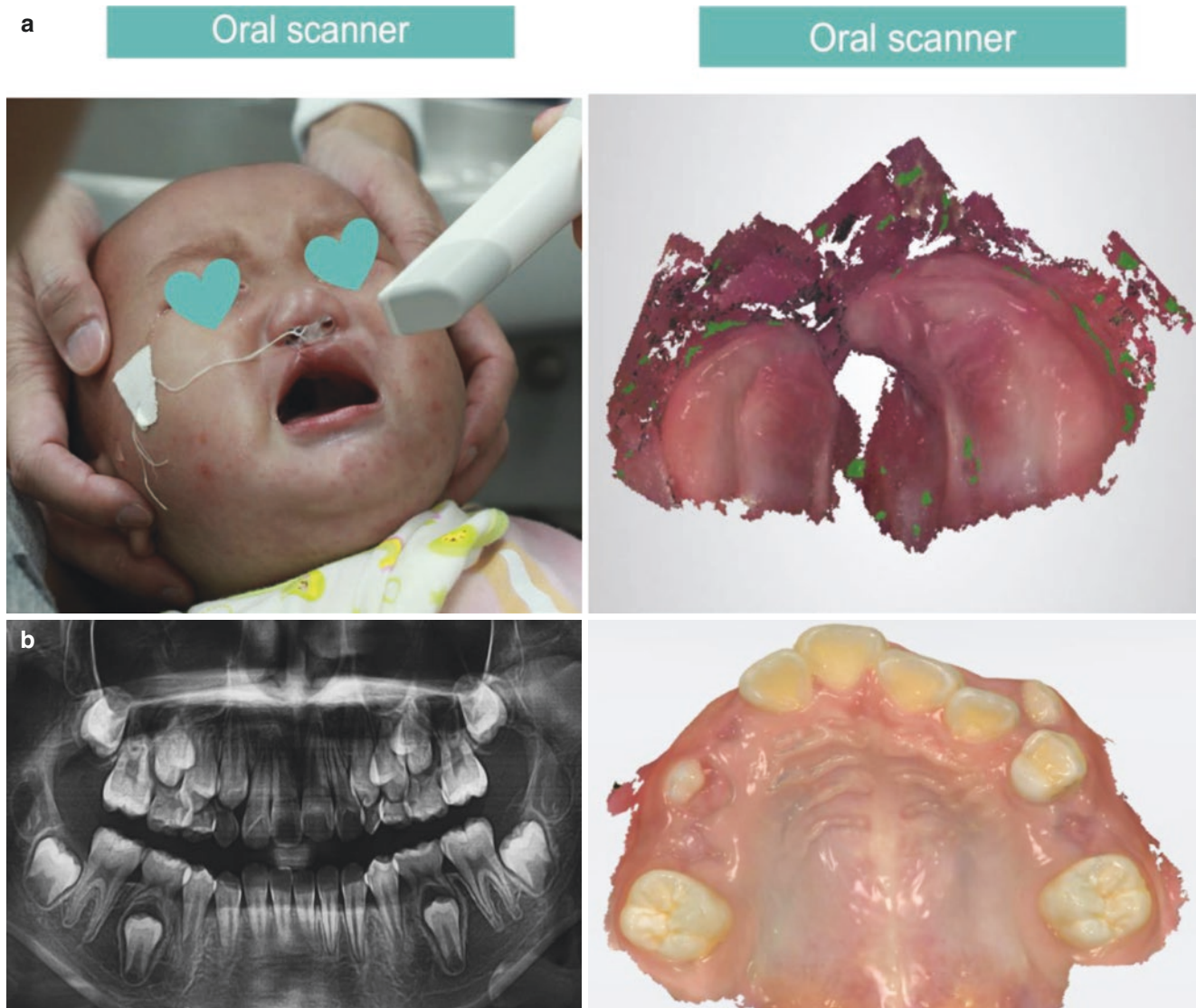


Fig. 2.15 Easily acceptable scans rid the patient of the discomfort of impression materials (Chaudhari & Kharbanda 2017) and overcome the problems of mobile teeth. (a) Cleft case, picture courtesy of Professor Dhirawat Jotikasthira. (b) The second example shows a patient in the

mixed dentition with highly mobile first and second primary molars that were removed and a digital study model taken immediately. An alginate impression for both cases would have been very uncomfortable and difficult to undertake



Fig. 2.16 From the intraoral scan, sketch for laboratory technician to follow design, to 3-D printing for fit into the patient's mouth

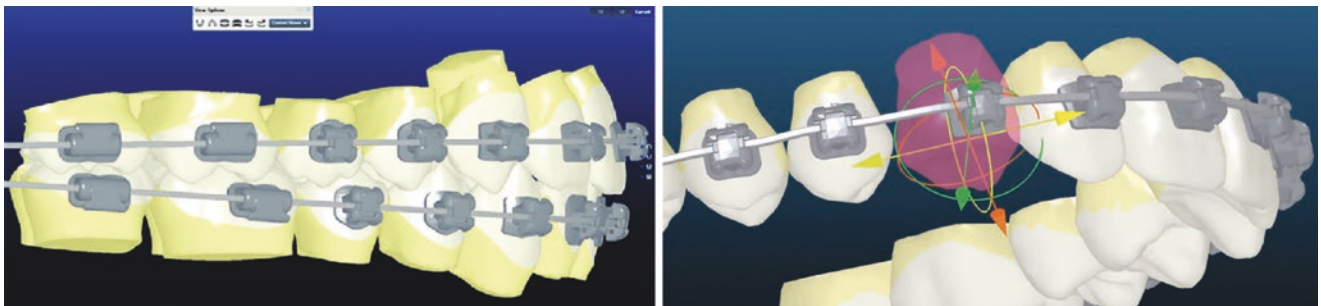


Fig. 2.17 CAD-CAM technology can provide us with customized prescriptions and customized arch wires. Pictures show treatment planning with the Insignia system

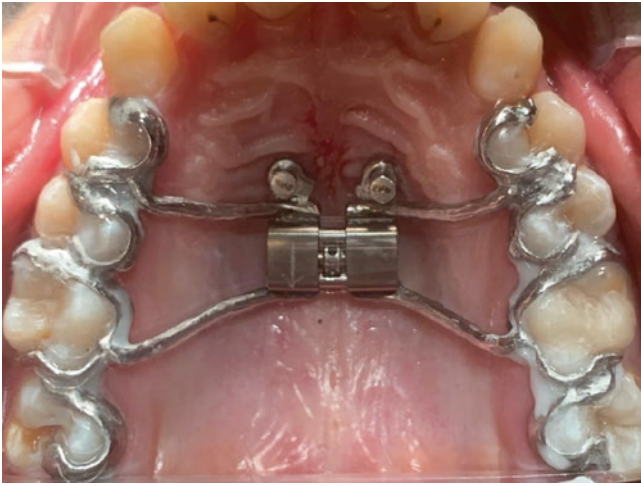


Fig. 2.18 Customized appliance for expansion. Made with the aid of digital technology (Graf 2017). Picture courtesy of Dr. Nikhilesh Vaid

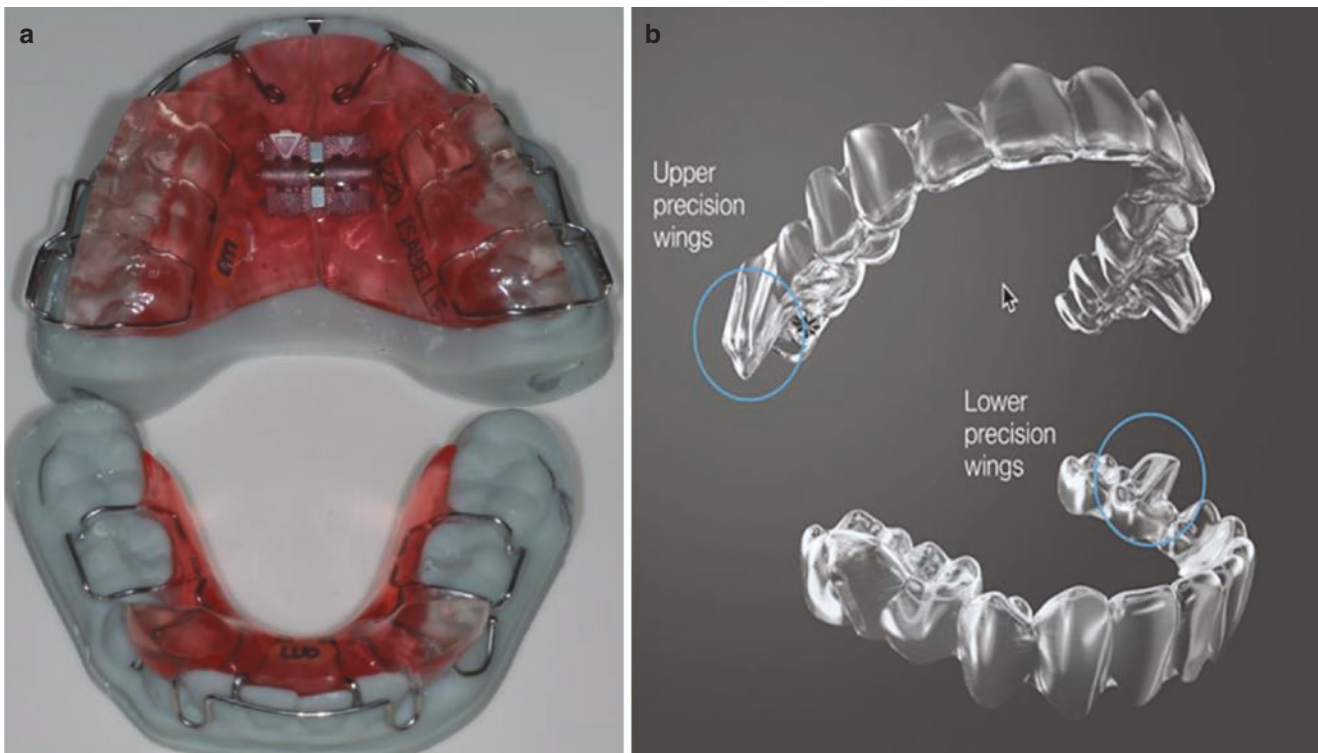


Fig. 2.19 Functional appliance: the present or could the future be more efficient? (a) Present-day twin block appliance with lab-based support. (b) Mandibular advancement along with dental alignment with clear aligners (Courtesy of Invisalign)



Fig. 2.20 The integration from records to treatment execution has improved by leaps and bounds with regard to the application in clear aligners (Keim 2018). Algorithms have also been refined and data bases increased to present a more predictable treatment option. An example below using Invisalign



Fig. 2.21 Removable retainers using digital technology. Cloud-based transfer to laboratory for 3-D print. Customized fabrication and delivery to patient



Fig. 2.22 Fixed retainers using digital technology. Memotain by Ormco is a CAD-CAM retainer made by precision cuts of nickel-titanium alloy (Kravitz et al. 2017) to fit exactly into the anatomy of the teeth

2.4 Pitfalls and Overreliance of Digital Technology

I carefully worded the title of this chapter as an aid to orthodontic management. Such technology, though extremely helpful, cannot replace the clinician (see Fig. 2.23).

When dealing with patients, health-care workers have long since recognized that human communication and compassion play a key role in the management of the disease. The dead pan responses of technology cannot replicate this (Dunbar et al. 2014).

Detection and the implication of systemic and oral diseases also require a dental surgeon's input.

AI, although extremely good at helping to determine an ideal method in obtaining tooth movement, is unable, as yet, to integrate facial forms and bony anatomy completely. Patients also exhibit differing permutations of malocclusion and respond differently to similar treatment modalities. Fine tuning and tailor-made plans are inevitable. Patients' needs and mental makeup also determine an appropriate treatment plan and goal (Faber et al 2019). Algorithms, as yet, cannot accomplish these requirements.

Finally, one must always be aware that the medicolegal implications of using such technology do not absolve the user from responsibilities.

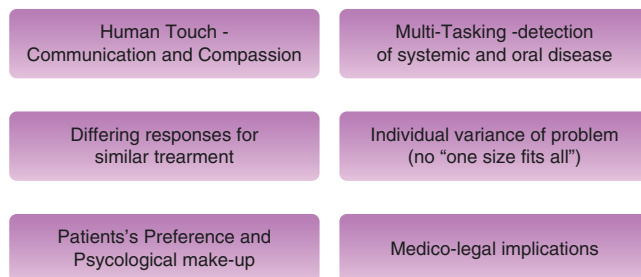


Fig. 2.23 Shortfalls and inability for digital technology to accomplish

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The Treatment of Class II Division 1 Malocclusion in Stages

3

Kurt Faltin Jr

The treatment of Class II Division I malocclusion is a multifactorial event whose factories should be analyzed and treated. It has high clinical prevalence, about 40%. This anomaly is considered acquired during the growth and development stages by general dysfunction of the neuromuscular epigenetic factors (Enlow 1968; Moyers 1988; Korkhaus 1940).

The orthopedic diagnosis shows the prevalent of 80% of mandible retrognathism and 20% of maxillary prognathism. The treatment protocol for both categories must be totally different.

First of all, we must have very clear priorities of the neuro-functional, orthopedic, and orthodontic aspects which are individually determined by accurate diagnosis protocols (Björk 1955).

The most important priority, as the first stage to be considered, is the maxillary transverse deficiency. It is absolutely necessary that the maxilla and upper dental arch be prepared to receive mandible in facial harmony, providing a normal Class I occlusion (Faltin Jr. et al. 2003).

The Bionator was develop by Prof. W. Balters in Germany in the 1960s, which is still being used today.

3.1 The Mandibular Retrognathism Treatment

The first example represents a case with a pronounced mandible retrognathic posture without dental arch discrepancies. The treatment protocol was Balters' Bionator to normalize facial harmony in anterior and vertical directions (Balters 1964) (Figs. 3.1 and 3.2).

During follow-up, after finishing treatment, the patient used the last Bionator 6 full days during 6 months and night-time for another 6 months. The results can be observed in Fig. 3.3a–e.

It is to be convinced that the functional orthopedic intervention normalizing development factors and correcting neurophysiologic impute, through the central neuron system, promote a very balance and stable development and excellent result (Petrovic and Stutzmann 1977) (Figs. 3.4, 3.5, 3.6, 3.7, 3.8, 3.9 and 3.10).

We must consider that only a few patients can be treated exclusively with Balters' Bionator, Frankel's functional regulator, or other functional therapies. Both therapies are similar and considered the only totally functional jaw orthopedic devices (Bishara and Ziara 1989).

The great majority of Class II Division I is patients with retrognathic mandible, transverse discrepancy of the maxilla, upper incisor protrusion, lower dental crowding, total Class II distal occlusion, and general dysfunctions. They need to be prepared before being submitted to a functional orthopedic treatment like the Bionator therapy.

RME is the first recommended intervention. The Schwarz plate or Ricketts lower utility arch may be indicated.

The next step of treatment will be the functional orthopedic stage with Balters' Bionator, respecting all aspects from the construction bite to the adjustment in the patient's mouth and instruction and during treatment control.

Unfortunately, a small percentage of cases can be treated only using Bionators.

Patient 3: J.D.S., 9 years 3 months. at the beginning of treatment (Fig. 3.11).

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Fig. 3.1 (a–e) Patient 1: M.S., 9 years 3 months, at the beginning of treatment



Fig. 3.2 (a–c) During 3 years 2 months, the patient used three Balter's Bionators



Fig. 3.3 (a–e) With no use of any other fixed appliance. He got a normal occlusion, an excellent facial harmony (divine proportion), and balanced neuromuscular functions

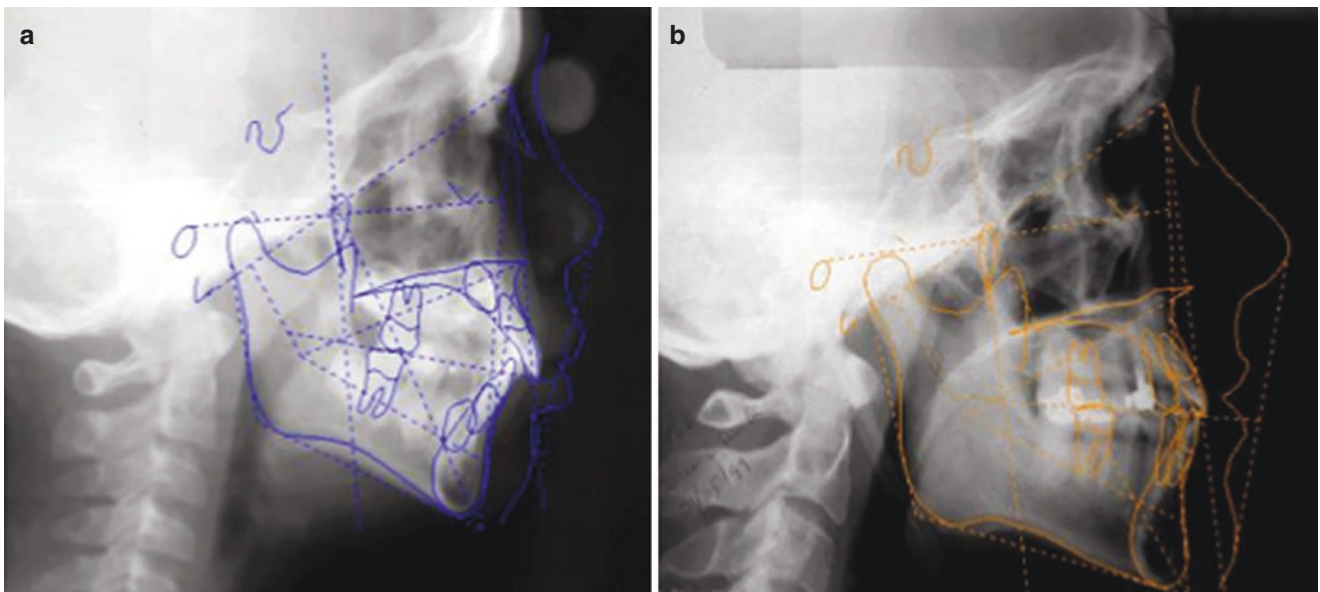


Fig. 3.4 (a, b) Illustrate a lateral cephalometric study before and after the treatment

After a total analysis of the various complementary examinations and appropriate analysis, the diagnosis will demonstrate upper transverse discrepancy in comparison with the lower one, a deep bite, or an open bite, dental crowding, and respiratory dysfunction (van der Linden 1986) (Fig. 3.12).

The patient must be prepared before being submitted to functional therapy like Balters' Bionator (Fig. 3.11).

Sequence of the first stage: rapid maxillary expansion and simultaneously lower utility arch were indicated to correct the lower incisors' implantation. This phase took 8 months.

The second stage started immediately and was related with the facial harmony. She must be treated with an appropriated protocol in vertical, latero-lateral, and antero-posterior directions. In this stage, the patient used a modified Balters' Bionator.

Balters' Bionator was installed without removing the lower utility arch in place. The use of Balters' Bionator took 1 year.

The purpose of the third stage is to correct teeth alignment and implantation and finally achieve functional normal occlusion.

The retention was upper plate and lower lingual fixed (Fig. 3.13 shows the final case and Fig. 3.14 lateral cephalometric image). There has been an absolutely excellent facial result. Facial dimensions are according to Fibonacci's divine proportion.

In cases like this, orthopedic and orthodontic treatment must be started very soon in order to be able to correct facial harmony, normal occlusion, and neuromuscular behavior.

G. Sander (2001) developed a new appliance—the SII. It consists of two plates with expansion screws and the upper one with a metallic guide that contacts the lower plate in the anterior region.

SII appliance is a mandible protractor with transverse expansion of the maxilla and up righting of molar posterior teeth. The advantage of SII treatment is the possibility to widen the maxilla, correct deep bite, and open space for dental orthodontic treatment and mandible advance at the same time. In these cases, it is recommended to use Sander's plate (SII).

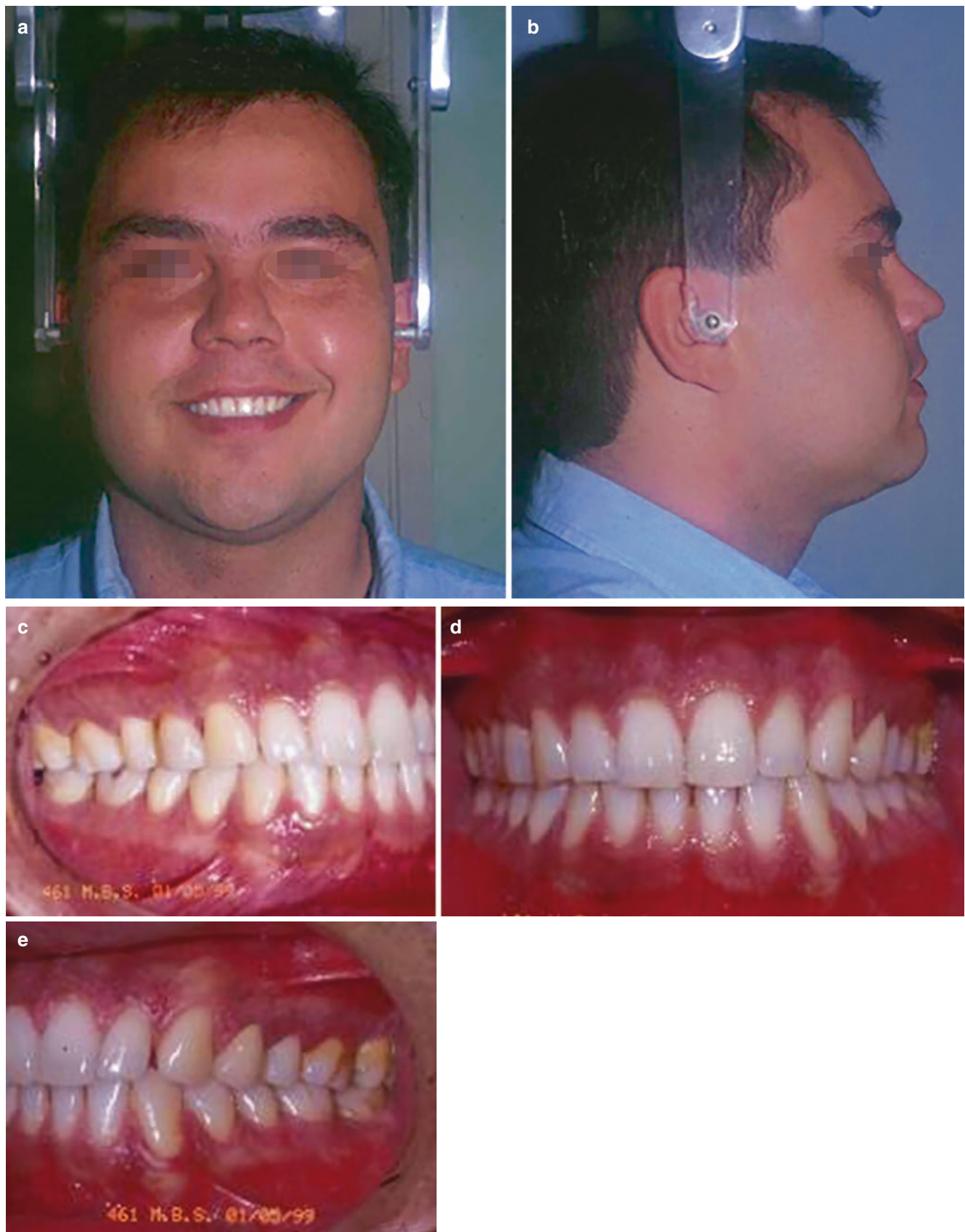


Fig. 3.5 (a–e) The long-term evaluation after 7 years was performed and demonstrates the stability and even a better situation after orthopedic mandible Class II treatment



Fig. 3.6 (a–c) Frankel's functional regulator (FR2) is another orthopedic appliance that can be used in the treatment of Class II Division I malocclusion with mandible retrognathism, in growing prepubertal period (Fränkel 1989)



Fig. 3.7 (a–e) The next clinical case: **Patient 2: P.H.L., 8y** at the beginning of treatment is similar to the first patient, but this case has some orthodontic problems such as crowding, upper arch protruded teeth, narrow maxilla arch, deep vertical bite, and dysfunctions



Fig. 3.8 (a–e) The patient used three FR2 over 5 years of treatment, progress situation at 12 years 7 months



Fig. 3.9 (a–e) The stability posttreatment over 2 years with no retention

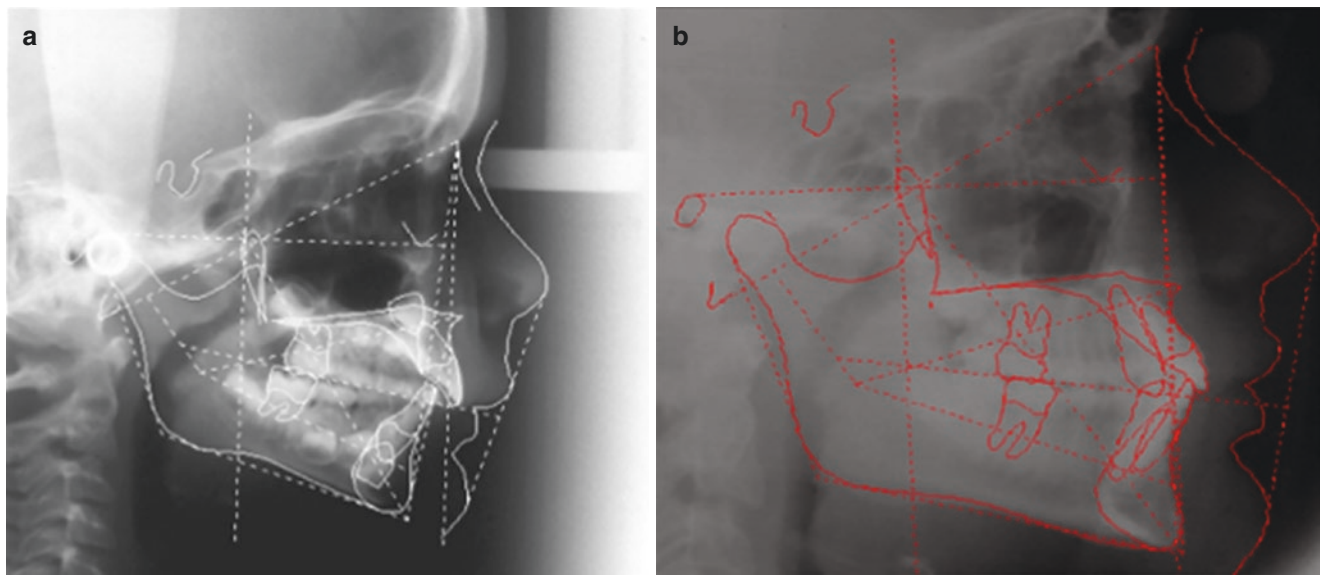


Fig. 3.10 (a, b) Illustrate a lateral cephalometric study before and after the treatment and the excellent quality of mandibular development



Fig. 3.11 Initial records



Fig. 3.12 The sequence before Balters' Bionator use



Fig. 3.13 Shows the final case

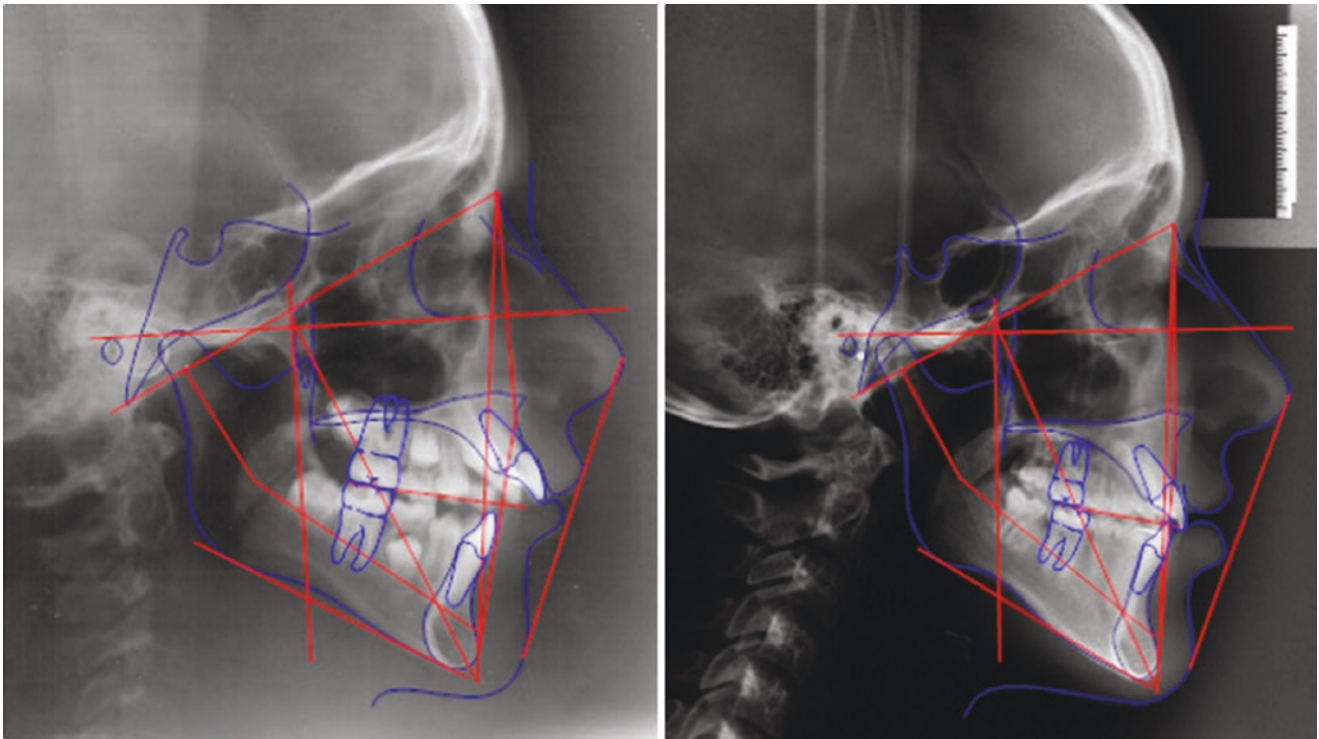


Fig. 3.14 Lateral cephalometric study before and 5 years after

Sander's SII and Clark's Twin Block have a similar action (Fig. 3.15).

The first stage of treatment which lasted 1 year and 6 months shows the evolution and complete treatment with SII. The next stage was with fix appliance and included a retention of 15 months (Sander 2001) (Fig. 3.16).

Figs. 3.17 (a–e) present the end of treatment.

Cases of patients with pronounced Class II Division I with severe retrognathic mandible, upper protrusion, deep bite, and dysfunctions but without lower crowding must be treated immediately, even in the deciduous dentition (Figs. 3.18 and 3.19).

The biological reason is that the development of the dental facial complex under such reverse epigenetic factors will get worse with time.

All priorities could be normalized and have facial orthopedic harmony, balanced occlusion, and balanced neuromus-

cular function. That is the real stimulation for normal functional adaptation including form, size, and shape of the masticator system.

The advanced of SII treatment is the possibility to wide maxilla, correct deep bite, open space for dental orthodontic treatment and advanced mandible.

Patient 5: L.M., 4 years 6 months. at the beginning of treatment. The treatment will take a long time using the Balters' Bionator during the first stage and Sander's double plates (SII) during the second stage (Figs. 3.20, 3.21, 3.22 and 3.23).

The observed result is very important taking in mind that he has a long development future. (Fig. 3.22)

These excellent results could only be obtained when the treatment starts at a very young age (Figs. 3.24, 3.25, 3.26, 3.27 and 3.28).



Fig. 3.15 (a–e) Patient 4: R.L.B.H., 12y at the beginning of treatment



Fig. 3.15 (continued)



Fig. 3.16 The next stage with fixed appliance including retention took 15 months in retention with stable results



Fig. 3.17 (a–e) Represent the result of patient who finished treatment with an excellent result



Fig. 3.18 (a–e) The long-term evaluation confirms a very stable result

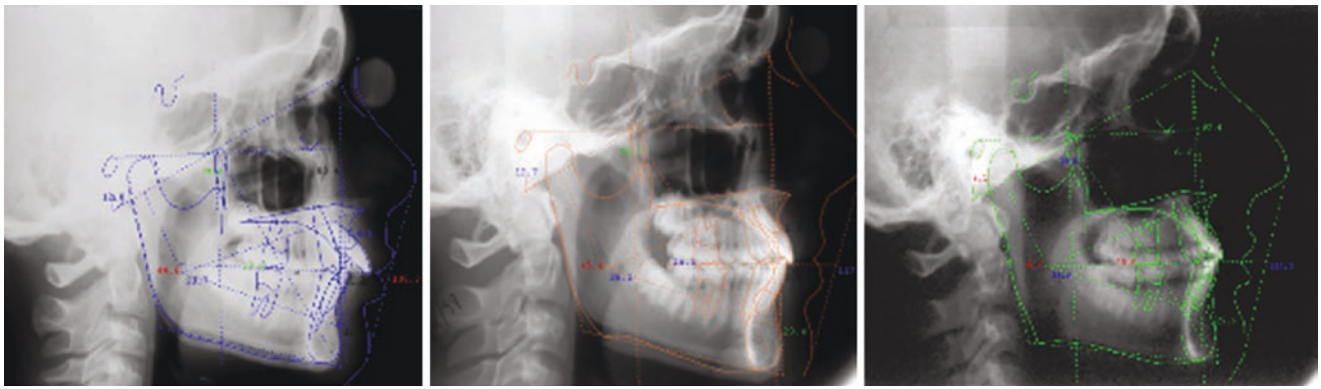


Fig. 3.19 Lateral cephalometric: before, immediate after, and a long-term treatment



Fig. 3.20 Pre treatment photographs



Fig. 3.21 The patient used upper expansion removable plate with superelastic screws, SII, and Bionator from November 2001 to March 2005



Fig. 3.22 From June 2010 to June 2013, the second stage, the patient was treated with fixed appliance and retention



Fig. 3.23 After long-term treatment

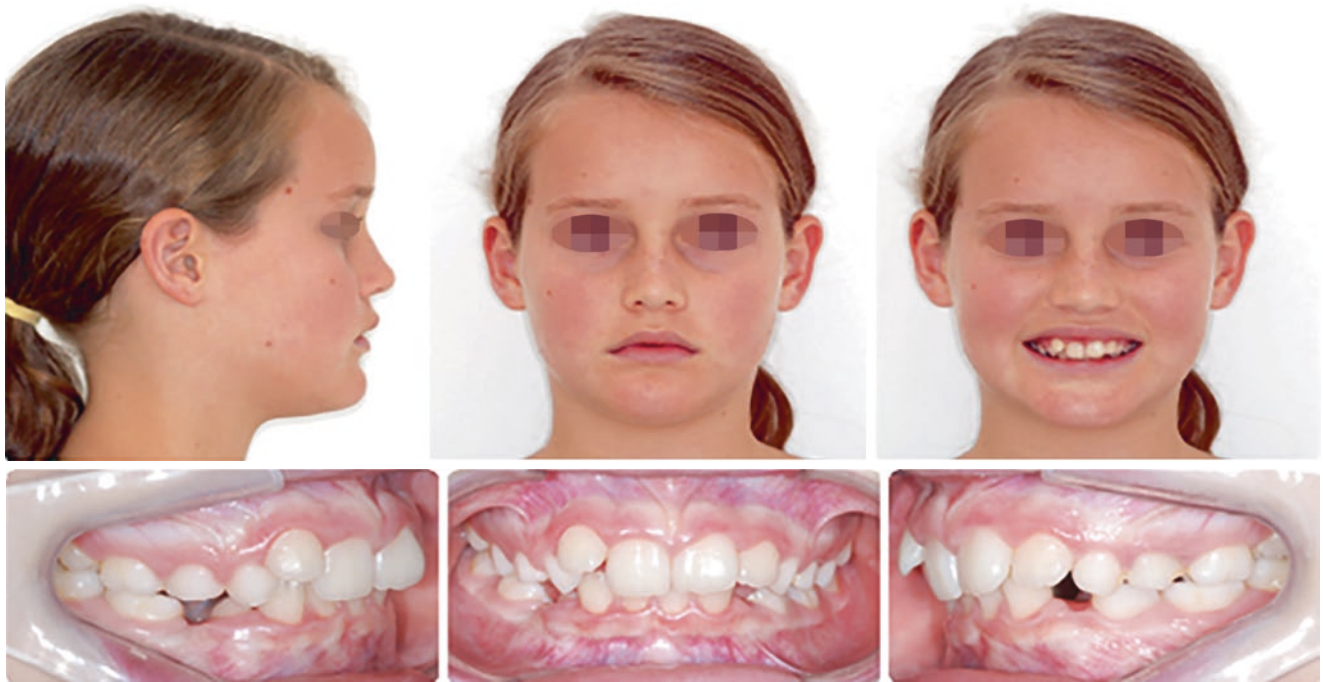


Fig. 3.24 Patient 6: K.B., 10y at the beginning of treatment

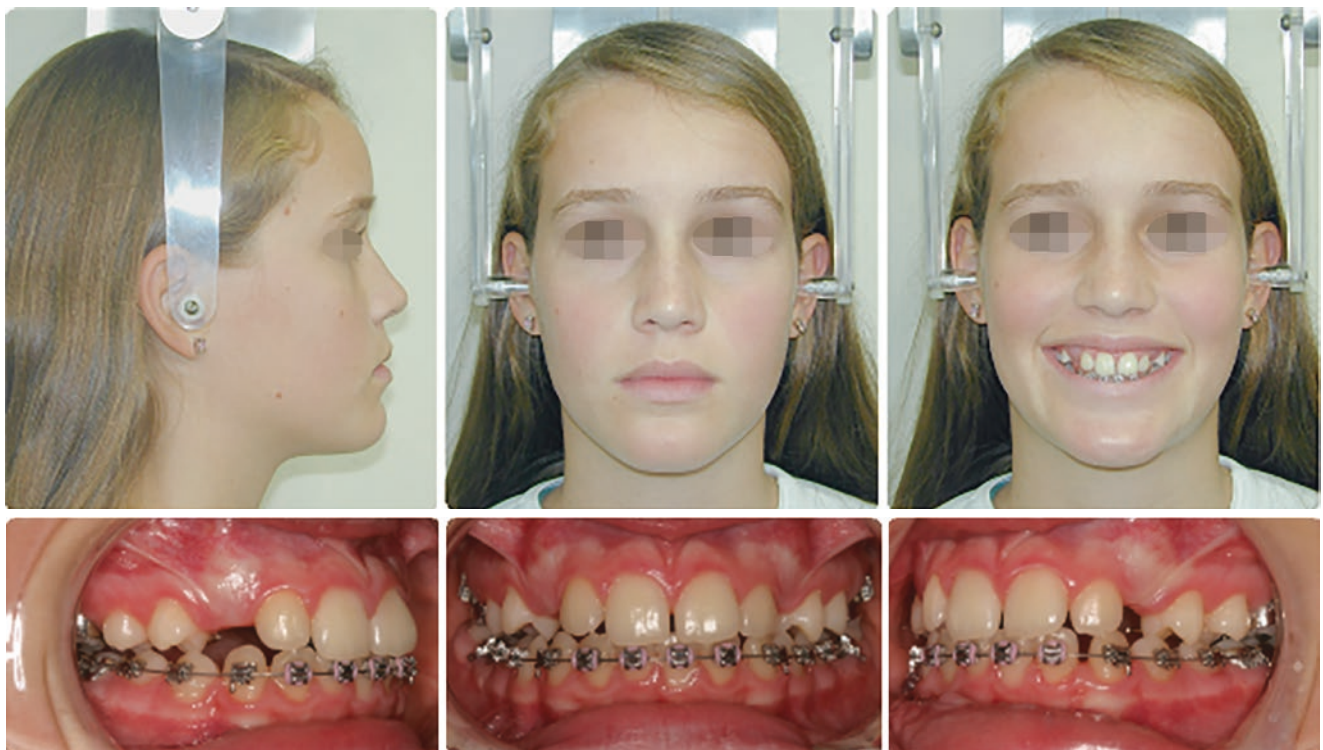


Fig. 3.25 Balters' Bionator result



Fig. 3.26 Then fixed appliance, and quadri-helix



Fig. 3.27 The end of treatment

The patient was treated in a unique stage. The priority was to achieve first the facial harmony because of the poor vertical dimensions. In sequence she was treated with biomechanics-fixed therapy.

The treatment sequence:

In this case because of the advanced stage of development, we decided to treat first the facial harmony with

Balters' Bionator philosophy and then fix appliance according to Ricketts' philosophy.

Patient 7: F.A., 10 years 2 months. at the beginning of treatment. Another typical case of mandible retrognathism (Figs. 3.29a–c and 3.30a–c), again priority number 1 facial harmony (Figs. 3.31, 3.32, 3.33 and 3.34).

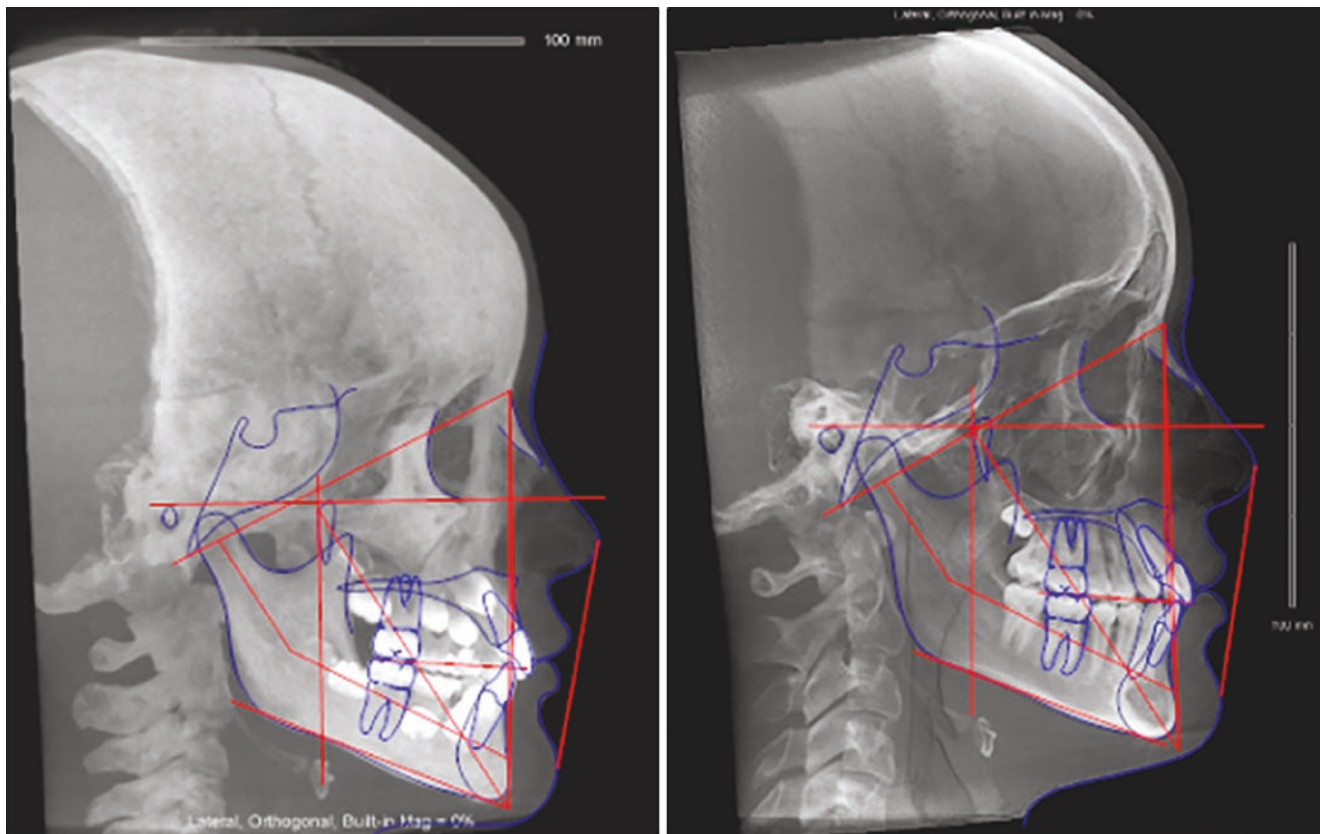


Fig. 3.28 Lateral cephalometric study: before and immediate after and a long term

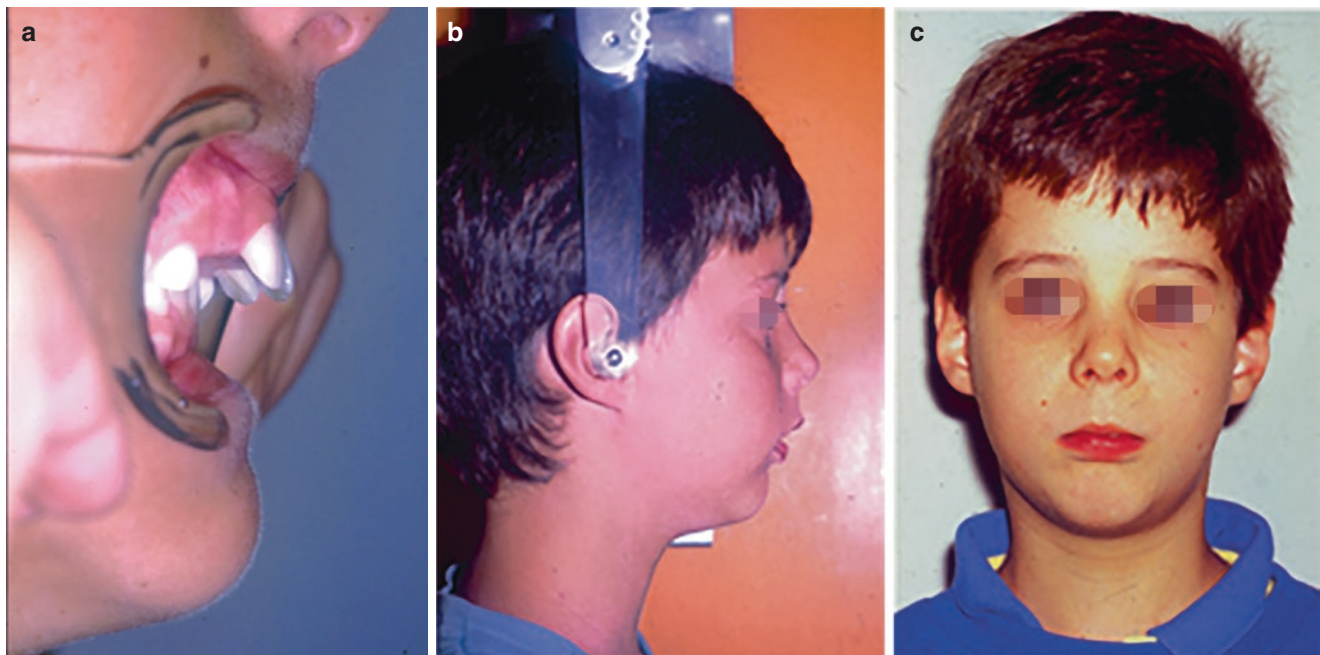


Fig. 3.29 Pre treatment photographs



Fig. 3.30 Frontal and lateral photographs at the beginning of the treatment

Figures 3.35 (a, b) are images from helicoidal tomography, before and after the treatment, demonstrating the functional adaptation on TMJs, relocating the condyles in glenoid cavities.

3.2 The Maxillary Prognathism Treatment

When Class II division I is characterized as maxillary protrusion, the treatment protocol must be realized and indicated extraoral traction, developed by G. Sander (Fig. 3.36). This special extraoral traction appliance has constant cervical force of 4–5 Newtons. The appliance should be used for 18 h/day.

The traction is always cervical. If the patient has a horizontal growth tendency, it is necessary to associate with an upper anterior bite plate. If the patient has a vertical growth tendency, it is indicated a lower posterior bite plate.

After the orthopedic correction, the treatment is finalized with biomechanics-fixed appliances and finale retention.

Patient 8: S.C.W., 11y at the beginning of treatment (Figs. 3.37a, b and 3.38a–c).

The first stage of treatment was maxillary expansion with upper removable expansion plate, and the treatment time was 8 months (Fig. 3.39).

The second stage of treatment was extraoral traction for 12 months, fixed orthodontic, and retention. The treatment time was a total of 2 years and 11 months (Fig. 3.39).

The long treatment evaluation is shown in Fig. 3.40.

Lateral cephalometric evaluation (Fig. 3.41) before, during, and long-term control shows a total stable situation.

Patient 9: C.P., 9y 10 m. at the beginning of treatment (Fig. 3.42). This case illustrates a combined treatment of extraoral appliance and Balters' Bionator.



Fig. 3.31 The occlusion with and without the Balters' Bionator when the class I was achieved. The patient used five Balters' Bionator during 2 years and 3 months and completed the treatment using fixed appliance

The sequence was as follows:

1. Maxilla transverse correction.
2. Balters' Bionator therapy during 2y and 10 m. (Fig. 3.43).
3. Extraoral appliance (1 year) and total fixed appliance (Fig. 3.44), shows the case at the end of the treatment.
4. Long-term control (Fig. 3.45).
5. Lateral cephalometric images before and after the treatment (Fig. 3.46).



Fig. 3.32 Present end of the treatment time was 4 years 3 months



Fig. 3.33 The stability of the treatment in long-term observation 6 years after retention

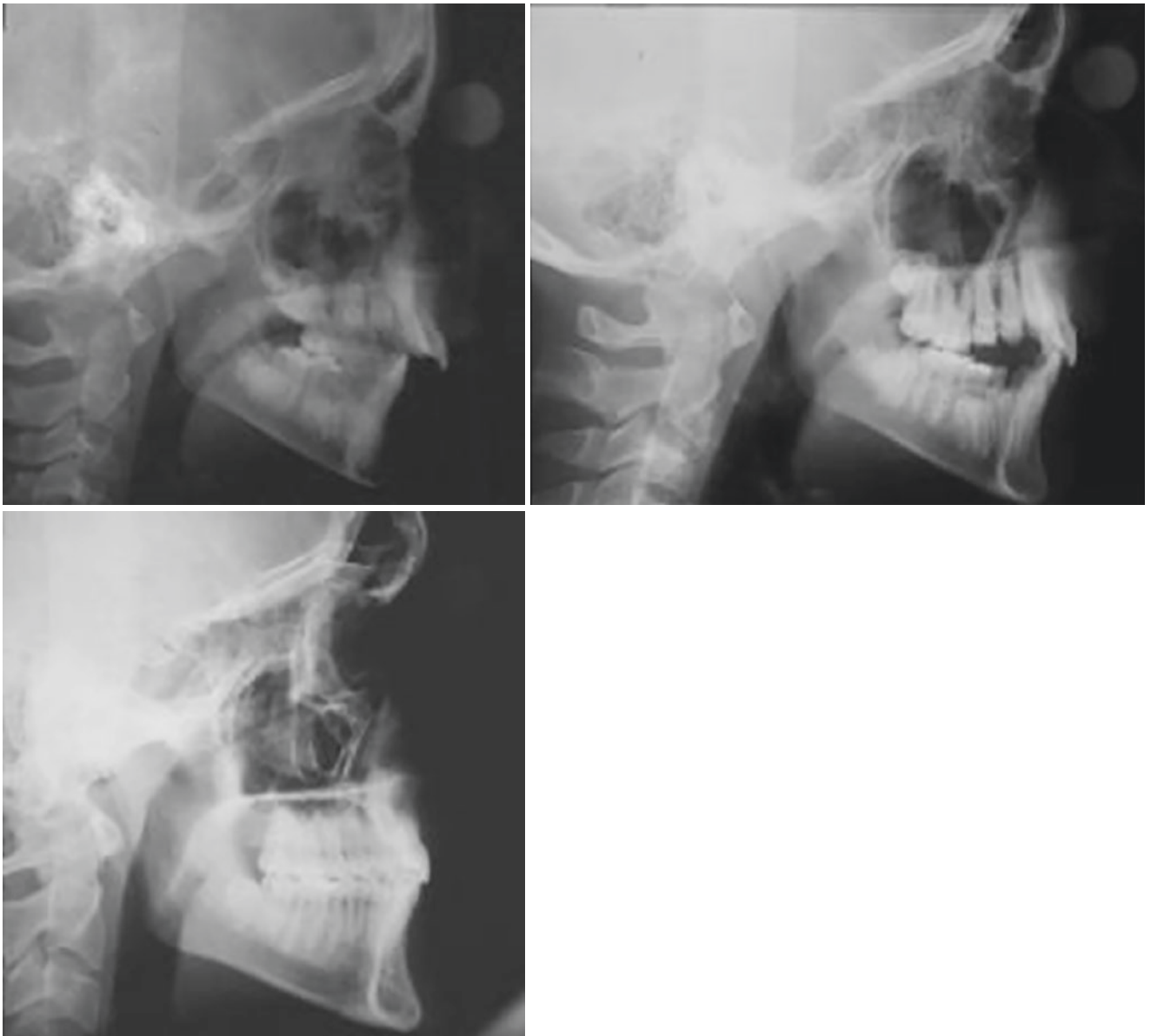


Fig. 3.34 The lateral Rx where it is possible to observe very clear the development of the face and recognize the mandible growth

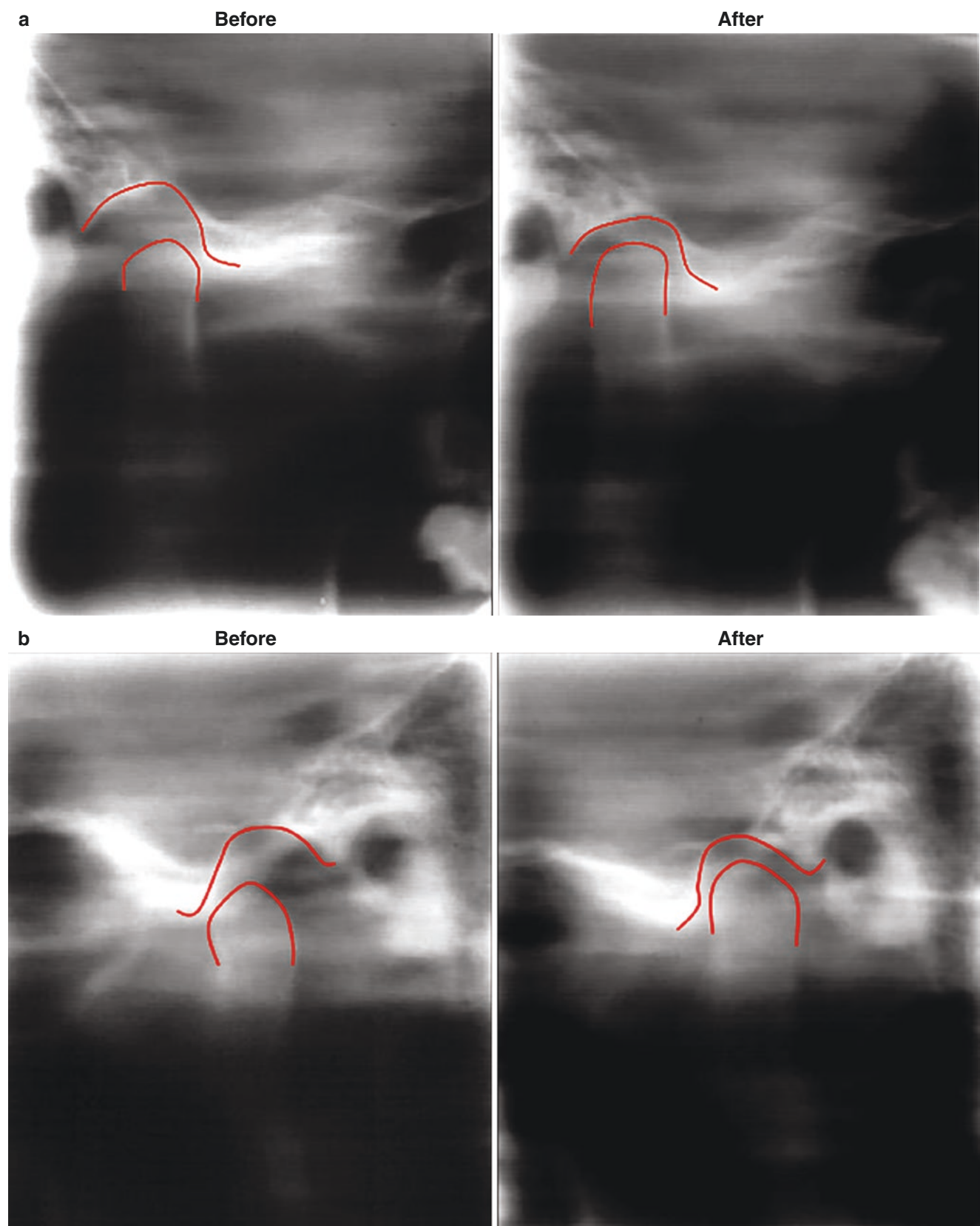


Fig. 3.35 (a) Right condyle. (b) Left condyle

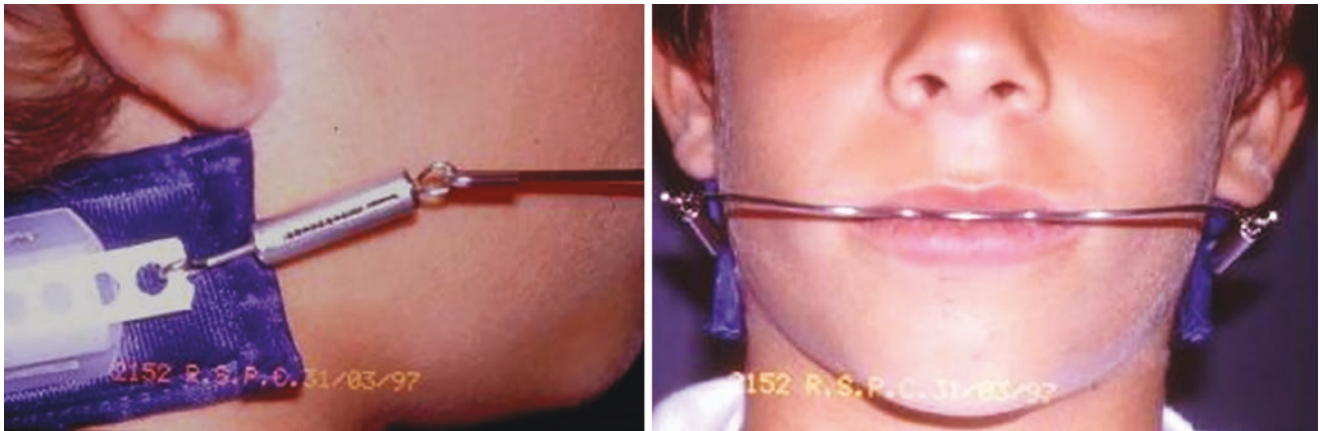


Fig. 3.36 Cervical extraoral appliance in place

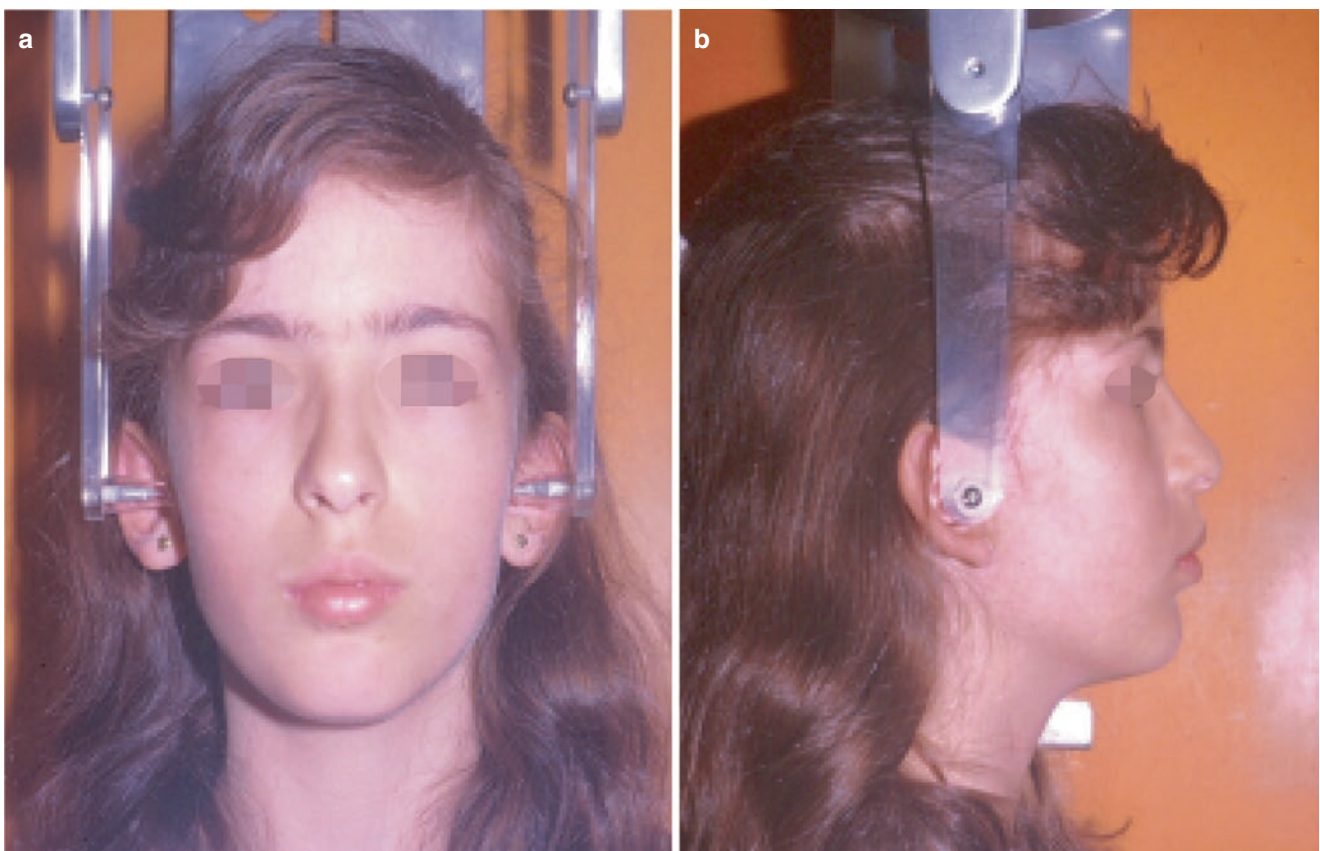


Fig. 3.37 Photographs at the beginning of the treatment



Fig. 3.38 Frontal and lateral pre treatment photographs



Fig. 3.39 Second stage of treatment



Fig. 3.40 Final photographs

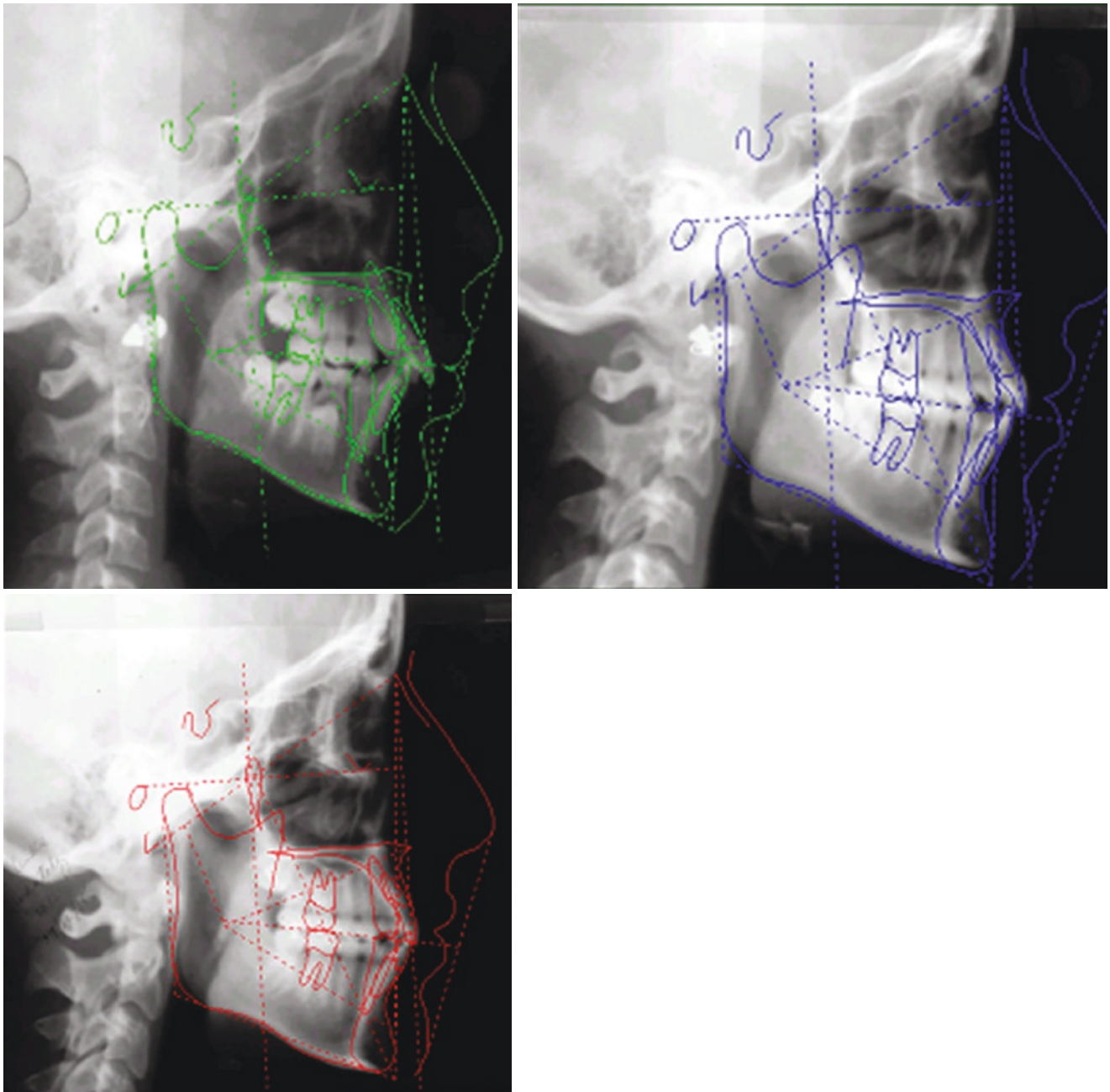


Fig. 3.41 Comparison pre and post lateral radiographs



Fig. 3.42 Initial photographs



Fig. 3.43 A bionator was indicated. An important improvement was observed.

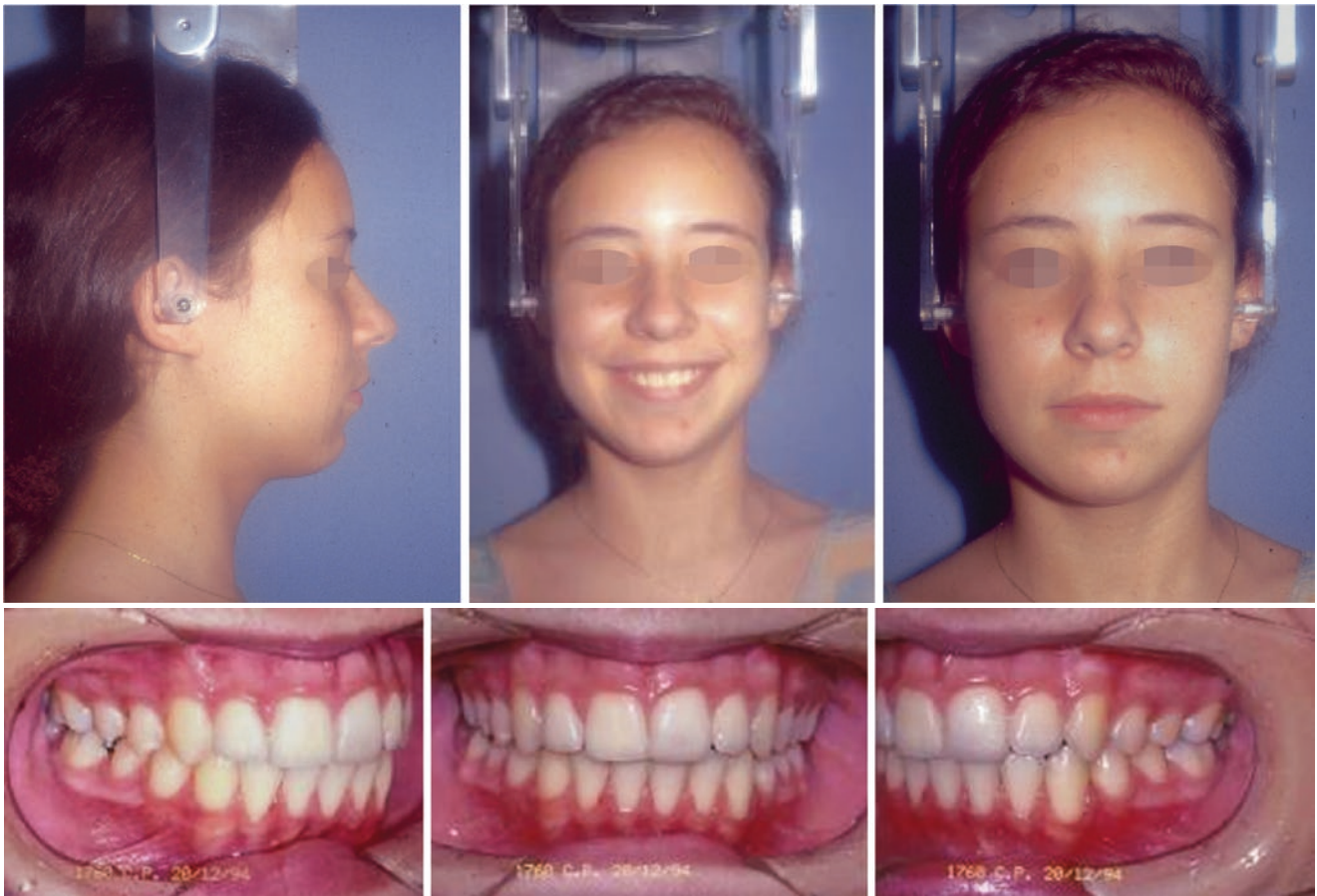


Fig. 3.44 Final photos



Fig. 3.45 Control 5 years later

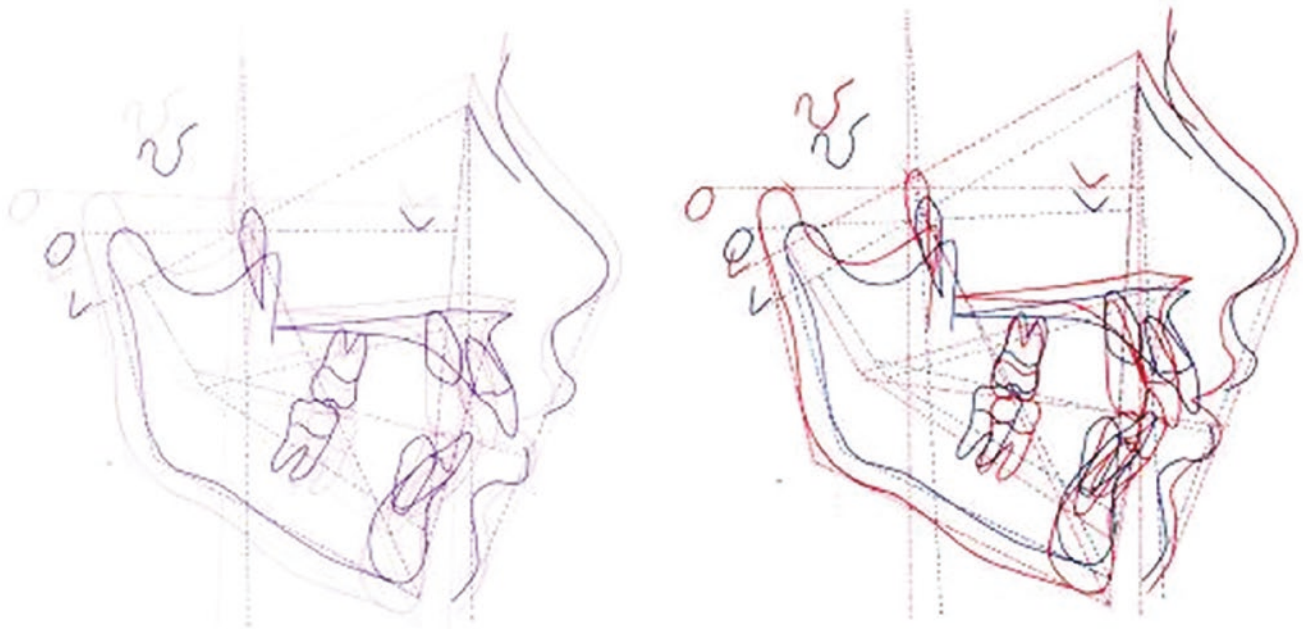


Fig. 3.46 Comparison Pre and post treatment cephalograms

3.3 Conclusion

According to the knowledge of the biological process involved in the dental masticatory system, such as the use of methods to individualize diagnosis and to create and correspond treatment planning, using the most efficient and appropriate therapeutic appliances, we certainly achieved facial harmony, normal occlusion, and neurophysiological corrections which provided a homodynamic activity.

The future tendency of science philosophy of our professional activity encourages us to recognize that facial orthopedics is the first priority before orthodontics every time. The neuromuscular balance gives the long-term stability and the maintenance of the normal occlusion.

The orthodontists must be prepared to understand the permanent evolution of our specialty respecting the basic principles.

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Is Early Class II Treatment Worth the Effort?

4

Amit Bhardwaj

Class II malocclusions are of interest to orthodontists since they constitute a significant 45% of the cases they treat (Bishara and Saunders 2001). In individuals with Class II malocclusions, etiology can be dental, skeletal, or a combination of both. Most children with Class II malocclusions have skeletal problems.

Early treatment mainly aims to modify growth of the jaws and reduce skeletal discrepancy and muscular imbalance (Moyers 1988). Objectives are to achieve good function, good esthetics, and good stability.

Before starting the treatment, we must begin with end results in mind, which means we must go through comprehensive examination, diagnosis, and treatment planning.

We do case analysis to recognize the problems, make a list of the problems, carry out necessary examination(s), and interpret examination results to diagnose.

According to Thomas Rakosi, cephalometric classification of Class II malocclusions is as follows (Graber et al. 1997):

1. Dentoalveolar Class II malocclusion.
2. Functional Class II malocclusion.
3. Skeletal Class II with fault in the maxilla.
4. Skeletal Class II with fault in the mandible.
5. Combination of 3 and 4.

One must bear in mind that we must treat at the right place at the right time with proper appliances.

4.1 Dentoalveolar Class II Malocclusion (Figs. 4.1, 4.2, and 4.3)

Abnormal oral habits, such as lip biting (Fig. 4.2) and thumb sucking (Fig. 4.3) (Fleming 2017), play important roles in causing this type of Class II malocclusion.

Simple orthodontic appliances can be used to correct axial inclination(s) of the upper and/or lower anterior teeth.

4.2 Functional Class II Malocclusion (Figs. 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, and 4.15)

4.2.1 Case # 1 (Figs. 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, and 4.14)

This functional Class II case fits into Reichenbach and Taatz's explanation of foot and shoe phenomenon (McNamara and Brudon 1993, 2001).

4.3 Skeletal Class II with Fault in the Maxilla (Fig. 4.16)

Many authors suggested the use of extraoral appliances to inhibit growth of the maxilla such as headgears, e.g., cervical pull headgear for horizontal growth pattern (Fig. 4.17a) and high-pull headgear for vertical growth pattern (Fig. 4.17b, c) (Firouz et al. 1992; Southard et al. 2013).

4.4 Skeletal Class II with Fault in the Mandible (Fig. 4.18)

4.4.1 Case # 2 (Figs. 4.19, 4.20, 4.21, 4.22, 4.23, 4.24, 4.25, 4.26, 4.27, and 4.28)

Functional appliances, both removable and fixed, are used to forward the mandible into a new position with the objective to minimize skeletal discrepancy. There is no consensus about the best functional appliance to be used for this

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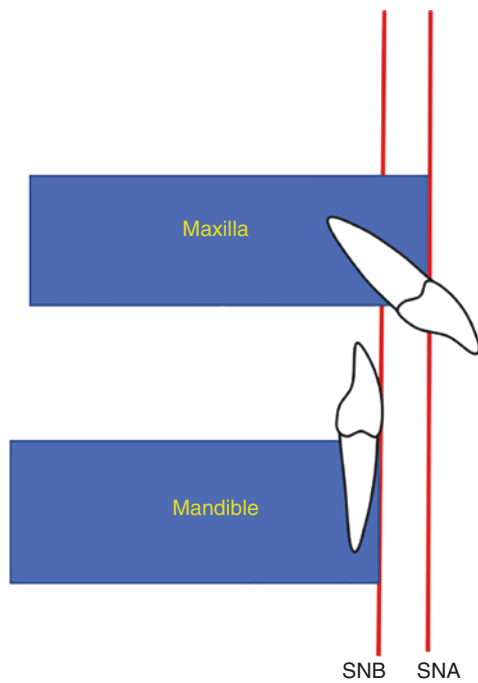


Fig. 4.1 Dentoalveolar Class II malocclusion, fault at axial inclination(s) of upper and/or lower anterior teeth



Fig. 4.3 Thumb sucking



Fig. 4.2 Lip biting, lower lip trapped between upper and lower anterior teeth

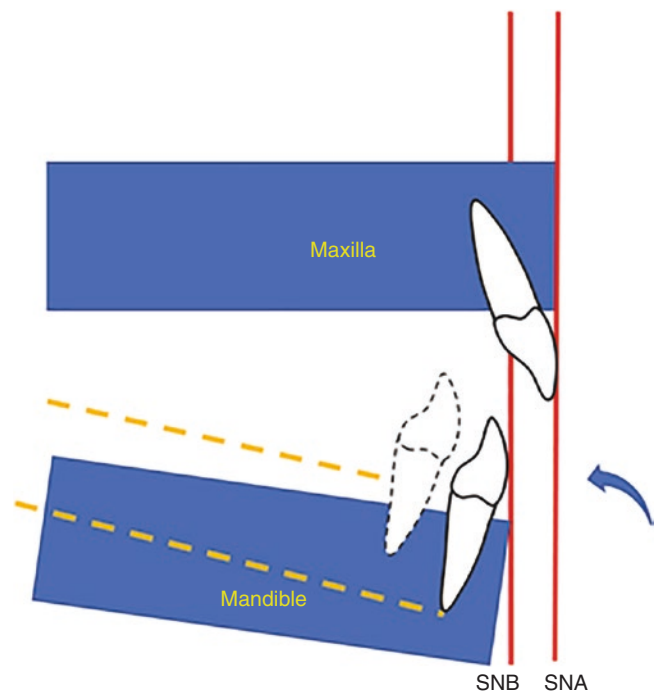


Fig. 4.4 Functional Class II relationship with a distally forced bite. From an anterior rest position, the mandible glides into a posterior habitual occlusion, under the influence of tooth guidance



Fig. 4.5 An extraoral picture of a 12-year-old boy at rest showed proclined maxillary incisors, his lower lip was trapped between the upper and lower anterior teeth

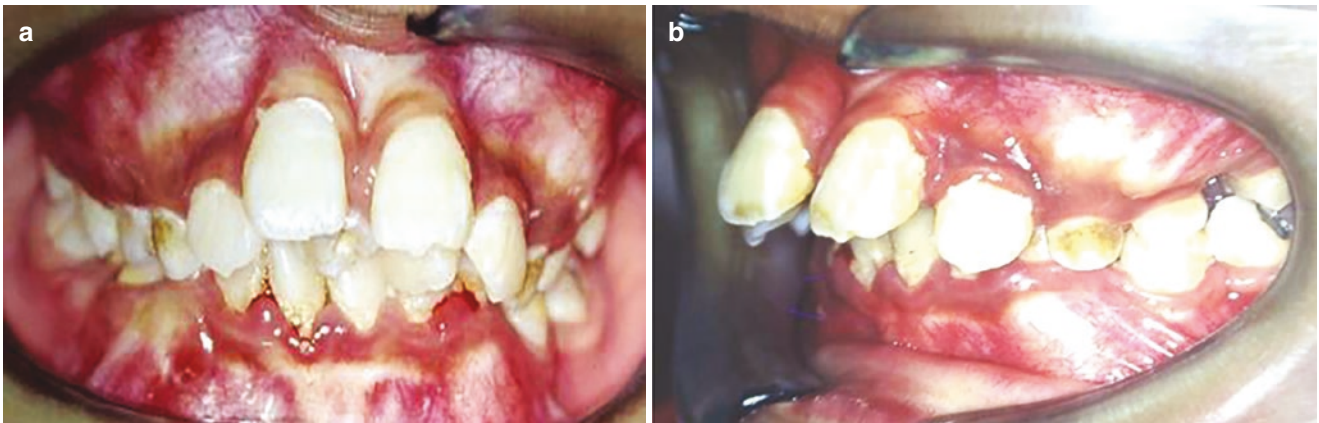


Fig. 4.6 (a, b) His intraoral pictures showed stage of mixed dentition; he had large overjet and poor oral hygiene

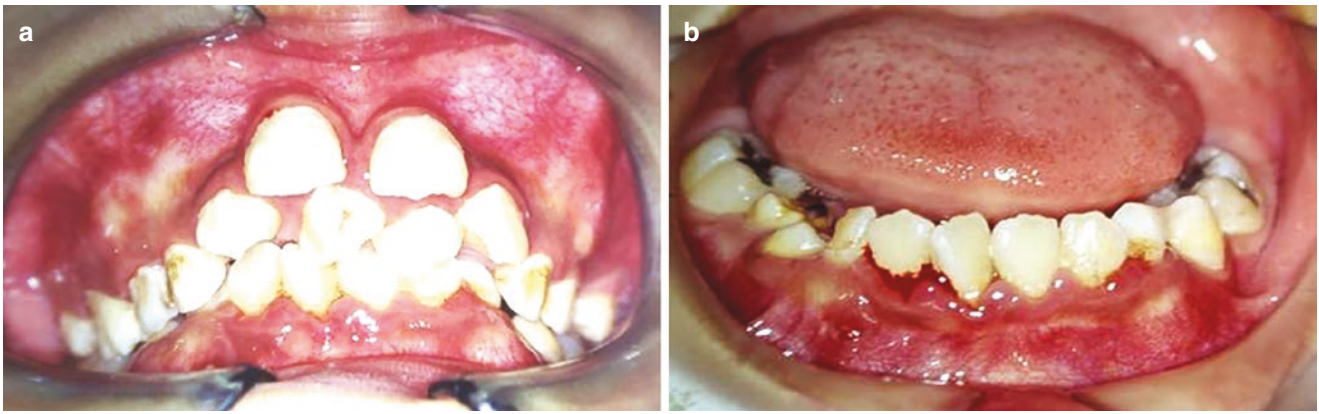


Fig. 4.7 (a, b) Intraoral pictures showed V-shaped maxillary arch form, two supernumerary teeth located posterior to the upper central incisors at the level of teeth # 12 and # 22. The lower arch form was

U-shaped (b); therefore, he could only occlude his teeth when he bit behind the supernumerary teeth



Fig. 4.8 His lateral cephalogram showed severe skeletal discrepancy between the maxilla and the mandible, as he could only occlude his teeth when he bit behind the supernumerary teeth

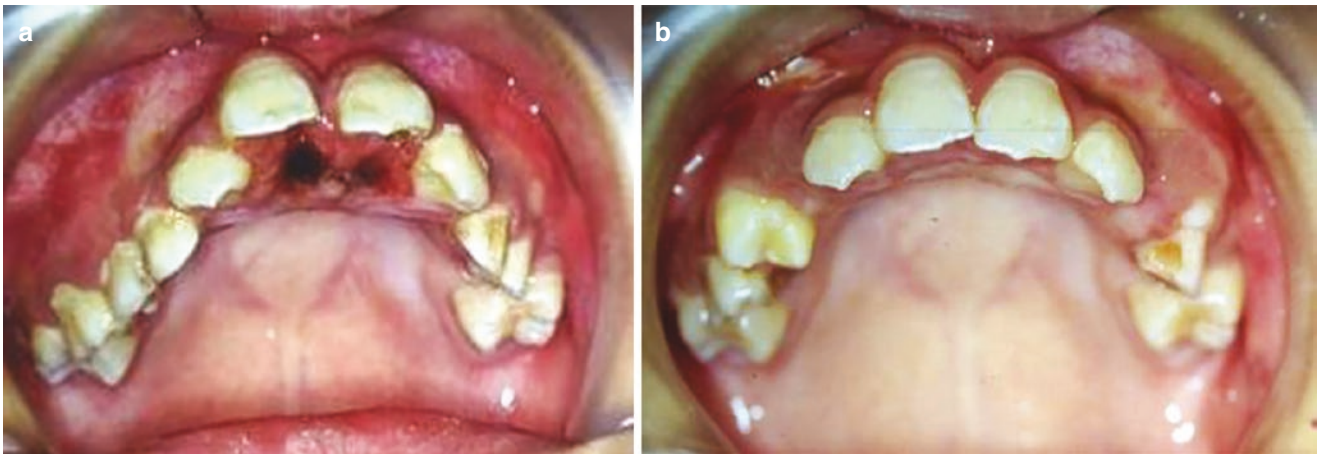


Fig. 4.9 (a, b) After the supernumerary teeth were extracted, the V-shaped upper arch gradually transformed into U-shaped

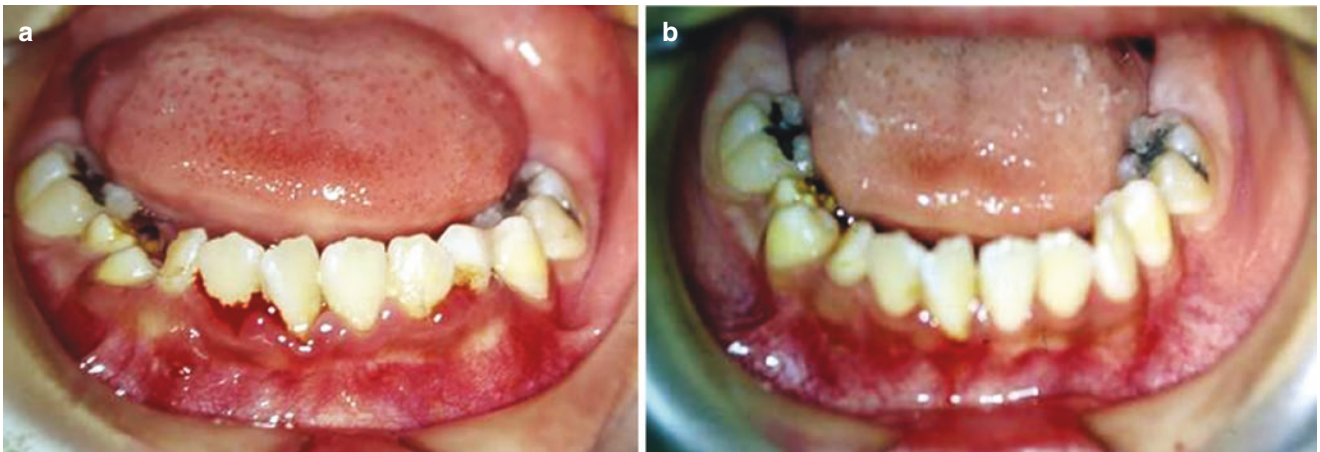


Fig. 4.10 (a, b) The lower arch transformed gradually as well to fit the transformed upper arch

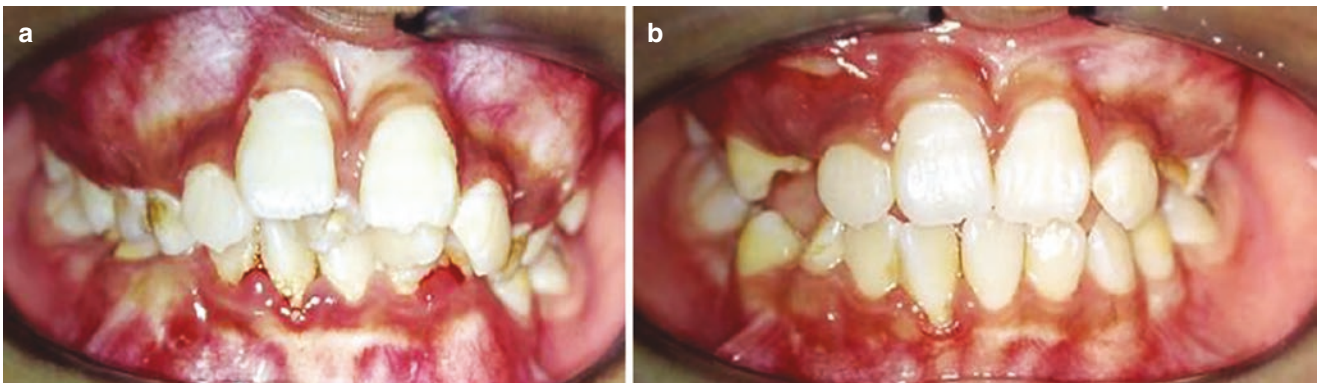


Fig. 4.11 (a, b) Intraoral pictures showed obvious changes occurred after extraction of the supernumerary teeth

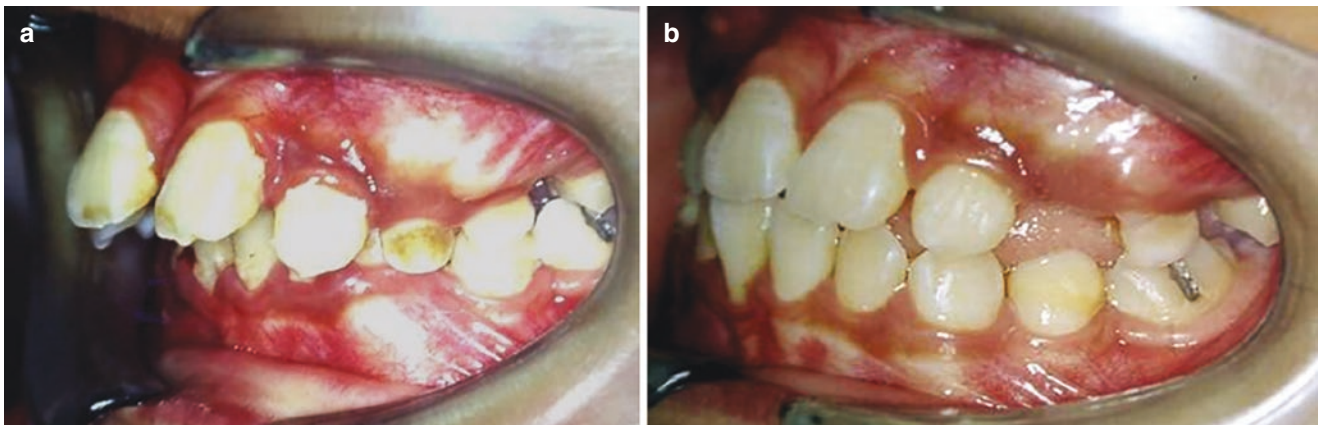


Fig. 4.12 (a, b) Improvement of both overjet and overbite

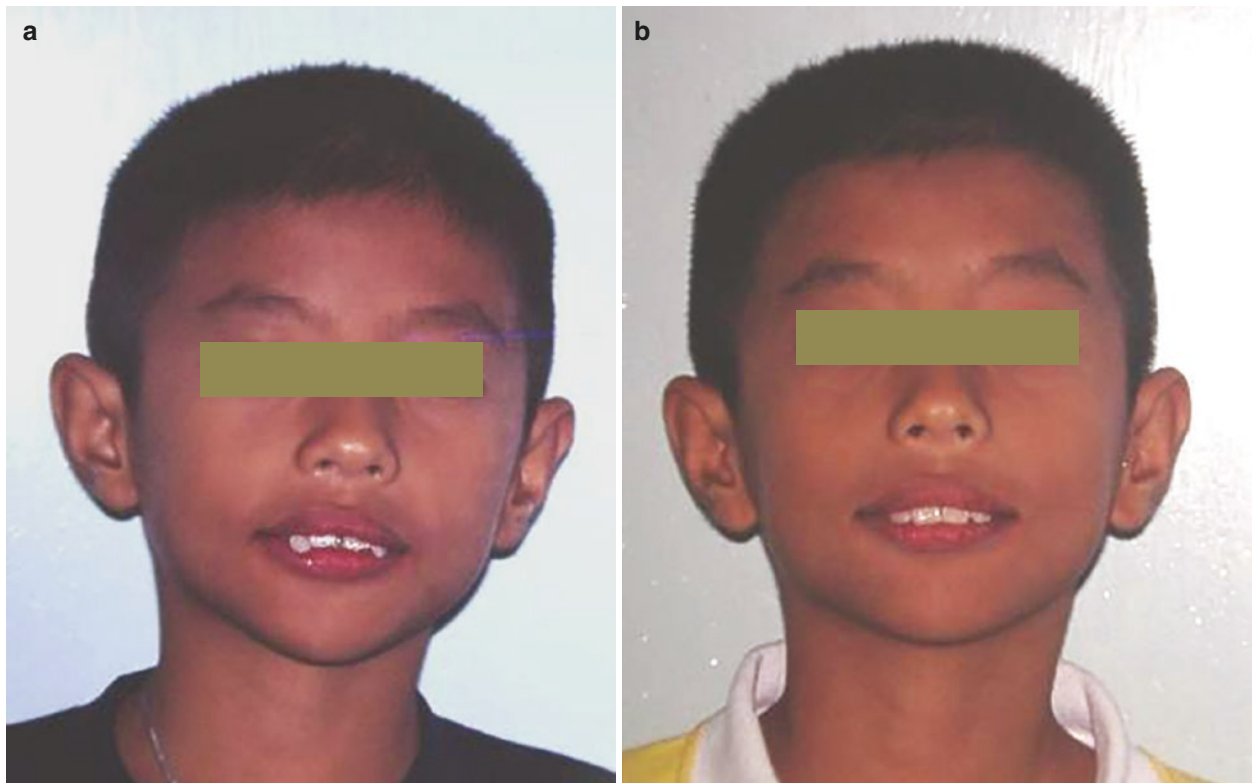


Fig. 4.13 (a, b) Comparison of extraoral pictures pre- (a) and postextraction of the supernumerary teeth (b); facial appearance and smile were improved

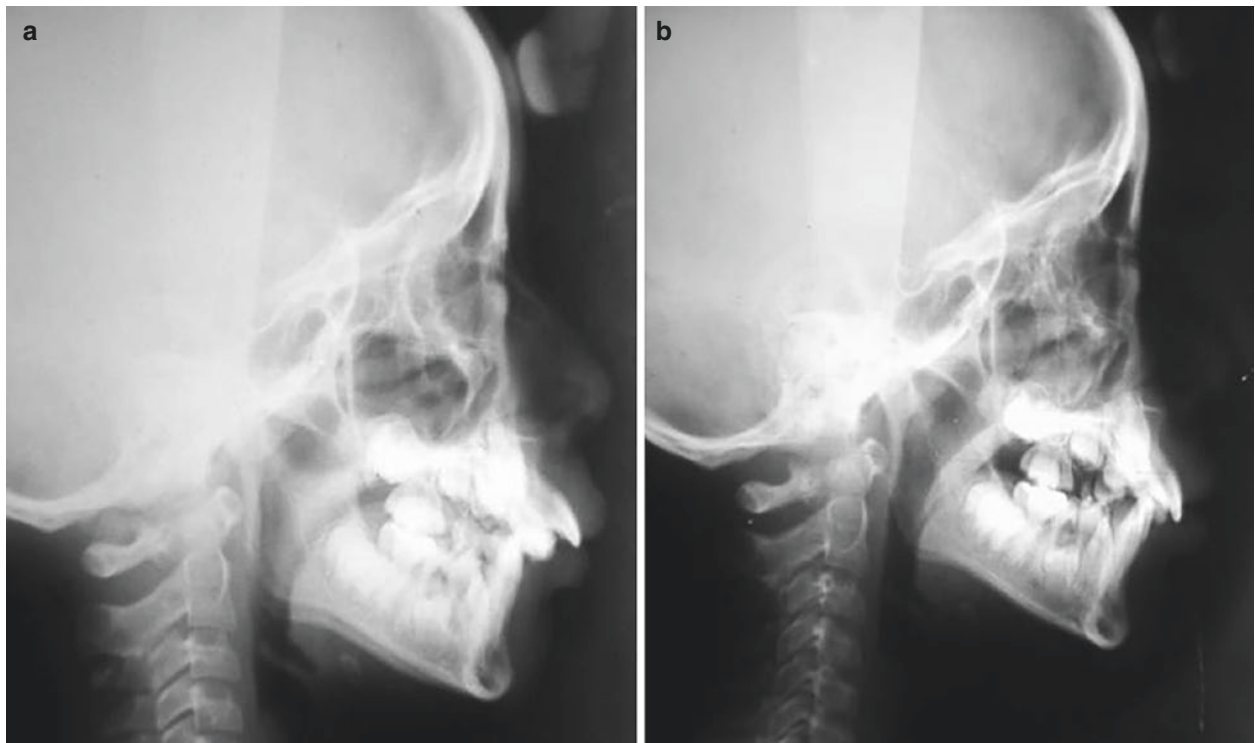


Fig. 4.14 (a, b) Comparison of his lateral cephalograms pre- and postextraction of the supernumerary teeth showed reduction of overjet as he could bite in a more forward position

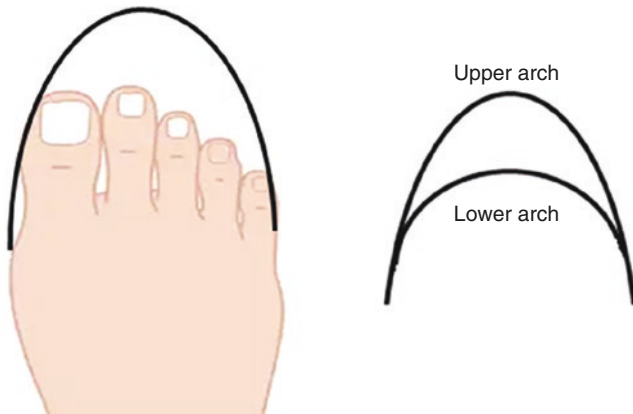


Fig. 4.15 The foot in figure represents U-shaped lower arch, could not slide forward to fit the narrow head shoe which represents the V-shaped upper arch

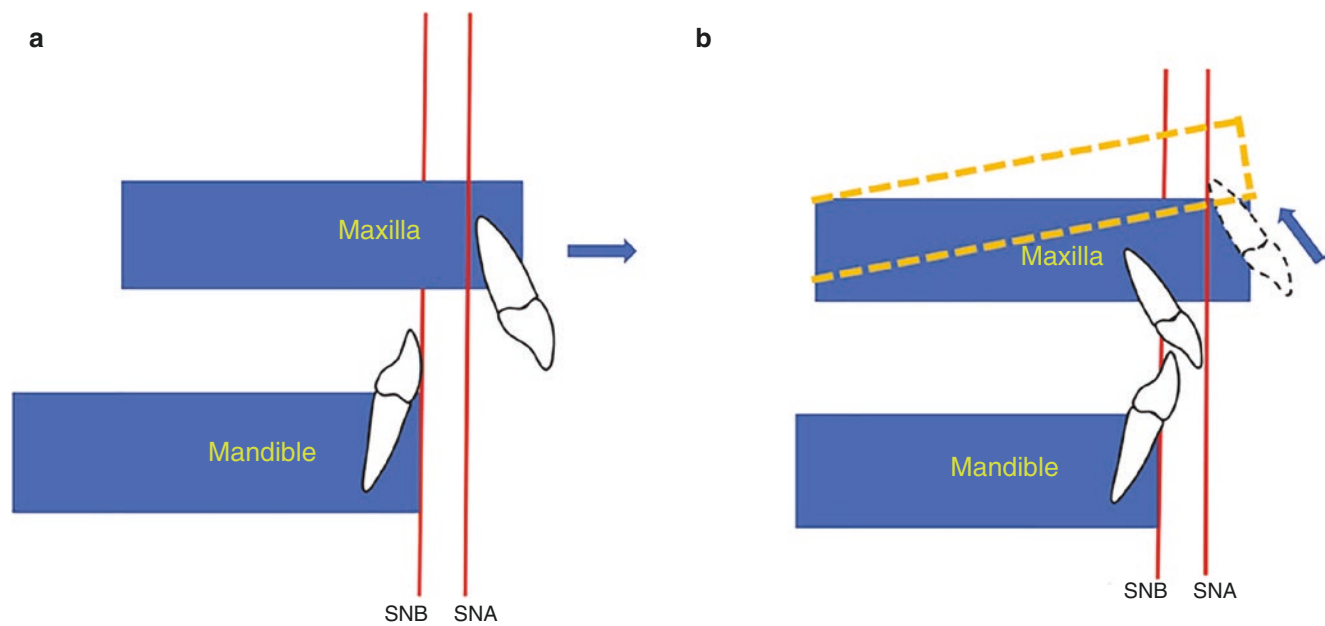


Fig. 4.16 (a) Skeletal Class II relationship with fault in the maxilla; maxilla is prognathic, mandible is orthognathic. (b) Skeletal Class II relationship with prognathism and ante-inclination of the maxilla (anterior end tipped up)

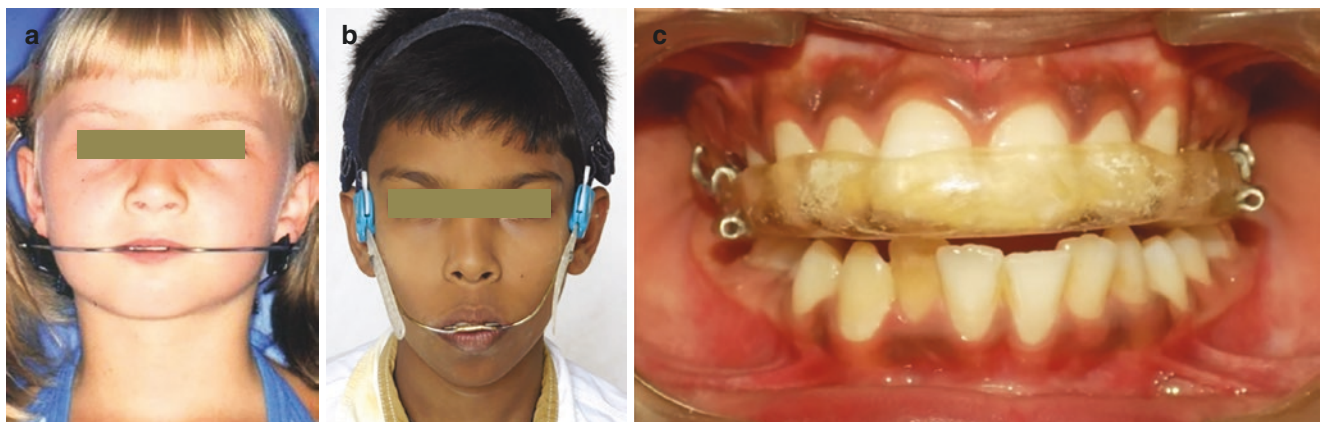


Fig. 4.17 (a) Cervical pull headgear. (b): High-pull headgear. (c) Splint with headgear tubes

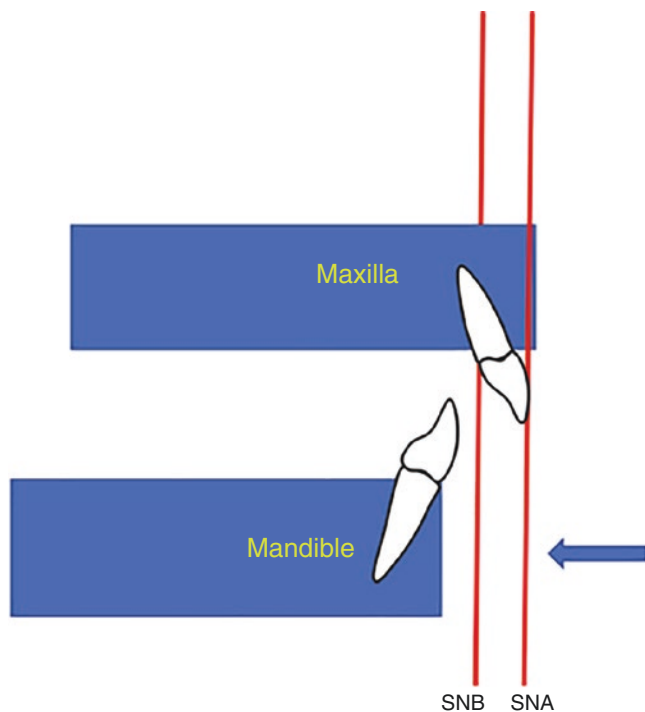


Fig. 4.18 Skeletal Class II relationship with fault in the mandible; maxilla is orthognathic and mandible is retrognathic

purpose. There are many roads to Rome; we should use the appliances which work best in our hands (Wishney et al. 2019).

Twin block, introduced by William J. Clark in 1977, is to be used in growing patient with retrognathic mandible and narrow maxillary arch (Clark and Clark 2014).

4.4.2 Case # 3 (Figs. 4.29, 4.30, 4.31, 4.32, 4.33, 4.34, 4.35, 4.36, and 4.37)

4.4.3 Case # 4 (Figs. 4.38, 4.39, 4.40, 4.41, 4.42, 4.43, 4.44, 4.45, 4.46, 4.47, 4.48, 4.49, 4.50, and 4.51)

After going through case # 2 to # 4, it can be concluded that different treatment approaches were used in each case, as all cases are unique. Therefore, we still have to emphasize on “treat at the right place, at the right time with proper appliances.”

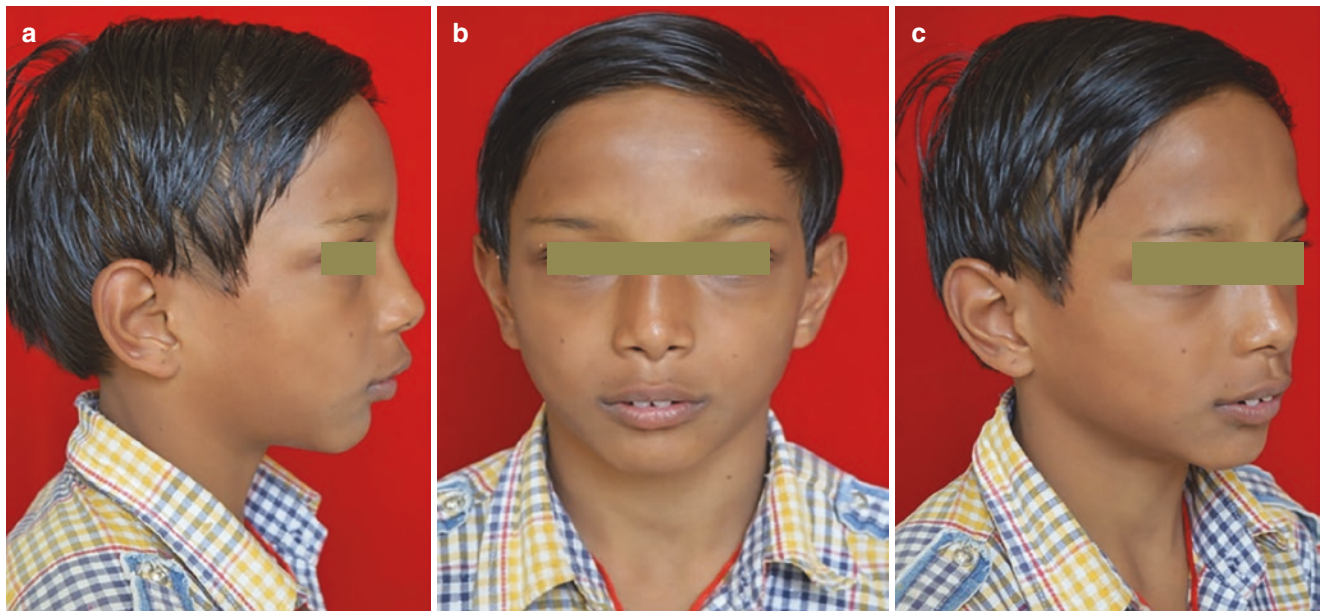


Fig. 4.19 (a–c) Extraoral pictures of a 12-year-old boy; he had convex facial profile and incompetent lips

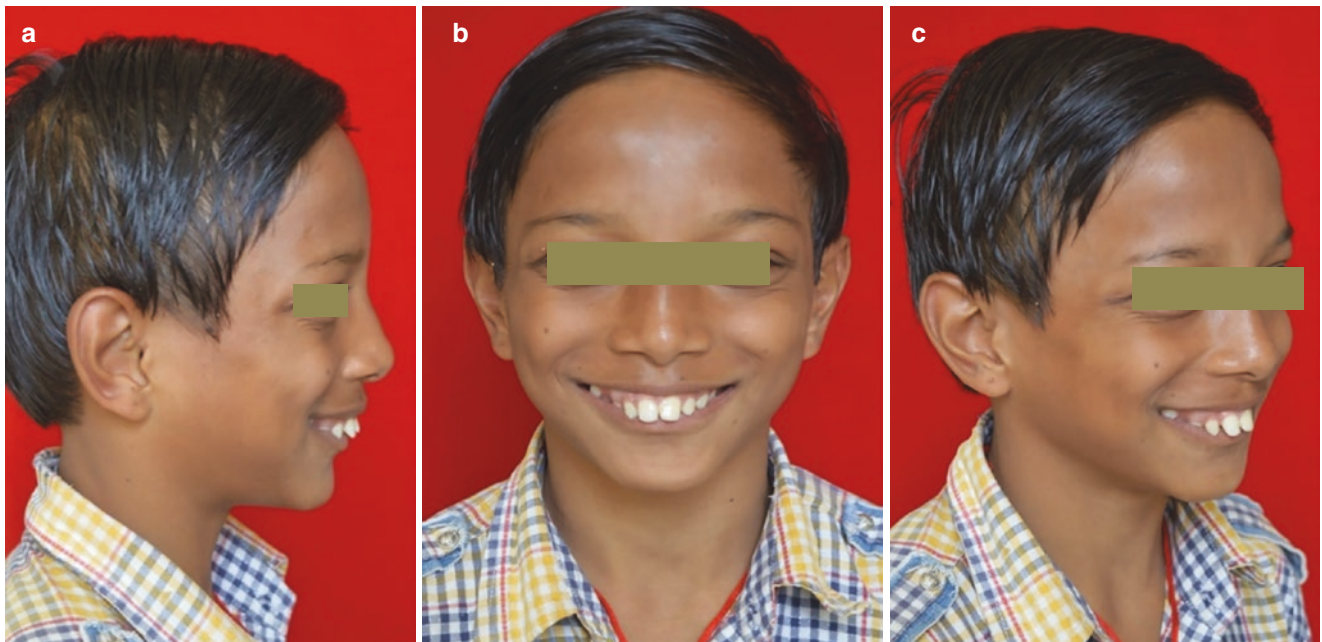


Fig. 4.20 (a–c) When smiling, his lower lip was trapped between the upper and lower anterior teeth, which could cause the upper anterior teeth to be more proclined and lower anterior teeth more retroclined

Fig. 4.21 (a, b) Visual treatment objective (VTO) program was used to predict the treatment outcomes

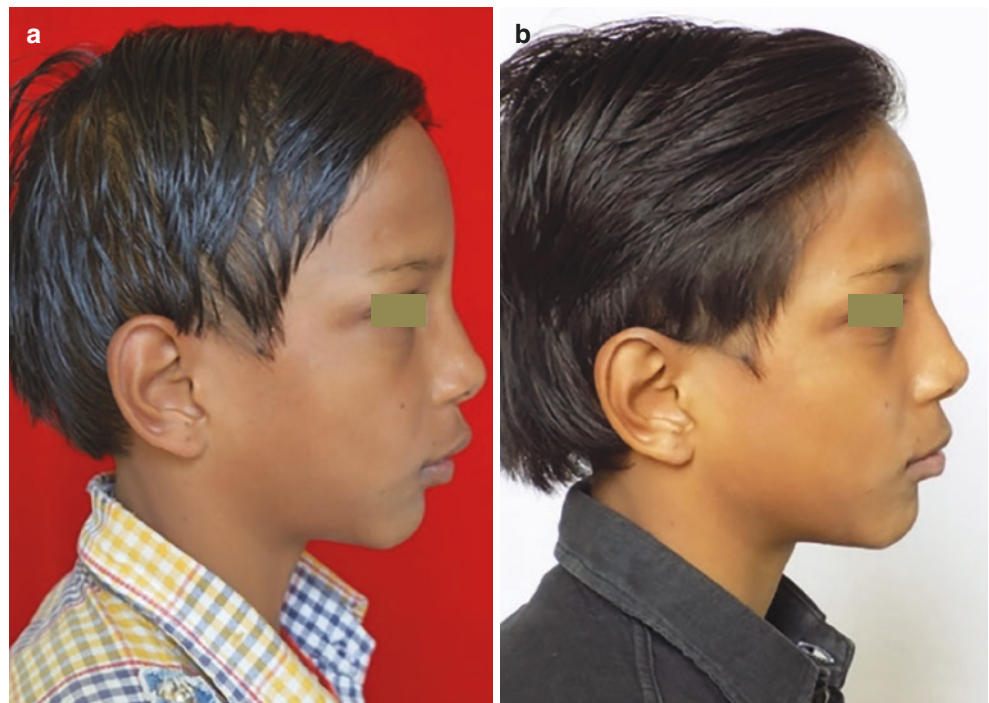




Fig. 4.22 (a–e) His intraoral pictures showed stage of late mixed dentition; he had V-shaped upper arch and U-shaped lower arch, Class II molar relationships and Class II canine relationship on the left side, while on the right side canine relationship could not be identified. He

had transposition of tooth # 13 (a, b, d), retention of tooth # 53, proclined upper anterior teeth, large overjet, and mild spacing in the upper arch



Fig. 4.23 (a–e) Twin block with expansion screw in the upper plate in situ (Maspero et al. 2015)

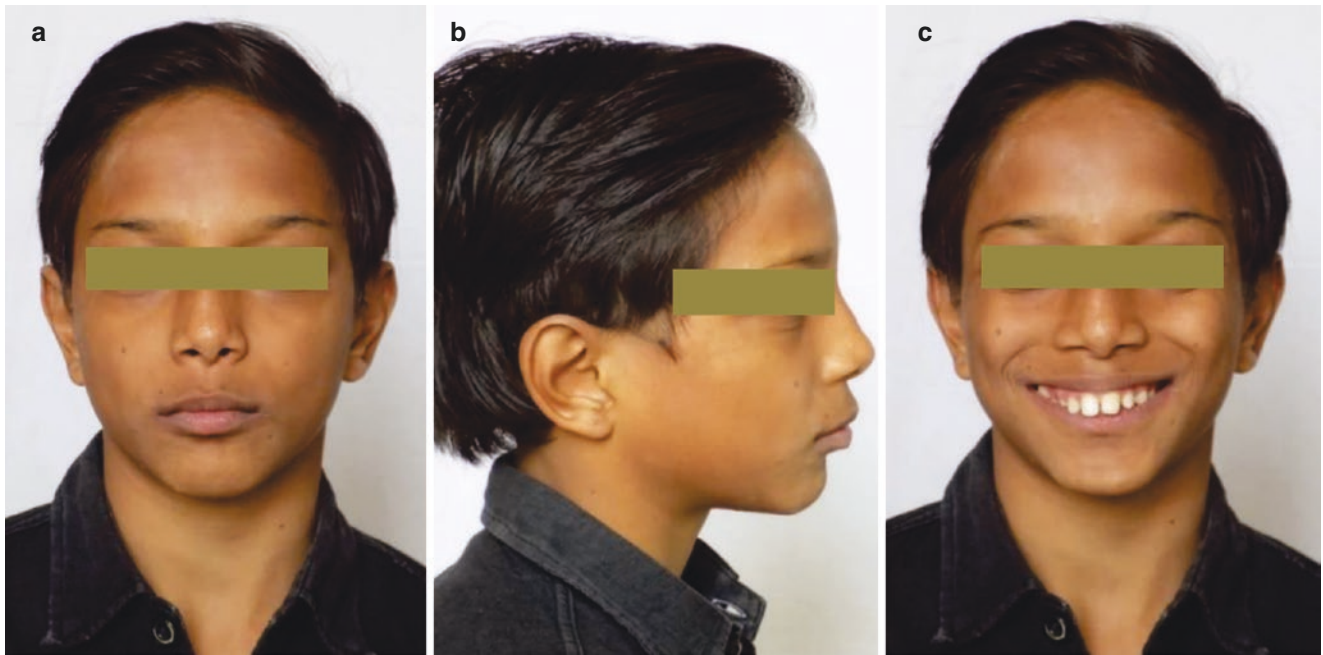


Fig. 4.24 (a–c) Extraoral pictures of post twin block treatment; he had more pleasing profile and pleasing smile due to forward movement of the mandible



Fig. 4.25 (a–e) Post-twin block intraoral pictures showed the mandible moved anteriorly. Class I molar relationships and Class I canine relationship on the left side and decreased overjet and decreased over-

bite could be seen here. Upper arch was expanded transversally (d) and fit well with the lower arch (e)



Fig. 4.25 (Continued)

Fig. 4.26 (a, b) Comparison of lateral cephalograms pre- and post-twin block showed the mandible in a more anterior position with reduction of overjet and overbite (Mills and McCulloch 1998)

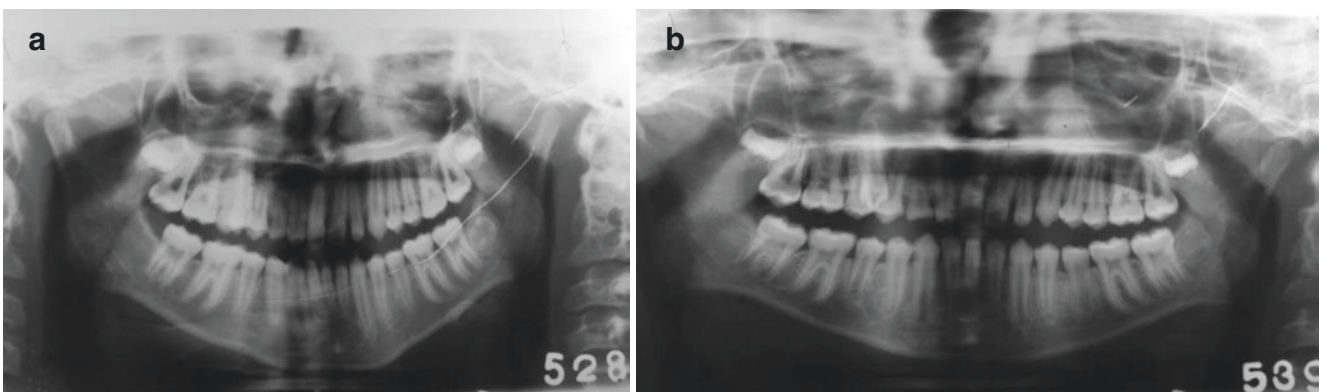
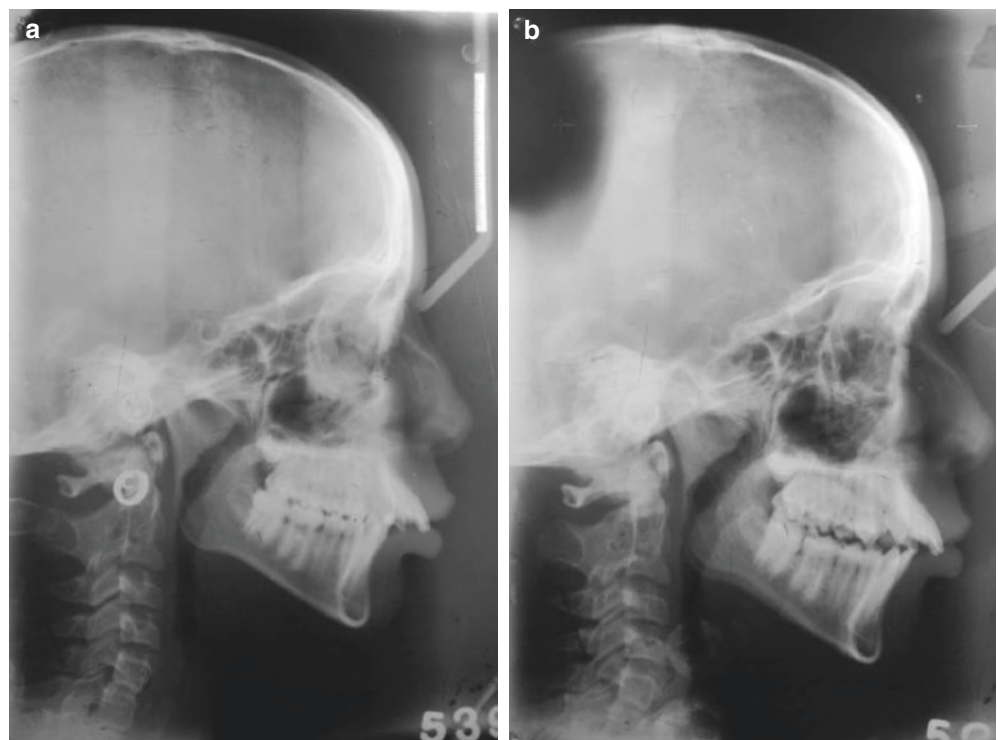


Fig. 4.27 (a, b) Orthopantomogram (OPG) pre- and post-twin block showed transposition of tooth # 13 and retention of # 53



Fig. 4.28 (a–e) Second phase treatment with fixed appliance to align tooth # 13 was one of the main objectives. Two alternatives were considered, either place it in between teeth # 14 and # 15 or move it forward to replace tooth # 53

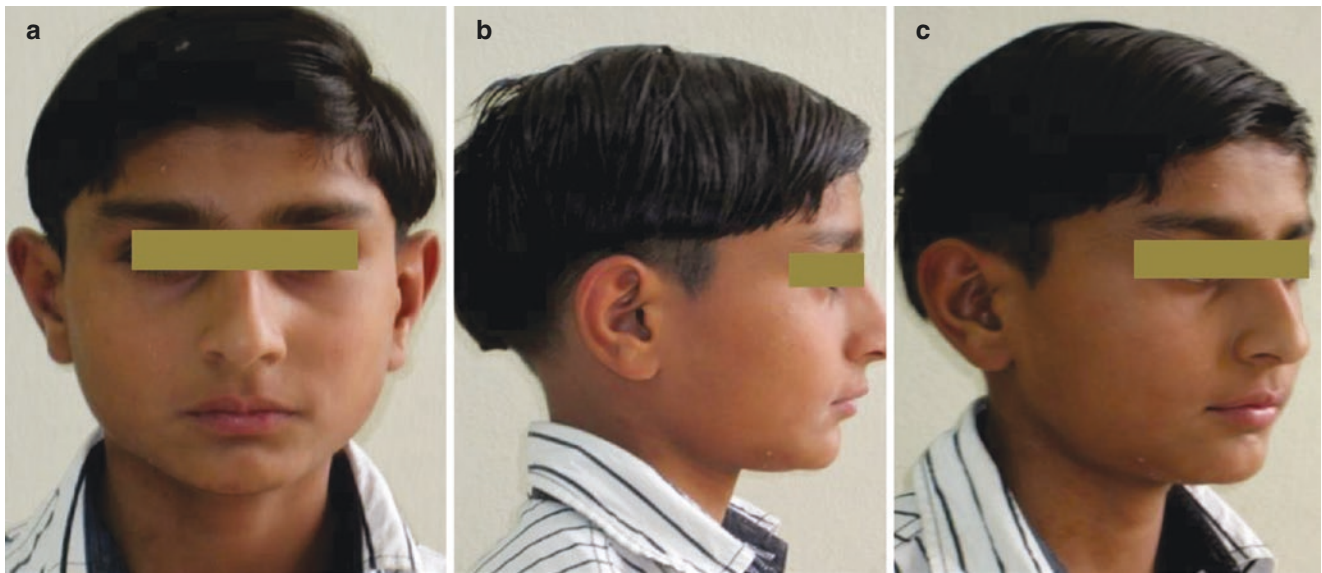


Fig. 4.29 (a–c) Extraoral pictures of a 12-year-old boy showed convex facial profile; he had competent lips and strong mentalis muscle

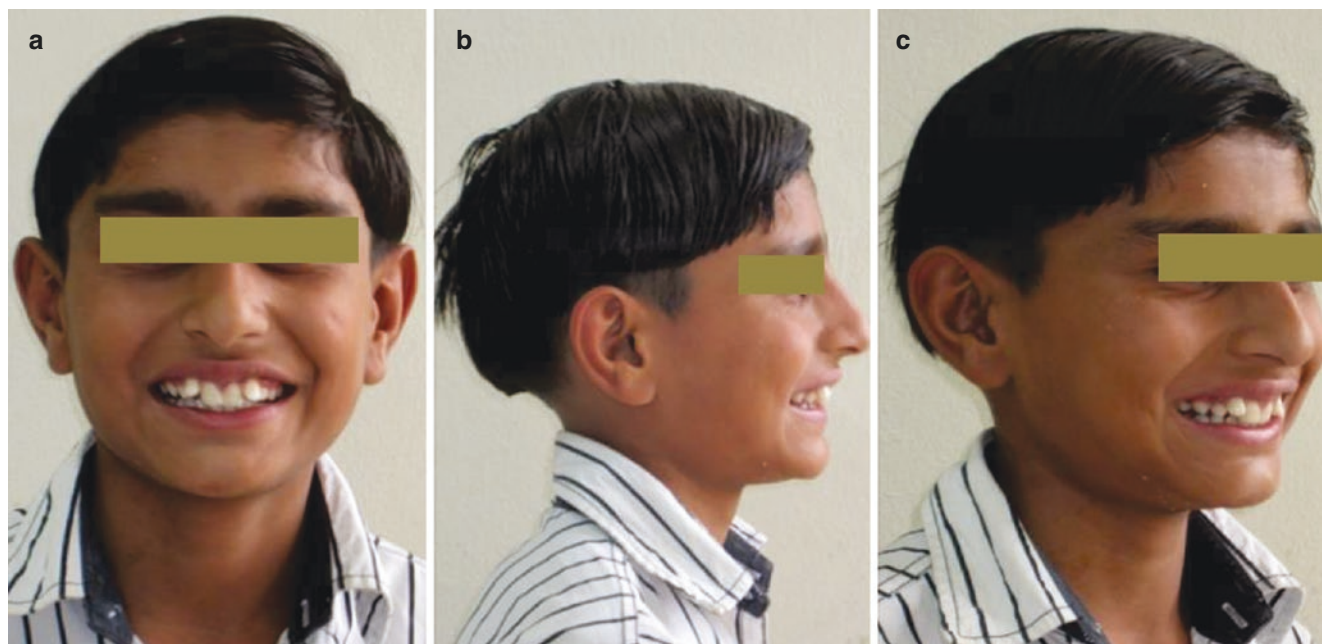


Fig. 4.30 (a–c) When smiling, typical pattern of Class II div.2 incisor pattern could be obviously seen here



Fig. 4.31 (a–e) Pretreatment intraoral pictures showed stage of mixed dentition. His dentition showed typical Class II Div.2 features; Class II molar relationships, retroclined upper central incisors, proclined upper lateral incisors, 80–90% deep bite, and reduced overjet

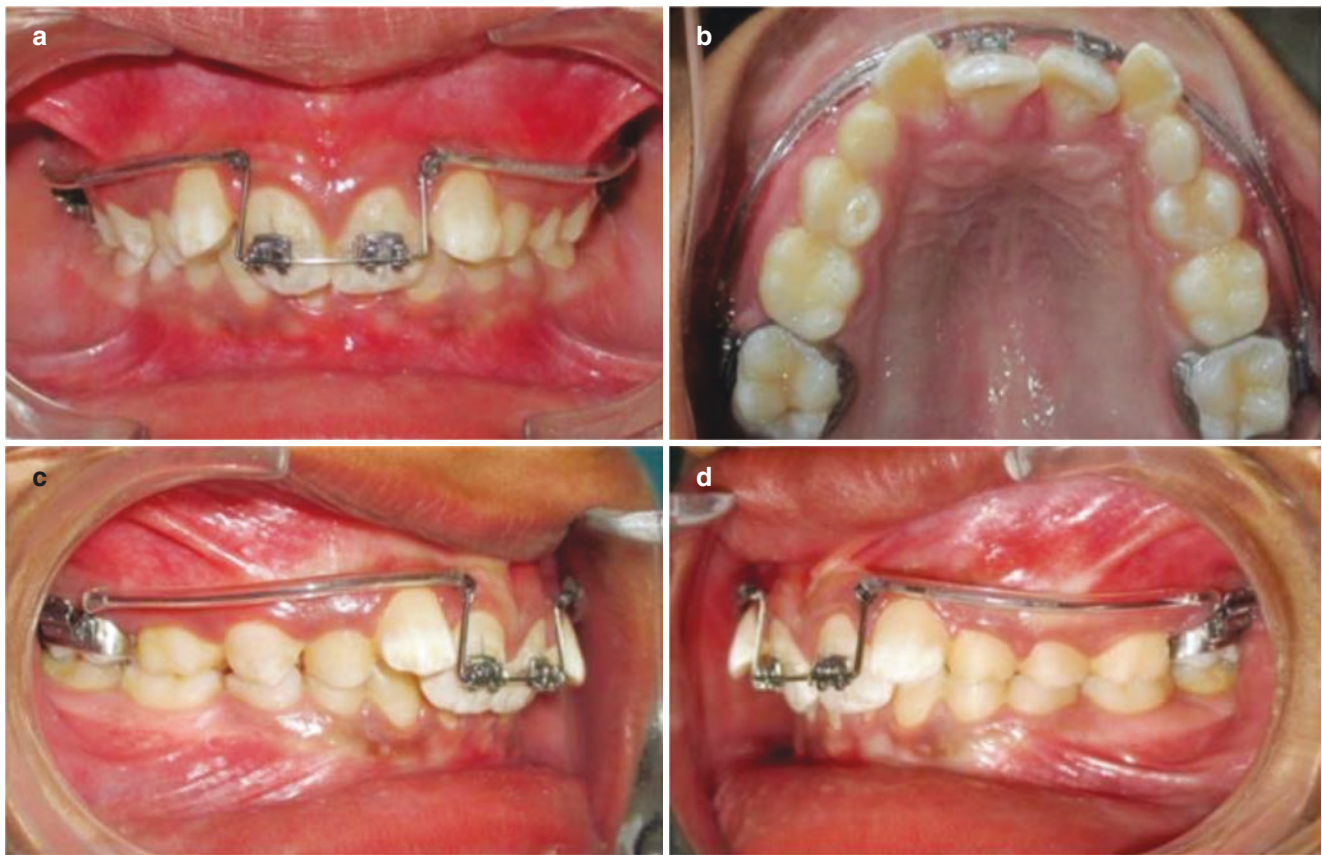


Fig. 4.32 (a–d) Intraoral pictures; modified protraction utility arch was used to alter axial inclination angle of upper central incisors



Fig. 4.33 (a–c) Intraoral pictures after correction of axial inclination angle of upper central incisors; the mandible could then be brought in a more anterior position by using twin block

Fig. 4.34 (a–d) Twin block with expansion screw in the upper plate in situ

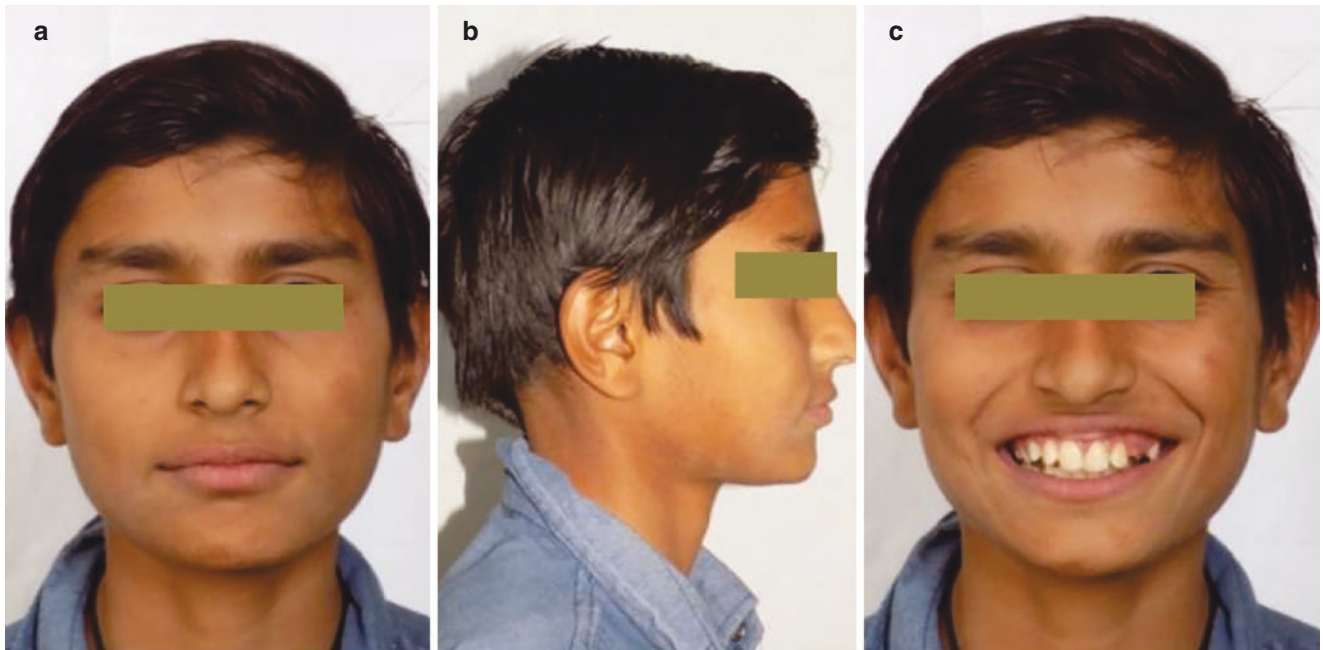
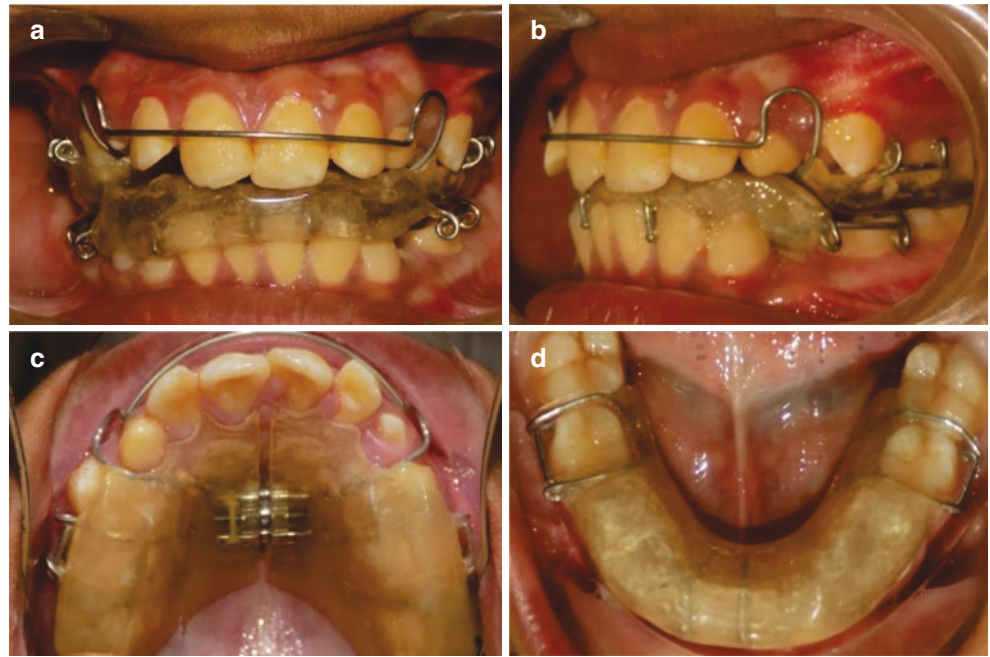


Fig. 4.35 (a–c) Extraoral pictures of post-twin block; he had competent lips, nice smile, and more pleasing profile due to forward movement of the mandible



Fig. 4.36 (a–e) Intraoral pictures of post-twin block showed stage of mixed dentition still; Class I molar relationships with acceptable overjet and over bite, tooth # 23 was erupting into oral cavity

Fig. 4.37 (a–c) second phase treatment with fixed appliances to optimize treatment results

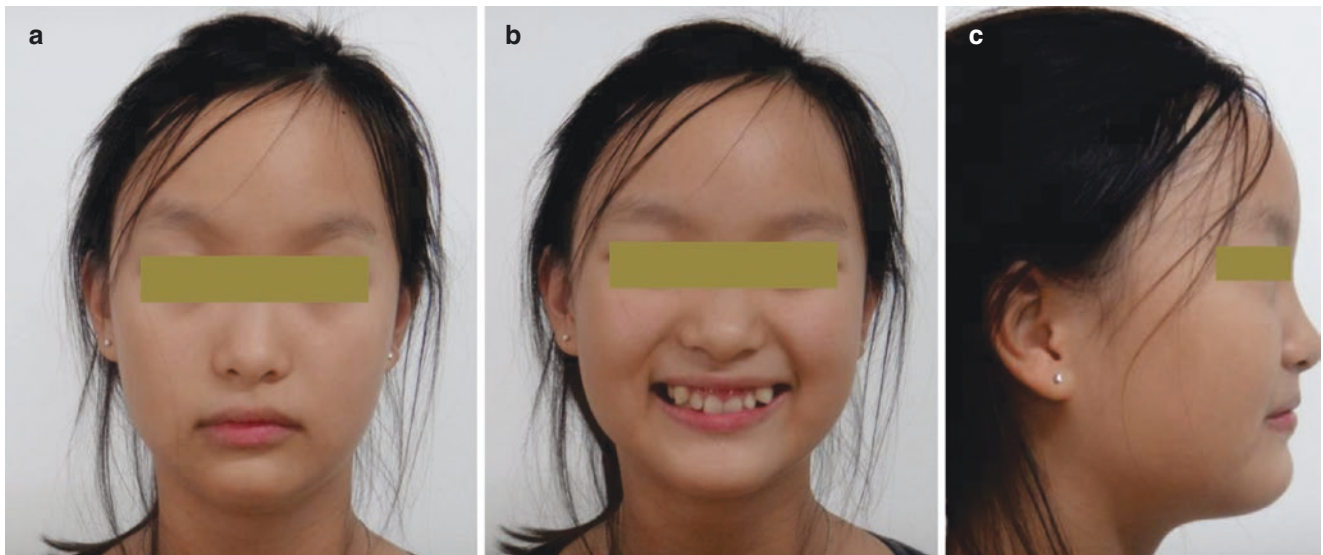
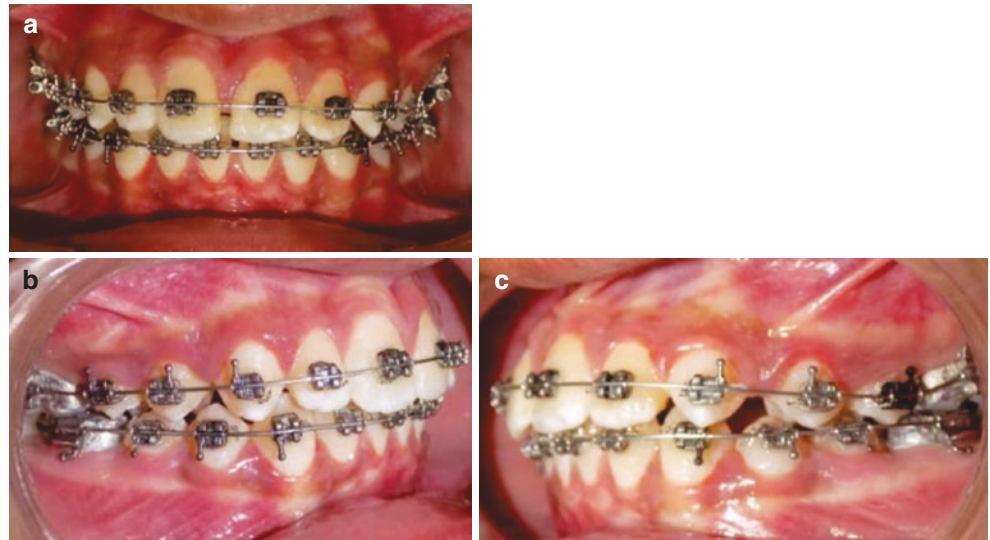


Fig. 4.38 (a–c) Extraoral pictures of a 10-year-old girl showed gummy smile and typical Class II div.2 incisors pattern

Fig. 4.39 (a–e) Intraoral pictures showed stage of mixed dentition; Class II molar relationships and Class II canine relationships with square-shaped upper arch, complete cover bite, typical Class II div.2 incisors pattern, retroclination of teeth # 13 and #23, scissor bite at teeth # 24 and # 34, and severe crowding of teeth in the lower arch



Fig. 4.40 (a–c) Intraoral pictures showed the upper teeth from teeth # 16 to # 26 were bonded with exception of teeth # 55 and # 65; NiTi wire was engaged to all bonded teeth except # 14 and # 24, in order to procline all teeth from the upper right canine to the upper left canine

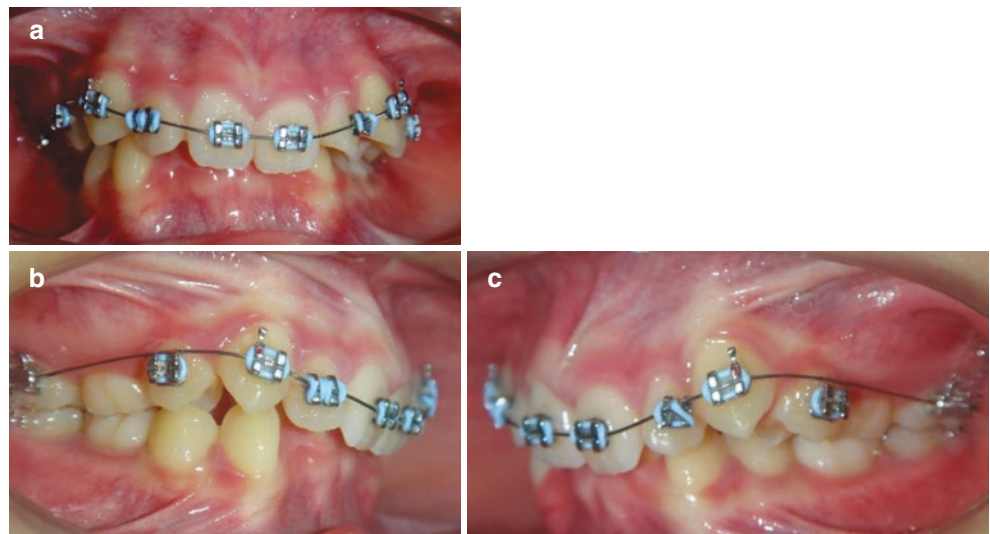


Fig. 4.41 (a, b) Extraoral pictures during the treatment showed a beautiful smile with good smile line, smile arc, and good buccal corridors. Change in axial inclination of the upper teeth could be seen in Fig. b

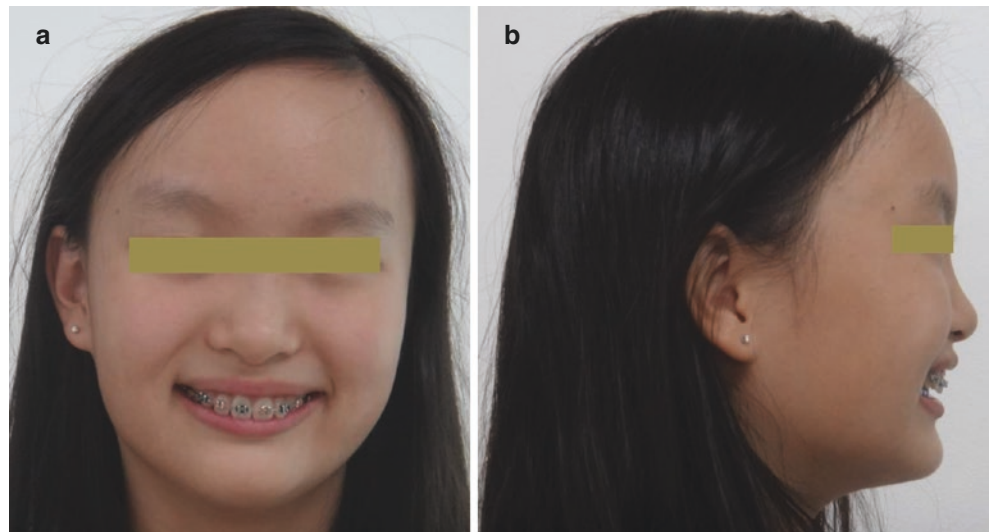


Fig. 4.42 (a–e) Intraoral pictures during the treatment showed some of the lower teeth were bonded, raised bites on teeth # 14, # 16, # 24, and #26 to align the lower teeth and to unlock the mandible. Tooth # 45 was erupting and teeth # 55, # 65, and # 75 were still present

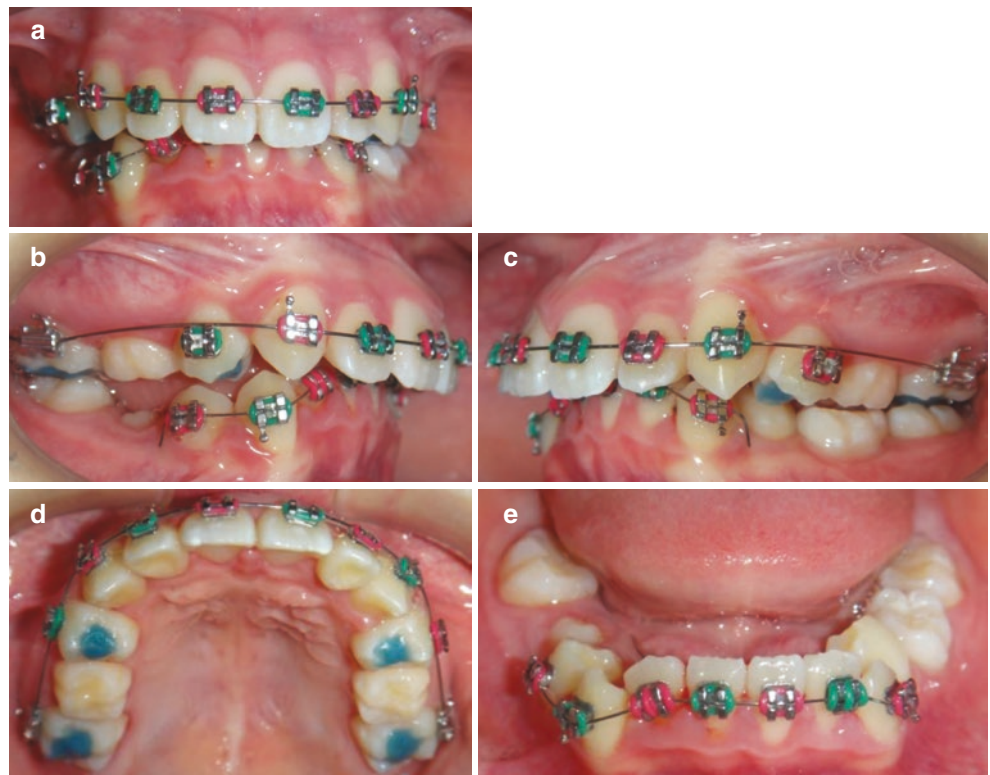


Fig. 4.43 (a, b) Comparison of extraoral pictures at rest, pre-, and during treatment showed improvement of frontal facial profile



Fig. 4.44 (a, b) Comparison of extraoral pictures when smiling; pre- and during treatment showed no more gummy but beautiful smile

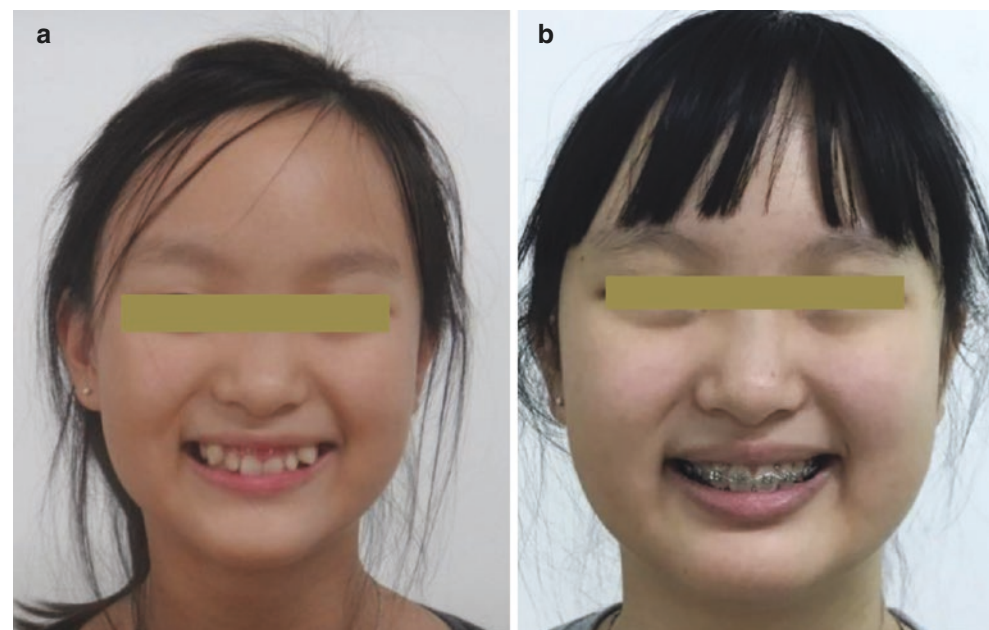


Fig. 4.45 (a, b) Comparison of lateral facial profile; pre- and during treatment showed satisfactory improvement

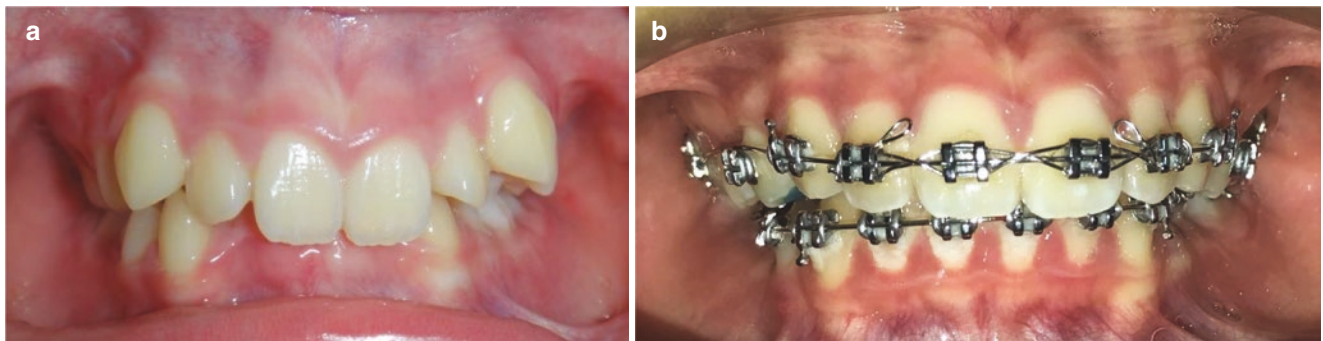
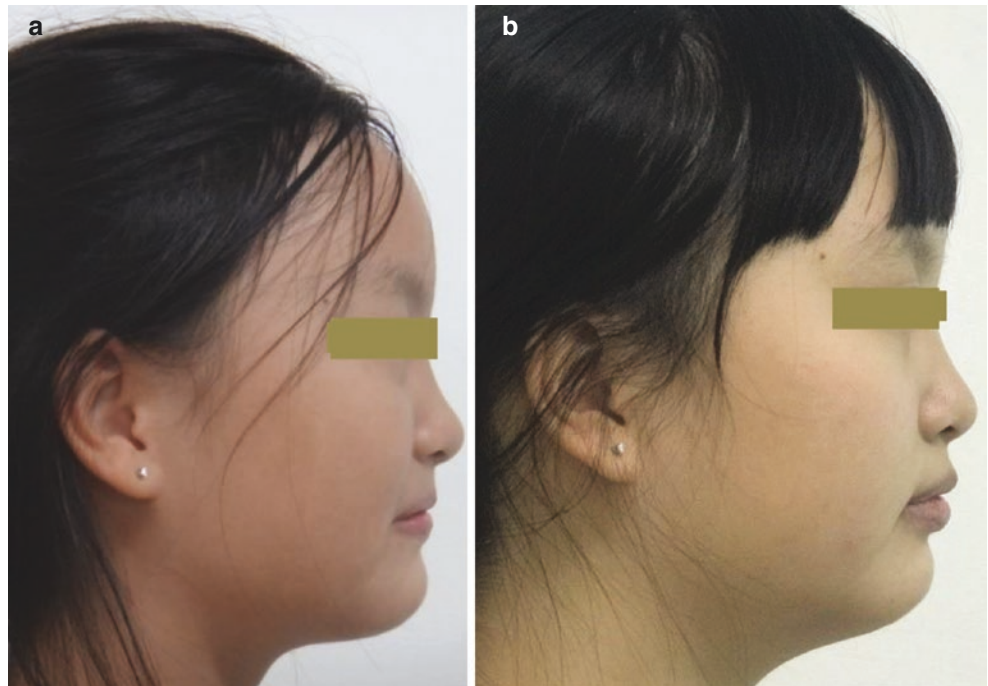


Fig. 4.46 (a, b) Comparison of intraoral pictures from frontal view; pre- and during treatment showed improvement of upper and lower arch forms; upper and lower anterior teeth became less crowded, improvement of the overjet and overbite

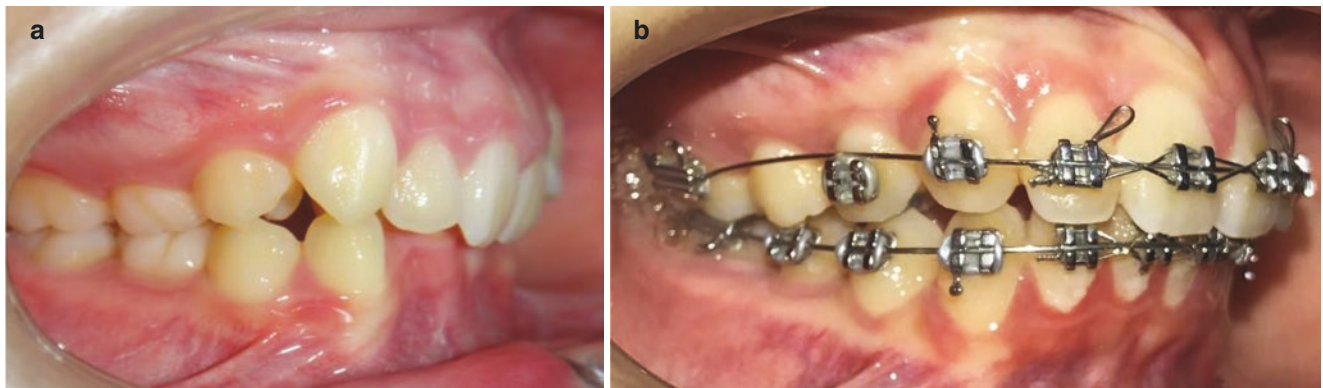


Fig. 4.47 (a, b) Comparison of intraoral pictures from the right side; pre- and during treatment; Class I molar relationship was achieved, improvement of axial inclination of upper and lower anterior teeth as well as overjet and overbite

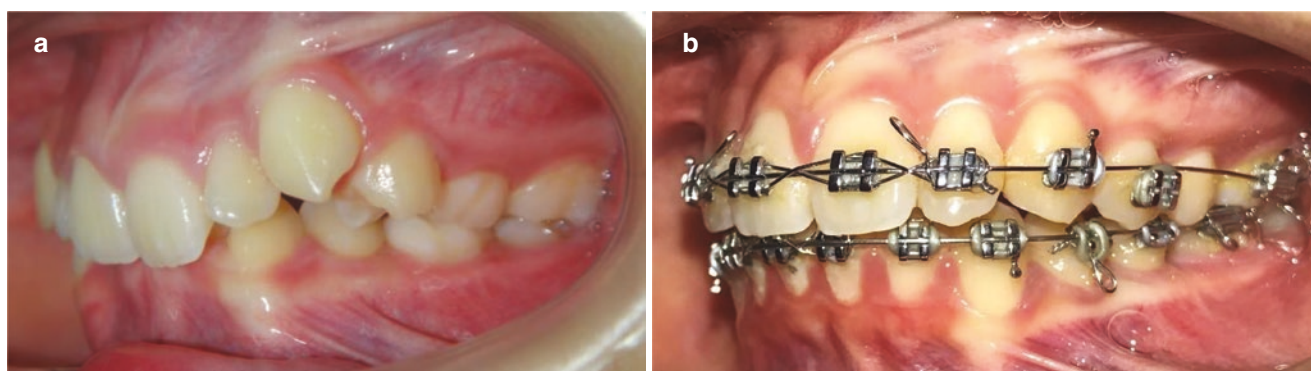


Fig. 4.48 (a, b) Comparison of intraoral pictures from the left side; pre- and during treatment; Class I molar relationship was achieved, improvement of axial inclination of upper and lower anterior teeth as well as overjet and overbite

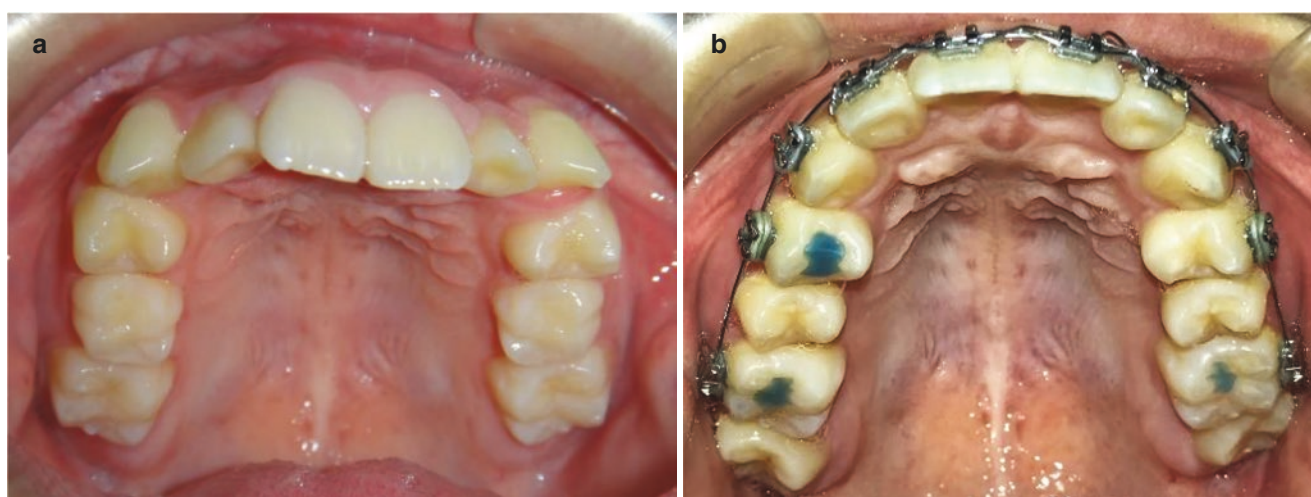


Fig. 4.49 (a, b) Comparison of intraoral pictures of the upper arch; pre- and during treatment, the upper teeth aligned nicely in a new well-formed upper arch

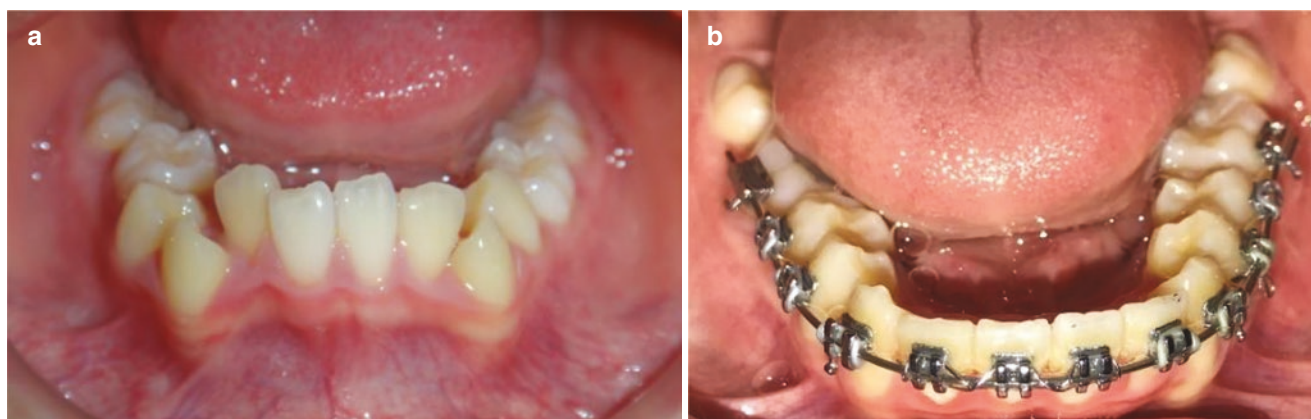


Fig. 4.50 (a, b) Comparison of intraoral pictures of the lower arch; pre- and during treatment, the lower teeth aligned nicely in a new well-formed lower arch

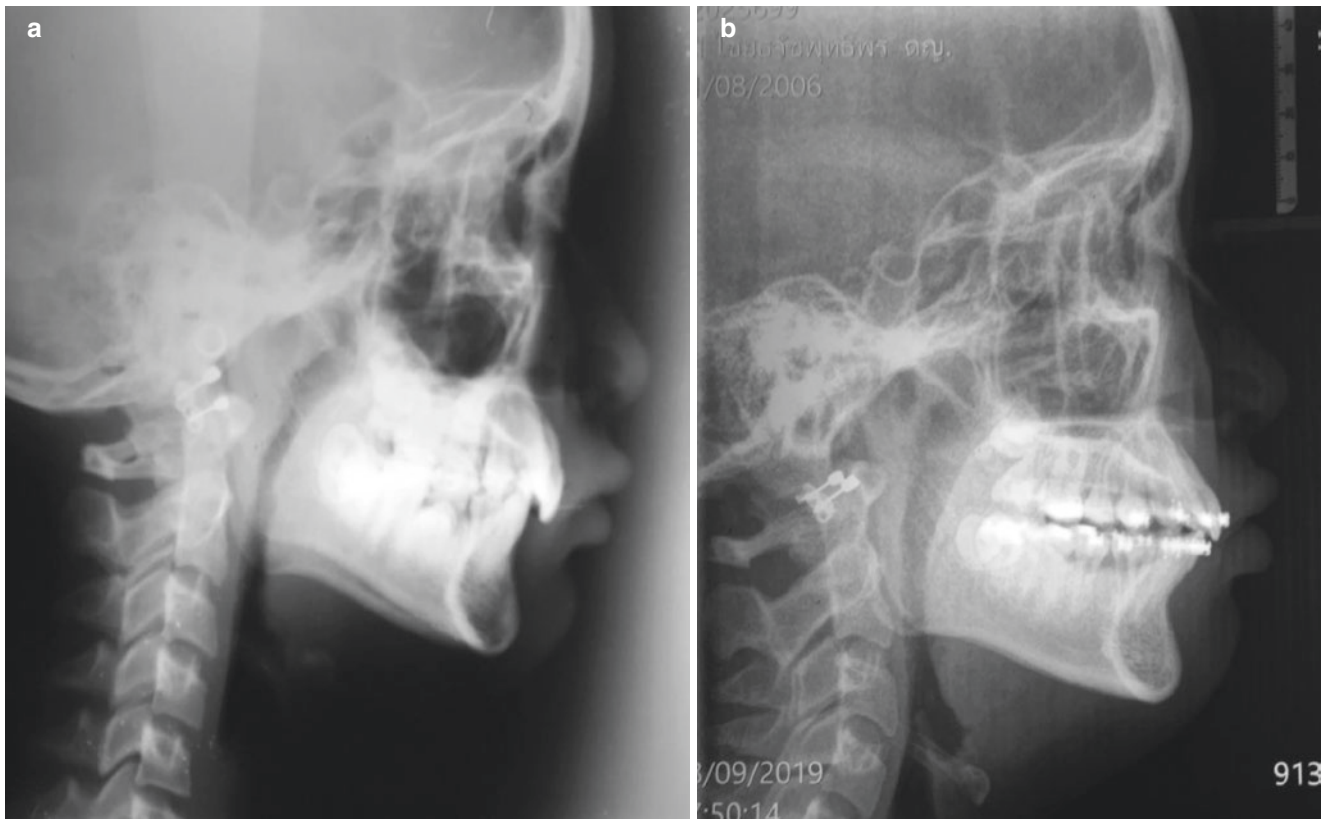


Fig. 4.51 (a, b) Lateral cephalograms pre- and during treatment showed improvement of lateral skeletal profile as well as the overjet and overbite

4.5 Skeletal Class II with Fault in both the Maxilla and the Mandible

Activator introduced by Viggo Andresen in 1908 was one of the first functional appliances used to correct jaw discrepancy in growing patients. Applications for the use of the Activator included Class II div.1, Class II div.2, Class III, and anterior open-bite cases (Luder 1982).

For skeletal Class II malocclusion with fault in both the maxilla and the mandible; Luder recommended Activator with thin construction bite, which would lead to improvement in mandibular retrognathism and reduction in maxillary prognathism (Luder 1982).

4.5.1 Case # 5 (Figs. 4.52, 4.53, 4.54, 4.55, 4.56, 4.57, 4.58, 4.59, and 4.60)

4.5.2 Case # 6 (Figs. 4.61, 4.62, 4.63, 4.64, 4.65, 4.66, 4.67, 4.68, and 4.69)

In this case, we used Activator to advance the mandible and headgear to control maxillary growth (Bhardwaj et al. 2020).

As mentioned previously, case analysis is very important. After comparing chronologic age, dental age, and skeletal age in this case, the patient was still in a stage of active growth. To use functional appliance with orthopedic extra-oral appliance would have a great chance to success in solving malocclusion.

So, Activator with high-pull headgear were used in this case to advance the mandible and to inhibit growth of the maxilla along with correction of maxillary ante-inclination.

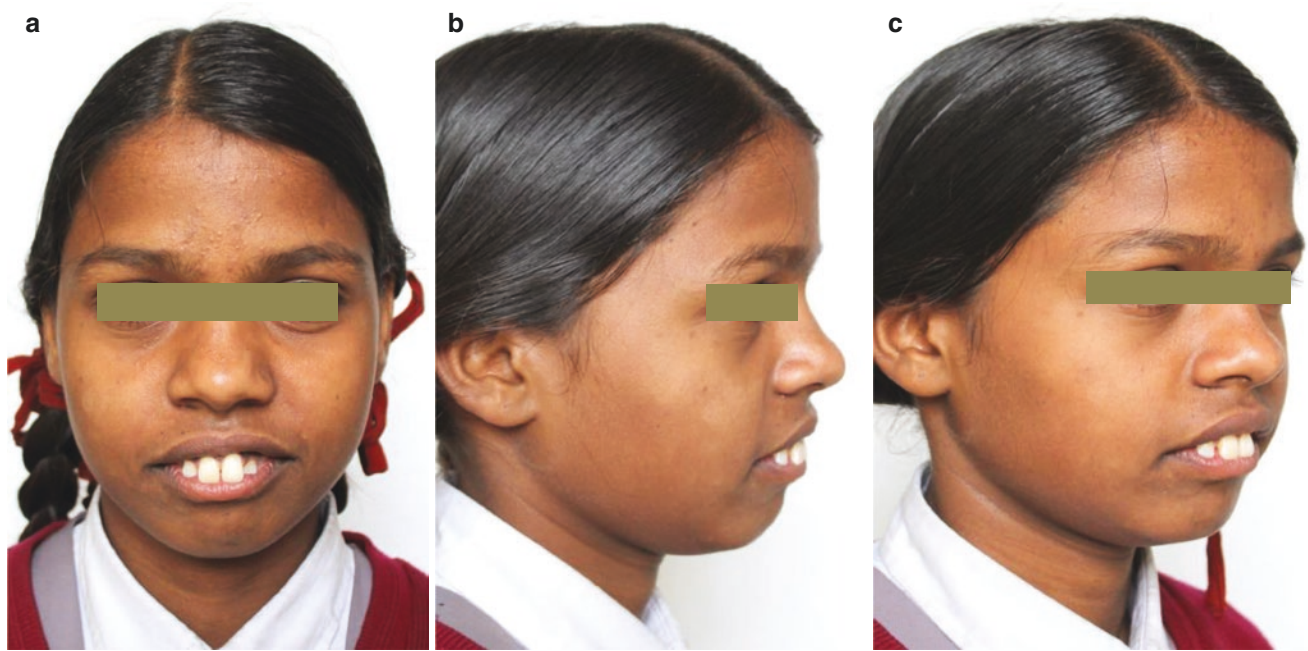


Fig. 4.52 (a–c) Extraoral pictures of a 12-year-old girl showed convex facial profile; protruding upper anterior teeth and lower lip trapped between upper and lower anterior teeth

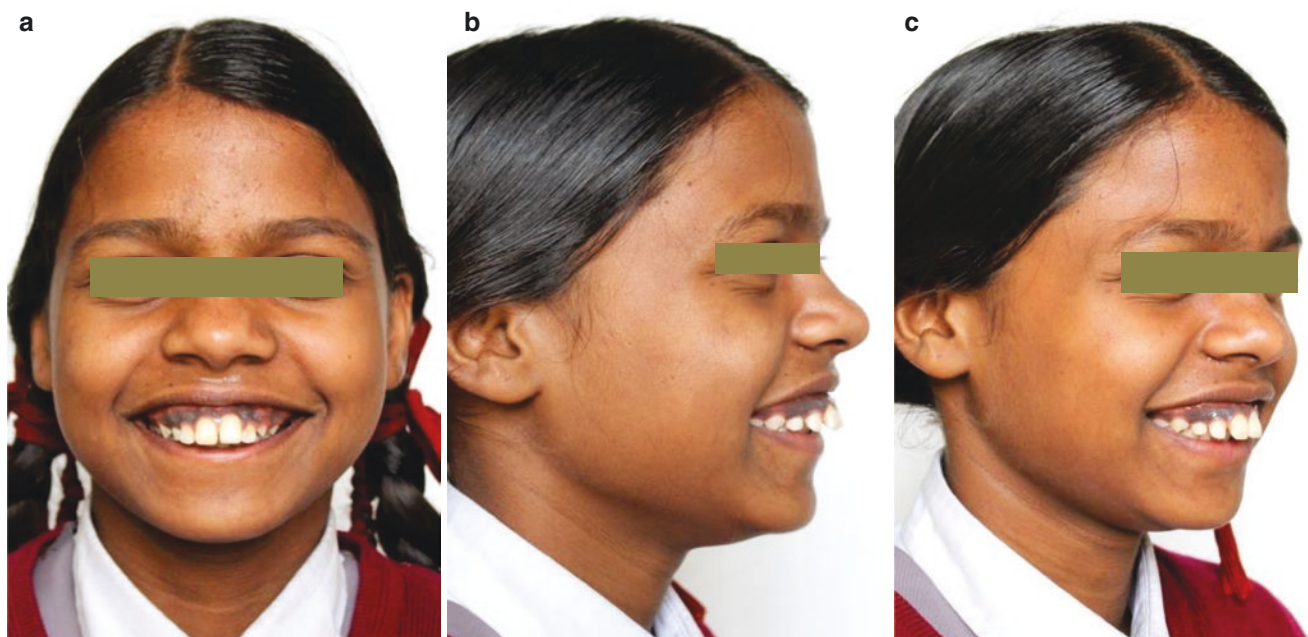


Fig. 4.53 (a–c) When smiling she showed gummy smile, prognathic maxilla, and protruding upper anterior teeth



Fig. 4.54 (a–e) Intraoral pictures showed stage of mixed dentition, Class II molar relationships with large overjet and deep overbite. Tooth # 33 was erupting lingual to tooth # 73

Fig. 4.55 Lateral cephalogram showed skeletal Class II malocclusion with large overjet, lower lip trapped between upper and lower anterior teeth

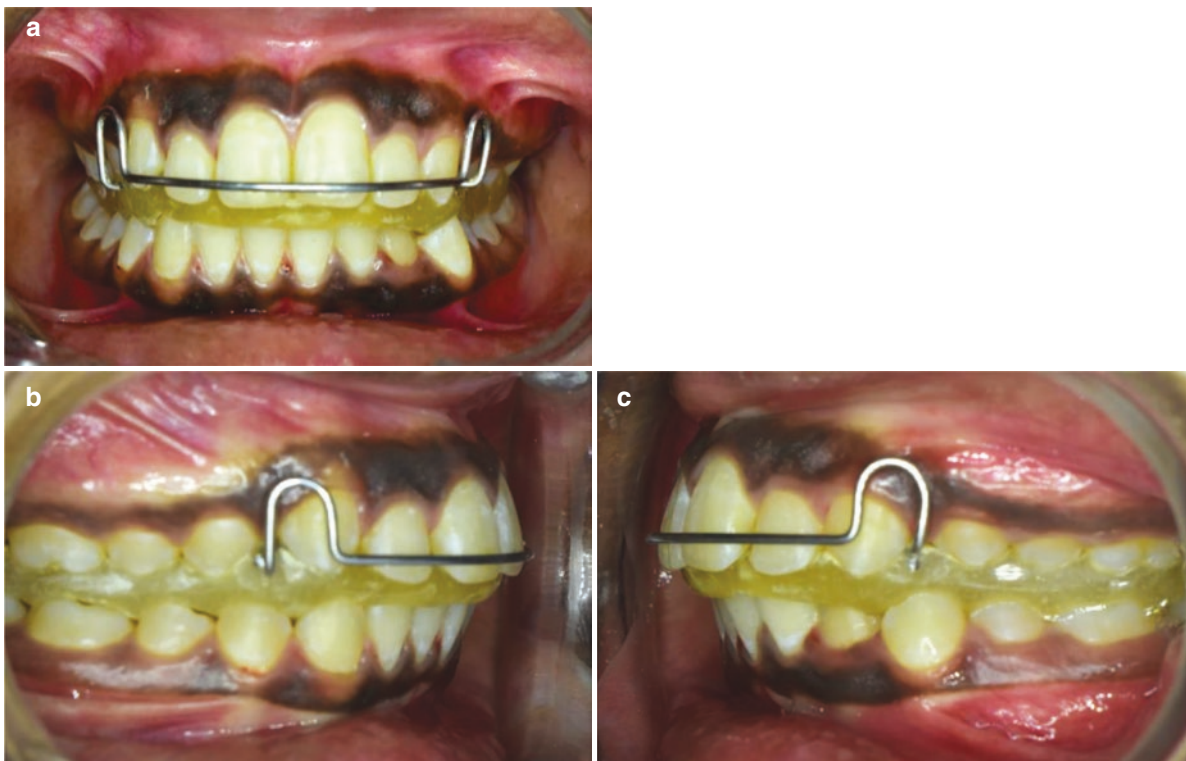


Fig. 4.56 (a–c) Activator with acrylic capped on incisal edges of lower anterior teeth was used in this case to prevent them from further proclination

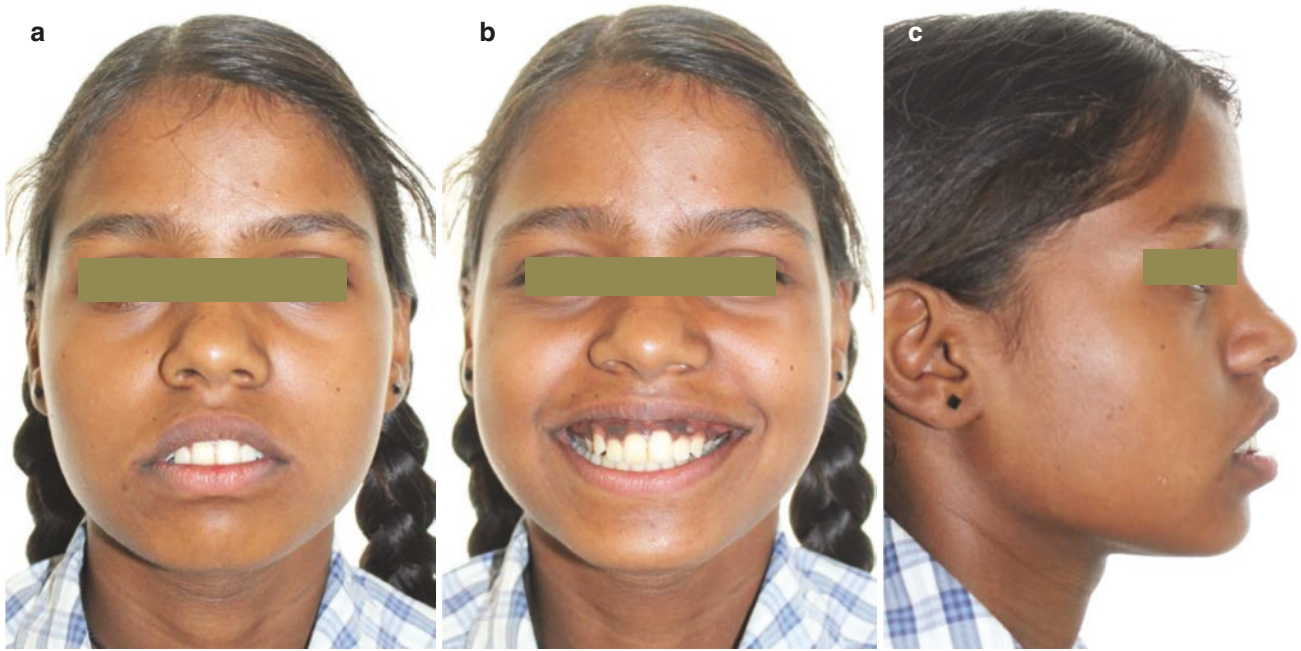


Fig. 4.57 (a–c) Extraoral pictures after Activator treatment showed more harmony of facial profile. She had everted upper lip resulting in incompetent lips; lower lip was not trapped



Fig. 4.58 (a–e) Intraoral pictures after Activator treatment showed Class I molar relationships, end on canine relationships; well aligned upper teeth and mild crowding in lower arch, upper and lower dental midlines were not coincided, acceptable overjet and overbite

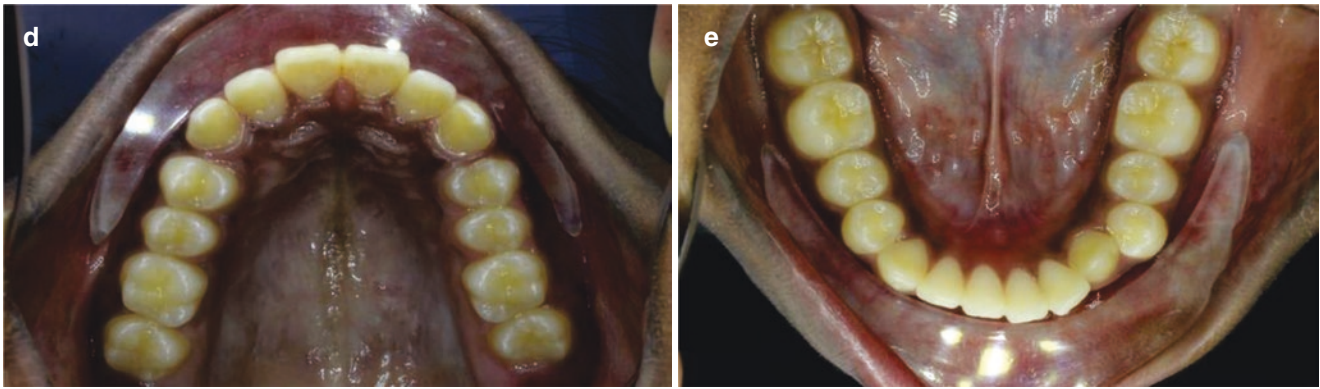


Fig. 4.58 (Continued)

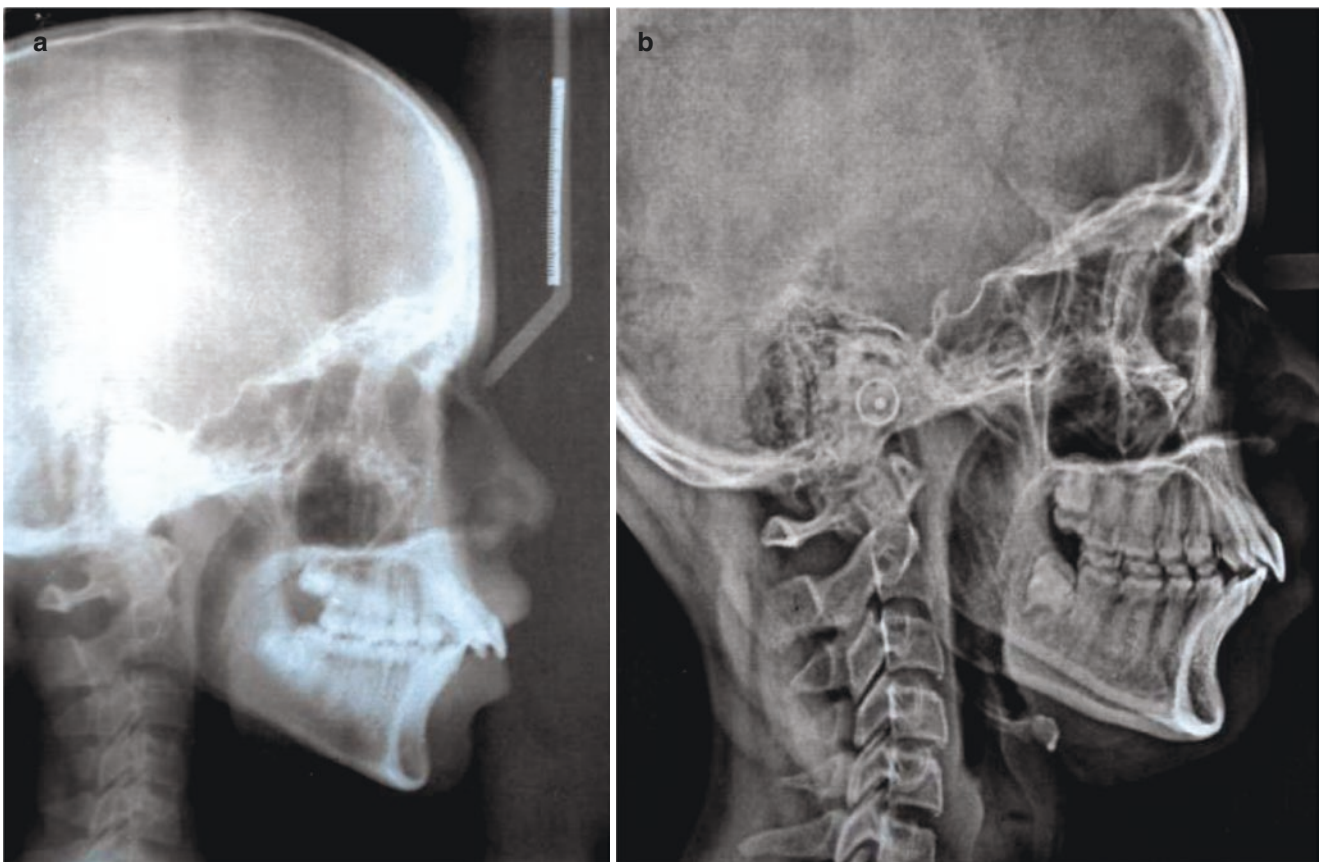


Fig. 4.59 (a, b) Comparison of lateral cephalograms pre- and post-Activator showed improvement of skeletal relationships between the maxilla and the mandible due to anterior positioning of the mandible and reduction of overjet and overbite



Fig. 4.60 (a–e) Second phase treatment with fixed appliances to optimize treatment results

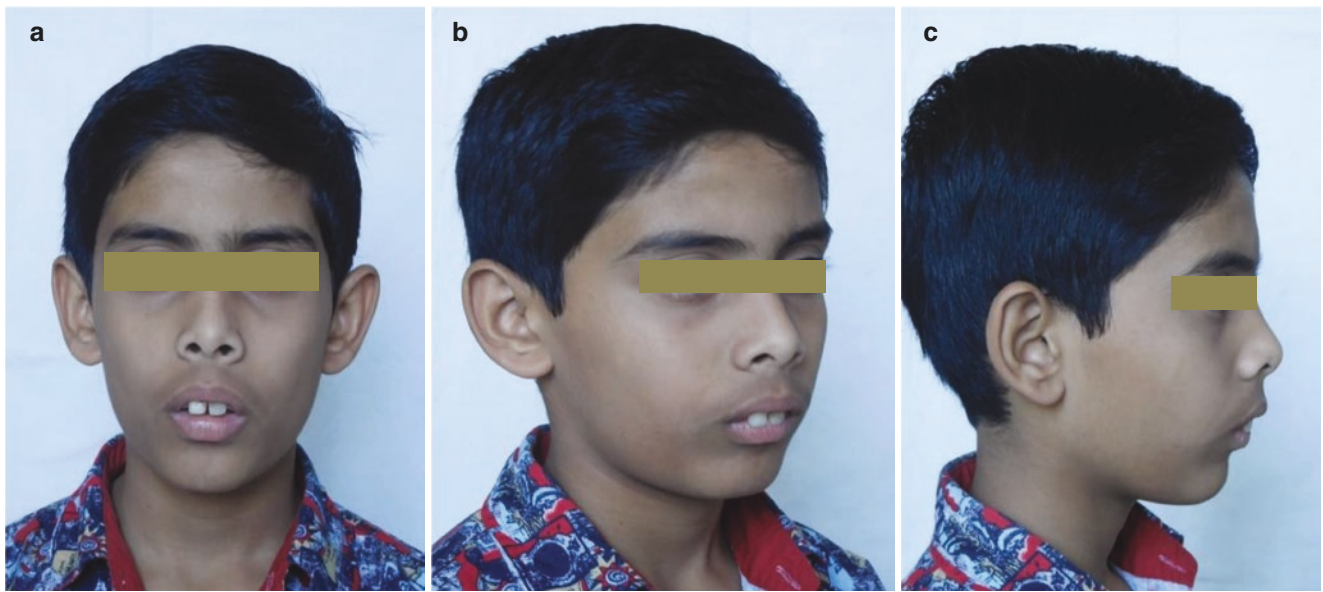


Fig. 4.61 (a–c) Extraoral pictures of a 12-year-old boy showed convex facial profile, lower lip trapped between upper and lower anterior teeth

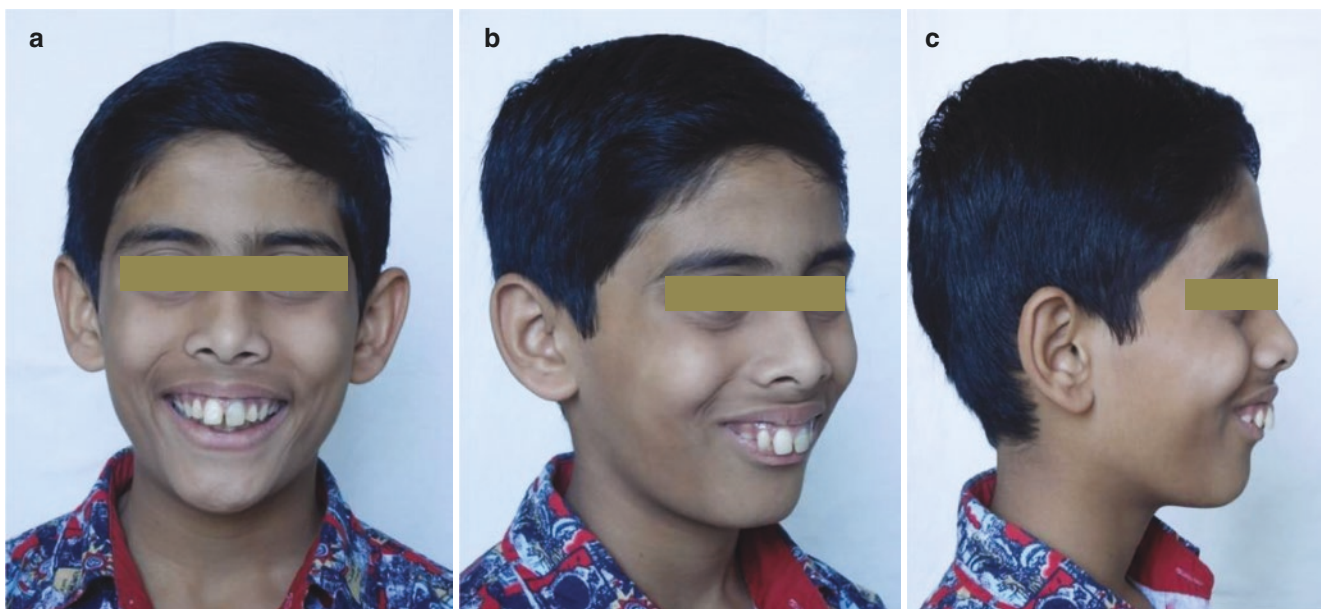


Fig. 4.62 (a–c) When smiling he showed prognathic maxilla with gummy smile, protruding upper anterior teeth, and lower lip trapped



Fig. 4.63 (a–e) Intraoral pictures showed stage of transition from mixed dentition to permanent dentition; he had Class II molar and Class II canine relationships, spacing in both arches, large overjet and deep overbite

Fig. 4.64 (a, b) Lateral cephalogram showed skeletal Class II malocclusion; prognathic maxilla with ante-inclination, retrognathic mandible with large mandibular symphysis as illustrated in Fig. b, and lower lip trapped. The patient was in CS2–CS3 according to cervical vertebral maturation index, indicated active growth potential (Baccetti et al. 2002)

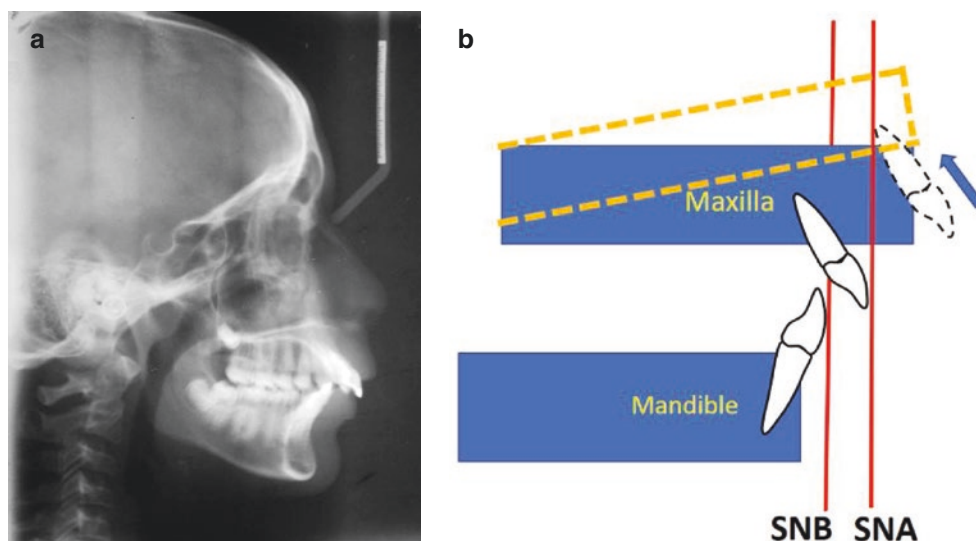


Fig. 4.65 (a, b) The patient with high-pull headgear (extraoral orthopedic device)



Fig. 4.66 (a–c) Intraoral pictures showed Activator with headgear tubes in situ



Fig. 4.67 (a–f) Change of smiles after Activator and headgear treatment; before the treatment (a, c, e) and after the treatment (b, d, f). Improvement in esthetic of the smiles is obvious

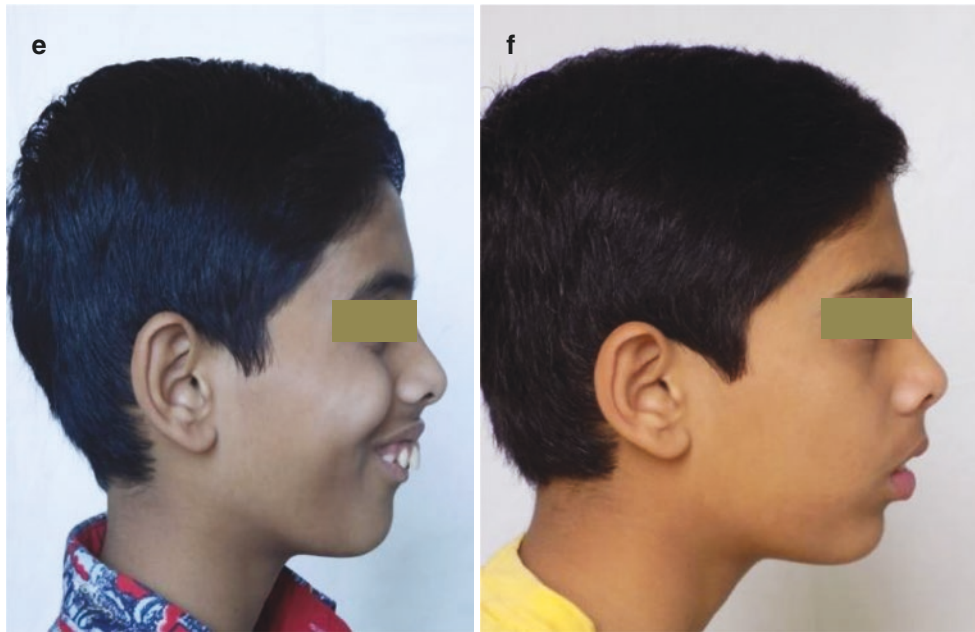


Fig. 4.67 (continued)



Fig. 4.68 (a–c) Intraoral pictures after Activator and headgear treatment showed Class I molar and Class I canine relationships; spacing in the upper arch, reduction in overjet and overbite



Fig. 4.68 (Continued)



Fig. 4.69 (a–c) second phase orthodontic treatment with fixed appliances to optimize treatment results

4.6 Stability

4.6.1 Case # 7 (Figs. 4.70, 4.71, 4.72, 4.73, 4.74, 4.75, and 4.76)

Fig. 4.70 (a, b) Extraoral pictures of a 9-year-old girl showed convex facial profile, lower lip trapped between upper and lower anterior teeth



Fig. 4.71 (a–c) Intraoral pictures showed stage of early mixed dentition; she had Class II molar relationships, large overjet, and deep overbite; upper and lower dental midlines were not coincided

Fig. 4.72 (a, b) Extraoral pictures at the end of the treatment showed improvement of her facial profile. She had pleasing smile with good combination of smile line, smile arch, and buccal corridors





Fig. 4.73 (a–c) Intraoral pictures at the end of the treatment showed Class I molar relationships; upper and lower dental midlines were coincided, acceptable overjet and overbite



Fig. 4.74 (a, b) Extraoral pictures 3 years and 5 months posttreatment showed stability of the treatment outcomes



Fig. 4.75 (a–c) Intraoral pictures 3 years and 5 months posttreatment showed as well stability of the treatment outcomes

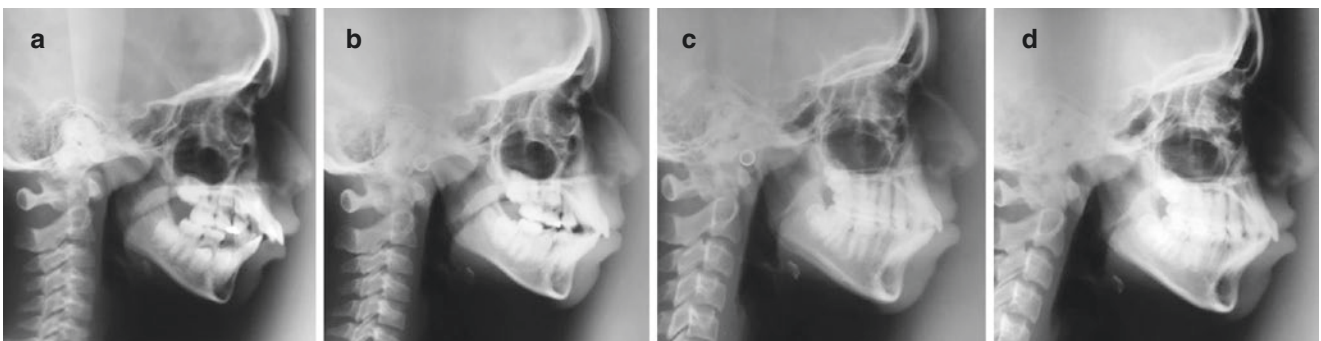


Fig. 4.76 (a–d) Comparison of lateral cephalograms before the treatment (a), 1 year later at the end of Class II Activator treatment (b), at the end of the orthodontic treatment (c), and 1 year posttreatment (d)

4.7 Conclusion

To answer the question whether it is worth the effort to treat Class II malocclusions early, we must contemplate treatment results. Treatment results should meet the treatment objectives, which are good function, good esthetics, and good stability.

To treat early, we can correct malocclusions and prevent them from becoming more severe in later stage. By using advantage of existing growth, orthodontists can harmonize skeletal discrepancy to improve function and esthetics. If not treated early, in many cases, the malocclusions could cause problem(s) in function and negative psychological impact on the patients.

According to the author's own experience, the author is convinced that early treatment gives positive results. The author feels that besides achieving improvement of function, the patients gained more self-esteem.

Stability is a real concern to orthodontists as relapse could occur at any time after the treatment, no matter how early or late. If stability could be added up to treatment results, the answer is "it is worth it to treat class II malocclusions early!"

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Early Treatment of Cover-Bite and Class II Division 2 Malocclusion

5

Bernd G. Lapatki

5.1 Introduction

Retroclination of upper central incisors is characteristic for two common designations of malocclusion: cover-bite and Angle's class II division 2 (div. 2).

In its original meaning, the term cover-bite refers to an extremely deep frontal overbite leading to the coverage of the lower incisors by the upper incisors (Mayrhofer 1912; Herbst 1922). The fact that such vertical deviation is typically combined with other characteristic symptoms, especially with retroclination of the maxillary central incisors, explains why “cover-bite” has been established as an independent designation with these two features as leading symptoms (Fränkel and Falck 1967; Pancherz and Zieber 1998; Peck et al. 1998). The independent malocclusion category cover-bite seems also justified from a pathogenetic perspective (see corresponding section below). There is a controversy in the literature with respect to the question to which extent these leading symptoms have to be manifested so that the malocclusion may actually be considered as a cover-bite. In this context, some authors designate patients with more mild expression of deep frontal overbite and upper incisor retroclination as “cover-bite-like” or an “anomaly with cover-bite character” (Hotz 1974; Schulze 1993).

The malocclusion classification scheme introduced by Edward H. Angle at the end of the nineteenth century (Angle 1899) distinguishes tooth and jaw malpositions primarily on the basis of the sagittal relationships between maxillary and mandibular first molars. The universal and sustainable application of this scheme may be explained by the fact that correction of the relationship between the upper and lower arches plays a key role in the treatment concept for most

patients. With regard to Angle's class II div. 2 malocclusion, however, it may be argued that the class II molar relationship is not manifested in approx. 20–40% of patients with retroclined maxillary central incisors (Schulze 1993). This means that a significant proportion of patients forming this clinical entity is not considered in Angle's classification scheme which may be considered as a limitation (Pancherz and Zieber 1998; Peck et al. 1998).

Obviously, this controversy and also historical aspects are the reason why cover-bite is still used in parallel to class II div. 2 as designation for patients with upper incisor retroclination—despite the fact that the characteristic and facultative symptoms largely overlap (Fig. 5.1). It has to be mentioned in this context that the term cover-bite is primarily used in the German-speaking area and less frequently in

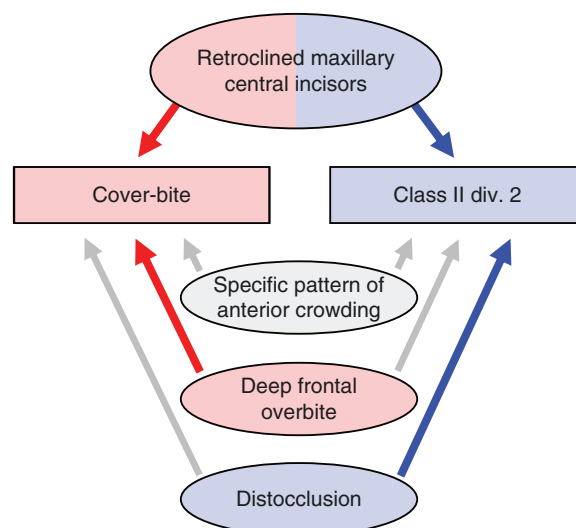


Fig. 5.1 Leading symptoms (red and blue arrows) and frequent facultative symptoms (gray arrows) of cover-bite and class II div. 2 malocclusion, respectively. Although the characteristic and facultative symptoms of these malocclusions overlap to a large extent, both designations are commonly used in orthodontic literature

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the English literature which reflects the global predominance of Angle's classification scheme. Nevertheless, in many respects—e.g., in the description of the clinical picture, pathogenesis, and possible treatment strategies—an overall assessment including both cover-bite and class II div. 2 malocclusion seems reasonable. Accordingly, also in this chapter, both anomalies are considered as one entity.

Regarding the designation of an individual malocclusion with upper incisor retroclination, the following use of the terms cover-bite and class II div. 2 is suggested: malocclusions without a class II component are designated as “cover-bite” (if the lower central incisors are completely covered by the upper centrals) or “cover-bite-like” (if lower centrals are only partially covered). The term “class II div. 2” is used (according to Angle's original definition) for patients with retroclined maxillary central incisors combined with a class II relationship of the buccal segments. If these patients additionally show a complete cover-bite, the malocclusion may be designated as “class II div. 2 with cover-bite.”

5.2 Cover-Bite and Class II Div. 2 Malocclusion

5.2.1 Prevalence

Reported percentages for the prevalence of cover-bite vary between 4% and 14% (average 6.8%) (Christiansen-Koch 1981), and those for class II div. 2 between 2% and 5% (Ingervall et al. 1972; Myllärniemi 1970; Ast et al. 1965). Obviously, this difference is related to the fact that investigated class II div. 2 samples excluded patients without distocclusion.

5.2.2 Characteristic Intraoral, Extraoral, and Skeletal Features

Patients with cover-bite or class II div. 2 often show a specific pattern of anterior crowding in the upper frontal segment (Jonas 2000; Schulze 1993; van der Linden 1988; Hotz 1974) in which retroclined upper central incisors are combined with proclined, distorted, and infrapositioned upper lateral incisors (Fig. 5.2a). This pattern, which may occur only on one side (Fig. 5.2b), differs significantly from the hereditary crowding pattern characterized by palatally displaced upper laterals reflecting the persistence of their germ position. The proclined upper lateral incisors in cover-bite patients are usually less elongated when compared to the upper centrals. The fact that also a pattern with inversion of all four maxillary incisors combined with labially displaced or aligned canines may occur (Fig. 5.2c) indicates the importance of collateral influ-

encing factors such as a reduced mesiodistal width of the upper incisors (Kaiser 2002; Peck et al. 1998).

Several morphological studies (Isik et al. 2006; Uysal et al. 2005; Lux et al. 2003; Walkow and Peck 2002) indicated that the increased sagittal dimension of the maxillary jaw base seems to be primarily related to an anterior position of the incisors' roots and not to a general overdevelopment of the maxillary dentoalveolar complex as hypothesized in most orthodontic textbooks.

Particularly in cover-bite cases with an extremely deep overbite, gingival recessions may occur either at the palatal gingival margins of upper incisors or at the labial gingival margins of the lower incisors. These recessions are in causal relationship with traumatic contacts of the lower or upper central incisors, respectively (Fig. 5.2c).

Extraoral features often reported as characteristic for cover-bite and class II div. 2 are a pronounced chin and a relatively large nose leading to a concave lower facial profile (Jonas 2000; Schulze 1993; van der Linden 1988; Hotz 1974), a pronounced supramental fold (Jonas 2000; Schulze 1993; Fletcher 1975; Hotz 1974; Burstone 1967; Korkhaus 1953), and a reduced upper lip height (van der Linden 1988). The patient shown in Figs. 5.3 and 5.4 demonstrates such extraoral features. Corresponding morphological studies, however, revealed that a specific facial morphology seems not to be regularly present in patients with retroclined maxillary incisors, which means that it cannot be considered as characteristic (Themann 1974). A number of studies, however, revealed that individuals with a cover-bite or class II div. 2 show a significantly higher lip line level when compared to controls or other malocclusion groups (Devreese et al. 2006; Karlsen 1994; Luffingham 1982; Fletcher 1975; Mills 1973).

Also cephalometric studies revealed that many dentofacial characteristics often associated with a cover-bite or class II div. 2 are actually inconsistent (Lux et al. 2004; Panherz and Zieber 1998; Fischer-Brandies et al. 1985; Droschl 1974; Godiawala and Joshi 1974). More specifically, morphological differences between such individuals and controls were found to be limited to variables describing vertical deviations such as a reduced lower facial height and reduced mandibular plane and gonion angles (Barbosa et al. 2017; Lux et al. 2004; Brezniak 2002; Panherz and Zieber 1998; Karlsen 1994; Maj and Lucchese 1982; Droschl 1974; Mills 1973). With respect to the anteroposterior jaw base relationship, most cephalometric studies reported an orthognathic position of the maxilla but found a retrognathic mandible (Lux et al. 2004; Brezniak et al. 2002; Panherz et al. 1997; Karlsen 1994; Fischer-Brandies et al. 1985; Hitchcock 1976; Mills 1973). Some studies found a neutral sagittal jaw base relationship (Barbosa et al. 2017; Peck et al. 1998) or even a skeletal class III (Brezniak et al. 2002; Demisch et al. 1992). Such broad range of sagittal jaw base relationships found in

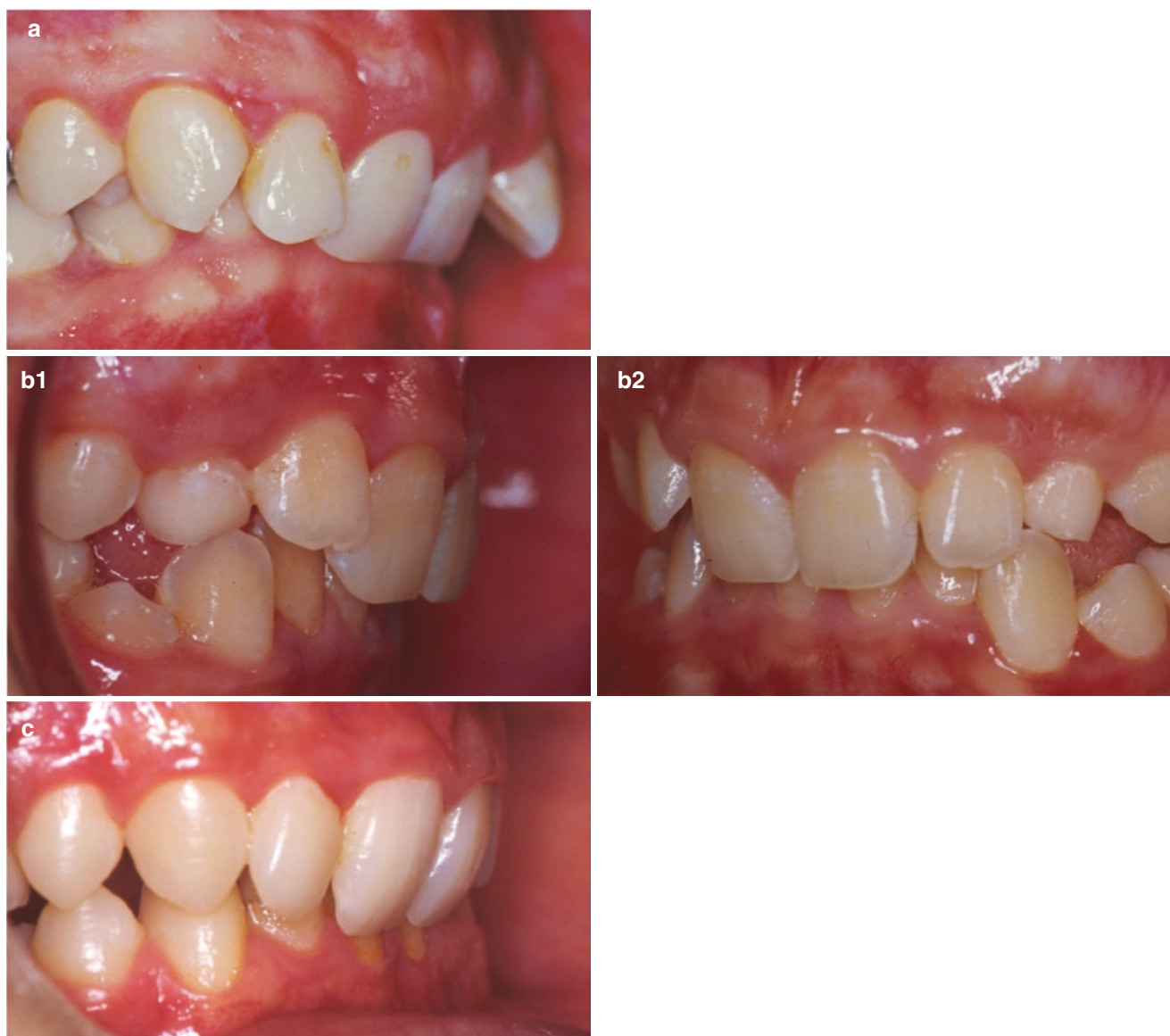


Fig. 5.2 (a–c) Variants of incisor malpositions in patients with a cover-bite and class II div. 2, respectively. (a) Retroclined maxillary central incisors combined with the characteristic anterior crowding pattern in the upper anterior segment, i.e., proclination and distorotation of the

lateral incisors. (b) Patient with retroinclination of only three of the four maxillary incisors; the right upper lateral is proclined and clearly less elongated than the other incisors. (c) Retroclination of all four upper incisors without anterior crowding

these studies may be related to different selection criteria applied. Moreover, it indicates that a class II div. 2 is not necessarily a skeletal class II but has more the character of a dentoalveolar malocclusion (Barbosa et al. 2017).

Regarding dentoalveolar morphology, cephalometric studies revealed that the retroclination frequently not only concerns the upper incisors but also the lower incisors (Pancherz et al. 1997; Hitchcock 1976; Mills 1973), though this trend is usually very mild or even statistically not significant (Brezniak et al. 2002; Peck et al. 1998; Godiawala and Joshi 1974). A comparative study has shown that lower incisor retroclination appears to be more pronounced in cases with neutral buccal occlusion than in cases with distocclu-

sion (Pancherz and Zieber 1998). The great majority of cephalometric studies identified the high lip line as one of the most prevailing morphological features of cover-bite and class II div. 2 malocclusion (Devreese et al. 2006; Karlsten 1994; Luffingham 1982; Fletcher 1975; Mills 1973).

The fact that cephalometric studies could not identify any consistent dentofacial morphological feature beyond the increased overlap of the maxillary incisors by the lower lip has been confirmed by an own cephalometric study of the skeletal, dentoalveolar, and soft tissue morphology (Lapatki et al. 2007). This study included a relatively large patient sample covering the whole spectrum from very mild to severe retroclination of upper central incisors (U1-SN

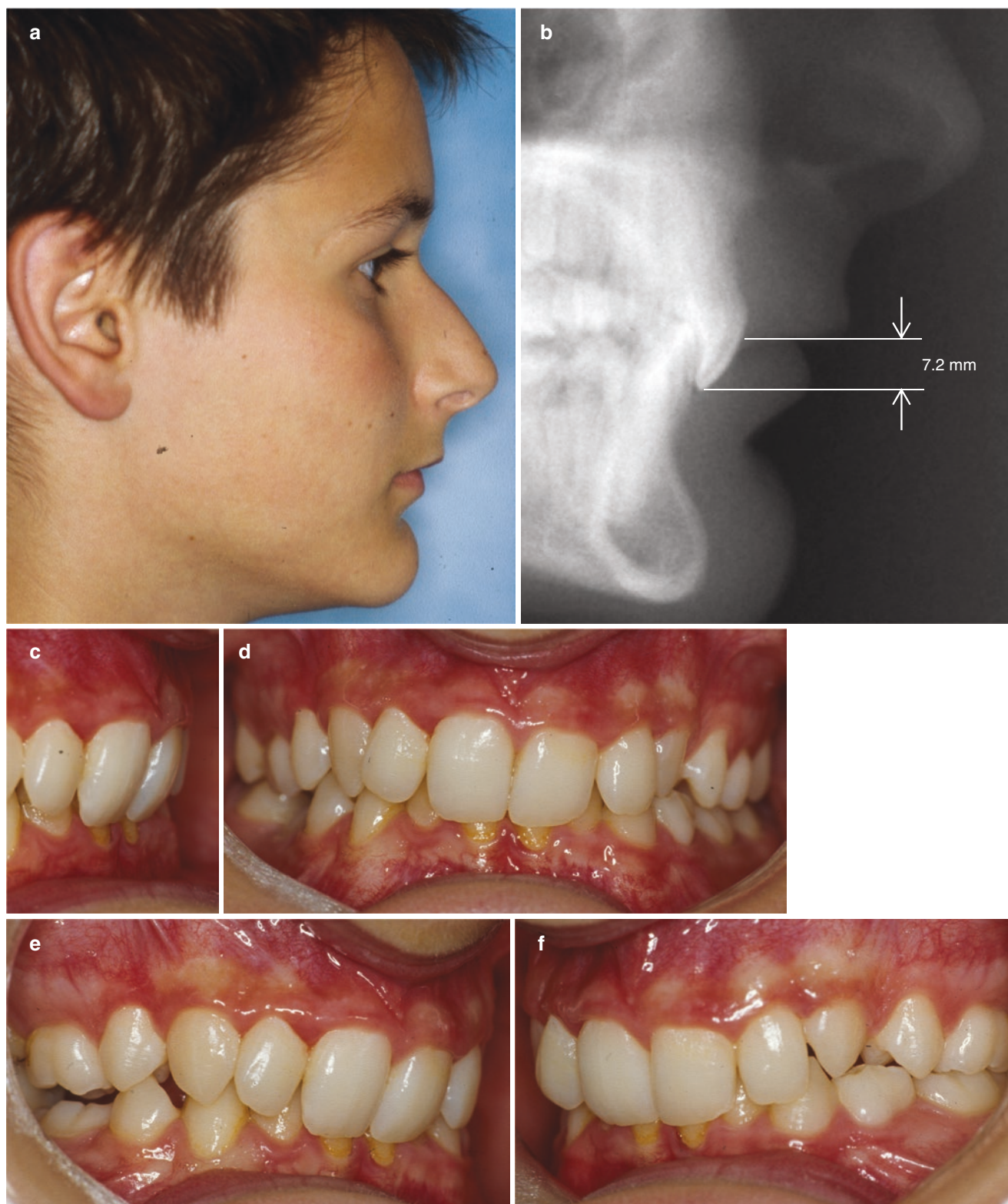


Fig. 5.3 Initial records of a patient with a class II div. 2 with an almost complete cover-bite. (a) The facial morphology of this patient is characterized by a concave lower facial profile, a deep supramental fold, and a pronounced chin. Although, these features are often reported as typical for cover-bite and class II div. 2 malocclusion, morphometric studies revealed that they are inconsistent. (b) Cephalogram showing the severe retroclination of the upper central

incisors with a deviation from reference of -12° and the high lip line level of 7.2 mm. The patient has a horizontal growth pattern and a neutral sagittal relationship of maxillary and mandibular jaw bases with a deviation of the ANB-angle from the individualized reference of 0.6° . (c–f) Intraoral situation showing the traumatic contact of the upper central incisors with the labial gingiva in the lower jaw leading to gingival recessions

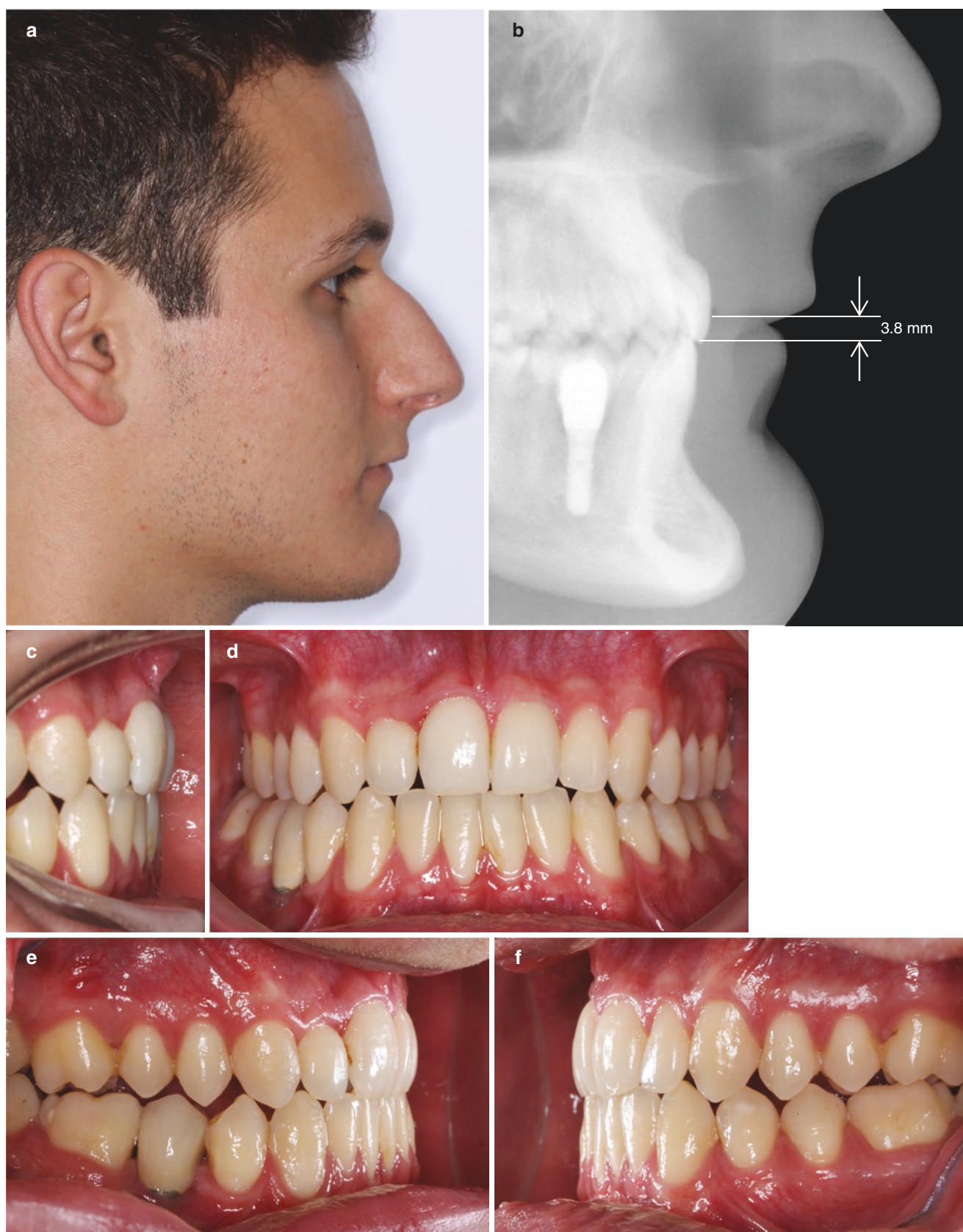


Fig. 5.4 Situation in the patient depicted in Fig. 5.3, 5 years after finalizing the active-mechanical therapy. (a) Facial profile. (b) Compared to the pretreatment cephalogram, upper central incisors have been proclined by 17.4° . The sagittal jaw base relationship shows a skeletal class III pattern (Wits appraisal: -2.5 mm, deviation of

ANB-angle from individualized reference: -2.5°). The high lip line was reduced from 7.2 to 3.8 mm. (c–f) Intraoral situation demonstrating the high stability of the correction of the frontal overbite and the neutral buccal occlusion. The congenitally missing tooth 45 is replaced by an implant crown

between 104° and 64°). Results revealed that the lip line level alone accounted for 47% of inclinational variability of the maxillary central incisors indicating the extraordinarily close correlation between these two variables. Multiple regression analysis revealed that the proportion of explained variability of upper central incisor inclination increased to a value of 81% by additional inclusion of the sagittal jaw base relationship and the inclination of the mandibular central incisors. These results demonstrate the predominance of the specific vertical incisor-lip relationship as the characteristic morphological feature for upper incisor retroclination. It may be hypothesized that the other two statistically significant model parameters, i.e., the skeletal class II pattern and retroclination of the mandibular incisors, either provide favorable conditions for upper incisor retroclination due to the increased interincisal sagittal distance or are secondary symptoms.

5.2.3 Etiology

The viewpoint that genetic factors play a major role in the etiology of cover-bite and class II div. 2 is mainly based on studies of twins (Christiansen-Koch 1981; Nakasima et al. 1982), families (Trauner et al. 1961; Kloeppel 1953; Corsten 1953), and probabilities of the anomaly's manifestation (Schulze 1993). Regarding the inheritance mechanism, a polygenic pattern is assumed (Christiansen-Koch 1981). The fact that environmental factors may significantly modify the phenotype or even may be crucial for the manifestation of upper incisor retroclination is impressively documented in the literature by two case reports describing the parallel manifestation of a class II div. 1 and a class II div. 2 in two discordant monozygote twins (Ruf and Panherz 1999; Leech 1955). It is assumed that this environmental influence is particularly effective during eruption of the permanent upper central incisors (van der Linden 1983).

Possible inherited morphological characteristics of individuals with upper incisors retroclination mentioned in the literature are an inverted inclination of the upper central incisors' germs (Fränkel and Falck 1967), specific morphological dental characteristics such as mesiodistally reduced tooth widths (Peck et al. 1998) or an increased collum angle of the upper centrals (Bryant et al. 1984; Delivanis and Kuftinec 1980), a characteristic perioral soft tissue morphology (van der Linden 1988; Fletcher 1975; Fränkel and Falck 1967), or an unphysiological motor function of the perioral musculature (Fischer-Brandies et al. 1985).

It has to be noted that only a few of these factors are evidence based. Moreover, it is scarcely conceivable that all these features are causative key factors. Instead, significant morphological characteristics of class II div. 2 samples such as decreased mesiodistal width of incisors or the slightly

increased collum angle of the upper centrals may rather facilitate or contribute to upper incisor retroclination (Schulze 1993) than trigger or initiate its manifestation. From all the morphogenetic factors considered, only the characteristic lip-to-incisor relationship in cover-bite and class II div. 2 patients expressed by a high lip line may be regarded as a potential causative key factor. Indeed, this seems to be confirmed by experimental studies on the pathogenesis of the malocclusion.

5.2.4 Pathogenesis

Longitudinal studies suggest that the manifestation of a cover-bite or class II div. 2 malocclusion is most likely not related to any preliminary stage but is developing only during the eruption of the deciduous or even the permanent upper incisors (Fletcher 1975; Fränkel and Falck 1967). It is assumed that the inversion of the upper centrals itself plays also an essential pathogenetic role, because it prevents the mutual support of the upper and lower incisors (which physiologically would inhibit the further eruption) and enhances the development of a deep frontal overbite (Kim and Little 1999; Karlsen 1994; Björk and Skieller 1972). Moreover, it is hypothesized that the retroposition of the incisal edges of the upper incisors may contribute or even cause retroinclination of the lower incisors and inhibit mandibular growth in the sagittal direction (Schulze 1993). Based on the mutual reinforcement of the key morphological features of class II div. 2 and cover-bite malocclusion during the eruption of the upper incisors and in the subsequent period of dentoalveolar growth, it may be hypothesized that an early therapeutic intervention may be highly beneficial for the prevention of an exacerbation of the malocclusion.

With respect to the initiation of the inversion process, several causative factors are discussed in the literature. The "functional theory" refers to the "equilibrium of tooth position" (Proffit 1978; Weinstein et al. 1963), i.e., the mechanical balance of forces on the teeth from oral and vestibular directions. It is supposed that the resting pressures exerted from the lips and cheeks are of particular importance due to their more static character when compared to tongue pressures (Thuer et al. 1999a; Proffit et al. 1975; Lear et al. 1974). This means that, for the development of upper incisor retroclination, increased resting lip pressure may be the potential factor disturbing the equilibrium (Jonas 2000; Schulze 1993; van der Linden 1983).

After several experimental studies failed to demonstrate an interrelation between pressure magnitude and upper central incisor inclination (Thuer and Ingervall 1986; Luffingham 1969; Gould and Picton 1968), an own study including 21 individuals with retroclined upper central incisors and 21 controls with physiological incisor inclination and neutral

occlusion could actually prove that the resting lip pressure on the upper central incisors is significantly different in these groups (Lapatki et al. 2002). This difference was found to be related to both the total resting pressure magnitude and its distribution on the crown surface. More specifically, in the controls, pressure data registered with two capacitive miniature pressure sensors on each of the two central incisors (Fig. 5.5a, b) revealed significantly higher resting pressures in the cervical region ($+1.34 \text{ cN/cm}^2$) when compared to the incisal region (-1.25 cN/cm^2). In contrast, subjects with retroclined upper centrals showed the reverse pattern, i.e., significantly higher resting pressure in the incisal region ($+3.05 \text{ cN/cm}^2$) compared to the cervical region (-1.24 cN/cm^2) (Fig. 5.5c). From correlation analyses, it could be concluded that actually the high lip line level accounts for this difference.

From these data, the following three principles could be derived:

1. In the region close to the lip line level, negligible pressure is applied to the teeth; the experimentally determined negative pressure values in this region might reflect the negative intraoral pressure; this observation agrees with other studies (Shellhart et al. 1996; Thuer et al. 1999b).
2. Resting pressure exerted by the lower lip is approx. 2.5 times higher than those exerted by the upper lip.
3. Total lip pressure magnitude exerted on the upper central's labial crown surfaces significantly depends from the level of the lip line which determines the amount of overlap between the upper centrals and the upper and lower lip, respectively.

Consequently, in case of a physiological lip line level, which means that the contact between the upper and lower lip occurs in the incisal third of the labial crown surface (Fig. 5.5d), upper central incisors are predominantly exposed to the relatively low upper lip resting pressure. Conversely, a high lip line level leads to the application of relatively high resting pressure magnitudes exerted by the lower lip (Fig. 5.5e).

Based on perioral surface EMG measurements, this experimental study has also proven that increased resting lip pressure in cover-bite and class II div. 2 is not related to increased perioral resting muscle activity. Hence, the specific vertical lip-to-incisor relationship may be regarded as the primary determinant of these malocclusions.

The frequent finding of proclined upper lateral incisors in individuals with a cover-bite or class II div. 2 does not contradict the causal interrelationship between incisor inclination and soft tissue resting pressure. The maxillary lateral incisors erupt approx. 1 year after the central incisors, and their eruption occurs from a position palatal to the central incisors in a labio-caudal direction (Schulze 1993; Baume 1955). The fact that the retroclination of the central incisors

already occurs prior to the eruption of the laterals, together with the specific eruption path of the laterals, provides a plausible explanation for their position labial to the frontal dental arch. The persistence of this position seems to be related, on the one hand, to the palatal displacement of the upper central crowns leading to reduced mesiodistal space for the laterals between the central incisor and the deciduous canine; this barrier makes lingual movement of the upper lateral incisors impossible (van der Linden 1983; Fletcher 1975). On the other hand, due to their proclined eruption path, contacting of the upper laterals with the lower lip occurs in the cranial lower lip region (and not behind the lower lip). These aspects explain why in many individuals with cover-bite or class II div. 2 malocclusion the upper lateral incisors remain in a more cranial position than the centrals. The fact that proclined upper laterals are more infrapositioned is demonstrated even more clearly in patients showing one retroclined and one proclined upper lateral incisor (Fig. 5.2c).

5.3 Pros and Cons of Early Treatment in the Mixed Dentition

Basically, early orthodontic treatment may be performed as a sole intervention in the mixed dentition. It is much more common, however, that the intervention in the mixed dentition is the first component of an early two-phase treatment approach which comprises fixed appliance therapy in the permanent dentition. The latter may be related to the fact that the majority of patients require the correction of remaining minor single tooth malpositions and a refinement of the occlusion after removable appliance treatment, together with the trend that patients become more and more demanding on the quality of the esthetical outcome.

Obviously, such two- or multiphase approach prolongs total treatment time. Since decades, it is discussed in the orthodontic literature whether the higher costs, longer treatment duration, and demands on the patient's compliance are actually in balance with the benefits (Ren 2004). Specifically in view of an early treatment of class II div. 2 and cover-bite malocclusion, the following issues may be relevant in this discussion: the effect of an early interception on the subsequent development of the malocclusion, the question whether the early intervention may significantly reduce the extent of tooth movement and dentoalveolar compensation required in the fixed appliance phase, the question whether the risk for therapeutic side effects can be reduced, the aspect of treatment efficiency and implications on post-orthodontic stability.

The main justification for an early orthodontic intervention is based on the interception of the pathogenesis before

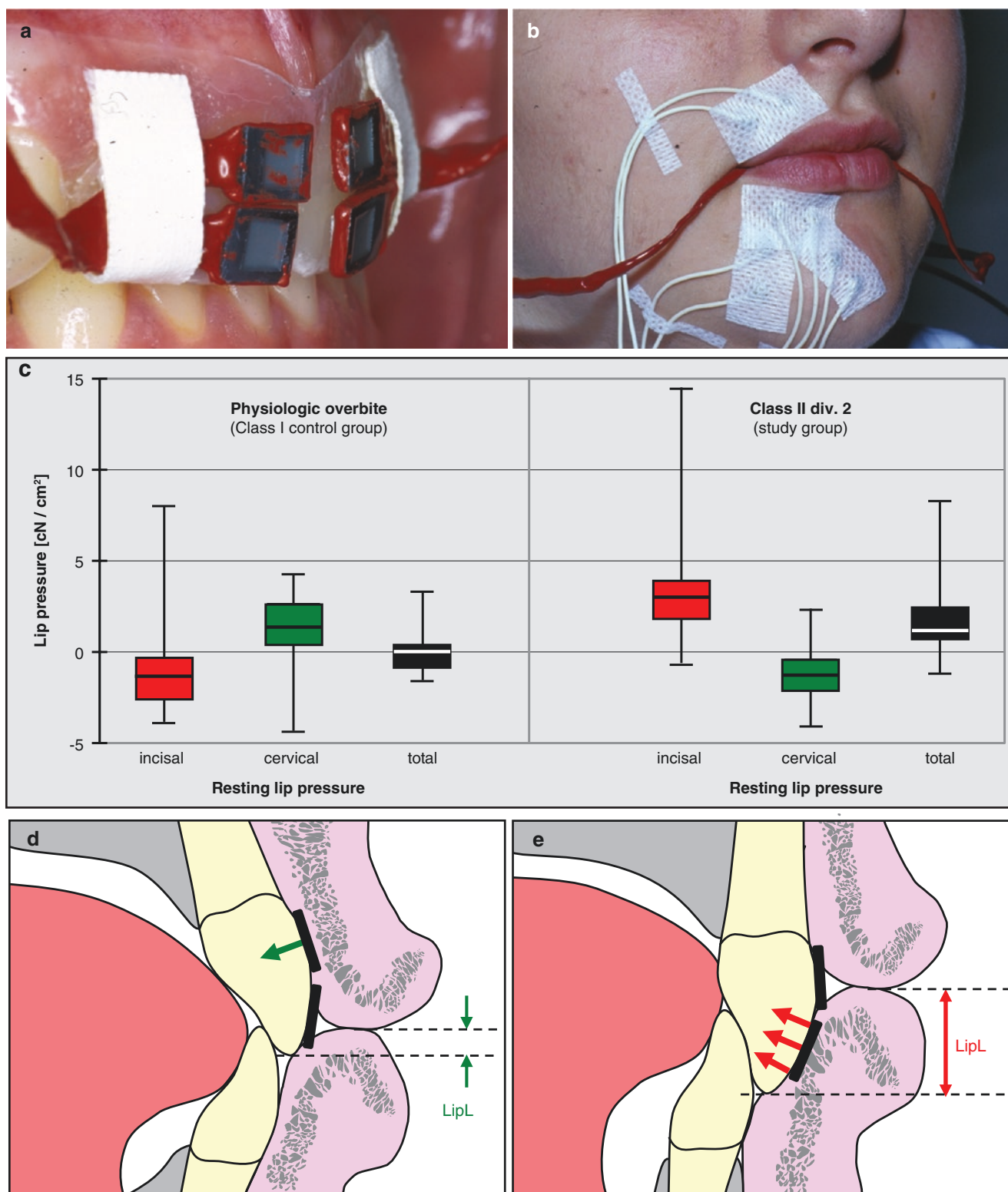


Fig. 5.5 Experimental study on the pathogenesis of upper central incisor retroclination (Lapatki et al. 2002). (a) Two thin miniature pressure sensors were positioned in the incisal and cervical region of the upper central incisors' labial crown surfaces. (b) Perioral muscle activity and lip pressure were registered while the lips were in their resting position. (c) Box plots showing the resting pressure magnitudes registered in the incisal and cervical crown areas. Negative pressure values reflect the

negative intraoral pressure. The weighted sum of incisal and cervical pressure (total) is significantly higher in the class II div. 2 sample. (d) In the controls showing a physiological lip-to-incisor relationship, relatively low resting pressure is applied by the upper lip (green arrow). (e) In the study group, the high lip line level (LipL) leads to exposure of the upper centrals to the resting pressure of the lower lip (red arrows) which is approx. 2.5 times higher than those of the upper lip

the malocclusion is fully manifested, in order to prevent a further exacerbation and to enhance the inherent growth potential. With regard to class II div. 2 and cover-bite malocclusion, such interception may be particularly effective for several reasons. Firstly, as described above, the major pathogenetic factor of the frontal aspect of the malocclusion is to be found in the specific lip-incisor relationship expressed through a high lip line; obviously, this factor is not *per se* existing, but it is developing during the eruption of the deciduous or permanent upper incisors (Fletcher 1975; Fränkel and Falck 1967). According to a study by Vig and Cohen (1979), the overlap between the upper incisors and the lower lip is increasing until 13 years of age. Consequently, it may be hypothesized that true intrusion of the upper incisors in the mixed dentition phase may terminate the pathogenetic process and prevent the further exacerbation of the frontal malocclusion. Secondly, an early dentoalveolar decompensation in the upper anterior region by proclination of the inverted upper incisors may “unlock” the restrained mandible (Thomson 1986; Litt and Nielsen 1984; Arvystas 1979). Such disinhibitory effect on the inherent mandibular growth potential may significantly contribute to class II correction (Woods 2008; Parker et al. 1995). Thirdly, in cover-bite cases with an extremely deep overbite, early correction of the deep frontal overbite may also eliminate gingival trauma and prevent an exacerbation of gingival recessions. These traumatic effects are related to contacting of the palatal gingiva or mandibular labial gingiva with incisal edges of lower and upper incisors, respectively (see Fig. 5.3).

If early intervention in class II div. 2 malocclusion could actually intercept the pathogenesis and prevent the exacerbation of the malocclusion, it would be logical that the finalization of the treatment in the permanent dentition is confronted with a far less manifested malocclusion. In particular, less active-mechanical palatal root torque for upper incisors and intrusion of the anterior segments should be required during final fixed appliance treatment. It has to be noted that especially these treatment tasks are associated with external apical root resorption (Harris 2000), which is the most common iatrogenic negative consequence of orthodontic treatment. These aspects might explain why the correction of a class II div. 2 leads to significantly more lower incisor root resorptions if the treatment occurs in a late one-phase approach compared to an earlier starting two-phase treatment (Faxén Sepanian and Sonnesen 2018). Another advantage of an early interception in class II div. 2 malocclusion may be related to the partial or even complete correction of the distocclusion during the early treatment phase; this should reduce the need for a dentoalveolar compensation of the class II and may avoid corresponding disadvantages. Admittedly, not all of these theoretical considerations and conclusions are evidence based. However, the well-

documented patient examples included in this chapter may at least provide individual clinical evidence.

A review of the literature with regard to the effect of early class II div. 2 therapy revealed that studies evaluating early treatment of class II div. 2 or cover-bite are sparse. Ferrazini (2008) studied the outcome of a sole early interceptive approach. All patients were treated according to the concept described by Hotz (1974) comprising a three-stage protocol aiming at (1) protrusion of the upper incisors by means of a maxillary plate with a protruding screw, (2) protrusion and intrusion of the mandibular incisors by equipping the plate with a guide plane, and (3) a subsequent “activator phase.” It was observed that after approx. 3 years of treatment all typical class II div. 2 features could be successfully corrected without any further therapeutic intervention. Furthermore, literature research indicated that studies evaluating a two-phase approach are sparse and focused more on deep overbite correction in general. The corresponding studies of Baccetti et al. (2012) and Franchi et al. (2011) included two patient samples both initially treated with maxillary bite plates in a two-phase approach—either with an earlier or later treatment start. With regard to class II div. 2 or cover-bite malocclusion, included patient numbers were relatively low and results were not separately reported for these patients. Generally, we did not identify any study specifically targeted at comparing the results from larger class II div. 2 samples obtained by a two-phase approach with those of a single-phase protocol in the permanent dentition.

An alternative approach for protrusion of the maxillary central incisors and creating the sagittal space for mandibular advancement—these are chief tasks of early class II div. 2 or cover-bite treatment—may be the use of a partial fixed appliance comprising the maxillary first molars and incisors. The utility arch introduced by Ricketts (1979) is the most common design of such two-by-two or two-by-four systems—as explained more detailed below. The great advantage of the use of a partial fixed appliance in the first stage of early class II div. 2 treatment is related to the possibility of simultaneous protrusion and true intrusion of the maxillary central incisors. Hence, the treatment may not only address the sagittal component of the malocclusion but may also be directly targeted to the reduction of the lip line level—i.e., the key pathogenetic factor of maxillary incisor retroclination.

In the discussion whether a two-phase treatment approach comprising an early phase in the mixed dentition may be considered efficient or not, two variables are particularly relevant: (1) the quality of the treatment outcome and (2) the treatment time required for achieving this result (von Bremen and Pancherz 2002). As noted by Ferrazini (2008) also the fundamentally different implications of removable and fixed appliances on treatment costs, requirement of

treatment monitoring, and intervention by the clinician are to be considered. For instance, during activator therapy, monitoring of the treatment by the clinician may be limited to 4–6 visits per year, and the patient usually has to use the appliance only at home and mainly at night. Additionally, removable appliances have other obvious advantages such as facilitated oral hygiene and less affected social life compared to the use of fixed appliances in combination with additional mechanics for class II correction (such as a Herbst appliance or skeletally anchored appliances for upper molar distalization). These aspects are also important in the discussion on whether treatment of class II div. 2 and cover-bite patients should already be started in the mixed dentition.

In conclusion, according to the opinion of the author of this chapter, the decision whether an early or later treatment start is preferred in class II div. 2 and cover-bite malocclusion is to be tailored to the individual patient and the available therapeutic tools. The basic prerequisite for an early begin of orthodontic treatment is the patient's and parent's willingness for a longer treatment when compared to a single-phase approach in the permanent dentition. Furthermore, interceptive treatment of a class II div. 2 or cover-bite malocclusion should be targeted to the pathogenetic key factors—i.e., the high lip line and the class II tendency (if applicable). Patients and parents must be involved in the decision-making process and have to be informed that an early intervention may prevent the further exacerbation of the malocclusion and, consequently, may reduce the need for tooth movements associated with a high risk for root resorption and dentoalveolar compensation of the class II. Such informed consent, however, must also include that not all of these arguments are based on very solid scientific evidence and that a controversy discussion regarding the justification of an early treatment of class II div. 2 and cover-bite is still ongoing.

5.4 Stability After Orthodontic Treatment

Many clinicians and authors consider cover-bite and class II div. 2 as relapse-prone malocclusions. For instance, Selwyn-Barnett (1991) concluded that class II div. 2 therapy is associated with a doubtful prognosis and high relapse probability. Mills (1973) reported that therapeutic proclination of maxillary incisors by 13° relapsed after >1 year of retention by approx. 50%. Other authors, however, stated that upper incisor proclination was relatively stable. Devreese et al. (2007)

reported that therapeutical upper incisor proclination by 15.2° relapsed only by 2.2° in the 3.5 years posttreatment interval. Several authors concluded that instability of upper incisor proclination does not apply to the majority of patients but in particular to individual cases with an extreme relapse tendency (Kinzel et al. 2002; Kim and Little 1999; Binda et al. 1994; Berg 1983).

The studies mentioned above investigated malocclusion samples which had undergone fixed appliance therapy in a two-phase or one-phase approach. There is only one study of Ferrazini (2008) investigating long-term stability of class II div. 2 correction comprising a sole early interceptive approach corresponding to the concept described by Hotz (1974). The author noted remarkable stability of most corrected dental and skeletal variables 20 years after treatment. An important finding, however, was that the therapeutical upper central incisor proclination by approx. 5–6° relapsed nearly completely. From a pathogenetic viewpoint, this may be explained by the fact that active-mechanical intrusion of upper incisors has not been an integral component in the applied treatment concept. Thus, the high lip line level may have persisted and, consequently, the pathogenetic mechanism of upper incisor reclination may have continued to exert its effect.

Actually, the latter hypothesis could be verified by two retrospective investigations on the basis of cephalometric analyses, evaluation of plaster casts and clinical measurements of the lip line level after mean post-therapeutic intervals of 2 years (Lapatki et al. 2004) and 9 years (Lapatki et al. 2006). Multiple regression models were calculated in these studies to statistically identify significant relapse determinants. A common finding of both studies was that the relapse of the therapeutic proclination of the maxillary central incisors mainly depends on the amount of therapeutic inclinational change as well as the post-therapeutic lip line level. Based on these results it may be concluded that one of the most important objectives when treating patients with cover-bite or class II div. 2 must be the reduction of increased overlap between the upper incisors and the lower lip—as demonstrated by the pre- and posttreatment records of the patient example shown in Figs. 5.3 and 5.4. This can be achieved either in an early treatment phase by active-mechanical intrusion and/or impeding the vertical development of the upper anterior segment (see patient examples below) or in the permanent dentition by active-mechanical intrusion of the upper incisors using segmented mechanics. Obviously, an increased relapse risk has to be taken into account if this aspect is not considered in treatment planning.

5.5 Early Treatment Phases and Therapeutical Approaches

5.5.1 Overview

The treatment of cover-bite and class II div. 2 malocclusion respectively can be subdivided into an early phase in the mixed dentition and a late phase beginning after complete eruption of the permanent canines and premolars.

The early treatment phase may be further divided into two successive main stages. The main focus of the first stage is to correct the key feature of the malocclusion—i.e., the retroclination and supraposition of the upper central incisors. The decision whether the deep frontal overbite is corrected primarily through intrusion of the upper incisors or intrusion of the lower incisors has to consider the lip-incisor relationship. This analysis should be undertaken with the lips in their resting posture (e.g., on the lateral cephalogram) and also during smiling (Zachrisson 2007)—as exemplified by the included patient examples. In patients with a more severe class II (i.e., more than half-step distocclusion of first molars), it is advisable to first distalize the upper first molars in a preliminary phase before the upper incisor segment is corrected.

The use of a removable functional appliance in the second stage of early treatment enables the retention of the achieved sagittal and vertical improvements in the upper frontal segment and further correction of the deep overbite by inhibiting the vertical development of the upper and lower anterior segments (i.e., relative intrusion) and enhancing the eruption of the first molars. Functional appliances may also stimulate mandibular growth (Pacha et al. 2016; Perinetti et al. 2015) which is favorable in the majority of cover-bite or class II div. 2 patients. In addition, they may guide canine and premolar eruption and may contribute to the correction of collateral problems such as anterior crowding or tooth agenesis.

If the treatment of a severe cover-bite or class II div. 2 malocclusion is started only in the late mixed dentition or in the early permanent dentition, it is recommended to replace the functional appliance by a Herbst (or Herbst-like) appliance (Schweitzer and Pancherz 2001; Obijou and Pancherz 1997) or by a skeletally anchored distalization appliance (Wilmes and Drescher 2010) for class II correction. Malpositions in the frontal segments are then to be treated subsequently in the permanent dentition, e.g., by using Burstone's segmented multibracket appliance mechanics (Burstone 2001) or adaptations of this approach.

This basic concept for early treatment of cover-bite and class II div. 2 malocclusion is described in more detail in the following sections. Reference is made to seven patient examples which are included and described at the end of this chapter; these patients were personally treated by the author of this chapter. The early treatment phase of patient

examples #1 to #4 followed the classical two-stage protocol comprising the intrusion and/or proclination of the upper central incisors and subsequent functional appliance therapy. Early treatment of patient example #5 skipped the first main stage for active-mechanical correction of the upper central incisors, and in the treatment of patient example #6 the second main stage (i.e., functional appliance therapy) was omitted due to the long duration of the initial utility arch and headgear treatment. In patient example #7, early treatment of the more severe distocclusion was not sufficient, which is why an intermediate phase for skeletally anchored distalization of upper molars was required between the functional appliance therapy and the final full multi-bracket treatment.

5.5.2 Pretreatment in Patients with Severe Distocclusion

As mentioned, the retroclination and supraposition of the upper central incisors is usually the therapeutic key measure of the first stage of early class II div. 2 and cover-bite treatment. In those patients, however, with a severe class II first molar relationship (i.e., with distocclusion clearly greater than half-step), it may be reasonable to start the treatment with distalization of the upper first molars using a cervical-pull headgear, which means that the upper incisors are corrected afterward. Such deviation from the standard procedure may be justified, because intrusion of upper incisors is difficult to be combined with cervical-pull headgear therapy; this is related to the extrusive effect on the upper first molars of both of these measures (see also Fig. 5.6); consequently, the extrusive effect may be too strong in total. As a cervical-pull headgear is more effective in distalizing upper molars than the high-pull headgear, the combination of parallel high-pull headgear and utility arch treatment (without a previous cervical-pull headgear phase) may be insufficient for correction of a severe distocclusion. Another reason for starting the treatment with upper molar distalization may be that headgear therapy must be initiated before the second molars begin to erupt—simultaneous distalization of first and second molars using a headgear has proven to be unrealistic.

It has to be noted that in an initial cervical-pull headgear phase only partial correction of the distocclusion is required. The correction of a remaining mild (e.g., quarter-step) distocclusion may be postponed to the second main stage of early treatment (see corresponding section below).

Generally, the collateral extrusion of upper first molars during cervical-pull headgear therapy is very desirable in class II div. 2 patients with a deep overbite or cover-bite. In this respect, the anterior bite opening during the initial headgear phase may represent the first measure addressing the vertical

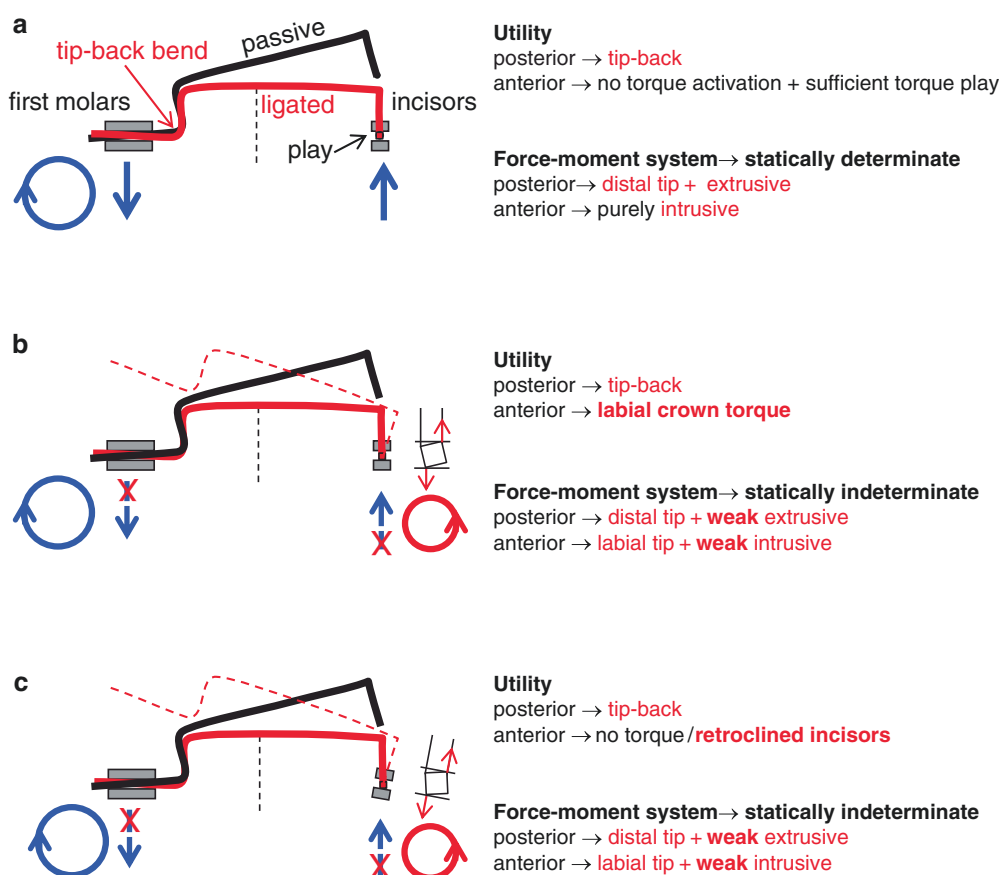


Fig. 5.6 Force-moment systems generated by the utility arch (Ricketts 1979) under different conditions. According to Newton's third axiom, the forces and the moments generated by an orthodontic appliance must be balanced in any plane. (a) In an idealized utility arch configuration, no moment would be applied to the maxillary anterior segment, due to sufficient play of the anterior wire segment in the anterior bracket slots. In this case, the utility arch would reflect a "one-couple configuration" generating a "statically determinate system"—which is desirable for quantitative control of the intrusive force. Practically, this may occur only under the following conditions: (1) wire dimensions are significantly smaller in relation to bracket slot height (e.g., 0.016 × 0.016-in. wire combined with 0.018-in. bracket slot height) and (2) there is no or

only a very weak curvature of the anterior wire segment—this should be the case if only the two central incisors are included (so-called two-by-two configuration, see Fig. 5.7a). (b) Activation of the utility arch's anterior segment for labial crown torque. Although labial crown torque may be favorable in class II div. 2 patients, such anterior torque activation is not recommended, because the intrusive effect on the incisors may significantly decrease. To avoid such partial or even complete elimination of the desired intrusive effect, the utility arch should only be tied to an anterior underlay wire segment or ligated on top of this segment only at the central incisor brackets (see examples in Fig. 5.7b, d). (c) Force-moment system equal to that of (b) resulting from extreme upper incisor retroclination

component of the malocclusion. It has to be noted that a preliminary headgear phase may already be combined with the treatment of collateral problems in the lower arch. In particular, a mandibular plate equipped with plane lateral bite plates may facilitate the distalization of the upper first molars. This effect is related to the elimination of mesially directed force components on the upper first molars during occlusion resulting from occlusal contacts with the lower first molars.

5.5.3 First Main Stage of Early Treatment

In most patients, the first main stage of early treatment of cover-bite and class II div. 2 is focused on the correction of

the malocclusion's key feature, i.e., the retroclination and supraposition of the upper central incisors. This task usually requires proclination and intrusion of the upper central (and often also the lateral) incisors, which may be simultaneously accomplished by means of a partial multibracket appliance comprising the fully erupted permanent incisors and the first molars as posterior support (see patient examples # 1, 2, 3, 6, 7). In this respect, the so-called utility arch design originally described by Ricketts (1979) is particularly suitable mainly for three reasons:

1. Provided that there is enough play between the wire and the anterior bracket slots, the utility arch induces a "statically determinate force-moment system" (Proffit et al.

2007b) which can be easily understood and clinically monitored (Fig. 5.6a).

2. It allows simple (re-)activation by means of bilateral tip-back bends mesial to the first molars.
3. The bypass of the deciduous canine and molar crowns at their cervical level makes the relatively long free wire segments less susceptible to plastic deformation during mastication.

To increase the patient's comfort, a silicone tube or dental flow composite may be used to cover the two upper bends of the utility arch; in this manner, irritation of the vestibular mucosa is minimized (see also Fig. 5.7a–c).

Root resorption is a very frequent consequence of tooth movement, especially intrusion and torquing of incisors (Linkous et al. 2020). The study of Goel et al. (2014) compared the rate of true intrusion, proclination, and root resorption of maxillary incisors for three different intrusion mechanics. The authors observed that Rickett's utility arch was most effective in all three tasks. The higher rate of root resorption observed for the utility arch may be related to the higher intrusion rate.

From a biomechanical point of view, the classical two-by-four utility arch basically reflects a two-couple configuration (Davidovitch and Rebellato 1995), because of the curvature of the incisor segment and the ligation of the rectangular 0.016 × 0.016-in. wire into the anterior brackets. The fact that in such “statically indeterminate system” moments with unknown magnitudes may be generated at the first molars and the incisor segment limits the control on therapeutically applied forces and moments (Fig. 5.6).

Although initial upper incisor retroclination may tempt to incorporate labial crown torque into the utility arch's anterior segment, such combined activation is absolutely not recommended. This is related to the generation of a reactive force couple consisting of extrusive anterior and intrusive posterior components. These reactive loads may significantly decrease or even completely neutralize the desired intrusive effect on the upper incisors (Fig. 5.6b). A preferable alternative for enhancement of the protrusive effect of a utility arch without losing control on its intrusive effect is to slightly activate the step bends in anteroposterior direction before ligation of the anterior segment. Such sagittal activation may also be performed asymmetrically, if the dental midline has to be corrected (see patient example #2).

Since the sagittal distance between the incisor and molar brackets is several centimeters, the resulting reactive moments exerted to the two first molars have a strong distally tipping effect. This (often undesired) collateral effect may be efficiently addressed by applying a high-pull headgear during nighttime with cranial angulation of its extraoral arms (see patient example #3). In this manner, the extraoral force

vector runs above the first molars' center-of-resistance (C_r) causing the required neutralizing moment with a counter-clockwise direction. The remaining distally directed force vector running above the C_r leads to bodily distalization of the first molars which is desirable in most patients with maxillary incisor retroclination due to their class II tendency.

As mentioned, simultaneous application of a maxillary utility arch with a cervical-pull headgear is absolutely not recommended. The relatively strong extrusive effect of both appliances together with occlusal precontacts exerting forces in opposite direction may lead to “jiggling” of the first molars which may overload the periodontal ligaments.

Ricketts originally recommended the use of 0.016 × 0.016-in. Elgiloy® blue as wire material. Mechanical in vitro testing in our lab at Ulm University, however, revealed that the force deflection behavior of 0.016 × 0.016-in. stainless steel is quite similar. Therefore, this cheaper alternative may also be recommended.

Depending on the question whether intrusion of only the upper centrals or all four maxillary incisors is required, the utility arch may be designed as two-by-two or two-by-four appliance (Fig. 5.7). Adequate force magnitudes for different scenarios can be determined on the following basis: recommended intrusive force magnitudes are 15 cN per maxillary central incisor and 10 cN per maxillary lateral incisor (Proffit et al. 2007b; Burstone 2001). Thus, adequate intrusive activations of the two-by-two and two-by-four utility arch configurations are 30 cN and 50 cN, respectively. Own in vitro testing revealed that a 0.016 × 0.016-in. stainless steel utility arch with tip-back bends of only 15° and 25°, respectively, produce such force magnitudes. Unilateral or asymmetrical activation of the utility arch enables the correction of a canted anterior occlusal plane.

It has to be noted that small deformation of the free segments (e.g., occurring during mastication) may easily be overlooked by the clinician. Such unintended bending may significantly alter the applied force systems leading to uncontrolled incisor and molar movements. Hence, to avoid application of an inadequate intrusive force magnitudes at least for longer time, it is recommended to detach the anterior utility arch segment during each patient appointment (see patient examples #1, #6, and #7).

Many patients initially require intrusion of the upper central incisors before the laterals are to be intruded, as well. This aspect might be clinically addressed using first a two-by-two appliance for upper central incisor intrusion until the level of the lateral incisors is reached. Subsequently, a supplemental underlay wire segment spanning all four incisors may be used. Usually, a superelastic underlay wire (e.g., 0.016 × 0.016-in. NiTi) is to be applied (Fig. 5.7b, d), because lateral incisors often need angulation or rotational corrections.



Fig. 5.7 Variants of the utility arch. **(a)** Two-by-two utility arch configuration activated by posterior tip-back bends for generating an intrusive force at the central incisor brackets. This configuration largely avoids anterior torque application which is, as already mentioned, favorable for vertical force control. **(b)** Example for inclusion of the lateral incisors at a later stage using a superelastic underlay wire. **(c)** Example of a classical two-by-four utility arch configuration without

underlay wire. **(d)** In this patient, full insertion of a utility arch in all four brackets of the reclined incisor segment would cause a proclining moment; consequently, the intrusive effect on the incisors would be decreased or even eliminated (see also Fig. 5.6c). This problem is minimized by using an underlay segmental wire and only tying the utility arch to the central incisor brackets

The decision whether combined intrusion and proclination of the upper incisors or only their protrusion is required has to consider both pathophysiological and esthetical issues. As mentioned, a high lip line is the most important causative factor for the retroclination of the upper central incisors (Lapatki et al. 2002). From a pure pathophysiological point of view, elimination of this factor is of utmost importance for achieving a high post-therapeutic stability (Lapatki et al. 2004, 2006). Orthodontic treatment, however, must also meet esthetical treatment goals. It has to be noted that in the majority of cover-bite and class II div. 2 patients, the upper central incisors are suprapositioned not only in relation to the occlusal plane but also relative to the lip line. The latter is usually reflected by the significant appearance of maxillary gingiva during smiling (see initial records of patient examples #1, #2, and #6). Thus, greater compromises between high treatment stability and favorable smile esthetics are often avoidable.

A certain part of the patients with retroclined upper incisors, however, displays no maxillary gingiva during smiling or shows even some coverage of the crowns' cervical regions by the upper lip (see initial records of patient examples #5 and #7). Provided that also the lip line level is only moderately high in these patients, the preferred strategy might be to omit the utility arch treatment for active-mechanical intrusion of the upper incisors and only to protrude the upper incisors. As a consequence, significantly more intrusion is later required in the lower incisor segment during the final multibracket treatment phase in the permanent dentition. If these esthetical considerations are ignored, it cannot be denied that the smile esthetics is unfavorable at least in the long term (Zachrisson 2007).

The simplest approach for protrusion without intrusion of upper incisors is the use of a maxillary plate with protrusion springs. This universally applicable orthodontic tool may effectively address other measures in parallel, such as the correction of a dental midline shift or transversal arch expansion in parallel (see patient example #4).

It is important to note that the correction of the malposition of the upper central incisors using a utility arch or maxillary plate may easily be combined with the treatment of collateral problems in the lower arch. For instance, a dental midline shift in the mandible can be corrected in parallel using a mandibular plate with finger springs (see patient example #4). The therapeutic tasks addressed with a mandibular plate may also include uprighting of proclined lower incisors (see patient examples #2 and #3) or transversal expansion of the lower dental arch (see patient example #4).

5.5.4 Second Main Stage of Early Treatment

The results achieved in the preceding early treatment phases (i.e., the intrusion and proclination of the upper incisors and, if required, the distalization of upper first

molars) require retention in both the vertical and sagittal dimensions. From a mechanical point of view, an appliance is needed that supports the incisal edges and palatal surfaces of the upper incisors. The vertical force components may also inhibit alveolar growth in the anterior segments leading to further correction of the deep frontal overbite. The prevention of mesial migration of the first molars in the late mixed dentition may be regarded as a further important function of the appliance, if a space discrepancy is present.

A bimaxillary removable appliance seems particularly suitable for these therapeutic tasks since the jaw closing muscles (i.e., the masseter and temporalis) are very effective in generating the required force components. If the malposition of the upper incisors is accompanied by distocclusion and/or a skeletal class II jaw base relationship—which applies for the majority of cover-bite patients—the bite registration required for fabrication of the bimaxillary removable appliance has to be taken in a approx. 4–5 mm protruded mandibular position. Systematic reviews showed that such functional appliances may significantly stimulate mandibular growth (Pacha et al. 2016; Perinetti et al. 2015).

The bite registration for an activator may also address the correction of a skeletally based mandibular midline deviation. It has to be noted, however, that this approach is only promising if the transversal occlusion of the buccal segments is adapted in parallel, e.g., by using differential crisscross elastics worn full-time together with the activator (see patient example #3). Otherwise, the neuromuscular training initiated by functional appliance therapy would be counteracted by occlusal guidance back into the laterognathic position (when the activator is not in situ).

From the available variations of functional appliances, Andresen's "activator" (Graber et al. 1997) or successor versions of this appliance seem most suitable for the second main stage of early cover-bite and class div. 2 treatment. This preference is mainly related to the following aspects:

- An activator enables the implementation of anterior bite planes in its acrylic basis to inhibit further vertical growth.
- This appliance may also enhance the vertical alveolar growth in the molar region by grinding of the interocclusal acrylic to eliminate the vertical support of the molars.
- The wire elements of the activator, together with the relatively large extensions of the acrylic basis to the palatal and lingual attached gingiva, provide a sufficiently good fit even in case of a compromised dental support, i.e., during eruption of the permanent canines and premolars in the late mixed dentition.
- A standard activator also comprises stop loops mesial to the first molars which prevent the mesial migration of the first molars; in this manner, the leeway space may be preserved for the anterior teeth.

The preservation of the leeway space is to be regarded as a highly efficient approach for reducing a space discrepancy in the dental arch (see patient examples #2). This is due to the possibility of gaining approx. 2.5 mm additional space on each side of the lower arch and approx. 1.5 mm per side in the upper arch (Proffit et al. 2007a). This measure is to be applied to the lower arch more frequently because many class II patients initially show proclined incisors which means that additional space is required for incisor uprighting by means of an activated labial bow. The proclination of the lower incisors observed during class II functional appliance therapy may cause or increase a space discrepancy in the lower arch. This effect is related to fatigue of the mandibular protractor muscles after the appliance is in situ for longer periods. Consequently, the mandible is not any more actively hold in its therapeutic anterior position and tends to return back into its original (more posteriorly located) resting position. As a result, the appliance exerts posteriorly directed contact forces on the maxillary first molars and incisors (via the stop loops and upper labial bow, respectively) and labially directed contact forces onto the mandibular teeth (mainly via the lower frontal acrylic part onto the lower incisors' lingual surfaces). The latter explains the collateral protrusion of the lower incisor during class II functional appliance therapy.

The preservation of the leeway space requires the intervention of the clinician (see patient example #2, Fig. 5.26). More concretely, if the incisors are to be uprighted, the first intervention is to grind the deciduous canines mesially. If the first deciduous molars are not exfoliating before or during the eruption of the permanent canines, another required intervention is to grind these teeth mesially or to extract them. The same applies for the second deciduous molars during eruption of the first premolars. To ensure that enough enamel is reduced by grinding of deciduous molars and to avoid contacting and damaging of erupting or erupted adjacent permanent teeth, it is recommended to use a very thin, long diamond bur and to leave a thin, vertical slice of enamel between the bur and the neighboring tooth (Fig. 5.26b). In this manner, approx. 1 mm of space may be provided.

In patients with congenitally missing mandibular second premolar(s), another task performed with an activator during the mixed dentition phase may be the guidance and enhancement of the mesial migration of the permanent molars into the second premolar space(s). The remaining spaces are then

to be closed by fixed appliance therapy, often in combination with skeletal anchorage.

According to own clinical experience, clinical monitoring of functional appliances in intervals of 2–3 months seems sufficient—particularly, in the “resting phase” of the mixed dentition, i.e., before the permanent canines and premolars begin to erupt. The subsequent eruption guidance in the late mixed dentition requires more careful examination of the appliance fit and grinding of the activator's interocclusal acrylic part (see Fig. 5.12a).

5.5.5 Consequences of Later Treatment Begin in the Final Mixed Dentition Stage

Particularly if the therapeutic correction of a class II div. 2 or cover-bite is started relatively late, i.e., in the final stage of the late mixed dentition, the second stage of early treatment (i.e., the functional appliance phase) may or must be omitted. This means that the treatment may directly or progressively transit from the utility arch to a full multibracket appliance. An advantage of omitting functional appliance therapy in these patients is that total treatment time is not unnecessarily prolonged which is particularly important in severe cover-bite cases requiring excessive and time-consuming further anterior bite opening and upper incisor torque correction.

If in such situation, however, significant distocclusion is present, an intermediate or parallel phase is required for correction of the class II pattern. The same applies to patients which are noncompliant with removable appliances for class II correction such as the headgear and activator. Depending on the localization of the problem (i.e., mandibular retrognathism, maxillary prognathism, or a combination of both) and on the inclination of the lower incisors, either a Herbst or Herbst-like appliance (Schweitzer and Panherz 2001; Obijou and Panherz 1997) or a skeletally anchorage distalization appliance (Wilmes and Drescher 2010) (see patient example #7) may be considered for class II correction. The frontal class II div. 2 features, i.e., the deep frontal overbite and the upper incisor retroclination, are then to be completely corrected during the subsequent treatment phase, e.g., by using Burstone's segmented multibracket appliance mechanics (Burstone 2001) or adaptations of this approach.

5.6 Patient-Specific Treatment Concepts for Successful Class II Div. 2 and Cover-Bite Correction: Seven Patient Examples

If orthodontic therapy of a cover-bite and class II div. 2 malocclusion is initiated in the early mixed dentition, a two-phase approach comprising the classical two stages of the first phase (as described above) and a directly following second multi-bracket phase may be applicable in most of these patients. Five of seven patient examples included in this chapter fall into this category. In the remaining two patients, treatment was either started with molar distalization with the omission of the first classical early treatment main stage (patient #5) or significant molar distalization was to be carried out prior to final multi-bracket therapy due to compromised compliance with the functional appliance (patient #7). All patients included were treated personally by the author of this chapter.

5.6.1 Patient Example #1

The clinical findings and the treatment approach applied in this female patient may be considered as typical for a severe class II div. 2 (Table 5.1). Her initial records show a complete

cover-bite combined with $\frac{3}{4}$ -step distocclusion and a skeletal class II (Figs. 5.8 and 5.9). Her initial lip-to-incisor relationship has been characterized by a high lip line level in the lips' resting posture and clear maxillary gingiva display during smiling. Hence, it could be assumed that intrusion of the maxillary incisors using a utility arch would not compromise the smile esthetics.

The course and result of early treatment is documented in Figs. 5.10, 5.11, 5.12, 5.13, and 5.14. Since the correction of the distocclusion during the two main early treatment stages has not been fully achieved, distalization of the upper molars by means of a cervical-pull headgear has been required before insertion of the full multibracket appliance. Figure 5.15 proves that this measure was successful. The records taken during the final multibracket phase, directly after debracketing and after 12 months retention (Figs. 5.16, 5.17, 5.18, 5.19, and 5.20) show that all treatment goals could be achieved. The observed proclination of the lower incisors in relation to the lower mandibular border should be considered unproblematic, due to the patient's horizontal growth pattern. As demonstrated by the frontal image during smiling taken in the retention period (Fig. 5.20), the smile esthetics was actually not compromised by the active-mechanical intrusion of the upper incisors. Figure 5.21 shows the buccal and frontal occlusal relationships prior to and after therapy.

Table 5.1 Problem list and conceptual treatment planning in patient #1. The items (a), (b) etc. are to be interpreted as successive treatment stages.

	Problem list and relevant collateral findings	Conceptual treatment planning
1.	Class II div. 2 malocclusion with a cover-bite • Retroclination of upper centrals by -13° • Deep frontal overbite of 5.5 mm with – Supraposition of upper centrals – Supraposition of all 4 lower incisors • High lip line level of 6 mm • Smile with 2 mm maxillary gingiva display	Treatment in mixed + permanent dentition (a) Early active-mechanical correction of upper centrals (utility arch) (b) Passive incisor intrusion (activator) (c) Active-mechanical finalization of incisor intrusion, palatal root torque for U1
2.	Severe distocclusion ($\frac{3}{4}$ -step) + skeletal class II pattern (Wits appraisal + 2.7 mm)	(a) Functional appliance therapy (activator) (b) (If required) active-mechanical distalization of upper molars prior to multibracket therapy
3.	Maxillary dental midline deviation (1 mm to right side)	Slightly asymmetric protrusive activation of the utility arch
4.	Multiple ankylosed deciduous molars	Extractions at the necessary times
5.	Peg-shaped tooth 22	Composite restoration after finalization of multibracket therapy
	Sequence of therapeutic measures (begin at the age of 9:0 years)	Duration
1.	Extraction of severely ankylosed tooth 55	
2.	Utility arch treatment (two-by-two) + high-pull headgear during bedtime	8 months
3.	Activator with mandibular advancement + anterior bite plates	1:04 years
	Reevaluation → further distalization of upper first molars was required	
4.	Cervical-pull headgear	11 months
5.	Multibracket appliance	1:03 years
6.	Retention with maxillary and mandibular plates	

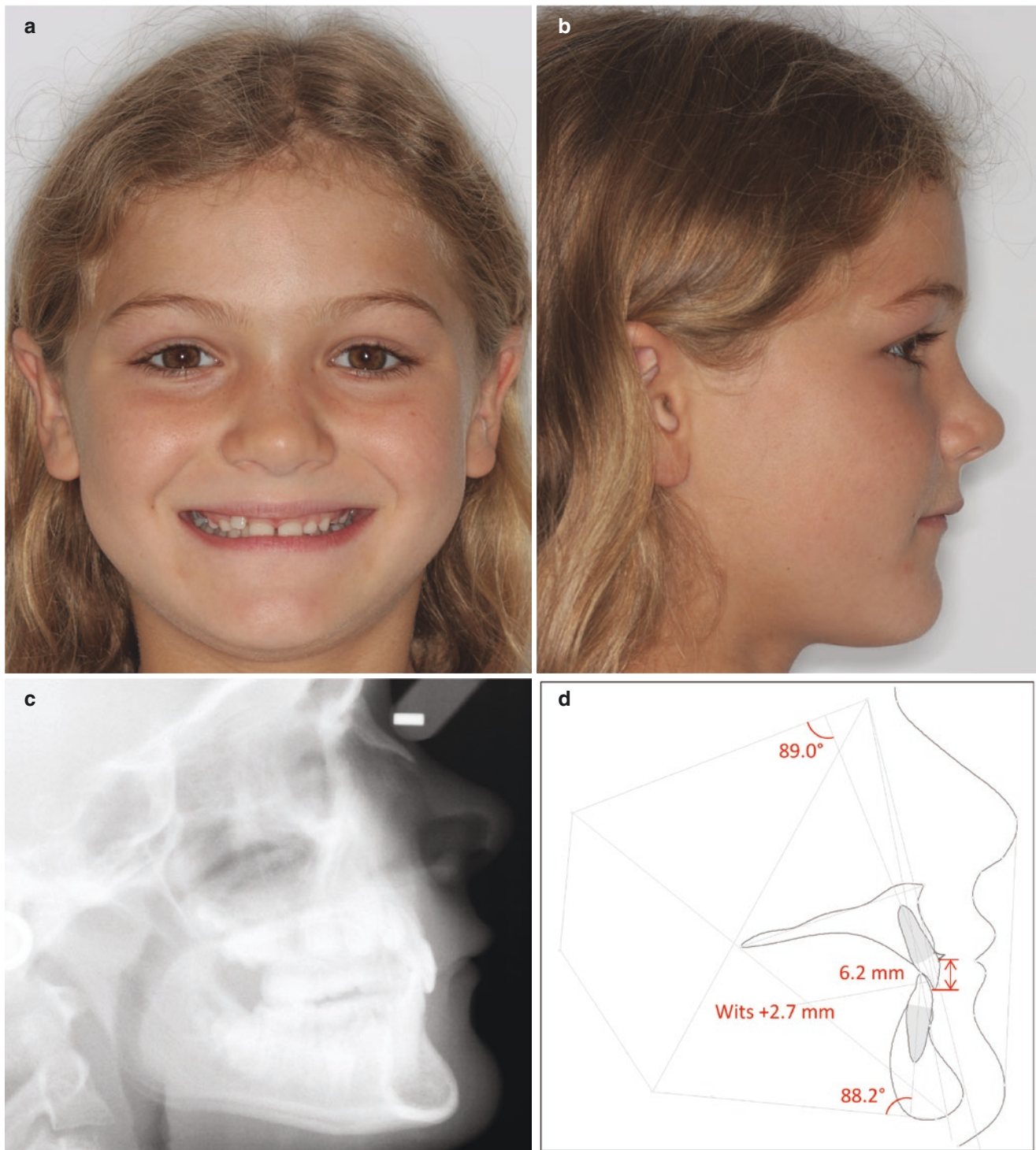


Fig. 5.8 (a–d)/patient #1. Facial images and cephalogram of patient #1 taken at age 8:11 years prior to treatment. (a) The frontal image shows the significant maxillary gingiva display during smiling. (b) The facial profile is concave due to a prominent chin. (c, d) The cephalogram

reveals the characteristic features of a cover-bite, i.e., a high lip line level, deep frontal overbite, and retroclination of the upper centrals reflected by an SN/U1 angle of 89.0° (reference: 102°). The Wits appraisal (+2.7 mm) indicates a skeletal class II pattern

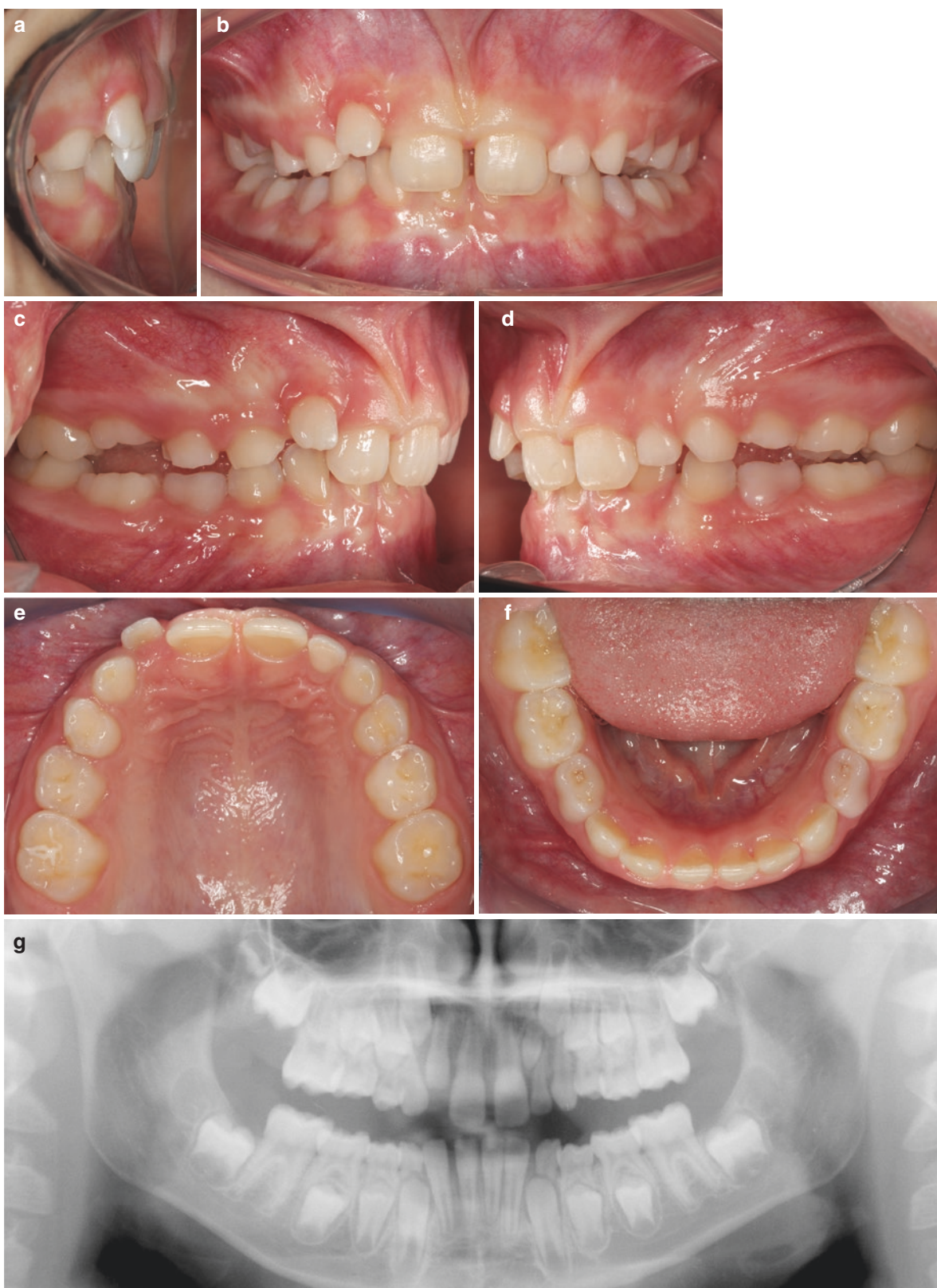


Fig. 5.9 (a–g)/patient #1. Dental images and panoramic X-ray of patient #1 associated with the records depicted in Fig. 5.8. (a, b) The frontal and lateral views of the dentition reveal the class II div. 2 malocclusion with a cover-bite in the early mixed dentition. The lower central incisors are nearly completely covered by the retroclined upper centrals. (c, d) First molars showed nearly full-step distocclusion. All

deciduous molars are ankylosed except for tooth 54. (e, f) Occlusal views on both arches. Tooth 12 is tipped labially. The infraposition of this tooth is related to the position of its incisal edge on top of the lower lip at rest. In the second quadrant, the deciduous lateral incisor is persisting. (g) The panoramic X-ray reveals the peg-shaped tooth 22 showing also a delayed development

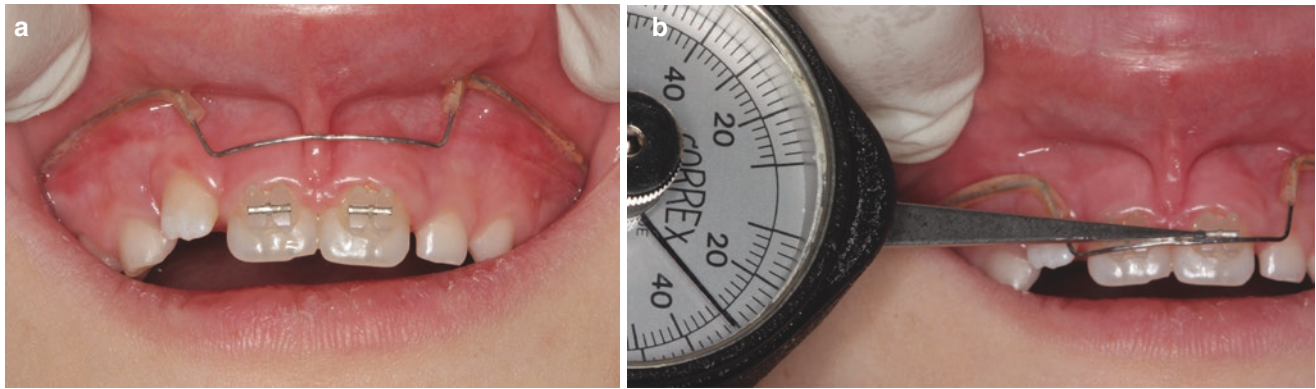


Fig. 5.10 (a, b)/patient #1. The first stage of early treatment comprised a utility arch (two-by-two configuration) in the upper jaw. (a) For the second reactivation 2 months after treatment start, the wire is detached from the brackets. For symmetric intrusion, the anterior wire segment has to run horizontally to achieve uniform loading of both incisors. (b) The intrusive force is measured by leveling the anterior wire segment

with the bracket slots using the tip of a spring balance. Attention must be paid that during the measurement that the utility arch contacts only the probe's tip. If necessary, the tip-back bends of the utility arch are adjusted to obtain an adequate total intrusive force of 30 cN (15 cN per tooth)



Fig. 5.11 (a–h)/patient #1. Situation after 9 months utility arch treatment. (a, b) The frontal view on the face during smiling shows the appearance of the upper centrals' incisal edges and the absence of maxillary gingiva display during smiling. (c, d) Intrusion and proclination of the upper central incisors resulted in a decrease of the frontal over-

bite to 3 mm. (e, f) The proclination of the upper central incisors led to a sagittal interincisal distance of 1.5 mm which is to be regarded as a precondition for the subsequently planned mandibular advancement in the second stage of early treatment. (g, h) Occlusal views indicating that sufficient space is provided in both arches for the permanent teeth

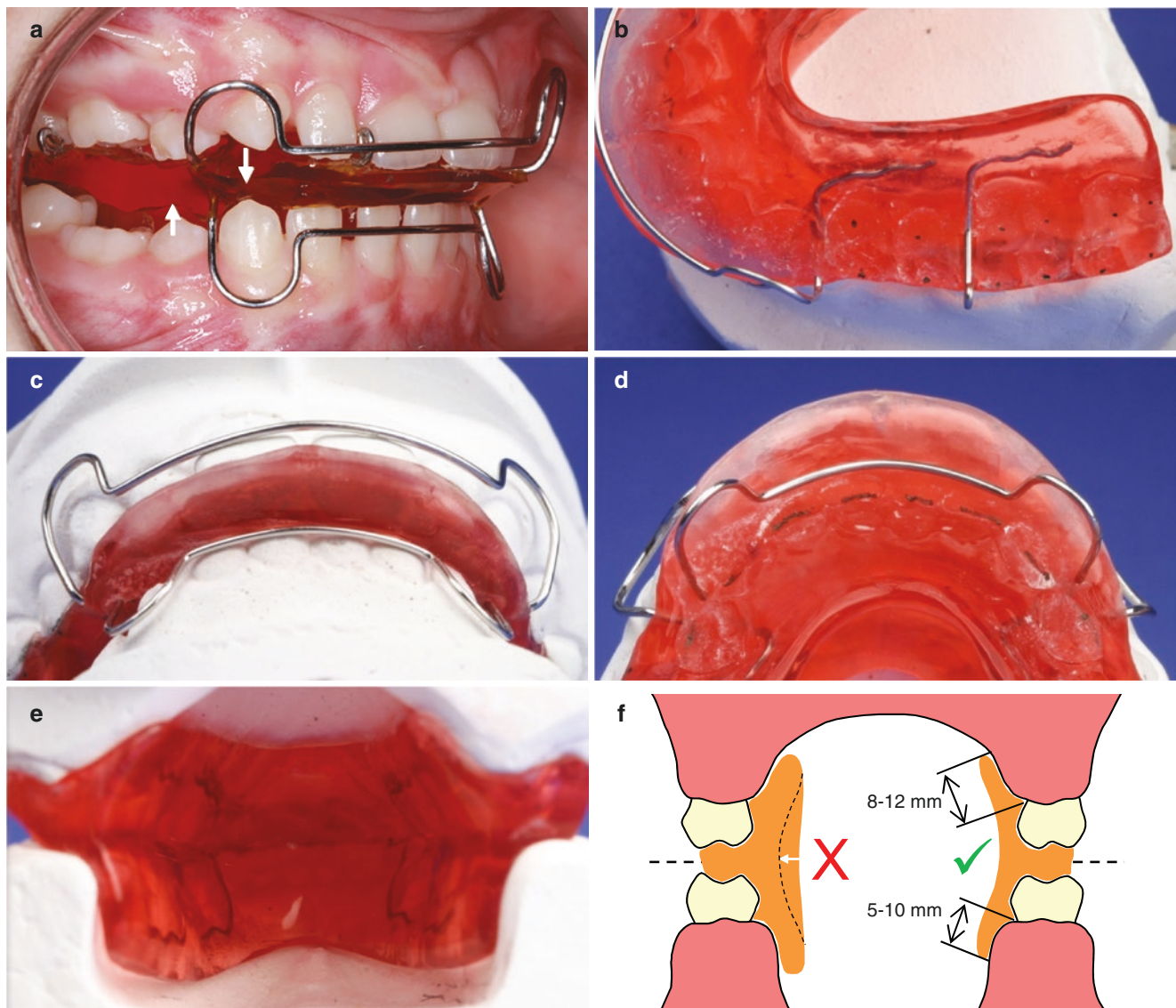


Fig. 5.12 (a–f)/patient #1. Construction of the class II activator. (a) A class II activator with anterior bite blocks is applied to patient #1 in the second early treatment stage. The construction bite has been registered during approx. 4 mm mandibular protrusion and approx. 3–4 mm bite opening in the first molar region. (b) During fabrication, the posterior acrylic part has to be extended so that it supports oral and buccal cusps of upper and lower buccal teeth. In situ, the interocclusal acrylic part may locally be ground to enable eruption of the permanent canines and premolars in the late mixed dentition (see panel (a), white arrows) or to enhance alveolar growth in the corresponding region. (c) In class II div.

2 patients with a deep frontal overbite, the anterior acrylic part has to support the maxillary incisors at their incisal and palatal surfaces for retention of the previously achieved intrusion and proclination of the upper incisors. (d) The activator's lower frontal surface contains grooves for the mandibular incisors' incisal edges to inhibit vertical alveolar growth in this region. (e) The activator's oral extension has to be concave so that the restriction of tongue functions is minimized. This is an important factor regarding the patient's compliance. (f) The vertical extension of the acrylic (usually 8–12 mm in the maxilla and 5–10 mm in the mandible) has to adapt to individual alveolar bone height

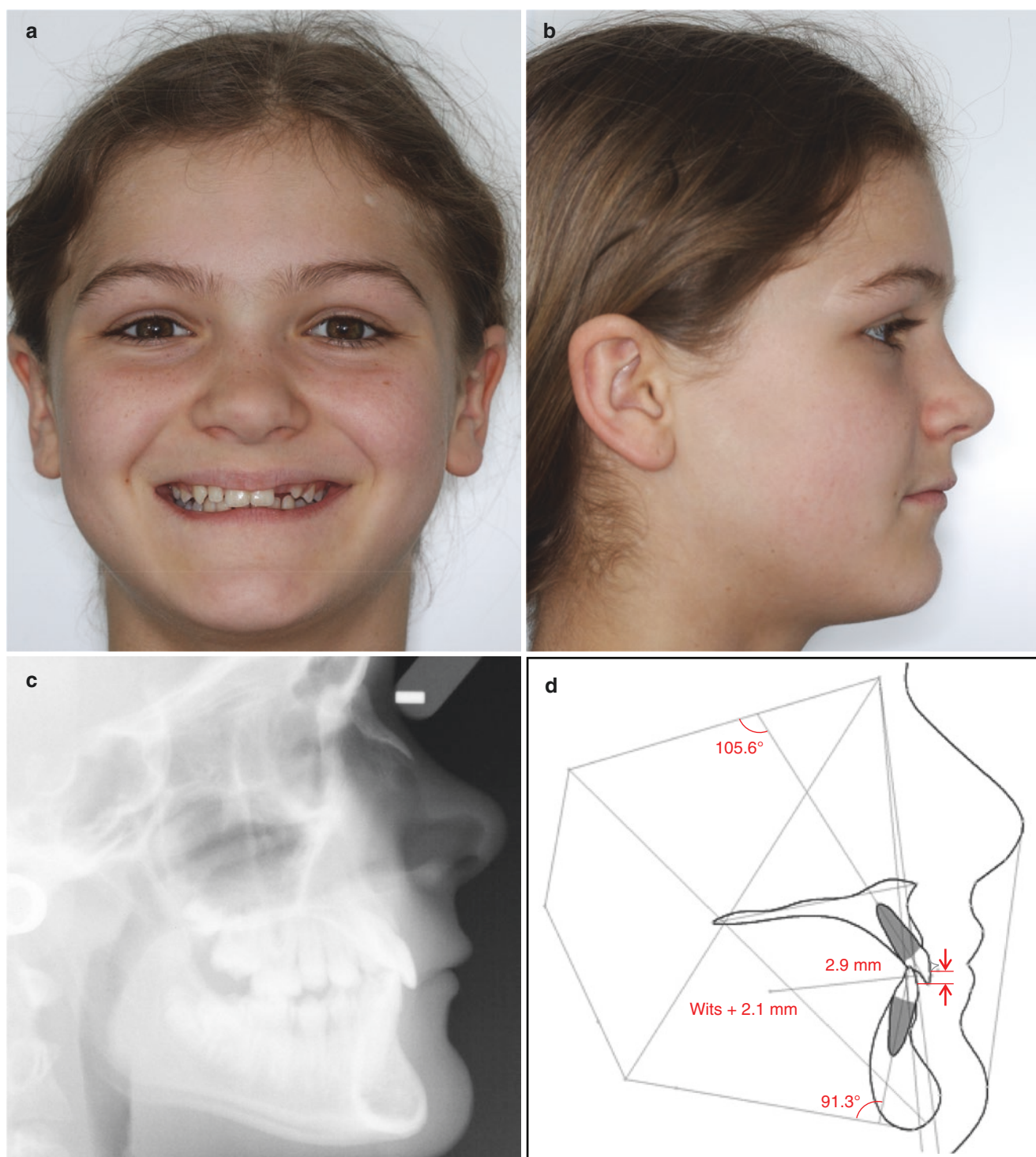


Fig. 5.13 (a–d)/patient #1. Facial images and lateral cephalogram taken after 9 months utility arch treatment and 7 months activator therapy. The lateral cephalogram demonstrates the achievements in the first

early treatment stage, i.e., proclination of the upper central incisors by 16.6° and reduction of the lip line level to approx. 3 mm



Fig. 5.14 (a–i)/patient #1. Dental images corresponding to the facial images and cephalogram depicted in Fig. 5.13. (a, b) Activator in situ. A rectangular spring welded to the labial bow is used for palatal movement of tooth 24. (c, d) The original cover-bite characteristics have already disappeared. (e) The late developed peg-shaped left upper lat-

eral incisor is shortly before eruption. (f, g) Buccal segments still show distocclusion $>1/2$ -step. Thus, an additional phase comprising the distalization of the upper first molars using a cervical-pull headgear was added to the original treatment plan. (h, i) Occlusal views on the dental arches



Fig. 5.15 (a–f)/patient #1. Dental images taken 12 months after begin of cervical-pull headgear therapy. Neutral occlusion of the first molars has been achieved. Maxillary premolars show passive distal drift. The

extrusive force component of the cervical-pull headgear resulted in a further reduction of the deep overbite. The peg-shaped tooth 22 is erupting

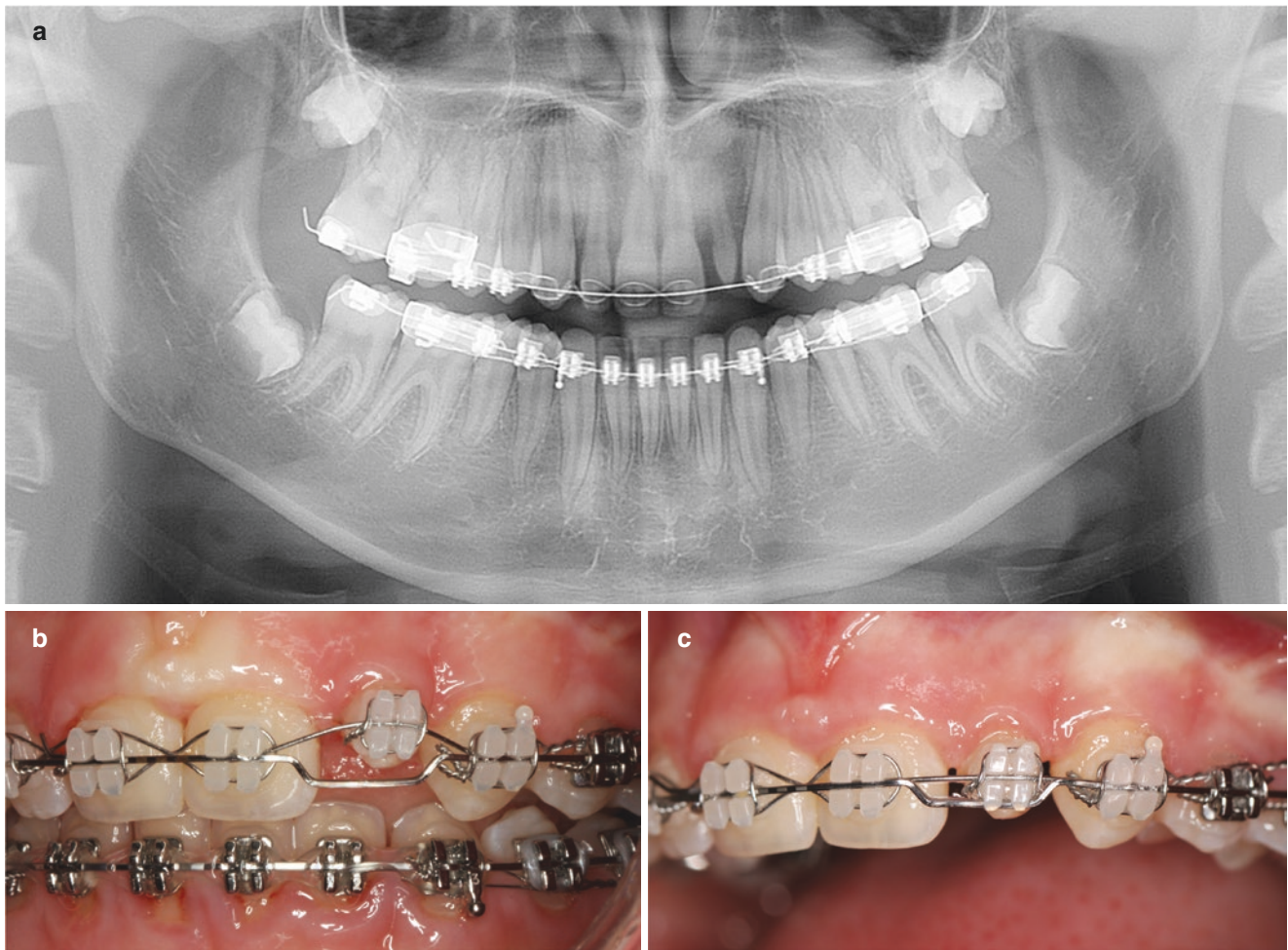


Fig. 5.16 (a–c)/patient #1. (a) Panoramic X-ray taken 6 months after bracketing for clarification whether the patient has a genetic predisposition to severe apical root resorptions (which is not the case). (b) Leveling and alignment are completed so that a 0.016 × 0.016-in. stain-

less steel wire with a 2.5-mm offset bend is inserted. Tooth 22 is now equipped with a bracket and integrated in the appliance using a 0.012-in. NiTi wire. (c) Eight months after bracketing, sufficient extrusion of tooth 22 is achieved so that a straight archwire can be inserted

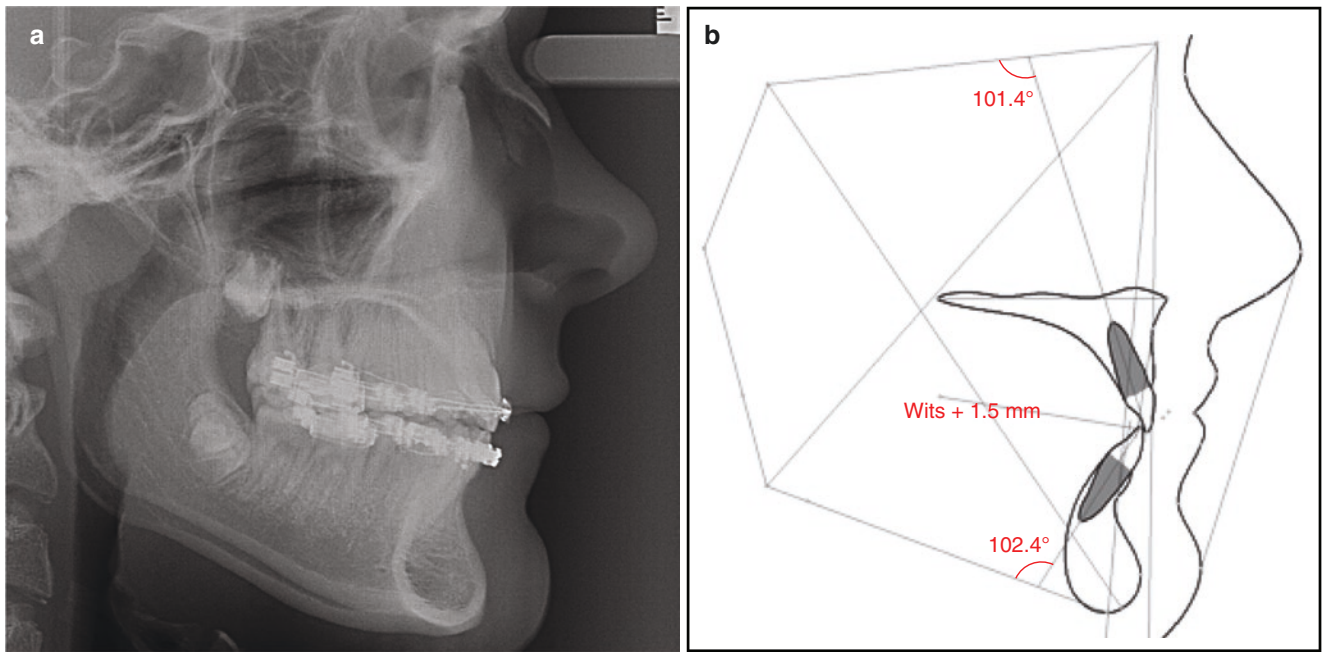


Fig. 5.17 (a, b)/patient #1. (a) Lateral cephalogram for control of incisor inclination in the final phase of multibracket therapy. (b) The tracing shows that axial the inclination of the upper central incisors agrees with the reference value (102°). As a side effect of the class II activator and class II elastics applied during multibracket therapy, the lower incisors

proclined by approx. 10°. The ANB angle (4.1°) is very close to the individualized reference value (3.9°), and the Wits appraisal improved from 2.7 mm to +1.5 mm. Hence, the mild class II jaw base relationship which was initially present is corrected



Fig. 5.18 (a–h)/patient #1. Debracketing after fixed appliance treatment for only 15 months. (a, b) The deep overbite is slightly overcorrected to a value of 1 mm. (c, d) Neutral buccal occlusion is achieved on both sides. (e) The spikes bonded to the upper central incisors' palatal surfaces during multibracket therapy are not yet removed to prevent

further bite opening due to the persisting viscerosomatic swallowing pattern. (f) Occlusal view on lower arch. (g, h) Acrylic plates are used in both jaws for retention. The patient is instructed to wear the retention appliances every night

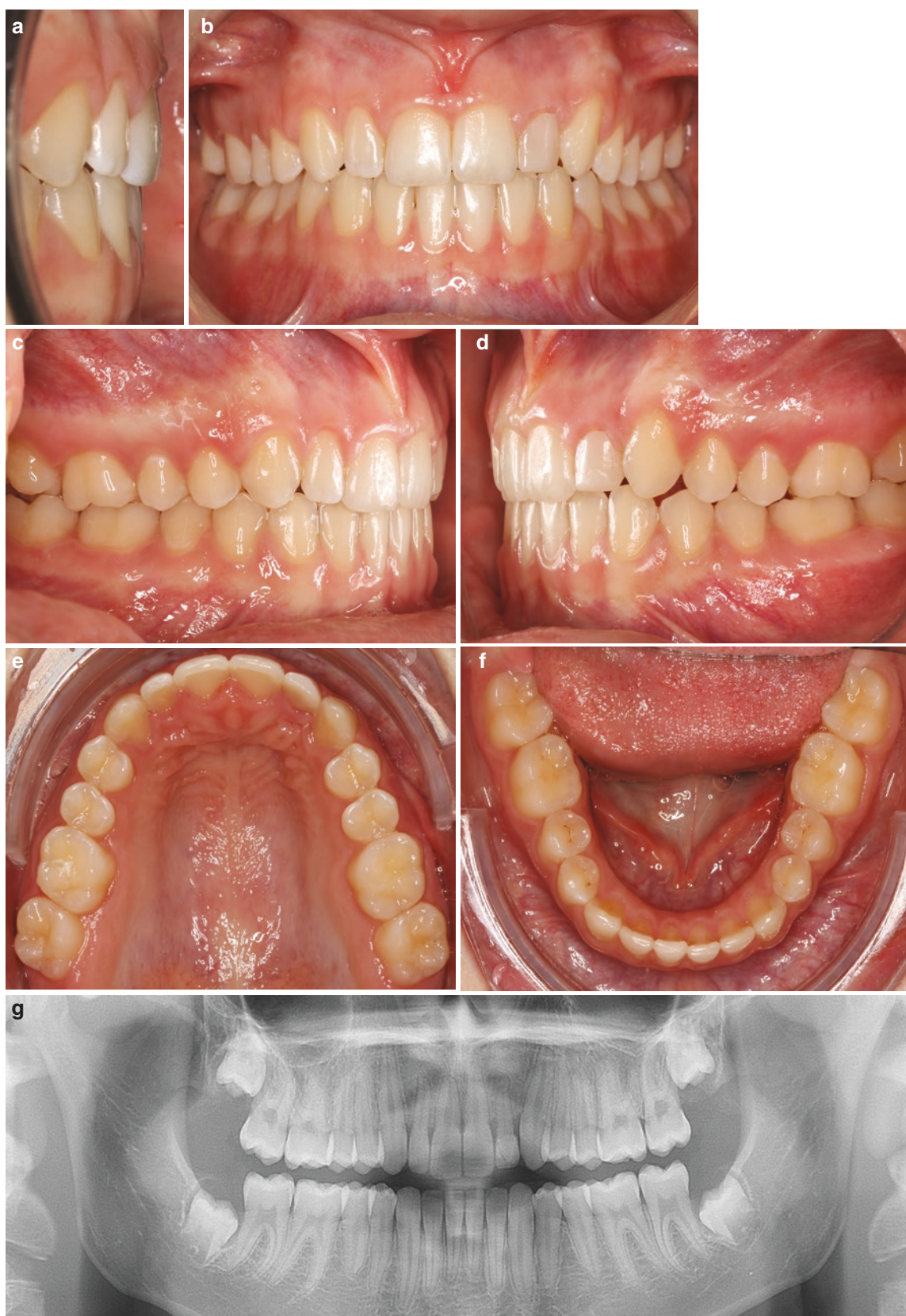


Fig. 5.19 (a–g)/patient #1. Dental images of patient #1 taken 12 months after debracketing. (a–c) The buccal occlusion has settled and the frontal overbite relaxed to a physiological value of 1.5 mm. The proclination of the upper centrals and the neutral buccal occlusion achieved during therapy remained stable. (d, e) Composite reconstruc-

tion of the left upper lateral incisor crown by the patient's general dentist. (f) Occlusal view on the lower dental arch. (g) The panoramic X-ray shows small root resorptions at teeth 12, 11, 31, and 45. The germs of the third molars are developing and show good axial inclinations so that their extraction is not indicated (at least at this stage)



Fig. 5.20 (a, b)/patient #1. Facial images of patient #1 associated with the dental records depicted in Fig. 5.19 taken after 12 months retention. (a) The patient shows a nice smile arc and buccal corridor and displays

the full upper central incisor crowns during smiling. (b) Lateral view on the face showing the patient's inherited concave facial profile



Fig. 5.21 (a, b)/patient #1. Buccal and frontal occlusal interrelationships prior to (a) and after therapy (b)

5.6.2 Patient Example #2

This patient showed severe upper central incisor retroclination related to a high lip line before therapy, but the frontal overbite was only moderately deep (6 mm), and the class II component showed relatively slight manifestation (Table 5.2, Figs. 5.22 and 5.23). The treatment course in this patient proves the effectiveness of the utility arch for upper incisor intrusion and proclination (Figs. 5.24 and 5.25). Moreover, this patient example demonstrates how early therapeutic intervention may easily and effectively address a hereditary space discrepancy in the dental arch. Such space discrepancy may typically be reflected by undermining resorption of the deciduous canines during eruption of the lateral incisors—as present in the patient's lower dental arch. Utilizing the leeway space for

anterior teeth requires the intervention of the clinician by means of prevention of the physiological mesial migration of the molars and by grinding or extraction of deciduous canines and molars which enables the eruption of the permanent canines and premolars more distally. As a result of the improved space conditions, transversal arch expansion or incisor protrusion during multibracket therapy and the corresponding relapse risk can be avoided or at least minimized.

The treatment of this patient has been still ongoing at publication date, so that posttreatment records have not been available. The latest dental images, however, taken in the final mixed dentition phase (Fig. 5.26) already demonstrate how a mild cover-bite can be effectively treated by early intervention, so that only very limited active-mechanical intervention is required in the permanent dentition—if at all.

Table 5.2 Problem list and conceptual treatment planning in patient #2

	Problem list and relevant collateral findings	Conceptual treatment planning
1.	Cover-bite-like malocclusion with • Retroclination of upper centrals by -15.5° • Deep frontal overbite of 6 mm with supraposition of upper centrals only • High lip line level of 7 mm • Smile with 3 mm maxillary gingiva display	Treatment in mixed + permanent dentition (a) Early active-mechanical correction of upper central incisors (utility arch) (b) Passive incisor intrusion (activator) (c) If required, subsequent multibracket therapy for additional incisor intrusion, palatal root torque for upper centrals
2.	Mild skeletal class II with physiological distocclusion of first molars	Slight mandibular advancement (activator)
3.	Midline deviation of 2 mm, due to combined • Latero-occlusion of 1 mm to right side (precontacts at 55/46 + 63/74) • Dental midline shift in lower arch of 1 mm to right side	Midline corrections by • Grinding of 55 distally and 63 palatally for elimination of precontacts • Early correction of the dental midline shift in the lower jaw
4.	Space discrepancy in lower jaw with undermined resorption of deciduous canines during eruption of lateral incisors → only 2 mm space for permanent canines	Utilizing the leeway space for anterior teeth • Successive grinding of deciduous molars • Prevention of mesial migration of upper and lower first molars in the late mixed dentition phase
5.	Mild symptoms for a temporo-mandibular disorder • Articular pain during compression of stratus superioris on right side • Muscle pain in masseter during palpation	Elimination of precontacts for reduction of the dorsal compression of the right temporo-mandibular joint in habitual occlusion
	Sequence of therapeutic measures (begin at the age of 8:06 years)	Duration
1.	Grinding of teeth 55 and 63	—
2.	Maxilla: Utility arch (two-by-two, later two-by-four) Mandibula: Plate for midline correction + prevention of leeway space	5 months
3.	Activator with • Anterior bite plates + stop loops for upper and lower first molars • Slight mandibular advancement	Ongoing since 1:06 years
	Reevaluation → palatal root torque necessary for upper centrals?	
4.	Multibracket or aligner therapy (depending on remaining tooth malpositions and patient's preference)	Forthcoming
5.	Retention using maxillary and mandibular plates	Forthcoming

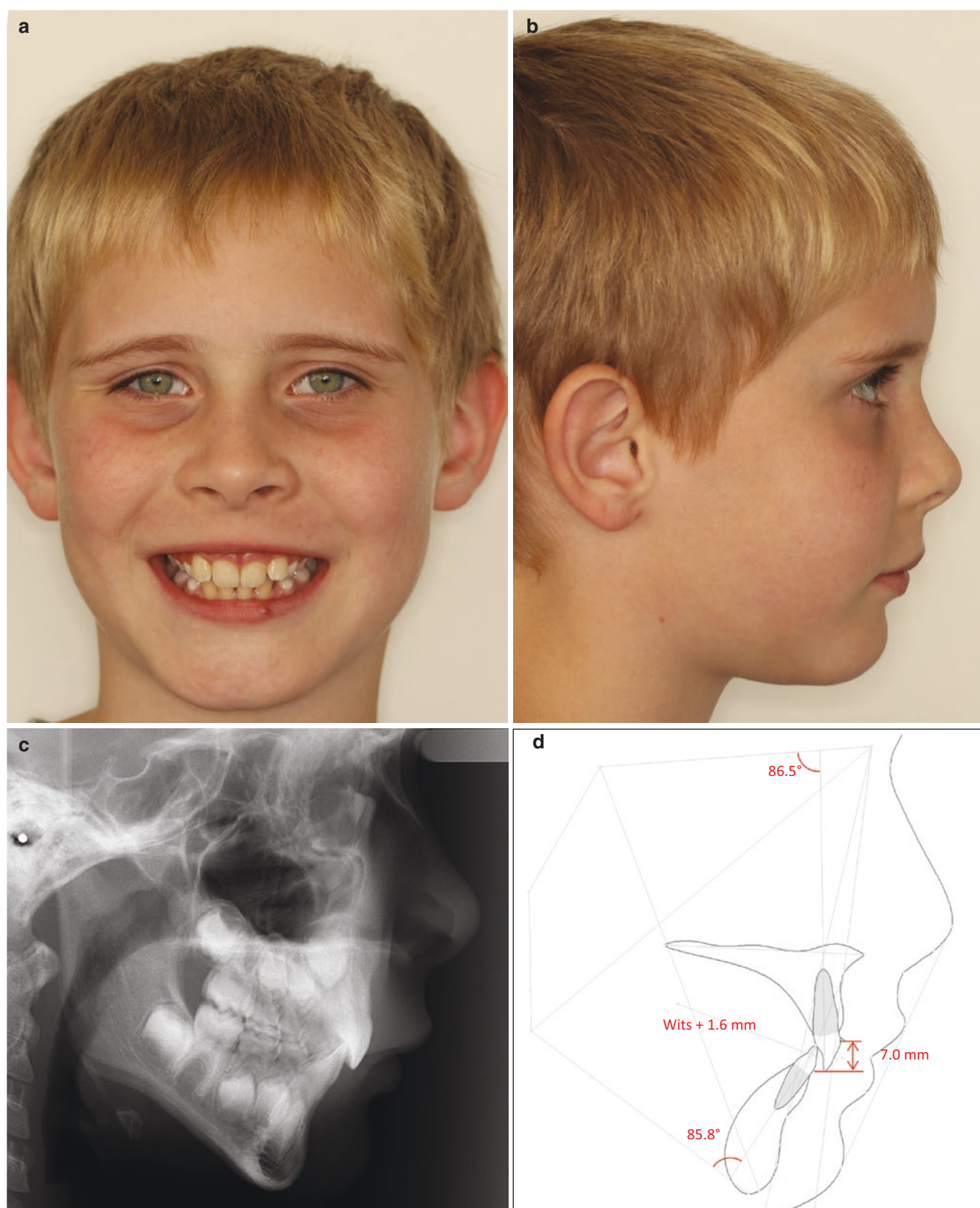


Fig. 5.22 (a–d)/patient #2. Initial facial images and cephalogram of patient #2 taken at age 8:02 years. (a) The frontal view of the face during smiling shows the significant maxillary gingiva display. (b) The facial profile is retrognathic. (c, d) Cephalometric analysis reveals the

severe retroclination of the upper central incisors by 15.5° and the high lip line level of 7 mm. The mild class II jaw base relationship is indicated by the Wits appraisal of +1.6 mm



Fig. 5.23 (a–g)/patient #2. Dental images of patient #2 associated with the records depicted in Fig. 5.22. (a, b) Severe retroclination of the upper centrals combined with a moderately deep overbite. The midline deviation of 2 mm is related to mandibular latero-occlusion by 1 mm and a dental midline shift in the lower arch by 1 mm to the right side. (c, d) The slight distocclusion of the first molars may be considered

physiological in this phase as canine relation is neutral. (e, f) Occlusal images of the dental arches. The early loss of the mandibular deciduous canines during eruption of the permanent lateral incisors indicates a hereditary crowding pattern. (g) Lateral cephalogram showing physiological dental development



Fig. 5.24 (a–f)/patient #2. Situation 5 months after insertion of the mandibular plate and 2 months after begin of utility arch treatment. (a, b) Upper incisors are partially intruded and proclined, and the midline shift is already completely eliminated. (c, d) The clasp retentions of the mandibular plate barely interfere with habitual occlusion. (e) The utility

arch follows the contour of maxillary arch form. (f) The mandibular dental midline has been corrected by successive activation of the finger spring distal to tooth 42. Incisors are partially uprighted by the active labial bow



Fig. 5.25 (a–d)/patient #2. Overview over the different stages during intrusion and proclination of the upper central incisors. (a) Situation at insertion of the mandibular plate. (b) Two months later, the utility arch (two-by-two configuration) is inserted. (c) Situation after treatment with the mandibular plate for 8 months and parallel utility arch treat-

ment for 5 months. Active intrusion of the upper central incisors by approx. 2 mm is clearly recognizable. (d) Insertion of an activator after utility arch treatment to retain the correction of the upper incisor segment and to address the other treatment tasks planned in the second main stage of early treatment



Fig. 5.26 (a–e)/patient #2. Different stages during the second main stage of early treatment of patient #2 illustrating the utilization of the leeway space for the anterior teeth. (a) Activator in situ. The stop loops located directly mesial to the mandibular first molars prevent mesial migration of these teeth after subsequent loss of the deciduous molars. (b) For grinding of deciduous molars adjacent to permanent teeth, it is recommended to preserve a slice of enamel for absolute protection of the permanent tooth. (c) Situation after grinding of the first deciduous molars which provided space for the erupting permanent canine. (d)

Both lower canines have migrated in distal direction so that their overlap with the lateral incisors is eliminated. The first deciduous molars are already exfoliated and the first premolars erupt direct distal to the canines into the space provided by grinding of the second deciduous molars at their mesial sides. (e) Situation after eruption of the lower second premolars. Although treatment has still been ongoing in this patient at publication date, it is demonstrated that the anterior space discrepancy has been completely eliminated by utilizing the leeway space for incisors, canines, and premolars

5.6.3 Patient Example #3

The class II div. 2 malocclusion in this patient may be characterized as moderate with respect to its vertical and sagittal manifestation (Table 5.3, Figs. 5.27 and 5.28). In Fig. 5.29 it is shown how a high-pull headgear has to be designed for achieving bodily distalization of upper first molars during utility arch treatment instead of distal tipping, and how the first early treatment stage may be used for early correction of a dental midline shift in parallel to the main intervention in the maxilla. The images taken at different times during the initial stage of early treatment (Fig. 5.30) again demonstrate the effectiveness of the utility arch for elimination of the typical cover-bite features by means of true incisor intrusion and first molar extrusion. More specifically, upper incisors are significantly proclined and the overbite is reduced by approx. 4 mm in only 4 months of treatment.

The specific problem in this patient, however, lies in the combination of the class II div. 2 pattern with mandibular laterognathism. The course of the treatment demonstrates how the latter problem may effectively be addressed parallel to the correction of the class II div. 2 features using an activator combined with differential crisscross elastics (Figs. 5.31 and 5.32). In this manner, it is possible to correct a laterognathic mandible causally during the growth period. In contrast, exclusive treatment in the permanent dentition would only have enabled the dentoalveolar compensation of the laterognathism.

Treatment has been still ongoing at publication date, but the main aspects of the initial malocclusion are already causally corrected by the early intervention in the mixed dentition phase. Hence after eruption of all permanent teeth, only a short final therapeutic phase using a multibracket appliance is to be expected.

Table 5.3 Problem list and conceptual treatment planning in patient #3

Problem list and relevant collateral findings	Conceptual treatment planning
1. Class II div. 2 malocclusion with • Retroclination of upper centrals by -14.5° • Deep frontal overbite of 6.5 mm • High lip line level of 7 mm • Smile with full crown display of upper centrals (but no maxillary gingiva display)	Treatment in mixed + permanent dentition (a) Early active-mechanical protrusion but limited intrusion of upper centrals (utility arch) (b) Passive incisor intrusion + molar extrusion (activator) (c) Multibracket therapy for active-mechanical incisor intrusion, palatal root torque for upper incisors
2. Mandibular retro- and laterognathism • Asymmetric distocclusion (1/2-step right side/full-step left side) • Mandibular midline shift of 3 mm to left side	(a) Asymmetric mandibular advancement after adaptation of transversal occlusion of molars (activator) (b) (If required) further active-mechanical distalization (using skeletal anchorage) (c) (If required) dentoalveolar compensation of mandibular laterognathism (multibracket appliance + mini screw for temporary anchorage in third quadrant)
4. Two supernumerous maxillary molars	Extraction before treatment start
5. Proclined lower incisors by 6° with fragile labial gingiva and gingiva recessions at teeth 31 + 41	Utilizing leeway space for anterior teeth • Grinding of deciduous canines and molars mesially • Prevention of mesial migration of all 4 first molars in late mixed dentition phase
Sequence of therapeutic measures (begin at the age of 9:08 years)	Duration
1. Extraction of supernumerous maxillary molars	
2. Maxilla: Utility treatment (two-by-two) + high-pull headgear Mandible: Plate for uprighting incisors + prevention of leeway space	4 months
3. Activator with asymmetric mandibular advancement, anterior bite plates and stop loops for upper and lower first molars; the posterior acrylic part of the activator is reduced so that it can be combined with differential crisscross elastics at right and left first molars	11 months
4. Standard activator with mandibular advancement and corrected midline Reevaluation → further asymmetric distalization in upper jaw and/or dentoalveolar compensation of mandibular laterognathism required?	Ongoing since 3 months
5. Multibracket therapy (with skeletal anchorage if required for further correction of asymmetry)	Forthcoming
6. Retention using maxillary and mandibular plates	Forthcoming

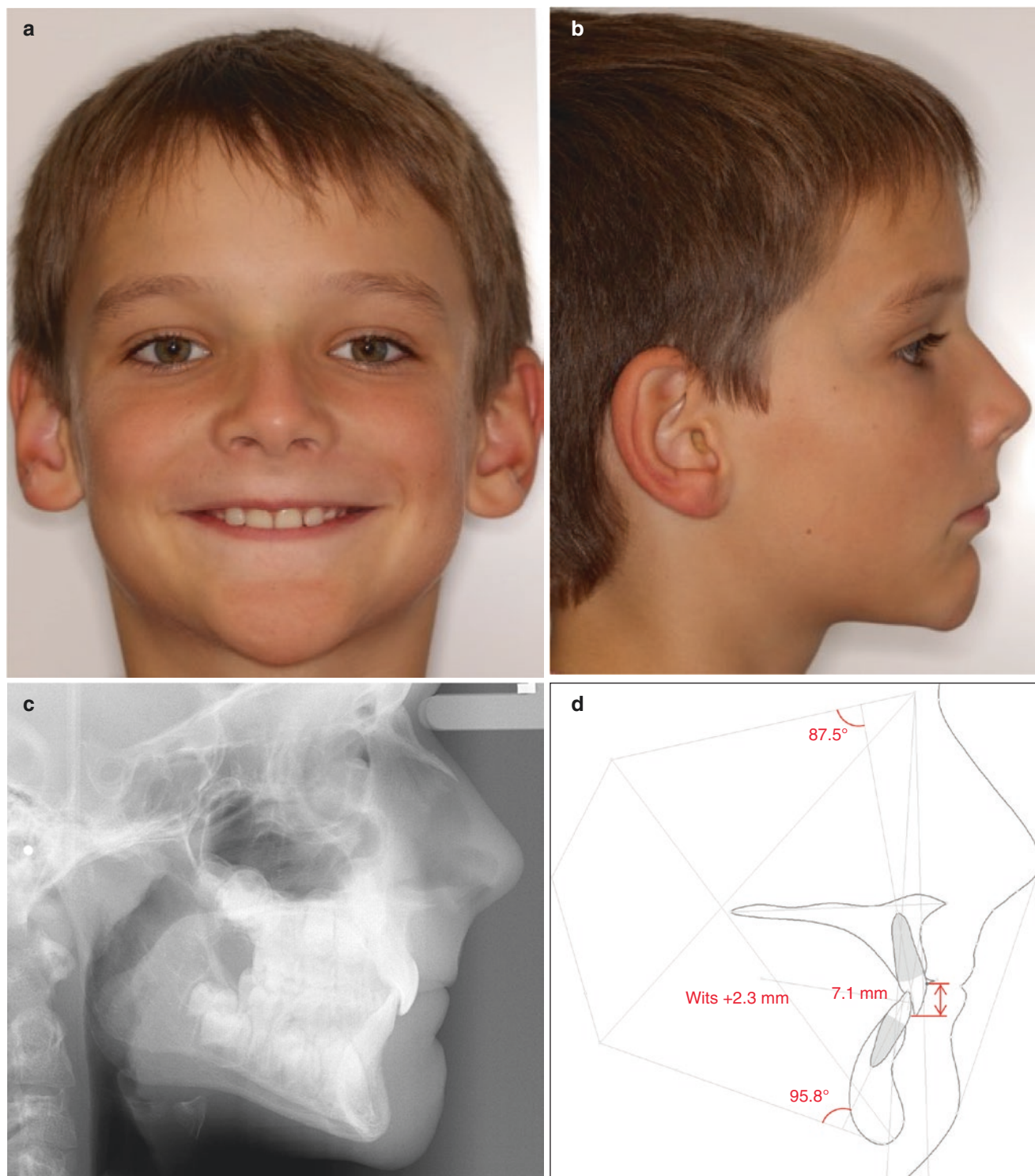


Fig. 5.27 (a–d)/patient #3. (a, b) Facial images of patient #3 taken at the age of 9:08 years before treatment begin. The patient displays the cervical regions of the upper central incisors' crowns during smiling but not their incisal edges. The facial profile is orthognathic. (c, d) Cephalogram showing severe retroclination of the upper central inci-

sors (-14.5°) and a high lip line level (7.1 mm). The jaw bases show a moderate skeletal class II pattern (Wits appraisal: +2.3 mm, deviation ANB/individualized reference: 2.1°) with a prominent chin. The lower incisors are proclined ($+5.8^\circ$)

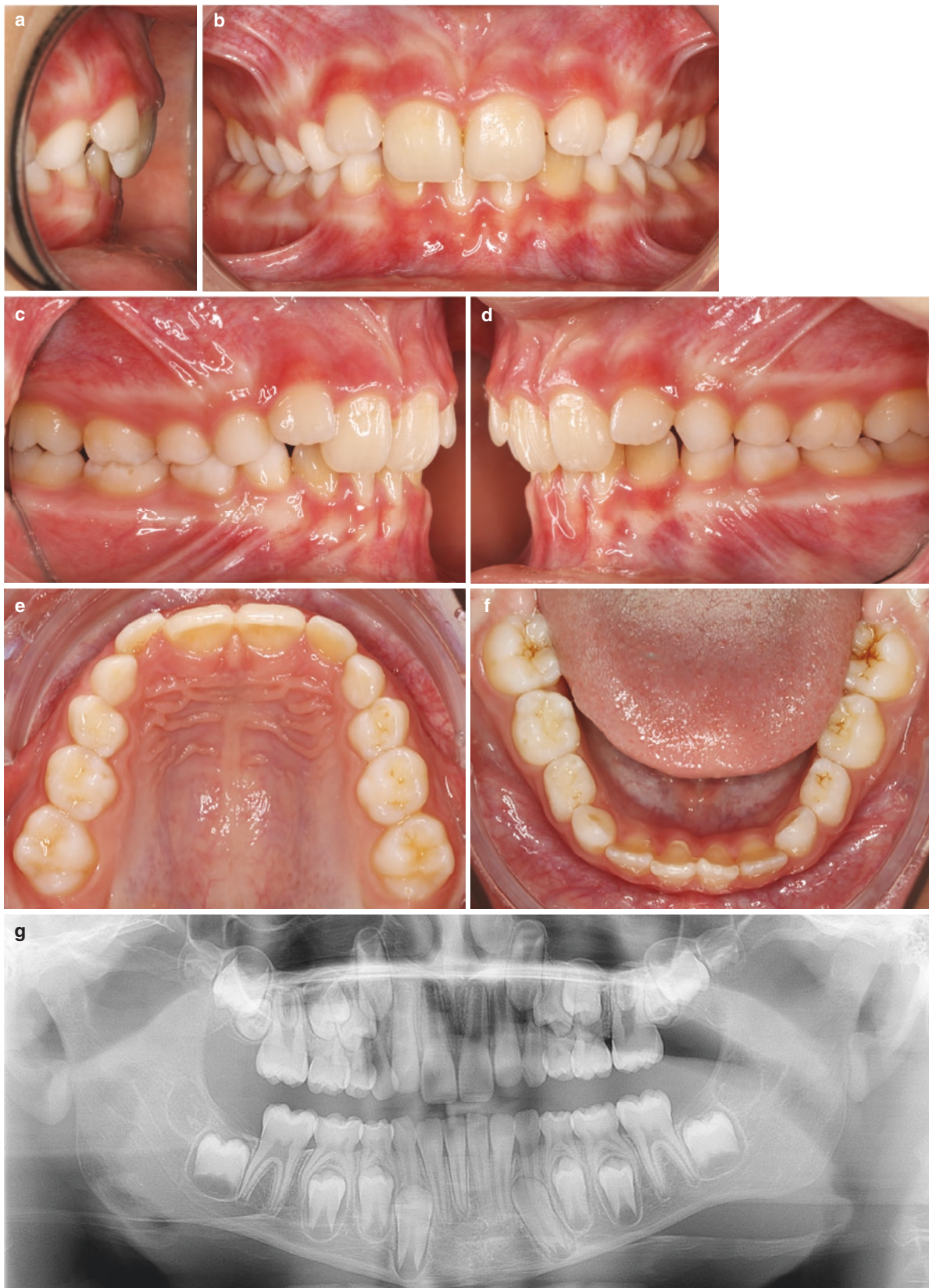


Fig. 5.28 (a–g)/patient #3. Initial dental images associated with the records depicted in Fig. 5.27. (a) Lateral view on the incisor segment. (b) The 3-mm midline deviation before treatment start is related to a laterognathic mandible (2 mm to left side) combined with a dental midline shift in the maxilla (1 mm to right side). (c, d) As a result of the

mandibular laterognathism, the distocclusion is asymmetric (half-step at right first molars and full-step at left first molars). (e, f) Occlusal views on the dental arches. (g) The panoramic X-ray reveals two supernumerary molars in the first and second quadrants. Deciduous canines and molars show insufficient root resorption

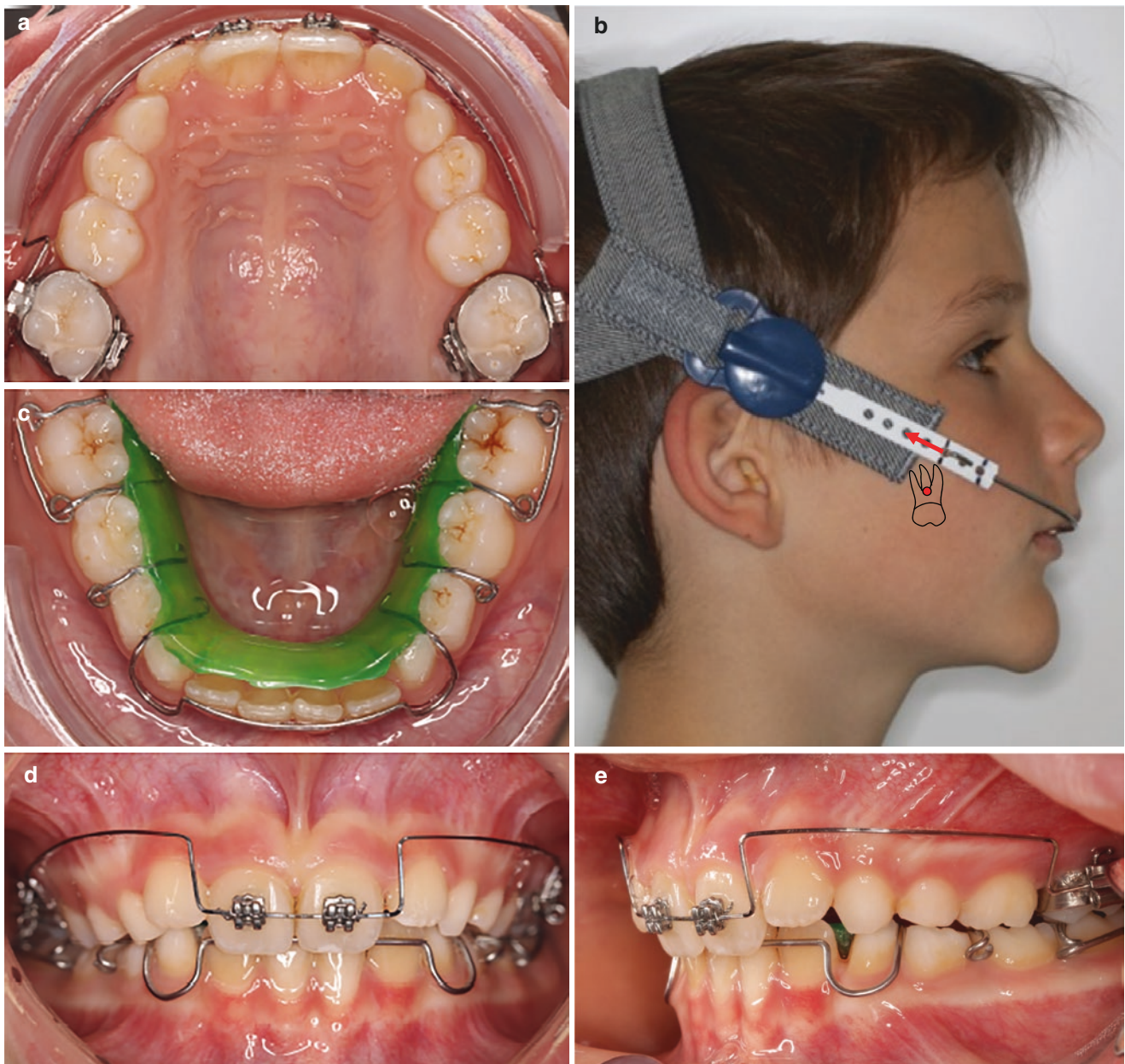


Fig. 5.29 (a–e)/patient #3. First stage of early treatment of patient #3. (a) Intervention in the maxilla comprises the intrusion and proclination of upper central incisors using a two-by-two utility arch. (b) The utility arch is combined with a high-pull headgear (to be worn only during bedtime) for preventing the distoangulation of the first molars. The outer headgear bow is angulated in dorso-cranial direction so that the force vector passes above the first molars' center of resistance (red dot on the schematic tooth). In this manner, the utility arch's distally tipping effect on the first molars (see Fig. 5.6) may be neutralized. (c) In the

lower jaw, the deciduous canines are ground mesially to provide space for uprighting of the incisors using a plate with an active labial bow. Before fabrication of the acrylic part on the cast model, a 2-mm thick dental wax plate was positioned on the incisor's lingual crown surfaces. Thus, grinding of the plate before insertion is not needed which may decrease the risk of breakage of the plate. (d, e) The optimal design and fabrication of the clasps' retentions minimizes their interference in habitual occlusion

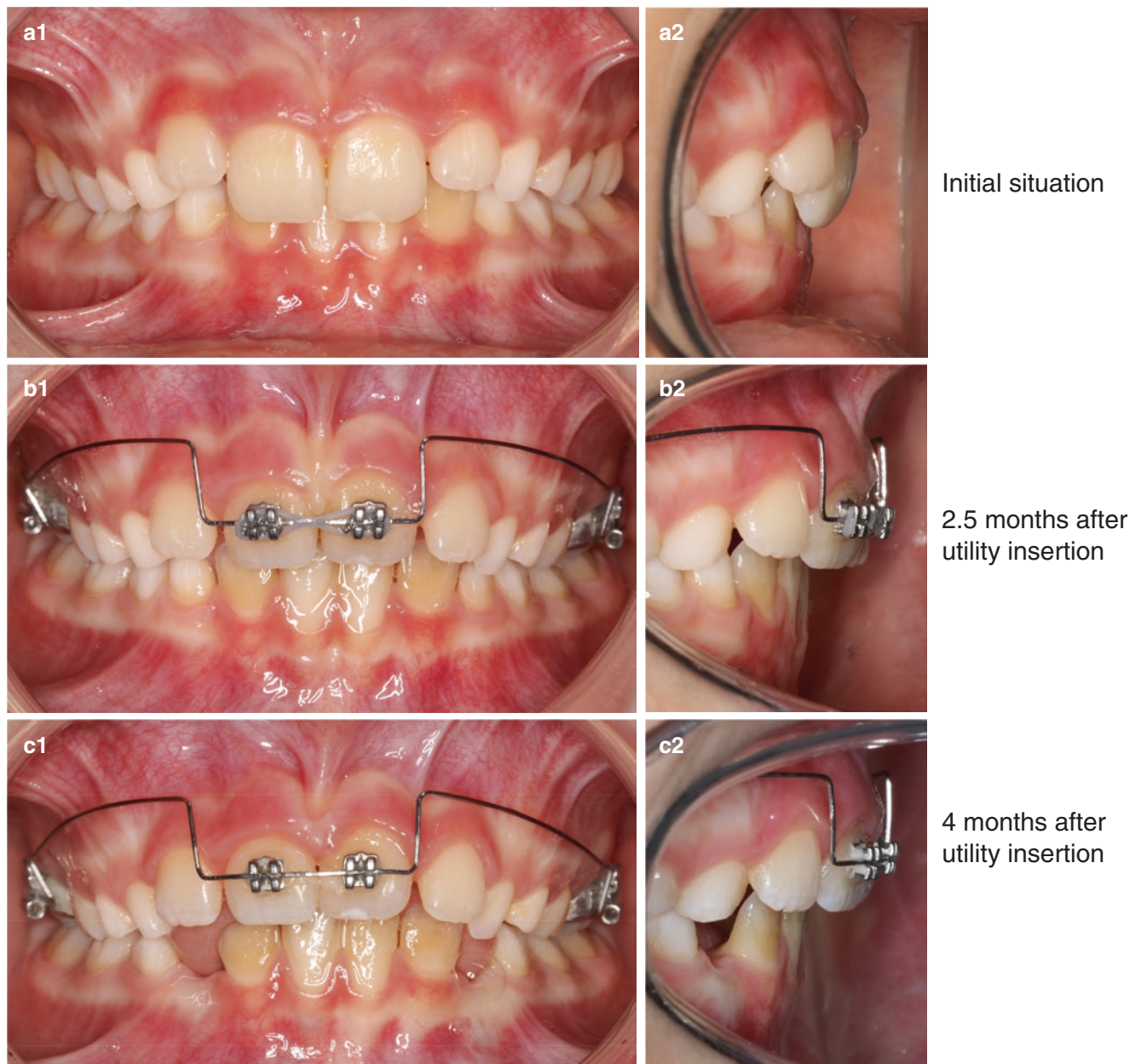


Fig. 5.30 (a–c)/patient #3. Dental images taken during the utility arch treatment showing the continuous, efficient intrusion and proclination of the upper central incisors. (a) Initial situation. (b) 2.5 months ongoing intrusion and protrusion of upper central incisors. Slight asymmetric sagittal activation of the utility's step bends in the first quadrant provides space for the erupting tooth 12 and eliminates the slight dental

midline shift in the upper jaw. (c) Sufficient correction of the upper frontal incisors is already achieved after 4 months utility arch treatment. The creation of an overjet with sagittal spacing of 3–4 mm between the upper and lower incisors enabled the subsequently planned mandibular enhancement



Fig. 5.31 (a–h)/patient #3. Second stage of early treatment. (a, b) After treatment with the utility arch, buccal occlusion has been neutral on the right but half-step distocclusion on the left side resulting from a 2-mm skeletal mandibular shift to the left side. (c) The deep bite and upper central incisor retroclination are already corrected. (d) The construction bite for fabrication of the subsequent activator was taken in a slightly overcorrected mandibular position (1 mm to right side) (e) Criss-cross

elastics in situ without (e1) and with activator (e2 – e4). The activator's posterior acrylic part is reduced to avoid interference with the crisscross elastics to be worn full-time for adaptation of transversal first molar occlusion. Additional grinding of the acrylic lingual to the molars of the second and fourth quadrant is required to allow lingual movement of these teeth; the mesiobuccal cusps of teeth 26 and 36 must maintain vertical support to avoid excessive extrusion by the crisscross elastics

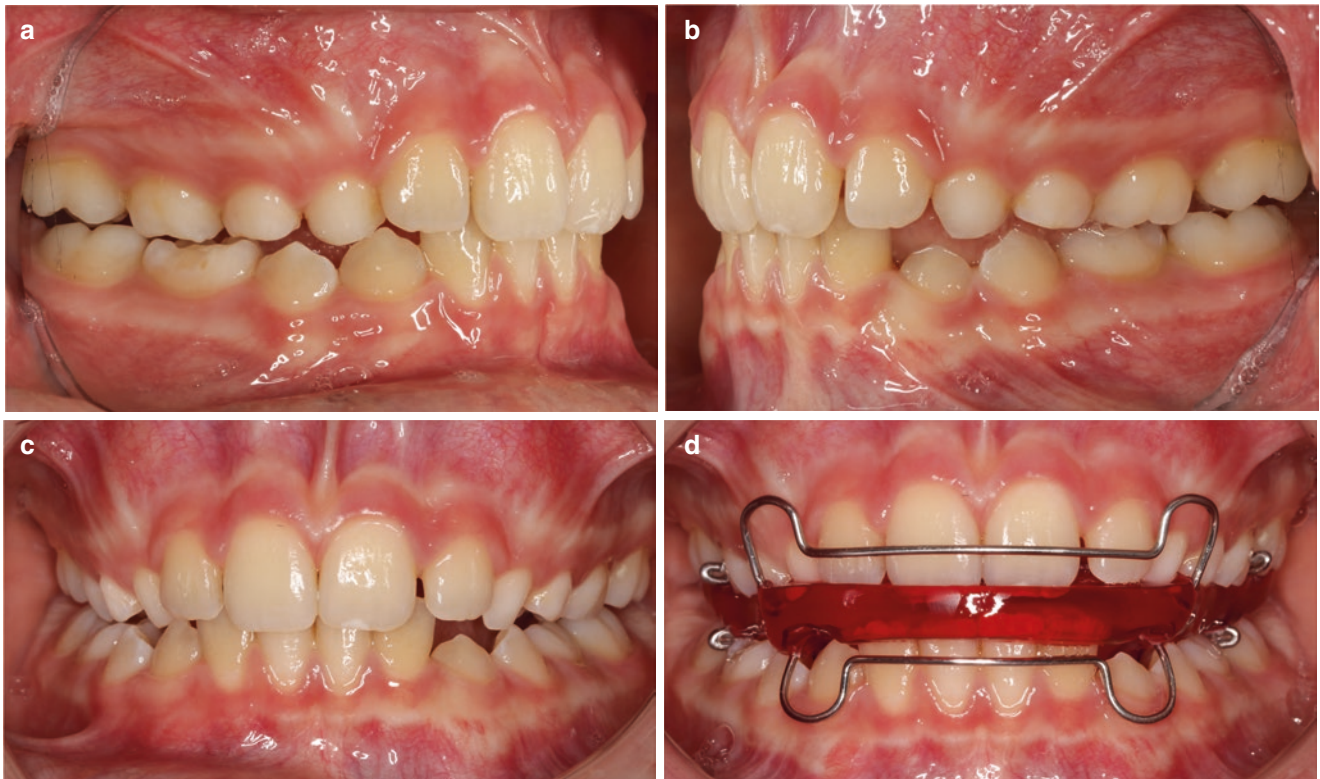


Fig. 5.32 (a–d)/patient #3. Situation after parallel neuromuscular intervention with the functional appliance and active-mechanical adaptation of transversal first molar occlusion using differential crisscross elastics. (a–c) Both, the distocclusion and mandibular midline shift are largely corrected. (d) A new activator with a centric construction bite and complete posterior acrylic extension is inserted for neuromuscular

stabilization and guided fine adjustment and settling of the transversal occlusion by targeted removal of acrylic. At publication date, functional appliance treatment was still ongoing in this patient. Subsequent multi-bracket therapy may comprise differential class II elastics (force on left side > right side) to stabilize the sagittal and transversal correction of the centric mandibular position

5.6.4 Patient Example #4

The malocclusion of this patient example is characterized by manifestation of cover-bite-like incisor malpositions combined with dental midline shifts in both dental arches and a mandibular space discrepancy (Figs. 5.33 and 5.34). Due to the fact that the frontal overbite is only moderately increased, and only little maxillary gingiva is displayed during smiling, active-mechanical intrusion of the upper central incisors using a utility arch was avoided (Table 5.4). Instead, an active maxillary plate with finger springs has been used in

the first stage of early treatment for upper central incisor proclination (Fig. 5.35). Also the concept applied during the multibracket phase for correction of the deep frontal overbite aimed at the preservation of the harmonic lip-incisor relationship during smiling. This exemplifies that therapeutic planning in patients with a class II div. 2 or a cover-bite has to consider both treatment stability and smile esthetics which is not always as easy as in this patient example. Figures 5.36, 5.37, 5.38, 5.39, 5.40, 5.41, and 5.42 show the records made during and post treatment. Figure 5.43 shows the buccal and frontal occlusal relationships prior to and after therapy.

Table 5.4 Problem list and conceptual treatment planning in patient #4

Problem list and relevant collateral findings		Conceptual treatment planning
1.	Cover-bite-like malocclusion with • Retroclination of upper centrals by -5° • Deep frontal overbite of 4.5 mm with supraposition of both upper centrals • Smile with 1 mm maxillary gingiva display and complete display of maxillary central incisors (lip line level cannot be determined as lateral cephalogram was taken with a protruded mandible)	Treatment in mixed + permanent dentition (a) Early active-mechanical protrusion of upper centrals (maxillary plate) (b) Passive incisor intrusion (activator) (c) (If required) further active-mechanical intrusion of upper and/or lower incisors, palatal incisor root torque
2.	Midline deviation of 2 mm, due to • Slight maxillary dental midline shift of 1 mm to left side • Mandibular dental midline shift of 1.5 mm to right side	Early correction of midline shifts in both jaws with maxillary and mandibular plates
3.	Moderate space discrepancy in lower arch	Utilizing leeway space for anterior teeth • Grinding of deciduous molars mesially • Prevention of mesial migration of upper and lower first molars in late mixed dentition
Sequence of therapeutic measures (begin at the age of 8:01 years)		Duration
1.	Maxillary + mandibular plates for dental midline correction and proclination of upper central incisors	1:10 years
2.	Activator with slight mandibular advancement + anterior bite plates + stop loops for upper and lower first molars Reevaluation of lip line level + smile esthetics → further incisor intrusion to be performed in maxilla and mandible	1:07 years
3.	Multibracket appliance	1:11 years (max.), 1:03 years (mand.)
4.	Maxillary and mandibular plates for retention	

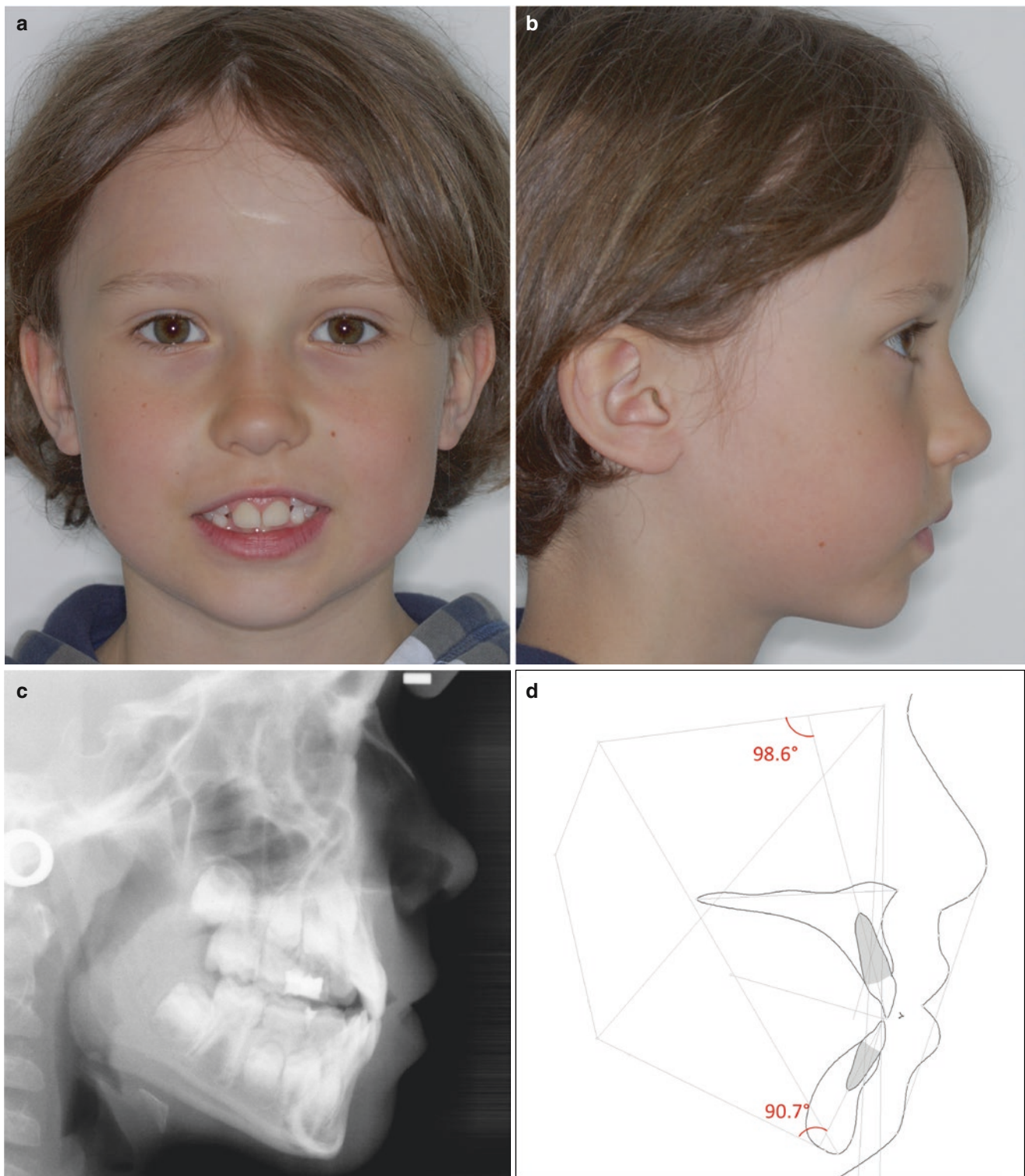


Fig. 5.33 (a–d)/patient #4. Initial facial images and cephalogram of patient #4 taken at age 7:09 years, 4 months prior to treatment begin. (a) He displays approx. 1 mm maxillary gingiva and the complete upper central incisor crowns during smiling. Thus, only minor intrusion of the upper incisors should be planned. (b) Facial profile. (c, d) The lateral

cephalogram reveals only mild retroclination of the upper central incisors, although the cover-bite-like appearance of the front teeth seems more severe on the corresponding intraoral images. (The sagittal and vertical jaw base relationship is not evaluable on this cephalogram, because the patient protruded the mandible during the recording)

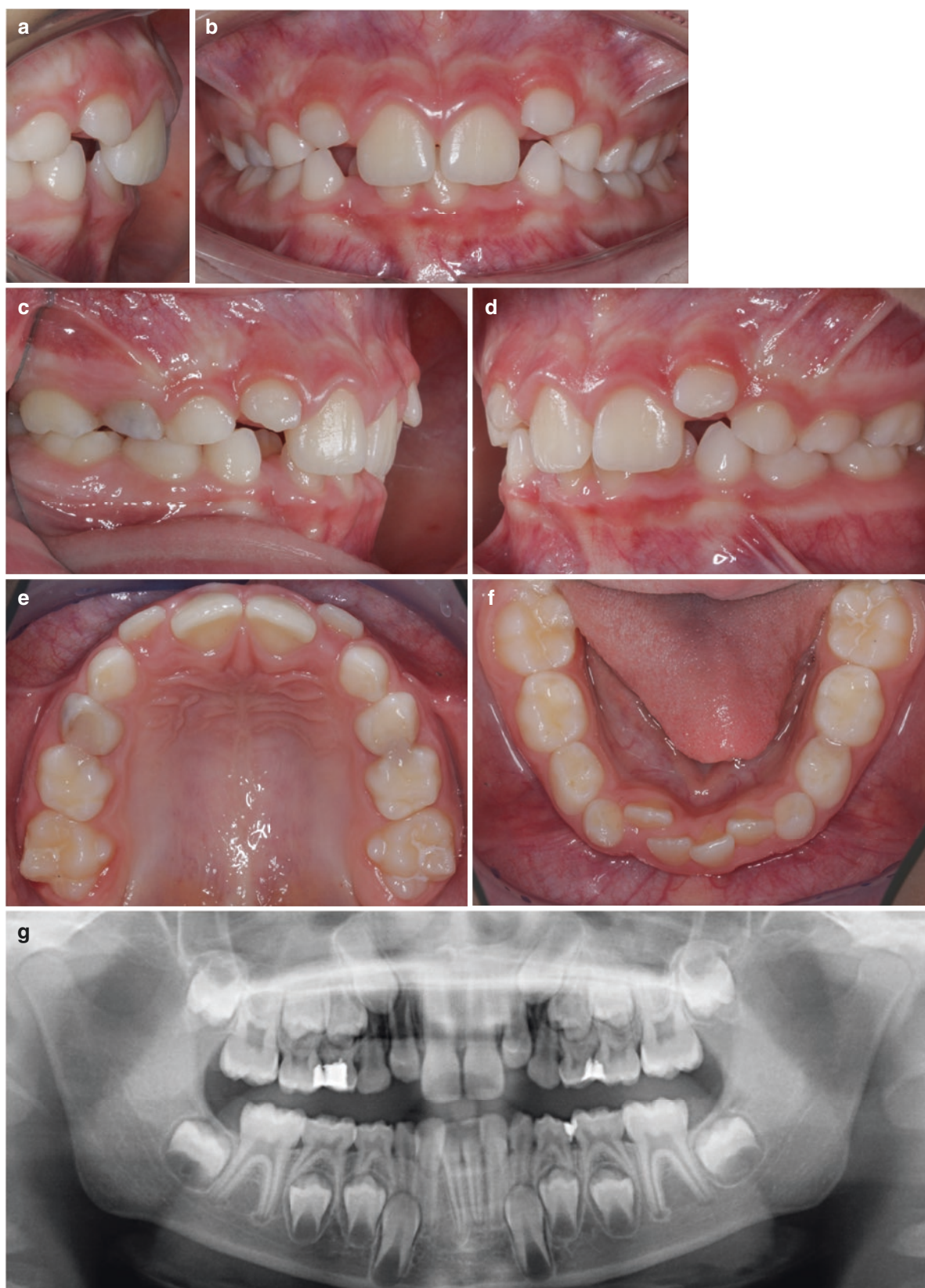


Fig. 5.34 (a–g)/patient #4. Initial dental images of patient #4 associated with the records depicted in Fig. 5.33. (a, b) The patient shows the typical cover-bite-like features in the final phase of the early mixed dentition. (c, d) First molars and canines are in neutral occlusion. (e, f) The dental midline shift has a maxillary (1 mm to the left) and a man-

dibular component (1.5 mm to the right). The latter is related to an asymmetric space discrepancy in the anterior lower arch of approx. 4 mm in total. (g) Panoramic X-ray showing physiological dental development

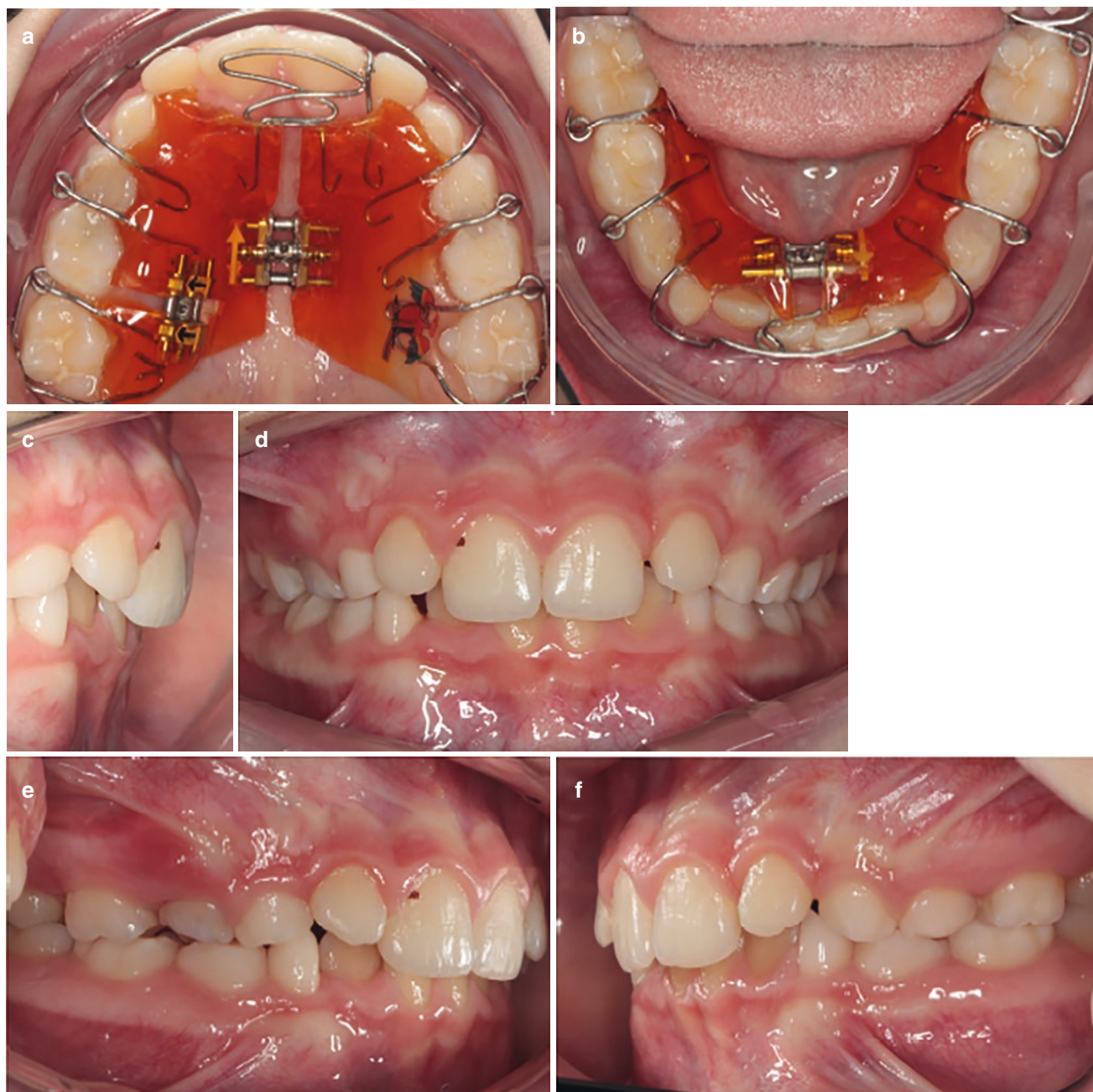


Fig. 5.35 (a–f)/patient #4. Situation after 9 months treatment with maxillary and mandibular plates. (a) The upper central incisors have been protruded using a protrusion spring crossing the midline; the active finger spring distal to tooth 21 has shifted the dental midline to the right side. Both arches are slightly expanded. (b) The space provided by grinding of both lower deciduous canines is occupied by the lateral incisors. The finger spring distal to tooth 41 has its retention in

the plate's left segment, so that it is continuously activated during transversal arch expansion. (c, d) The frontal overbite has clearly aggravated when compared to the records prior to treatment (see Fig. 5.34). The midline shifts in the upper and lower dental arches, however, are already slightly overcorrected. (e, f) Views on the right and left lateral segments

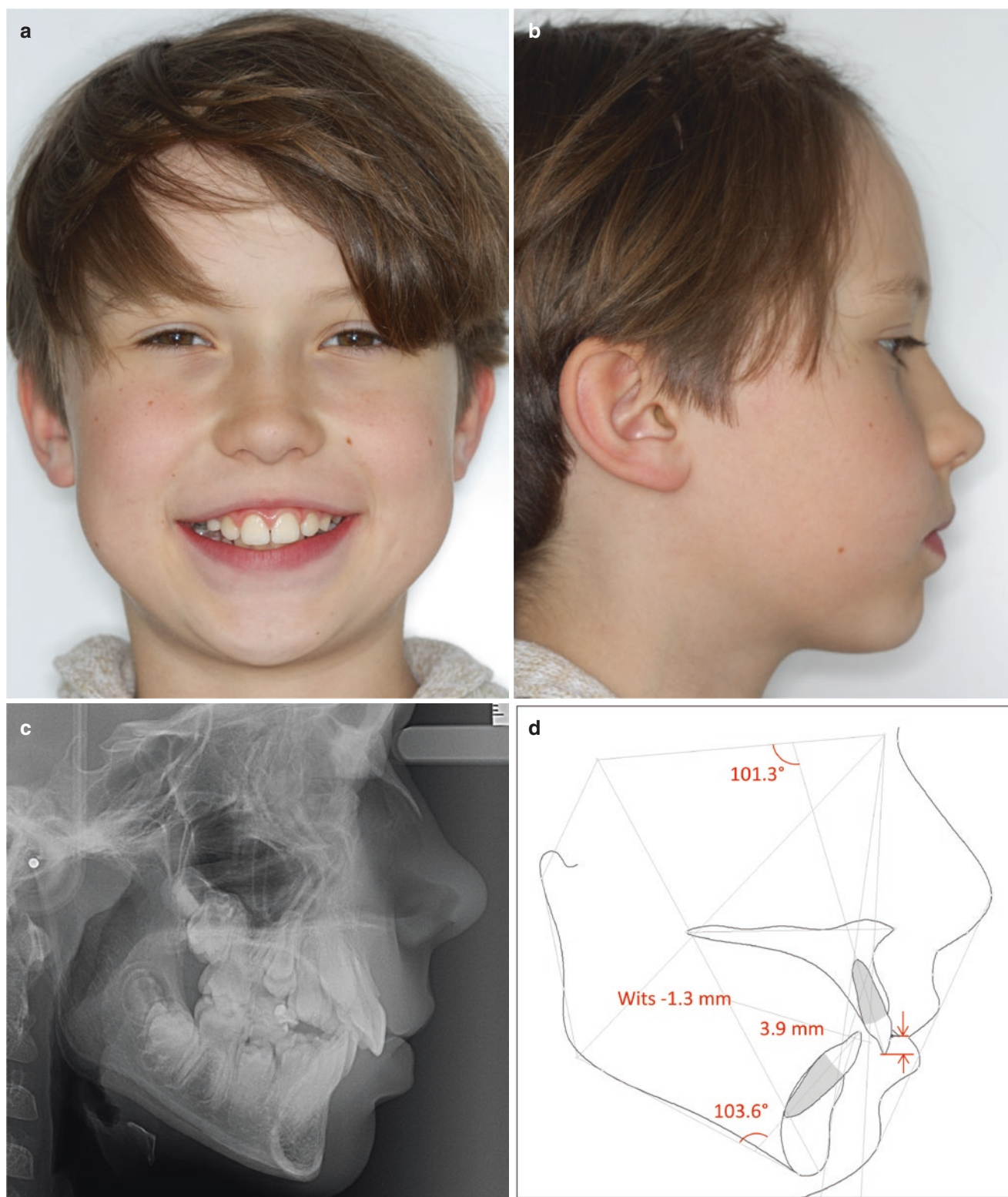


Fig. 5.36 (a–d)/patient #4. Reevaluation at age 9:11 years after treatment with maxillary and mandibular plates for 1:08 years. (a, b) The smile esthetics and the facial profile are unchanged. (c, d) The Wits appraisal indicates a very mild skeletal class III jaw base relationship. The lip line level is approx. 4 mm. The very pronounced proclination of

the lower central incisors by $+13.6^\circ$ is related to their integration in the dental arch. Consequently, during the subsequently planned activator treatment, the remaining leeway space in the lower arch has to be preserved for uprighting lower incisors



Fig. 5.37 (a–g)/patient #4. Dental images corresponding to the facial images and cephalogram depicted in Fig. 5.36. (a–d) The cover-bite characteristics are no longer recognizable. (e) All four upper incisors are integrated in the dental arch. (f) Anterior crowding in the lower

anterior region is reduced. (g) The panoramic X-ray shows physiological dental development in the late mixed dentition. All third molar germs can be recognized

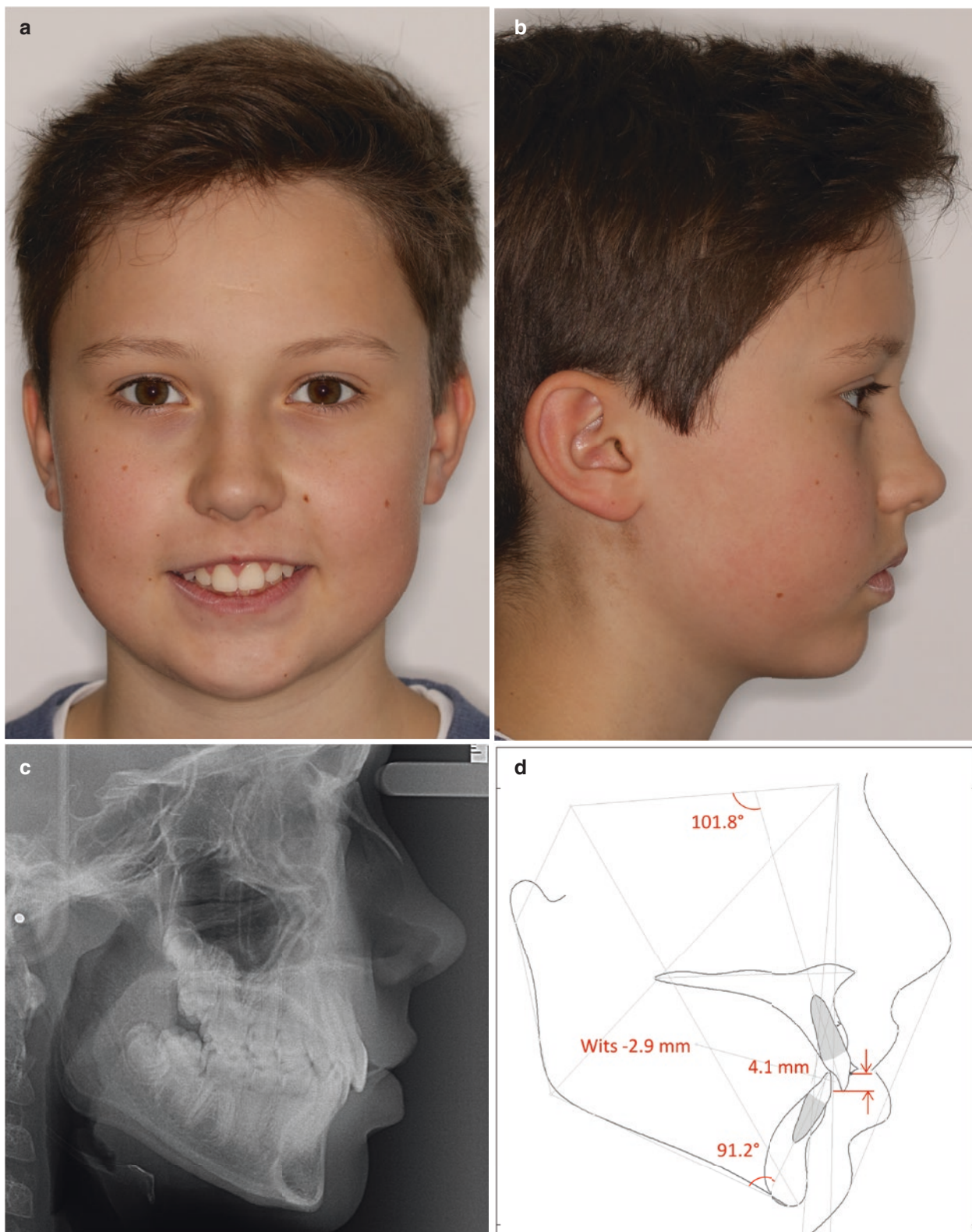


Fig. 5.38 (a–d)/patient #4. Facial images and lateral cephalogram for reevaluation of the treatment plan after activator therapy for 1:07 years. The activator's construction bite has been taken in neutral sagittal mandibular position due to the neutral buccal occlusion and was equipped with stop loops for the four first molars to prevent the mesial migration of these teeth during the late mixed dentition phase. (a) The lip-incisor relationship during smiling tolerates correction of the deep frontal over-

bite by equal intrusion of the upper and lower incisors. (b) Facial profile. (c, d) The tracing of the cephalogram shows that the inclination of the upper central incisors agrees with the reference value of 102° (angle U1/SN). Successive activation of the labial bow of the activator and preservation of the lower leeway space respectively resulted in uprighting of the lower incisors by 12°



Fig. 5.39 (a–f)/patient #4. Dental images associated with the records depicted in Fig. 5.38. (a, b) The frontal overbite shows little improvement as it decreased only by approx. 1 mm when compared to the records before activator insertion. (c, d) Neutral buccal occlusion is

achieved on both sides. (e) Good alignment of all permanent teeth is to be observed in the upper arch. (f) The anterior space discrepancy is slightly reduced by occupation of the leeway space by the lower incisors



Fig. 5.40 (a–d)/patient #4. Different stages during multibracket therapy. (a) Due to the slight supraposition of the upper incisors, 1-mm steps between upper laterals and canines are bent into the 0.012 and 0.016-in. NiTi leveling wires to prevent extrusion of the canines. Steps are fabricated using a “Nice-End-Plier” (Hammacher, Germany). Their height can be precisely adjusted by changing the steps’ angulation after bending. Bracketing in the lower arch is planned after slight protrusion and intrusion of the upper frontal segment to avoid precontacts between

upper incisors and lower incisor brackets. (b) After 4 months leveling, a 0.016×0.022 TMA overlay wire is inserted in the upper arch for frontal intrusion. (c) One month later, the three segments are replaced by a full 0.016×0.016 SS wire; the overlay intrusion arch is left for another 3 months until lower brackets could be bonded. (d) Situation during the finishing phase, after leveling the deep curve-of-Spee in the lower arch; the deep overbite is already eliminated by equal intrusion of the upper and lower frontal segments



Fig. 5.41 (a–f)/patient #4. Dental images taken 1:01 years after debanding. (a, b) Both, the corrections of the midline shifts in the upper and lower jaw and the deep frontal overbite (to a physiological value of

2 mm) are stable. (c, d) Neutral buccal relationships were achieved with settling of the occlusion. (e, f) Occlusal views on upper and lower dental arches

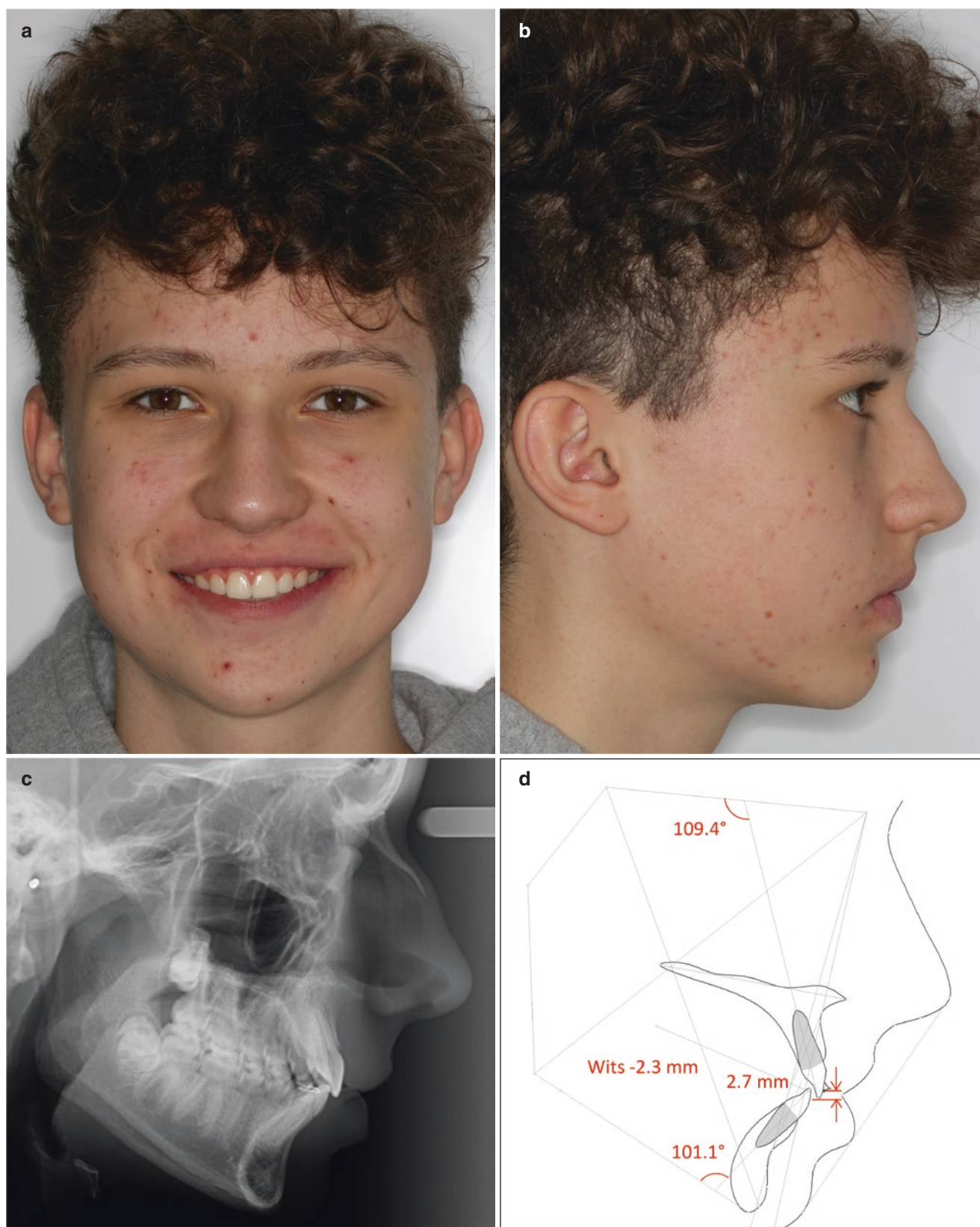


Fig. 5.42 (a–d)/patient #4. Facial images and cephalogram corresponding to the records depicted in Fig. 5.41. (a) The patients slightly displays the maxillary gingiva so that the smile esthetics is not compromised by the concept of equal intrusion of upper and lower frontal segments. (b) The facial profile is harmonic. (c, d) The tendency toward a

skeletal class III has slightly weakened. The proclination of upper and lower central incisors may result from the intrusive mechanics acting anterior to the incisor's center-of-resistance; in the lower arch, the space discrepancy contributed to incisor proclination. From the low post-therapeutic lip line level, high treatment stability is to be expected



Fig. 5.43 (a, b)/patient #4. Buccal and frontal occlusal interrelationships prior to (a) and after therapy (b)

5.6.5 Patient Example #5

This patient exemplifies that in specific manifestations of class II div. 2 malocclusions it may be reasonable to omit the first main stage of early treatment. In this specific patient, the main arguments for this decision were that the lip-incisor relationship during smiling seemed to be quite well-balanced and did not suggest any therapeutical change (Fig. 5.44). Moreover, the sagittal component of the class II div. 2 (i.e., the distocclusion) was obviously more pronounced than the frontal component; concretely, upper central incisor retroclination by only 7° and a frontal overbite of 5 mm may be considered as a mild cover-bite-like manifestation (Fig. 5.45). The deep overbite was mainly due to the supraposition of the lower anterior segment. Based on these diagnostic findings, it was concluded that the major effects of a maxillary utility arch, i.e., significant intrusion and protrusion of upper incisors, were not needed or were even disadvantageous. Consequently, the decision was taken to focus early treatment of this patient on class II correction, and to address the deep frontal overbite mainly in the per-

manent dentition by segmented intrusion of the lower frontal segment (Table 5.5).

The decision to start the therapeutic intervention with a cervical-pull headgear for upper first molar distalization also considered the bite-opening effect of this appliance related to the application of a dorso-caudally directed force (Fig. 5.46). The extrusive effect on the upper first molars led to the reduction of the frontal overbite without changing the well-balanced lip-incisor relationship present in this patient at begin of the treatment. The second stage of early treatment was conducted in the classical manner using an activator for mandibular advancement and for further overbite reduction (Figs. 5.46, 5.47, and 5.48).

Figure 5.49 comprising different stages during multi-bracket therapy shows a consistent and systematic approach for segmented intrusion of the lower frontal segment. Moreover, the treatment results depicted in Figs. 5.50 and 5.51 demonstrate that asymmetric activation and/or localization of the intrusive force enables the correction of a canted suprapositioned lower anterior segment. Figure 5.52 shows the buccal and frontal occlusal relationships prior to and after therapy.

Table 5.5 Problem list and conceptual treatment planning in patient #5

Problem list and relevant collateral findings		Conceptual treatment planning
1.	Class II div. 2 malocclusion with • Retroclination of upper centrals by -7° • Deep frontal overbite of 5 mm with – Supraposition of all 4 upper incisors – Deep curve-of-Spee in lower arch • Moderately increased lip line level of 3.8 mm • Smile with full crown display of maxillary central incisors (no maxillary gingiva display)	Treatment in mixed + permanent dentition (a) Extrusion of upper molars for bite opening (cervical-pull headgear) (b) Passive incisor intrusion + molar extrusion for further bite opening (activator) (c) Leveling of mandibular curve-of-Spee + (if required) palatal root torque of upper incisors and further active-mechanical incisor intrusion (multibracket appliance)
2.	Significant distocclusion of 2/3-step at first molars	(a) Early active-mechanical distalization of upper first molars (cervical-pull headgear). (b) Mandibular advancement (activator)
3.	Mild space discrepancy in lower arch due to proclined lower incisors	Utilizing the leeway space for anterior teeth • Grinding of deciduous molars mesially • Prevention of mesial migration of upper and lower first molars in late mixed dentition • Uprighting of lower incisors
4.	Tooth size discrepancy with mesiodistal width of lower teeth 2 mm larger (acc. to Bolton's reference values)	(If required) Tooth size reduction in lower jaw
Sequence of therapeutic measures (begin at the age of 10:03 years)		Duration
1.	Cervical-pull headgear	8 months
2.	Activator with slight mandibular advancement + anterior bite plates + stop loops for upper and lower first molars	2:03 years
Reevaluation of smile esthetics and lip line level → overbite correction is to be completed primarily by further intrusion of lower frontal segment		
3.	Multibracket appliance	1:05 years
4.	Maxillary and mandibular plates for retention	

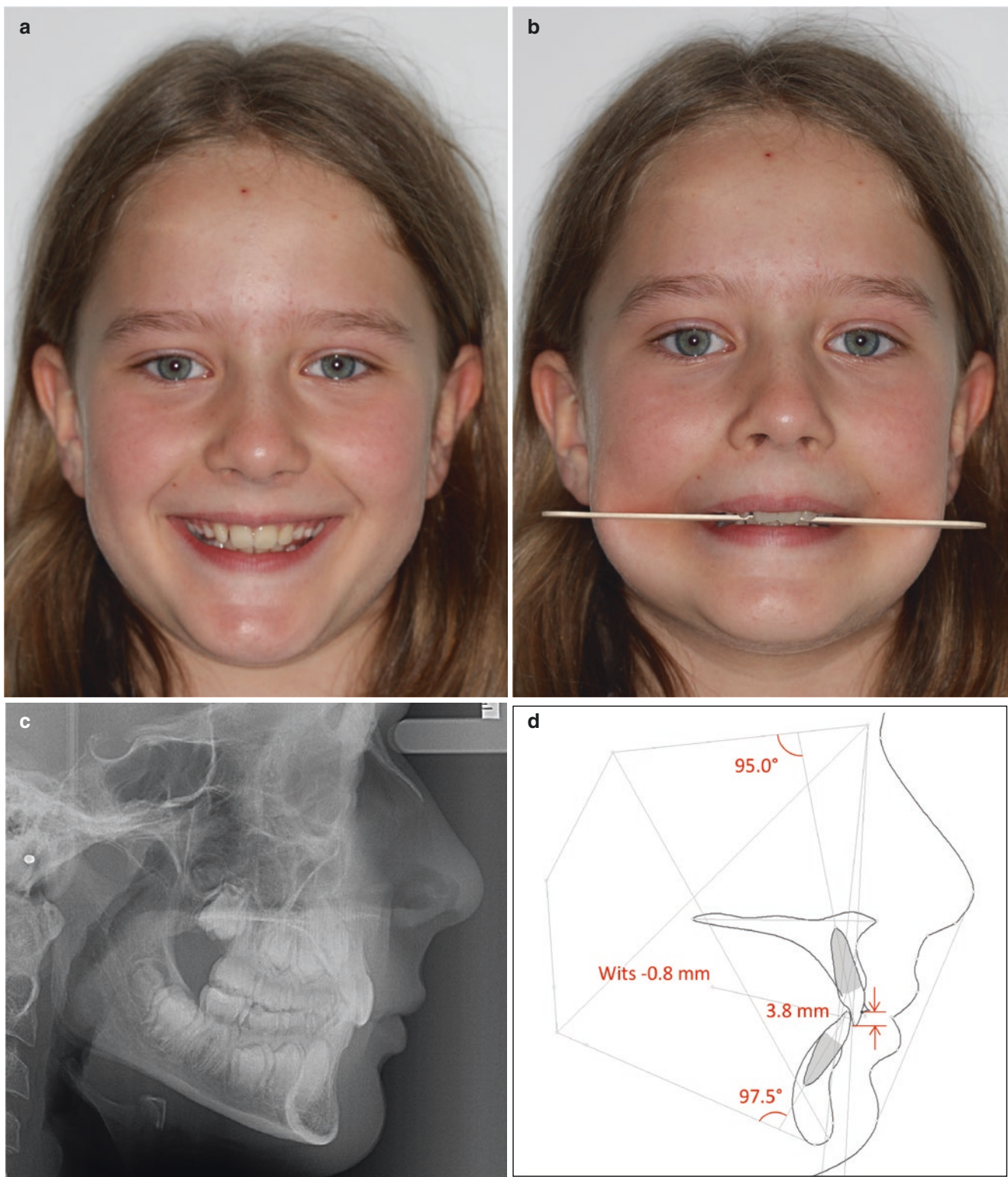


Fig. 5.44 (a–d)/patient #5. Facial images and lateral cephalogram of patient #5 taken at age 10:01 years prior to treatment begin. (a) The frontal facial view shows nearly complete display of upper central incisor crowns during smiling. (b) The occlusal plane shows a slight cant-

ing, i.e., right buccal teeth are in a more cranial position in both jaws. (c, d) The lip line level is only moderately high and upper centrals show reclination by 7.0°. Lower incisors are proclined by 7.5°



Fig. 5.45 (a–g)/patient #5. Initial dental images of patient #5 corresponding to the records depicted in Fig. 5.44. (a, b) The lateral and frontal views reveal the typical features of a class II div. 2 in the mixed dentition. (c, d) First molars show slight distocclusion (quarter-step).

(e, f) The large deciduous lower molars may provide sufficient leeway space for uprighting the proclined lower incisors. (g) Development of tooth 25 is delayed



Fig. 5.46 (a–g)/patient #5. Situation after 8 months cervical-pull headgear treatment. (a, b) The frontal overbite is slightly decreased by approx. 1 mm. (c, d) Upper first molars are distalized into neutral occlusion. (e, f) Occlusal views on upper and lower dental arches. Passive

distal migration of the deciduous molars and canines can be observed. (g) At this stage, an activator with anterior bite plates and stop loops for retention of maxillary first molars is inserted

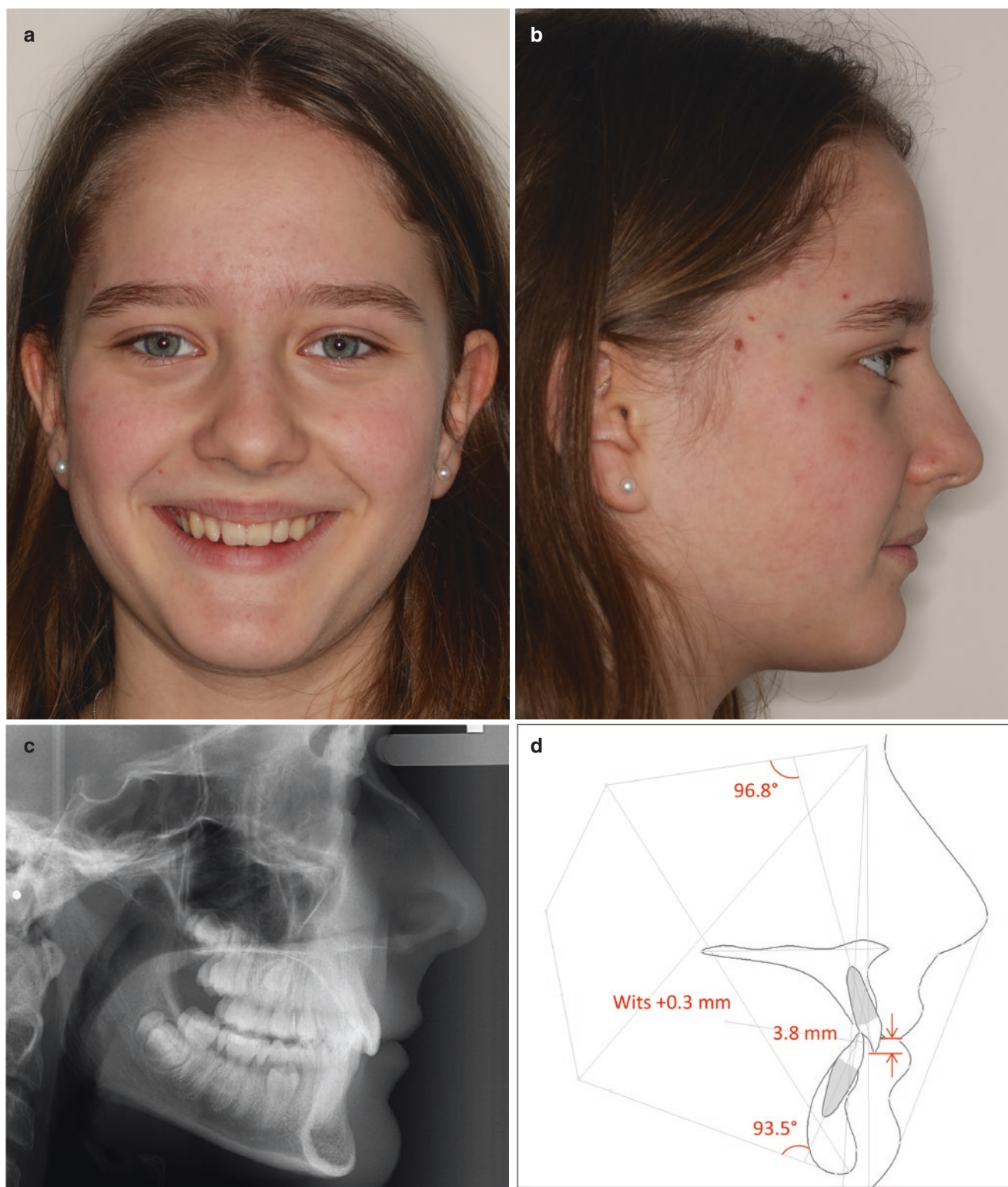


Fig. 5.47 (a–d)/patient #5. Reevaluation during the final early treatment stage with ongoing activator therapy for 1:10 years; treatment is monitored only every 3 months. (a, b) The harmonic smile esthetics suggests to keep the vertical position of the upper incisal segment at this level. (c, d) The lip line level is only slightly increased so that upper incisor intrusion is also not required with respect to treatment stability

issues. The lower centrals are slightly uprighted (by 4.0°) when compared to the initial cephalogram. The initial, mild retroclination of the upper central incisors has only been reduced by 2° , although it has to be noted that the remaining deviation from the reference value of 102° is only 5°

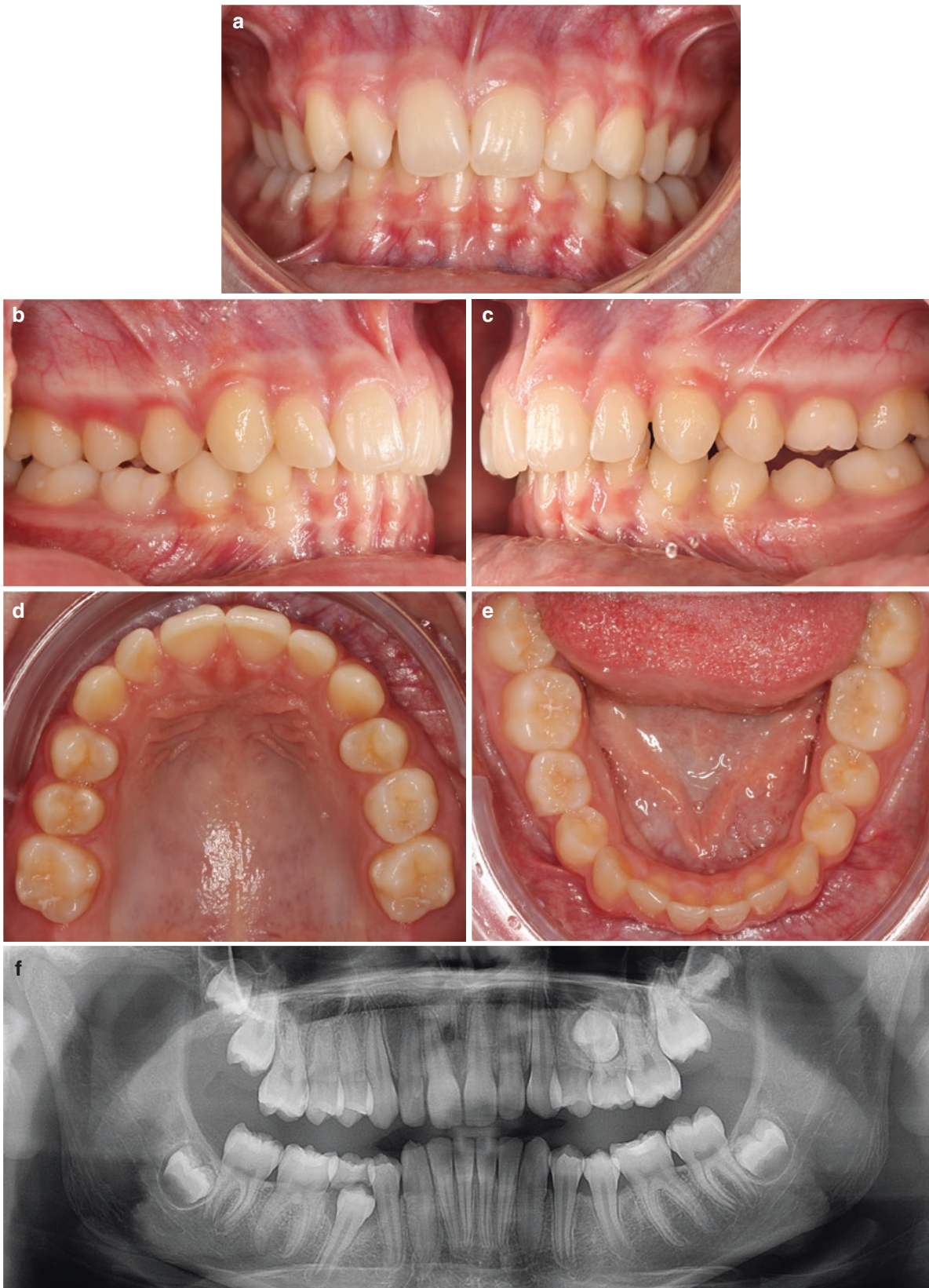


Fig. 5.48 (a–f)/patient #5. Dental images corresponding to the records shown in Fig. 5.47. (a) Frontal view. (b, c) Neutral buccal occlusion has been achieved by the cervical-pull headgear. (d, e) Subsequent activator therapy has been successful in the retention of the neutral buccal occlusion and in preserving the mandibular leeway space. The space pro-

vided by grinding of tooth 85 mesially is already occupied by tooth 44 (tooth 85 is to be extracted now). (f) Due to late development of tooth 25 and incomplete root development of teeth 35 and 45, the start of multibacket therapy is postponed by approx. 6 months

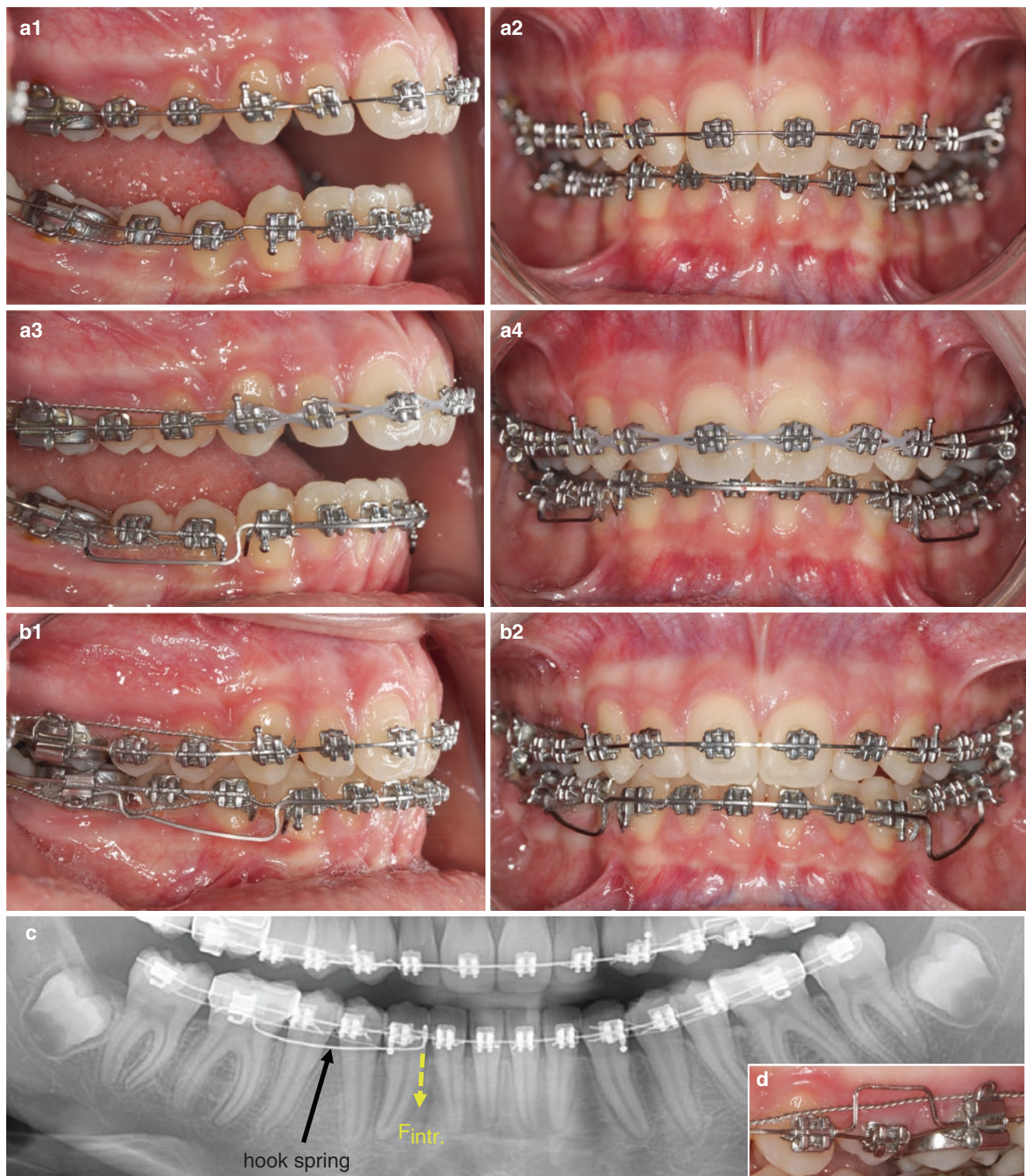


Fig. 5.49 (a–d)/patient #5. Different stages during multibracket therapy. (a) Situation after separate leveling of the frontal and lateral segments using 0.012- and 0.016-in. NiTi wires with step bends (a1 and a2). At this stage, leveling wires are replaced by three 0.016 × 0.022-in. segment steel wires and a 0.016 × 0.022-in. TMA overlay intrusion arch (a3 and a4) with slightly asymmetric activation (35/25 cN at right/left sides). (b) Situation after intrusion of the lower anterior segment for 4.5 months. The mandibular occlusal plane is still canted as indicated

by the oblique course of the frontal wire segment and the suprapositioned lower right premolars. (c) The panoramic X-ray shows the inserted spring attached to 46 and hooked in between 42/43 to correct the canting by further unilateral intrusion. No significant root resorptions are to be observed which may be also due to the careful monitoring of the intrusion force during reactivation of the mechanics. (d) Integration of late developed tooth 25 using an underlay NiTi leveling wire



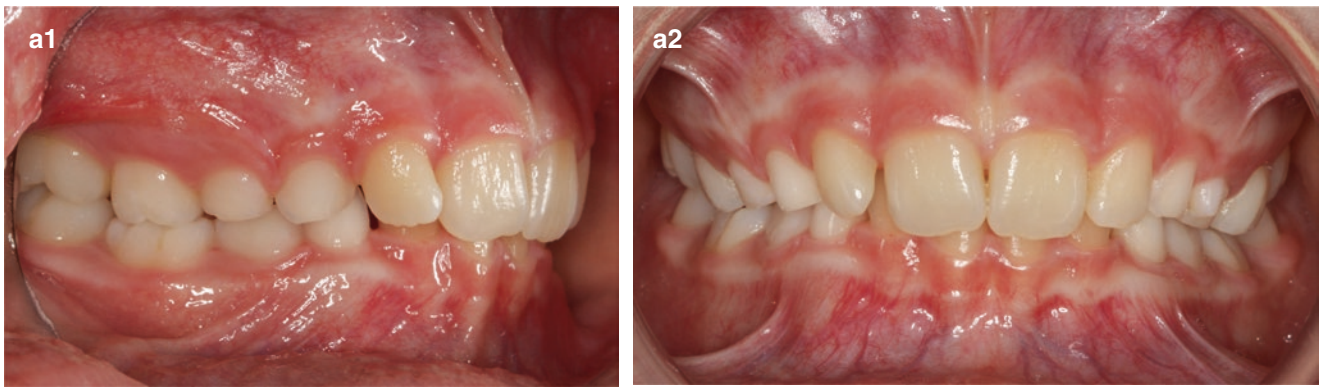
Fig. 5.50 (a–h)/patient #5. Dental images of patient #5 taken 2 weeks after debracketing. The fixed appliance was in situ for 1:07 years. (a, b) All major problems, i.e., the retroclination of the upper incisors, the deep frontal overbite, the canting of the mandibular occlusal plane, and the midline shift, are successfully corrected. The overbite is even slightly overcorrected to a value of 1.5 mm to account for a possible

slight relapse. (c, d) Neutral occlusion of canines and molars and a physiological incisal occlusion are achieved. (e, f) Occlusal views on the dental arches. (g, h) Maxillary and mandibular plates with acrylic-covered labial bows combined with a flattened 8-braided steel wire in the lower anterior segment are used for retention. Further settling of the occlusion is to be expected



Fig. 5.51 (a, b)/patient #5. Frontal images corresponding to the dental records shown in Fig. 5.50. The occlusal plane runs now parallel to the bipupilar line. Cervical regions of the upper central incisors are only slightly covered by the upper lip and the smile arch appears harmonic. This outcome seems to confirm the concept chosen for this patient con-

sisting of overbite correction primarily by intrusion of the lower frontal segment instead of intrusion of upper incisors. Since, the lip line level prior to multibracket therapy was only barely increased (value: 3.8 mm, see Fig. 5.47), the proclination of the upper incisors is expected to be stable



Initial



Final

Fig. 5.52 (a, b)/patient #5. Buccal and frontal occlusal interrelationships prior to (a) and after therapy (b)

5.6.6 Patient Example #6

The records of this male patient prior to treatment reveal a severe class II div. 2 combined with a complete cover-bite (Table 5.6, Figs. 5.53 and 5.54). Since the extremely deep overbite of 10 mm and the large interincisal angle was not only due to supraposition and retroclination of the upper central incisors but also of all four lower incisors, it was decided to apply a partial fixed appliance technique for active-mechanical intrusion and proclination of the anterior teeth not only in the upper arch (Figs. 5.55 and 5.56) but (as soon as bracketing has been possible) also in the lower anterior segment.

As treatment has begun in the late mixed dentition phase at the age of 12, and the permanent canines and premolars already erupted during the correction of the upper and lower incisor segments, it was decided to omit the originally planned functional appliance treatment. Instead, permanent canines and premolars were integrated step by step into the multibracket appliance (Fig. 5.57) so that total treatment duration was not unnecessarily prolonged. Nevertheless, approx. 4.5 years of partial and full-fixed appliance treatment were required in total to successfully correct all aspects of this severe malocclusion (Figs. 5.58 and 5.59). Figure 5.60 shows the buccal and frontal occlusal relationships prior to and after therapy.

Table 5.6 Problem list and conceptual treatment planning in patient #6

Problem list and relevant collateral findings		Conceptual treatment planning
1.	Severe class II div. 2 malocclusion with a complete cover-bite • Retroclination of upper centrals by -16.5° • Deep frontal overbite of 10 mm with – Supraposition of all upper incisors ($U1 > U2$) – Supraposition (+6 mm) and severe retroclination (-15°) of all 4 lower incisors • High lip line level of 7 mm • Maxillary gingiva display of 4 mm during smiling	Treatment in mixed + permanent dentition (a) Early active-mechanical intrusion + protrusion of upper incisors (utility arch) (b) Segmented active-mechanical intrusion of lower incisors (partial multibracket appliance) (c) (If sufficient time) further passive anterior bite opening (activator) (d) Further active-mechanical incisor intrusion, retraction of upper incisors with palatal root torque, lingual root torque for lower incisors (full multibracket appliance)
2.	Severe class II pattern • Severe asymmetric distocclusion (full-step on right side, 1/2-step on left side) • Skeletal class II (Wits + 2.8 mm)	(a) Early distalization parallel to utility arch (high-pull headgear) (b) (If sufficient time) mandibular advancement (activator) (c) (If required) further distalization of upper molars before multibracket phase (skeletally anchored distalslider) OR correction of remaining small distocclusion (multibracket appliance + class II elastics)
3.	Severe ankylosis of multiple deciduous molars • Particularly severe in teeth 55, 84, 85 • Resulting mesial migration/tipping of teeth 16 + 46	• Extraction of ankylosed deciduous molars at appropriate times (begin with tooth 55) • Asymmetric distalization of upper first molars, uprighting of lower molars as collateral effect of incisor intrusion
Sequence of therapeutic measures (begin at the age of 12:0 years)		Duration
1.	Maxilla: Utility arch (two-by-two)	3.5 months
2.	Maxilla: Utility arch (two-by-four)	6 months
Reevaluation → decision was taken to omit functional appliance treatment		
3.	Maxilla: Step-by-step transition to full multibracket appliance + cervical-pull headgear Mandible: Utility arch (two-by-six)	10 months
4.	Maxilla: Segmented multibracket appliance + high-pull headgear during bedtime Mandible: Transition to full multibracket appliance + overlay intrusion arch	3:00 years
5.	Maxillary and mandibular plates for retention	

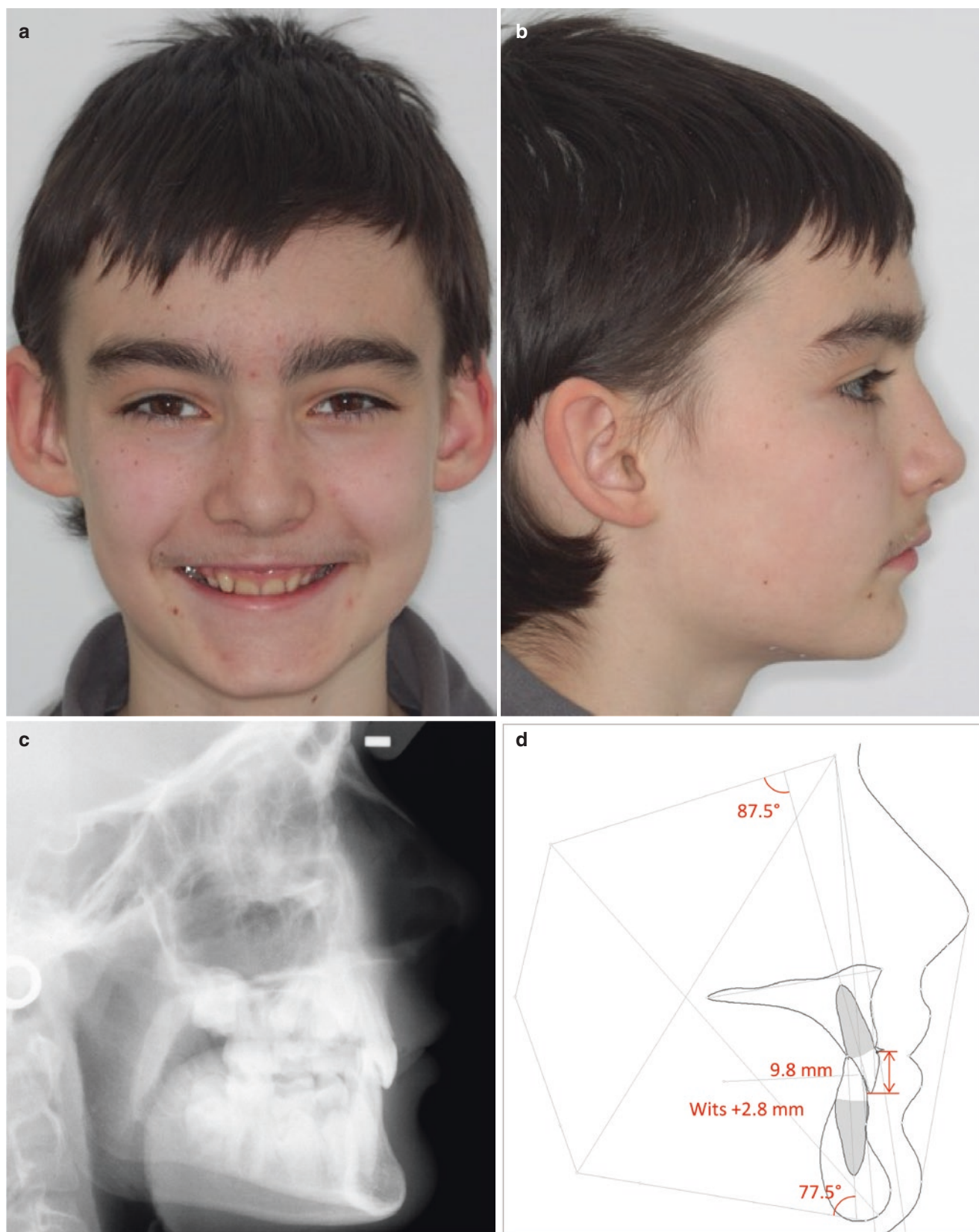


Fig. 5.53 (a–d)/patient #6. Facial images and lateral cephalogram of patient #6 taken at age 11:08 years, 4 months prior to treatment begin. (a, b) The significant maxillary gingiva display during smiling is due to the extreme supraposition of the upper central incisors. The facial profile indicates mandibular retrognathism. (c, d) The lateral cephalogram reveals the typical characteristics of a severe cover-bite, i.e., pronounced

upper central incisor retroclination (-14.5°) combined with an extremely high lip line level (9.8 mm). The jaw bases show a clear skeletal class II pattern (Wits appraisal: +2.8 mm, deviation ANB/individualized reference: 2.7°). The lower incisors are also retroclined (by 12.5°)

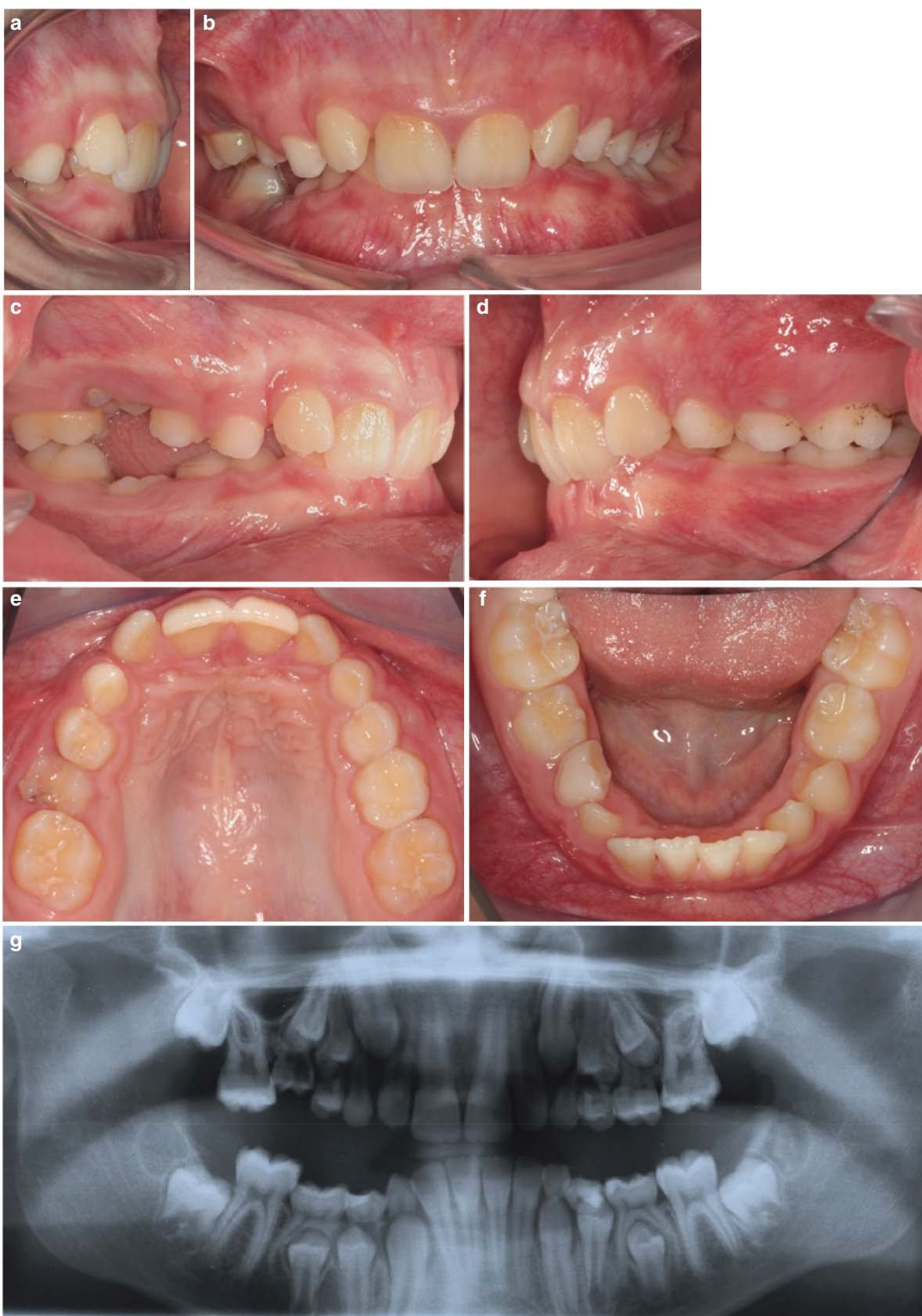


Fig. 5.54 (a–g)/patient #6. Initial dental images of patient #6 associated with the records depicted in Fig. 5.53. (a, b) The lateral and frontal view reveal a complete cover-bite in the late mixed dentition. (c, d) The cover-bite is combined with asymmetric distocclusion. The severe

ankylosis of the second deciduous molars in first and fourth quadrants started already in the primary dentition. (e, f) Occlusal views on dental arches. (g) The panoramic X-ray taken 6 months before the other initial records reveals insufficient resorption of all second deciduous molars

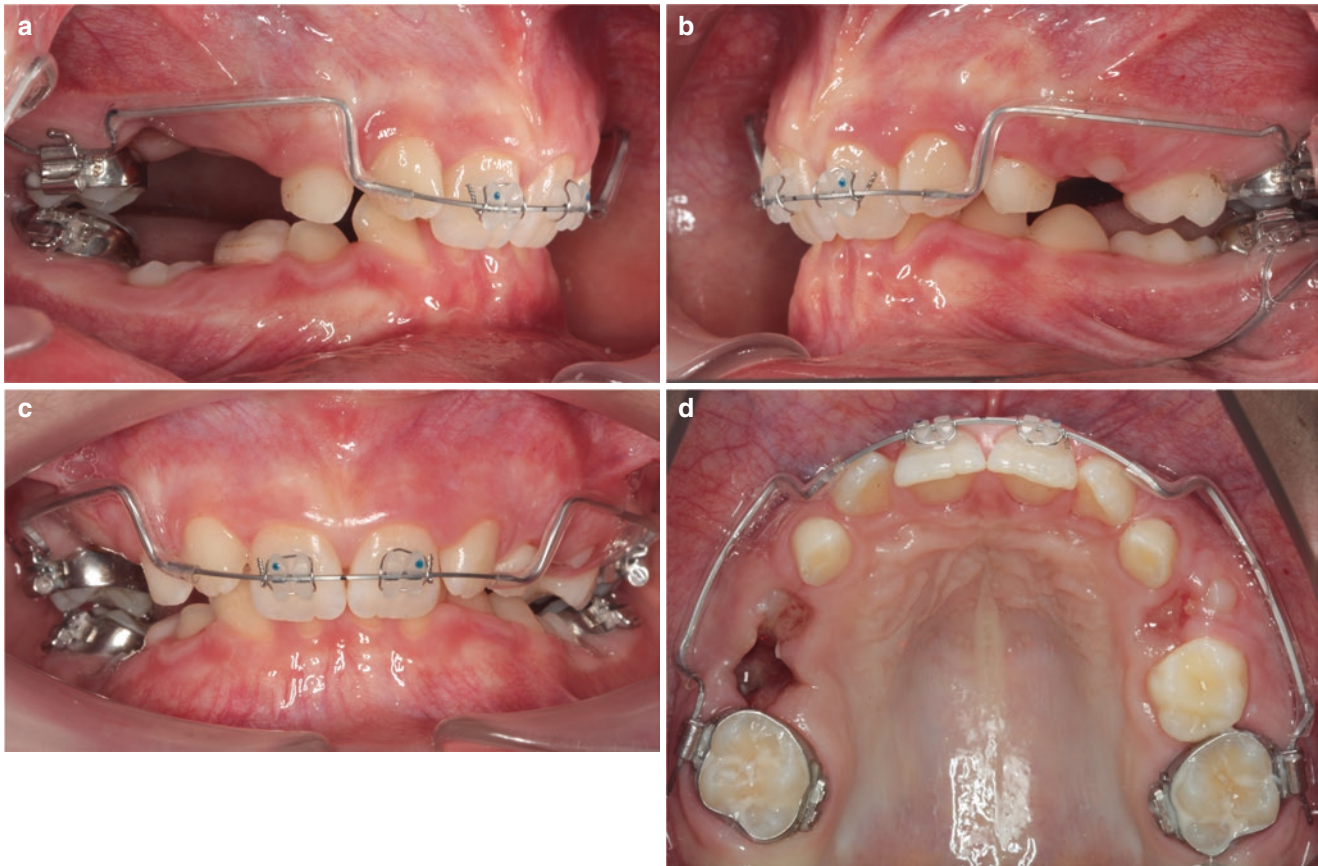


Fig. 5.55 (a–d)/patient #6. (a–c) The first early treatment stage is started after extraction of the two ankylosed deciduous molars in the first quadrant. It comprises intrusion and proclination of the maxillary central incisors using a two-by-two utility arch. This arch is designed to allow integration of the lateral incisors at a later stage. The partial mul-

tibracket appliance is not combined with a high-pull headgear at this stage, because some distal tipping of upper first molars is desired (particularly, in tooth 16). (d) The occlusal view on the upper arch shows the severe alveolar bone loss after extraction of teeth 54 and 55



Fig. 5.56 (a–e)/patient #6. (a–c) The monitoring of the intrusive force requires detachment of the utility arch's frontal segment. The tip-back bends into the most distal part of the bypass wire are slightly increased on both sides to achieve a total intrusive force of 30 cN. (d, e) Inclusion

of the two lateral incisors 3.5 months after treatment start. Bracketing in the lower frontal segment is not yet possible at this stage due to the remaining deep overbite and contacting between upper and lower incisors

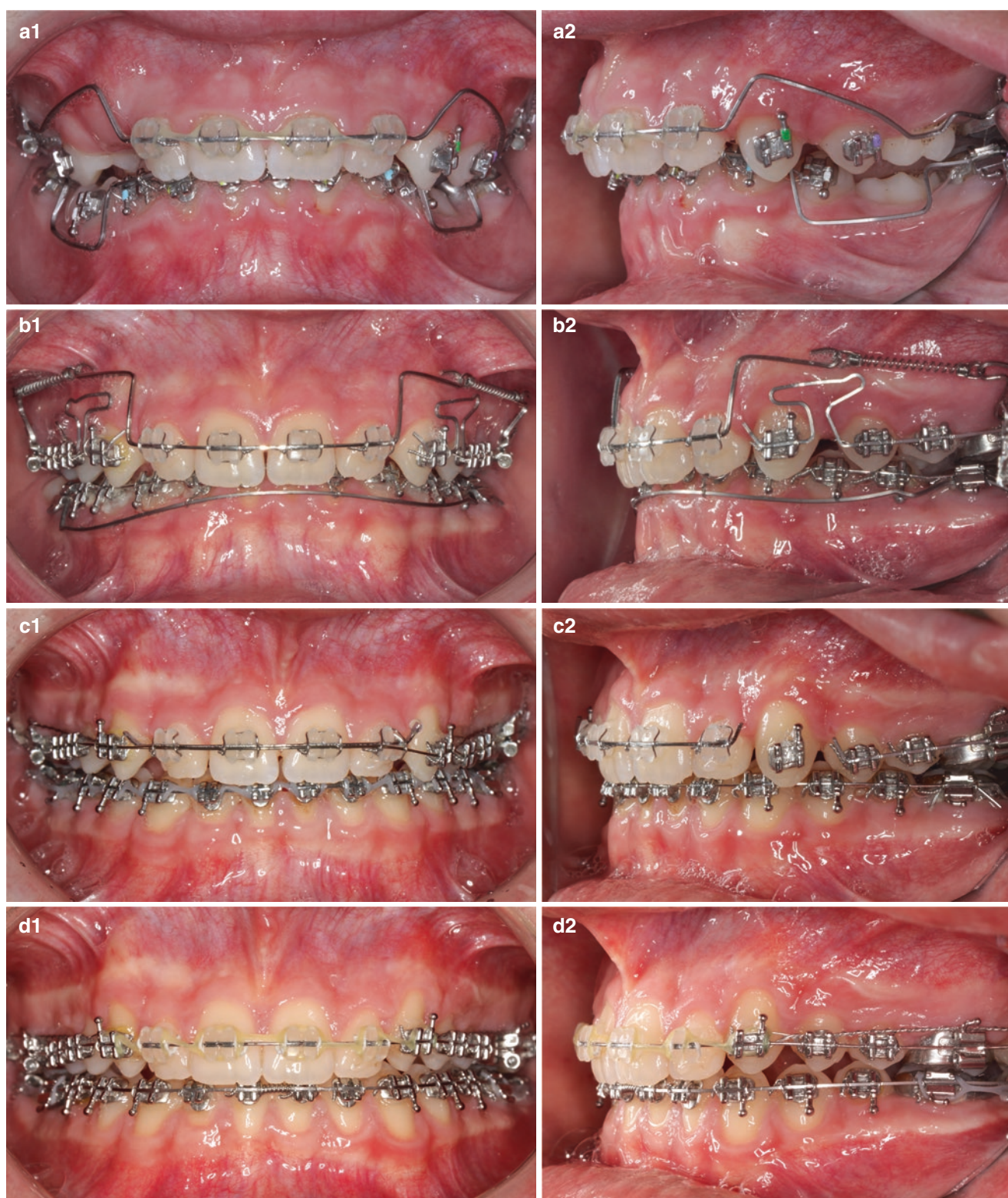


Fig. 5.57 (a–d)/patient #6. Intermediate stages of multibracket therapy. (a) Intrusion of the maxillary and mandibular front teeth using two-by-four and two-by-six utility arches in the upper and lower jaw, respectively. (b) After sufficient intrusion of upper incisors, a segmented technique was applied for bodily retraction of these teeth using bilateral superelastic coil springs generating force vectors passing approximately through the incisor segment's center of resistance and parallel to the occlusal plane. Simultaneously, both upper canines are intruded and retracted using a segmental T-loop wire. In the lower arch,

a 0.016-in. NiTi leveling archwire is combined with a 0.016 × 0.022-in. TMA overlay intrusion arch. (c) During subsequent leveling of the frontal and the two lateral segments in the upper arch using a 0.016 round NiTi full arch, the incisal part of the 0.016 × 0.016 stainless steel segmental wire is maintained as underlay wire to avoid overloading of the lateral incisors. (d) Situation after further bite opening. The remaining distocclusion has been corrected using class II elastics and a cervical-pull headgear worn during bedtime



Fig. 5.58 (a–g)/patient #6. (a–f) Dental images taken after 3:00 years full multibracket therapy and subsequent 1:02 years of retention. The extremely deep overbite of 10 mm which was initially present is corrected to 3.5 mm. (g) The panoramic X-ray reveals no sign of apical

root resorptions. Due to compromised space conditions for the upper and lower third molars and the absence of any restoration, extraction of all third molars is recommended to the patient

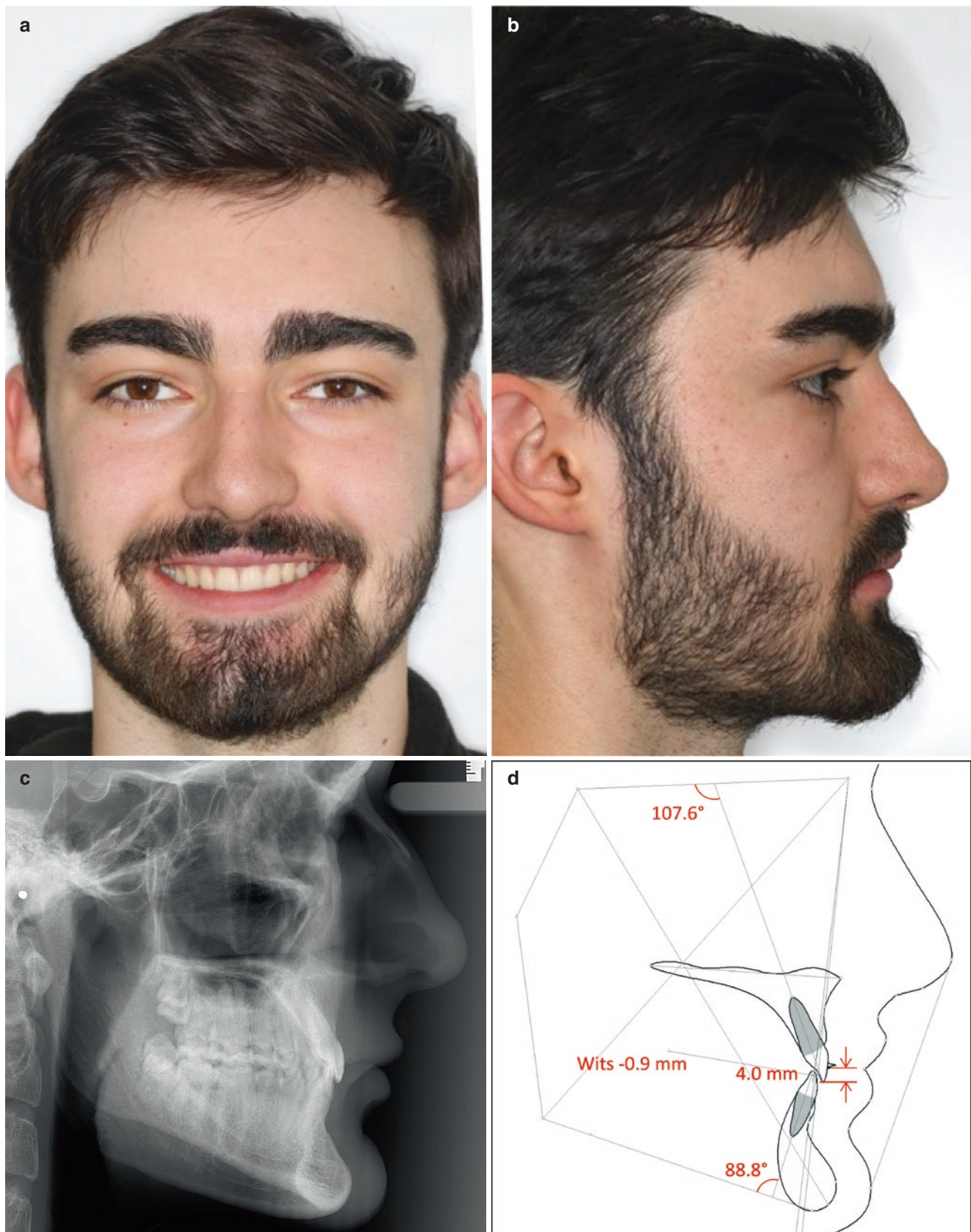


Fig. 5.59 (a–d)/patient #6. Facial images and cephalogram of patient #6 associated with the dental records shown in Fig. 5.58. (a, b) The patient's nice smile is related to the correction of the high lip line to only 4 mm (initial level: 10 mm). The facial profile is harmonic. (c, d)

Both upper and lower incisors are significantly proclined with some over-correction in the upper arch. The skeletal class II pattern is completely corrected as indicated by the neutral Wits appraisal



Fig. 5.60 (a, b)/patient #6. Buccal and frontal occlusal interrelationships prior to (a) and after therapy (b)

5.6.7 Patient Example #7

The original treatment plan of this patient comprised only a short phase for upper incisor proclination using a utility arch to create the conditions for subsequent mandibular advancement for causal (and at least partial) correction of the malocclusion's severe sagittal component reflected by distocclusion of first molars of more than one full step (Table 5.7, Figs. 5.61 and 5.62).

The treatment documentation of this patient (Figs. 5.63, 5.64, 5.65, and 5.66), however, demonstrates that—e.g., in case of severe distocclusion and a relatively late treatment begin in the final mixed dentition phase combined with insufficient patient compliance—the second stage of early class II div. 2 treatment may not always be effective enough for achieving at least a nearly neutral occlusion of the buccal

segments before multibracket therapy is started—which is generally the goal.

Based on the patient's relatively poor compliance with removable appliances, the almost completed eruption of the upper second molars at the time of reevaluation (approx. 1 year after treatment begin) and lower incisor proclination, it was decided to apply a skeletally anchored distalslider for correction of the class II molar relationship. Six months later, the appliance was extended to a full multibracket appliance in both jaws. Concrete tasks were bodily retraction of upper incisors and additional palatal torque of upper incisor roots using a segmented arch technique and intrusion of the lower anterior teeth using an overlay wire. All treatment goals were successfully achieved (Figs. 5.67, 5.68, and 5.69). Figure 5.70 shows the buccal and frontal occlusal relationships prior to and after therapy.

Table 5.7 Problem list and conceptual treatment planning in patient #7

Problem list and relevant collateral findings		Conceptual treatment planning
1.	Severe class II div. 2 malocclusion with • Retroclination of upper centrals by -13° • Deep frontal overbite of 6.5 mm with supraposition of upper centrals by 2 mm • Incomplete display (ca. $\frac{3}{4}$) of maxillary incisor crowns during smiling (lip line level cannot be determined on the lateral cephalogram, because the interlabial border was not visible)	Treatment in mixed + permanent dentition (a) Early active-mechanical protrusion + limited intrusion of upper incisors (utility arch) (b) Segmented active-mechanical intrusion of lower incisors (partial multibracket appliance) (c) (If sufficient time) further passive anterior bite opening (activator) (d) Further active-mechanical retraction of upper incisors with palatal root torque, lingual root torque and intrusion of the lower anterior segment (segmented multibracket appliance)
2.	Severe class II pattern with • Distocclusion (1+1/2-step of right first molars, full-step of left first molars) • Skeletal class II (Wits appraisal + 2.3 mm)	(a) Mandibular advancement (activator) (b) (If required) active-mechanical distalization of upper molars (skeletally anchored distalslider)
3.	Significant proclination of lower incisors ($+13^\circ$)	Utilizing remaining leeway space in lower arch for incisor uprighing (mandibular plate parallel to utility arch)
Sequence of therapeutic measures (begin at the age of 11:0 years)		Duration
1.	Grinding of tooth 75 mesially	
2.	Maxilla: Utility arch (two-by-two) + high-pull headgear during bedtime Mandible: Plate with positive labial bow	3 months
3.	Activator with mandibular advancement + anterior bite plates + positive lower labial bow	8 months
	Reanalysis → headgear + activator were not effective enough due to poor compliance → non-compliance approach for distalization in upper arch required	
4.	Skeletally anchored distalslider with extrusive direction of guiding wires + mandibular plate with lateral bite plates for uncoupling the buccal occlusion and uprighing of lower incisors	4 months
5.	Full multibracket appliance (with distalslider maintained until debracketing) • Bodily retraction of upper incisors and additional palatal root torque • Overlay intrusion of lower anterior segment	1:11 years
6.	Maxillary and mandibular plates for retention	

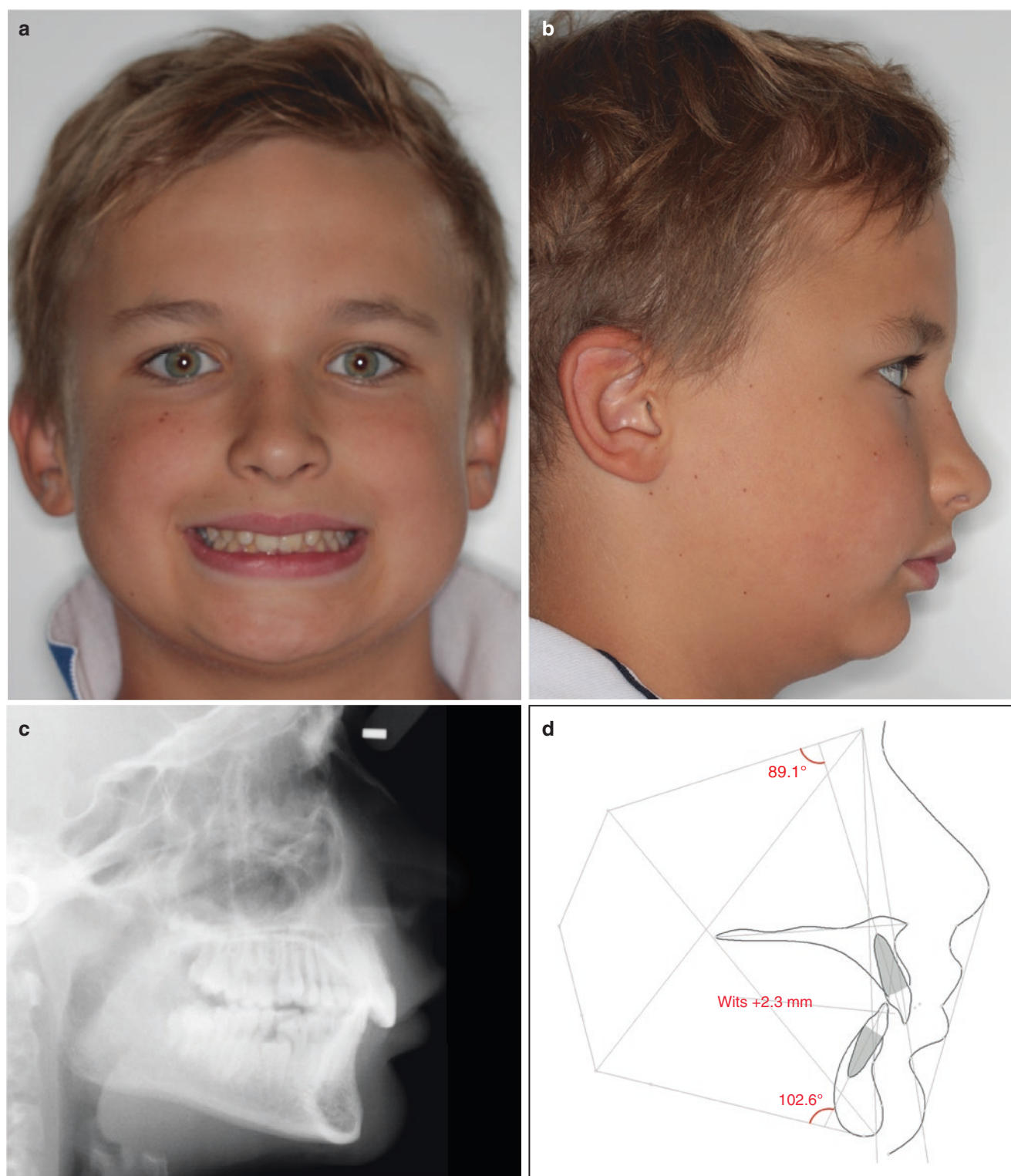


Fig. 5.61 (a–d)/patient #7. Facial images and cephalogram of patient #7 taken at age 10:09 years, 3 months prior to treatment begin. (a, b) Frontal and lateral facial views. Upper central incisor crowns are incompletely displayed during smiling. The facial profile is characterized by the retrognathic mandible. (c, d) The lateral cephalogram indicates retroclination of the upper central incisors by 12.9°, and significant proclination of the lower incisors by 12.6°. The lip line level is not

recognizable on this cephalogram. The clear skeletal class II pattern is reflected by the Wits appraisal of +2.3 mm and the deviation of the ANB angle from the individualized reference by 3.3°. The mandible is retrognathic (SNB 74°) and the maxilla is orthognathic (SNA 80.7°). The decreased angle between upper and lower jaw bases of 17.4° (reference: 25°) indicates a skeletal deep bite

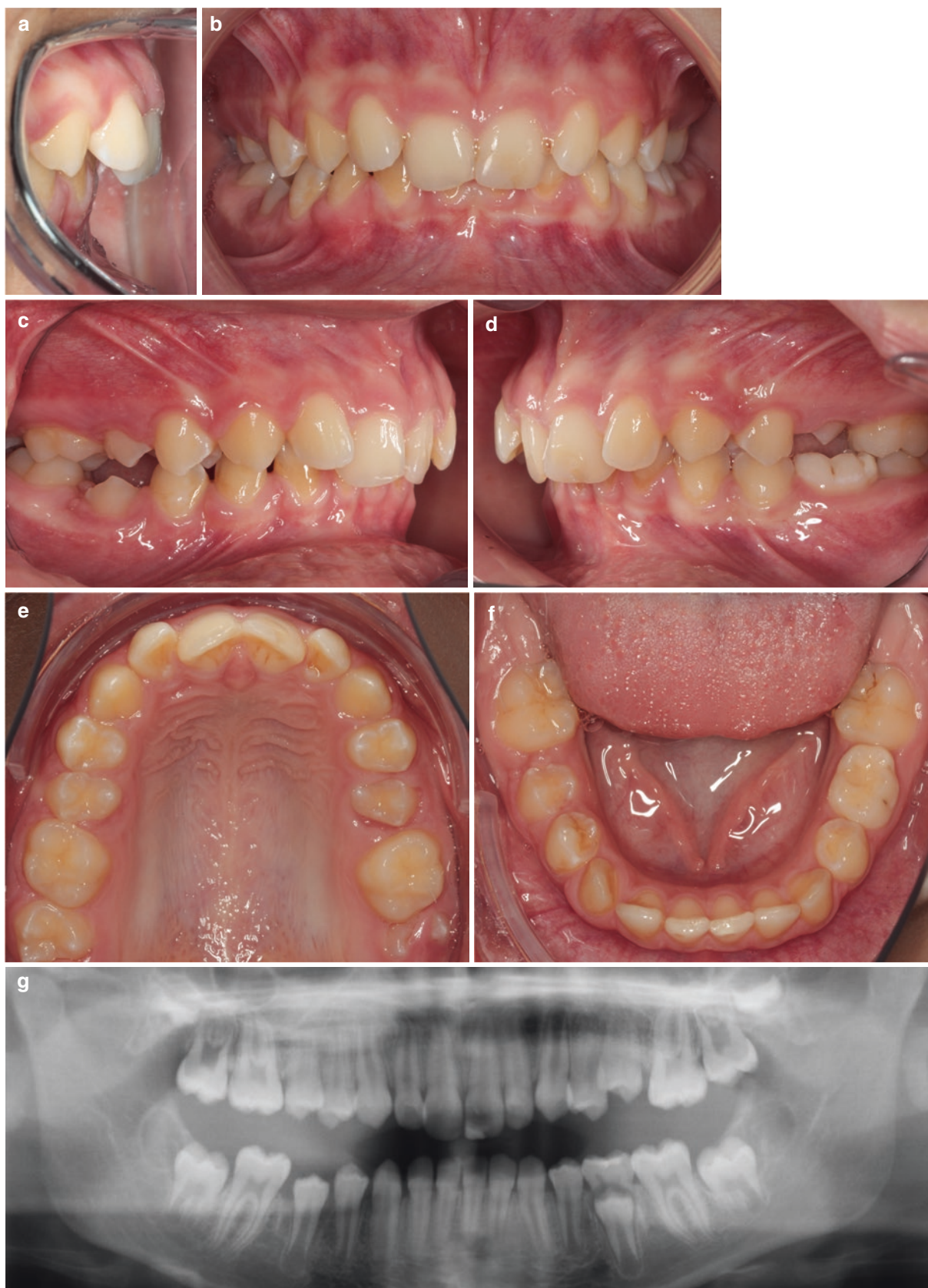


Fig. 5.62 (a–g)/patient #7. Initial dental records associated with the facial images and cephalogram depicted in Fig. 5.61. (a, b) The patient shows the typical features of a severe class II div. 2 with isolated supra- and retroclination of the two upper central incisors in the late mixed dentition. (c, d) First molars show one-and-a-half-step distocclu-

sion of right first molars and full-step distocclusion of left first molars. (e, f) Eruption of the upper second molars is almost completed and tooth 75 is the only deciduous tooth present intraorally. Mesial migration of lower molars into the leeway space did not yet occur. (g) The panoramic X-ray reveals the composite restoration of tooth 21 after trauma at age 7



Fig. 5.63 (a–d)/patient #7. (a) Insertion of the utility arch (0.016 × 0.016-in. stainless steel) to correct the malposition of the two upper centrals. Since this patient does not display the maxillary gingiva during smiling, it was planned to limit active-mechanical intrusion of the upper central incisors to approx. 2 mm. (b) Control measurement to

ensure the application of 30 cN in total onto both upper centrals. (c) Occlusal view on the maxillary arch. (d) Reclination of lower front teeth using a plate with active labial bow. Before manufacturing the acrylic part of the plate, 2-mm thick dental wax is applied to the lingual surfaces of incisors and canines to provide the space for uprighting



Fig. 5.64 (a–c)/patient #7. Situation after 3 months early treatment with the utility arch and the mandibular plate. (a) Intrusion of the upper central incisors by approx. 2 mm and sufficient proclination of these teeth is achieved. (b) The lateral view on the incisor segment shows the sagittal distance between the upper and lower incisors which is the

important regarding the planned subsequent mandibular advancement using an activator with anterior bite blocks. (c) The lower incisors are slightly retruded. Tooth 75 is ground mesially to allow further distal migration of tooth 34

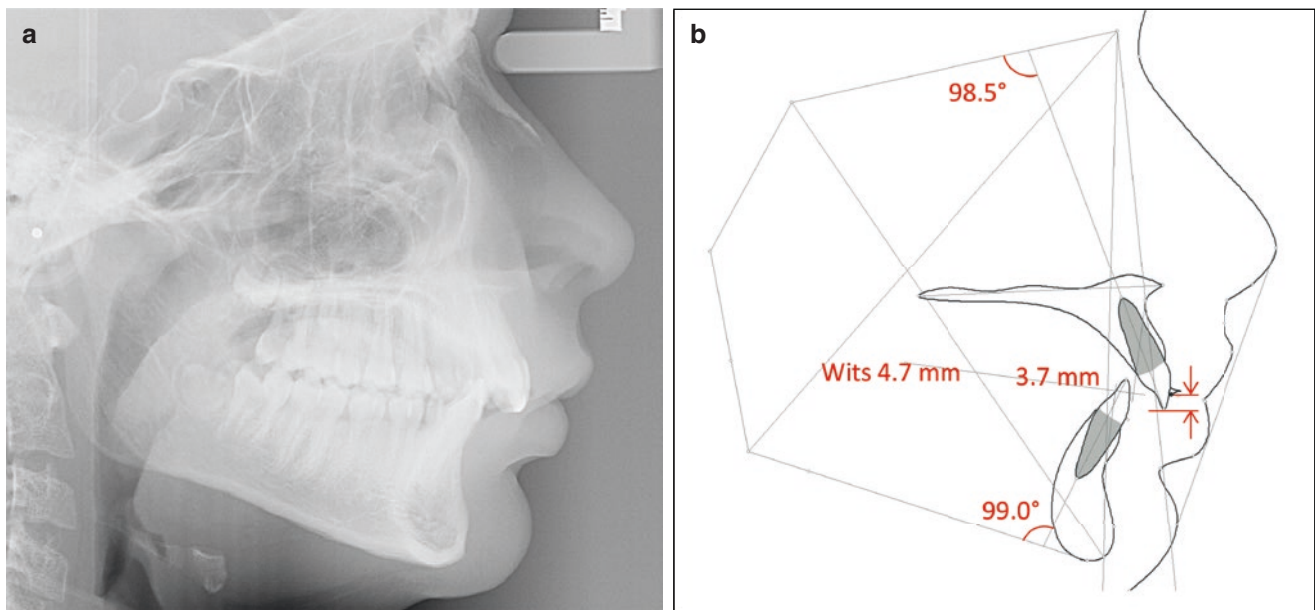


Fig. 5.65 (a, b)/patient #7. (a, b) Cephalometric analysis after finishing both main stages of early treatment, i.e., 3 months utility arch and 8 months activator treatment. The proclination of the upper incisors by 9.4° (initial value: 89.1°) and the uprighting of the lower incisors by 3.6° (initial value: 102.6°) demonstrates the significant improvement of the frontal features of the malocclusion by the early treatment in the late mixed dentition. The increase of the Wits appraisal from 2.3 to 3.7 mm

and the stable deviation of the ANB angle from the individualized reference of 3.2° (compared to 3.3° initially), however, indicate that mandibular growth could not be stimulated sufficiently. This may be explained by the relatively late begin of functional appliance therapy at the age of 11:09 years and the patient's poor compliance during this treatment phase

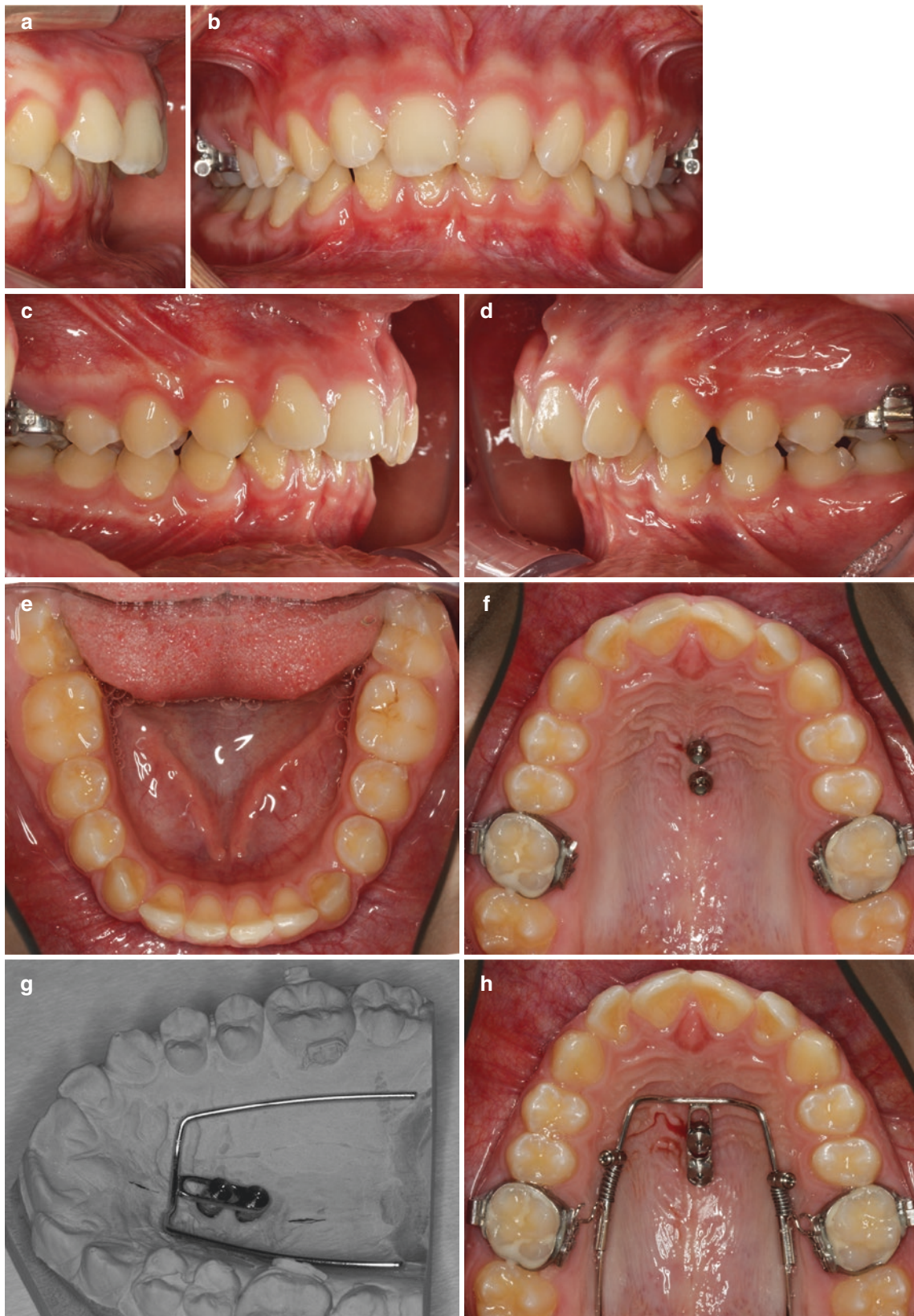


Fig. 5.66 (a–h)/patient #7. Dental situation 2 months after the cephalogram depicted in Fig. 5.65 has been taken. (a, b) Lateral and frontal images showing that the deep overbite is only partly corrected. (c, d) First molars are still in approx. 2/3-step distocclusion after full eruption of permanent canines and premolars. (e) In the lower arch, these teeth

migrated into the leeway space. (f–h) Insertion of a skeletally anchored distalslider (Wilmes and Drescher 2010) for distalization of upper molars comprising two mini screws in the anterior palate before multi-bracket therapy

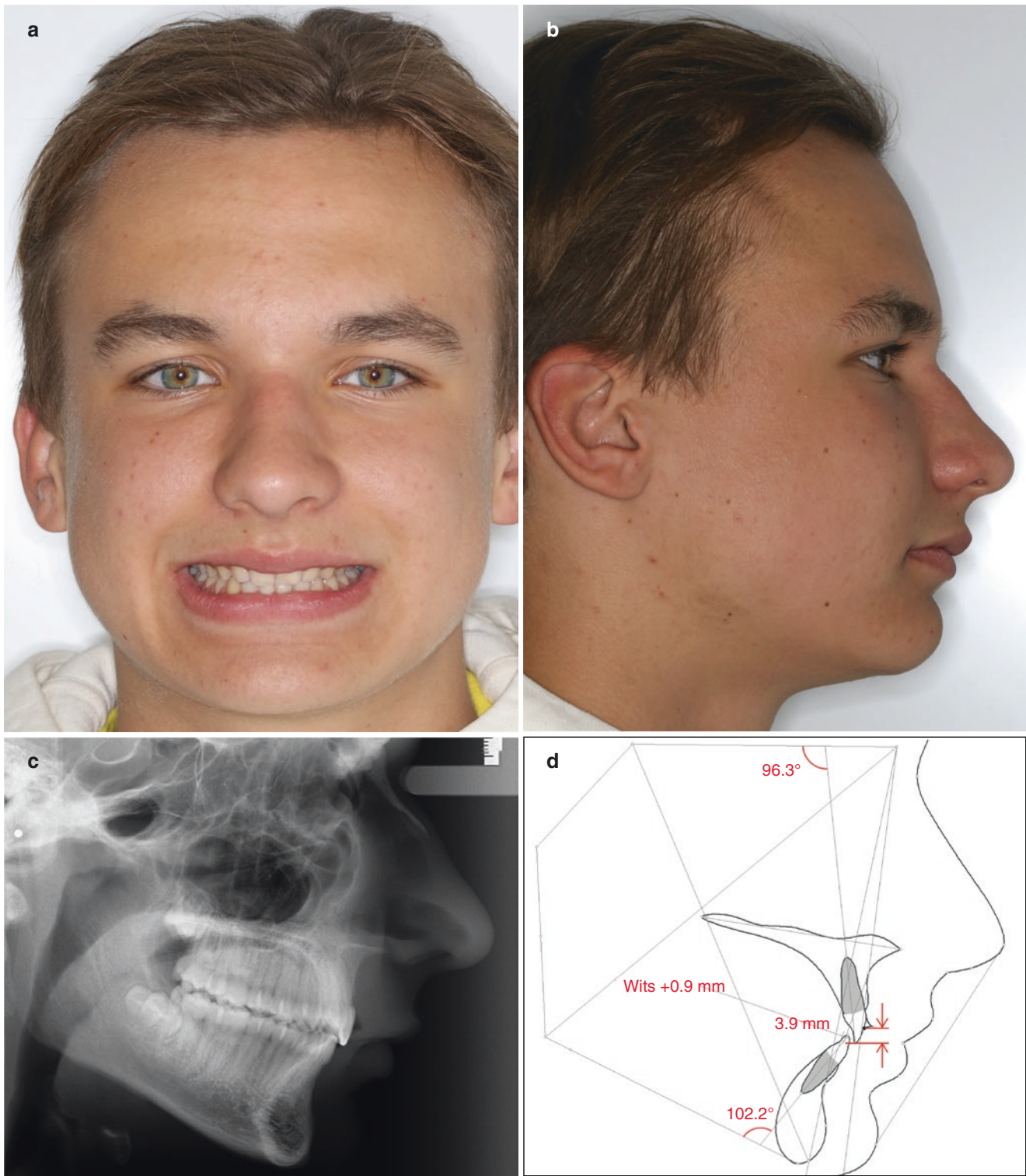


Fig. 5.67 (a–d)/patient #7. Facial images and lateral cephalogram taken after 6 months skeletally anchored distalization and subsequent 1:11 years therapy with a segmented full multibracket appliance. (a, b) Frontal and lateral facial views. The patient still displays only incisal halves of upper central incisor crowns. (c, d) Lateral cephalogram. The Wits appraisal of +0.9 mm and the remaining deviation of only 1.2°

between the ANB angle and its individualized reference indicates an almost neutral sagittal jaw base relationship. The distalization of the complete maxillary dentition by approx. 5 mm comprised bodily retraction of the upper frontal segment with additional palatal root torque, i.e., large incisor root movement. This may explain the persisting mild retroclination of the upper central incisors



Fig. 5.68 (a–h)/patient #7. Dental images after debracketing associated with the records depicted in Fig. 5.67. (a, b) The frontal overbite is 1.5 mm, and upper and lower incisors show good axial inclinations and mutual support. (c, d) Molars and canines show neutral occlusion and optimum intercuspitation. (e, f) Occlusal views on both dental arches.

(g, h) The patient is asked to wear maxillary and mandibular plates at night for retention. The distal extensions of the double-loop clasps for lower first molars and the recesses in the acrylic coverage of the labial bow (mesial to the canines) allow the insertion of light class II elastics for retention of the achieved neutral sagittal occlusion



Fig. 5.69 Patient #7. Panoramic X-ray of patient #7 at the age of 15:06 years (i.e., 1:03 years after debracketing). Angulations of the third molars seem favorable for eruption, but spatial conditions for teeth 38 and 48 are still unclear



Initial

Final



Fig. 5.70 (a, b)/patient #7. Buccal and frontal occlusal interrelationships prior to (a) and after therapy (b)

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Early Treatment of Class III Malocclusions

6

Somchai Satravaha

Class III malocclusions are considered among most difficult malocclusions to be treated. If it is possible to intercept early, severity of the malocclusions will be reduced. To treat early, careful considerations must be taken such as treatment possibility and limitation in certain cases. Complexities of Class III malocclusions involve their etiologies which can be hereditary (Figs. 6.1, 6.2, 6.3, and 6.4) or environment origin (Figs. 6.5, 6.6, 6.7, 6.8 and 6.9) or both.

Class III malocclusions will become more severe if the etiologies are from both hereditary combined with environment.

According to Rakosi, Class III malocclusions can be cephalometrically categorized into five types:

1. Dentoalveolar Class III malocclusion (Fig. 6.10).
2. Skeletal Class III malocclusion with fault in the maxilla (Fig. 6.11).
3. Skeletal Class III malocclusion with fault in the mandible (Fig. 6.12).
4. Skeletal Class III malocclusion with combination of 2 and 3 (Fig. 6.13).
5. Skeletal Class III malocclusion with pseudo forced bite (Figs. 6.14 and 6.15).

In many cases, Class III malocclusions are both skeletal and dental (Rakosi 1985; Graber et al. 1997; Rakosi and Graber 2010).



Fig. 6.1 A 9-year-old girl with concave facial profile

6.1 Functional Class III Malocclusion

Function analysis can help in differential diagnosis of Class III malocclusions to specify whether the malocclusion is of hereditary or environment or from both origins as stomatognathic system is dynamic not static. The temporomandibular joints are the most used joints in the whole human body.

Therefore, movement of the mandible and joint function must be examined (Figs. 6.16 and 6.17).

Rakosi mentioned that mandibular movement plays important clue to the prognosis of skeletal Class III malocclusions when treated with his Class III activator, when the mandible is pushed backward to a new desired posterior position. He suggested that the mandible normally closes in a rotation manner into initial tooth contact, then slide either forward or backward into maximum tooth contact. The case

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Fig. 6.2 Her cephalometric head film showed skeletal Class III malocclusion



Fig. 6.3 She had a deep anterior crossbite



Fig. 6.4 Her photograph with her father showed both of them had concave facial profiles, and her father had also anterior crossbite; which obviously indicate hereditary cause for the daughter's malocclusion



Fig. 6.5 Oral habit as seen here can cause anterior crossbite because the mandible was dragged forward to a more anterior position to the maxilla when this patient tried to touch the tip of her nose with her tongue. Anterior portion of her maxilla was compressed by the force from the tongue, which could cause anterior crossbite and could develop into skeletal Class III malocclusion if not intercepted

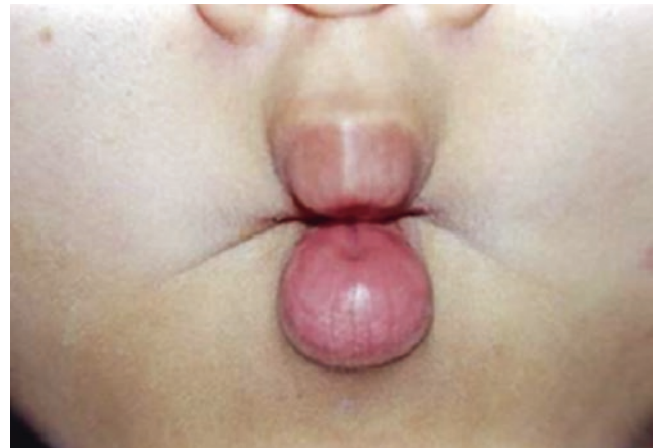


Fig. 6.6 An additional habit of making a ribbon with the lips as seen here can cause narrow upper and lower arches

where the mandible closes with rotation and slide forward has better prognosis than that of a rotation with a slide backward.

In addition, from doing functional analyses on the patients, it can be concluded that patients with skeletal Class III malocclusions have incompetent lips, low tongue position with anterior thrust, and visceral or infantile swallowing pattern. The characteristic of the tongue, lips, and their functions contributes to more severity of the malocclusions and instability of treatment outcomes (Graber 1963; Rakosi 1985; Graber et al. 1997; Rakosi and Graber 2010).

Fig. 6.7 Two intraoral pictures of the same patient in Figs. 6.5 and 6.6 showed anterior crossbite with large negative overjet and bilateral posterior crossbites. Narrow upper and lower arches with linguoversion of posterior teeth in both arches were caused by her abnormal oral habits



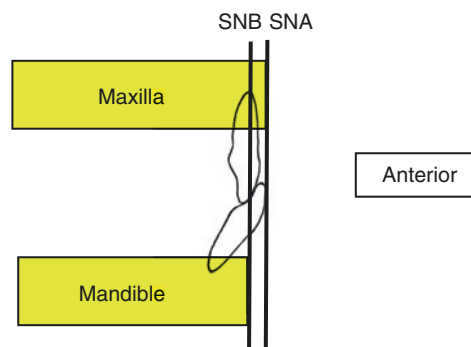
Fig. 6.8 Polyp seen in the right nostril can obstruct the patient's upper airway and cause mouth breathing



Fig. 6.9 Large tonsils can obstruct the patient's upper airway and cause mouth breathing and low tongue position. Force from flat tongue position can cause lower anterior teeth to flare out labially

Dento-alveolar Class III malocclusion

ANB normal



Fault at axial inclination(s) of upper and/or lower anterior teeth

Fig. 6.10 Dentoalveolar Class III malocclusion with fault at axial inclination (s) of upper and/or lower anterior teeth

Skeletal Class III malocclusion with fault in the maxilla

ANB = -ve or < normal

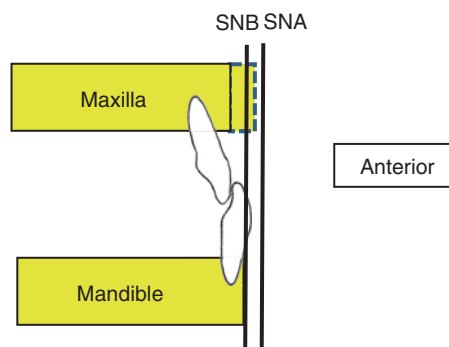


Fig. 6.11 Skeletal Class III malocclusion with fault in the maxilla; the maxilla is underdeveloped while the mandible is normal

Skeletal Class III malocclusion with fault in the mandible

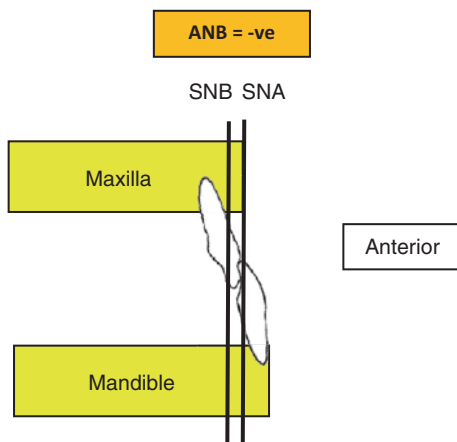


Fig. 6.12 Skeletal Class III malocclusion with fault in the mandible; the mandible is overdeveloped while the maxilla is normal

Skeletal Class III malocclusion with fault in both, the maxilla and the mandible

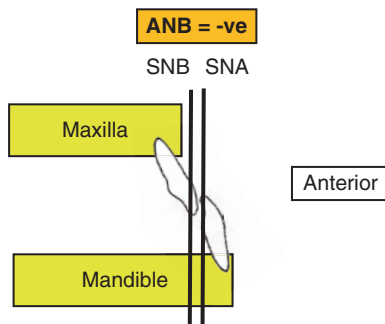


Fig. 6.13 Skeletal Class III malocclusion with fault in both the maxilla and the mandible. The maxilla is underdeveloped while the mandible is overdeveloped

Skeletal Class III malocclusion with pseudo forced bite

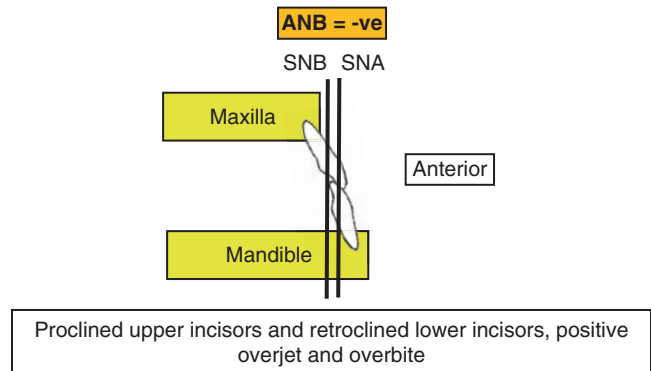


Fig. 6.14 Skeletal Class III with pseudo forced bite, proclination of upper anterior teeth, and retroinclination of the lower anterior teeth compensate skeletal discrepancy resulting in positive overjet and positive overbite

Skeletal Class III malocclusion with pseudo forced bite

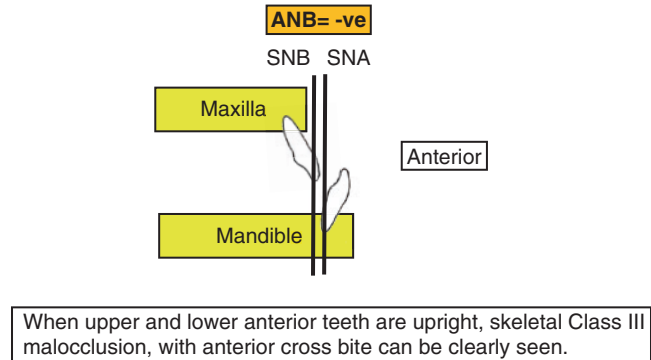


Fig. 6.15 When both upper and lower anterior teeth in Fig. 6.14 are upright, severe skeletal Class III malocclusion is revealed



Fig. 6.16 (a, b) A patient at maximum tooth contact or CO showed anterior crossbite



Fig. 6.17 (a, b) The same patient at physiologic rest position; no anterior crossbite was presented

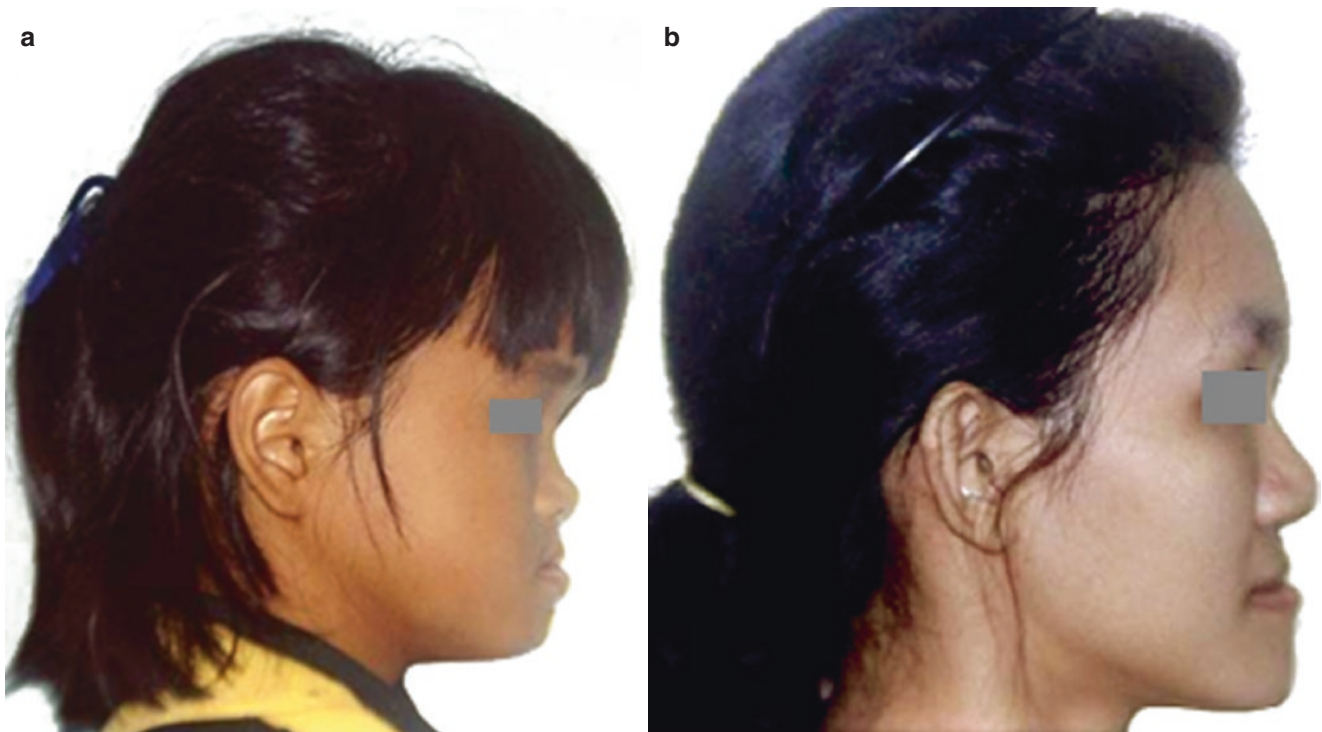


Fig. 6.18 (a, b) If not treated early, the girl on (a) might grow up to become a woman on (b). This certainly has psychological impact on the patient, especially being teased for having a non-esthetic concave facial profile

6.2 Reasons for Early Treatment

If not treated, severity of the malocclusions will increase which can cause function problems and have psychological impact on the patients (Figs. 6.18, 6.19, and 6.20).

There has been a controversy in treatment of Class III malocclusions early, especially whether growth can be mod-

ified. There are natural growth and induced growth which cannot be measured separately. The author believes that the treatment outcomes are the most crucial for the decision whether to treat early or not. If the treatment outcomes can reduce severity of malocclusions and are satisfactory to both patients and orthodontists, then the interception is worth doing.



Fig. 6.19 (a–f) Severity of the malocclusion could increase tremendously if not treated



Fig. 6.20 (a, b) An untreated male patient showed a facial asymmetry in a permanent dentition illustrated anterior crossbite and unilateral posterior crossbite on the left side

6.3 To Treat Early: When Is the Right Time?

Once we decide to treat the cases, we must begin with the end in mind knowing the goals and how the finished cases should be.

Treatment objectives should be the same as all orthodontic treatments which are to achieve good function, acceptable esthetics, and good stability. The treatment should be at the right place, at the right time and with proper appliances.

6.4 In Deciduous Dentition

It is rather early to treat Class III malocclusions during this stage as Class III malocclusions are rather complex. The treatment might take a very long time, and patients can get burnt out. Most cases are to be under growth and development observation (Figs. 6.21 and 6.22), and many of the cases anterior crossbite was corrected through eruption of permanent upper and lower anterior teeth.

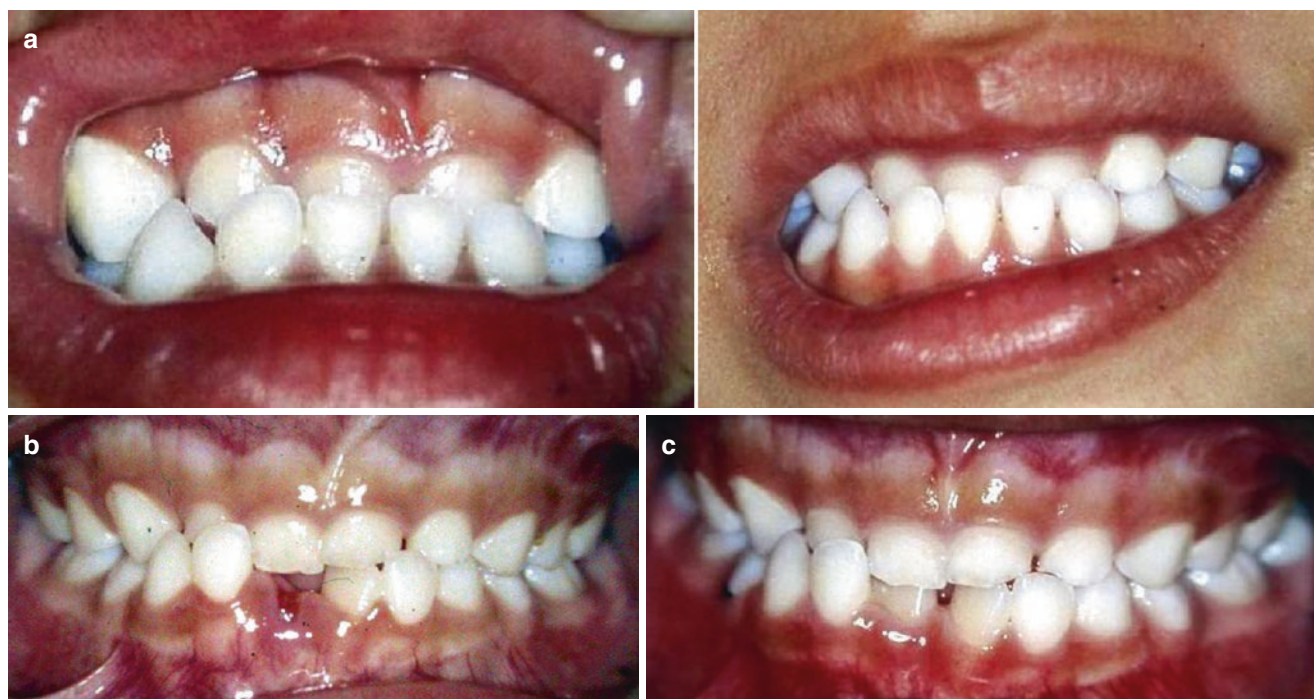


Fig. 6.21 (a–c) Tooth #31 and #41 erupted lingually to tooth #61 and #51; crossbite was self-eliminated

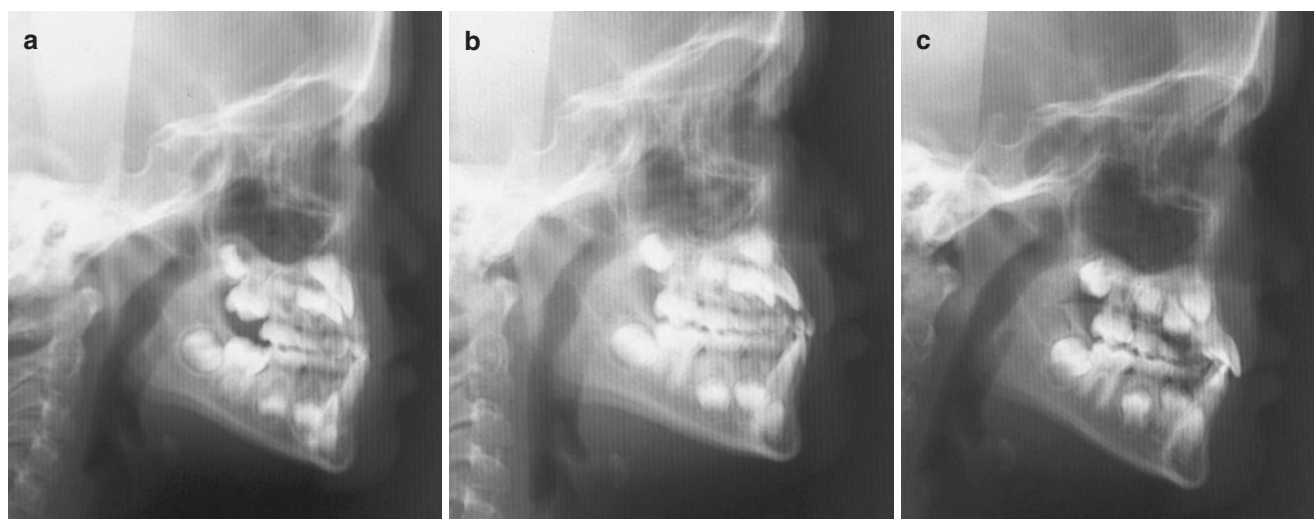


Fig. 6.22 (a–c) Cephalometric head films of the patient in Fig. 6.21 at age 6, 7, and 8, respectively, showed path of eruptions of upper and lower anterior teeth. Anterior crossbite was self-corrected through eruption of upper and lower anterior teeth

6.5 Early Treatment of Dentoalveolar Class III (Figs. 6.23, 6.24, 6.25, 6.26, 6.27, 6.28, 6.29, 6.30, 6.31, 6.32, 6.33, 6.34, 6.35, 6.36, 6.37, 6.38, 6.39, and 6.40)

6.5.1 In Early Mixed Dentition



Fig. 6.23 An intraoral picture of an 8-year-old girl in an early mixed dentition, #11 was in crossbite with #41 and #42. A treatment to correct the crossbite was needed. If not treated, growth of the maxilla at #11 would be inhibited



Fig. 6.24 An upper plate with posterior raised bite and a protrusion spring were used to correct the crossbite



Fig. 6.25 The crossbite was corrected. Upper permanent lateral incisors erupted more into the oral cavity while the lower canines started to erupt



Fig. 6.26 Diastema media was seen here



Fig. 6.27 An upper plate with two finger springs was used to close the spaces in the upper anterior region. No raised bite needed here



Fig. 6.28 Spaces were closed

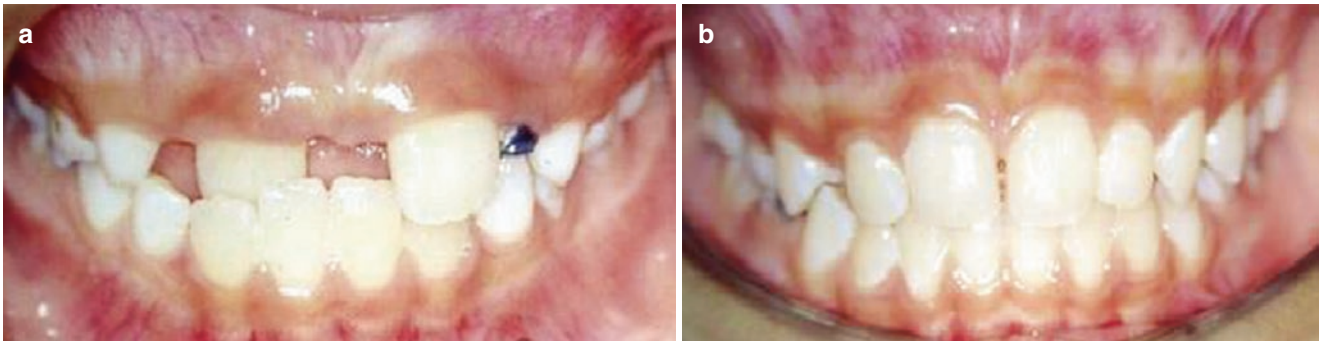


Fig. 6.29 (a, b) Comparison between before the treatment and sometime after correction of the crossbite and spaces closing in the upper anterior region

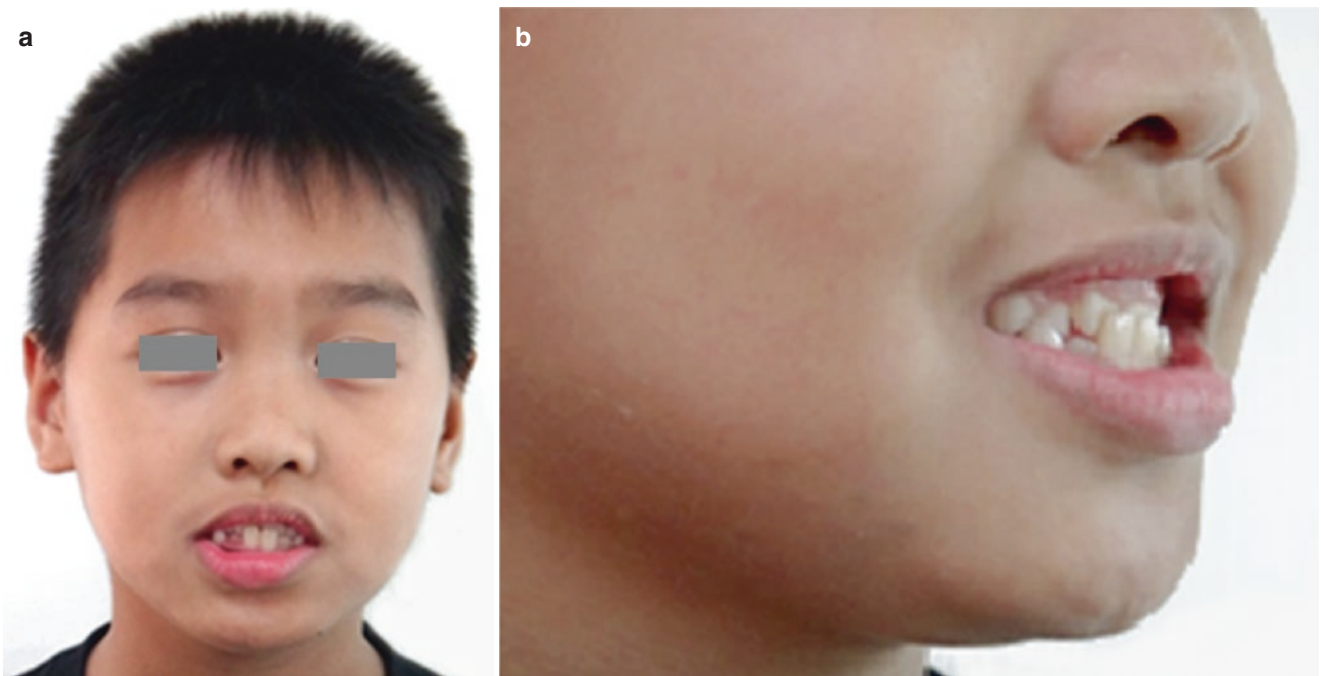


Fig. 6.30 (a, b) An 8-year-old boy with dentoalveolar Class III malocclusion; he showed lower anterior teeth at smile

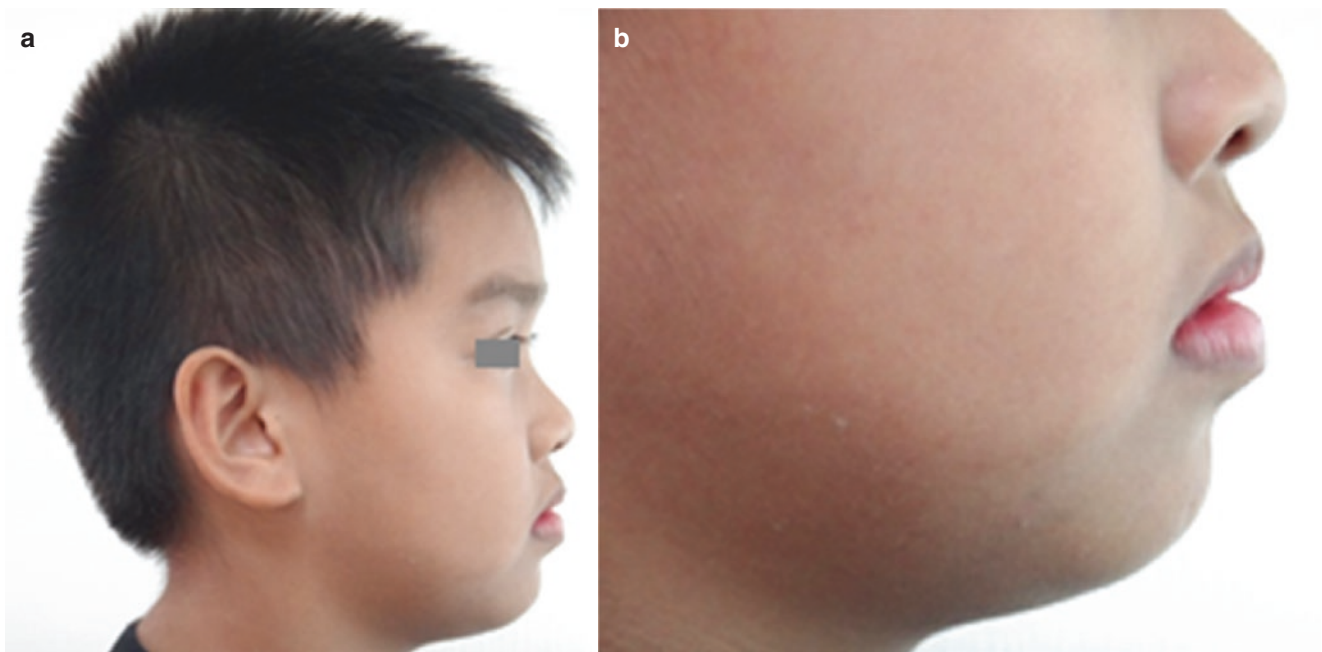


Fig. 6.31 (a, b) He had normal facial profile



Fig. 6.32 (a–c) Anterior crossbite was presented



Fig. 6.33 Anterior crossbite was corrected by using an upper plate with protrusion screw to protrude the upper permanent anterior teeth

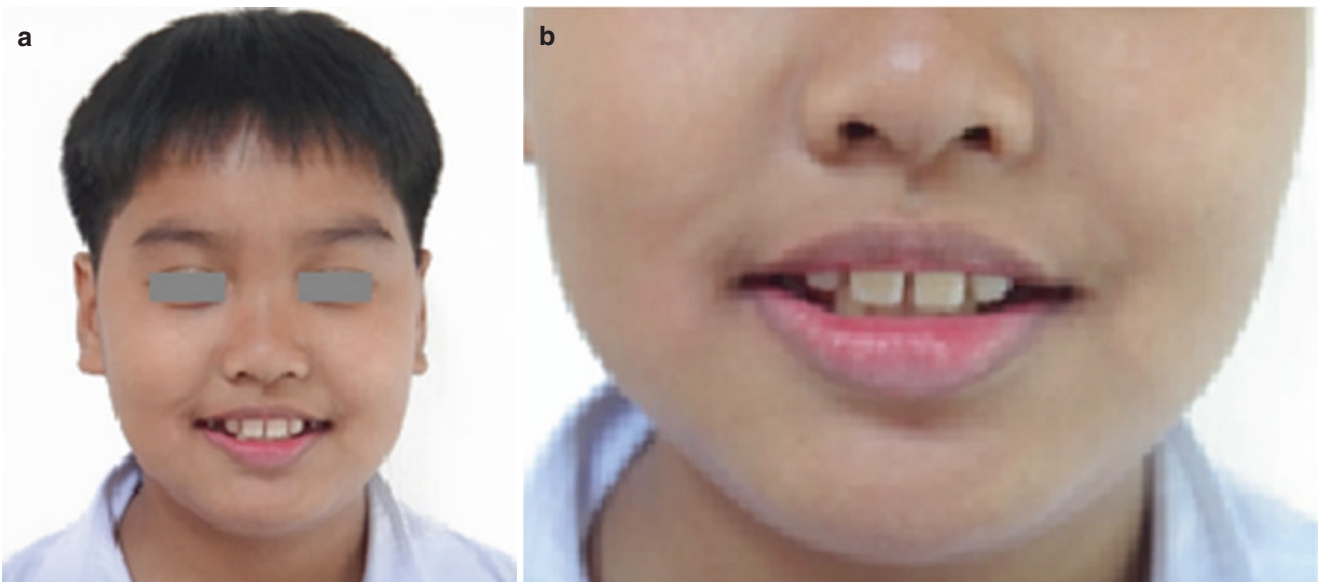


Fig. 6.34 (a, b) After correction of the anterior crossbite, the patient showed upper anterior teeth at smile which is esthetically more pleasant than before the treatment

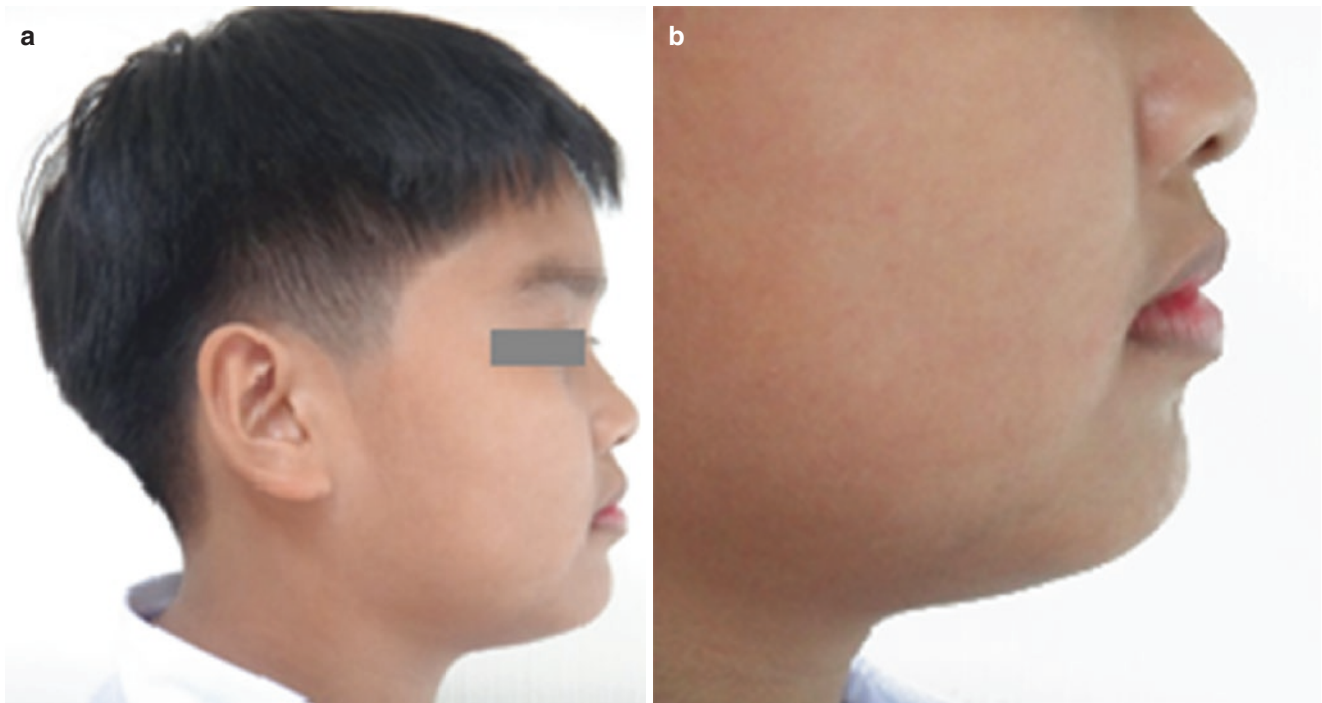


Fig. 6.35 (a, b) His profiles remained acceptable



Fig. 6.36 (a–c) Intraoral pictures, 2 years after the beginning of the treatment

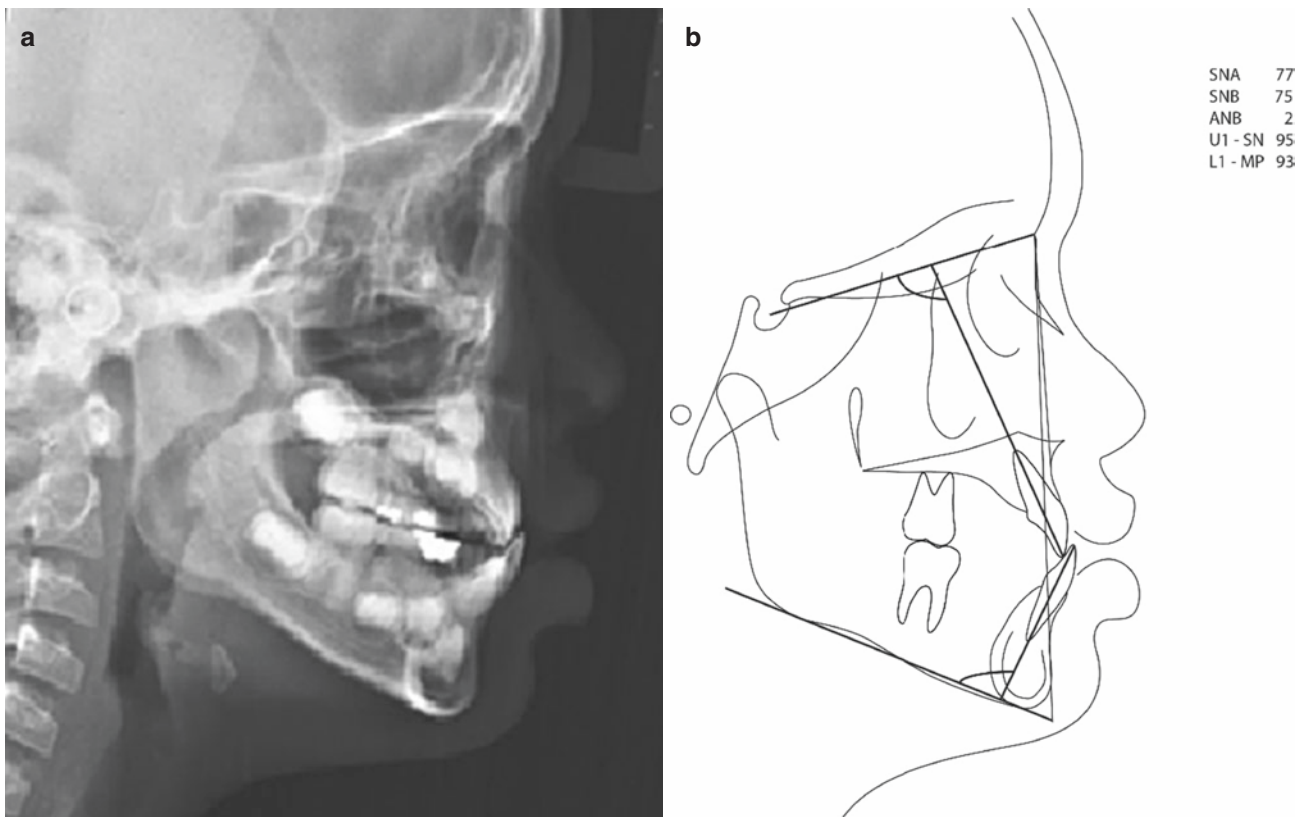


Fig. 6.37 (a, b) Cephalometric x-ray of the patient in Figs. 6.30 to 6.36 and the tracing showed that he has a +2 ANB before the treatment which indicated no fault in both the maxilla and the mandible. The cause for anterior crossbite was from inclination of upper and lower anterior teeth

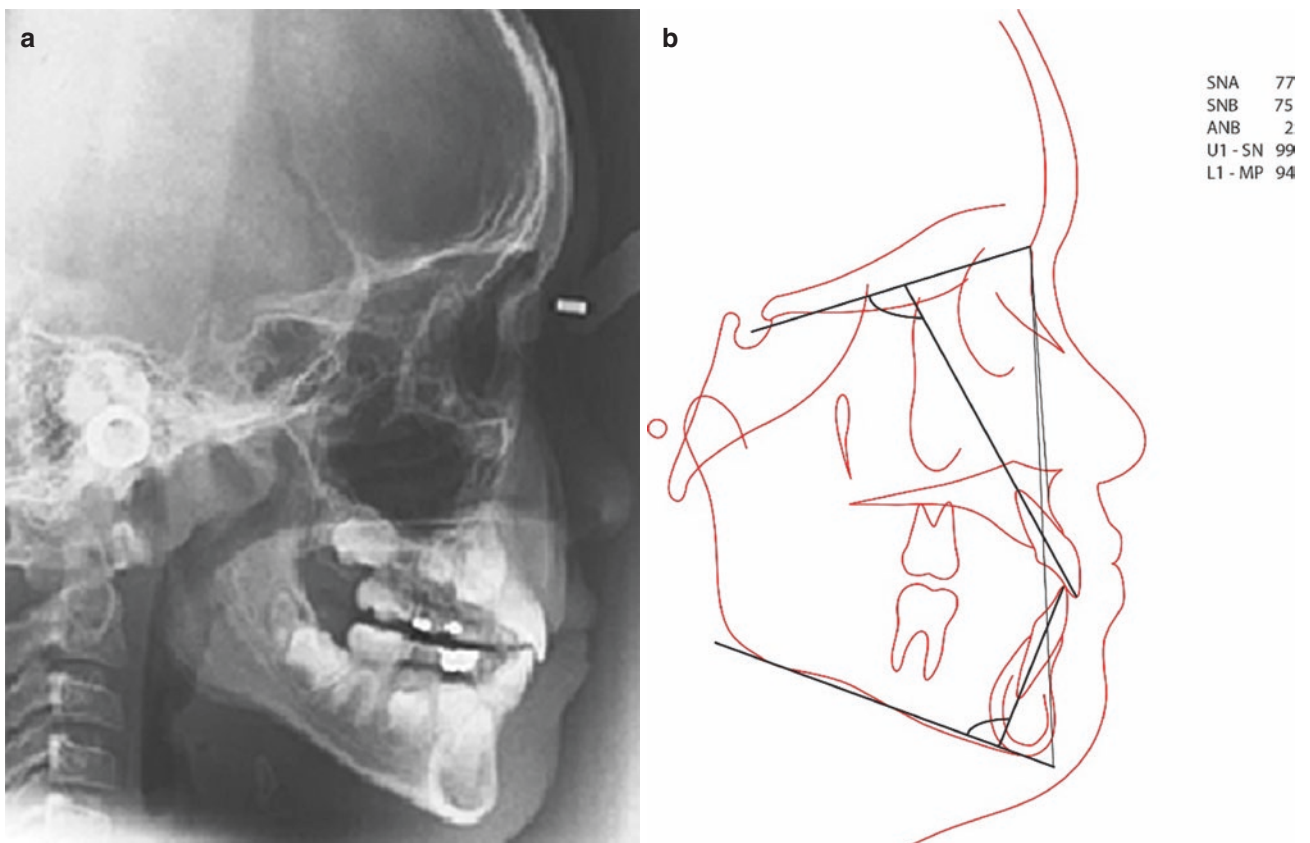


Fig. 6.38 (a, b) Cephalometric x-ray of the same patient and the tracing after correction of the anterior crossbite

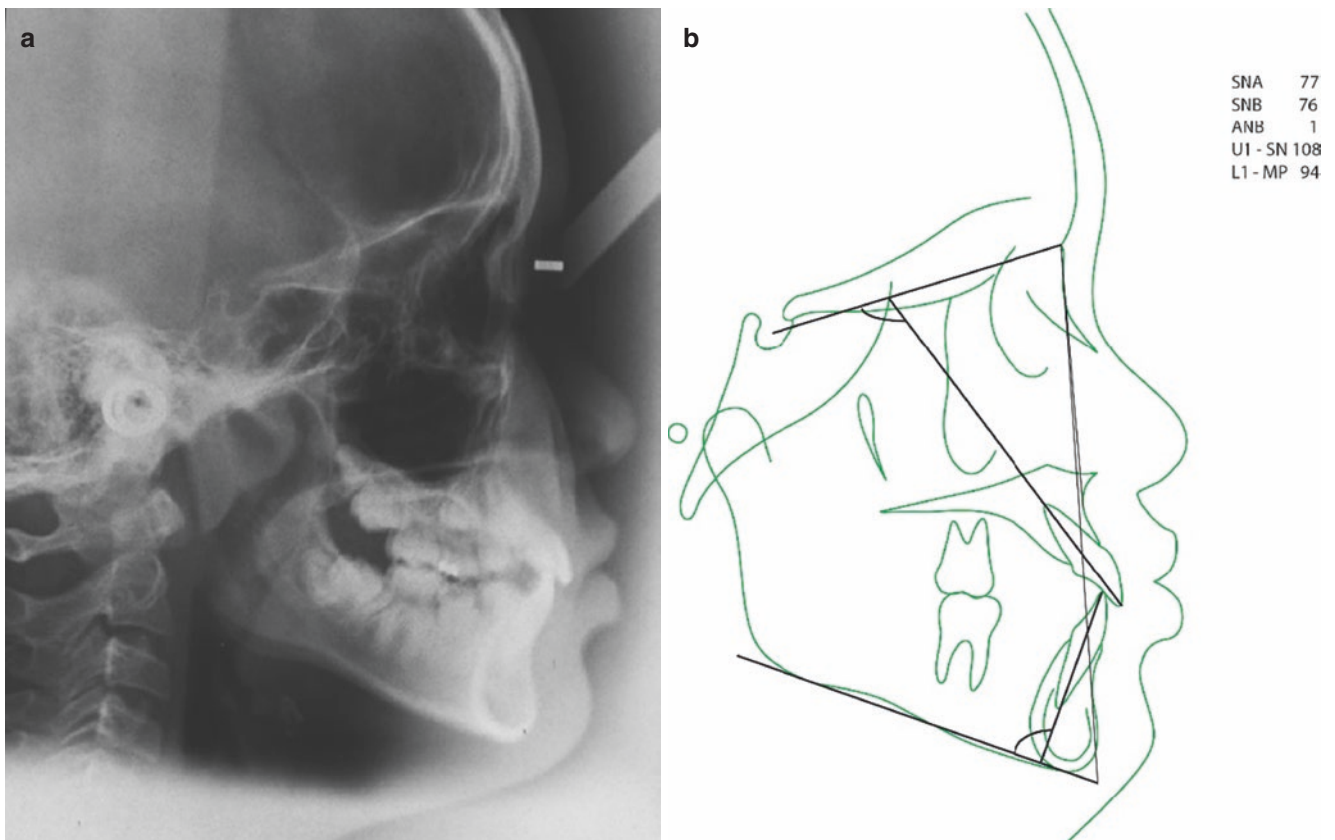


Fig. 6.39 (a, b) 2 years after the anterior crossbite was corrected

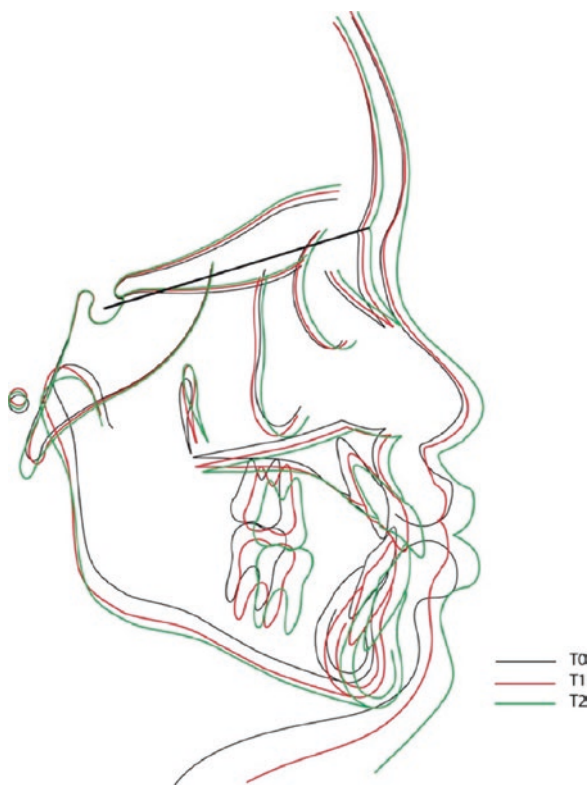


Fig. 6.40 Superimposition of the tracings at the three timelines, before treatment (T0), after correction of the anterior crossbite (T1), and 2 years after the treatment began (T2)

6.6 Treatment of Skeletal Class III Malocclusions

6.6.1 The Use of Facemask or Facemask Combined with Rapid Palatal Expansion (Figs. 6.41, 6.42, 6.43, 6.44, 6.45, 6.46, 6.47, and 6.48)

Many authors suggested the use of facemask or RPE (rapid palatal expansion) or facemask combined with RPE to enhance growth of the maxilla or together with the attempt to control growth of the mandible. Temporary anchorage device (TAD) has also been used to protract the maxilla (Baccetti and McNamara 2004; Cha 2003; Gallagher et al. 1998; Gu et al. 2000; Hass 1980; Kajiyama et al. 2000; Keles et al. 2002; Liou 2005; McNamara 2000; Mermingo et al. 1990; Ngan 2002; Ngan et al. 2015; Pangrazio-Kulbersh et al. 1998; Saadia and Torres 2000; Turley 2002; Yüksel et al. 2001).

The author prefers to use RPE not too early as it is easier to work with the patient, and it was mentioned in many researches that the results of doing RPE in early or late have no significant difference.

6.6.2 The Use of Chincap (Chincup) (Fig. 6.49)

Chincap have been used to modify growth of the mandible and the maxilla, and many studies on the effectiveness of its



Fig. 6.41 Facemask to protract maxilla and to inhibit growth of the mandible

use have been done by many authors. Hideo Mitani stated on his article, “Early application of Chincap therapy to skeletal Class III malocclusion” that chincap works sufficiently on the first 2 years of the treatment but need long retention time as the condylar cartilage might gradually become accustomed to the chincap force, allowing bone formation to return to the initial level even under compressive force, and if the chincap therapy is stopped before facial growth is complete, the decreased pressure appears to stimulate and accelerate condylar growth, and some recovery growth might take place. He also added that the improper use of the chincap can cause temporomandibular disorders and that the chincap should be used and monitored carefully (Deguchi et al. 1999; Deguchi et al. 2002; Graber 1977; Ishikawa et al. 1988; Ko et al. 2004; Mitani 2002; Sugawara et al. 1990; Wendell et al. 1985).

6.6.3 The Use of Functional Appliances

Functional appliances such as Fränkel’s FR 3, Bimler’s Bionator, etc. have been used to treat skeletal Class III malocclusions (Fränkel and Fränkel 1989; Graber et al. 1997; Levin et al. 2008; Rakosi 1985; Rakosi and Graber 2010; Satravaha 1993; Satravaha and Taweeseedt 1996a, 1996b; Satravaha and Taweeseedt 1999).



Fig. 6.42 (a–f) Extra- and intraoral pictures of a 14-year-old girl, with a concave facial profile; she had a Class III malocclusion with large negative overjet and severe crowding in the upper arch. She had a large

tongue with low tongue position; the bite was slightly opened. At smile, a large anterior crossbite appeared and she showed more of the lower anterior teeth than the upper anterior teeth



Fig. 6.42 (continued)

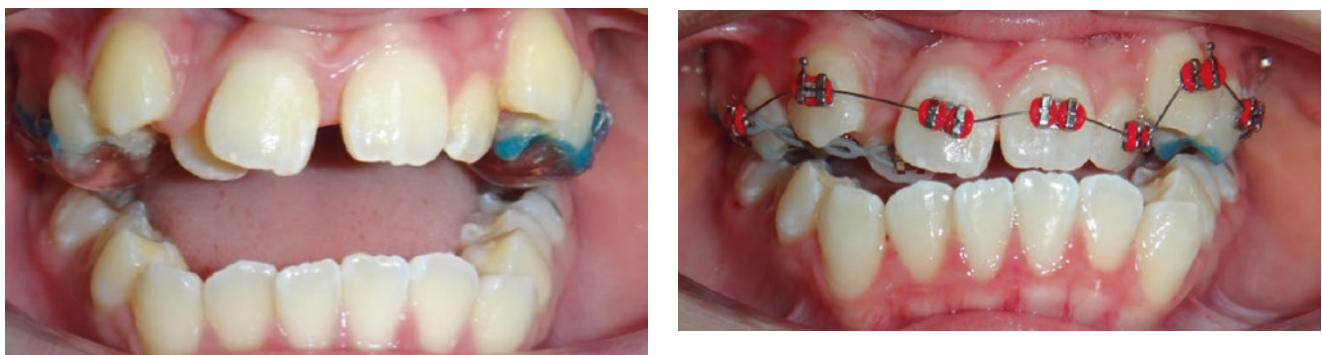


Fig. 6.43 RPE was used to expand the upper arch transversally and to bring the maxilla forward

Fig. 6.44 After removal of RPE, fixed appliances were used to correct upper arch crowding

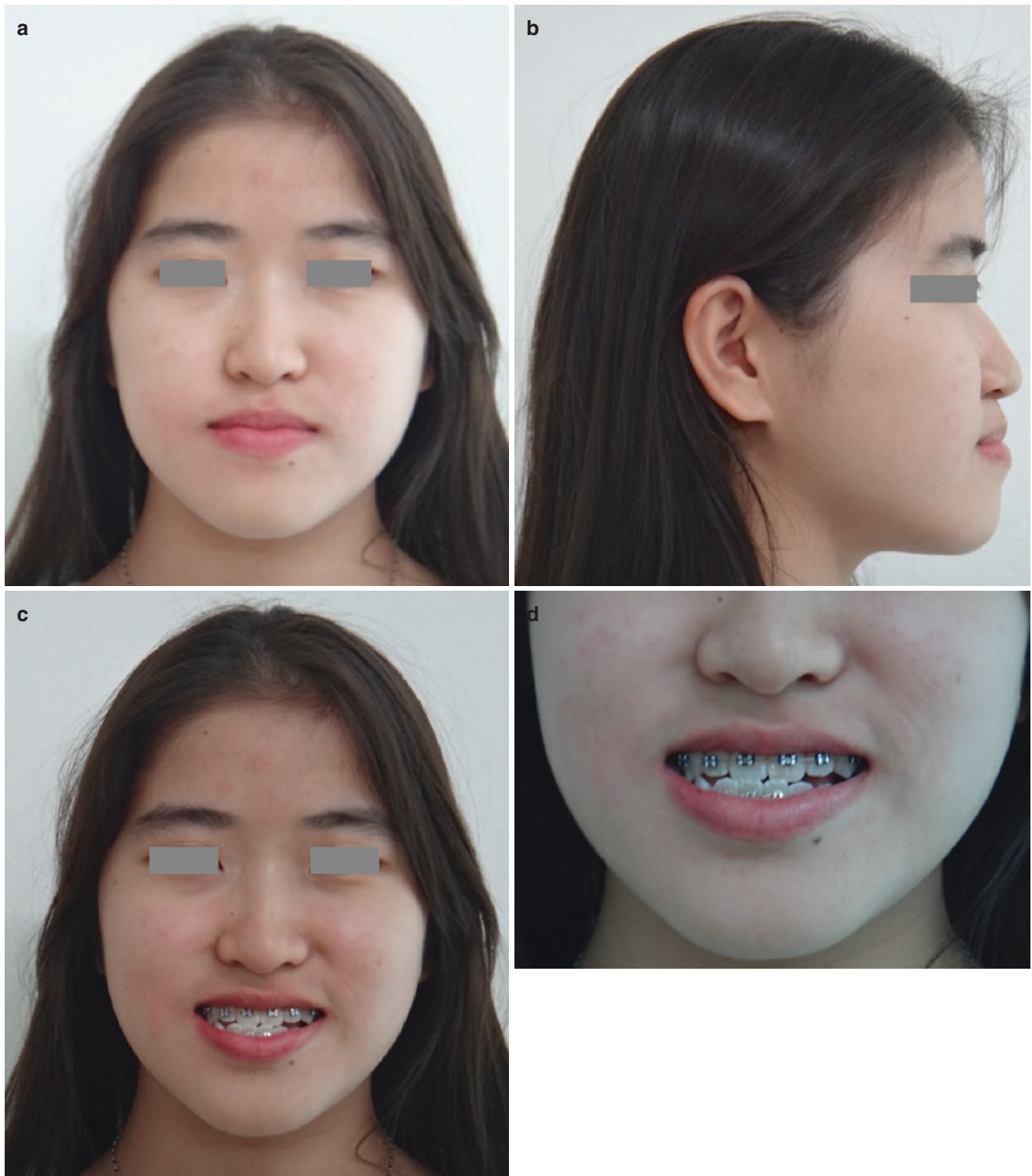


Fig. 6.45 (a–d) After removal of the RPE, orthodontic fixed appliances were used during the second phase of treatment; her facial appearance and lateral profile were esthetically improved

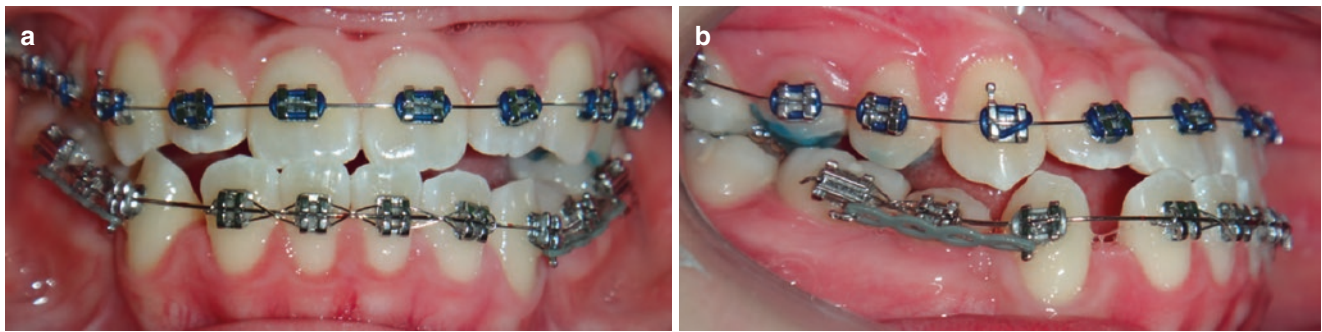


Fig. 6.46 (a, b) Severe crowding in the upper anterior region was corrected; teeth #34 and #44 were extracted in order to move lower canines backward and later lower anterior teeth to achieve positive overbite and positive overjet

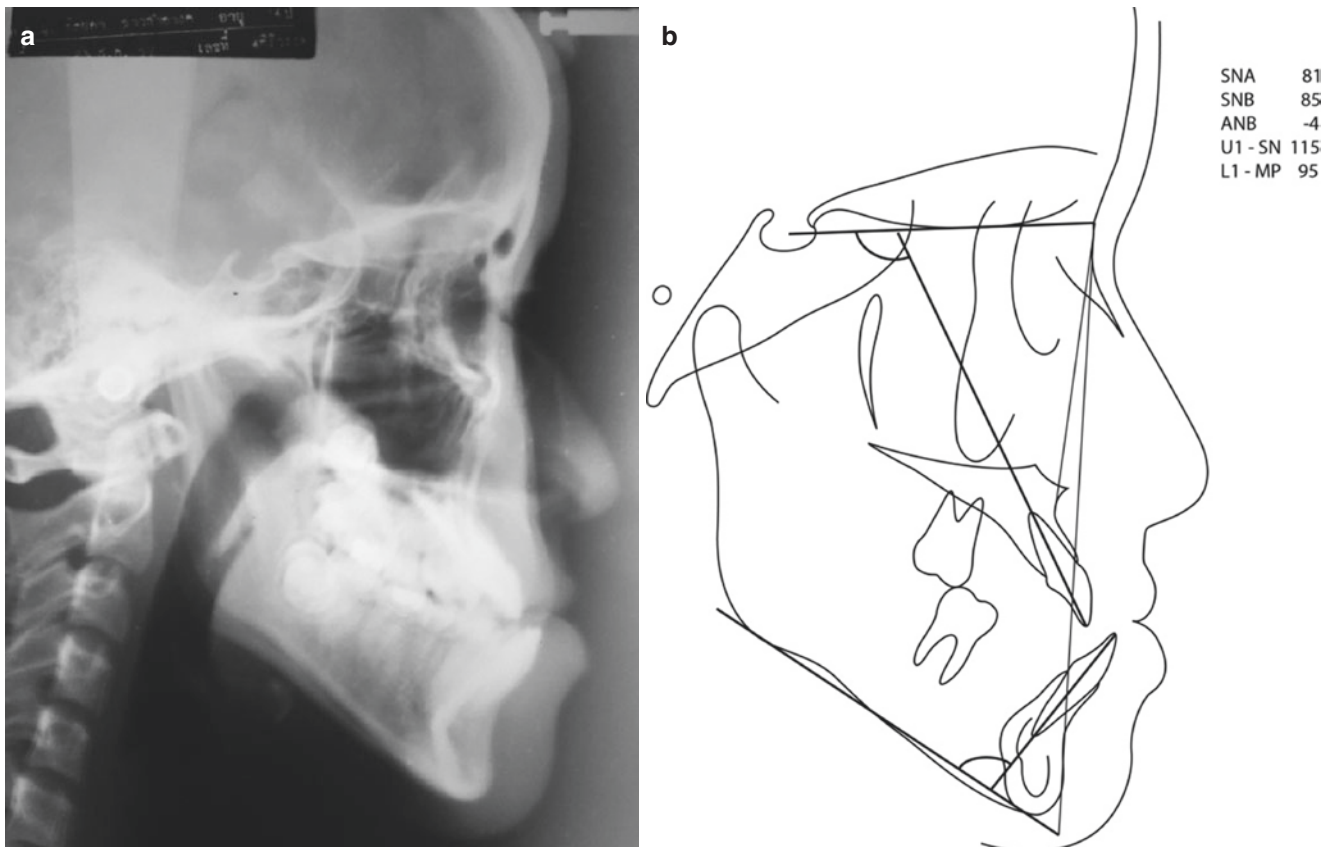


Fig. 6.47 (a, b) Cephalometric and tracing of the same girl before an RPE was used to expand the upper arch; her SNA angle was 81 degrees

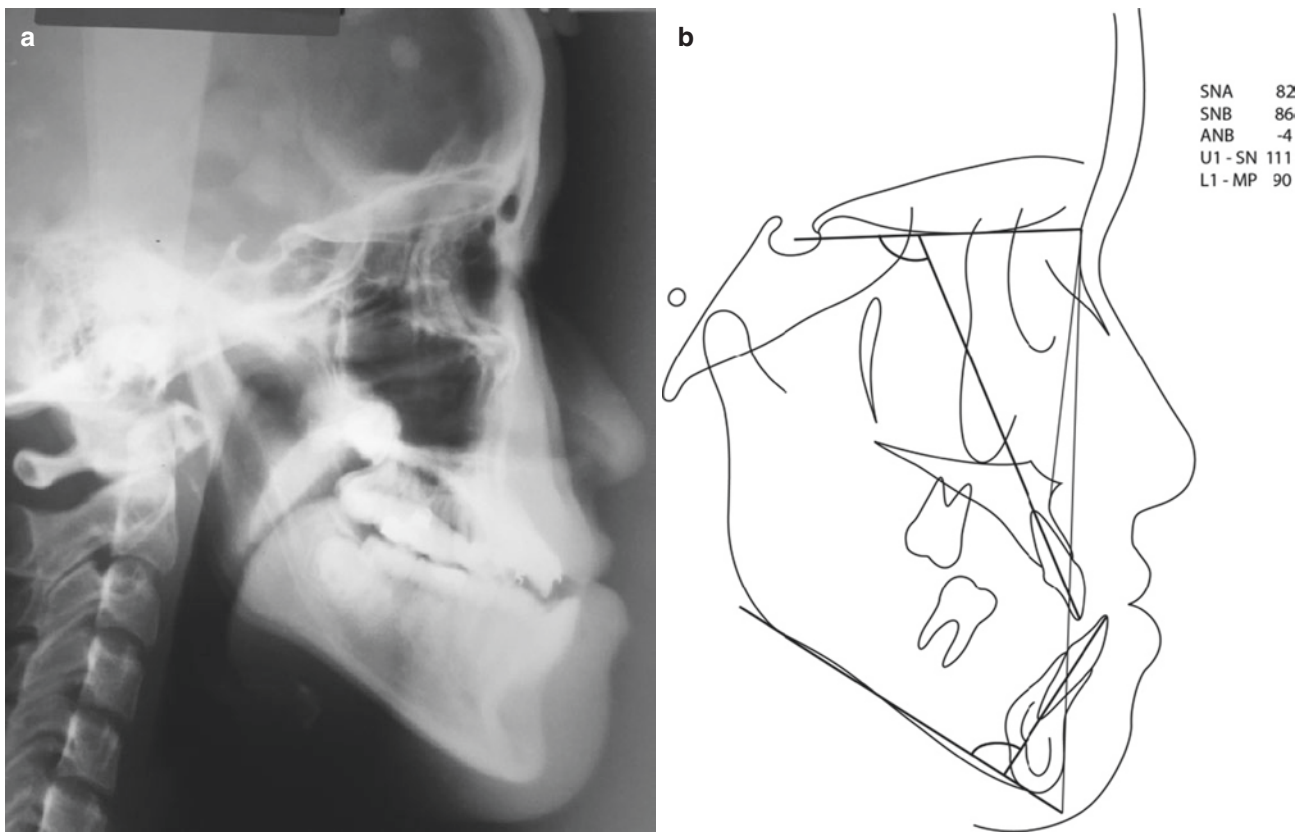


Fig. 6.48 (a, b) After RPE was used, SNA increased from 81 to 82 degrees

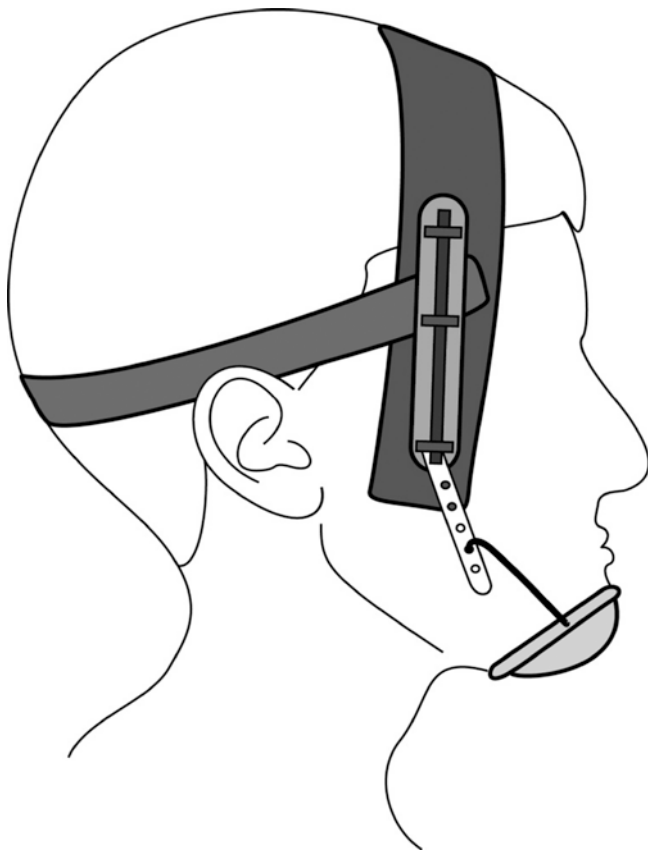


Fig. 6.49 Chincap

6.6.4 The Use of Class III Activator (Figs. 6.50, 6.51, and 6.52)

The author recommends Class III activator of Thomas Rakosi (Rakosi 1985; Satravaha 1993; Graber et al. 1997; Rakosi and Graber 2010) to be used in early stage of treatment of skeletal Class III malocclusion, and the objectives of using this appliance are as follows:

1. To achieve a more posterior position of the mandible.
2. To protract the maxilla.
3. To get positive overjet.
4. To get positive overbite.

Class III activator of Thomas Rakosi is a bimaxillary appliance, composed of acrylic part and wire components. The components and their functions are as follows:

1. Upper labial pads to stimulate bone formation or enhance growth of the maxilla.
2. Lower labial bow to stabilize the appliance, and the author recommends not to have any force from the lower labial bow on the lower anterior teeth. Its distance to the labial surfaces of the lower anterior teeth should be about 2 mm.
3. Stop loops located mesial to all the 6-year molars to stabilize the appliance.
4. Tongue guard to prevent force from a flat and low tongue position which exert force upon and flare out the lower anterior teeth.

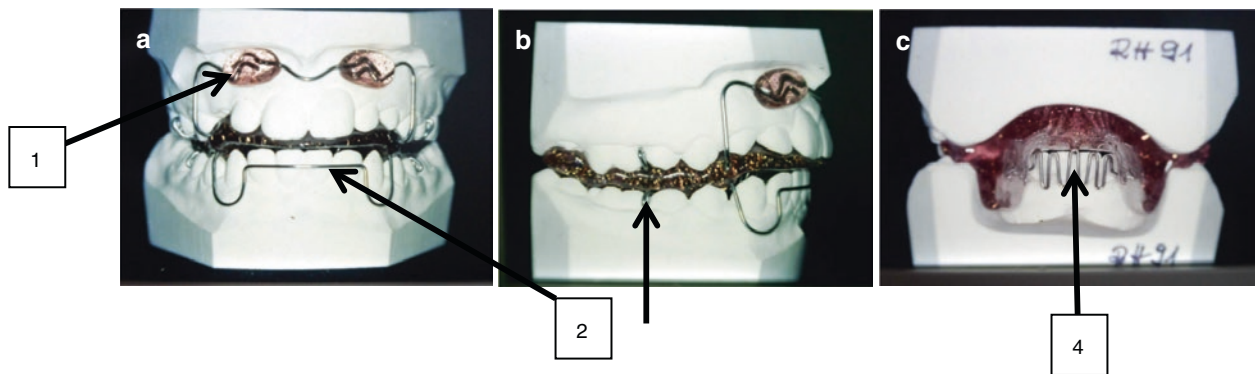


Fig. 6.50 (a–c) Class III activator



Fig. 6.51 Cephalogram taken before using Class III activator



Fig. 6.53 A construction bite

6.7 Construction of Class III Activator (Figs. 6.53, 6.54, 6.55, 6.56, 6.57, and 6.58)

A construction bite must be registered to designate a new position of the mandible which is more posterior to its original position. Construction bite must be done on the patient. Its thickness varies according to growth pattern of the patient but must be thicker than the freeway space of that patient as activator functions through natural force of the muscles (Rakosi 1985; Graber et al. 1997; Rakosi and Graber 2010; Witt and Gehrke 1981).

In horizontal growth pattern patients, the mandible can be pushed backward in a more distance than that of the patients with vertical growth pattern. Patients with horizontal growth pattern therefore have more favorable prognosis than those of vertical growth pattern when using Class III activator for correction of sagittal discrepancy.



Fig. 6.52 Cephalogram of the same patient in Fig. 6.51 showed positive overjet and positive overbite after the use of Class III activator, and it can be clearly seen here that the mandible of this patient was pushed backward into a new position



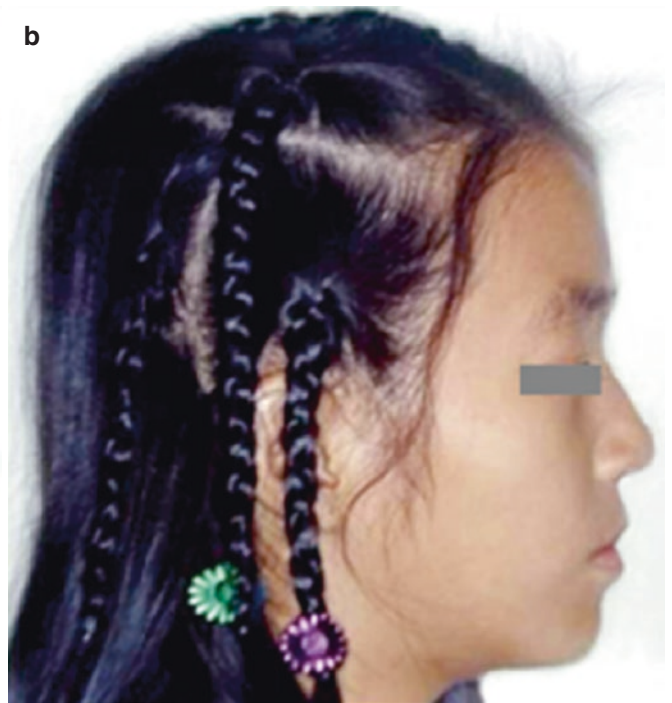
Fig. 6.54 A cephalogram of a horizontal growth pattern patient



Fig. 6.55 A cephalogram of a vertical growth pattern patient



Fig. 6.56 (a) showed lateral profile of a 9-year-old girl without a construction bite in the mouth. Figure (b) shows the same girl with construction bite in the mouth. Her lower face height increased while



having construction bite in the mouth, resulting in better proportion of the face and improving in esthetics



Fig. 6.57 A cephalometric x-ray of a patient at occlusion



Fig. 6.58 A cephalometric x-ray of the same patient with a construction bite; note that the construction bite brought the mandible backward into a more posterior position. Lower facial height of the patient increased and resulted in a better facial proportion and esthetics

6.7.1 Checklist when Registering Construction Bite

1. The patients with the construction bites in the mouth must be able to close their lips without muscle strain.
2. The patients' mandibular and facial midlines must coincide. Skeletal midline shift should be corrected through construction bite registration.
3. As there will be permanent changes in facial appearances of the patients, patients' and parental approval are needed.

6.7.2 Patient's Instruction at Insertion of Class III Activator (Figs. 6.59 and 6.60)

1. Inform the patients and their parents that Class III activator is a bimaxillary appliance, which loosely fit in the patients' mouth.
2. The patients should wear the appliances at least 12 hours a day and mostly at night due to secretion of growth hormone (Funatsu et al. 2006).
3. The patients can wear the activators during doing their homework; they can talk while having the appliances in the mouths.
4. After the insertion, the patients should be able to put the appliances on and take them off by themselves. At the first night, when waking up in the morning, the patients should check whether the appliances are still in the mouth. If not, they should wear the appliances more during the daytime.



Fig. 6.59 Class III activator in situ



Fig. 6.60 Cephalogram of a patient with Class III activator

The patients with large adenoid/tonsils or mouth breathers will have difficulties in holding the appliances in the mouths during sleep. This problem should be eliminated before using Class III activator.

5. The average time for the use of Class III activator is approximately 1 year.

6.7.3 Patient's Appointment

The patients should come for appliance adjustment every 4 weeks.

6.7.4 Appliance Adjustment

6.8 Objectives

1. To achieve positive overbite.
2. To achieve positive overjet.
3. To control tooth eruption.
4. To get good intercuspitation.

6.8.1 Appliance Activation Is Done by (Fig. 6.61)

1. Adding self-curing acrylic on the appliance at the area lingually to lingual surfaces of upper anterior teeth to protrude upper anterior teeth.
2. Activate upper labial pads to produce periosteal pull to enhance growth of the maxilla.
3. Leveling curve of Spee by trimming of the acrylic and control tooth eruption.
4. Keep the lower labial bow negative as the lower anterior teeth trend to tip more lingually when use Class III activator, which might result from contraction of perioral muscle during visceral swallowing and from tongue guard. Tongue guard prevents opposite force from the tongue from acting upon lower anterior teeth.



Fig. 6.61 Self-curing acrylic was added to protrude upper anterior teeth at every appointment in order to achieve positive overjet and overbite

6.9 Example of Cases Treated with Class III Activator (Figs. 6.62, 6.63, 6.64, 6.65, 6.66, 6.67, 6.68, 6.69, 6.70, 6.71, 6.72, 6.73, 6.74, 6.75, 6.76, 6.77, 6.78, 6.79, 6.80, 6.81, 6.82, 6.83, 6.84, 6.85, 6.86, 6.87, 6.88, 6.89, 6.90, 6.91, 6.92, 6.93, 6.94, 6.95, 6.96, 6.97, 6.98, 6.99, 6.100, 6.101, 6.102, 6.103, 6.104, 6.105, 6.106, 6.107, 6.108, 6.109, 6.110, 6.111, 6.112, 6.113, 6.114, 6.115, 6.116, 6.117, 6.118, 6.119, 6.120, 6.121, 6.122, and 6.123)

6.9.1 Case #1 (Figs. 6.62, 6.63, 6.64, 6.65, 6.66, and 6.67)



Fig. 6.62 (a–g) Extra- and intraoral pictures of a 9-year-old boy showed protrusive profile, Class III molar and canine relationships, and anterior crossbite. He showed lower teeth at smile



Fig. 6.62 (continued)

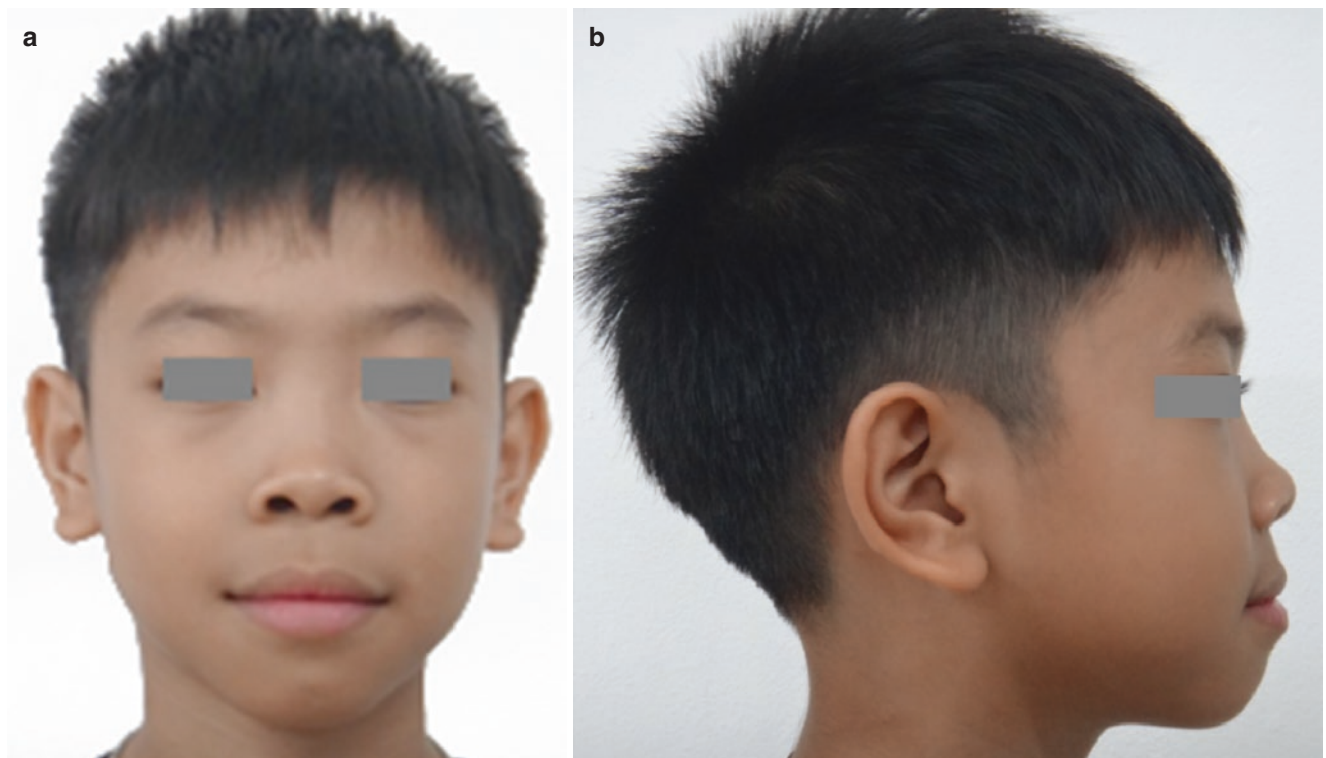


Fig. 6.63 (a–g) Extra- and intraoral pictures of the same boy after treated with Class III activator; his facial profile improved. He showed more upper teeth at smile than before the treatment which is esthetically

improved. Anterior crossbite was corrected. Class I molar and canine relationships were achieved



Fig. 6.63 (continued)

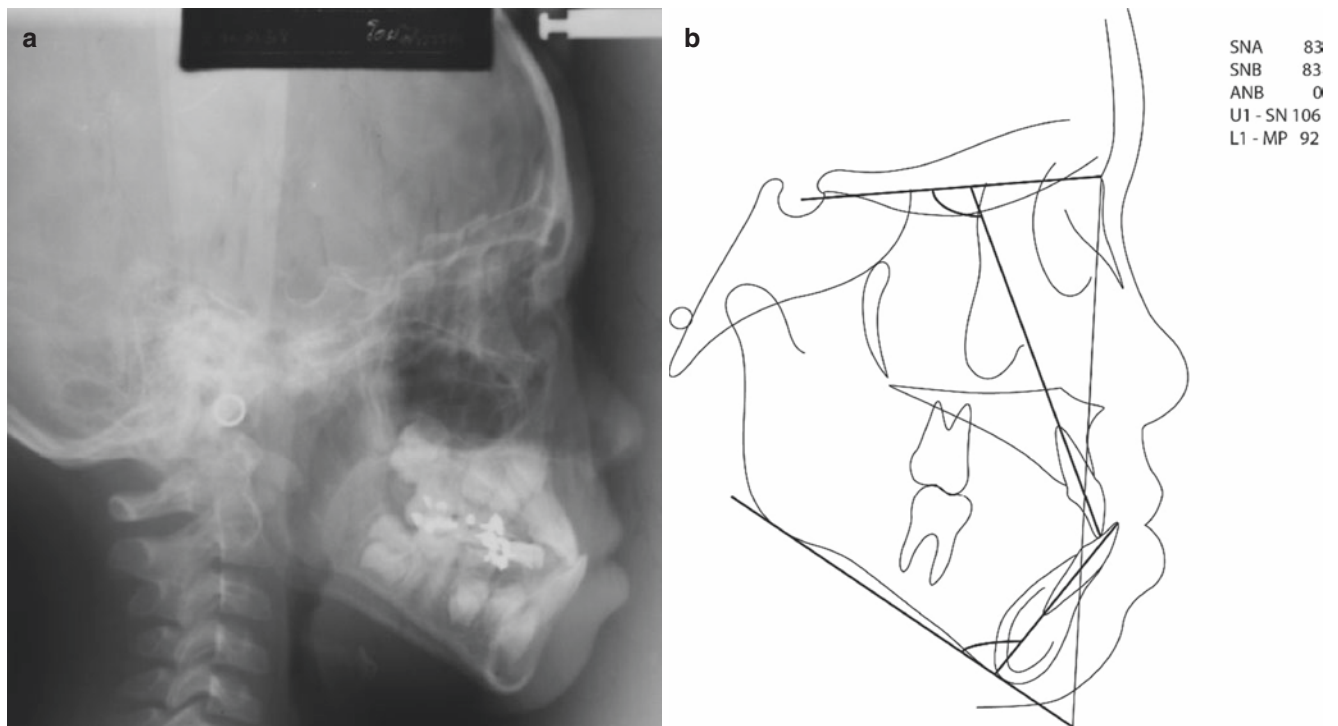


Fig. 6.64 (a, b) Cephalogram and tracing before the treatment; ANB angle was 0 degree

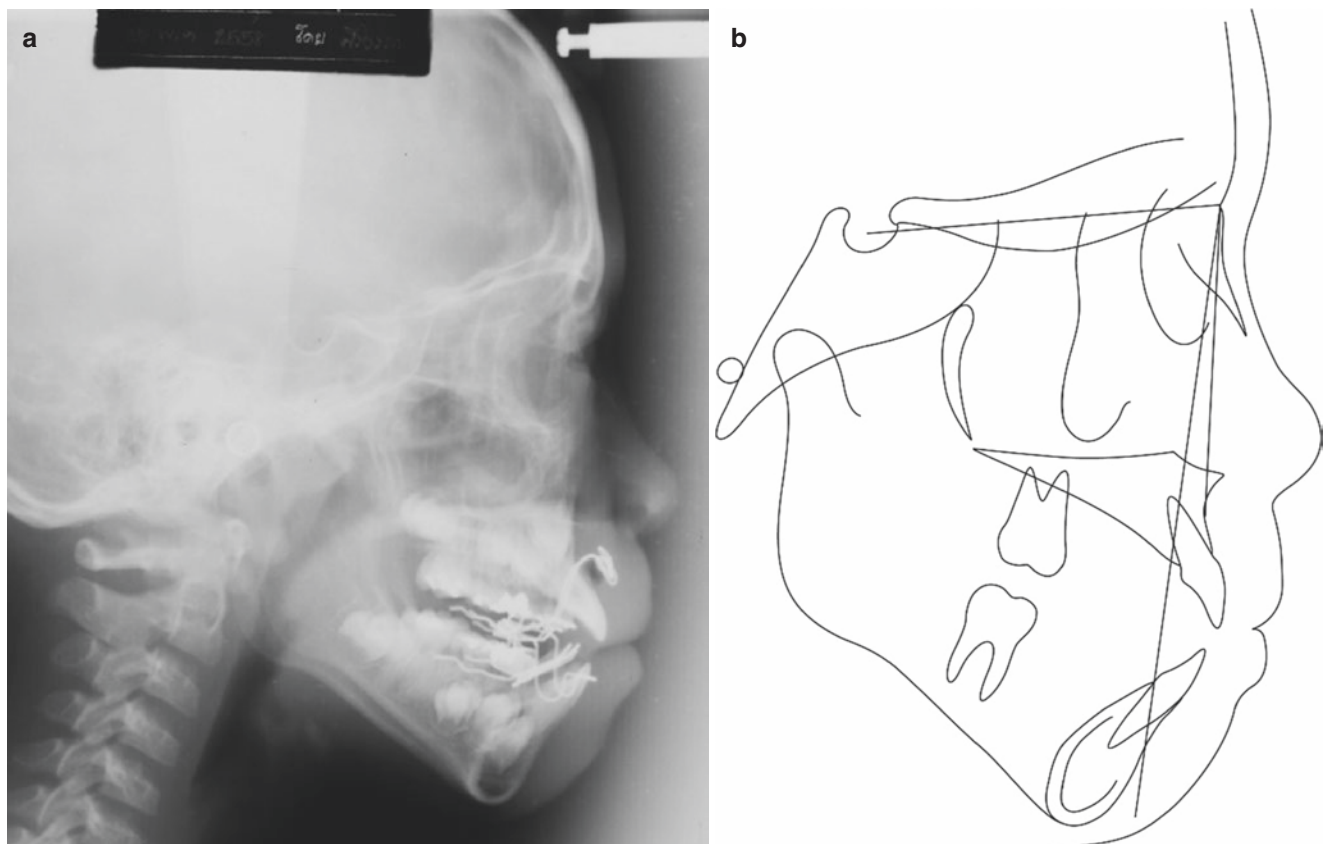


Fig. 6.65 (a, b) Cephalogram and tracing with Class III activator in situ, showing that the mandible was brought to a more posterior position than its original position

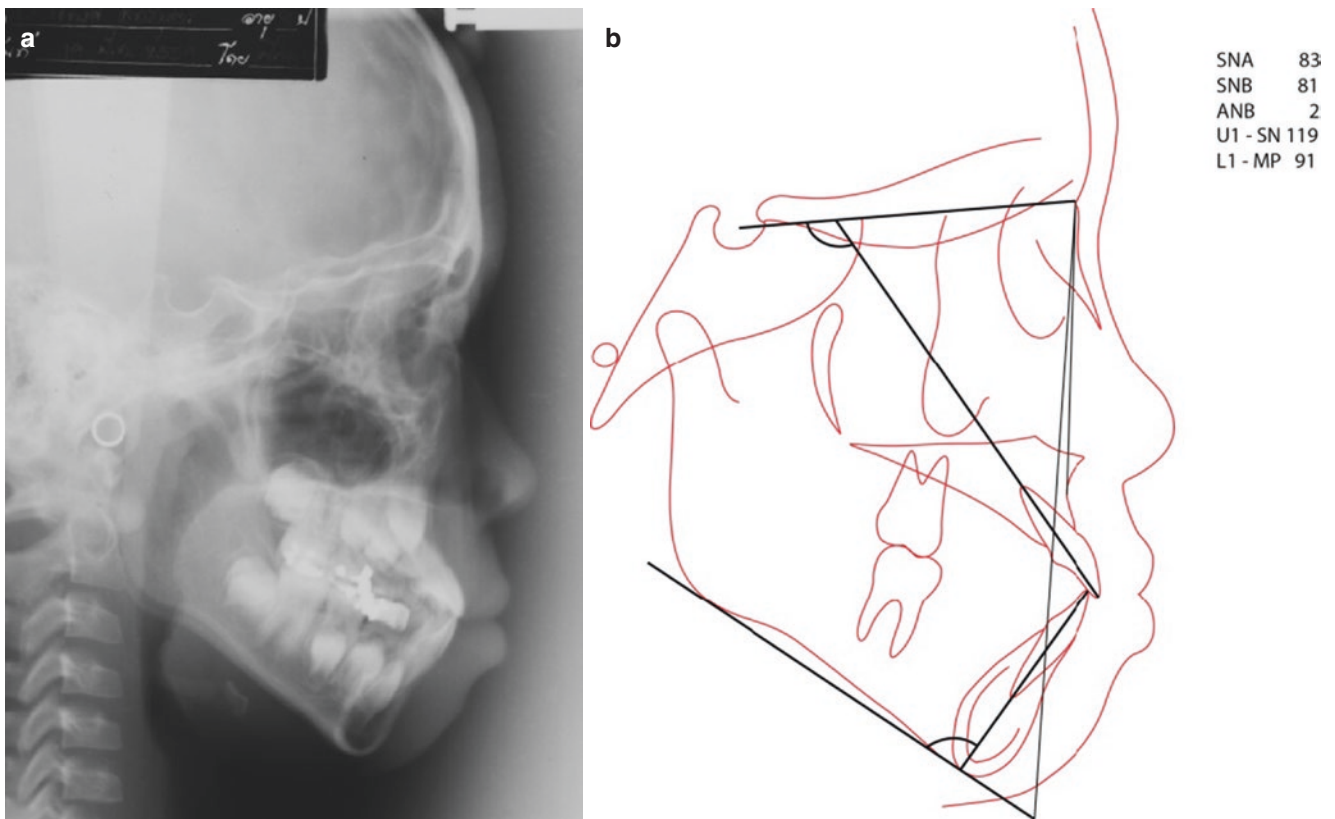


Fig. 6.66 (a, b) Cephalogram and tracing after positive overjet and positive overbite were achieved; ANB angle increased from 0 to 2 degrees



Fig. 6.67 Superimposition of cephalometric tracings before the treatment (T0) and after positive overjet and positive overbite were achieved (T1)

6.10 Treatment of Class III Malocclusion with Pseudo Forced Bite (Figs. 6.68, 6.69, 6.70, 6.71, 6.72, 6.73, 6.74, 6.75, 6.76, 6.77, 6.78, 6.79, 6.80, 6.81, 6.82, and 6.83)

In many cases of skeletal Class III malocclusion with pseudo forced bite, the skeletal discrepancies are very severe (Pirttiniemi 1994); orthognathic surgery might be required in later age when mandibular growth ceases.

In some cases when we treat early enough, interceptive attempt could be made to reduce severity of the malocclusion.

6.10.1 Case #2

Fig. 6.68 (a–d) Extraoral pictures of a 7-year-old girl showed facial asymmetry at smile, and her chin deviated to the right side

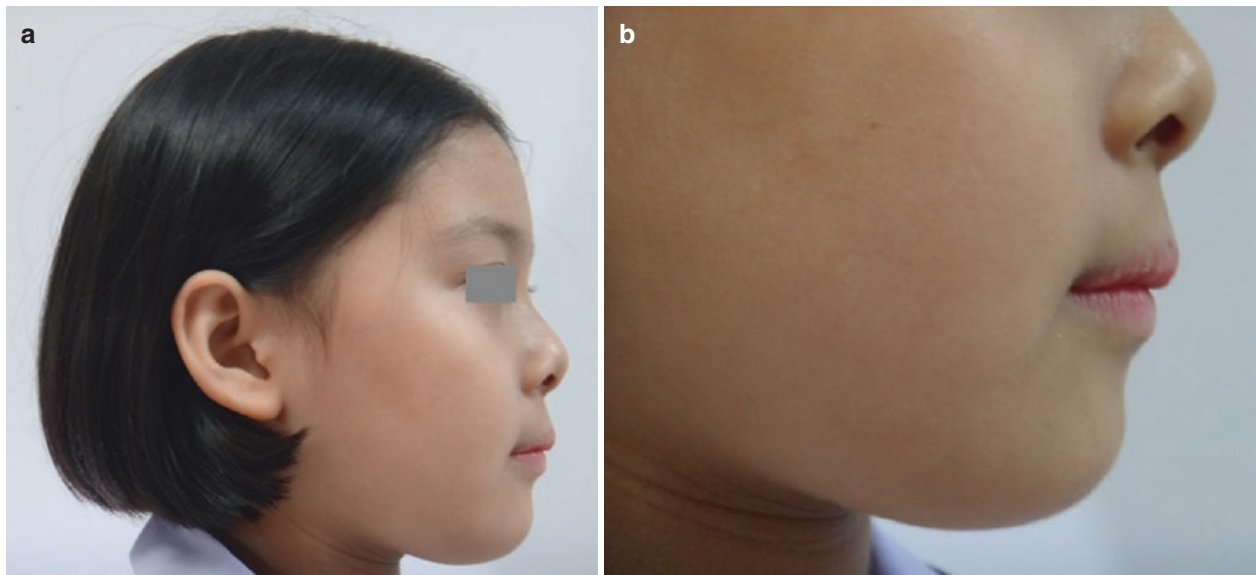


Fig. 6.69 (a, b) Her lateral profile showed a large body of mandible and prominent chin. Her mandible was obviously too large for her age



Fig. 6.70 (a–c) Intraoral pictures showed moderate crowding of the lower anterior teeth, tooth #32 erupted lingual to tooth #73, positive overjet and overbite, resulting from retroclined lower anterior teeth. No crossbite presented

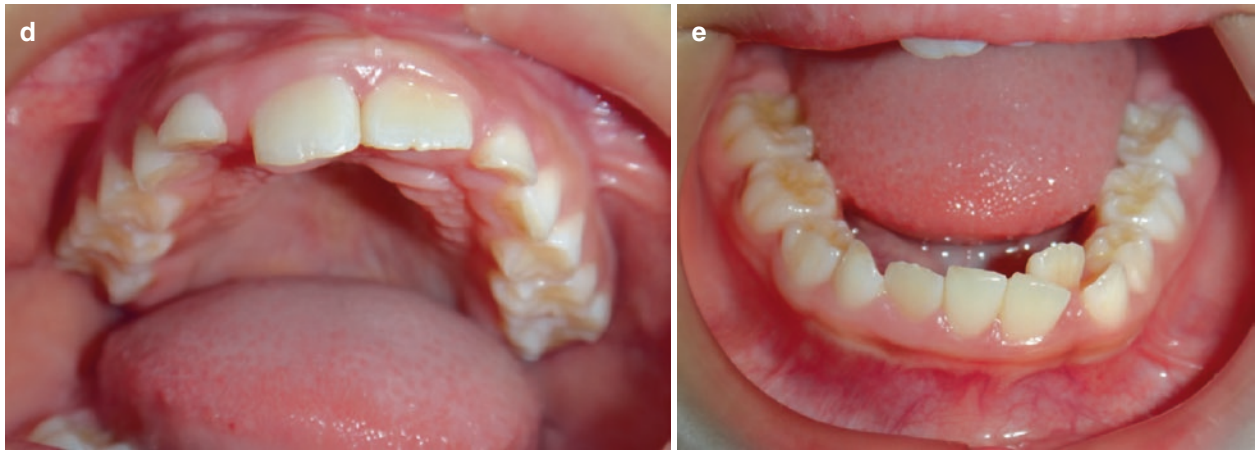


Fig. 6.70 (continued)



Fig. 6.71 (a–d) After the use of Class III activator, the mandibular midline was brought to coincide with the facial midline and the facial asymmetry was eliminated

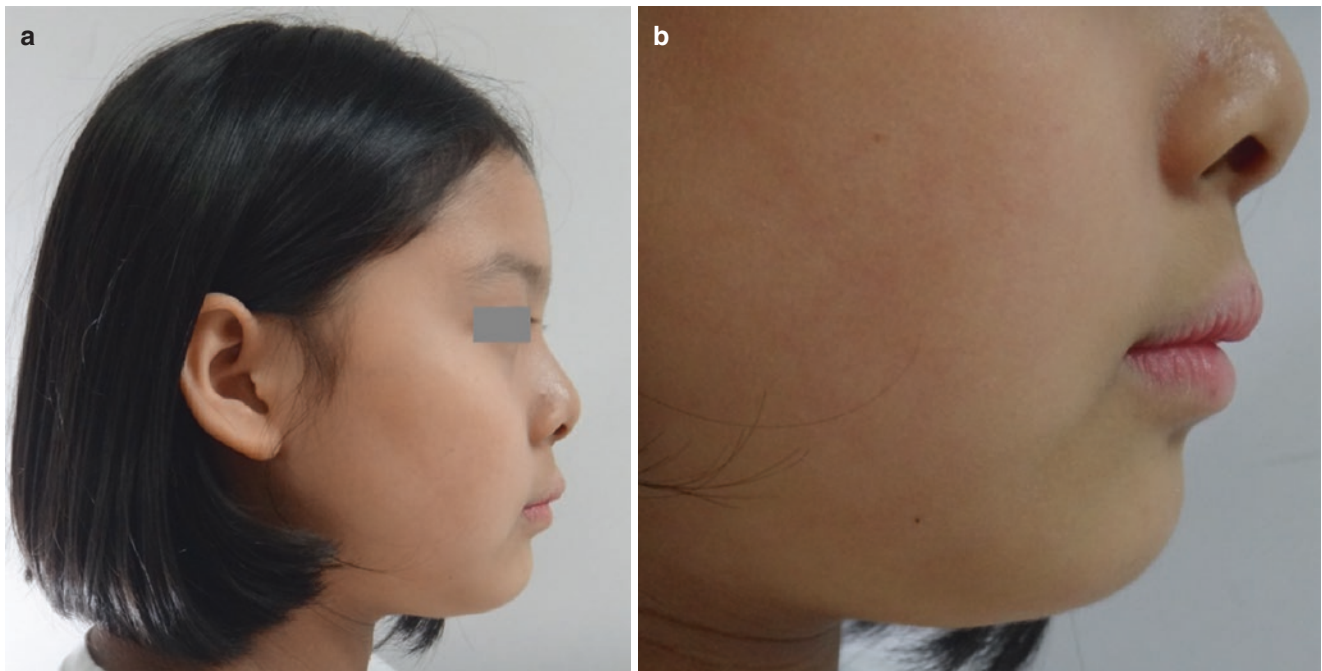


Fig. 6.72 (a, b) Lateral profile was esthetically improved after the use of Class III activator; the mandible and the chin appeared to be in good proportion to the maxilla

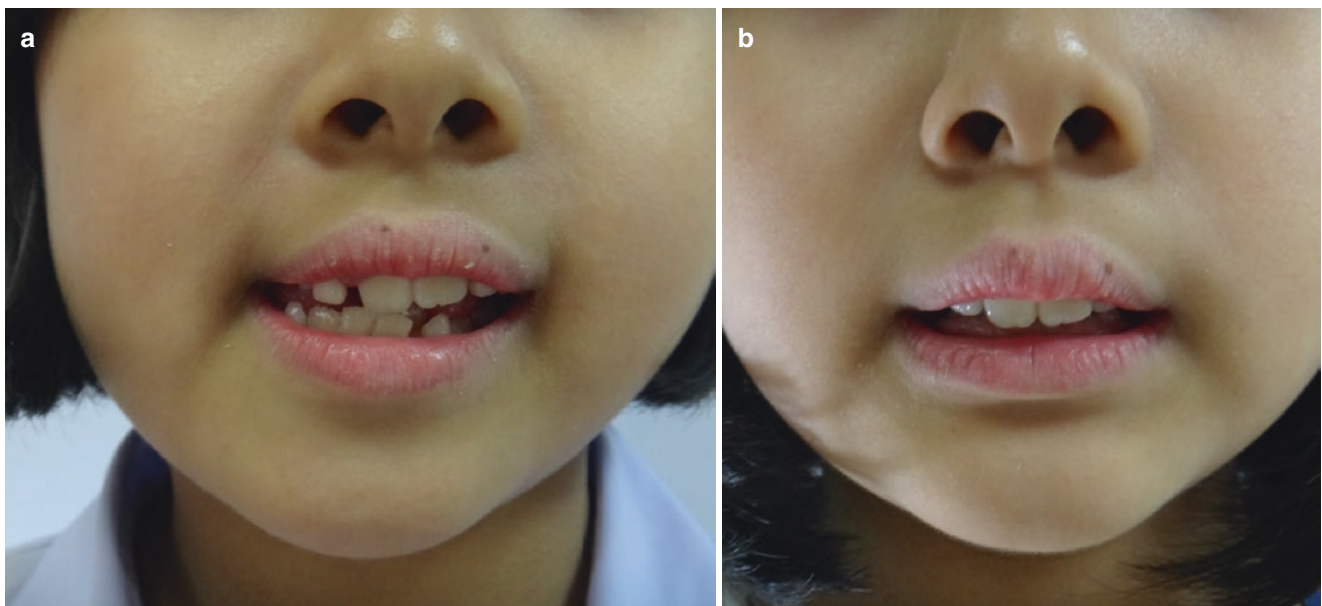


Fig. 6.73 (a, b) Comparison of her smiles before the treatment and after the midline correction using Class III activator



Fig. 6.74 (a–d) She maintained a facial symmetry 2 years after the treatment. The treatment result was stable



Fig. 6.75 (a–e) Intraoral pictures showed crossbite at # 63, #73, and #34; lower anterior teeth were aligned by the use of partial fixed appliances

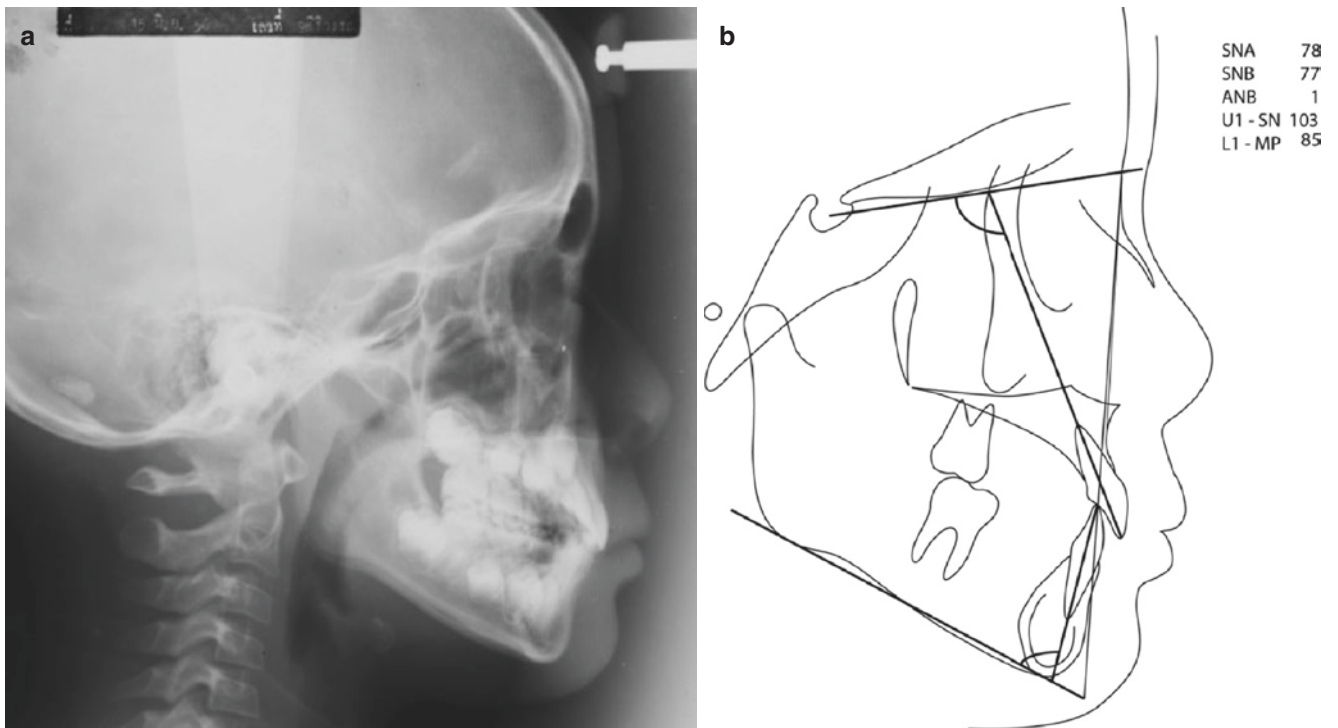


Fig. 6.76 (a, b) A cephalogram and a tracing before the treatment showed the ANB angle of +1 degree, positive overjet and positive overbite through retroclined of lower anterior teeth, which fell into category skeletal Class III malocclusion with pseudo forced bite

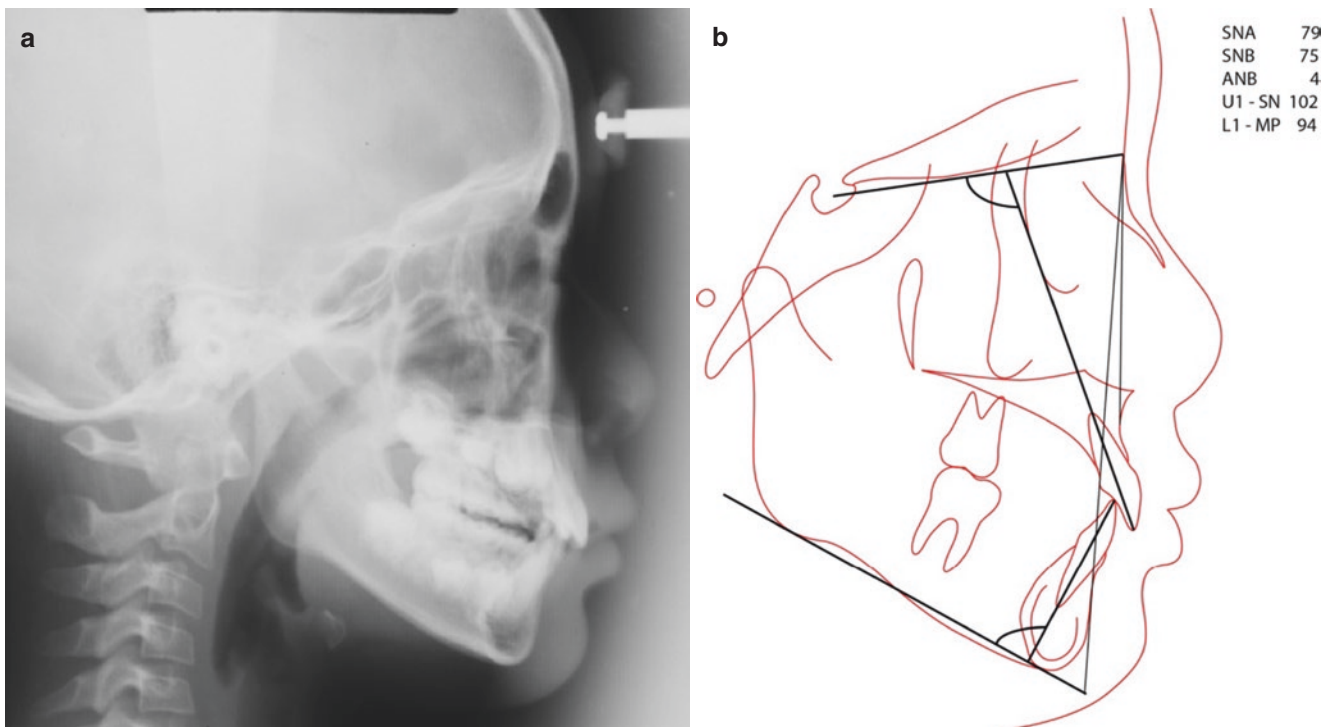


Fig. 6.77 (a, b) The mandible was pushed backward into a more posterior position through the use of Class III activator; ANB angle became bigger changing from +1 to +4 degrees

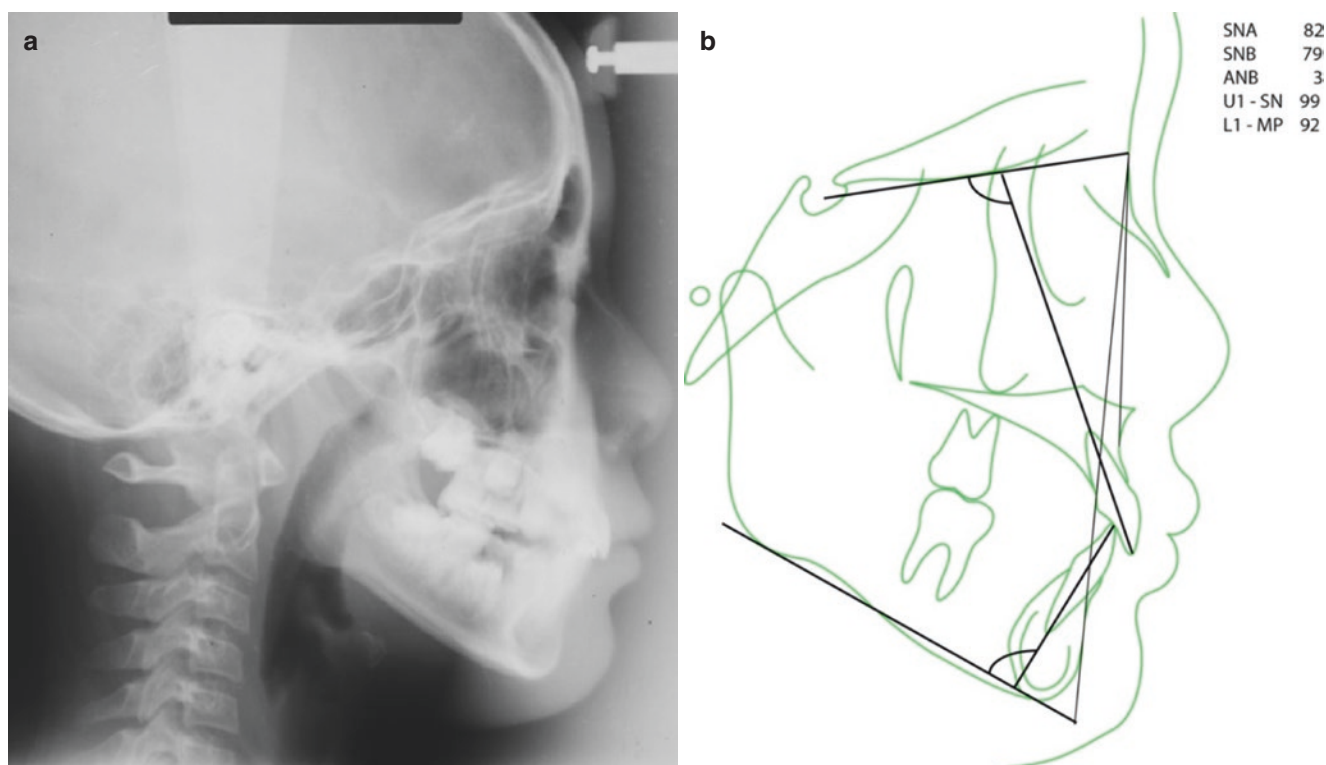


Fig. 6.78 (a, b) A cephalogram and a tracing 2 years after the treatment with Class III activator and before beginning of partial fixed appliances to align the crowded lower incisors. The mandible continued to grow fast as the ANB angle decreased from +4 to +3 degree



Fig. 6.79 Superimposition of cephalometric tracing at the three time-lines, before treatment (T0), 1 years after Class III activator treatment (T1), and 2 years after the treatment began (T2)

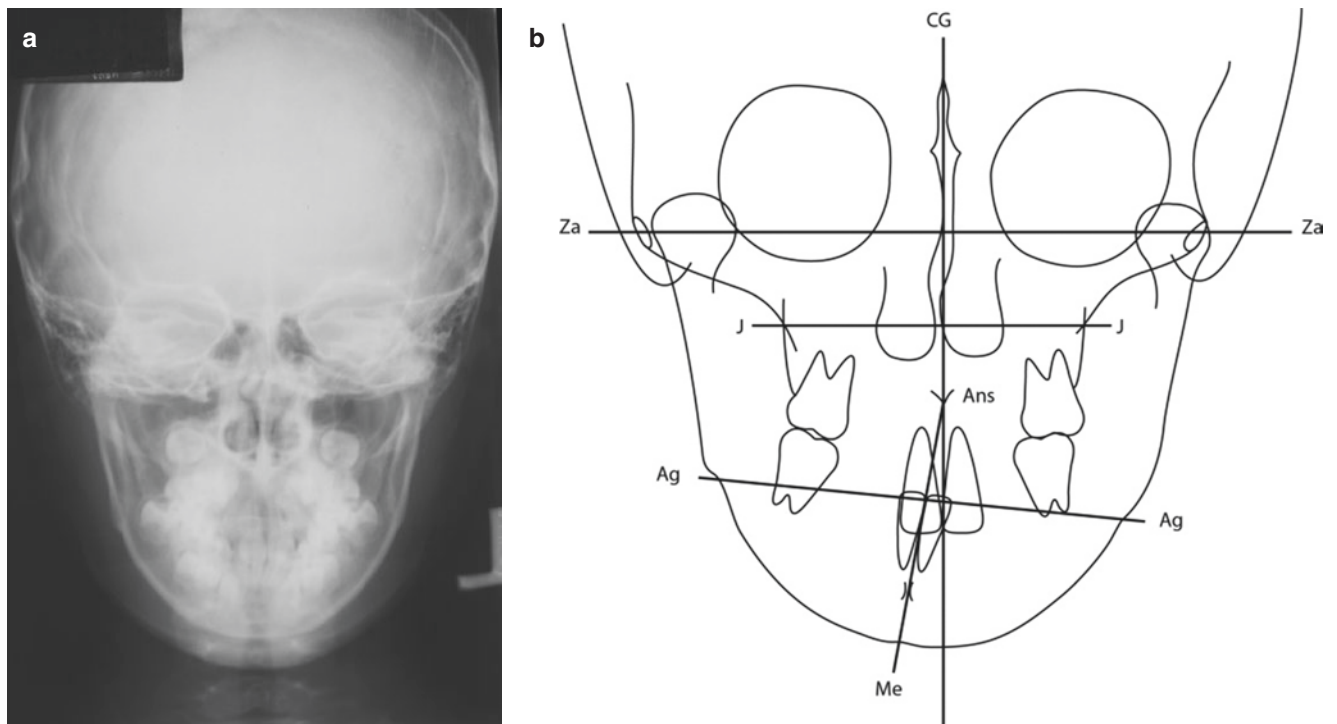


Fig. 6.80 (a, b) Posteroanterior cephalometric x-ray (PA) and tracing of the patient before the treatment showed obvious facial asymmetry with the mandibular midline shifted to the right side of the patient

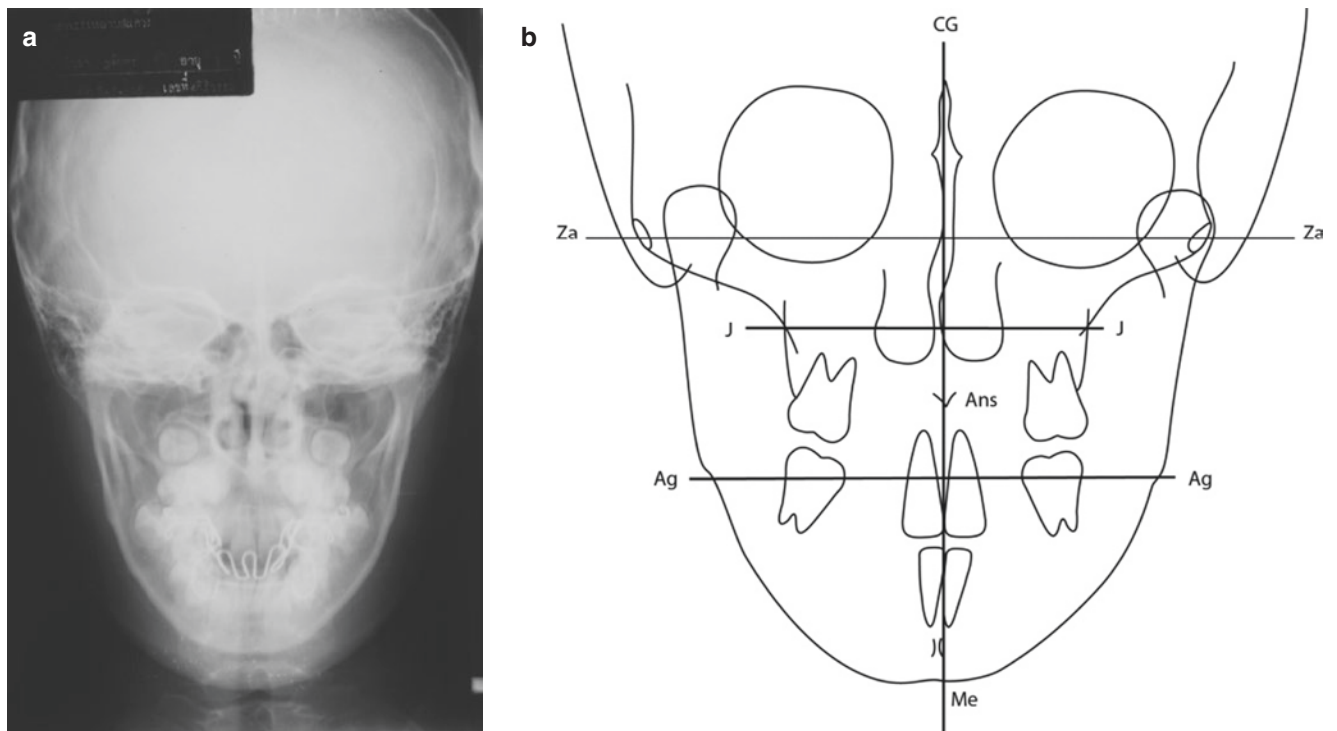


Fig. 6.81 (a, b) A PA head film and a tracing of the patient with Class III activator in situ showed the shifted mandibular midline was brought to a position which coincides with the facial midline. No facial asymmetry presented

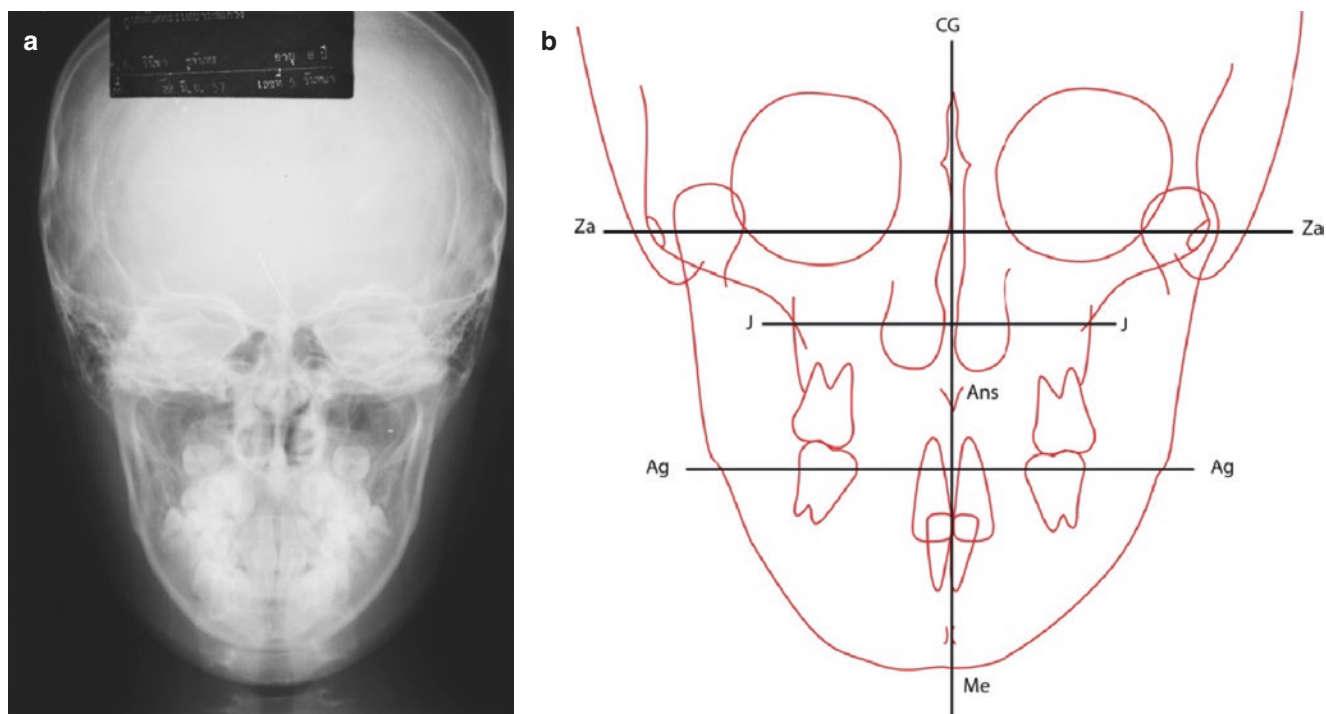


Fig. 6.82 (a, b) A PA head films of the patient and a tracing after the use of Class III activator to correct facial asymmetry, where the mandibular midline coincides with the facial midline

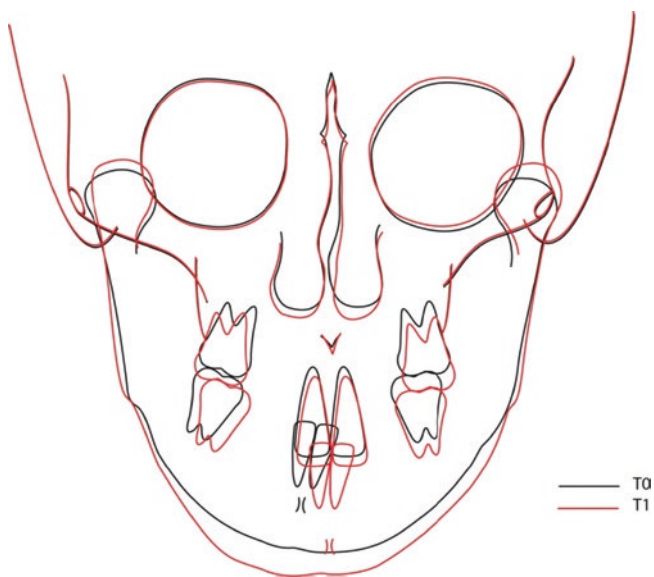


Fig. 6.83 Superimposition of the PA head films of the patient before the treatment (T0) and after correction of facial asymmetry with the use of Class III activator (T1)

6.11 Class III Activator Can be Used for Treatment of Functional Class III Malocclusion when the Patient Can do an Edge-to-Edge Bite (Figs. 6.84, 6.85, 6.86, 6.87, 6.88, 6.89, 6.90, 6.91)

6.11.1 Case #3



Fig. 6.84 (a–d) Extraoral pictures of a 7-year-old girl at rest position and at smile; she showed both upper and lower anterior teeth



Fig. 6.85 (a–d) Her intraoral pictures showed a very early stage of mixed dentition with a complete block out of upper anterior deciduous teeth. Tooth #11 was erupting; the patient was able to bite edge to edge



Fig. 6.86 (a–c) After using Class III activator, the mandible was push into a more posterior position; path of eruption of #11 and #21 were guided; positive overjet and positive overbite were achieved

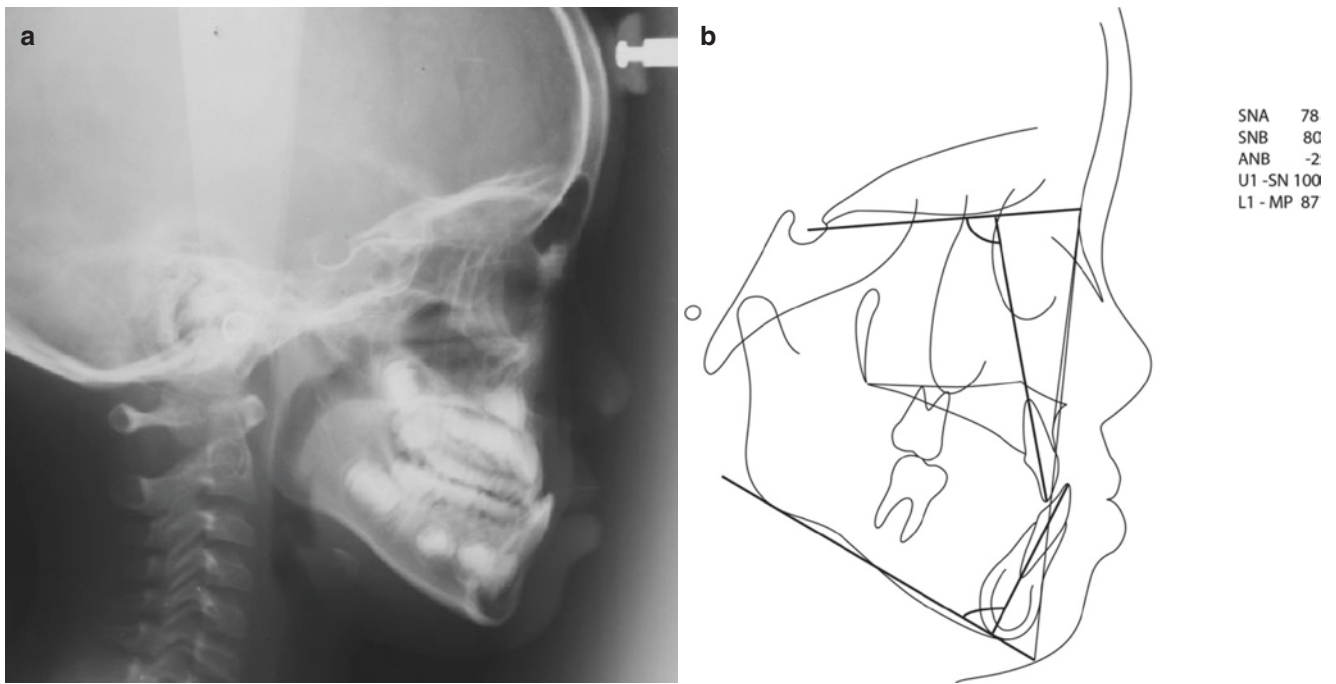


Fig. 6.87 (a, b) A cephalogram and tracing before the treatment showed anterior crossbite and the ANB angle of -2 degrees. Both upper and lower anterior teeth were both retroclined

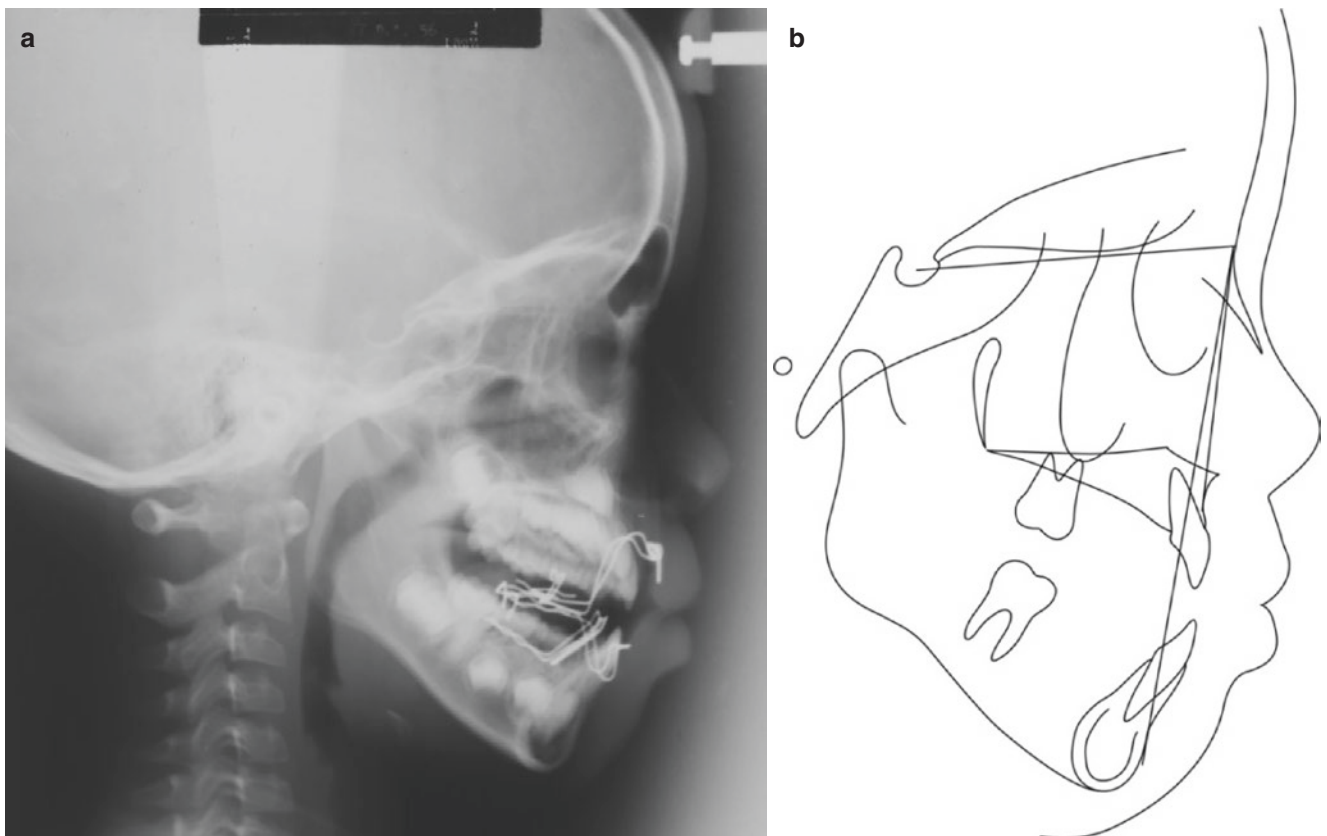


Fig. 6.88 (a, b) A cephalogram and a tracing with Class III activator in situ showed that the mandible was brought backward into a new position

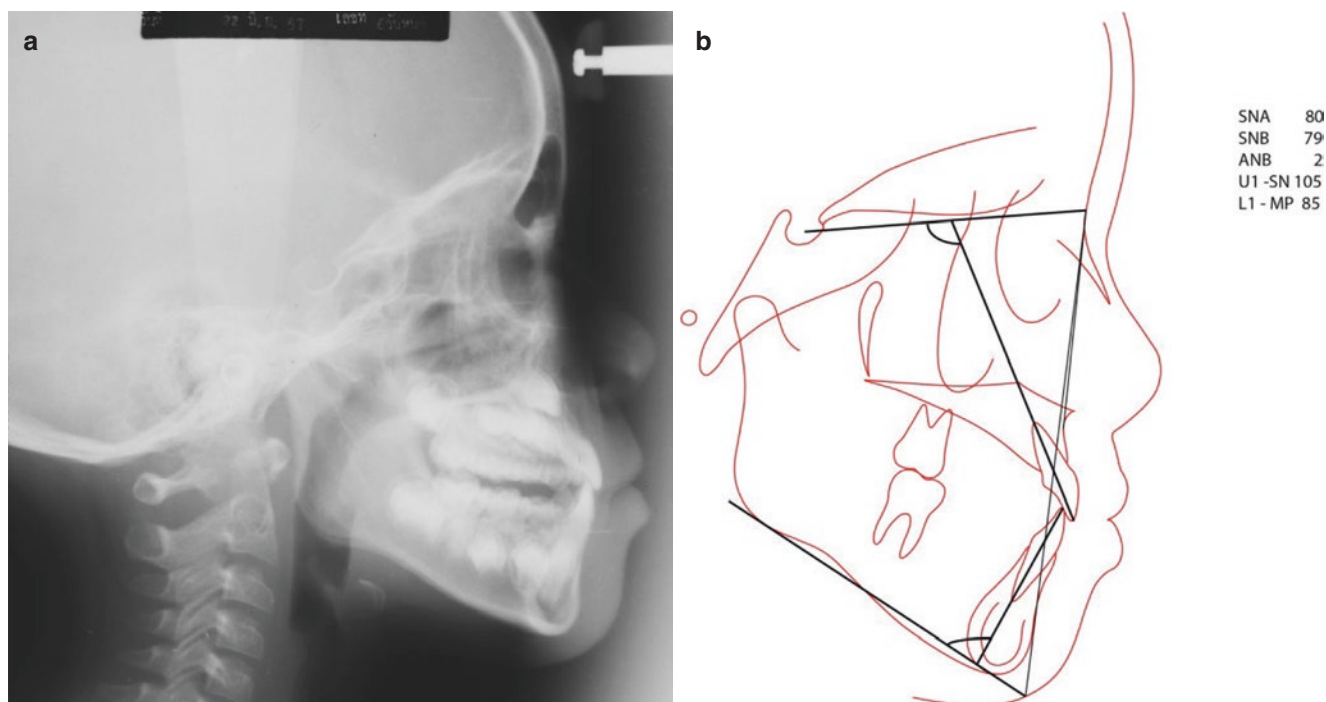


Fig. 6.89 (a, b) A cephalogram and a tracing during the treatment with Class III activator, the ANB angle increased from -2 to $+2$ degree, increase in inclination angle of the upper anterior teeth from 100 to 105 degree, and positive overjet and positive overbite were achieved

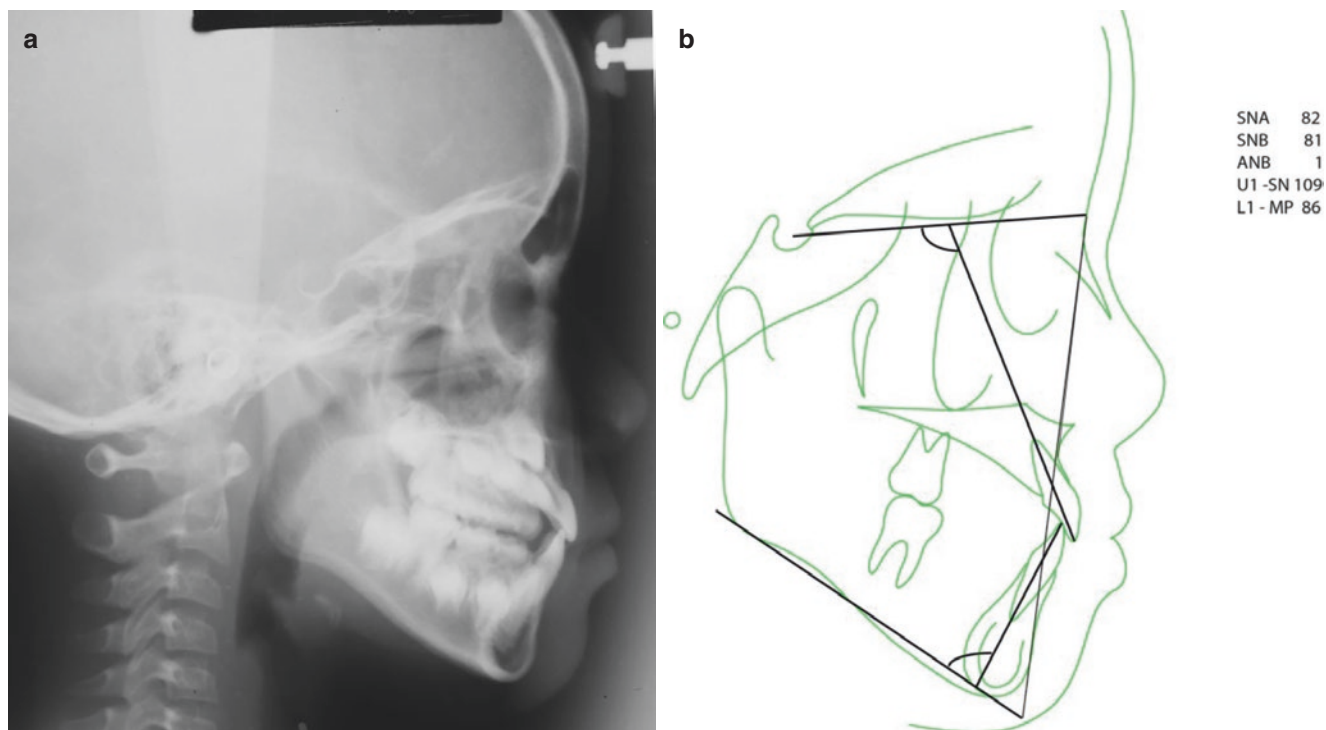


Fig. 6.90 (a, b) A cephalogram and a tracing during the treatment with Class III activator after positive overjet and positive overbite were achieved by guided path of eruption of teeth #11 and #21. The mandible continued to grow fast as the ANB angle decreased from $+2$ to $+1$ degree



Fig. 6.91 Superimposition of the three timelines, before treatment (T0), after positive overjet and positive overbite were achieved (T1), and after they were secured by occlusion of posterior teeth (T2)

6.12 What to do if the Mandible cannot be Pushed Backward

Sometimes it is not possible to push the mandible backward into a more posterior position due to antagonistic forces from lateral pterygoid muscles, which could come from stress. An upper removable bite plate is recommended for the patient to wear more or less 24×7 to allow the mandible to move into its most preferable position. (Figs. 6.92, 6.93, 6.94, 6.95, 6.96, 6.97, 6.98, 6.99, 6.100, and 6.101).

6.12.1 Case #4

In this case, the mandible could not be pushed backward. Within 1 month after using removable upper bite plate, Class III activator could be then constructed and used for the treatment.

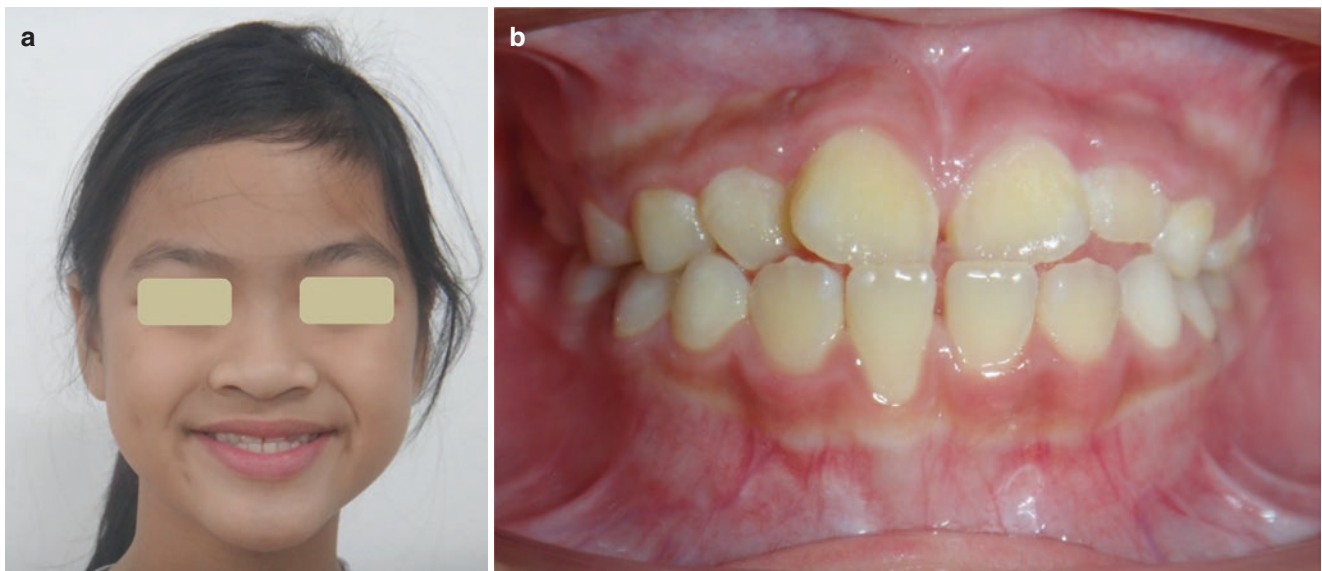


Fig. 6.92 (a, b) Extraoral and intraoral pictures of a 9-year-old girl, when smiling she showed more lower anterior teeth than upper anterior teeth; she had anterior crossbite with an open bite tendency



Fig. 6.93 Her cephalogram obviously showed that she had a very small maxilla compared to her mandible; she had an anterior crossbite and protruding lower lip

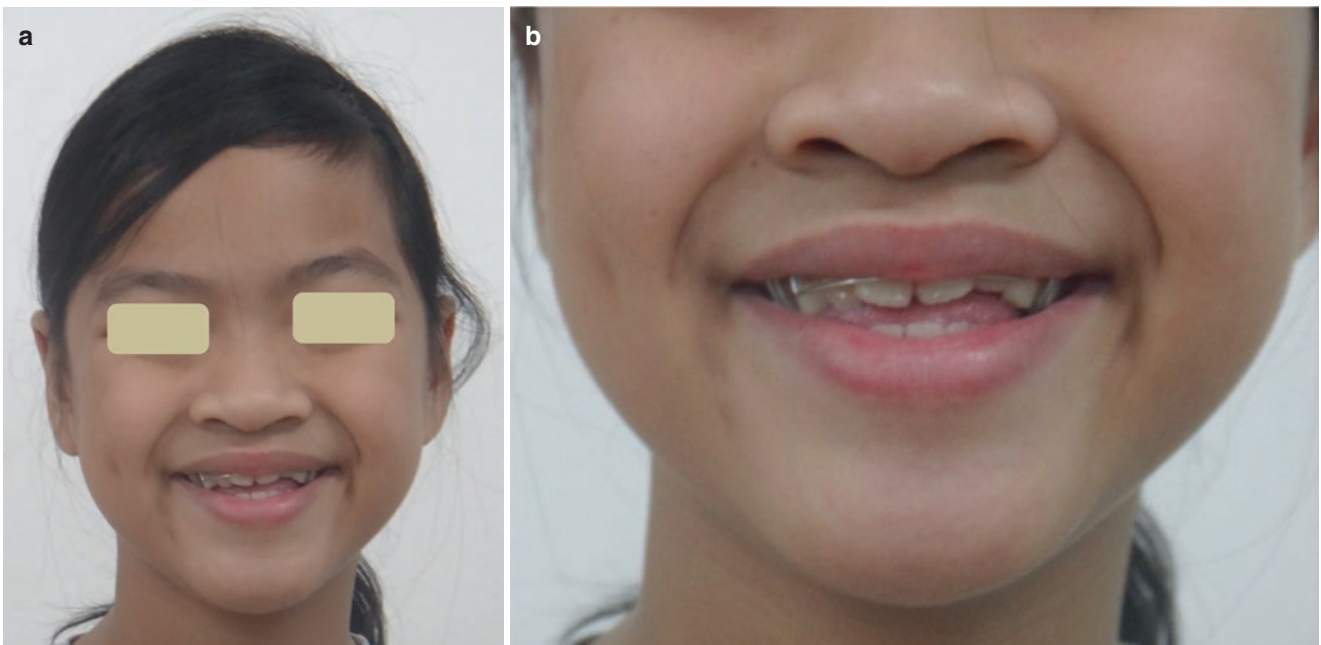


Fig. 6.94 (a, b) Removable upper bite plate with upper labial pads in situ; when smiling the patient showed more of the upper anterior teeth then, meaning that the mandible had moved backward while wearing the appliance

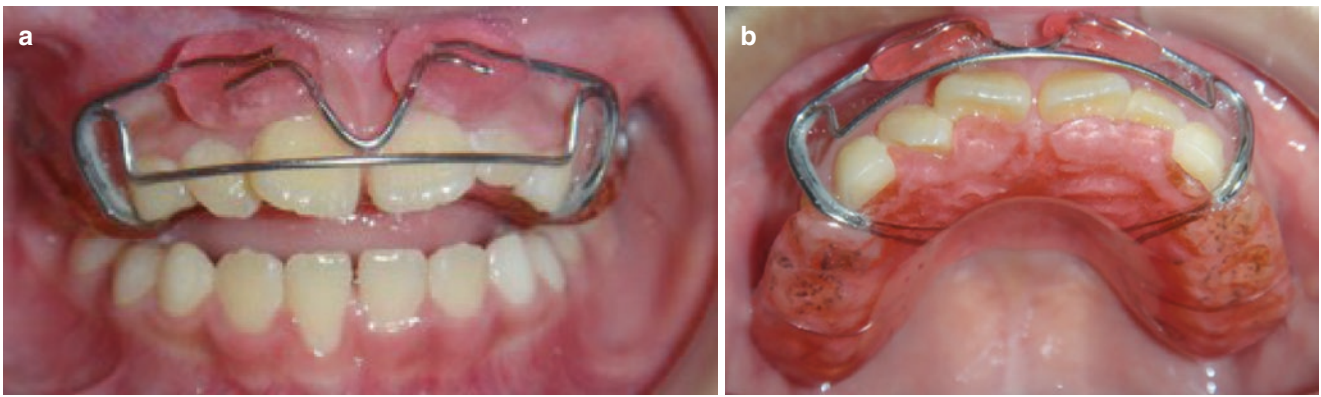


Fig. 6.95 (a, b) Removable upper bite plate with upper labial pads

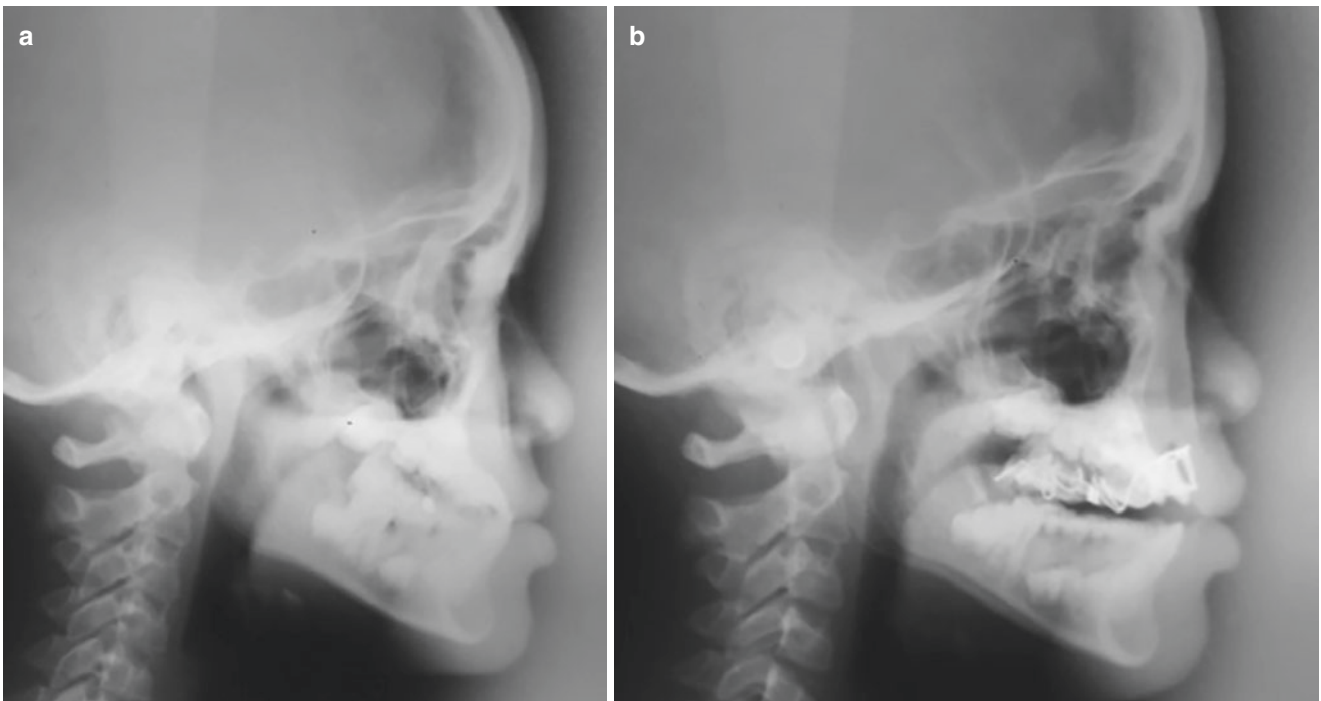


Fig. 6.96 (a, b) Comparison of cephalograms taken on the same day, without (a) and with upper bite plate in situ (b); the mandible could clearly be seen in a more posterior position and the lateral profile became more pleasing while wearing the upper bite plate

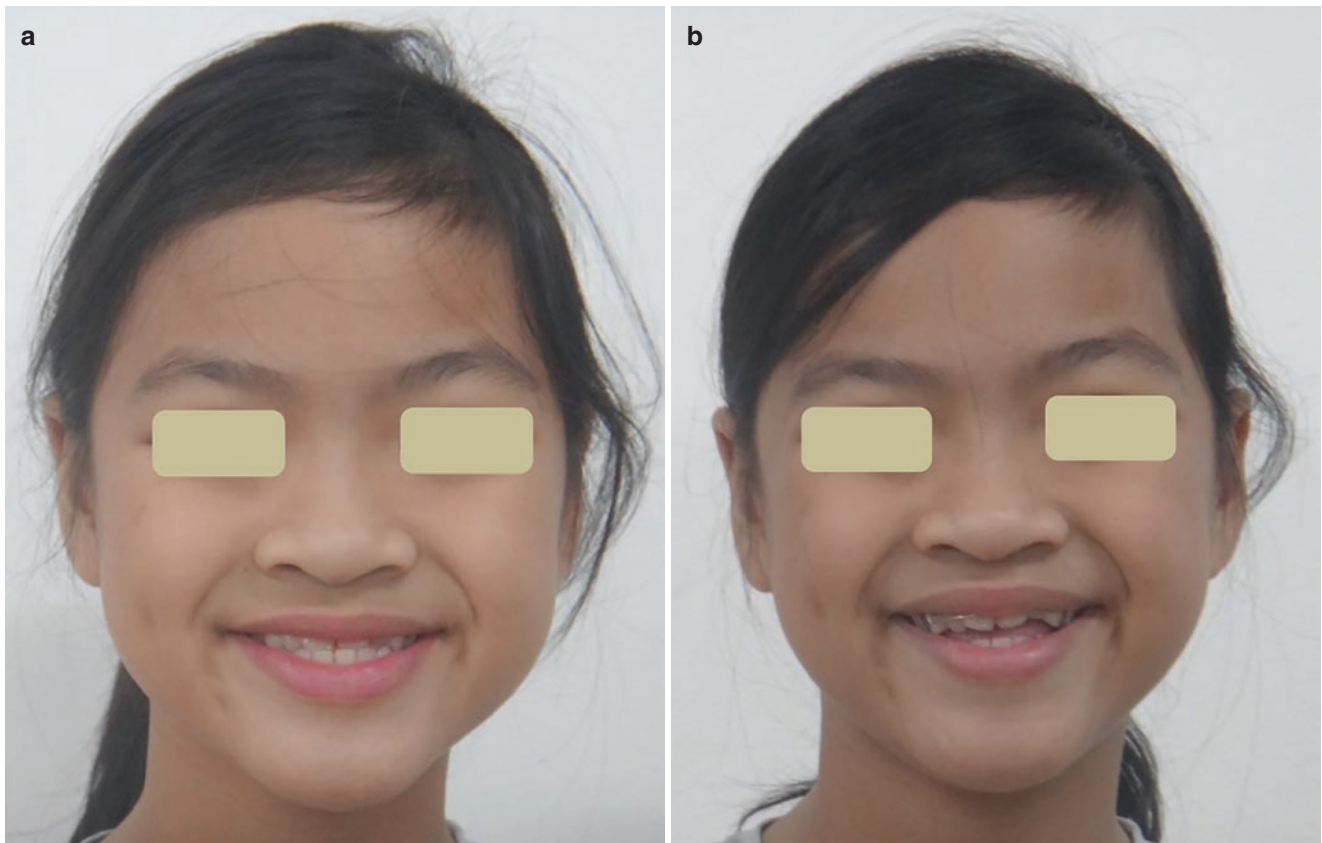


Fig. 6.97 (a, b) Different smiles on the same day; without and with upper bite plate



Fig. 6.98 Class III activator could be constructed then and was used to push the mandible into a more posterior position



Fig. 6.99 (a–d) Pictures taken 1 year after using Class III activator; the bite became edge-to-edge, when smiling the patient showed more upper anterior teeth

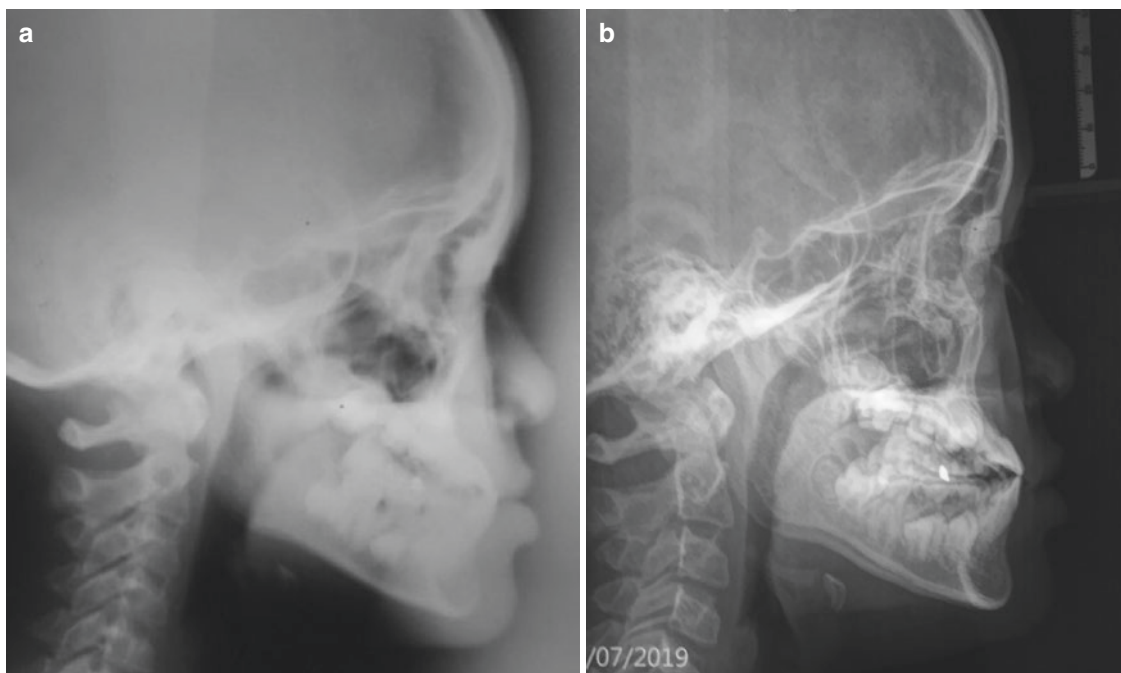


Fig. 6.100 (a, b) Comparison of cephalograms at the beginning of the treatment (a) and 1 year after using Class III activator (b) showed improvement of sagittal relationship between the maxilla and the mandible

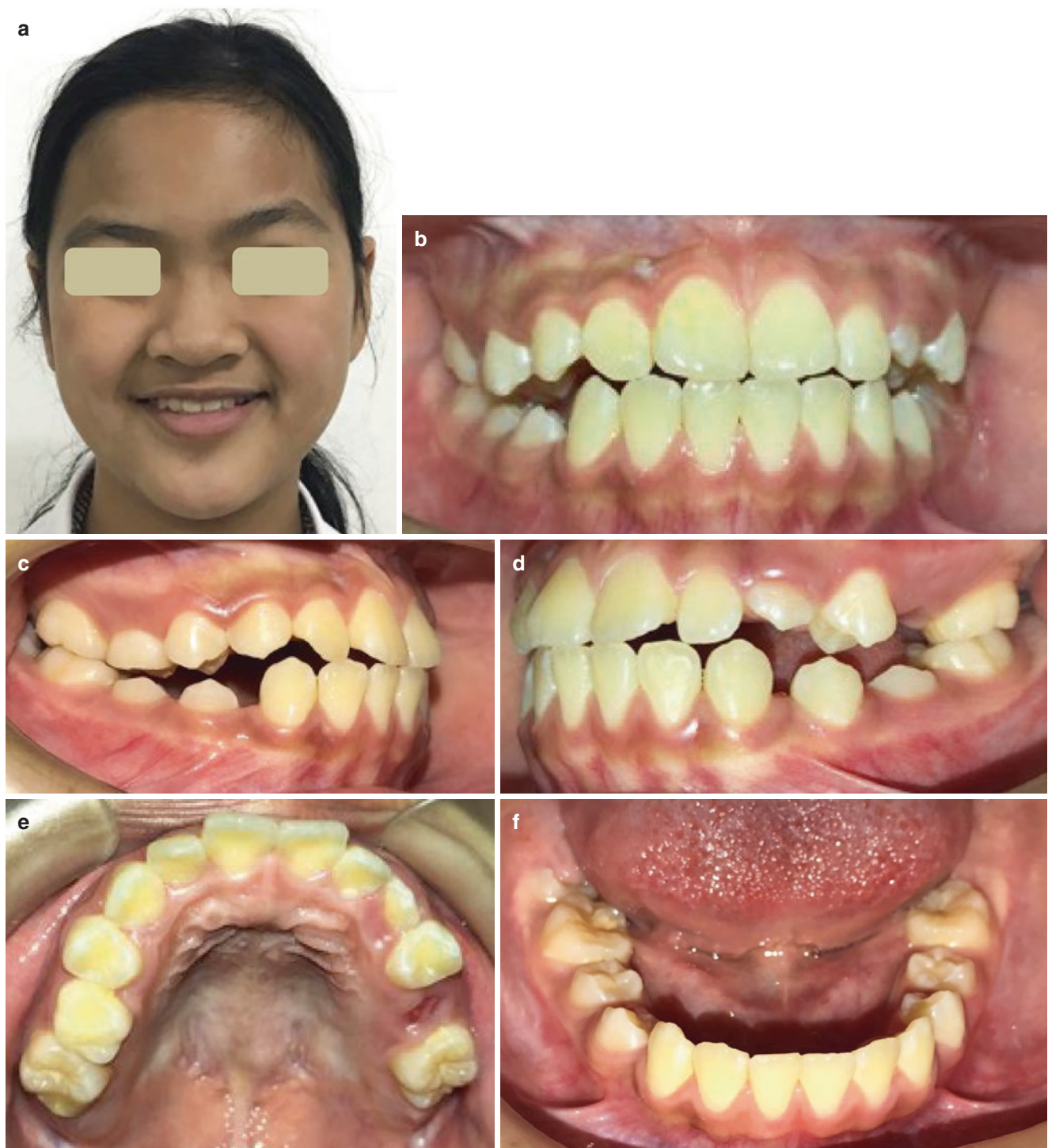


Fig. 6.101 (a–f) Her extraoral and intraoral pictures 2 years after using Class III activator; when smiling she showed only upper anterior teeth which is esthetically good; enough spaces both in upper and lower

arches for all premolars and for retracting lower anterior teeth to achieved positive overjet and positive overbite

6.13 Stability of the Skeletal and Dental Changes after Treatment with Class III Activator (Figs. 6.102, 6.103, 6.104, 6.105, 6.106, 6.107, 6.108, 6.109, 6.110, 6.111, 6.112, 6.113, 6.114, 6.115, 6.116, 6.117, 6.118, 6.119, 6.120, 6.121, 6.122, and 6.123)

Class III activator causes changes in both skeletal and dental. Clinical research on stability of skeletal changes after activator treatment of patients with Class III malocclusions was done by Satravaha et al.; they found significant skeletal effects with improvement of skeletal profiles and these changes remained (Satravaha 1993; Satravaha and Taweeseedt 1996a; Satravaha and Taweeseedt 1996b; Satravaha and Taweeseedt 1999).

6.13.1 Cause of Dental Instability

As previously mentioned, patient with Class III malocclusions mostly have large tongue, low tongue position and visceral swallowing pattern. Force from the tongue play major role in the cause of dental instability (Figs. 6.102, 6.103, 6.104, 6.105, 6.106, 6.107, 6.108, 6.109, 6.110, 6.111, 6.112, 6.113, 6.114, 6.115, 6.116, 6.117, 6.118, 6.119, 6.120, 6.121, 6.122, and 6.123).

6.13.2 Case #5

The author routinely recommends myofunction exercises according to Daniel Garliner for all Class III malocclusion patients and uses in addition Pearlen plate as upper retainer as a reminder and for tongue exercise (Figs. 6.105 and 6.106) (Garliner 1981; Satravaha 1990; Satravaha and Taweeseedt 2002).



Fig. 6.102 (a–d) Extra- and intraoral pictures of a 12-year-old girl after using Class III activator, large tongue thrusting anteriorly and laterally. Her tongue and both upper and lower anterior teeth could be seen at smile



Fig. 6.103 (a–d) The upper brackets were debonded, despite persistent tongue thrusting at the area in the circle in (d). The father of the patient and the patient were informed about the risk of having dental relapse



Fig. 6.104 (a–e) A few months after, as a result from large tongue and tongue thrusting, crossbite, open bite, and space can be seen in the intraoral pictures

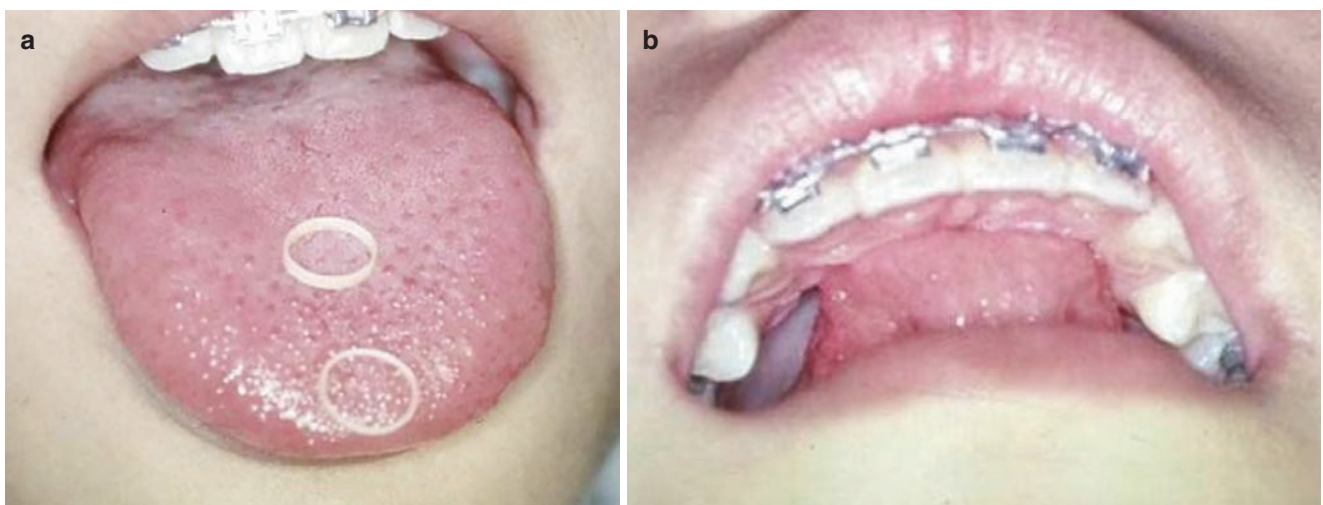


Fig. 6.105 (a, b) Rubber ring are used in myofunction exercises

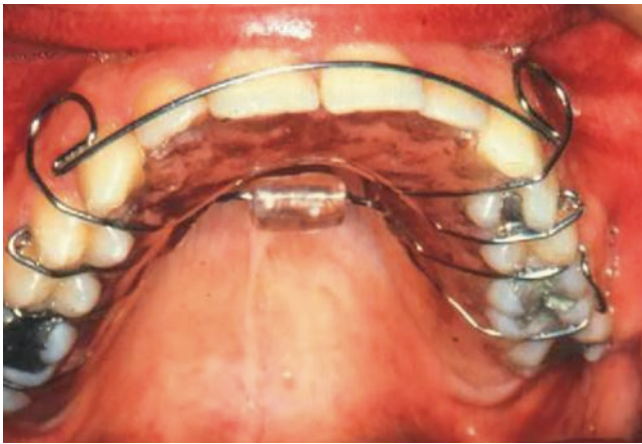


Fig. 6.106 Pearlen plate

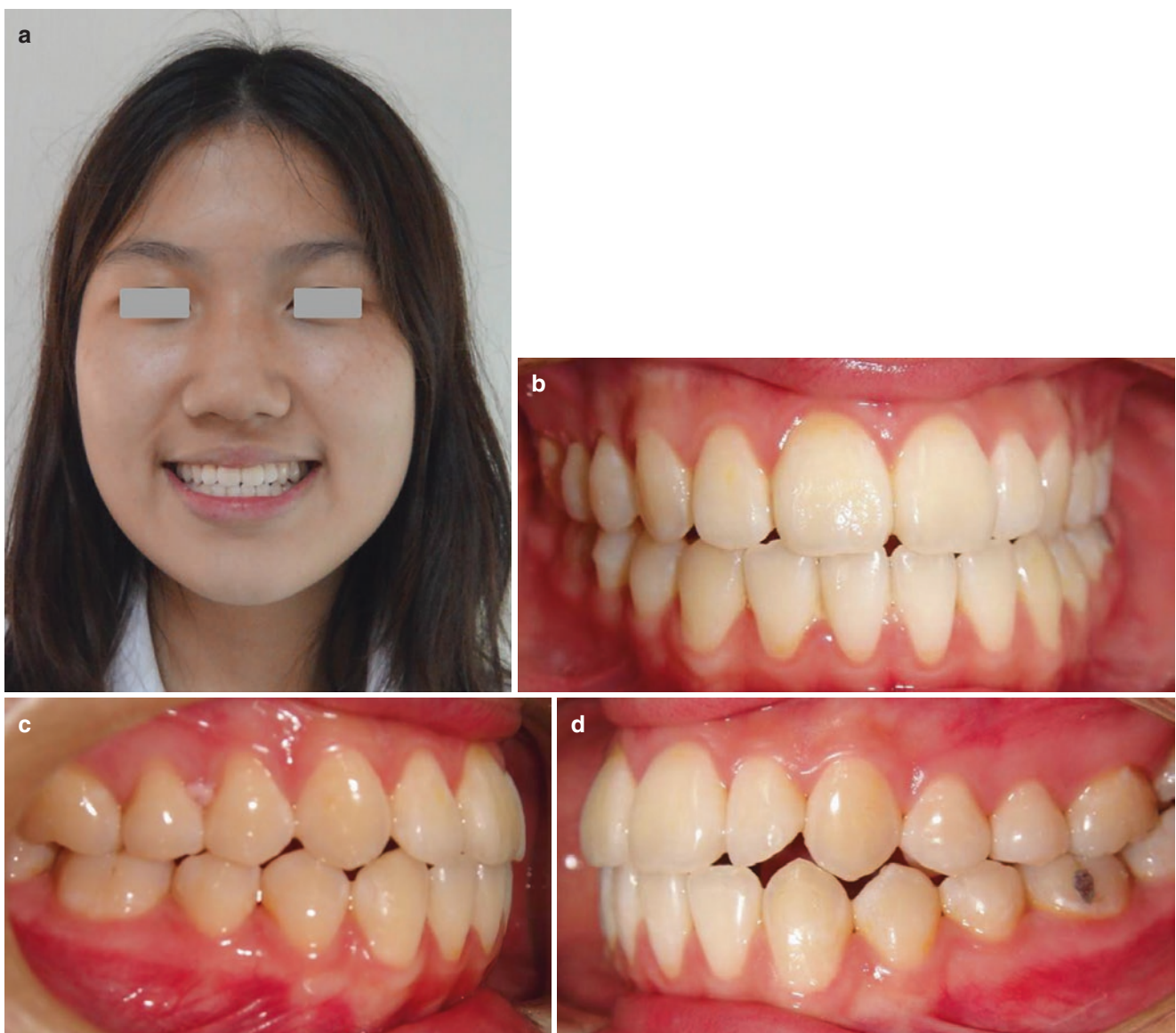


Fig. 6.107 (a–d) Extra- and intraoral pictures at the time of debonding all fixed appliances; the occlusion was improved but the risk of having relapse was still present. Tendency of having open bites at the #13, #43,

and #44 and at #23, #24, #33, and #34 can be seen in Figs. c and d. Pearlen plate was used as upper retainer to help as a reminder and for tongue training



Fig. 6.108 (a–f) Extra- and intraoral pictures at recall, 3 years and 1 month after debonding all the fixed appliances; the patient carried on with myofunction exercises; the treatment outcomes remained stable

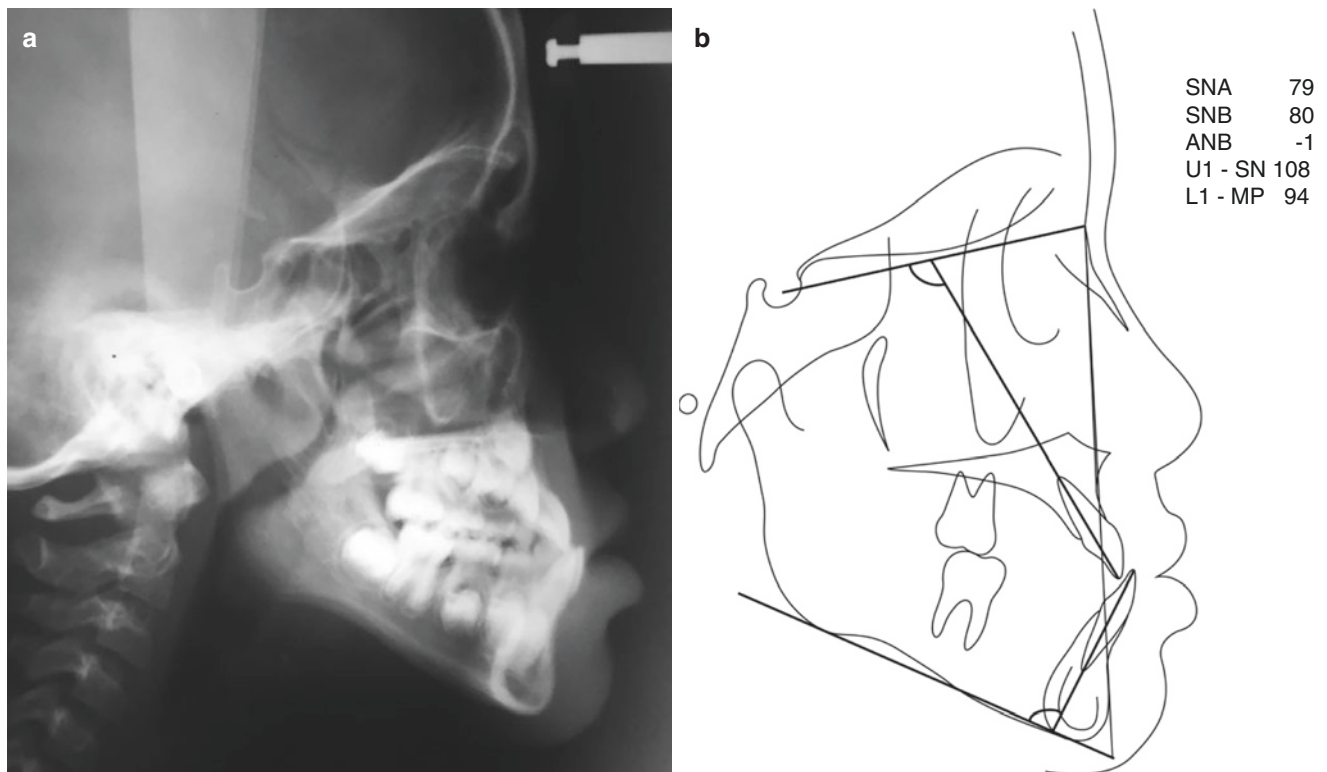


Fig. 6.109 (a, b) Cephalometric head film and tracing at beginning of the treatment; ANB angle was -1 degree

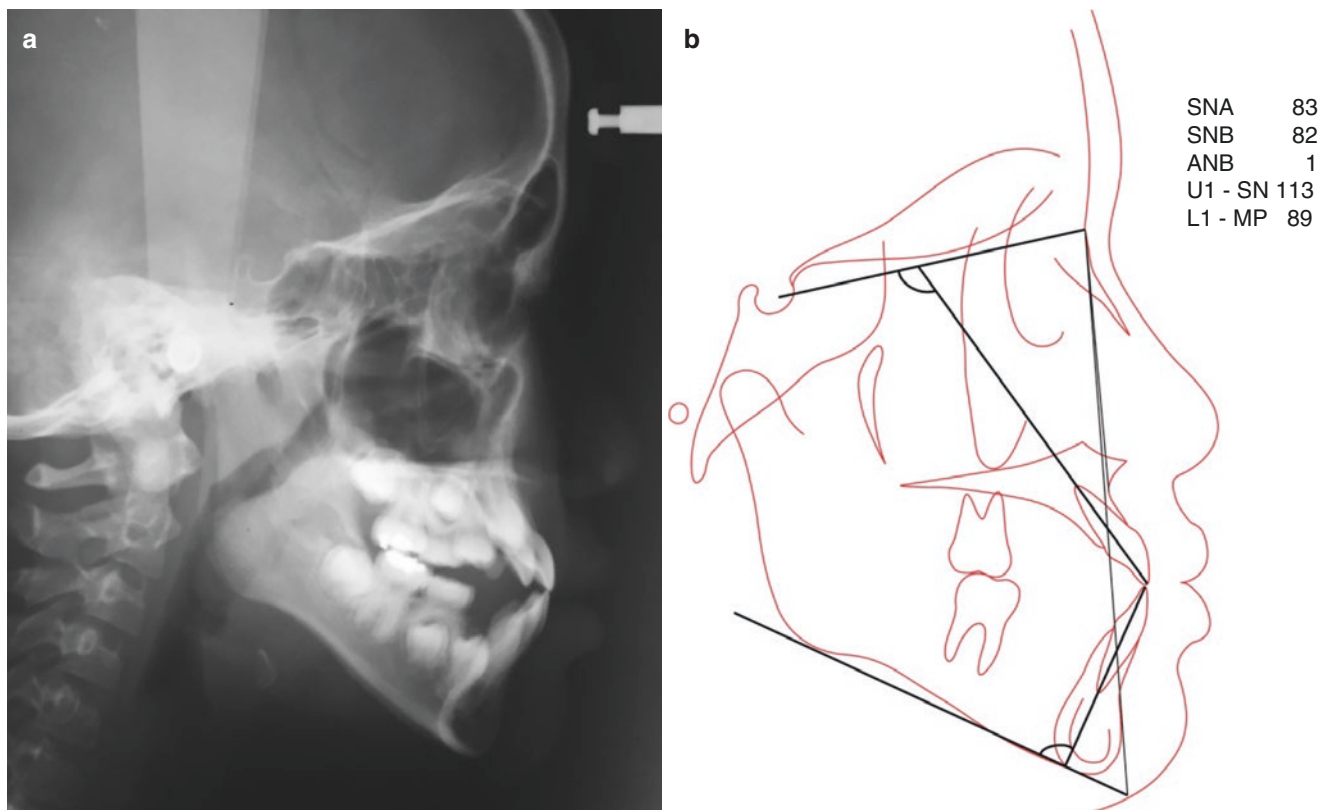


Fig. 6.110 (a, b) Cephalometric head film and tracing after the use of Class III activator; ANB angle increased from -1 to $+1$ degree. Upper anterior teeth were more proclined U1- SN increased from 108 to 113 degrees, while lower anterior teeth were more retroclined L1-MP decreased from 94 to 89 degrees

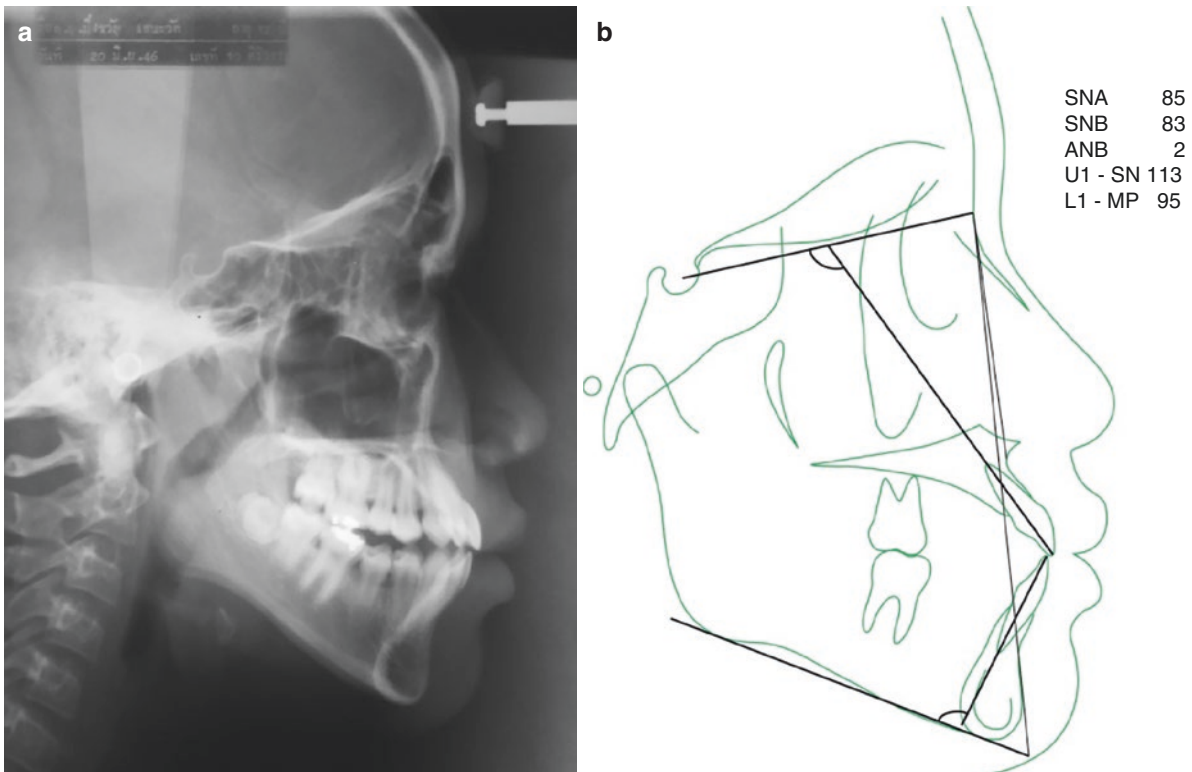


Fig. 6.111 (a, b) Cephalometric head film and tracing before the use of fixed appliances in the second phase treatment; ANB angle was 2 degree. The upper anterior teeth remained stable while lower anterior teeth became more proclined, and L1-MP increased from 89 to 95 degree

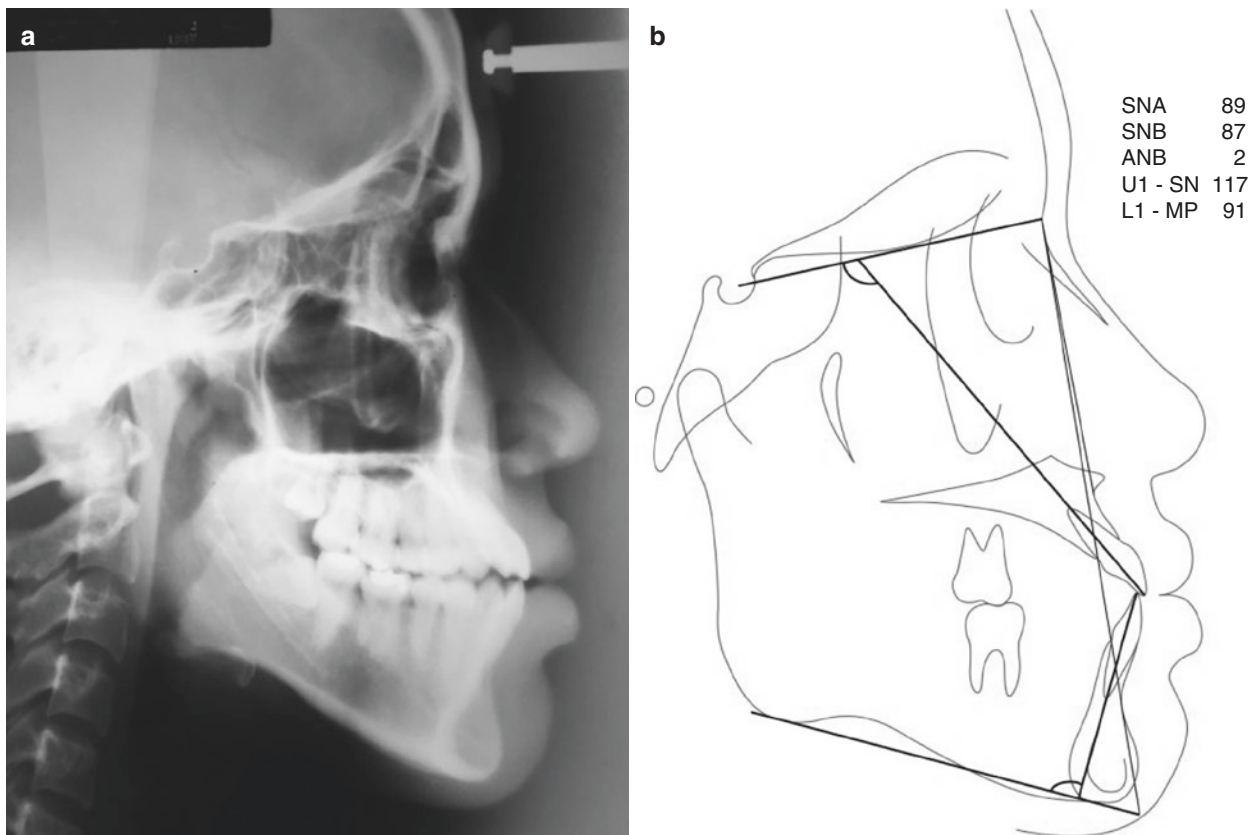


Fig. 6.112 (a, b) Cephalometric head film and tracing at the end of fixed appliances, and ANB angle was 2 degrees; the upper anterior teeth U1-SN became more proclined from 113 to 117 degree while the lower anterior teeth were more retroclined L1-MP reduced from 95 to 91 degree

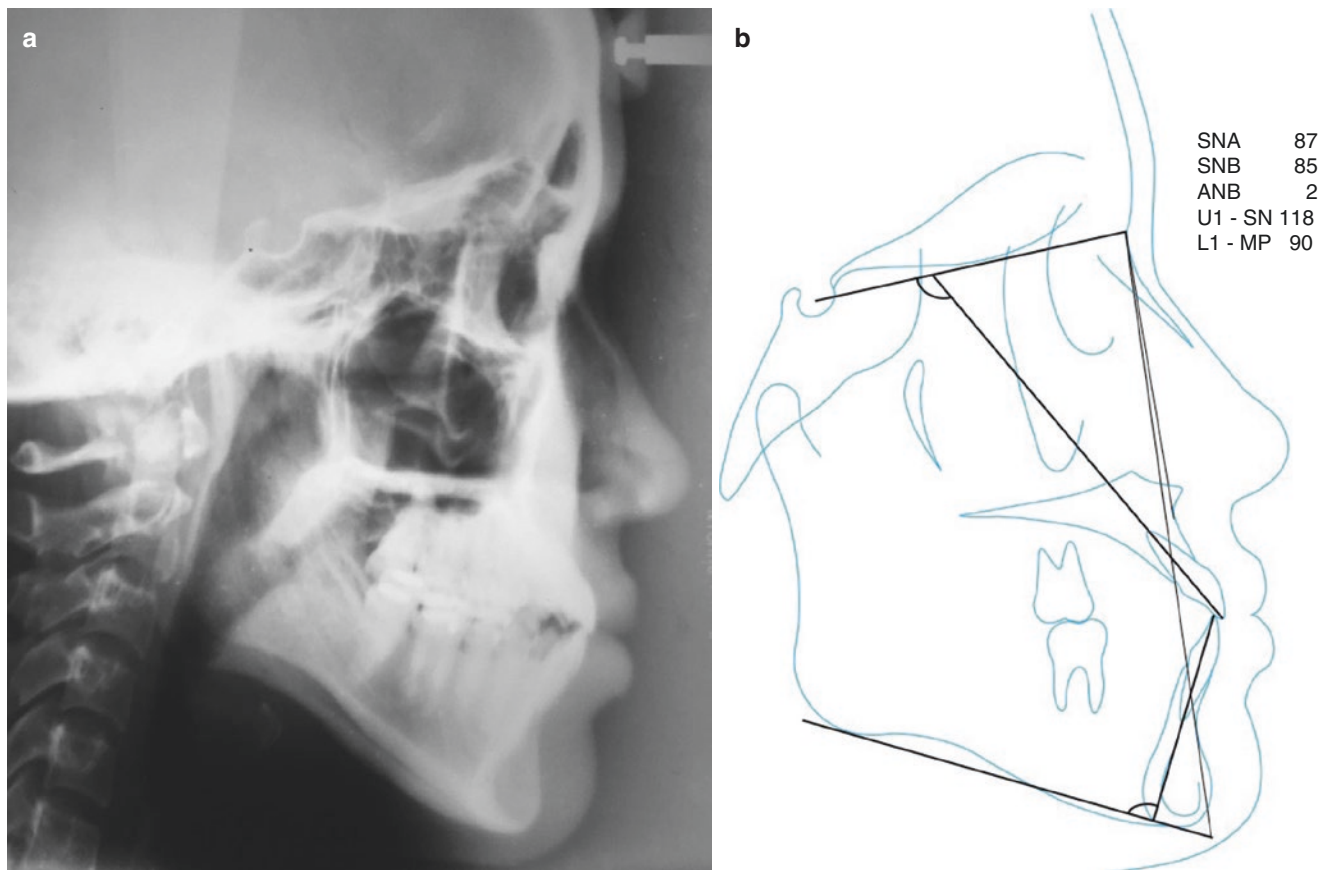


Fig. 6.113 (a, b) Cephalometric head film and tracing 3 years and 1 month after the end of the treatment, ANB angle, and upper and lower anterior teeth remained stable



Fig. 6.114 Superimposition at different timelines

Stability of both skeletal and dental could be achieved after Class III activator treatment combined with myofunction exercises (Figs. 6.115, 6.116, 6.117, 6.118, 6.119, 6.120, 6.121, 6.122, and 6.123).

6.13.3 Case #6



Fig. 6.115 (a–h) Extraoral pictures of a 9-year-old girl showed a concave facial profile; intraoral pictures showed that teeth #11, #21, #42, #41, #31, and #32 were in crossbite, teeth #12 and #22 were proclined, and she had Class III molar relationships

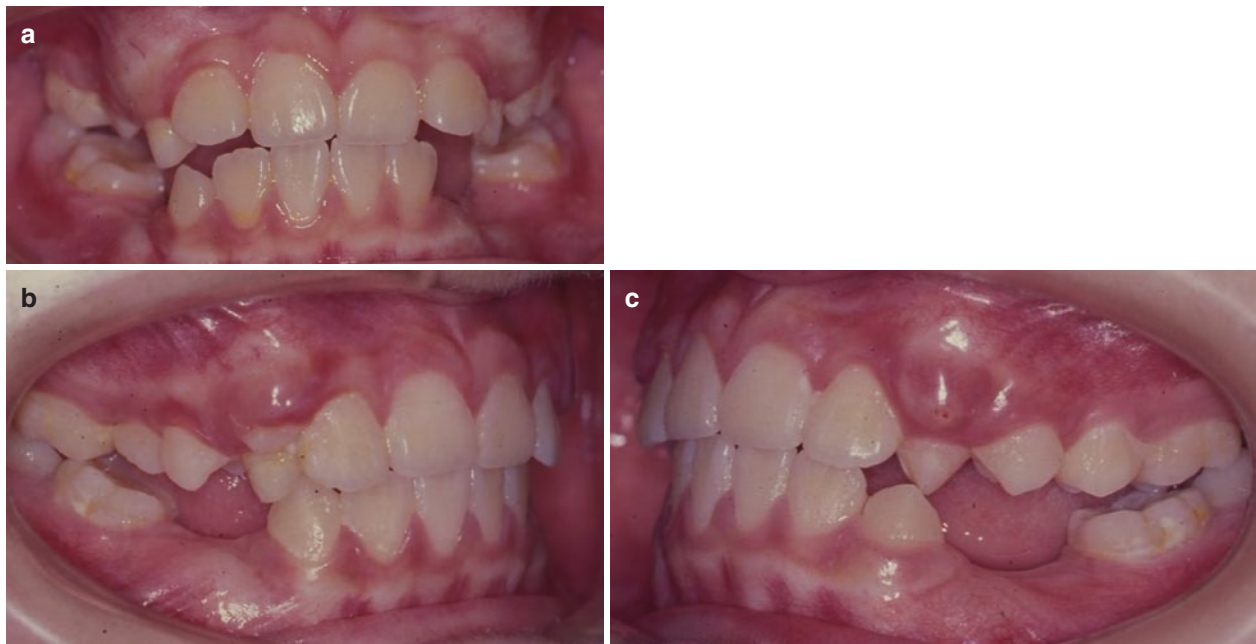


Fig. 6.116 (a–c) Pictures showed positive overjet and positive overbite during Class III activator treatment



Fig. 6.117 (a–h) Extra- and intraoral pictures at recall; 5 years after the end of second phase treatment with fixed appliances showed good stability of the treatment outcomes. The patient had large tongue but she was

well aware of the relapse risk, and she continued with myofunction exercises

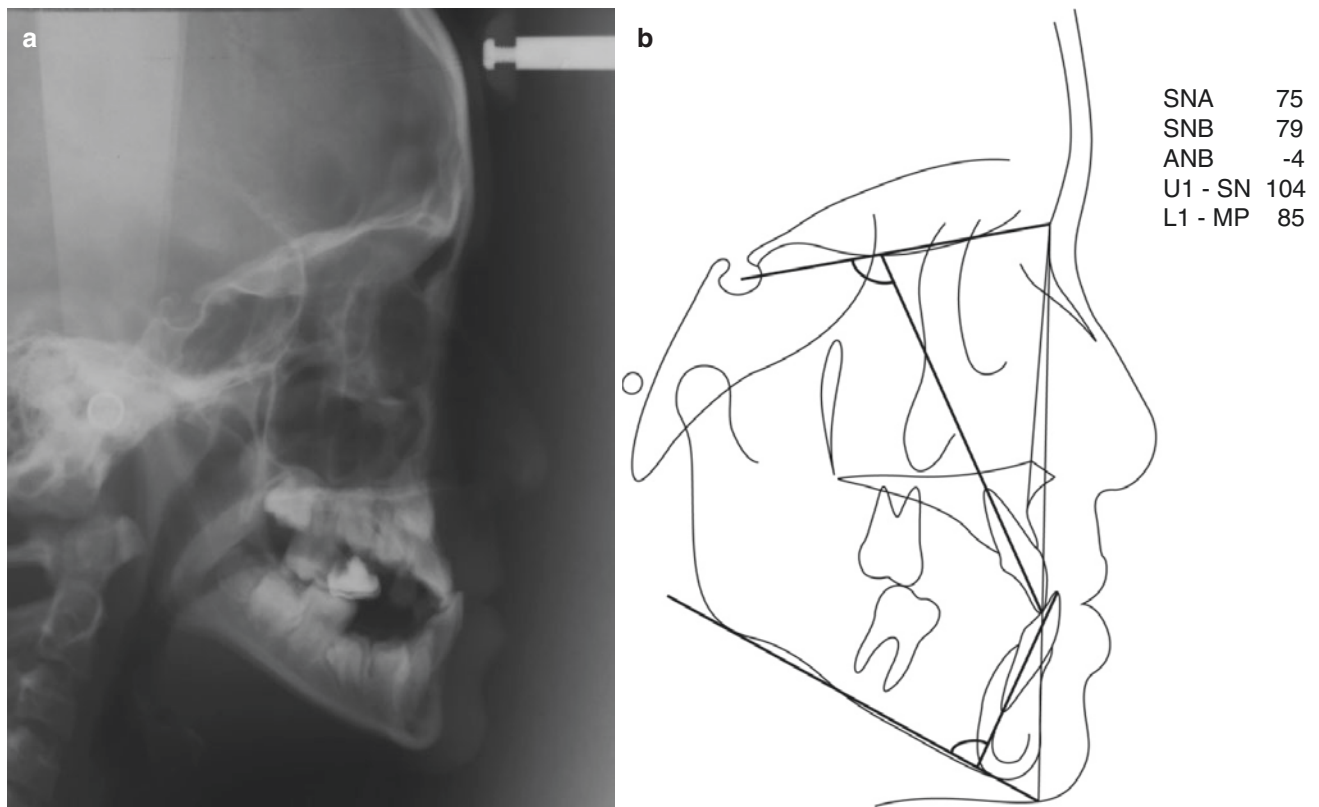


Fig. 6.118 (a, b) Cephalometric head film and tracing at beginning of the treatment, and ANB angle was -4 degrees

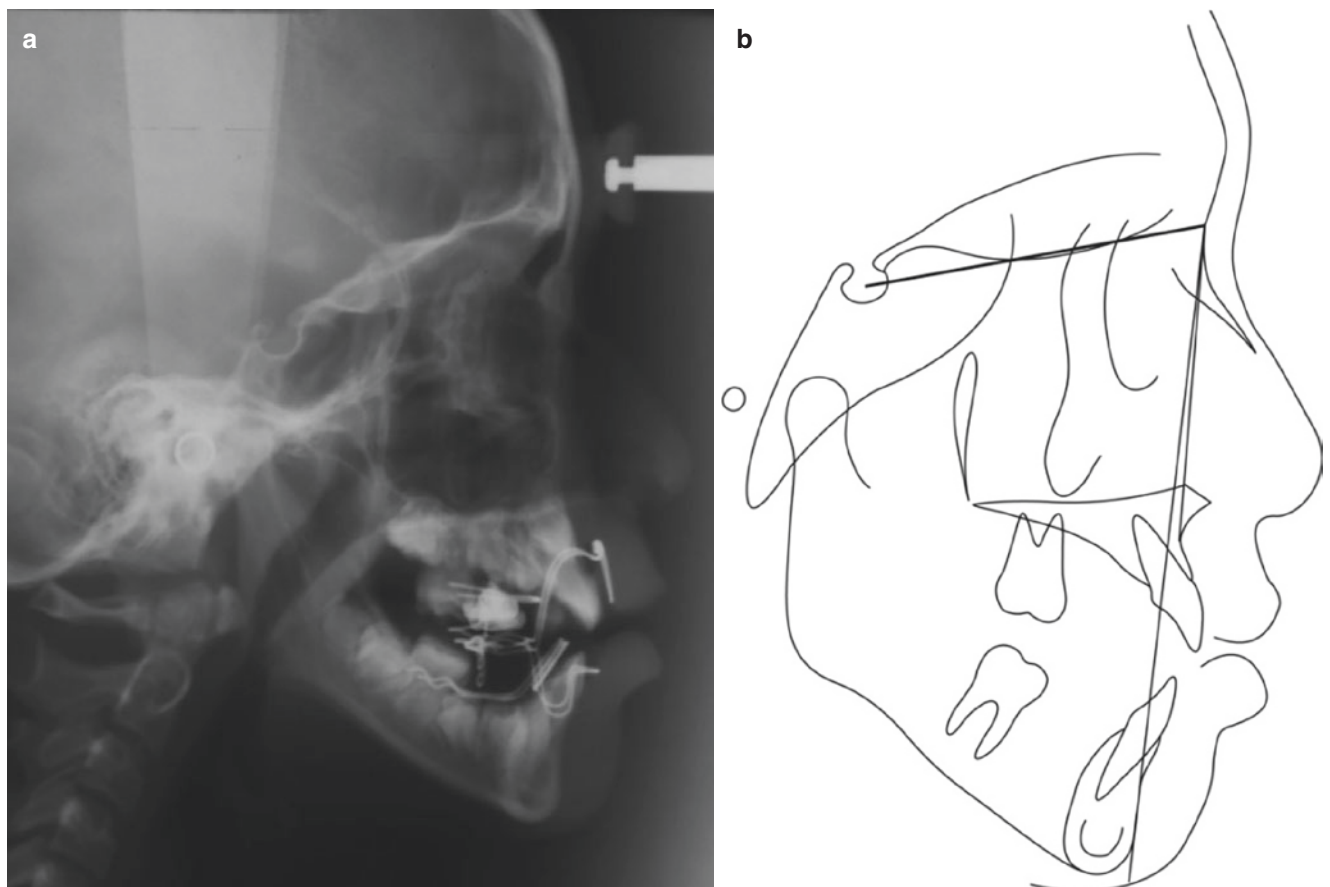


Fig. 6.119 (a, b) A cephalogram and a tracing with Class III activator in situ

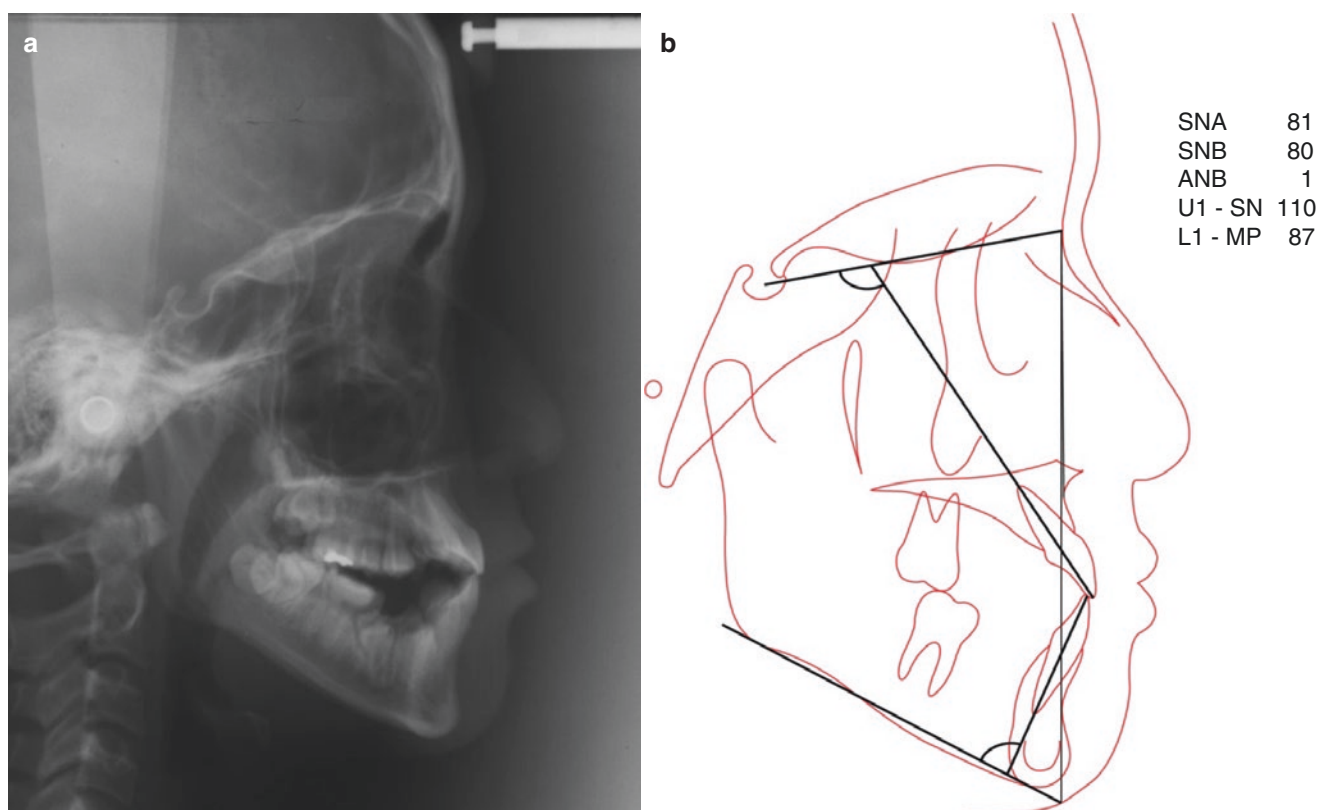


Fig. 6.120 (a, b) A cephalogram and a tracing during the treatment with Class III activator; the ANB angle increased from -4 to $+1$ degree, increase in inclination angle of the upper anterior teeth from 104 to 110

degrees, and lower anterior teeth from 85 to 87 degrees. Positive overjet and positive overbite were achieved

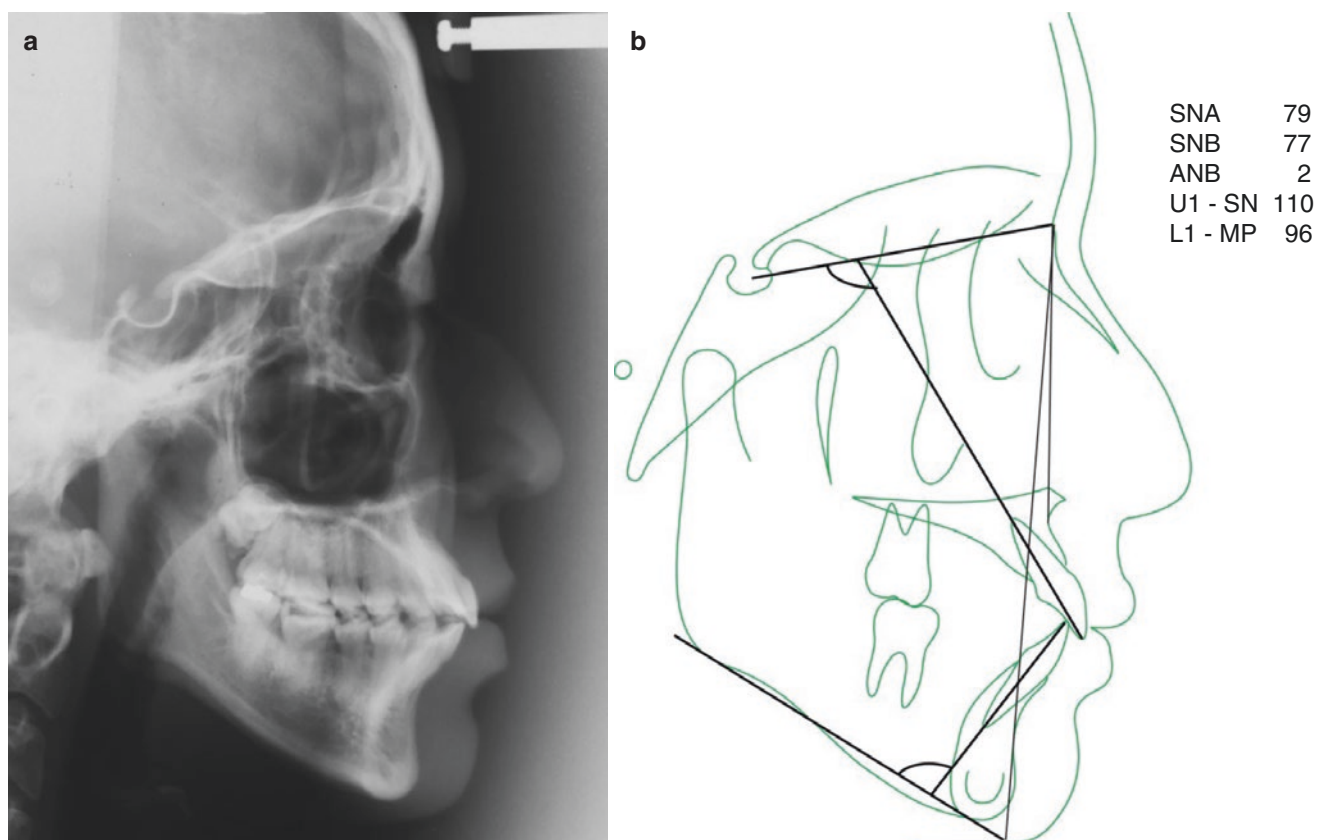


Fig. 6.121 (a, b) Cephalometric head film at the end of the treatment; ANB angle was 2 degrees

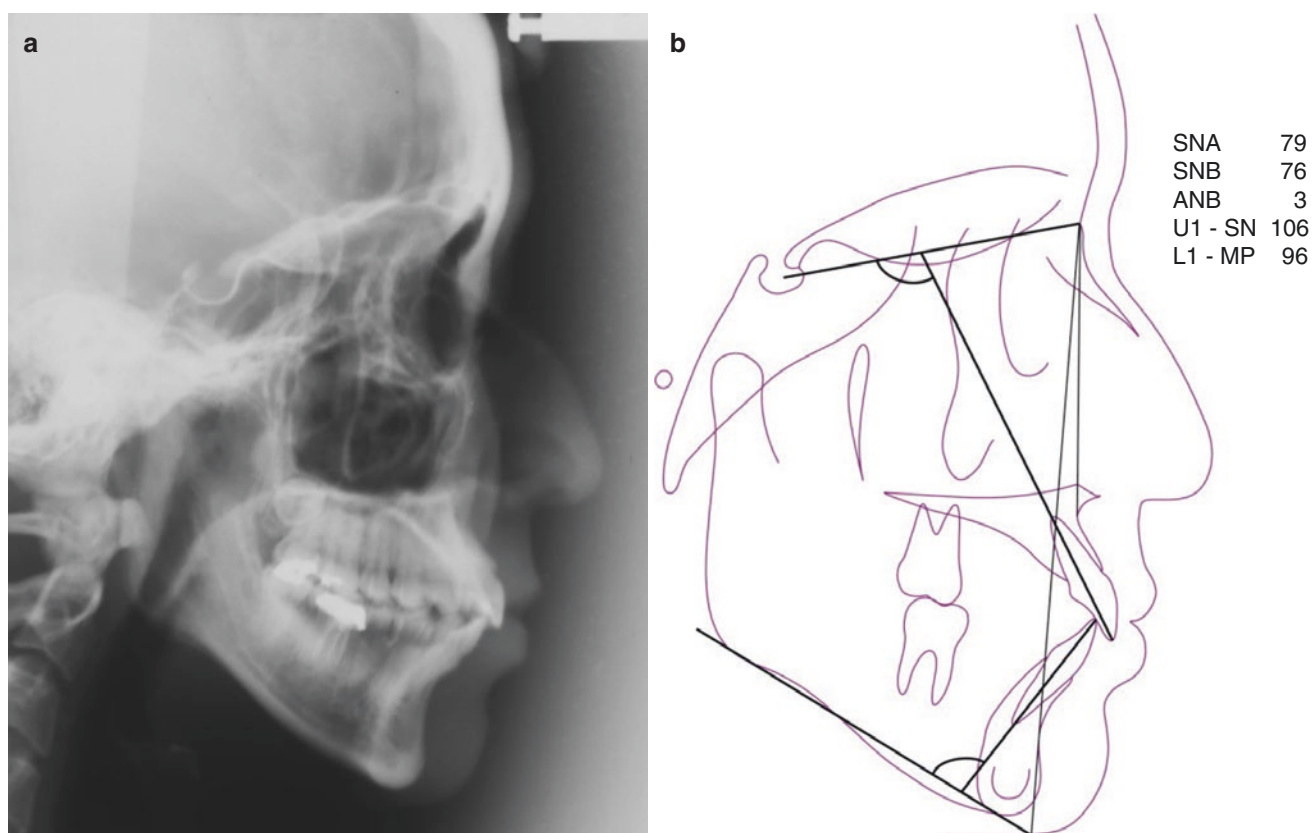


Fig. 6.122 (a, b) Cephalometric head film and tracing 9 years after the end of the treatment; the treatment results both skeletal and dental were stable

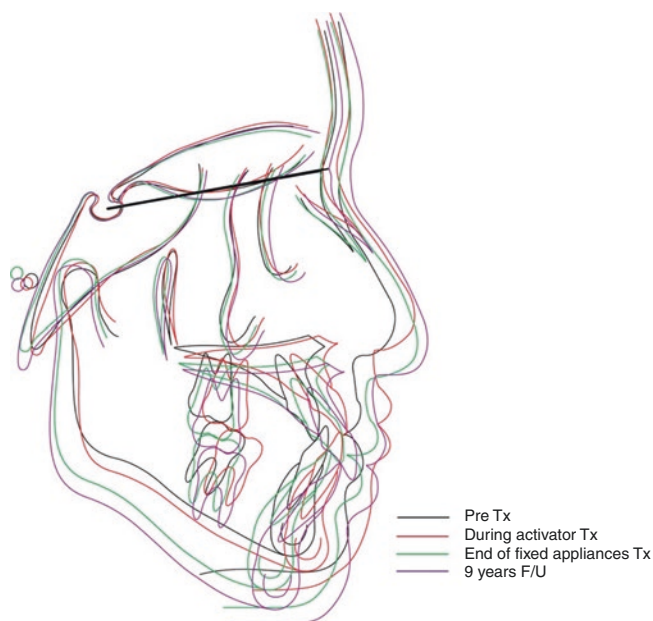


Fig. 6.123 Superimposition of cephalometric tracings at different timelines

6.14 Conclusion

As mentioned before that Class III malocclusions are one of the most difficult malocclusions to be treated. Anyhow, early Class III treatment could be done successfully when proper diagnosis and proper treatment plan are carefully carried out and the treatments are done following the concept of treating at the right place, at the right time with the right appliances. The purposes of early treatment can be causative treatment, in case of dentoalveolar Class III malocclusion. In case of skeletal Class III malocclusions, growth modification can be done with awareness of limitation in severe cases where orthognathic surgery is required in the later stage.

Most skeletal Class III malocclusions exhibit discrepancies in all dimensions, in the sagittal, transversal, and vertical dimension. Therefore, second phase treatment is required in many cases. Anyhow, early treatment of Class III malocclusions when carefully done help reduce severity of the malocclusions, and it can help prevent major surgery. Therefore, it can be concluded that Class III activator maybe a viable mode for initial stage of Class III treatment in conjunction with fixed or removable therapy.

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Early Treatment of Open Bite Problems

7

Julia Harfin

The normalization of functional disturbances is one of the main objectives that need to be achieved during early orthodontic treatment.

There is a close relationship between anterior open bite in young patients and abnormal habits that are some of the main etiologic factors of malocclusion.

Among the most common habits are thumb-sucking, lip/nail biting, tongue-thrusting, and mouth breathing mode.

Normally all of these habits could cause interferences with the circumoral musculature and tongue pressure balance and as a consequence, they develop unaltered maxillary and mandibular arch forms (Urzal et al. 2013).

Of course, the duration, frequency, and intensity of these habits play an important role, not only in the diagnosis and treatment plan but also during the whole retention phase.

Since there is not only one reason for digital sucking or the prolonged use of pacifiers, there is not only one treatment for all of them. It is important to control the habit after 2 years of age. In some patients, the help of a psychologist is valuable (Dugoni).

Digital sucking is responsible for causing significant changes in the maxilla and in the mandible during the growth period.

In general the maxilla becomes narrow and V shaped, the mandible tends to be retrognathic, and as a consequence, a significant open bite is developed with proclined upper incisors and retruded lower incisors.

Due to the excessive proclination of the upper incisors, lips become incompetent and the tongue is placed between the upper and lower incisors during the swallowing process worsening it.

There is a close relationship between lip and tongue position and action during speech and swallowing, and they may interfere with normal facial growth.

Also, there is a significant link between the respiration mode, the direction of the facial growth, and the development of the malocclusions (posterior crossbite and anterior open bite), due to abnormal contraction of the cheek muscles.

Hypertrophic lymphoid tissues and nasal obstruction in combination with large adenoids and tonsils are the most common cause of nasal obstruction and mouth breathing as they push the tongue forward due to pain and decrease in the amount of posterior space for the tongue.

This atypical swallowing pattern and the anterior posture of the tongue at rest prevents the eruption of the incisors and increases the anterior open bite with lower lip interposition every time the patient swallows.

In general these young patients are sent to the speech therapist in order to improve the pronunciation of certain words but it is important to remember that the anterior open bite is the consequence not the cause.

It has been demonstrated that tongue dysfunction plays an important role not only in the etiology of the open bite but also in the relapse of treated open bite patients.

Also, orofacial and speech dysfunction could be combined with problems at the TMJ that could worsen in the future.

In addition to TMJ problems, episodes of sleep apnea could be added. The child could stop breathing several times during the night (20–40 times per hour of sleep). As a consequence, he or she would feel daytime sleepiness, headaches, fatigue, obesity, changes in personality, lack of attention at school in the morning, etc.

Since sleep apnea is a progressive disorder, the consultation with the specialist is very important from the first day in order to perform a multi- and interdisciplinary treatment plan and avoid relapse (Pascualy et al.)

It is important to remember that sleep-walking in young children and enuresis are commonly related to open bite problems.

The real question is who, when, why, and how to treat.

The higher the percentage of environmental factors in relation to the genetic ones, the better the prognosis. Among the deleterious habits, the prolonged use of pacifiers, mouth

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breathing, or thumb-sucking are the determinants. In some patients, the help of a psychologist is fundamental to control these habits.

Unfortunately, there is not only one type of appliance to treat all these patients. The appliance selection has to be related to the etiology, age of the patient, seriousness of the problem, etc. The orthodontist is responsible for the appropriate selection.

The decision of whether to use a removable, fixed appliance or a combination of both is related to the etiology and the skeletal maturity in order to maximize the effectiveness of the orthodontic treatment.

The normalization of the vertical dimension is extremely challenging for the orthodontist to control, especially in high angle patients with mouth breathing.

If problems leading to an open bite could be identified and treated early, it might be possible to minimize or even eliminate an undesirable pattern of growth.

According to the structures affected, anterior open bite can be divided into three main categories: dental, dentoalveolar, and skeletal.

Dental and dentoalveolar open bite develop as a result of prolonged mechanical blockage of the normal vertical development of anterior teeth and alveolar process (Torres).

The skeletal form, in turn, is characterized by a significant vertical skeletal discrepancy, with features such as counterclockwise rotation of the palatine process, increased lower anterior facial height and gonial angle, short mandibular ramus, and increased posterior dentoalveolar height in both the mandible and maxilla.

The diagnosis process has to include medical and dental analysis, patients' chief complaint, evaluation of growth, functional analysis, etc.

The treatment goals should include the removal of the etiologic and environmental factors to permit the normalization of the anterior growth development.

No consensus has been reached until now to determine the best time to initiate the orthopedic/orthodontic treatment. Nonetheless, it is totally accepted that the earlier the correction of the open bite begins, the better the results will be. Also, early treatment helps decrease chances of relapse or avoid it completely.

Myofunctional therapy is the best option to normalize mouth breathing.

Control and reduction of the extrusion of the molars are fundamental to allow a counterclockwise rotation of the mandible to maintain the results.

Failure to control bad habits may be the most important reason of relapse.

The role of the otolaryngologist to improve and normalize nasal breathing during the diagnosis process and speech pathology is of prime importance.

In general anterior open bite in temporary or early mixed dentition is associated with digital sucking habit and tongue anterior interposition.

Its correction is very important since otherwise the problem could worsen and turn into a skeletal alteration.

The size and length of the lips are also important to maintain a proper lip seal during day and night. Also it is necessary to normalize the position and function of the tongue.

Normally children who breathe through their mouth have a narrow maxillary arch, protrusive incisors, Class II occlusion, convex facial profile, bags under the eyes, open mouth posture, and narrow nostrils.

The importance of the multidisciplinary treatment cannot be denied.

Treatment strategies are in close relationship with etiology, facial biotype, age of the patient, and clinical experiences.

The management of the tongue thrust and mouth breathing involves the interception of the habit. First of all, the doctor has to determine that the patient can use his/her nose to breathe normally.

It is important to remember that mouth breathing is abnormal and can affect the whole stomatognathic system, body posture, etc. and not only the position of the teeth.

As soon as this problem is corrected, fewer consequences appear.

Different appliances could be used according to the age of the patient and his/her medical history, in order to establish a new neuromuscular pattern.

According to the etiology and the importance of the problem, removable, fixed, or a combination of both types of appliances can be used.

The orthodontist has the final decision.

The following examples will describe each option in detail.

This 6-year, 8-month-old patient was sent to the office by her family dentist in search of a second opinion regarding her anterior open bite.

An adenoidectomy was performed 4 months earlier. Nonetheless, mouth breathing and tongue thrusting continued. It was difficult for her to close and maintain the lips sealed. She used a pacifier until 4 years of age (Fig. 7.1a and b).

Her profile was convex and the nasolabial angle was reduced.

Even though she was only 6 years and 8 months of age, she had a double chin.

Hyperactivity of the musculature of the lips in combination with tongue thrust was observed during the clinical exam with abnormal tongue posture during speech.

The front photograph showed a significant open bite in the anterior region in combination with a midline deviation. Only the central upper and lower incisors were erupting at that time (Fig. 7.2a and b).



Fig. 7.1 (a and b) Pretreatment frontal and lateral smile. The tongue was clearly visible between the front teeth

No posterior crossbite was present. Normal eruption of the upper and lower incisors was affected due to the position of the tongue. Due to the presence of large cavities, some stainless steel crowns were placed on the temporary molars (Fig. 7.3a and b).

The treatment objective (Phase I) was to normalize overbite and overjet, maintain Class I molar, control tongue thrust, improve the activity of the lips, and enhance her profile.

To achieve this objective, the use of a functional appliance is decided on. Of all the possible choices, a prefabricated functional appliance also known as Trainer System TM (Myofunctional Research Co. Australia) was chosen. It is fabricated with a special type of polyurethane and helps the correction and normalization of the muscular dysfunction.

The appliance is especially designed to stimulate anterior and lateral muscles and help to achieve normal nasal breathing. Since the material is soft, no major problems of adaptation are present (Fig. 7.4a and b).

It is recommendable that at the beginning this appliance be used few hours during the day (2–3 hours) and then all night (Fig. 7.5a and b).

After 9 months, a significant improvement of the maxillo-mandibular relationship was clearly observed. The anterior open bite was totally closed and midlines were almost normalized (Fig. 7.6a and b).

The transverse development observed in some patients could be due to the buccal shields of the functional appliance that stimulates the lateral muscles using the same principles that Frankel regulator does.

The treatment goals were totally achieved without the use of any other appliance.

When analyzing the front and lateral photographs, a significant improvement in the lower third of the face was achieved. The patient could close her lips without tension, and the tongue was located in its right position not only at rest but in active position too (Fig. 7.7a and b).

These were the results 18 months later. Class I canine was achieved and Class I molar was maintained. Overjet and

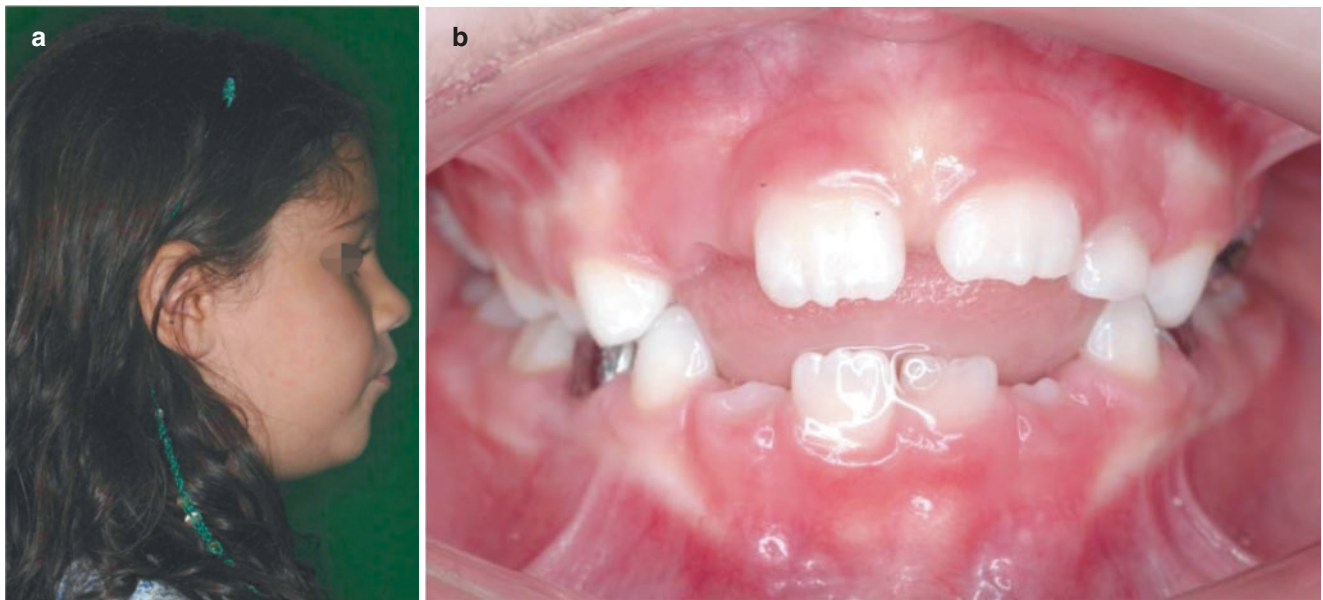


Fig. 7.2 (a, b) The lateral photograph showed a convex profile with a double chin. The front dental photograph confirmed the anterior position of the tongue

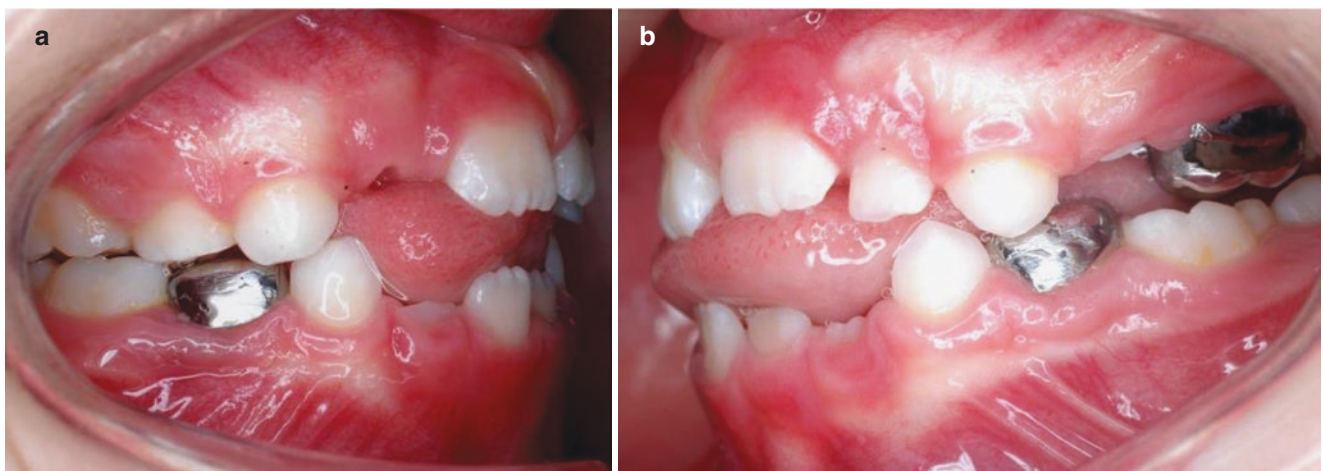


Fig. 7.3 (a and b) Pretreatment lateral views with the tongue between the upper and lower incisors

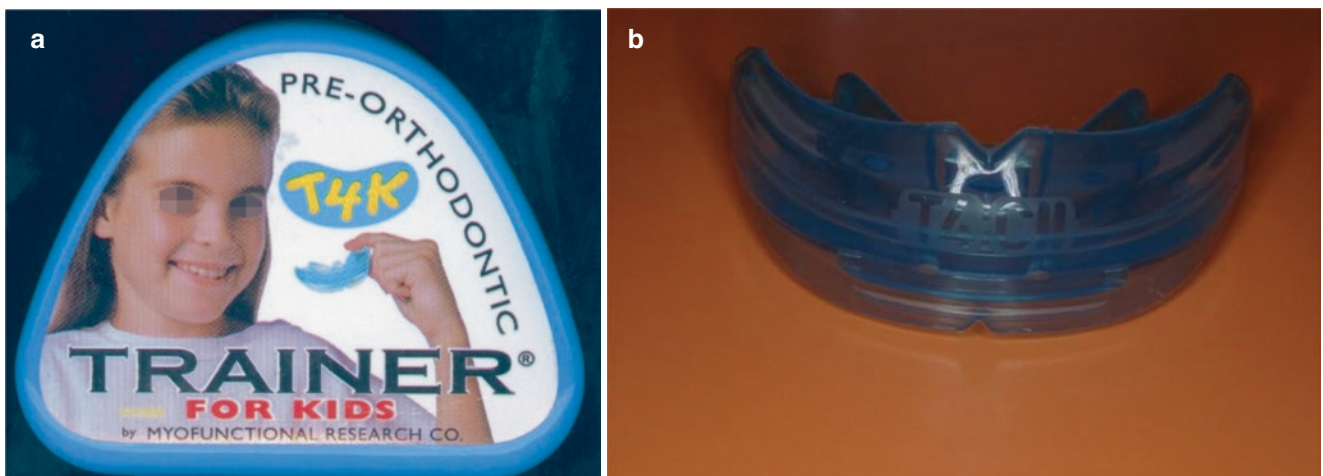


Fig. 7.4 (a and b) Trainer System TM (Myofunctional Research Co. Australia)

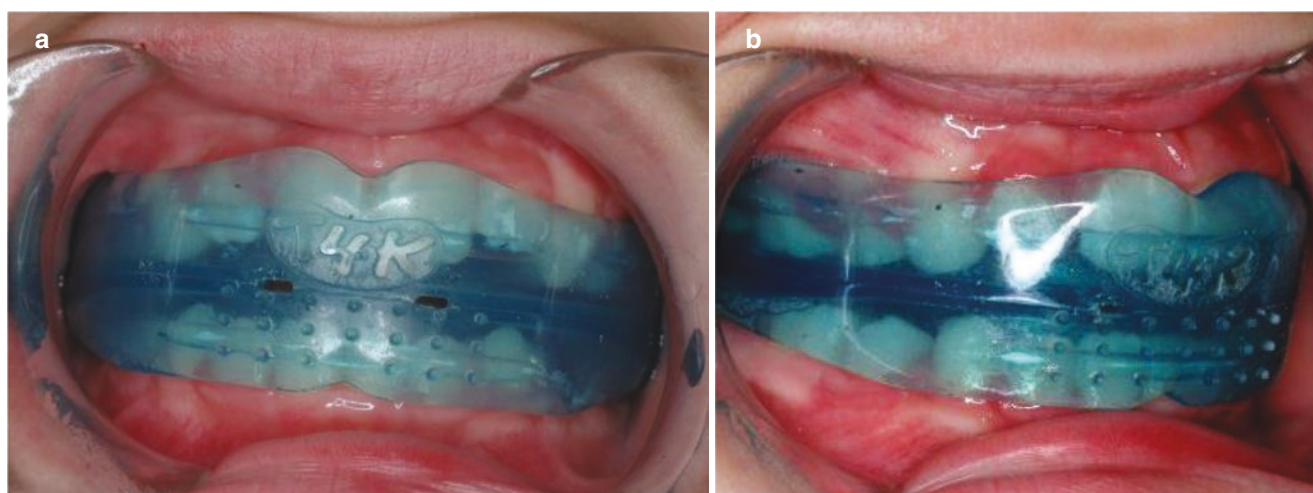


Fig. 7.5 (a and b) Functional appliance in place

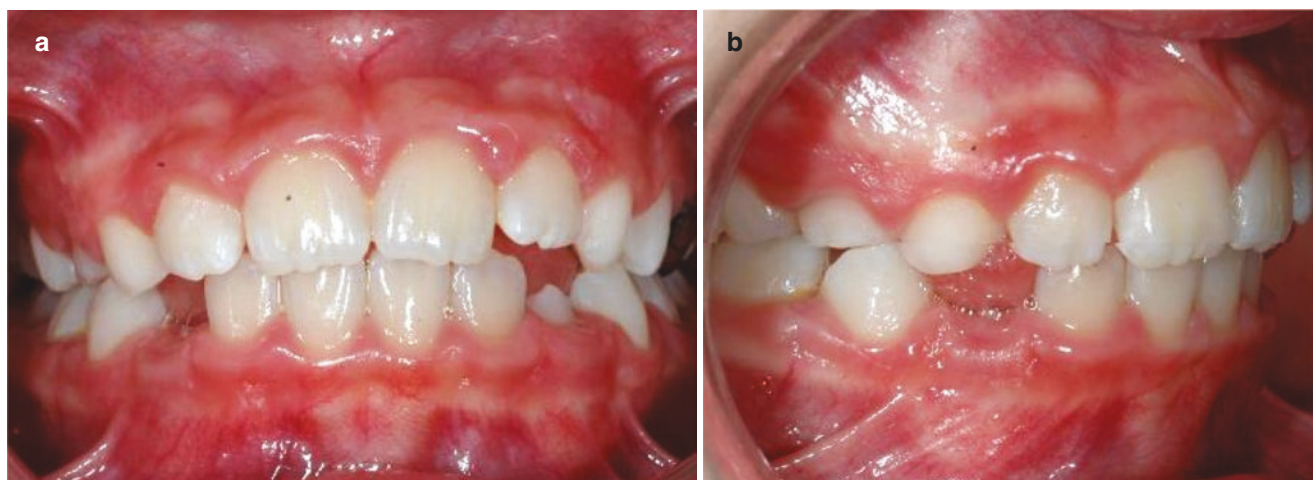


Fig. 7.6 (a and b) Frontal and lateral results after 9 months using the functional appliance

overbite were normalized and midlines were normal. Oral hygiene was fairly good. Gingival line and occlusal plane were parallel (Fig. 7.8a and b).

The profile and smile lateral photographs confirmed the results. The lips were relaxed and the double chin was absent. A 6-month control was highly recommended (Fig. 7.9a and b).

It is advisable that open bites be treated as early as possible and in this way reinstate normal oral and breathing functions with least the possible relapse.

The type of Trainer (T4K) or Myobrace is a valid alternative to treat open bite patients at an early age. It also helps to improve dental arch development during the early and late mixed dentition, and most importantly, this appliance helps normalize bad habits.

Also, other types of functional appliances can be used in accordance with the orthodontist's preferences. As always, correct diagnosis is more important than the type of the appliance used.

The comparison between the pre- and posttreatment front dental photographs showed evidence of the normalization of the anterior open bite and the parallelism between the occlusal and gingival plane.

No brackets were required to achieve the expected results.

Ideally an overcorrection of the overjet and overbite is highly recommended (Fig. 7.10a and b).

A 6-month control was recommended until all the second molars erupted.

Upon analyzing the lower third of the face and the nasolabial angle, a significant improvement was confirmed. Moreover, the lips were more relaxed and the double chin was normalized (Fig. 7.11a and b).

Further studies should be conducted to analyze whether the use of this treatment protocol could have a skeletal effect in patients with anterior open bite.

In general, patients with anterior open bite have a high angle facial pattern and also have discrepancies in the



Fig. 7.7 (a and b) Frontal and lateral photograph after 9 months of treatment

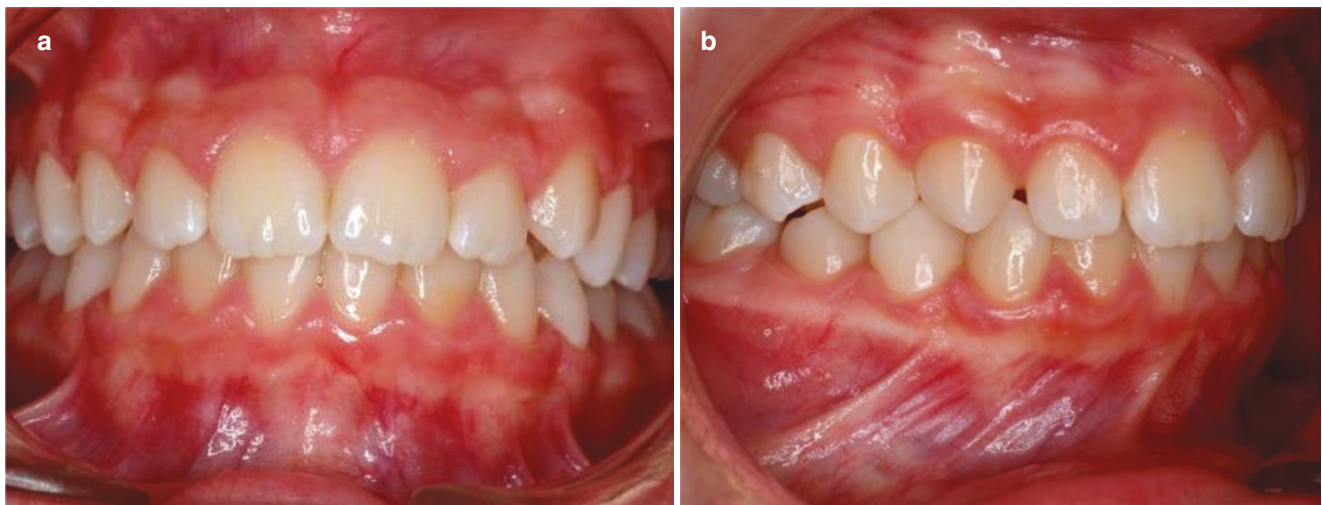


Fig. 7.8 (a and b) Results 18 months later. Class I molar and canine was achieved



Fig. 7.9 (a and b) The profile and smile lateral photographs confirmed the results

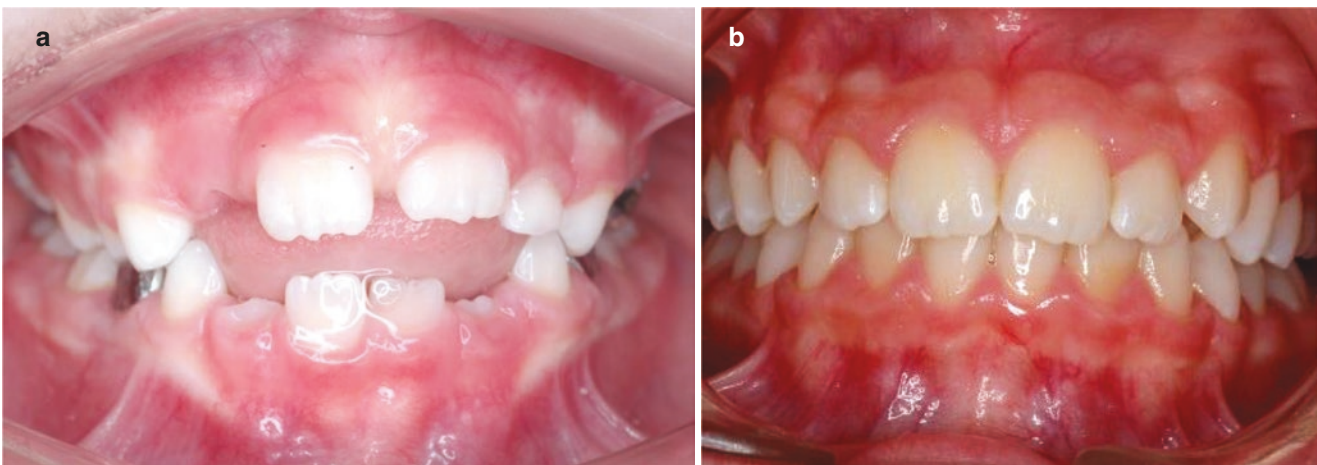


Fig. 7.10 (a and b) Comparison pre- and posttreatment front dental photographs



Fig. 7.11 (a and b) The comparison pre- and posttreatment photographs clearly confirmed the excellent results achieved after correcting the bad habits. The double chin was no longer present and the patient was able to close her lips effortlessly

anteroposterior and transverse dimensions. The retention protocol has to include a strict control of the position and function of the tongue and the normalization of the breathing pattern.

This 9-year, 2-month-old patient was sent by her family dentist due to her significant midline deviation and slight Class III tendency.

Her profile was straight with a normal nasolabial angle. She snored loudly at night very often (Fig. 7.12a and b).

The dental front photograph clearly showed the anterior open bite and the important deviation of the midlines (3 mm). She presented a V-shaped maxilla (Fig. 7.13a and b).

The right second temporary molars had a Class III tendency, and there was a significant lateral crossbite on the left side that was maintained in central relation.

No TMJ symptoms were present until then, but she preferred to eat only soft food.

Her dental hygiene was fairly good and no cavities were present (Fig. 7.14a and b).

The panoramic Rx confirmed that no agenesis were present and the lateral radiograph showed normal development according to her age. The anterior open bite was clearly visible (Fig. 7.15a and b).

The treatment objectives were as follows:

1. Align and level the arches.
2. Normalize transverse dimension.
3. Normalize overjet and overbite.
4. Achieve Class I molar and canine.
5. Control tongue thrust.
6. Long-term stability.

To achieve these objectives, the following treatment plan was designed:

Phase I

1. Rapid maxillary expansion to normalize the transverse problems.
2. Speech therapy treatment to control tongue thrust.

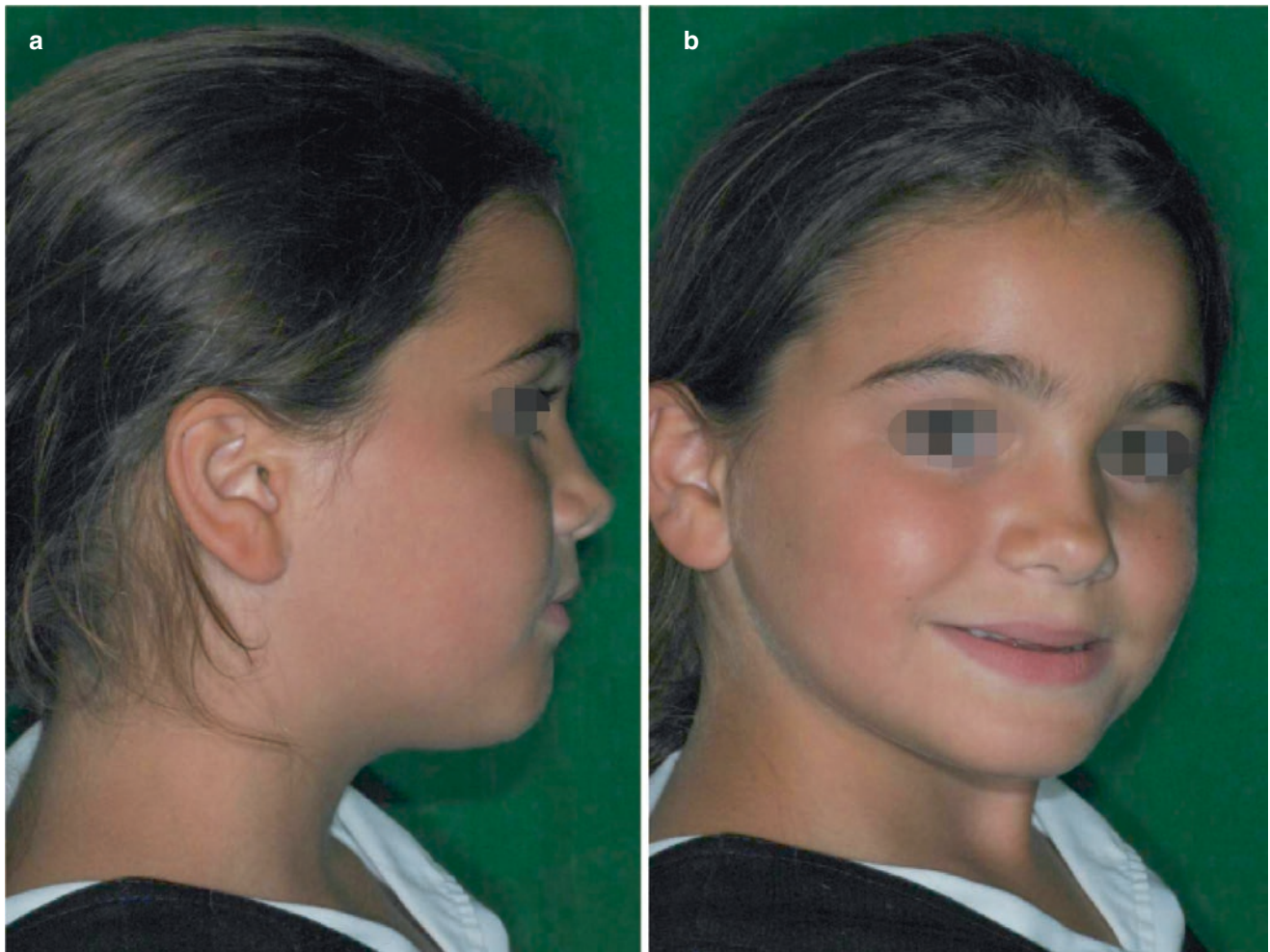


Fig. 7.12 (a and b) Pretreatment lateral and smile photographs

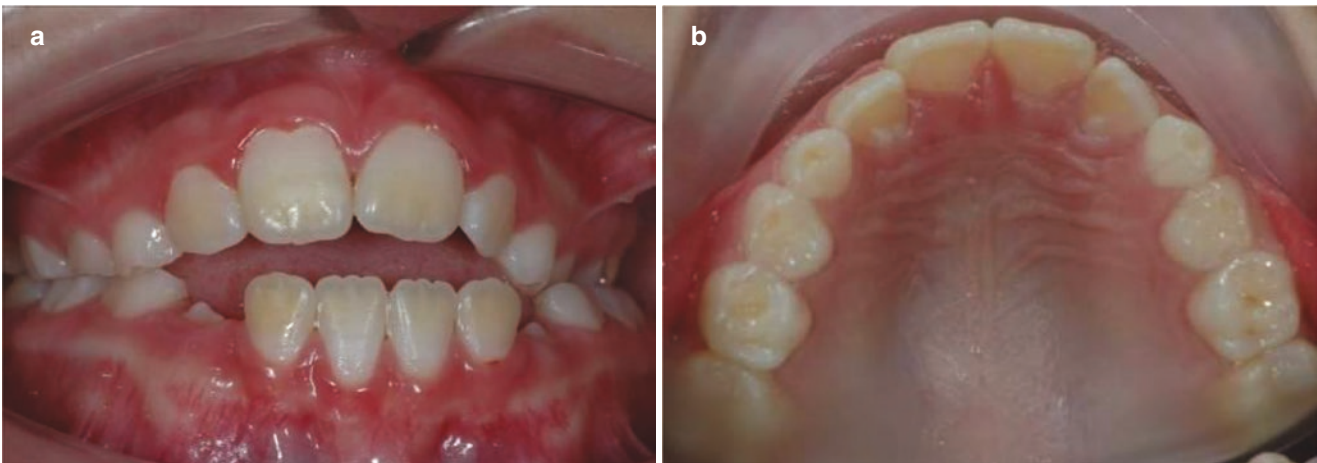


Fig. 7.13 (a and b) Considerable frontal open bite with a significant midline deviation to the left and a V-shaped upper maxilla

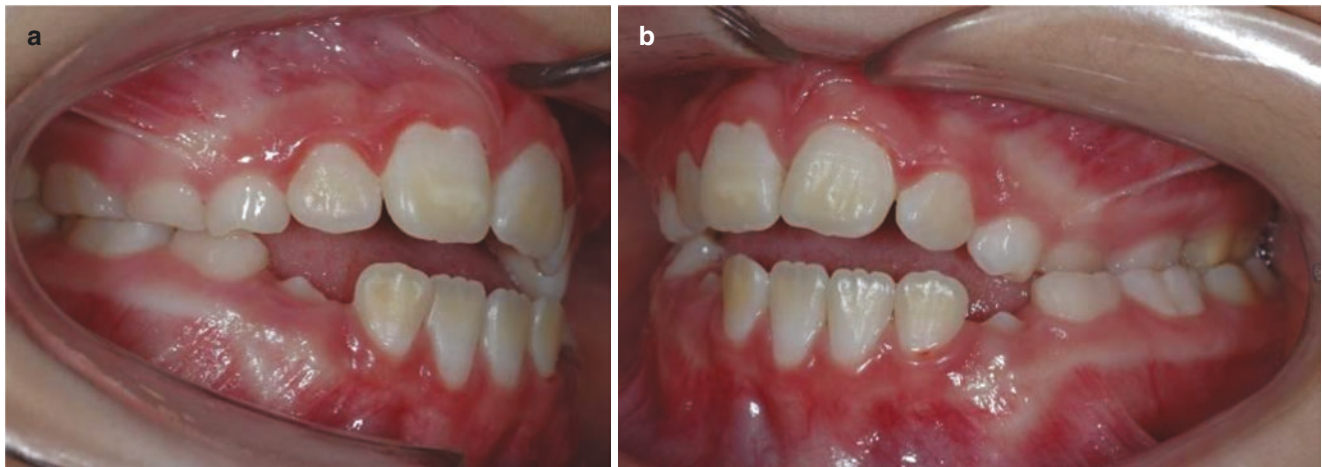
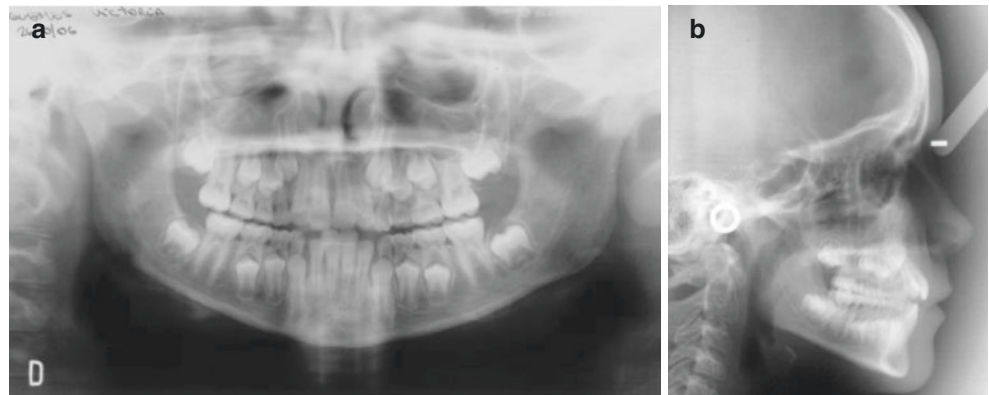


Fig. 7.14 (a and b) Pretreatment lateral views with a significant lateral left molar crossbite

Fig. 7.15 (a and b)
Pre-panoramic and lateral
radiograph



Phase II.

If necessary, esthetic brackets, 0, 22" slot in order to normalize dental positions, would be used.

To correct the transverse deficiency, a modified hyrax appliance was suggested. The protocol of activation was twice a day. The lateral arms were bonded with composite to the temporary molars to improve stability. After 2 weeks, the inter-incisal diastema between the central incisors confirmed that the central suture was open (Fig. 7.16a and b).

The correction of maxillary constriction is very often a target for treatment in open bite patients (McNamara).

As usual, 1 month later, the diastema closed on its own and a monthly control was suggested. The anterior open bite was totally normalized with the help of a speech therapist. Midlines were almost corrected.

In these cases, it is highly recommendable that RME appliance be kept in place a minimum of 6 months to prevent relapse (Fig. 7.17a and b).

At the end of the first phase of treatment, all the objectives were achieved. The overjet and overbite were normalized as well as the position of the first molars. A removable retainer used during the night was recommended to maintain the correction of the transverse dimension, until the second molars and upper canines erupted (Fig. 7.18a and b).

The lateral and smile posttreatment photographs confirmed the results that were achieved. The lips closed smoothly without tension and the nasolabial angle was normal (Fig. 7.19a and b).

The patient returned to the office seeking improvement of the position of the canines 20 months later. To achieve these results, esthetic brackets slot 0.022" were bonded in conjunction with a 0,016" SS wire (Fig. 7.20a and b).

A nickel-titanium open coil spring was placed on the left side to improve the position of the first upper left bicuspid (Fig. 7.21a and b).

The orthodontic brackets were removed and the tongue thrusting habit was totally corrected 7 months later (Fig. 7.22a and b).

Front photographs at the end of the second phase treatment. The face was symmetrical with balanced proportions and normal exposure of the maxillary teeth. The smile and tongue position were totally normalized (Fig. 7.23a and b).

The lateral photographs confirmed the results. The patient was able to close her lips gently in concordance with a nice and pleasant profile and a passive lip seal (Fig. 7.24a and b).

The comparison pre- and posttreatment dental front photographs confirmed that the treatment objectives were totally achieved.

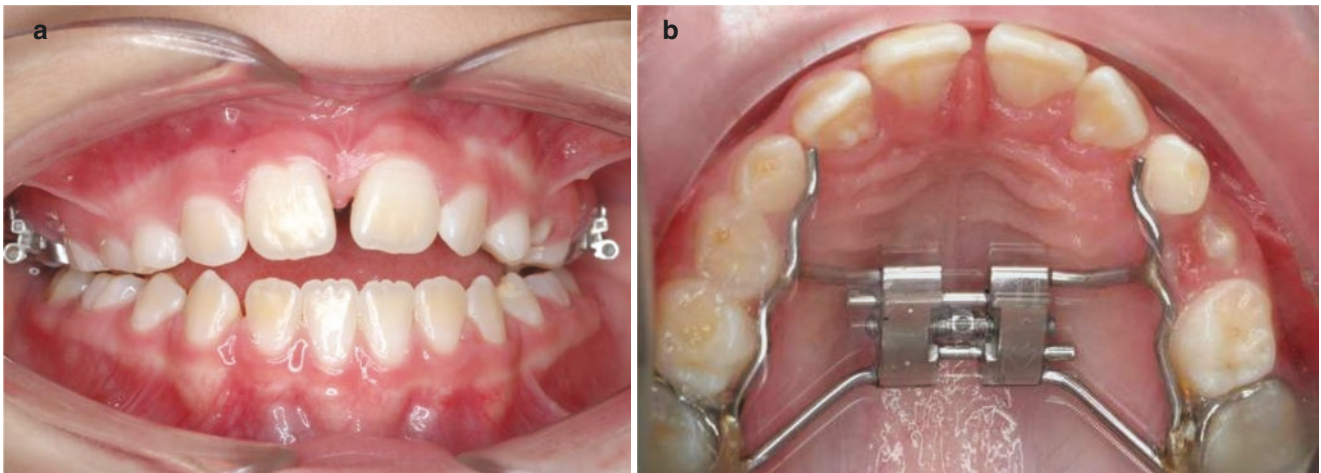


Fig. 7.16 (a and b) Upper rapid maxillary expander in place

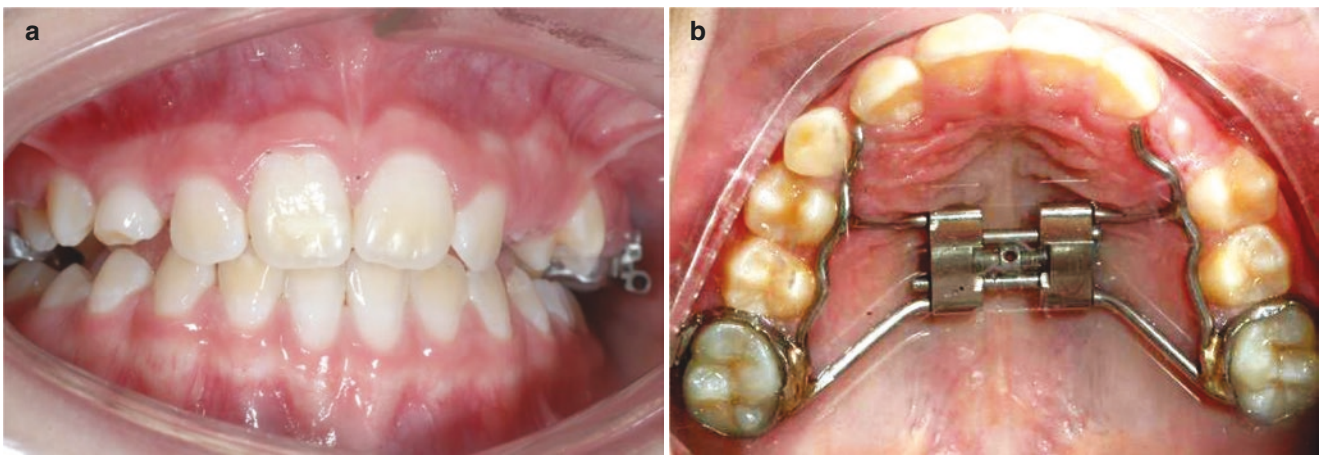


Fig. 7.17 (a and b) Rapid maxillary expander in place 1 month after the expansion was completed

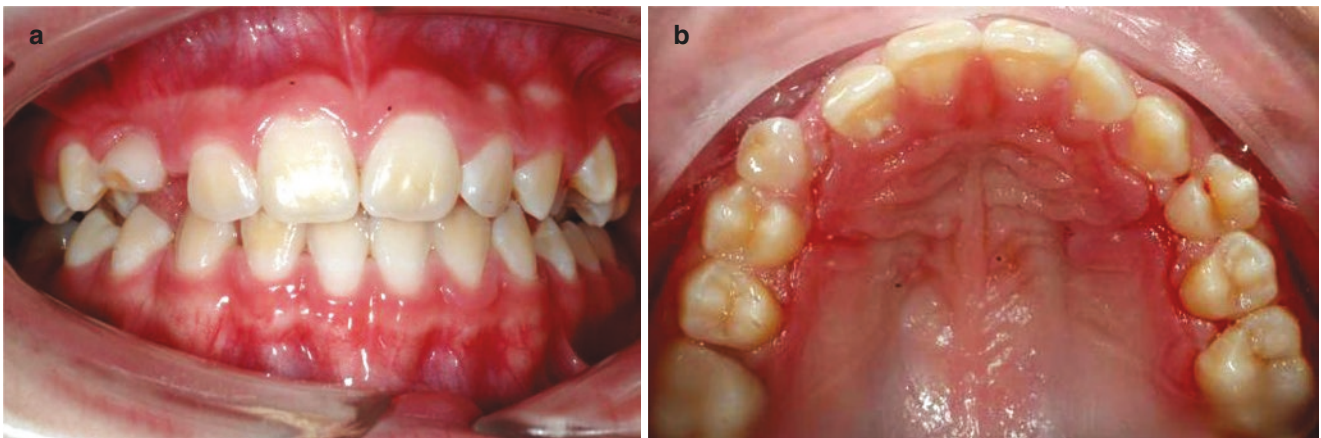


Fig. 7.18 (a and b) Frontal and upper arch at the end of the first phase of treatment. Considerable expansion was achieved



Fig. 7.19 (a and b) Lateral and smile posttreatment photographs

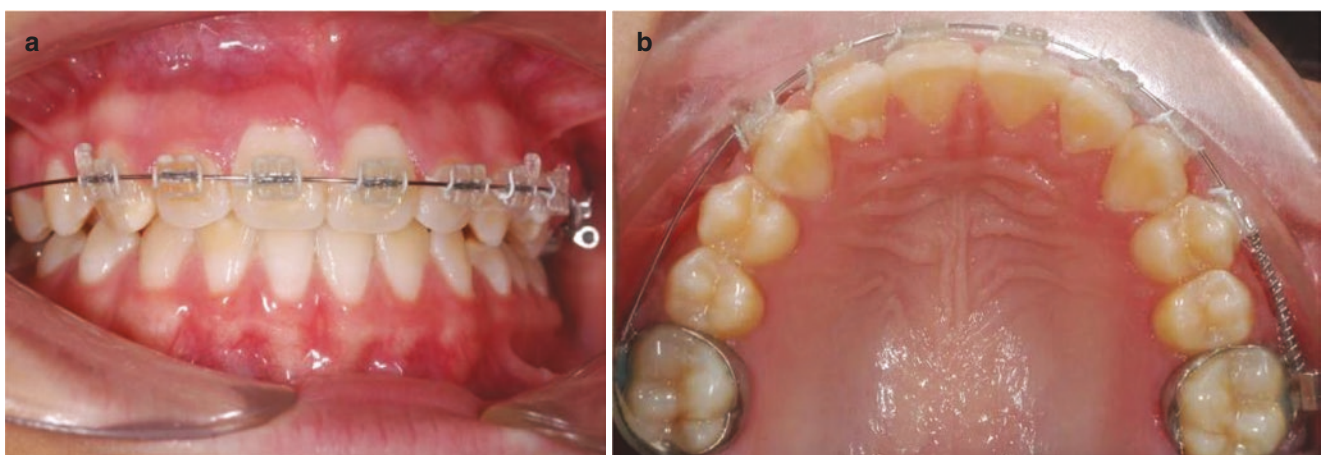


Fig. 7.20 (a and b) Esthetic brackets slot 0.022" were bonded in conjunction with a SS 0.016" wire to correct the position of the canines

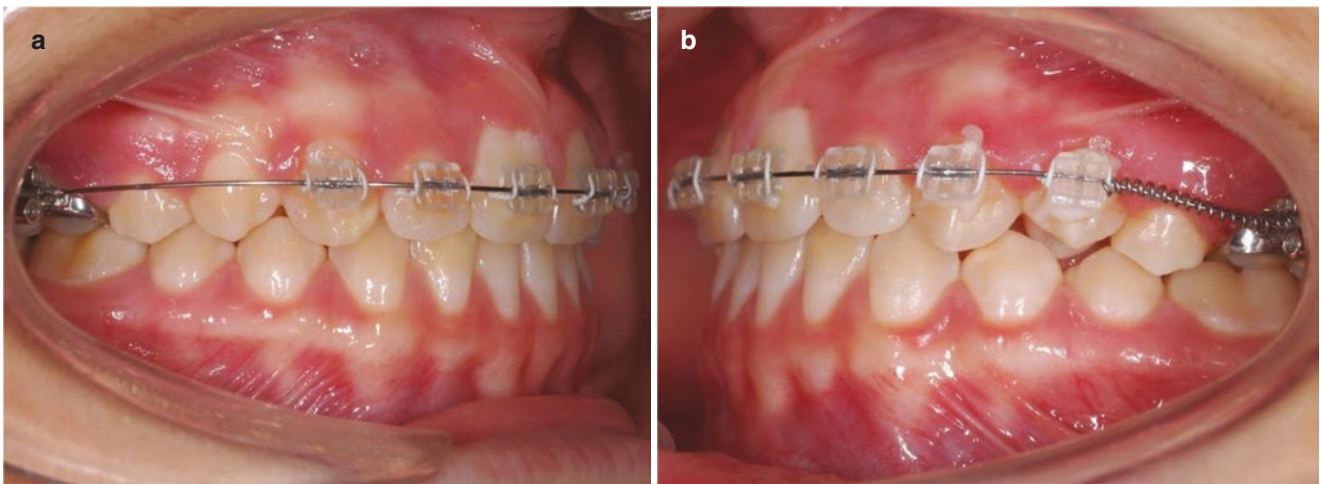


Fig. 7.21 (a and b) A nickel-titanium open coil spring was placed on the left side to improve the position of the first upper left bicuspid

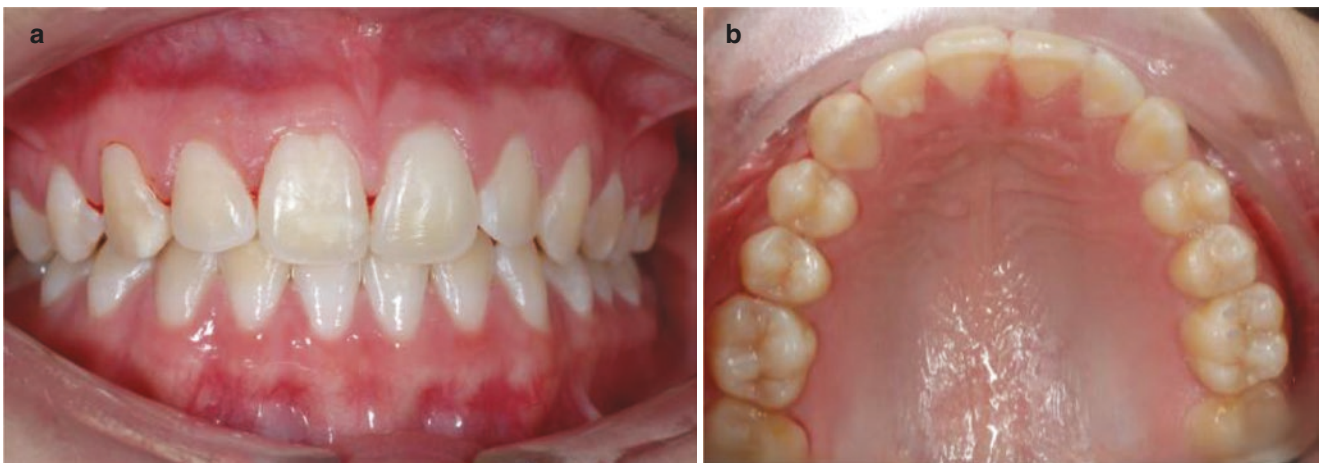


Fig. 7.22 (a and b) Final dental photographs at the end of the active orthodontic treatment

Dental midlines were corrected and overjet and overbite were normalized.

The gingival and occlusal planes were parallel, and the oral hygiene was fairly good (Fig. 7.25a and b).

Several environmental factors can be associated with the development of a complex skeletal malocclusion as the anterior tongue posture (Quiroga Souki).

The importance of the normalization of the functional problems specially the influence of respiration and its relation on the nasomaxillary complex is clearly demonstrated when the following patient is analyzed.

She was 7-year, 3 months of age and was sent to the office by her pediatric doctor due to her loud night snoring that disturbed not only her sister but also her parents' sleep.

She had a convex profile, difficulty to achieve lips closure, and double chin which are typical in all mouth breathers in conjunction with a larger lower third face and the presence of circles under their eyes.

Frequently she had colds with fever and was medicated with corticoids and antibiotics (Fig. 7.26a and b).

It is important to remember that abnormal tongue posture is associated with enlarged adenoids and tonsils in addition to sucking habits and tongue thrust. All of these affect the development of the normal function and consequently dental occlusion.

Thus, the early treatment of complex malocclusions that compromise dental and facial esthetics can have important psychosocial implications for some patients since they are considered less attractive by their peers (Kijak). These were the most important reasons to determine a two-phase treatment.

The stability of these open bite treatments might increase when the parafunctional habits were corrected.

The front dental photographs clearly confirmed the anterior position of the tongue at rest and a considerable open bite of 7 mm in the incisor region (Fig. 7.27a and b).

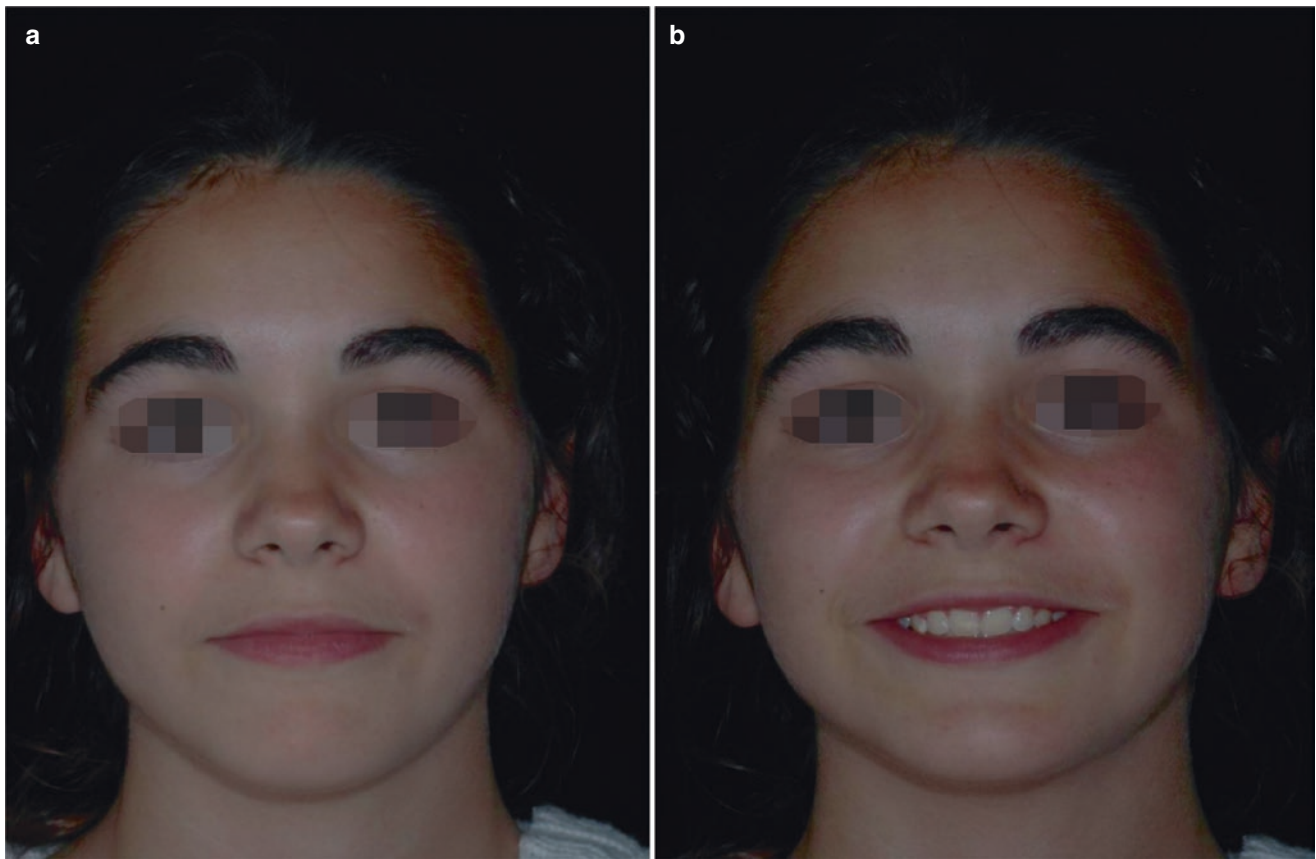


Fig. 7.23 (a and b) Final frontal photographs

The lateral views showed Class II molar on the right side and Class I molar on the left side. The temporary right canine, first and second molar, and permanent first molar were in crossbite occlusion.

The oral hygiene was good and no cavities were observed (Fig. 7.28a and b).

The panoramic radiograph confirmed that all the permanent teeth were present in different stages of development in accordance to her age. The open bite was confirmed on the lateral radiograph, and it was clearly visible that the respiratory airway was obstructed (Fig. 7.29a and b).

After the consultation with the specialist, the following treatment plan was decided:

1. Normalize the mouth breathing pattern.
2. Improve the position of the tongue at rest.
3. Normalize the position of the right canine and molars.
4. Achieve normal overjet and overbite.
5. Long-term stability.

In order to correct the transverse problem, a fixed bonded rapid maxillary expander was suggested. The design included bands on the right and left temporary second molars to protect the permanent first molars.

The activation was a quarter twice a day for 2 weeks.

At the same time she was sent to the speech therapist to normalize the position of the tongue and in this way help to close the anterior open bite (Fig. 7.30a and b).

After 2 weeks, the expansion was completed. It is highly recommendable that the expander be maintained in place for a minimum of 6 months to have better control over relapse (Fig. 7.31a and b).

The speech therapist had to continue working until the overjet and overbite were normalized.

A follow-up 2 months later confirmed the improvement achieved. The inter-incisal diastema was closing normally, and the position of the central incisors was normalized.

Different types of RME can be used but it is preferable to use those without acrylic plates, not only on the palatal tissues but also on the occlusal surfaces of the molars.

The protocol of activation is determined by the orthodontist but twice a day is usually sufficient (Fig. 7.32a and b).

The patient was gone for 2 years and then she returned without the RME.

The anterior occlusion was edge to edge and some open bite was still present. Cuspids and bicuspid were almost erupted (Fig. 7.33a and b).



Fig. 7.24 (a and b) Lateral photographs at the end of the active orthodontic treatment

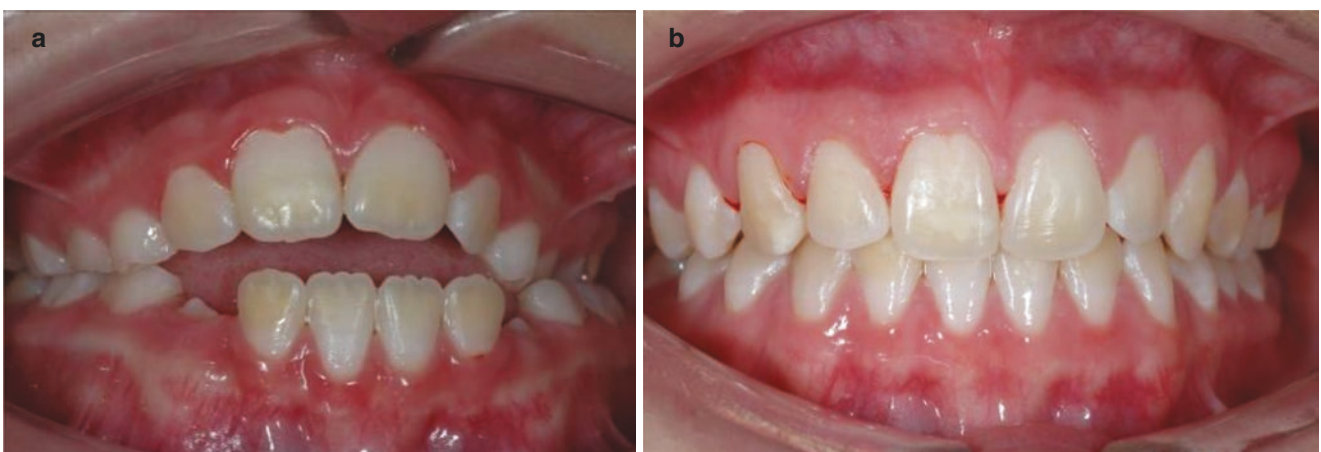


Fig. 7.25 (a and b) Comparison pre- and posttreatment. Midlines were totally corrected and overjet and overbite were normalized



Fig. 7.26 (a and b) 7 years, 6 months pretreatment photographs. A severe open bite was present along with a double chin

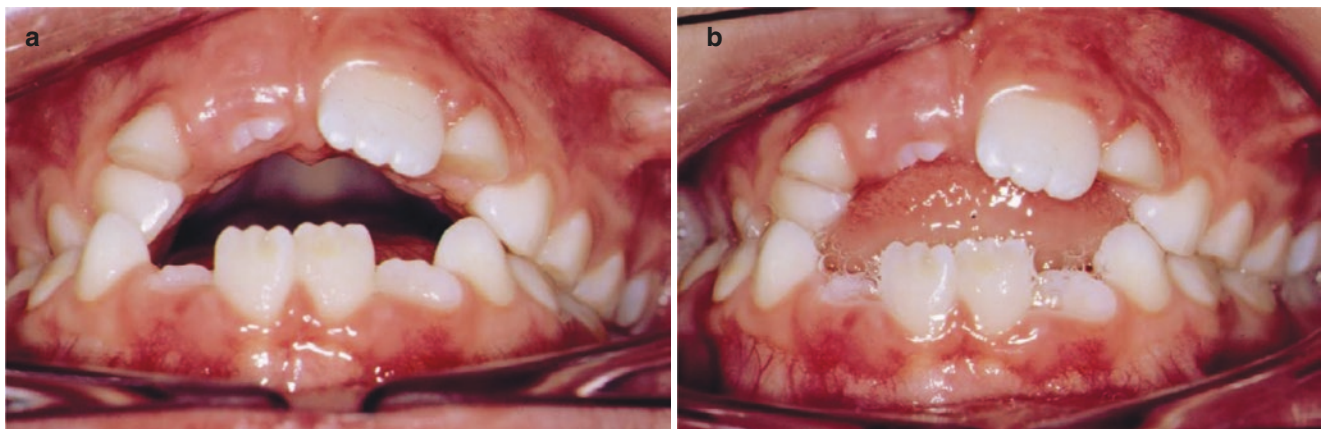


Fig. 7.27 (a and b) A severe 7 mm open bite was present

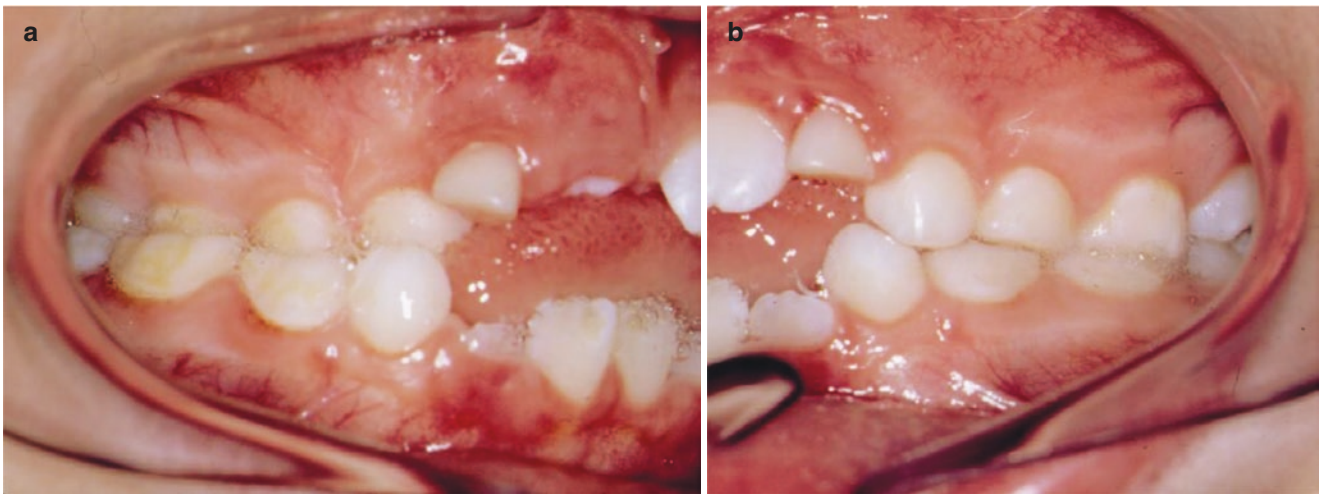


Fig. 7.28 (a and b) Pretreatment lateral views. Right lateral cross bite was present along with a considerable frontal open bite

Fig. 7.29 (a and b)
Panoramic and pretreatment
lateral radiographs. Anterior
open bite is clearly confirmed

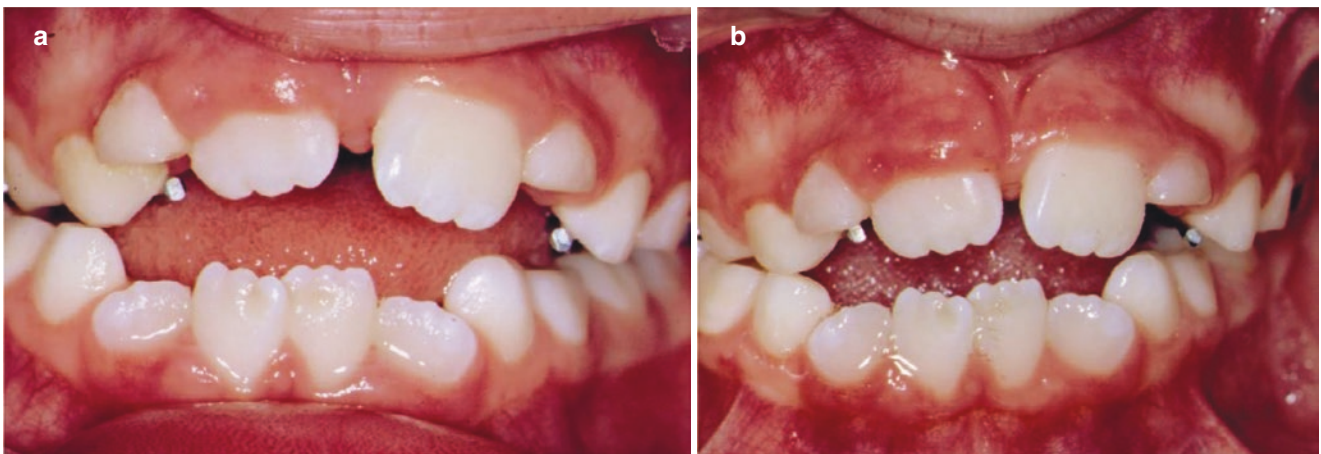
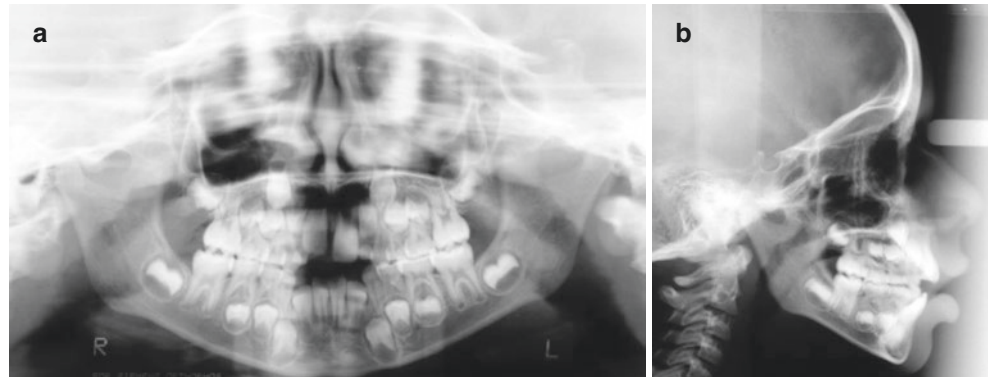


Fig. 7.30 (a and b) Rapid maxillary expander in place (a) and after 2 weeks activation (b)

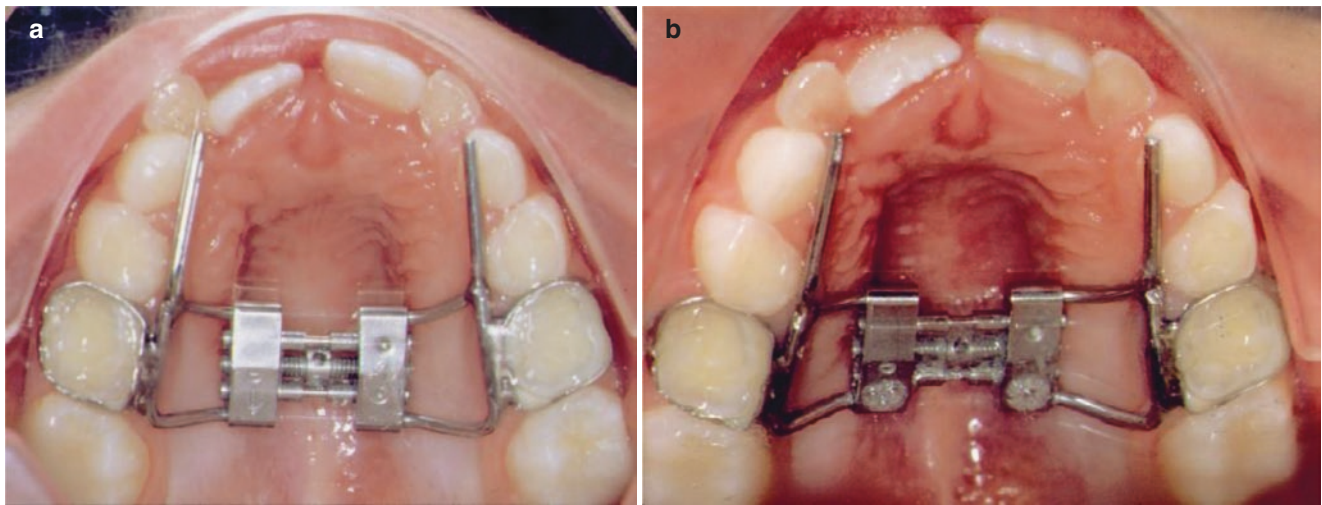


Fig. 7.31 (a and b) Rapid maxillary expansion in place after the expansion was completed

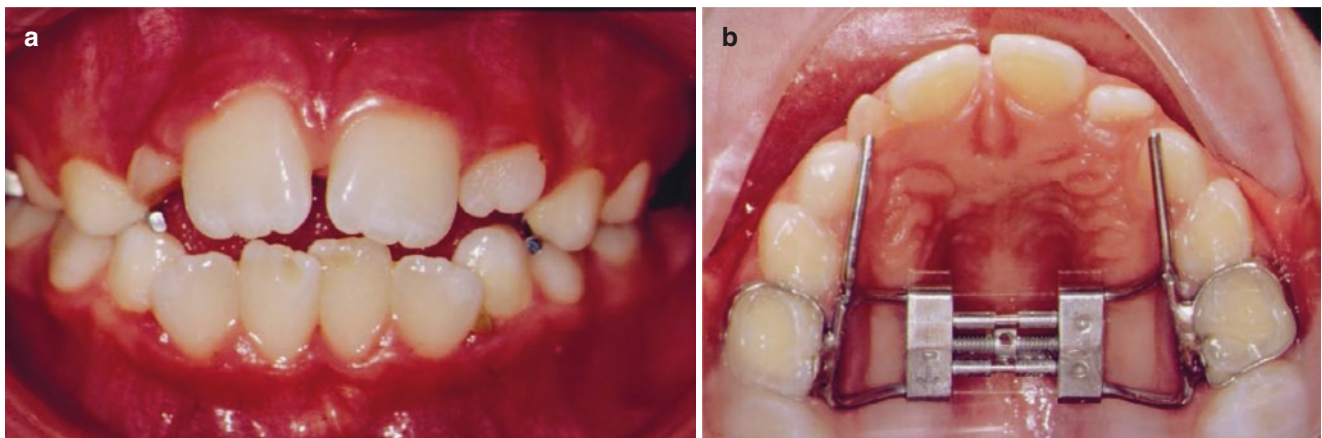


Fig. 7.32 (a and b) Follow-up 1 month later

The lateral photographs showed slight lateral open bite in the lateral.

Incisor and canine region, and tongue interposition was still present in this area (Fig. 7.34a and b).

After a long conversation with the parents and the patient, they accepted a Phase II treatment with fixed appliances in order to improve her dental occlusion and prevent any type of relapse of the anterior open bite (Fig. 7.35a and b).

New panoramic and lateral radiographs showed normal eruption of the cuspids and bicuspid with no evidence of root resorption.

According to Ricketts, she had a dolichofacial pattern with some protrusive incisors and a moderately increased lower anterior facial height and gonial angle (Fig. 7.36a and b).

Esthetic preprogrammed 0.022" slot brackets were bonded on the upper and lower teeth with SS 0.016" wires to

align and level the arches. No extraction of bicuspid was planned at that time.

Midlines are almost coincident (Fig. 7.37a and b).

No brackets were bonded on the second lower temporary molars. However, manual stripping was performed on the mesial side in order to achieve Class I canine on the left and right side (Fig. 7.38a and b).

The upper and lower arches showed great improvement. The lower second right and left temporary molars were still in place (Fig. 7.39a and b).

The dentoalveolar changes were significant with a greater improvement in the incisor position and inclination. Vertical control was very important in order to avoid an increase of the lower facial height, during the growth period.

These were the results 2 years after debonding. Midlines were coincident. Overbite and overjet were almost normal and the oral hygiene was fairly good (Fig. 7.40a and b).

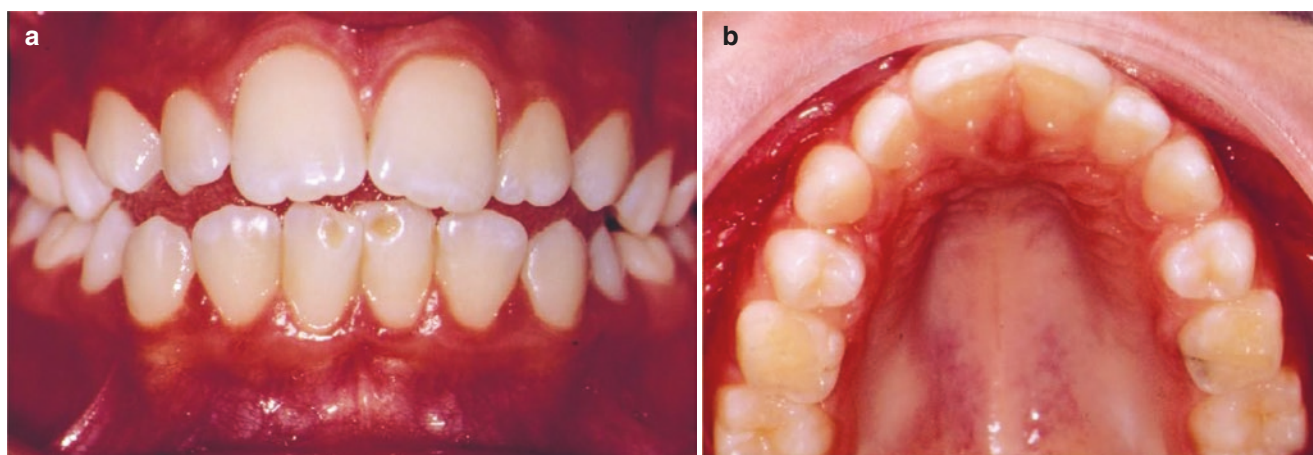


Fig. 7.33 (a and b) Frontal photographs after 2 years without follow-up. The anterior position of the tongue was still present

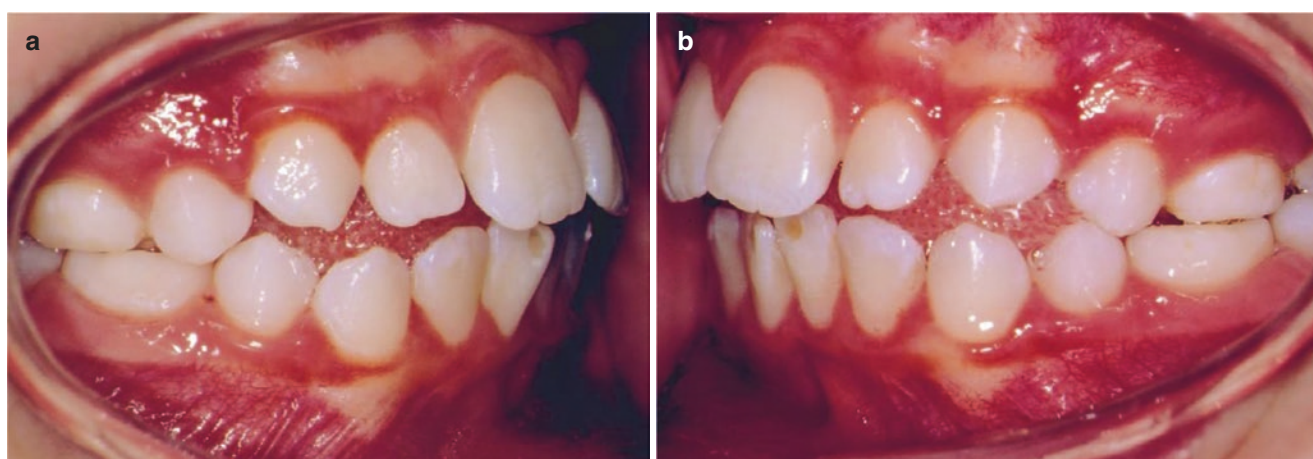


Fig. 7.34 (a and b) Lateral views after 2 years without follow-up

Right and left Class I canine and molar were obtained with good interdigitation in the bicuspid area. The gingival line and the occlusal plane were parallel (Fig. 7.41a and b).

A fixed retention wire was bonded on the upper and lower arches to maintain the position of the incisors. Long-term retention in addition to a removable appliance was recommended to control the function of the tongue (Fig. 7.42a and b).

The final photographs after the orthodontic treatment showed a significant improvement in the lower third of the face. She could close the lips without tension and there was

no gingival smile. The dental midline was coincident with the facial one (Fig. 7.43a and b).

The profile photographs clearly showed a muscle equilibrium. The profile was still straight and the nasolabial angle was normal (Fig. 7.44a and b).

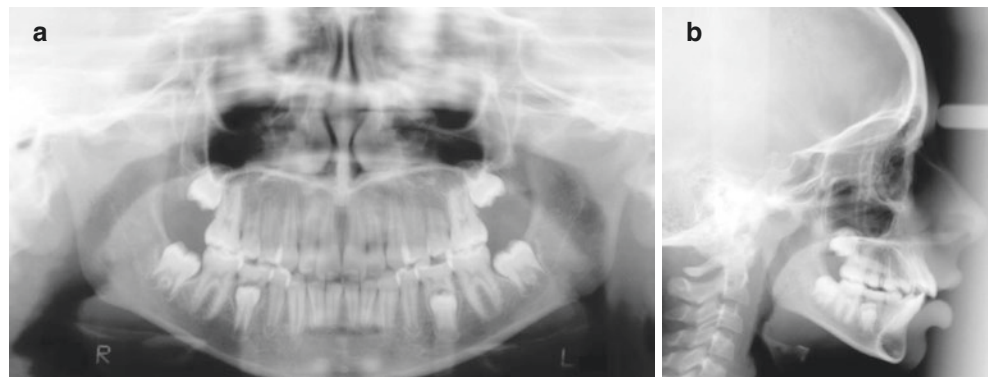
The patient returned 3 years later for a control of her retention wires.

Her smile was better than ever and the oral muscles were completely relaxed. At the end she presented a symmetrical face with balanced proportions (Fig. 7.45a and b).



Fig. 7.35 (a and b) Frontal and profile photographs at the beginning of the second phase of treatment

Fig. 7.36 (a and b)
Panoramic and lateral
radiograph 2 years later
without orthodontic control



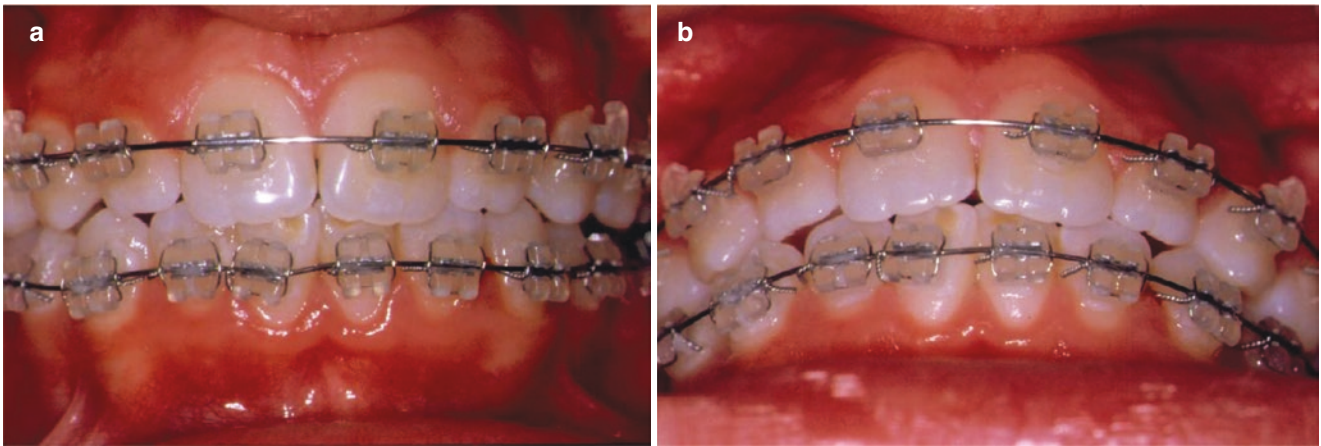


Fig. 7.37 (a and b) Esthetic 0.022" slot preprogrammed brackets were bonded on the upper and lower arches along with SS 0.016" arches

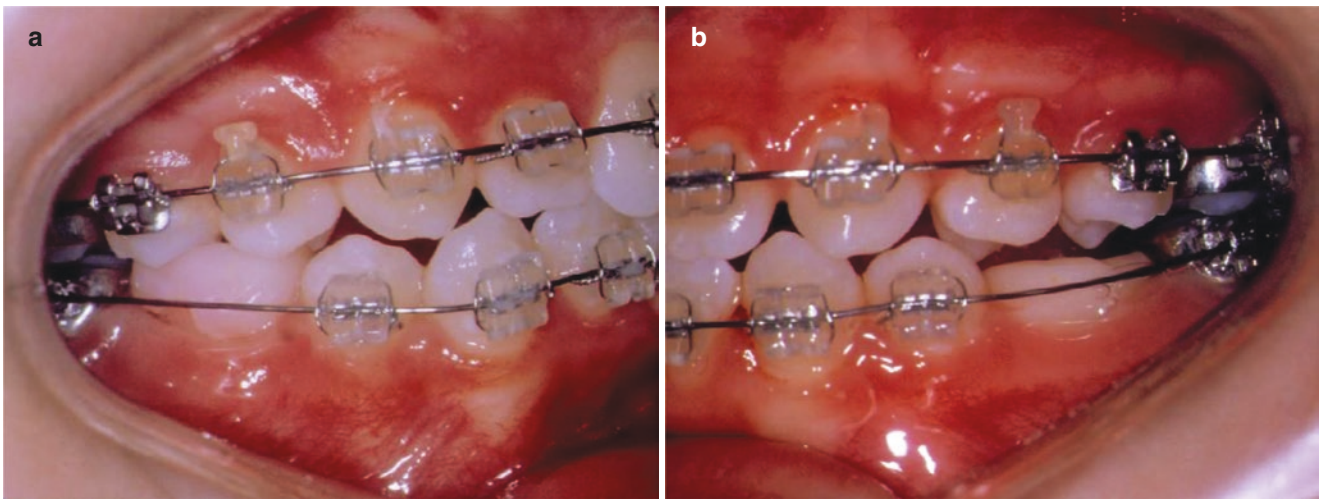


Fig. 7.38 (a and b) Lateral views after bonding the brackets

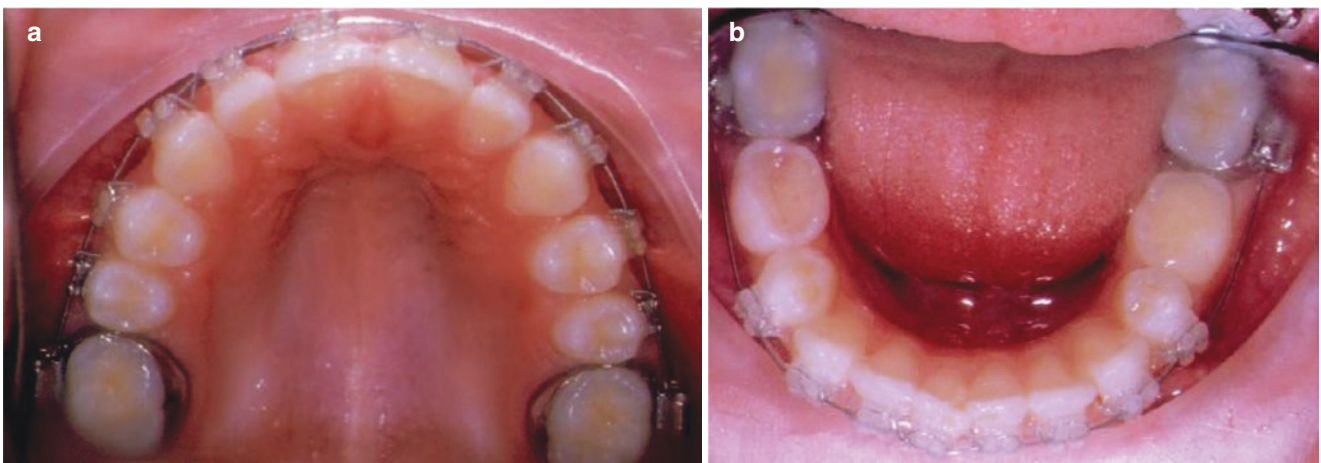


Fig. 7.39 (a and b) Upper and lower arches at the beginning of the second phase of treatment

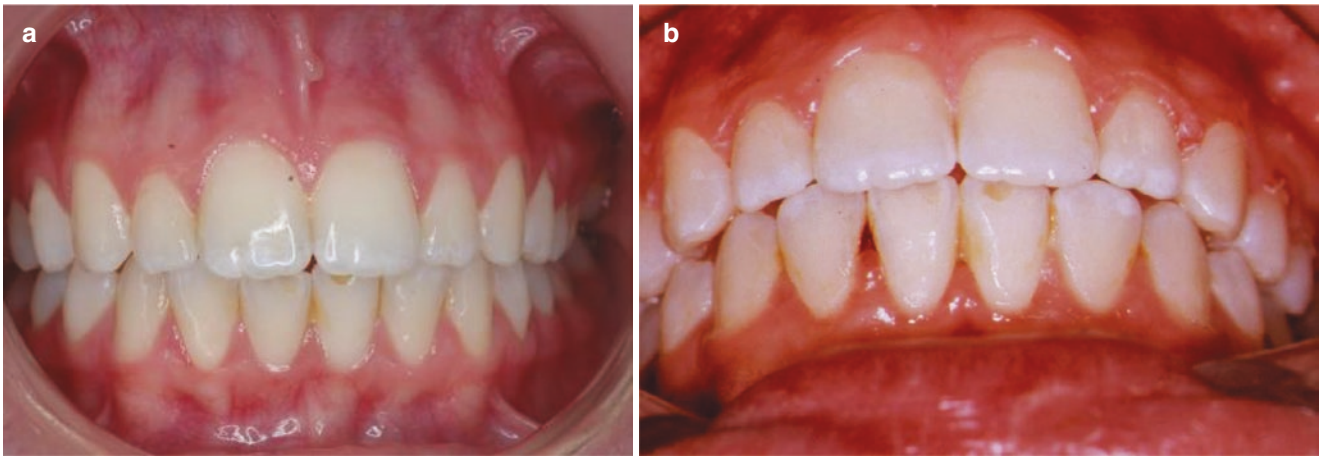


Fig. 7.40 (a and b) Control 2 years after treatment. Midlines were coincident

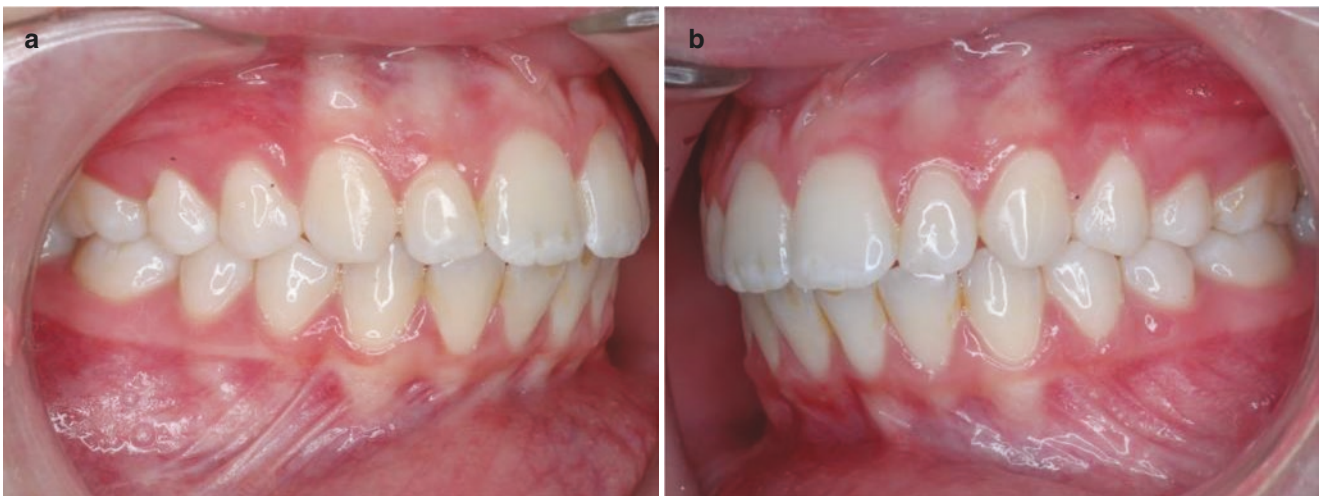


Fig. 7.41 (a and b) Right and left Class I canine and molar were achieved

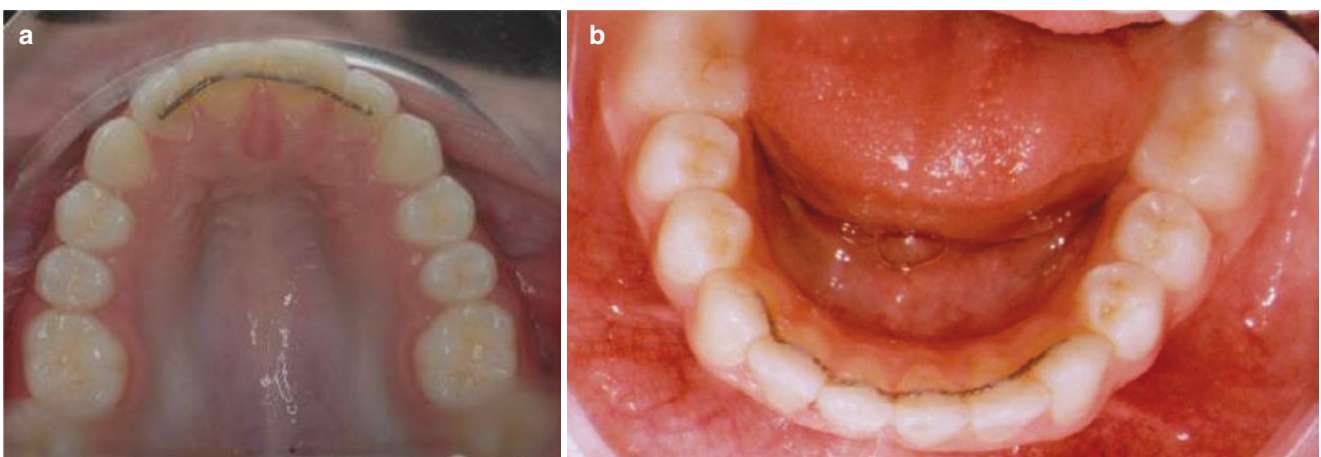


Fig. 7.42 (a and b) Fixed upper and lower retention was bonded on the upper and lower arch



Fig. 7.43 (a and b) Final frontal and frontal smile photograph at the end of the treatment



Fig. 7.44 (a and b) Lateral and smile profile photograph at the end of the treatment

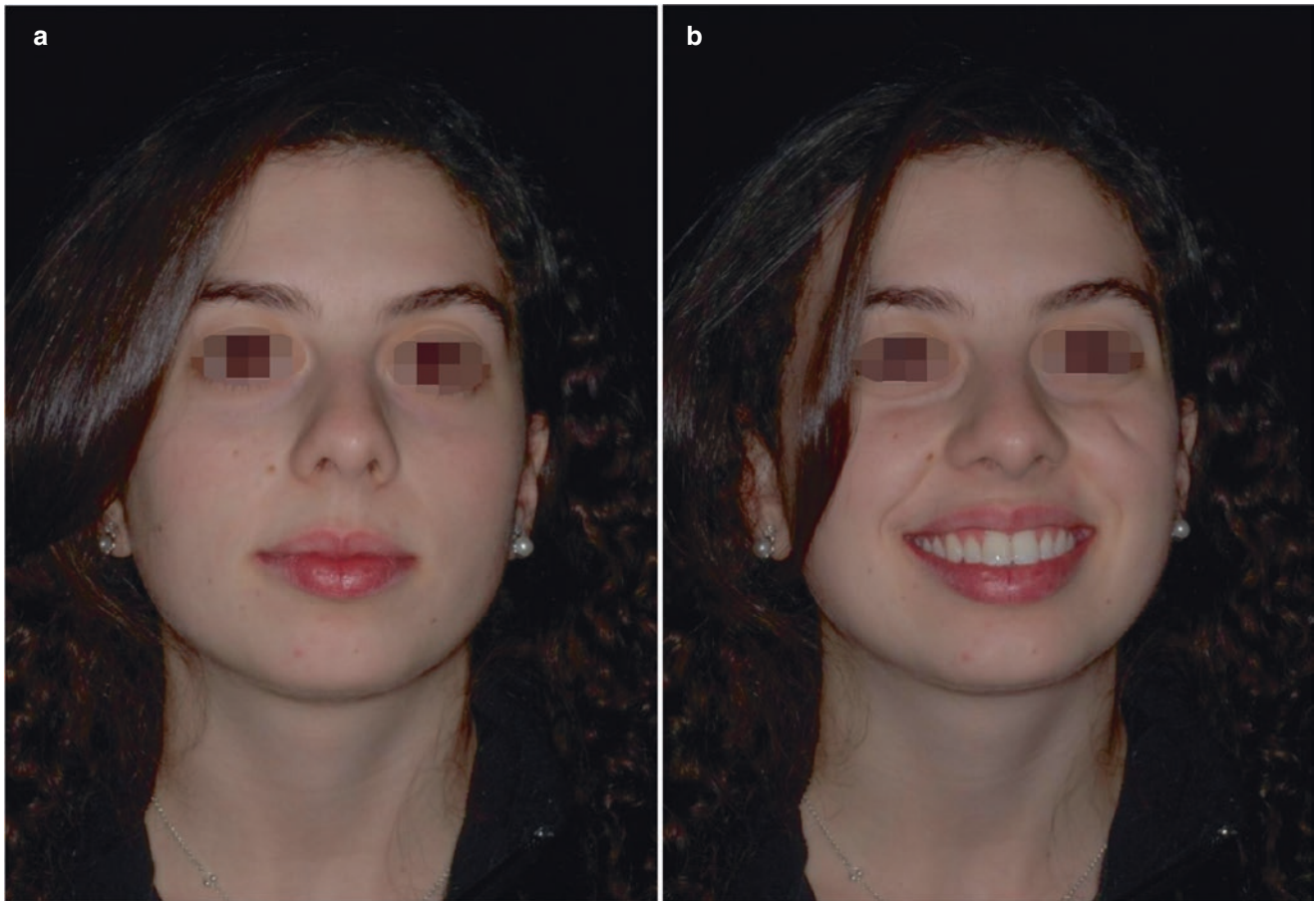
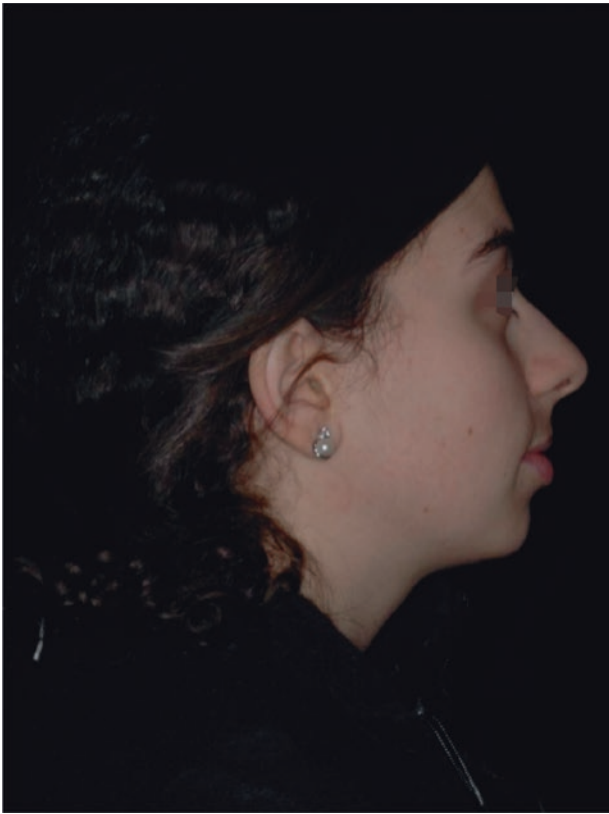


Fig. 7.45 (a and b) Follow-up 3 years later

The nasolabial angle was more open even though no extractions were performed in the upper arch nor in the mandible. A nice and broad smile was achieved.



When analyzing the front photographs 3 years later, a slight relapse in the anterior region was observed. With this in mind, it was advisable to finish the case with bigger overbite in order to relapse.



Class I canine and molar were maintained. A 6-month follow-up was highly advisable in order to maintain or improve the results that were achieved.



The observation of the pre- and postfrontal dental photographs showed that the treatment objectives were achieved. The gingival line and the occlusal plane were parallel and the hygiene was very good.

This confirmed that to obtain an efficient therapeutic result, correct diagnosis and treatment timing are very important.



The comparison of the pre- and postfrontal photographs clearly demonstrated how the soft tissues were improved as a consequence of the correction of the bad habits. Now, the patient closes her lips normally.

The importance of tongue posture and tongue function cannot be denied.



The results were similar from the lateral side. She had a straight profile and closed her mouth in a normal way with reduction of the lip protrusion and decreased mentalis strain.

The nasolabial angle was less protrusive even though no bicuspid extractions were performed.

There was a significant improvement in vertical skeletal and dentoalveolar relationships due to the elimination of the tongue thrust and mouth breathing. This patient confirms the

theory that early treatment in conjunction with the normalization of functional habits prevents asymmetric alveolar bone growth that affects the permanent dentition.

There is considerable evidence to support the benefits of early orthodontic treatment to correct parafunctional habits as well as to improve oral function in a growing child, thus contributing to better skeletal and occlusal development (Quiroga Souki).



The present clinical case clearly demonstrates that if proper diagnosis is obtained and orthodontic biomechanics are well designed, stable results can be achieved in a patient with severe anterior open bite.

The post-retention stability of open bite treatment is a controversial topic in orthodontics. Relapse is unpredictable.

The etiology could be tongue thrust, its size or posture, respiratory problems, sucking habits, condylar resorption, direction of growth, etc.

Habit elimination is mandatory to prevent open bite relapse.

How can relapse be prevented? Better diagnosis and an individualized treatment and retention plan.

7.1 Conclusions

Ideally, open bite patients should be treated as early as possible.

Unfortunately there is no specific bracket or archwire to help the normalization of the position of the tongue.

These three patients were treated with different appliances since the etiologic reasons at the beginning were different: the first one used a pacifier until 4 years of age and had an adenoidectomy, the second one had a persistent tongue thrusting habit until 9 years of age and the third one was a combination of both.

From a clinical point of view, early treatment with removable or fixed appliances is more effective and reduces the length of treatment in the permanent dentition with less surgical procedures and more stability.

It is well-known that environmental and neuromuscular influences may alter the position of the teeth and the direction of the maxilla and mandibular growth.

It is important to determine the presence or absence of anos- or oropharyngeal obstructions that can alter the position of the tongue and the mandibular posture.

Dentofacial changes associated with mouth breathing and its relation with some types of malocclusions that involve the presence of long face syndrome are well recognized (Linder-Aronson and Woodside).

The role of the otolaryngologist and speech therapist is unquestionable in the diagnosis and treatment procedures.

There is strong evidence that the earlier the open bite malocclusion is corrected, the better the prognosis will be and of

course, habit elimination is mandatory to prevent open bite relapse.

Ideally the treatment has to begin when the children are 4–6 years old as most of the functional and dentofacial problems begin at this age and also there is a reduction in the risk of trauma of the upper front teeth.

The prevention of apnea is more important than the correction of the snoring. Remember that snoring in children in conjunction with poor concentration at school and behavioral problems are the most typical signs of sleep apnea episodes in children.

Relapse is unpredictable since the etiology could be multifactorial (condylar resorption, respiratory problems, continuous tongue thrust, direction of growth, habits, etc.).

It is well-known that the stability after retention of the open bite treatment is a controversial issue for the orthodontists.

The effectiveness and efficiency of an early orthopedic/orthodontic treatment, based on a correct individualized and exhaustive diagnosis, is undeniable.

Long-term control is fundamental to confirm the achieved results (Huang).

The normalization of the anterior open bite is imperative taking into account the health problems that can occur later on.

Also, it is important to take into account that these patients are prone to having mild-to-moderate obstructive sleep apnea (OSA). This problem includes a disorder of breathing during sleep, and these children can present nocturnal snoring, sleepiness during the day, and nightmares and could or are likely to develop some type of craniomandibular dysfunction.

Unfortunately there is not a specific bracket or wire to treat all these patients nor to help in the normalization of the tongue position.

The parents and the young patients have to be aware that the earlier the correction of the dysfunctional habits begin, the better and more effective the results will be.

A complete multi- and interdisciplinary early treatment plan is the key to correct the anterior open bite and the functional disturbances associated with it.

Reference

- Urzal V, Braga AC, Ferreira AP. Oral habits as risk factors for anterior openbite in the deciduous and mixed dentition-cross sectional study. *Eur J Pediatric Dent.* 2013;14:299–302.

Correction of the Transverse Problems

8

Julia Harfin

Normalization of the upper arch has always been one of the most important issues in the treatment of young children with constricted maxillary arch with uni- or bilateral crossbite.

The etiology is multifactorial and the functional problems play an important role. The environmental factors are determinant not only in the beginning but also in the maintenance of the malocclusion. It can be present in Class I, II, or III patients with or without crowding.

It is acknowledged worldwide that transverse problems have to be normalized in temporary or early mixed dentition to allow a normal eruption of the bicuspid and cuspids.

It is well accepted that the younger the patient, the easier it is to achieve excellent results with fewer chances of relapse. The most appropriate timing for treatment appears to be before the eruption of the permanent lateral incisors.

The recovery of the normal maxillary width not only allows the gaining of space in the lateral areas but also gives the tongue more space to function in the correct position and maintain the results until adulthood.

After the treatment not only is the normalization of the arch perimeter achieved but in most of the cases the patients recover normal nose breathing (day and night) and stop snoring.

Expansion is one of the noninvasive methods of gaining or recover space in the transverse dimension.

It can be classified in slow or rapid expansion according to the rate of activation and also it can be uni- or bilateral according to its direction.

Dentoalveolar expansion produces dental expansion without any skeletal change and in general a removable appliance is used. This type of appliance is able to tip the teeth buccally but are not able to open the midpalatal suture (Fig. 8.1a and b).

Dr. Emelson C. Angell in 1860 described this treatment for the first time. He is considered the father of the rapid maxillary expansion. In 1950, Korhauss and Andrew Hass reintroduced this appliance, and now its use is highly recommendable no matter what type of other appliances is combined.

Rapid maxillary expansion (RME) is considered as dento-facial orthopedic appliance that produces a splint at the middle palate suture. Teeth are generally used as anchorage units (Hass), but in the last years bone-teeth or skeletal anchorage appliances are described with very interesting results (Wilmes).

Indications for maxillary rapid expansion include uni- or bilateral posterior or anterior crossbite, constricted maxillary arches with mouth breathing tendency, tooth size-arch length discrepancy, etc.

Moreover, limited information is available about the long-term stability of the changes of the airway produced by RME (McNamara). Some studies have shown that maxillary constriction has a very close relationship with apnea in children, and this is an important issue to take into account.

To maintain the results, a fixed quad-helix appliance is suggested in almost all the young patients until the complete growth period is finalized.

When the diagnosis indicates that a skeletal expansion is recommendable, it has to be performed by a fixed appliance, and the result is the movement of the maxillary shelves away from each other (Fig. 8.2a and b). The pre- and post-occlusal radiographs after 2 weeks of activation of a rapid palatal expander showed the expansion that was produced in the midpalatal suture very clearly.

It is highly recommendable that this procedure be initiated prior the ossification of the midpalatal suture. There is an individual variation among all the patients but it is recognized that in general girls complete their growth period between 12 and 14 years of age and boys a little later (14–17 years old).

This procedure is always used in order to increase maxillary arch perimeter, correct uni- or bilateral cross-

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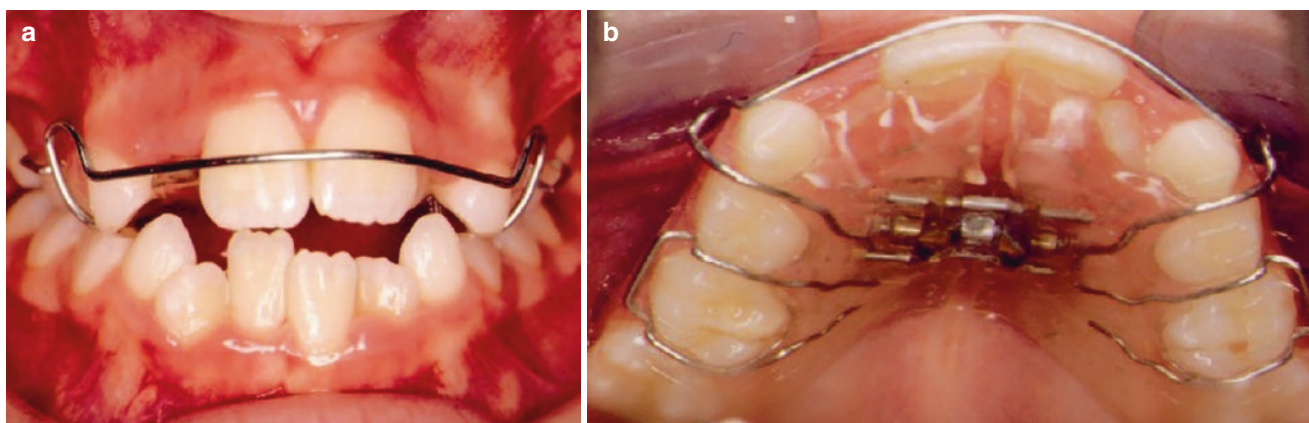


Fig. 8.1 (a and b) Example of a removable appliance to correct a slight transverse problem

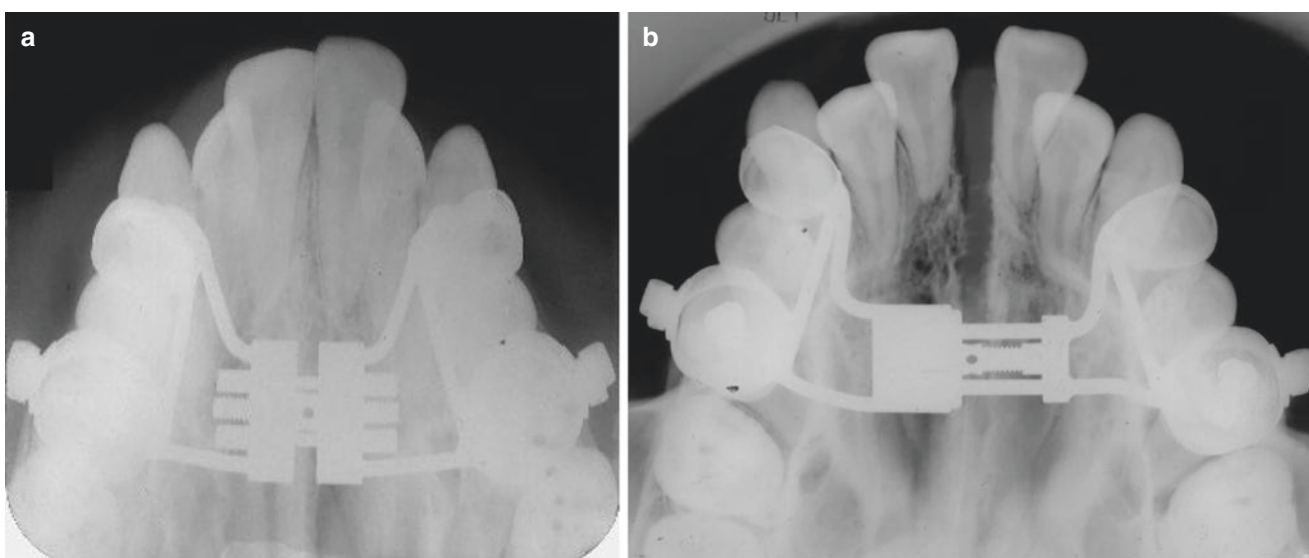


Fig. 8.2 (a and b) Pre- and post-occlusal radiographs after the use of a rapid maxillary expander for 2 weeks

bite, improve anterior crossbite, and in some cases improve airway flow.

According to the diagnosis and treatment plan, all the appliances have a similar design with bands on the first molars or metallic crowns on the first and second temporary molars. Different designs were described by different authors (bonded or cemented) but all of them include a central expansion screw.

The activation protocol involves the generation of orthopedic forces that could split the midpalatal suture. The screw has to be activated 1, 2, or 3 times a day (one quarter turn) according to the individualized treatment objectives. No pain and little discomfort could be present during the first days. The parents and the patients have to be instructed on the maintenance of the appliance and strict oral hygiene is nec-

essary. Very few difficulties in speech and mastication could be present during the first 3–4 days.

It is advisable to give the patient an instruction sheet listing the schedule of activation and all the cares to take into account during the whole procedure. The parents' help is invaluable.

Normally the suture will open between 6 and 10 days.

An important interincisal diastema is always present when the midpalatal suture is set apart and then closes spontaneously after 2–3 weeks due to the action of the supra-crestal fibers. The patient has to be controlled once a week to monitor the treatment during the expansion phase.

The lack of space in the anterior region is also an indication for using RME during the early mixed dentition period (Rosa). This procedure does not require any patient

cooperation and allows the increase of the perimeter of the upper arch.

In general, raising of the bite is not necessary in meso-, braqui-, or dolichofacial patients. The results are very predictable in a relatively short period of time.

Different types of RME can be used (Fig. 8.3a and b).

The following patients are a clear example of the results that can be achieved using this protocol.

The first one is an 8-year-old patient that was sent to the office by the family dentist due to lack of space for the eruption of the upper lateral incisors. The mother was worried about the central interincisal diastema. Mild constriction of

the upper arch was present at the beginning of the treatment (Fig. 8.4a and b).

To increase the transversal width of the upper arch, a standard rapid maxillary expander was bonded with bands on the second temporary upper molars in order to protect the first molars and avoid eventual decalcifications or cavities. A distal extension wire was welded to the screw toward the right and left first molars and a mesial one until the temporary canines (Fig. 8.5a). The screw was activated twice a day (once in the morning and again after dinner). The results were achieved in two weeks and, as always, the interincisal diastema became wider (Fig. 8.5b).

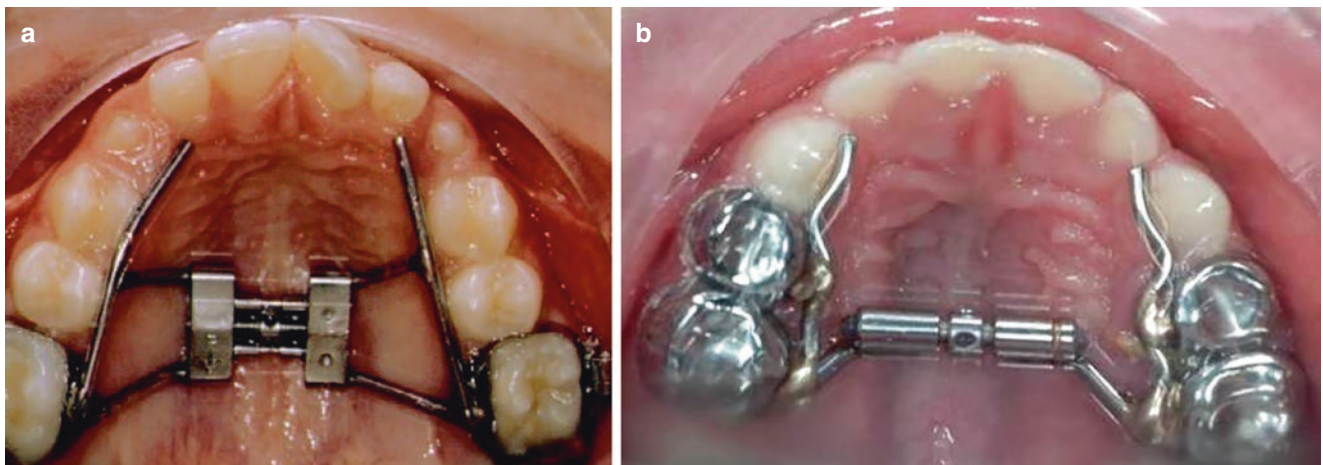


Fig. 8.3 (a and b) Different types of RME can be used with the same protocol of activation

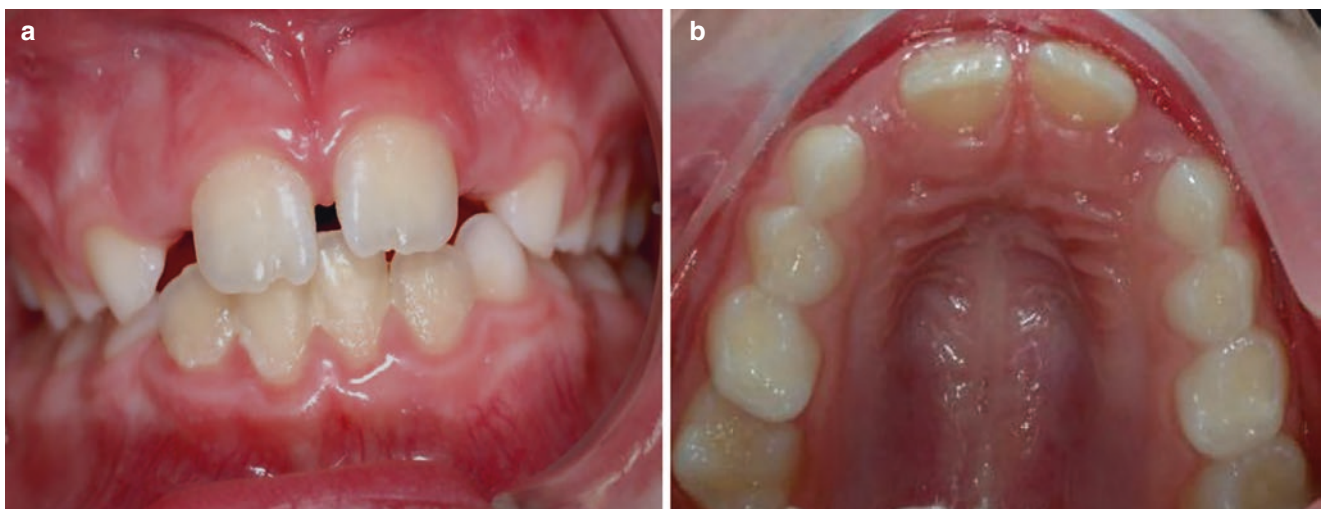


Fig. 8.4 (a and b) Pretreatment intraoral photographs. The lack of space for the upper lateral incisors was evident

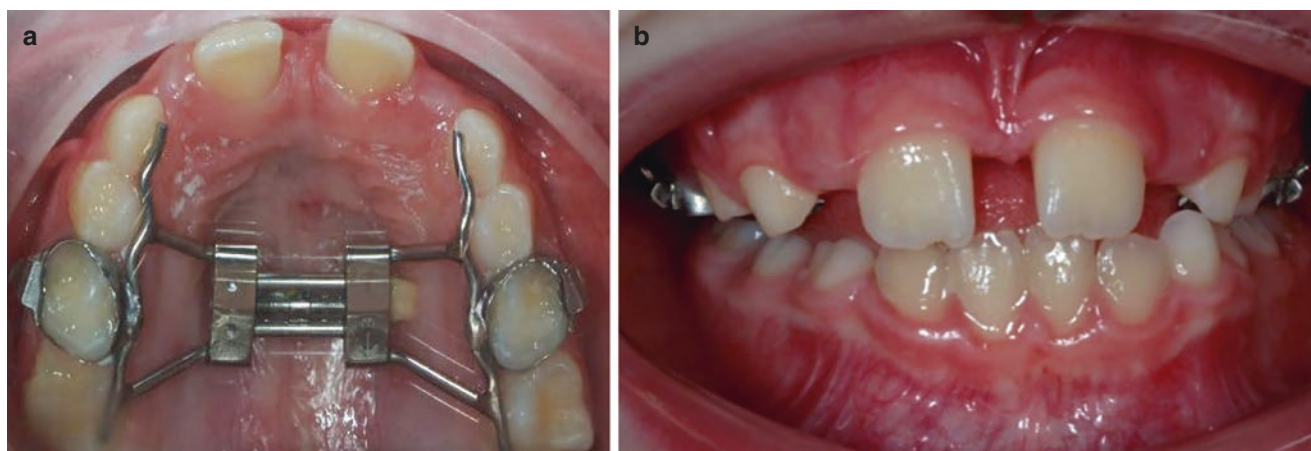


Fig. 8.5 (a and b) Results after 14 days of activation. A wider diastema was clearly visible

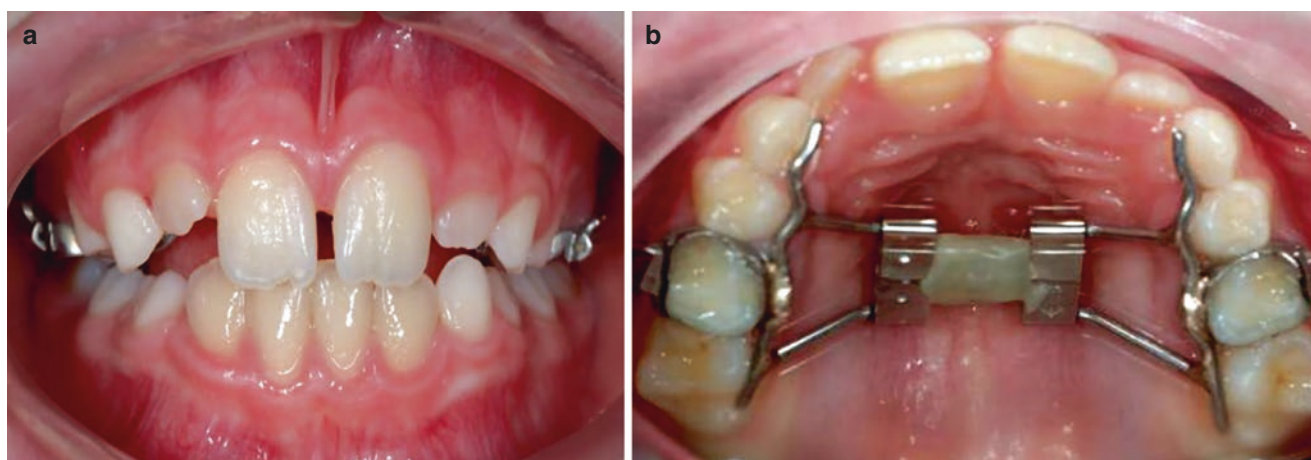


Fig. 8.6 (a and b) After 3 weeks the diastema was almost closed. The expander screw was fixed with composite

As was expected 3 weeks later, the diastema was almost closed and the upper lateral incisors began to erupt. The expander's screw was fixed with composite. In these cases, it is highly recommendable that the same appliance be used as a fixed retainer for a period of 6 months at least (Fig. 8.6a and b).

For personal reasons the patient returned 3 years later, and no other orthodontic treatment had been performed in that span of time. The upper lateral incisors erupted and the interincisal diastema was closed. The occlusal photograph showed that the bicuspid erupted in their right position, and the width of the upper arch was maintained (Fig. 8.7a and b).

This patient is a clear example of the importance of the normalization of the arch perimeter in the early mixed dentition.

In cases where the extraction of bicuspid is necessary, it is important that they be postponed until the rapid maxillary expansion process is concluded.

In general, a retention period of 6 months with the appliance in place is recommendable in order to control any type

of relapse and permit a complete reorganization of the suture and all the surrounding tissues. This time is also important to allow the adaptation of the facial muscles to the new transverse dimension of the maxillary arch.

Otherwise, relapse will be the consequence. It is important to keep in mind that muscles play an important role in maintaining the results achieved in the transverse dimension.

In general, when the RME appliance is placed on the temporary molars, a slight normalization of the position of the incisors is achieved as result of the anterior expansion of the upper arch perimeter in the early mixed dentition.

There is no doubt about the effectiveness of the RME when it is cemented on the temporary molars with a wire welded to the palatal surfaces of the first permanent molars. In general expansion is achieved in the first permanent molar area too (Mutinelli) (Fig. 8.8).

The efficacy of this appliance is well acknowledged by all the orthodontists. The relationship between arch perimeter

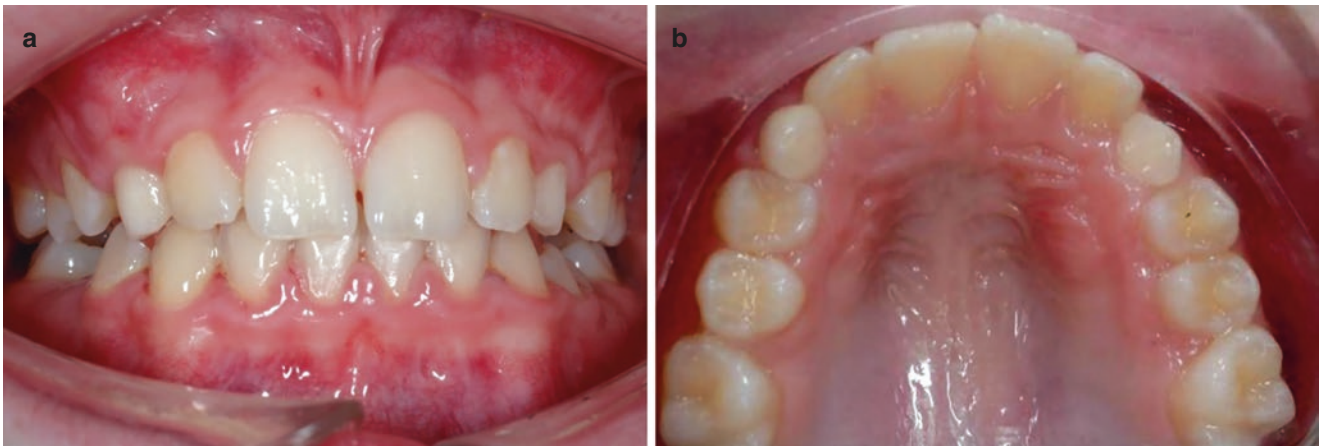


Fig. 8.7 (a and b) Results 3 years later without any orthodontic treatment. All the treatment objectives were achieved

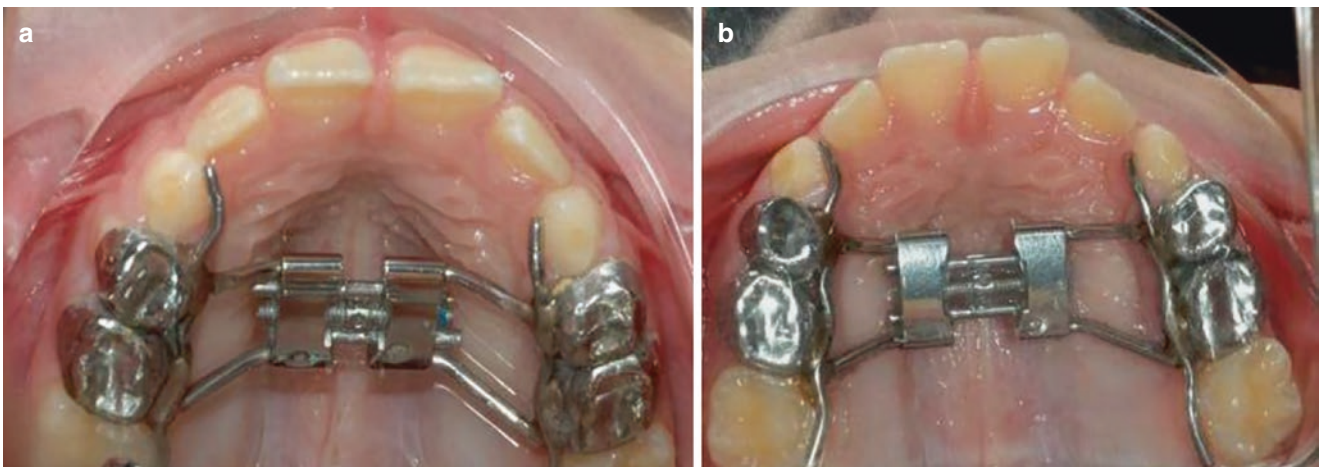


Fig. 8.8 (a and b) An example of an RME bonded on the temporary molars. The use of crowns on the temporary molars is advisable for better retention

and arch expansion was very well studied by Adkins and coworkers. They concluded that an average of 0.7 mm arch perimeter is increased after 1 mm of transpalatal width enlargement, but these proportions could vary according to the age and patient facial biotype.

The next 8-year-old patient was sent to the office by her mother, a pediatric pulmonologist, who was worried about the triangular shape of her maxillary arch (Fig. 8.9a). The child was a mouth breather until 6 years of age, and after a 1 year treatment with a speech therapist, she was able to correct this habit. To normalize the shape of the upper arch and at the same time make sufficient space for the upper incisors, an RME was placed with bands on the first molars and extension wires bonded to the temporary canines. The activation protocol was two turns a day. The interincisal diastema was visible after the first week of treatment (Fig. 8.9b).

After 8 months, metal preprogrammed brackets (0.022") were bonded on the rotated upper incisors and temporary

canines to correct their position with a SS 0.016" archwire for a 6-month period (Fig. 8.10a). Excellent results were achieved 7 months later. The cuspids and bicuspid erupted in the correct position without any additional appliance. The arch width was maintained and a removable retention was placed (Fig. 8.10b).

The comparison between the pre- and posttreatment smile clearly showed its improvement. This is one of the best protocols to obtain a broad smile in a very controlled procedure (Fig. 8.11a and b).

The lateral smile photographs confirmed how the thickness of the upper lip changed. Since the facial biotype plays an important role in the maintenance of the results, it is important to determine an individualized treatment plan. A 6-month follow-up was recommended until the second molars fully erupted (Fig. 8.12a and b).

Silva and coworkers describe that after RME, the maxilla is displaced downward and backward. Meanwhile, Hass

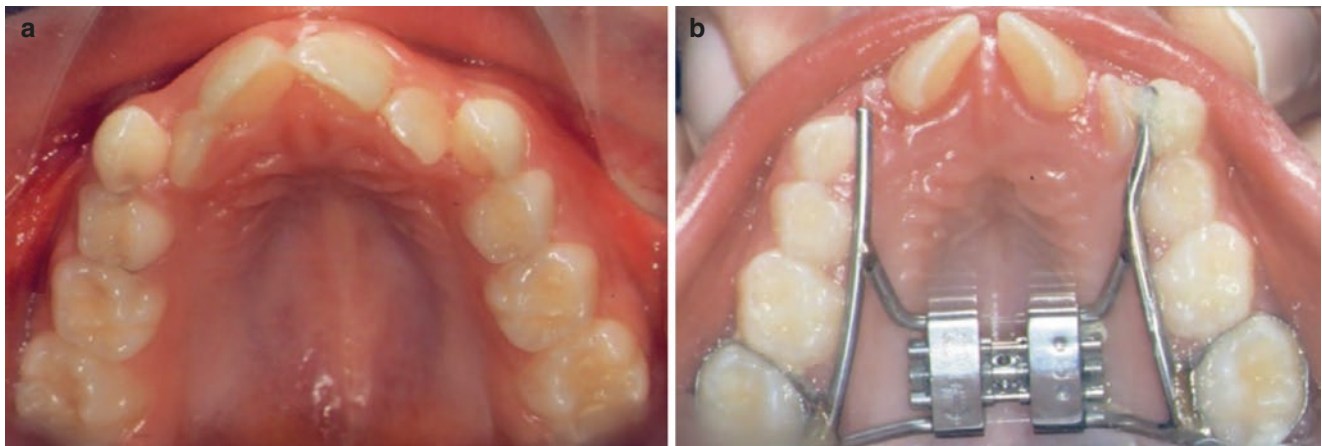


Fig. 8.9 (a and b) Pretreatment occlusal photograph and 1 week after the activation of an RME

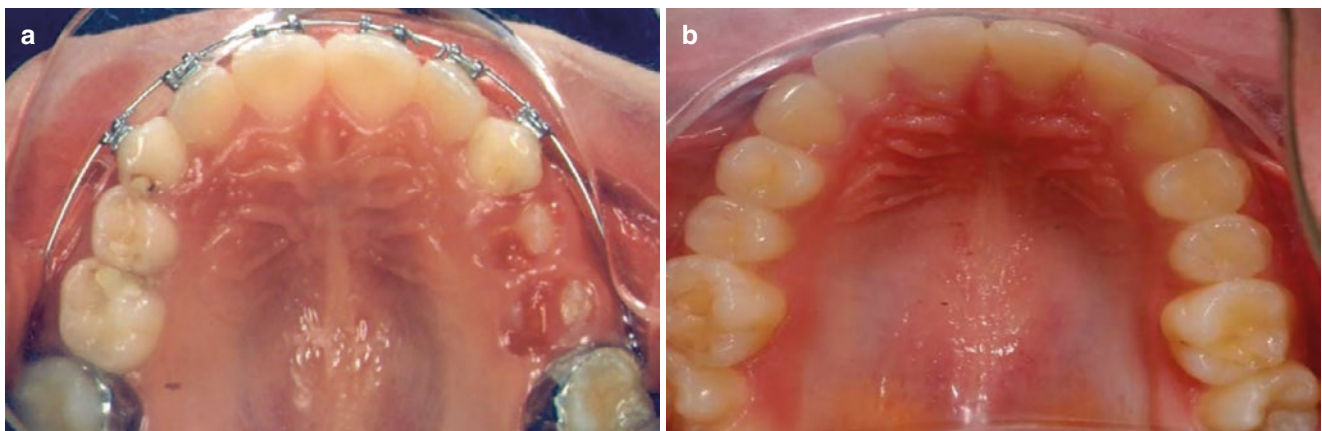


Fig. 8.10 (a and b) Occlusal photographs during the second phase of treatment and at the end of the active procedure

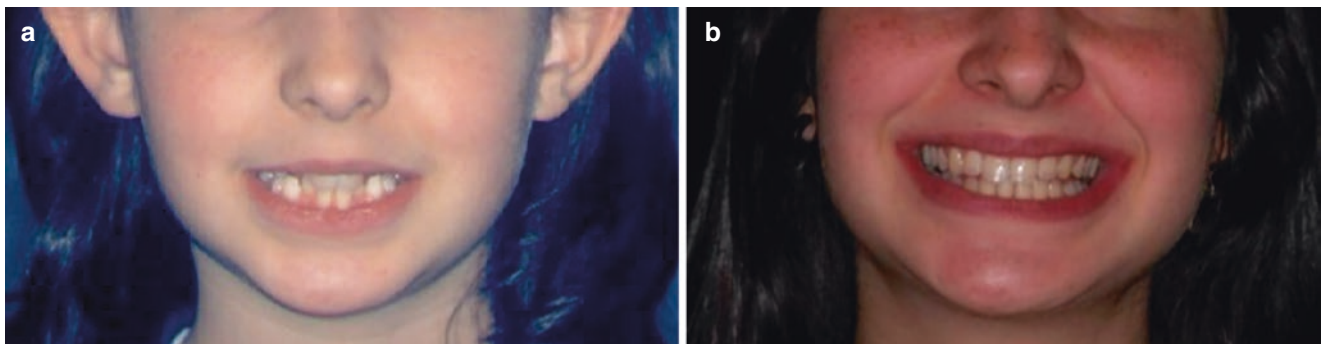


Fig. 8.11 (a and b) Comparison of pre- and posttreatment frontal smile. A significant improvement was achieved

showed that the result is a slight bite opening and a forward displacement of Point A. It is very difficult to compare all these studies.

The retention protocol could change according to various circumstances and includes a removable palatal plate such as a Hawley or Schwartz appliance or functional appliances like

Trainers (myofunctional appliances). There is no specific period of time for all patients but a minimum of 12 months is required in order to give the reorganization of the soft and hard tissues enough time to avoid relapse.

The following case is another interesting example of correction of transverse problems. The following patient was



Fig. 8.12 (a and b) The improvement in the thickness of the upper lip in concordance with a broadened smile was more than satisfactory

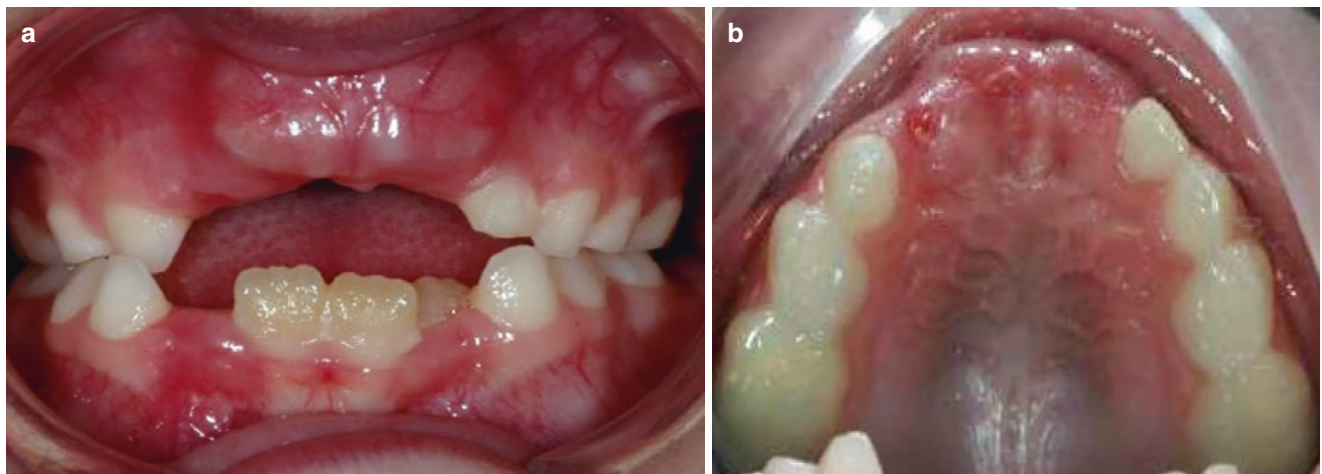


Fig. 8.13 (a and b) Pretreatment frontal and occlusal photographs of a 7-year and 6-month-old patient

7 years and 6 months of age in the first consultation. He was the youngest of four children, three of them with class III molar and canine.

No important medical history was present.

She had difficulties with the pronunciation of some consonants due to the absence of the upper incisors in conjunction with the anterior position of the tongue (Fig. 8.13a and b).

Upon analyzing the lateral views, a slight compression in the temporary canine and molar region was present. The right canines were in crossbite position (Fig. 8.14a and b).

The panoramic radiograph showed that there were no agenesis nor supernumerary teeth (Fig. 8.15a), and the lateral radiograph confirmed that the patient would have a mesofacial growth. The lips were closed without tension with a normal nasolabial angle (Fig. 8.15b).

The treatment objectives were as follows:

1. Normalize the transverse dimension.
2. Normalize overjet and overbite.
3. Maintain Class I canine and molar.
4. Long-term stability.

To fulfil the treatment objectives, a two-phase treatment was suggested. During the first phase, a Haas expander was placed with metallic bands on the second temporary molars and extension wires bonded on the temporary canines. An activation twice a day was recommended along with a weekly control. This protocol has been demonstrated to be efficient at this age (Fig. 8.16a and b). No brackets were placed on the lower arch to correct the anterior crowding during this phase of treatment.

One of the disadvantages of the RME is that in some clinical cases the anterior open bite can be increased when the molars are crossed to the labial position (Fig. 8.17a). To monitor the position of the tongue, a removable functional appliance (Trainers) was used to enhance tongue position and nasal breathing. Its use was recommended 3–4 hours during the day and all night (Fig. 8.17b).

A 3-month follow-up later showed the improvement in the position of the upper incisors while the RME was still in place as a retention appliance. No molar tipping was observed (Fig. 8.18a and b). The patient had to continue using the Trainer to control the position of the tongue.

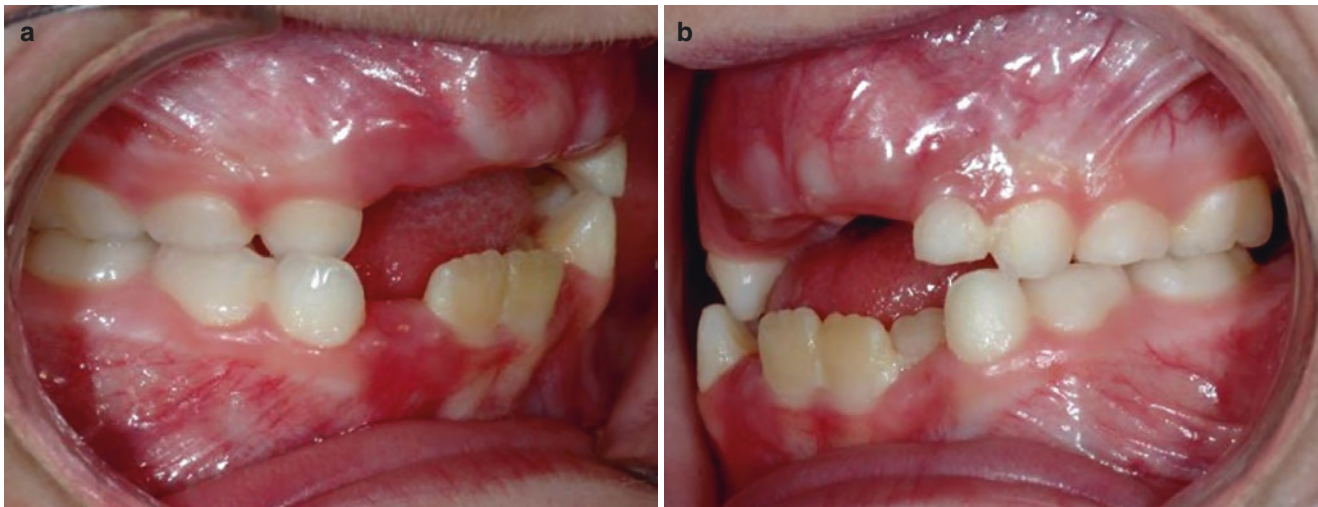


Fig. 8.14 (a and b) Lateral views at the beginning of the treatment. A crossbite relationship was present on the right side

Fig. 8.15 (a and b) Pretreatment panoramic and lateral radiograph

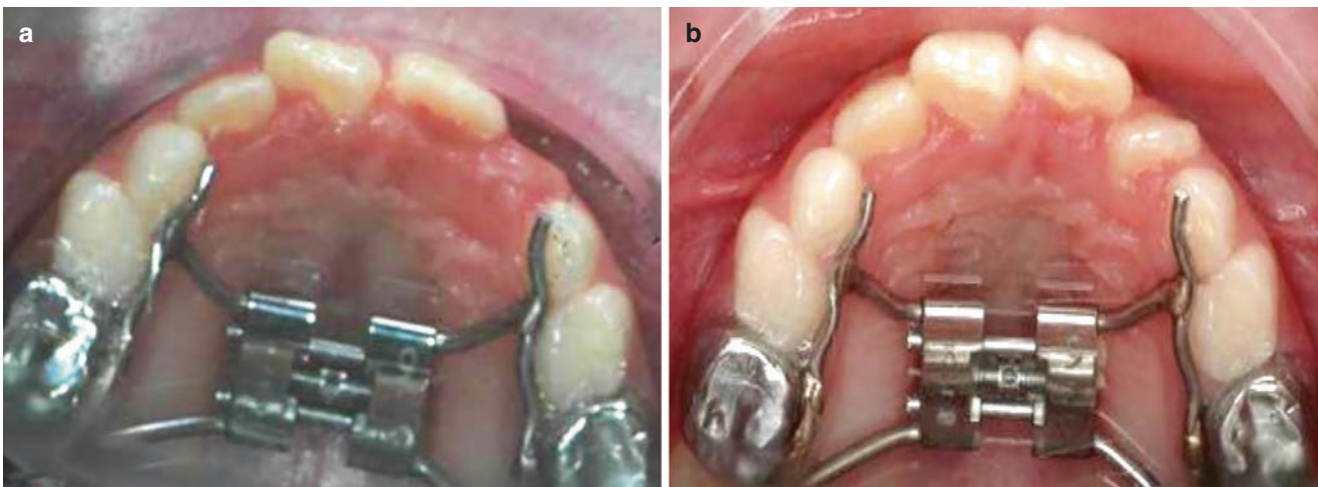
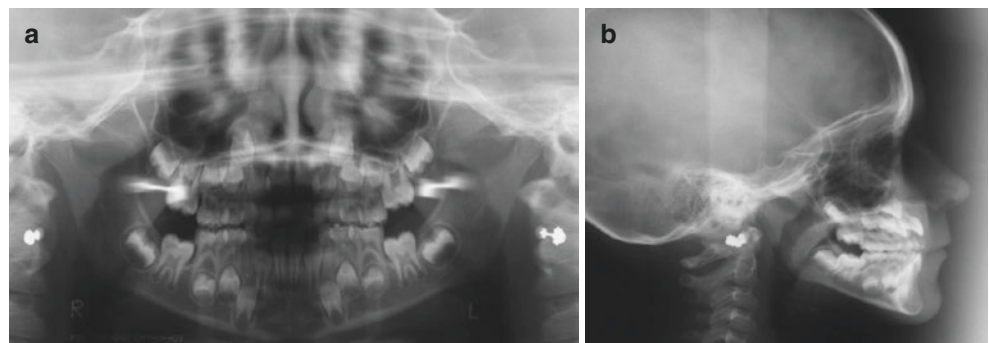


Fig. 8.16 (a and b) First phase of treatment. RME in place with bands on the temporary upper second molars

The patient was ready for the second phase of treatment, 1 year later. The open bite was totally closed. Esthetic brackets (0,022" slot) with an esthetic 0,016" SS archwire were placed in the upper and lower arches. To recover the space for the upper canines, an open coil spring was placed on the

right and left side with more activation on the left quarter to correct midlines (Fig. 8.19a and b).

Since there was enough room for the eruption of the canine on the right side, but not on the left side, additional activation of the left open coil spring was necessary. To correct anterior

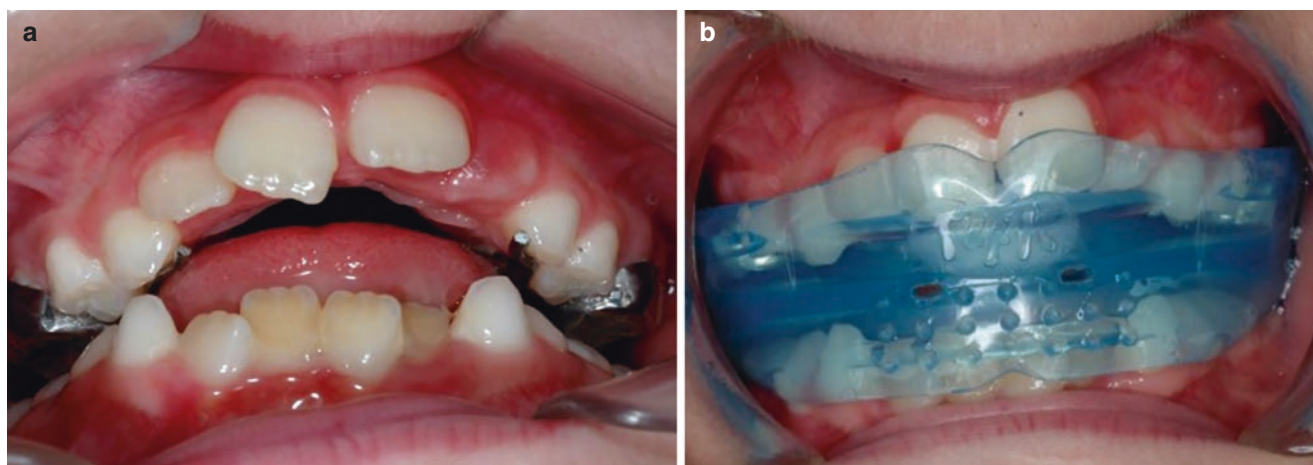


Fig. 8.17 (a and b) The use of a removable functional appliance to normalize nasal breathing and tongue position is highly advisable (Trainer Myofunctional Research)

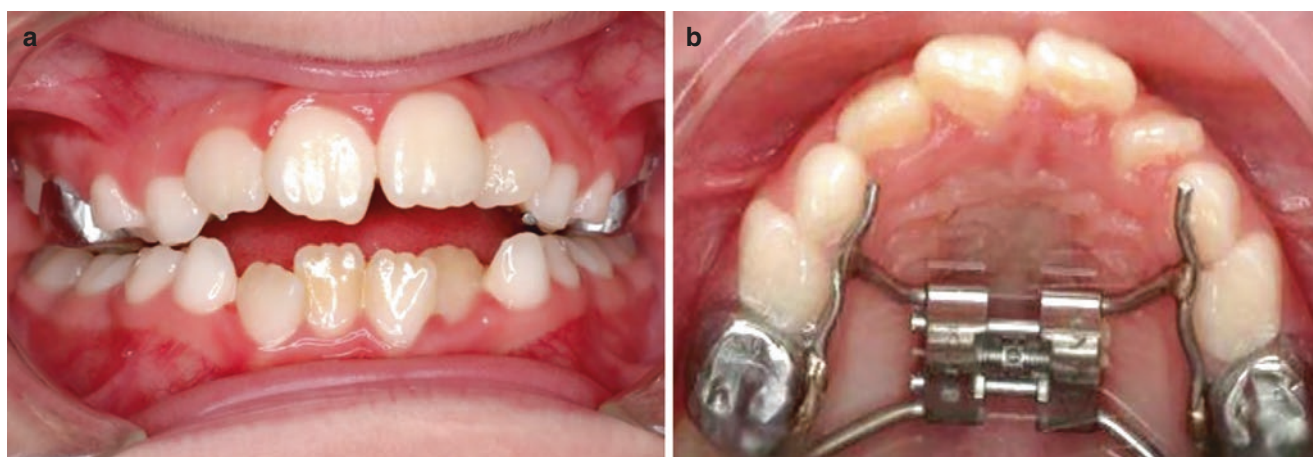


Fig. 8.18 (a and b) A 3-month follow-up later with the RME in place as a retention device in conjunction with the use of the Trainer to normalize the position of the tongue

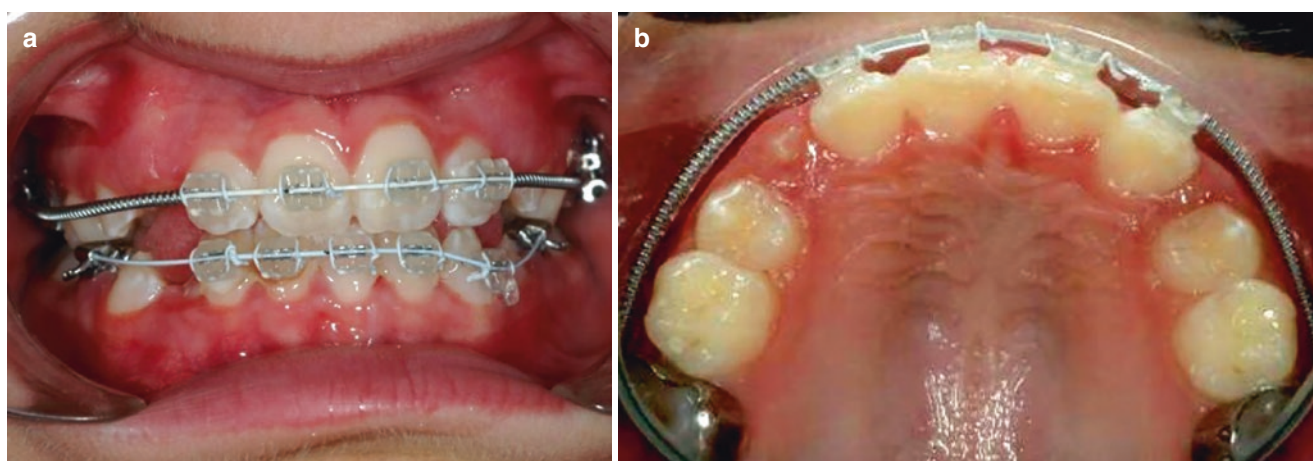


Fig. 8.19 (a and b) At the beginning of the second phase of treatment, the upper and lower 0.022" esthetic brackets were bonded. An activated coil spring on the left side was placed to achieve the space for the left canine

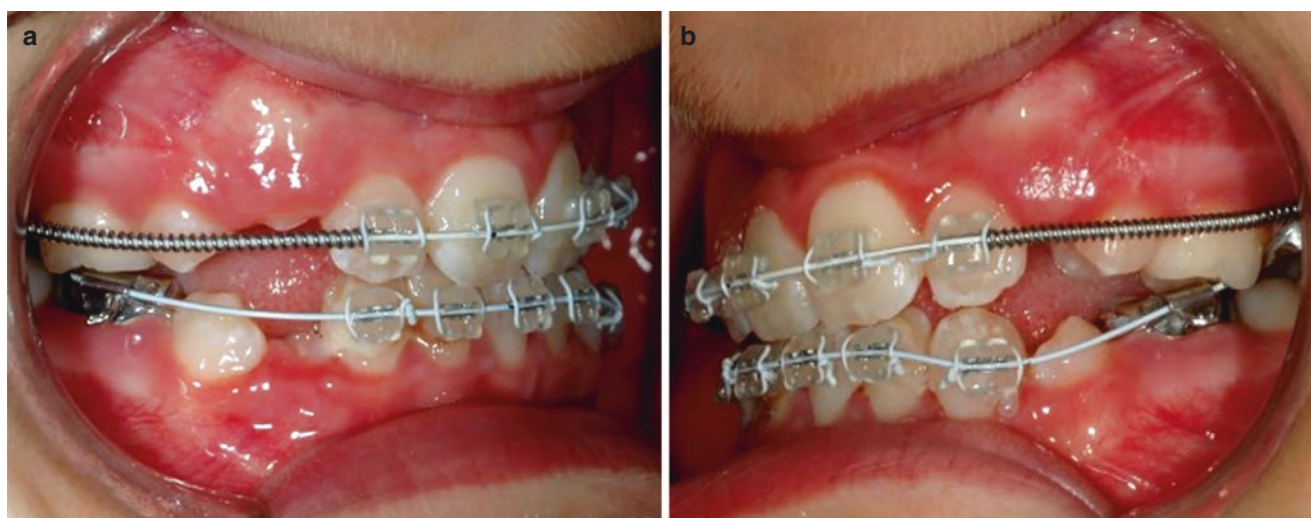


Fig. 8.20 (a and b) Right and left side at this stage of the treatment. A coil spring was placed on the left side and activated more

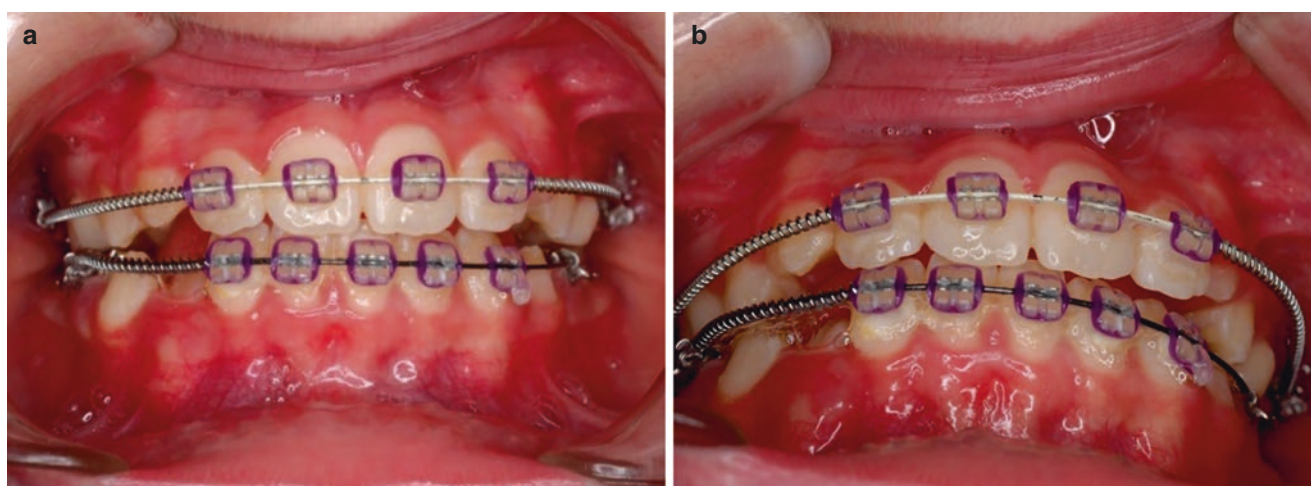


Fig. 8.21 (a and b) Follow-up 3 months later. The anterior lower crowding was almost corrected

crowding, the same type of brackets were bonded on the lower arch with bands on the temporary second molars along with a 0,014" Ni-Ti wire (Fig. 8.20a and b).

Follow-up 3 months later showed a considerable improvement. Overjet and overbite were almost normal. The oral hygiene was fairly good (Fig. 8.21a and b).

Although the patient was 11 years old, the upper canines began to erupt before the second bicuspid. To improve anterior torque, the upper coil springs along with a 0,016" $\times$ 0,022" SS esthetic archwire were maintained until the eruption of all the bicuspid. A 0.018" Ni-ti lower archwire with an open coil spring was placed on the left side to gain space for the left canine and first bicuspid (Fig. 8.22a and b).

The evaluation of the upper and lower arch confirmed that all the first bicuspid erupted and no crowding was present. Lower bands were still in place on the temporary second molars (Fig. 8.23a and b).

Final front photographs. All the objectives were fulfilled: midlines were almost coincident, gingival line was parallel to the occlusal plane, and overjet and overbite were within the normal values (Fig. 8.24a and b).

The lateral views corroborated that all the treatment objectives of the second phase of treatment were achieved. The normalization of the occlusal plane as well as the gingival line was achieved with Class I canine and molar (Fig. 8.25a and b).

The retention plan included upper and lower fixed retention wires at least until the third molars erupted (Fig. 8.26a and b).

The final radiographs confirmed the parallelism of the roots. Also, the second and third upper and lower molars were erupting normally (Fig. 8.27a and b).

The comparison of the front photographs pre- and post-treatment showed the significant improvement that was

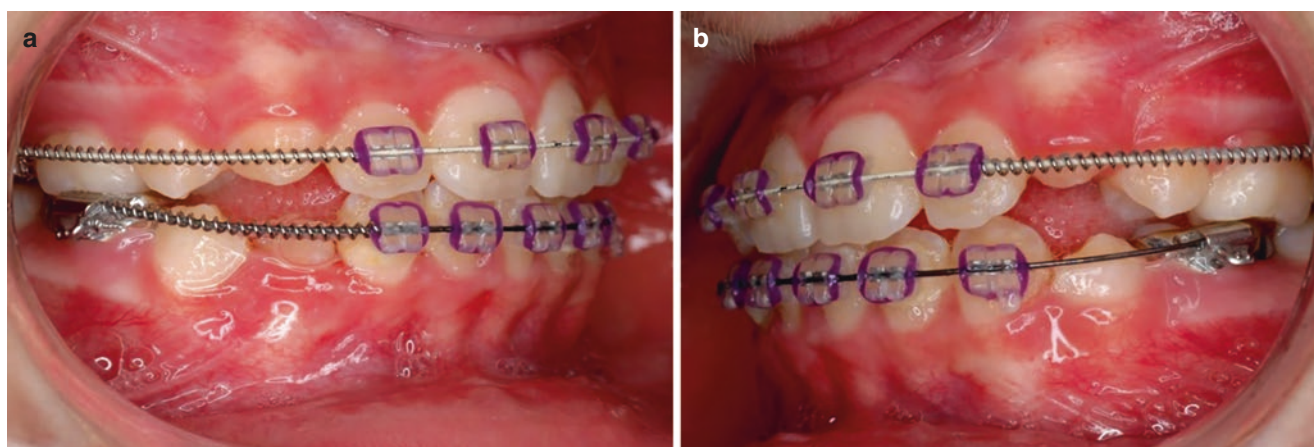


Fig. 8.22 (a and b) Lateral views at this stage of treatment. Right and left upper canines began their eruption path before the second bicuspids

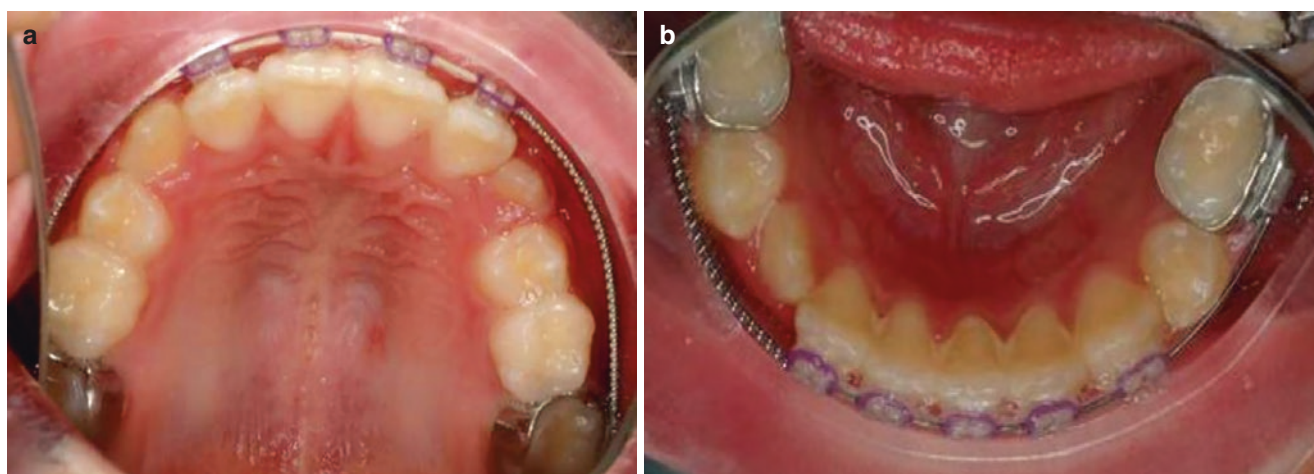


Fig. 8.23 (a and b) Upper and lower occlusal photographs. The second upper and lower temporary molars are still in place

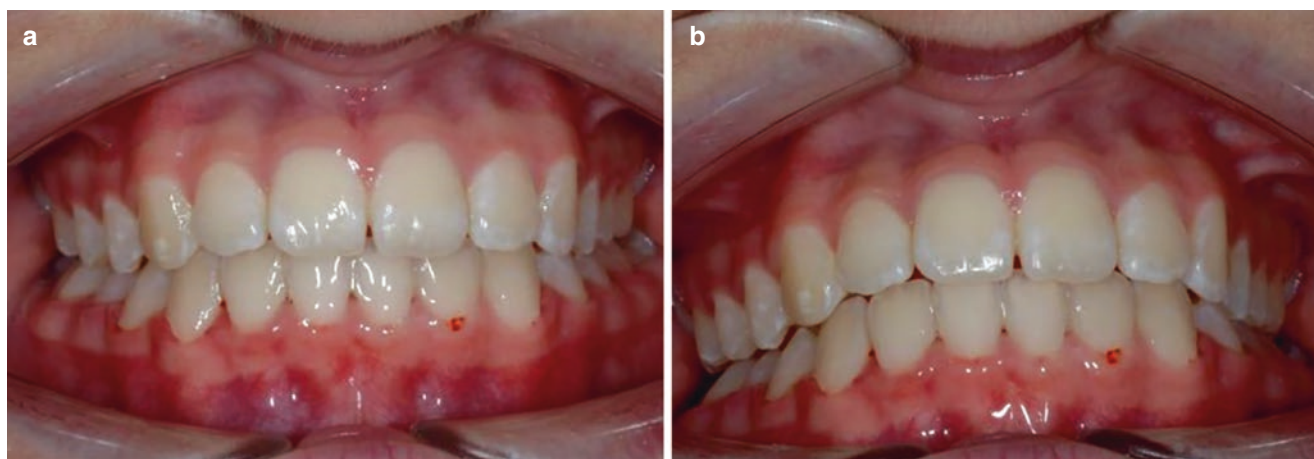


Fig. 8.24 (a and b) Frontal photographs at the end of the orthodontic active treatment. Midlines were almost coincident with overjet and overbite within normal ranges

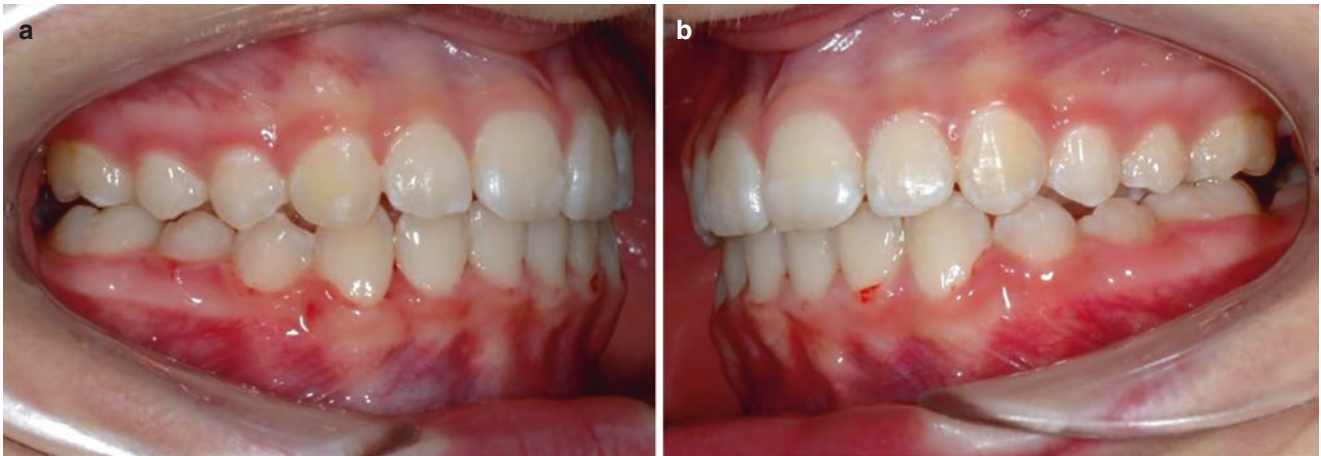


Fig. 8.25 (a and b) Lateral views at the end of the second phase of treatment

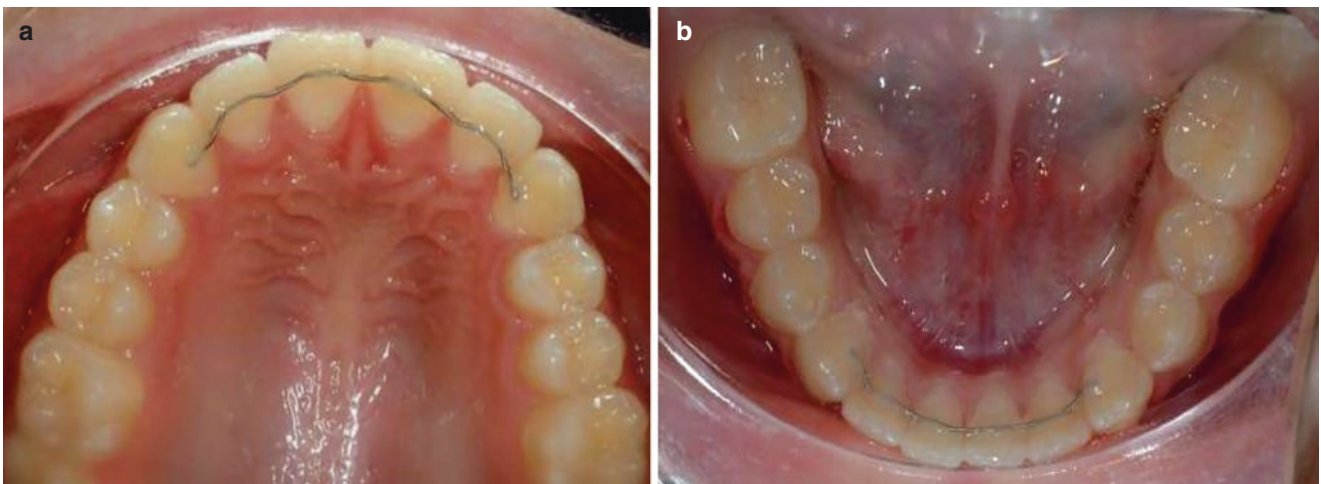
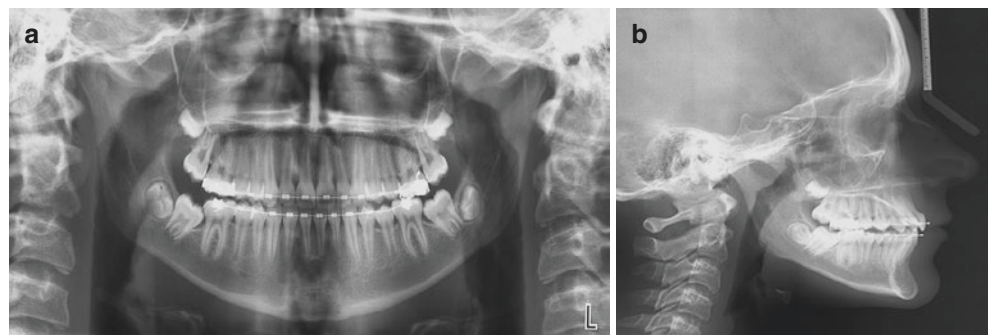


Fig. 8.26 (a and b) Upper and lower occlusal views with the retention wires bonded between upper and lower right and left canines

Fig. 8.27 (a and b)
Panoramic and lateral
radiograph at the end of the
treatment



achieved during the second-phase orthodontic treatment (Fig. 8.28a and b).

Similar results were observed from the occlusal point of view. A fixed retention wire was bonded from the right to the left canine to maintain the position of the upper anterior teeth (Fig. 8.29a and b).

Follow-up 30 months after the finalization of the active treatment showed that there was a little relapse in the anterior region, regarding overjet and overbite. A consultation with the speech therapist was recommended to improve the position of the tongue and certain swallowing habits in order to maintain the results in the vertical dimension (Fig. 8.30a and b).

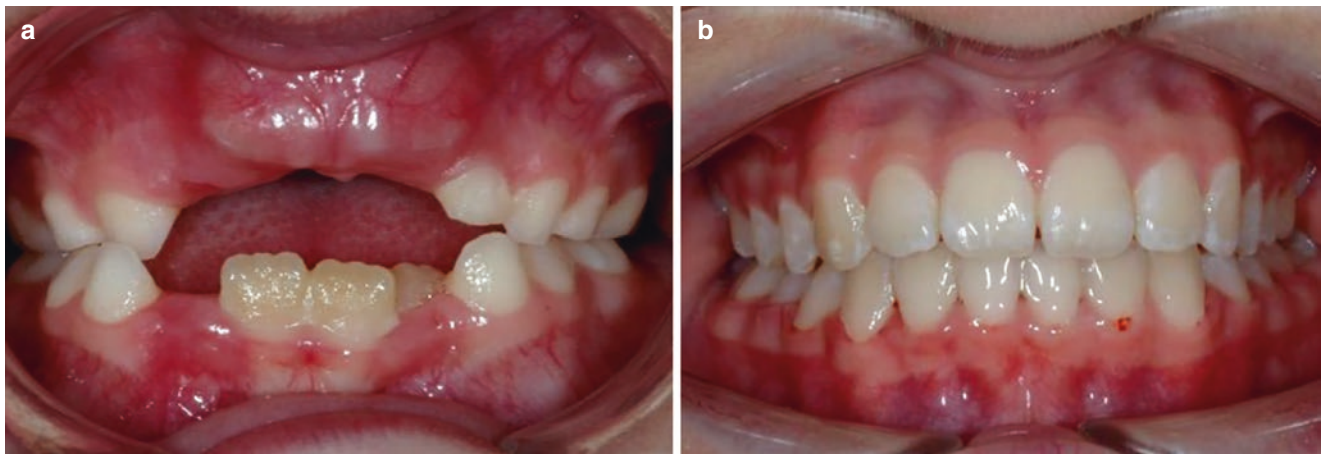


Fig. 8.28 (a and b) Comparison pre- and posttreatment front photographs. The improvement was noticeable. Overjet and overbite were normal. Occlusal and gingival lines were parallel

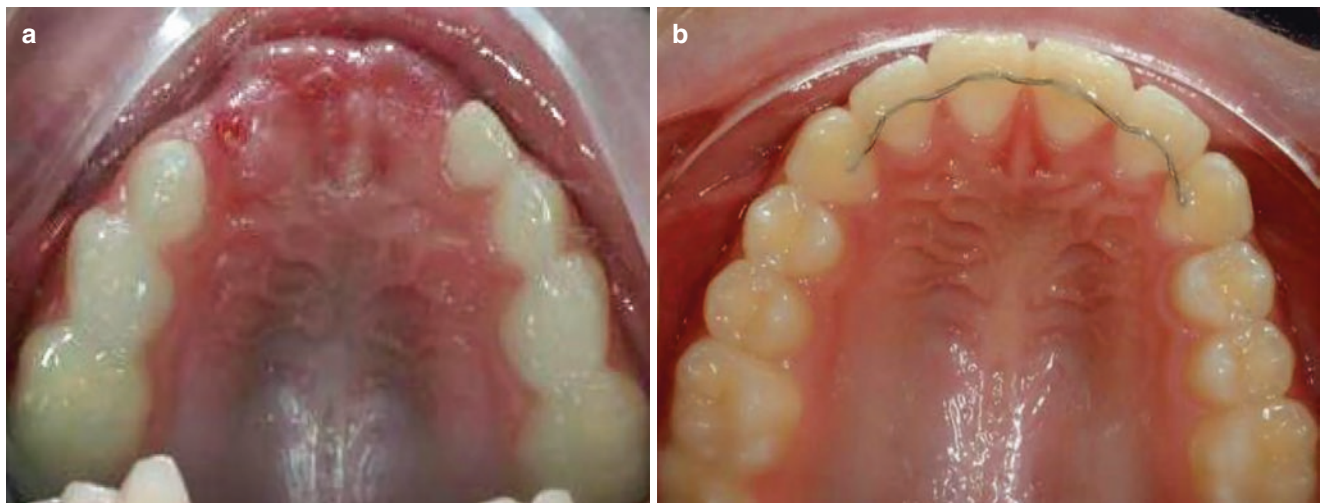


Fig. 8.29 (a and b) A significant change in the upper arch was evident. The final photograph showed the retention wire bonded between the canines

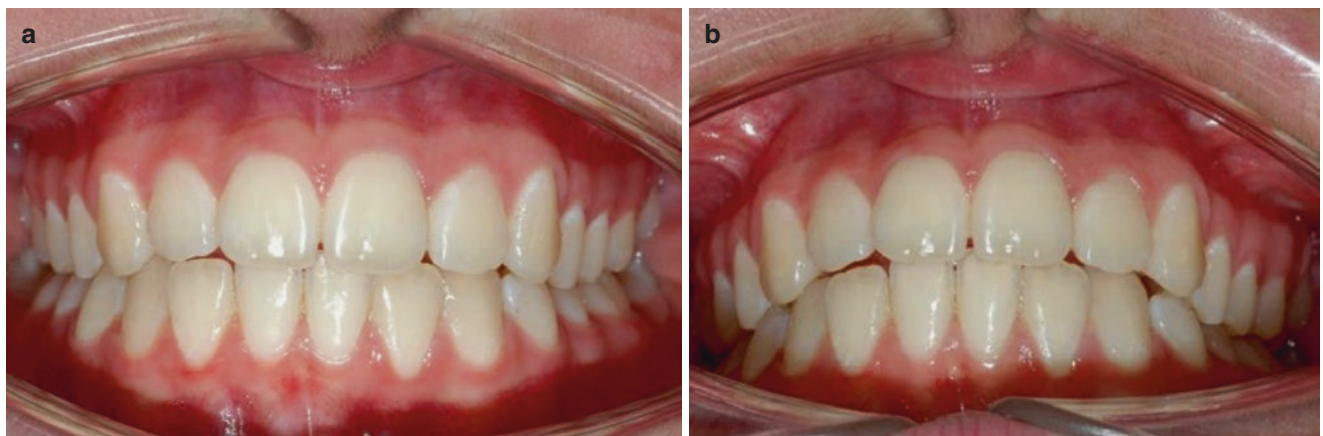


Fig. 8.30 (a and b) A slight relapse was visible in the anterior region during the 30-month follow-up. It was important that the patient continue going to the speech therapist to control the anterior position of the tongue

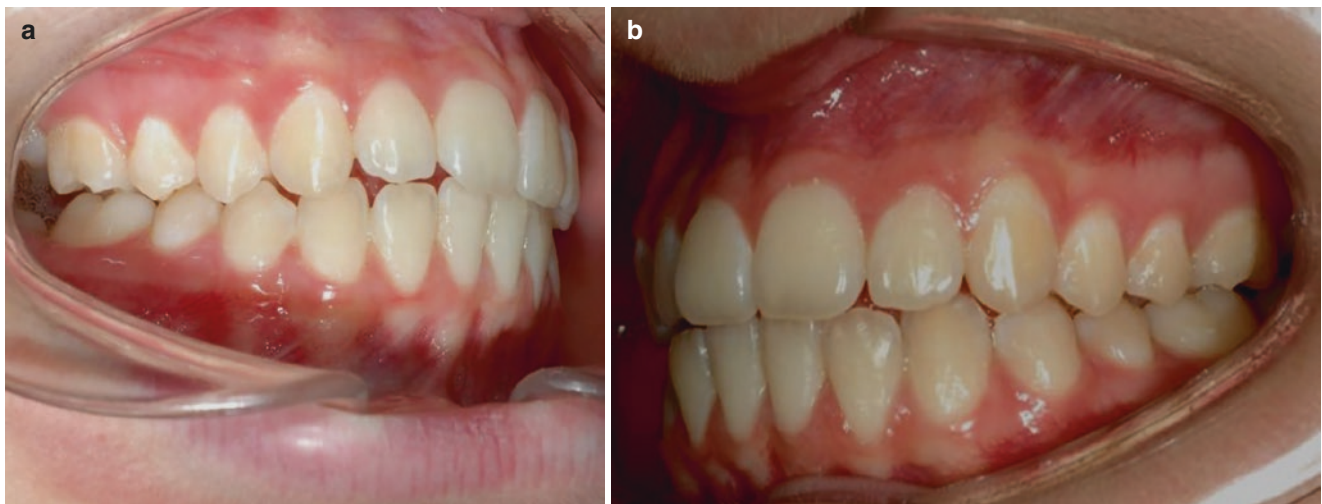


Fig. 8.31 (a and b) Lateral views confirmed a slight relapse in the anterior region

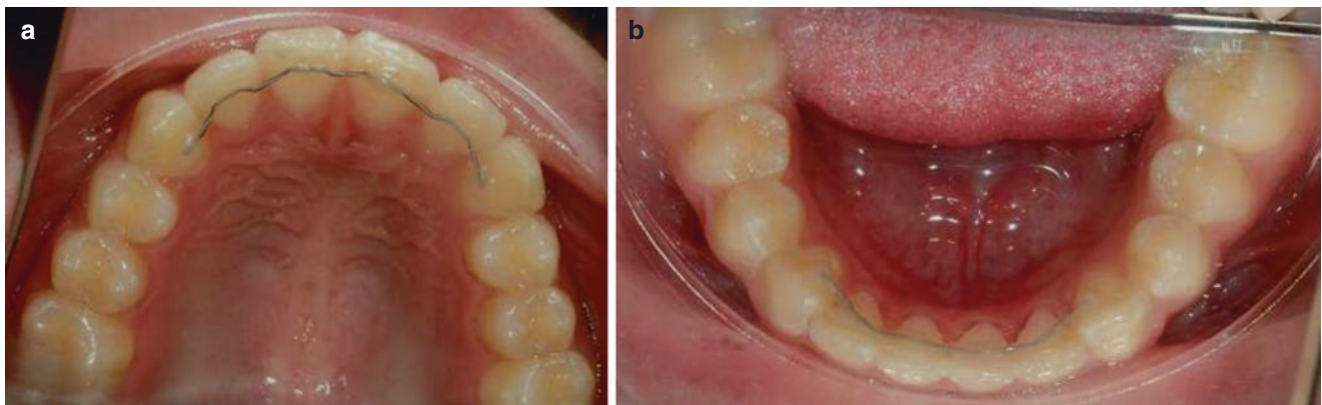


Fig. 8.32 (a and b) Occlusal photographs 30 months later with the retention wires in place

Similar conclusions were observed after analyzing the right and left side. Class I canine and molar were perfectly maintained but slight changes were observed in the anterior region (Fig. 8.31a and b).

Fixed retention wires were placed and the upper and lower dental arch forms were maintained (Fig. 8.32a and b). The treatment objectives were fulfilled with a very conservative and efficient protocol.

To conclude, the best time to normalize the transverse width of the maxilla is during late primary or early mixed dentition. This procedure provides better and more stable results.

8.1 Conclusions

Slow or rapid maxillary expansion is one of the noninvasive methods of gaining space at any age or facial biotype.

Rapid maxillary expansion performed in temporary or mixed dentition did not produce undesirable root resorption or side effects on the periodontal bone tissues (Garib) when the appliance was bonded on deciduous molars. Also, it protects the first permanent molars from undesirable side effects. The use of an RME appliance is a procedure that was used to split the midpalatal suture and widen the dental arches. Its action has a more skeletal effect with less dental tipping than the removable ones.

Ideally it has to be used prior to the ossification of the midpalatal suture and long-term results are confirmed. Of course there is variability in the amount of changes according to the age, facial biotype, and etiology of the problem.

The protocol of activation has to be determined by the orthodontist but during the early or late mixed dentition two turns a day is the most commonly used.

Since there is a considerable correlation between the transverse, anteroposterior, and vertical discrepancies, the

early normalization of the transverse dimension discrepancy is very important. It was widely demonstrated that maxillary arch constriction produces insufficient maxillary arch width causing anterior crowding and lack of the space for the canines (Bahreman).

Rapid maxillary expansion is useful in correcting posterior crossbites, increasing arch length, facilitating Class II and III correction, improving space for canine eruption, improving nasal breathing, and broadening the smile (McNamara).

Different types of RME can be used but to avoid caries or enamel decalcifications it is preferable to use those without acrylic plates not only on the palatal tissues but also cemented on the occlusal surfaces of the molars.

This protocol creates optimal conditions for the normal growth of the craniofacial skeleton and helps to develop a normal stomatognathic system.

In general, no significant secondary effects were observed in patients in either genders.

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Management of Dental Asymmetries

9

Julia Harfin

Facial symmetry is an important goal in orthodontic treatment. Smiling involves not only the teeth but also the surrounding soft tissues. This is very important during the diagnostic process and treatment planning procedures since patients view themselves from the frontal perspective and no coincidence of midlines is very evident.

Treatment strategies include growth modification and occlusal guidance. They have to be applied in growing children during primary or mixed dentition to minimize dentoalveolar and skeletal disharmonies that can affect normal growth.

Facial symmetry means balance throughout all the structures of the face. There is a very thin line to determine when asymmetry really begins.

A thorough diagnosis is the basis for success. A detailed medical and dental history along with radiographic and functional studies that help determine the real reason of the asymmetry is important.

The digital panoramic radiograph is very useful in determining bone and dental discrepancies between the right and left structures. A midsagittal reference plan is also useful to determine not only the quantity but also the place of the discrepancies.

Normally, there are differences between the right and left side of the face. Unfortunately, there is not a critical number of measurement that can delimit it, and it is often determined “by the clinician’s sense of balance and the patient’s perception of the imbalance” (Bishara).

Asymmetries can be classified as dental, skeletal, or functional or their combination. Soft tissues play an important role since they can make asymmetries more evident or, contrary to this, hide them (Fig. 9.1a and b). It is important to remember that abnormal muscle function often results in

skeletal and dental deviations, and the younger the patient, the easier the normalization.

Etiology could be multifactorial. The genetic factors involve craniofacial syndromes such as cleft palate, hemifacial microsomias, craniosynostosis, ankylosis, and facial clefts, as shown in Fig. 9.2a and b.

The following patient had an important left deviation due to a fibrous ankylosis on the same side. She also had limited mouth opening, only 29 mm instead of 40 mm as the norm indicates. Unilateral condyle ankylosis affects normal growth on one side in conjunction with facial asymmetry due to deficient growth on the affected side (Fig. 9.3a and b).

Significant differences were seen when skeletal or dental asymmetries were analyzed. Skeletal asymmetries may involve the maxilla, mandible, or both and can be accompanied with muscular or functional imbalances (McNamara).

Dental asymmetries can be caused by proximal caries, loss of temporary molars, agenesis, discrepancies in the mesiodistal size of the anterior teeth, compression of the upper arch with molars in crossbite position, etc.

Both types of asymmetries can cause uni- or bilateral posterior dental or skeletal crossbite. Posterior crossbite is one of the most prevalent malocclusions in primary and early mixed dentition and is reported to occur in 8% to 22% of the cases (Kutin and Egermark). The functional factors most frequently found are premature contacts that deviate the path of occlusion when the patient’s mouth closes in centric occlusion.

A close relationship between unilateral posterior crossbite in centric occlusion and body posture was observed (Zurita-Hernandez). Since unilateral posterior crossbite with functional shift is one of the most common malocclusions in mixed dentition, the early correction of this condition is highly recommendable in order to avoid asymmetric muscular activity and, as a result, an abnormal mandibular growth.

Diagnosis is the most important stage to determine the correct treatment plan. In general, some patients with early mixed dentition have a shifted midline in addition to a unilateral crossbite when they bite in centric occlusion. However,

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Fig. 9.1 (a and b) Patient with an asymmetric smile due to temporary paralysis after a car accident and fracture of the left ramus



Fig. 9.2 (a and b) Patients with cleft lip and palate, respectively. The facial asymmetry in the middle and lower third of the face is evident

when the patient is in centric relation, the occlusion changes completely: midlines coincide and the crossbite is bilateral (Fig. 9.4a and b).

These functional deviations may be caused by a narrow maxilla or an upper or lower tooth in a malposition that pro-

duces an abnormal initial tooth contact and a midline deviation in centric occlusion as a consequence.

Treatment mechanics are chosen in correlation with a correct diagnosis and treatment plan. Some clinical cases need asymmetric mechanics, while with others, surgery is the best option.

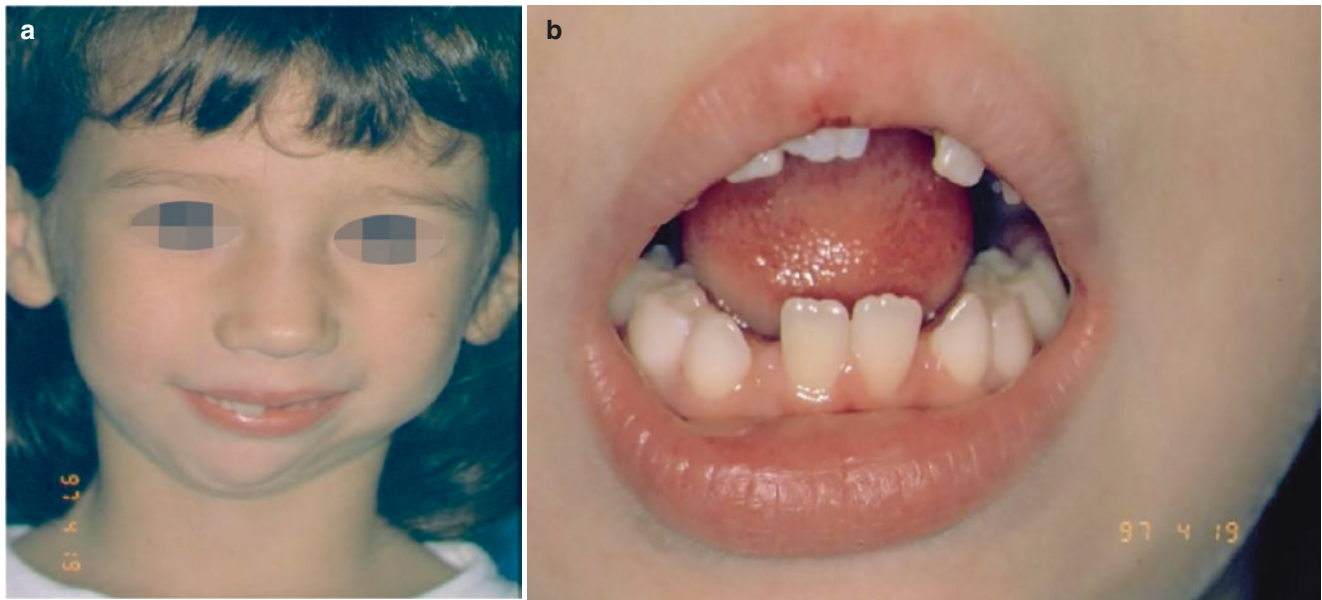


Fig. 9.3 (a and b) Facial asymmetry due to condyle ankylosis

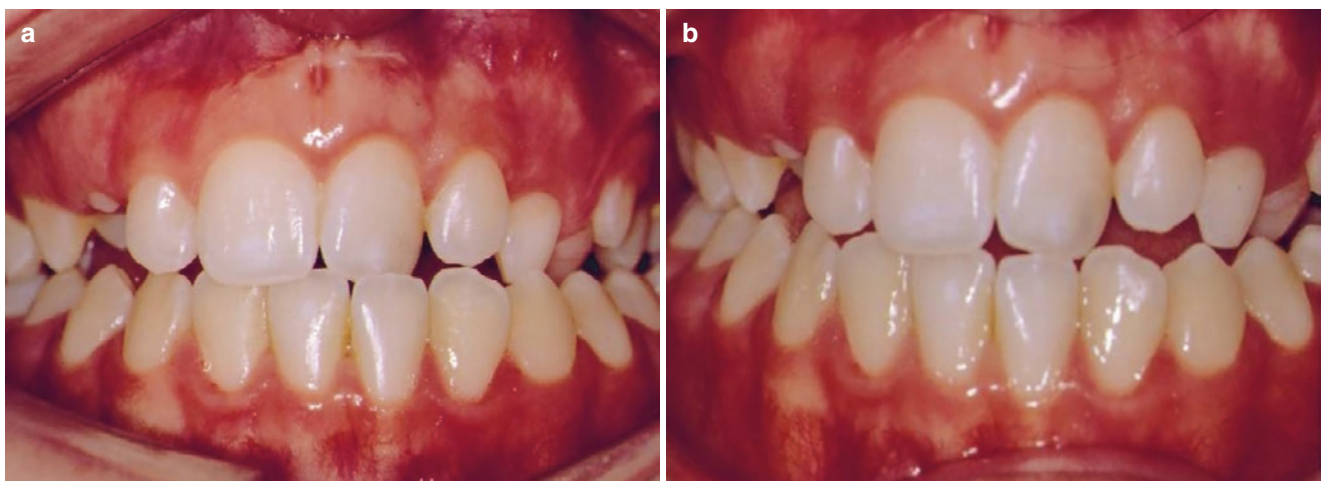


Fig. 9.4 (a and b) Patient with a functional deviation. The centric occlusion and centric relation occlusion is quite different. Midlines are coincident in centric relation

It is mandatory to begin the treatment as soon as possible. Otherwise, this unilateral posterior crossbite can produce alterations in the dental, muscular, or skeletal development of the face and body.

As always, some patients tend to chew more on one side and can develop more asymmetries that are very difficult to correct in adolescence or adulthood.

This is a case of a 5-year-old patient with significant unilateral crossbite on the left side along with a considerable frontal and lateral overbite. In occlusion, the mandibular dental midline is deviated to the left (Fig. 9.5a and b).

A complete correction of the frontal and lateral crossbite was achieved after 2 years and 6 months of treatment with functional appliances. The midline was almost normal and

the lateral crossbite was totally corrected (Fig. 9.6a and b). It is clear that mandibular function is essential to normalize maxilla and mandibular growth and development.

The comparison between pre- and posttreatment lateral photographs clearly demonstrates that all treatment objectives in the frontal and lateral areas were achieved (Fig. 9.7a and b).

The following patient clearly demonstrates the importance in performing an accurate diagnosis in centric relation. This 8-year, 6-month-old patient was sent to the office by her family dentist to correct the posterior right crossbite. No TMJ problems were present up to this moment (Fig. 9.8a and b).

These crossbites develop early and are not self-correcting. Some of the suggested etiologic factors of crossbites include

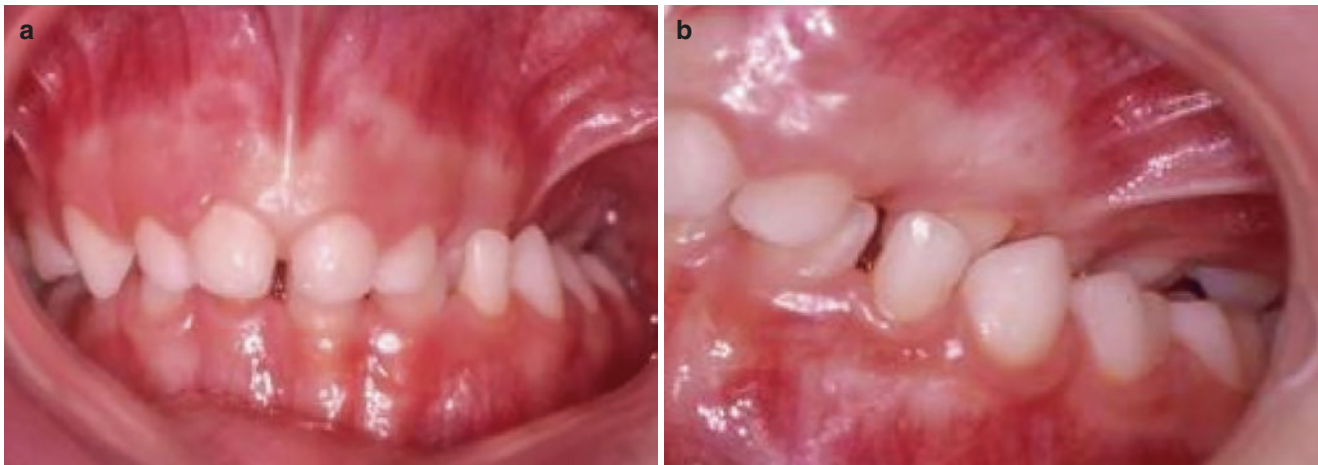


Fig. 9.5 (a and b) Considerable lateral crossbite on the left side along with a significant overbite

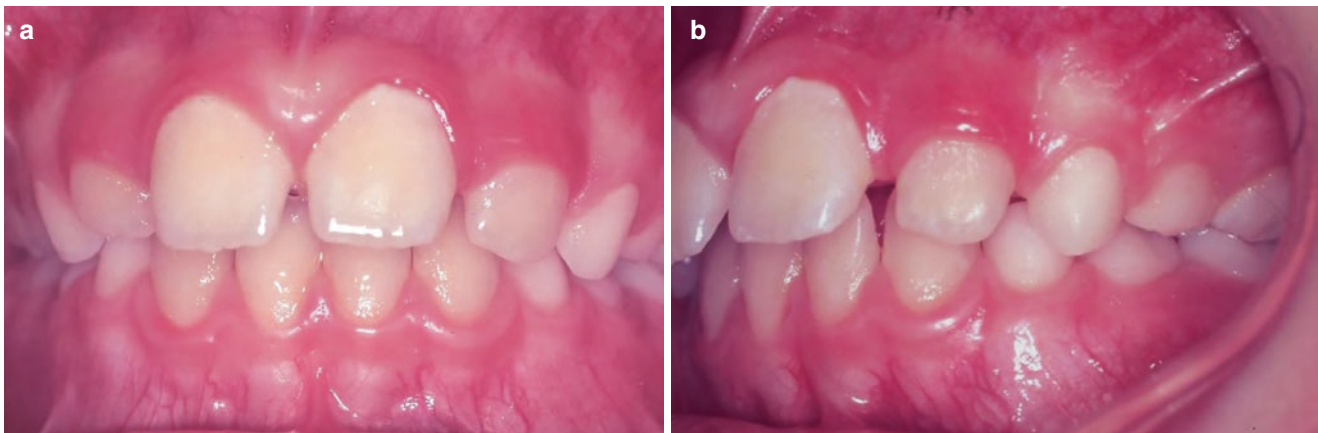


Fig. 9.6 (a and b) Frontal and lateral photos after treatment

prolonged retention of deciduous teeth, crowding, premature loss of the deciduous teeth, and arch deficiencies.

The first issue is to attain a correct diagnosis to identify the real problem. When the lateral crossbite is accomplished with a midline deviation, a diagnosis in centric relation is mandatory to determine if the patient has a skeletal asymmetry or if it is a posterior crossbite with a functional shift.

The treatment and retention plan would be completely different in each case.

The lateral photos showed that the right first and second temporary molars as well as the permanent right first molar were in a complete crossbite position on the right side and “normal” occlusion on the left side with fairly good oral hygiene (Fig. 9.9a and b).

However, when the patient was in centric relation, the occlusion changed dramatically. Now, midlines were coincident and an anterior and lateral open bite was present. The sole contact point was between the left upper and lower temporary canines (Fig. 9.10a and b).

The treatment plan was grinding the cuspids of the left upper and lower canines until centric occlusion and centric relation were coincident.

In general, unilateral posterior crossbite is due to an asymmetric mandibular shift from the OC to the RC. The mandible is usually symmetric but markedly positioned asymmetrically. However, if this position is not corrected, skeletal asymmetry would result (Fig. 9.11a and b).

The midline was typically deviated to the crossbite side, and the patient had Class III on one side and Class II on the other side, but in centric relation, the midlines were coincident.

Due to the fact that neuromuscular guidance of the mandible is generated by the central nervous system, as soon as it is diagnosed, it helps prevent the asymmetrical positioning and growth of the condyles.

It was demonstrated that children with posterior crossbite can have reduced bite force and asymmetrical muscle function where the anterior temporalis is more active and the

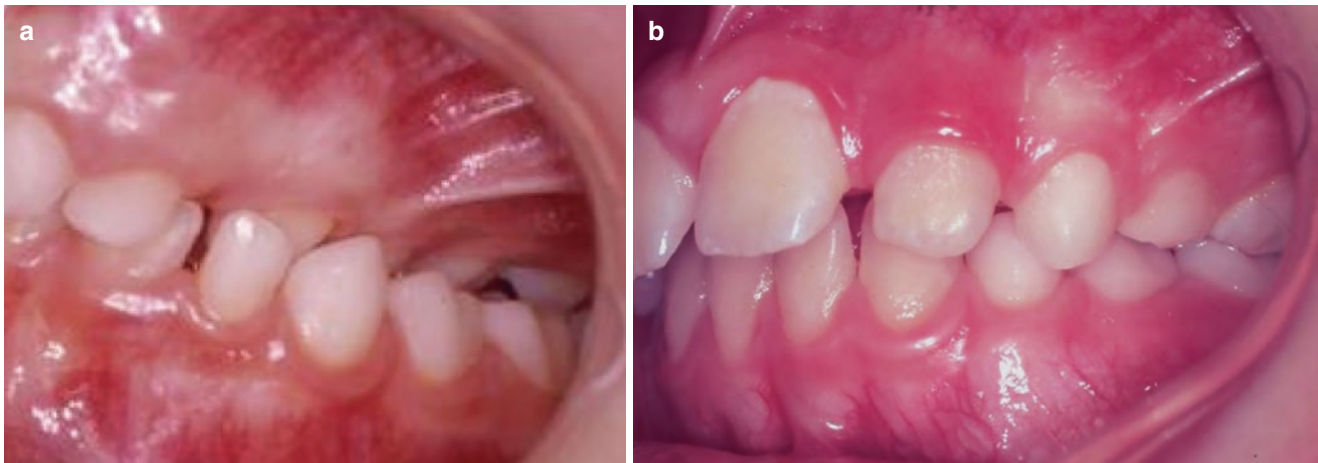


Fig. 9.7 (a and b) The significant left crossbite occlusion was totally normalized, as was the negative overbite

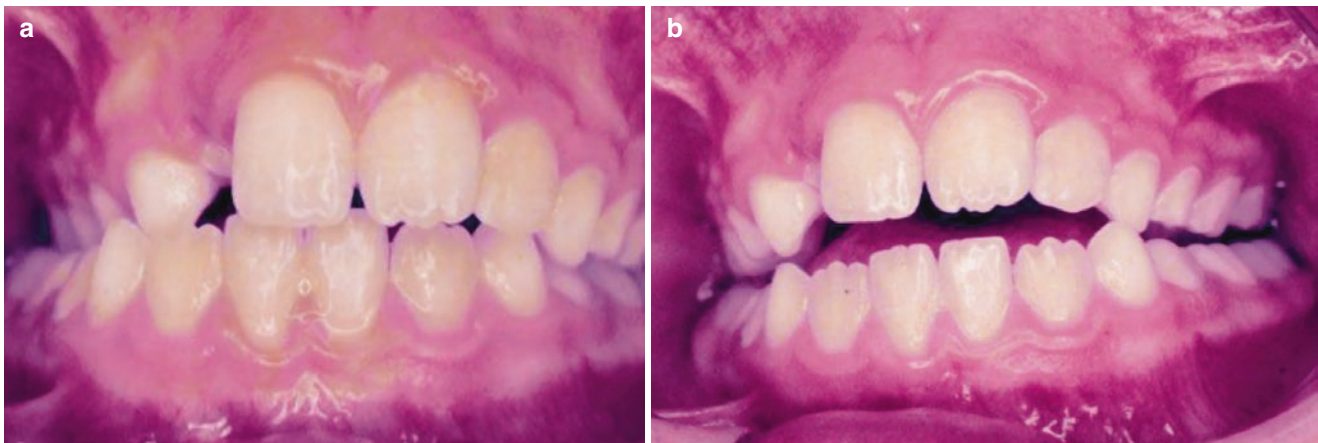


Fig. 9.8 Front dental photographs in (a) centric occlusion and (b) centric relation

masseter less active on the crossbite side. Moreover, there is a significant association between crossbite and TMJ problems (da Silva Andrade).

The patient returned when she was 14 years old without having had any other orthodontic treatment. Midlines were centered, and the occlusion was almost normal but with a reduced overjet and overbite. A second phase of orthodontic treatment was suggested, but the patient refused (Fig. 9.12a and b).

After analyzing the right and left dental photographs, normal Class I canine and molar relationship was confirmed without any other orthodontic treatment (Fig. 9.13a and b).

The comparison between the pre- and posttreatment frontal photographs clearly demonstrated that the treatment objectives were achieved with a very simple and conservative protocol (Fig. 9.14a and b). As always, diagnosis is the most important tool to identify these asymmetries and to differentiate between dental, dentoalveolar, or skeletal cause (Burstone). Also, an overall evaluation of the skeletal and

facial pattern of the patient is necessary to complete the final treatment and retention plan.

Early normalization is very important because it is very difficult to achieve spontaneous correction, and posterior crossbite could be transferred from primary to permanent dentition, with long-term effects on the growth and development of the stomatognathic system. The condyles on the crossbite side are positioned relatively more superiorly and posteriorly in the glenoid fossa than those on the non-crossbite side, and this position has a great influence on the development of the mandible.

The following patient is a clear example of this pattern. An 11-year, 8-month-old boy was sent to the orthodontic department for a second opinion due to a significant asymmetry in the lower third of the face. He lived 850 km from the city. The chin was deviated to the right, and apparently, the left side of the mandible was longer than that on the right side. Although he was almost 12 years old, nearly all teeth had erupted. The first diagnosis was to wait until he was

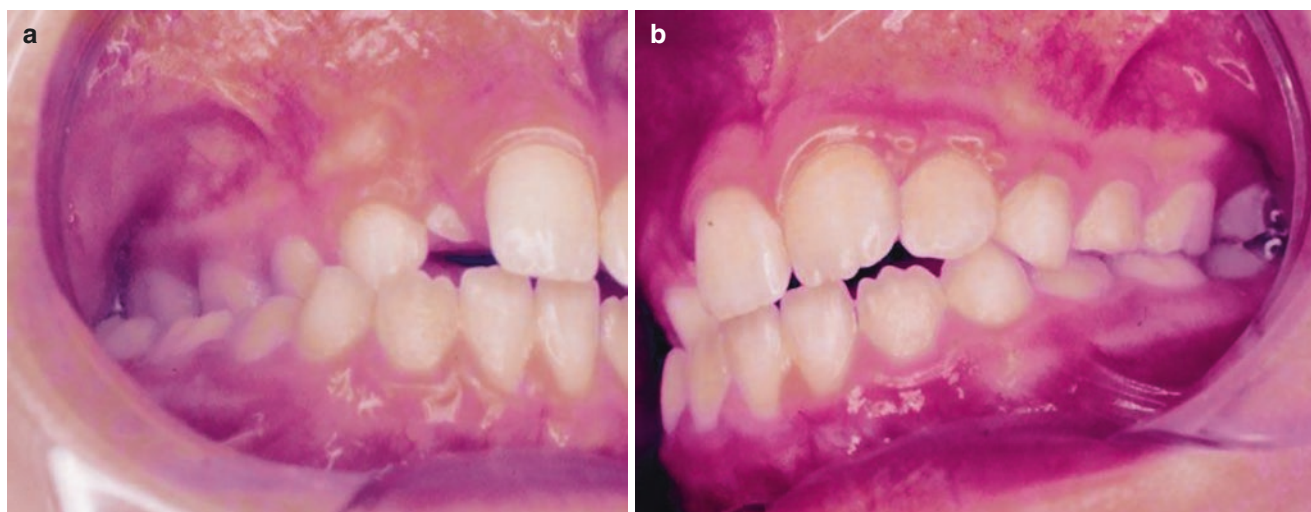


Fig. 9.9 (a and b) Lateral views in the first appointment. The right side shows a crossbite occlusion, while a normal one can be seen on the left side

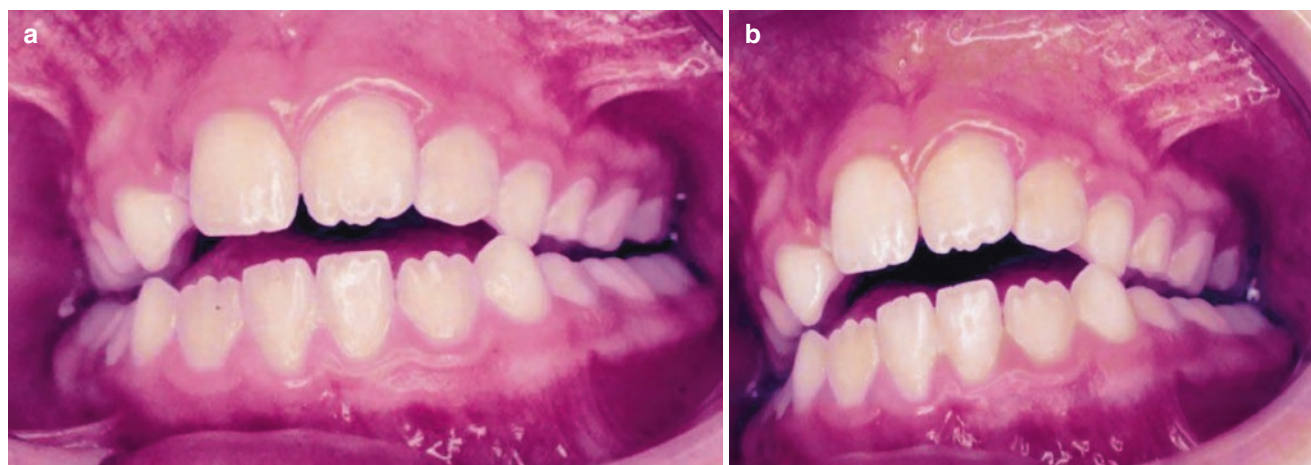


Fig. 9.10 (a and b) Occlusion in centric relation. Only one contact point in the left canines was observed

20–22 years old and correct the problem through an orthognathic surgery procedure.

As always, the first step is to identify the problems in order to determine the cause or causes of the asymmetry and then decide the most realistic treatment plan for this patient at this age (Fig. 9.15a and b). A close clinical examination in concordance with radiographs are required to make a reliable diagnosis. Ideally, radiographic images have to be taken in the centric relation to determine the exact position of the mandible. Also, it is necessary to determine the percentage of dental and skeletal influence in the anterior or posterior crossbites.

Analyzing the frontal dental photographs in centric occlusion, a significant midline deviation was observed (Fig. 9.16a), but when the patient was in centric relation (Fig. 9.16b), the midlines coincided and a large anterior and lateral open bite was present.

When the lateral photographs were observed in centric occlusion, Class II canine and Class I molar on the right side were present. Meanwhile, on the left side, Class III canine and Class I molar were seen (Fig. 9.17a and b).

In centric relation, a significant lateral open bite was present, leading to a completely different treatment plan. It is important to observe the mesiodistal axial inclination of the posterior teeth before brackets are bonded (Burstone). The normalization of the axial inclination of the anterior and posterior teeth should be obtained during the first phase of treatment (Fig. 9.18a and b).

Radiographic images are very useful to confirm the clinical findings. Panoramic radiography is the most commonly used, which shows the potential differences in size and shape of the condyles, as well as the ramus and corpus of the mandible (Fig. 9.19). Patients with unilateral posterior crossbite had more asymmetric condyles than in those with sym-

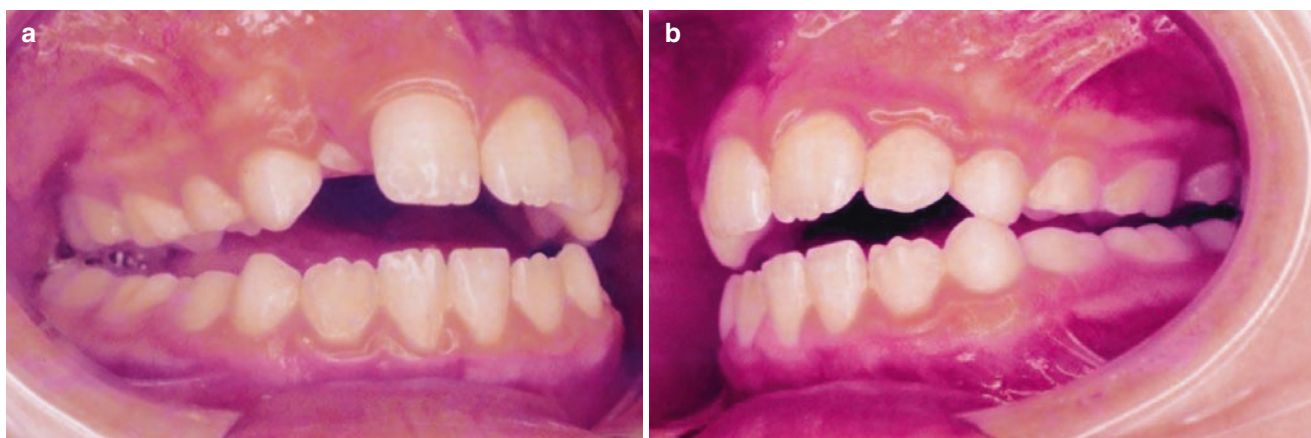


Fig. 9.11 (a and b). Lateral photos in centric relation. A significant open bite was present along with a premature contact in the canine region

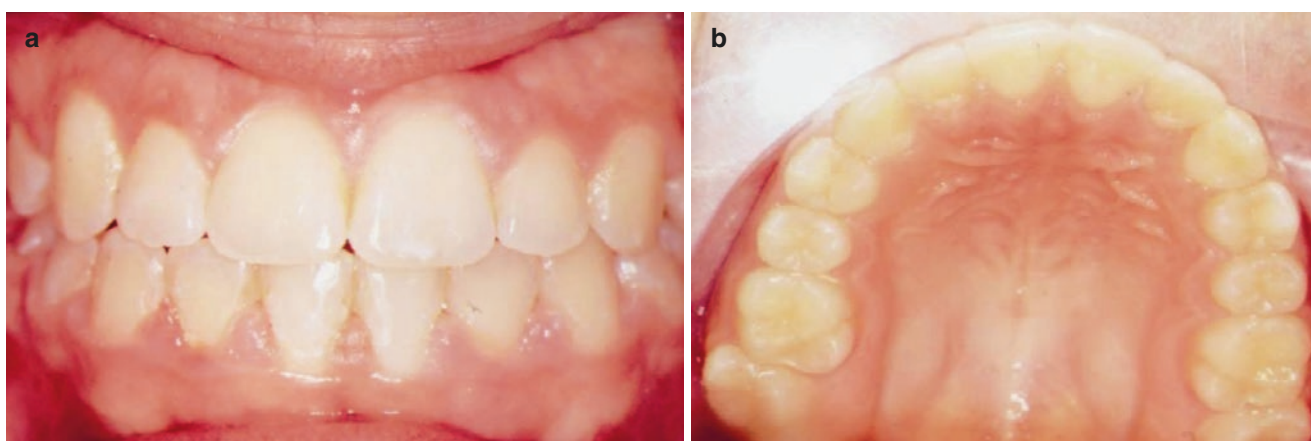


Fig. 9.12 (a and b) Five years later without any orthodontic treatment. Midlines were coincident with reduced overjet and overbite

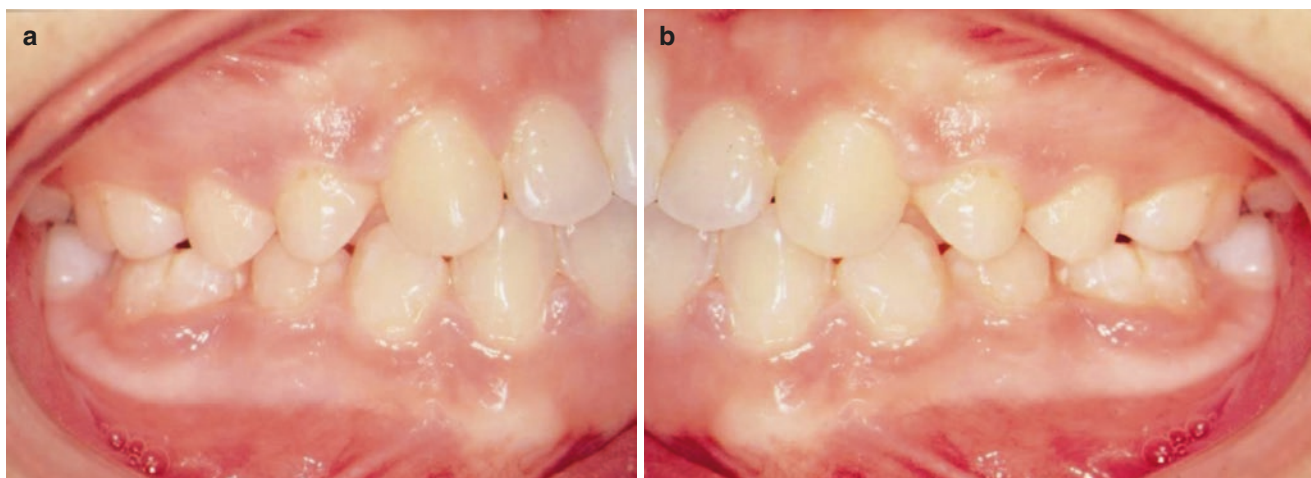


Fig. 9.13 (a and b) Lateral occlusion at 14 years of age. Class I molar and canine were present. No brackets or other removable appliance was used

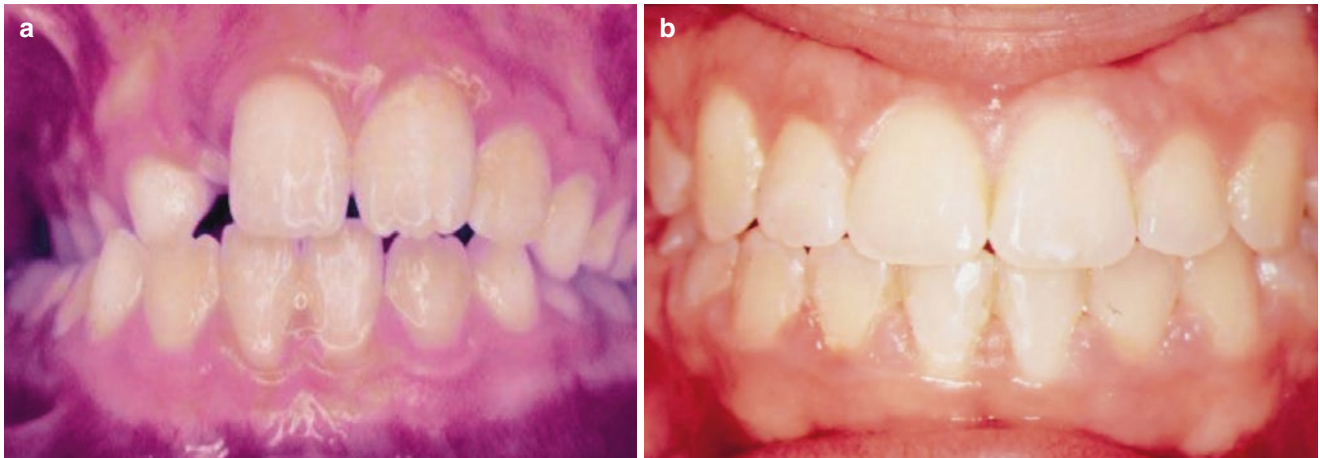


Fig. 9.14 (a and b) Pre- and posttreatment frontal photographs without any active orthodontic treatment



Fig. 9.15 (a and b) Pretreatment frontal photographs The asymmetry is visible with the chin deviated to the right

metric condyles. In addition, condylar, ramus, and condylar-plus-ramal heights on the crossbite side were smaller than in those on the non-crossbite side (Kilic).

The lateral and frontal radiographic images confirm the asymmetry in centric occlusion (Fig. 9.20a and b). In this patient. The deviation of the mandible to the right is very evident. Another radiograph in centric relation would have been helpful to confirm these findings.

It was demonstrated that the adaptation of the neuromuscular area to the acquired mandibular position can cause

asymmetric mandibular growth, facial disharmony, and several functional changes in the masticatory muscles and TMA as seen in the following patient (Fig. 9.21a and b). A large difference between the two photos can be observed in only 3 years without treatment. To determine the best treatment plan, it is mandatory to know if the asymmetry is stable or progressive and distinguish the real etiology of the problem before the treatment plan is defined.

An individualized and profound diagnosis is mandatory to determine the real causes of such asymmetry. Without a

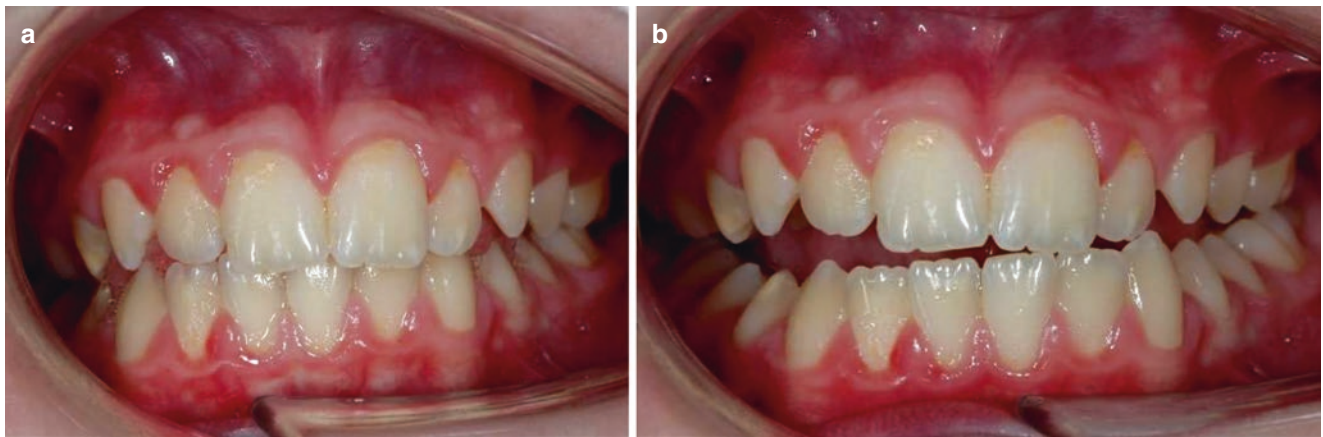


Fig. 9.16 (a and b) A significant difference between centric occlusion and centric relation is observed. In centric relation, the midlines were almost coincident

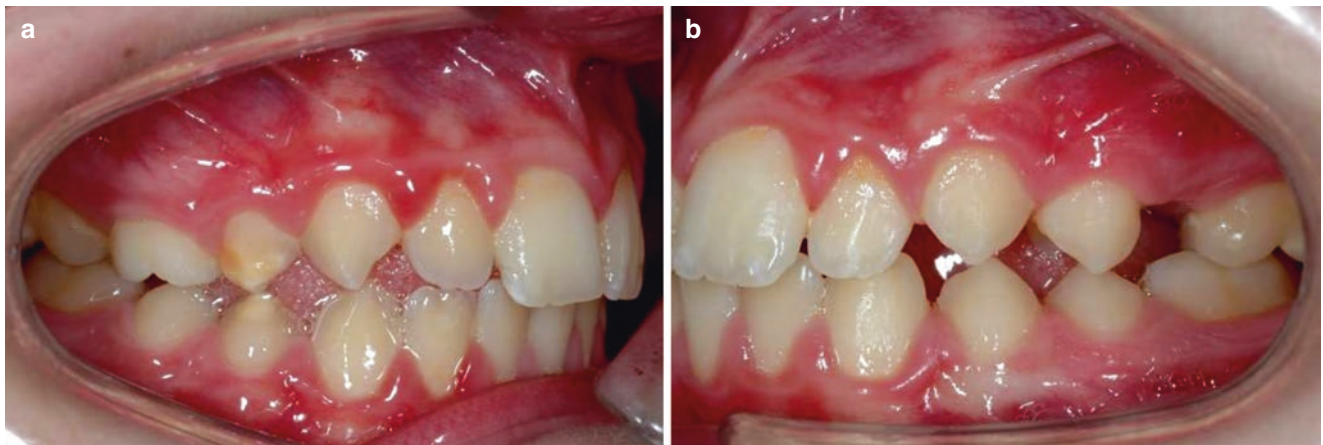


Fig. 9.17 (a and b) Lateral views in centric occlusion. Class II canine on the right side and Class III canine on the left side were observed

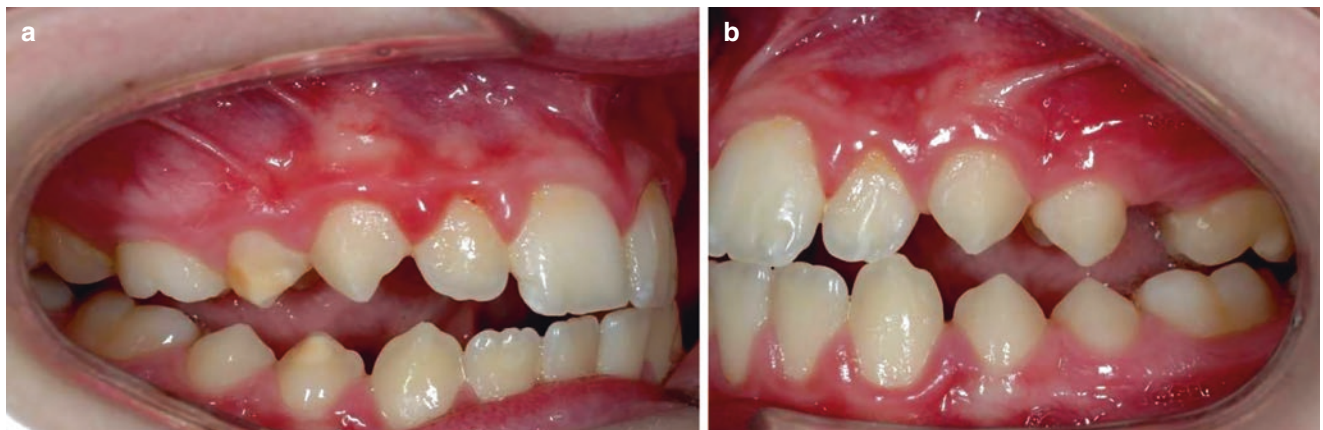


Fig. 9.18 (a and b) Lateral views at centric relation. A significant right and left open bite was present

real and comprehensive diagnosis, it is not possible to achieve the treatment goals.

Studies have shown that crossbites, especially when associated with a lateral shift, play an important role in cranio-mandibular disorders. Since posterior crossbite generally causes dual bite with a lateral mandibular shift, an asymmetrical condylar movement pattern can develop (Schmid). Changes in condylar movement might induce asymmetrical mandibular growth. Schmid et al. indicated that morphological asymmetry in growing children is the result of mandibular displacement consequent to occlusal alterations.

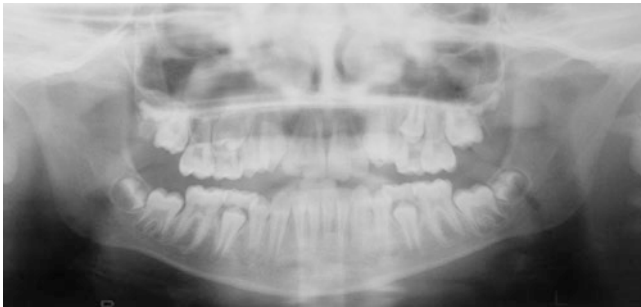


Fig. 9.19 The panoramic radiographic image clearly showing the asymmetry between the right and left side of the condyle and ramus areas

Positional asymmetries might have immediate morphological influence in the mandibular growth.

These characteristics were shown in the following patient that was sent to the orthodontic department for a second opinion since her doctor at that time realized that she had a lateral deviation to the left when she opened her mouth. The asymmetry was barely noticeable when the mouth was closed. The left side was a little more rounded than that on the right side (Fig. 9.22a and b). Her medical record provided insight as to why this happened. When she was 2 years old, she had fallen from a high place and fractured her condyle. No surgical intervention nor other treatment was offered at that time. She was able to open her mouth normally (40 mm). Moreover, no dysfunction (clicking, popping) or pain was present in the TMJ at that time. To decide on a correct diagnosis, it is important to determine the anatomic level of the fracture. No previous radiographic images were available.

The frontal dental photographs showed a very slight dental deviation and a compression in the upper arch. A premature contact between the upper and lower incisors was visible in conjunction with an edge to edge occlusion and anterior open bite (Fig. 9.23a and b).

Class I molar was present along with the crossbite position of the right and left temporary molars (Fig. 9.24a and b).

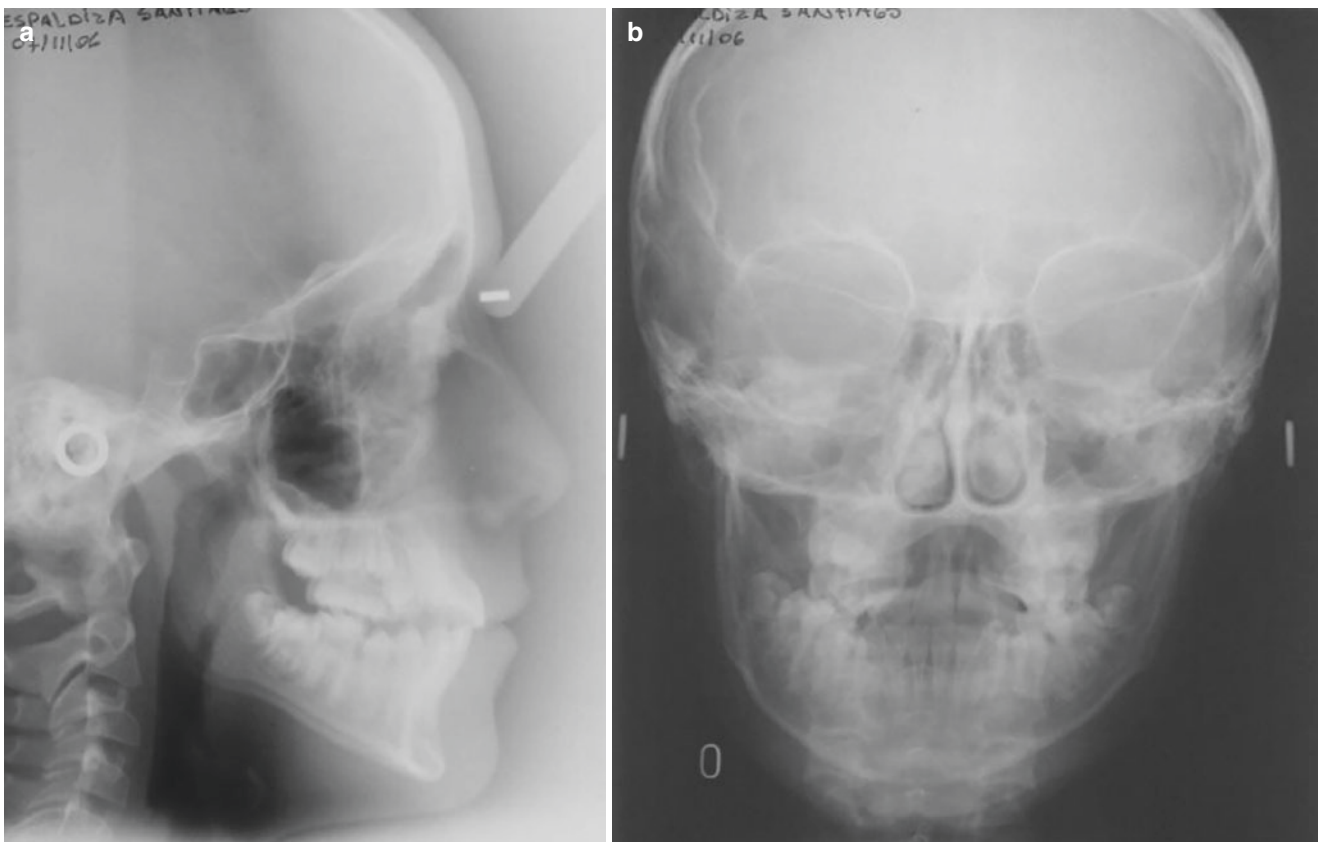


Fig. 9.20 (a and b) Lateral and frontal radiographic images where the asymmetry is clearly evident

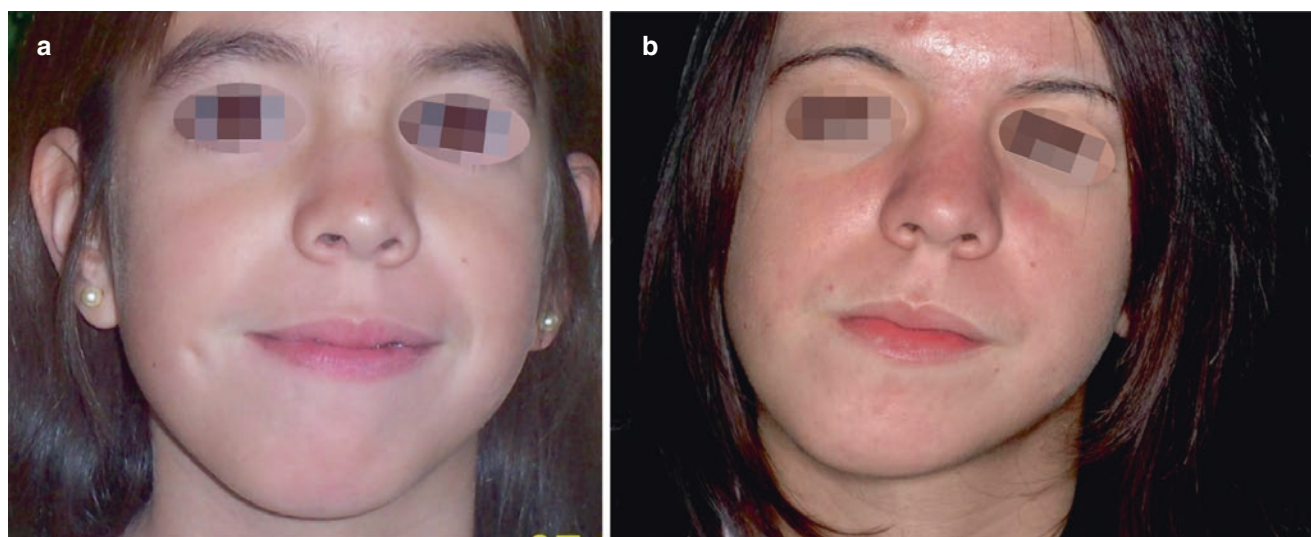


Fig. 9.21 (a and b) Frontal photographs with a 3-year difference without any kind of treatment

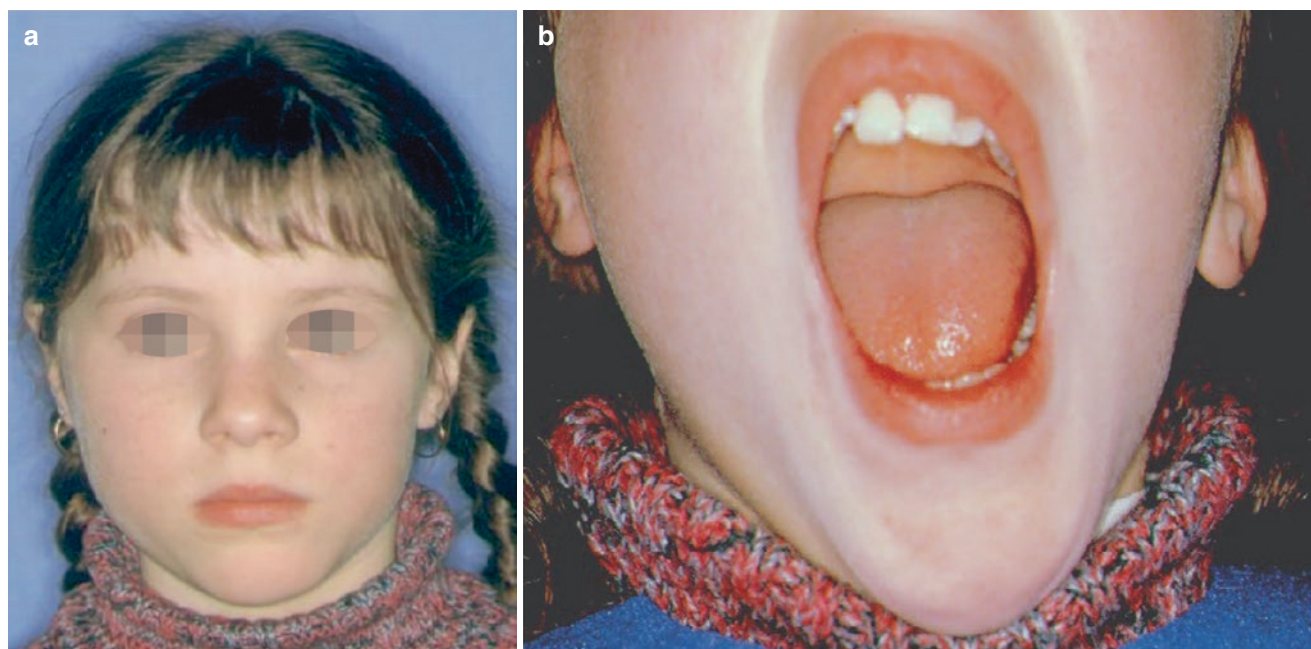


Fig. 9.22 (a and b) The asymmetry was clearly confirmed when the patient opened her mouth, although she could open it for up to 40 mm, which is the average

The premature contact between the upper and lower central incisors was clearly visible.

The panoramic radiographic image confirmed the fracture on the neck of the condyle. In addition, there was a significant difference between the right and left ramus and coronoid process. The eruption of the permanent teeth seemed to be normal according to her age (Fig. 9.25a).

The lateral radiographic image confirmed the mandibular asymmetry and showed a double image in the lower and distal borders of the mandible (Fig. 9.25b).

The patient returned 1 year later with the same pathology; a significant deviation to the left side when the mouth was opened without any pain or clicking. The TMJ specialist described an anteromedial disc displacement and mild musculature atrophy on that side (Fig. 9.26a and b).

The frontal dental photographs at this stage showed that the midlines were almost coincident with a significant open bite on the right side. The tongue was interposed between the maxilla and the mandible at rest and in function. Oral hygiene was fairly good (Fig. 9.27a and b).

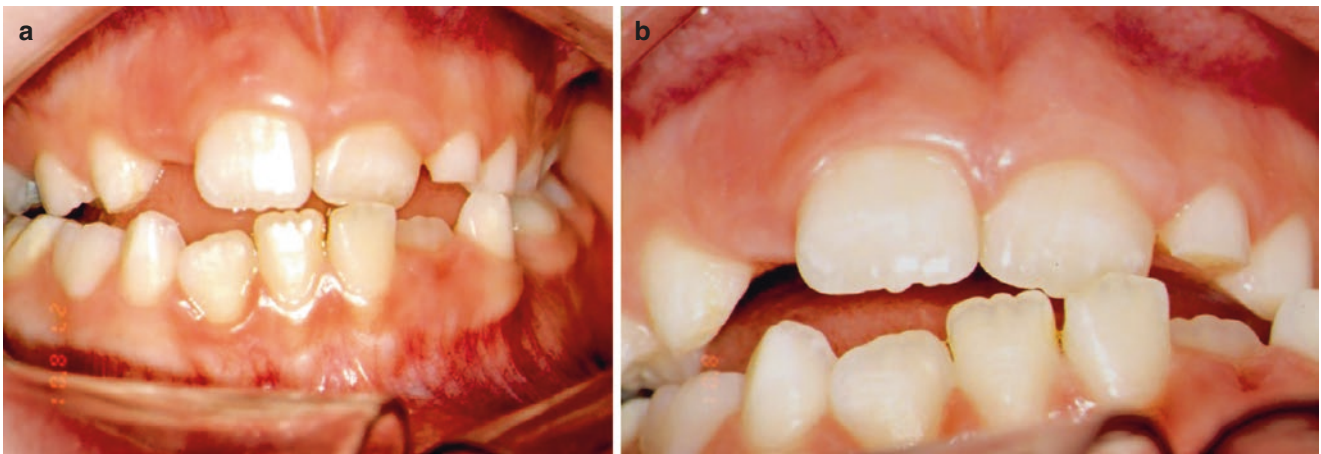


Fig. 9.23 (a and b) Pretreatment frontal dental photographs. A premature contact was clearly seen between the upper and lower central incisors with noncoincident midlines

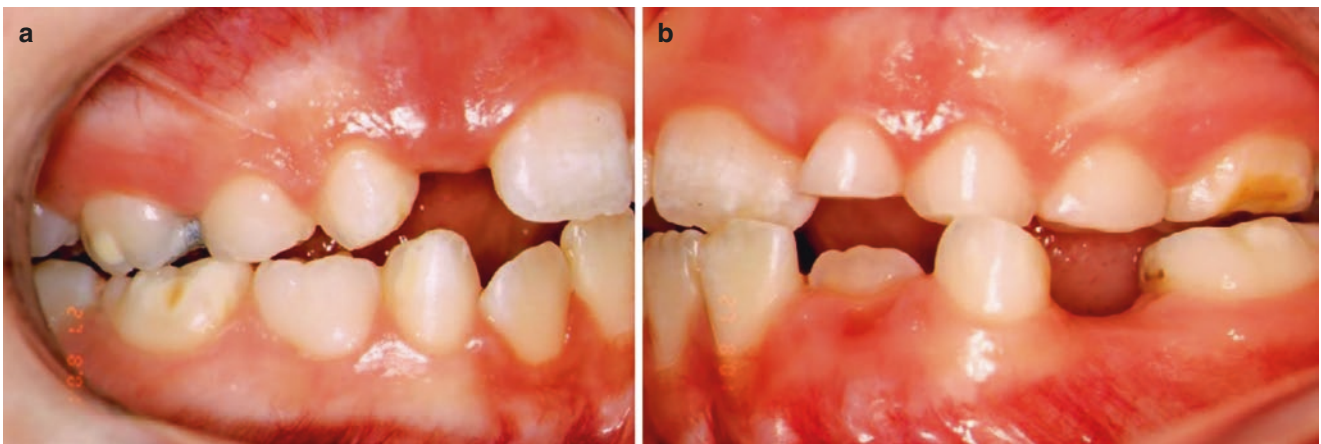


Fig. 9.24 (a and b) Noticeable compression of the upper arch

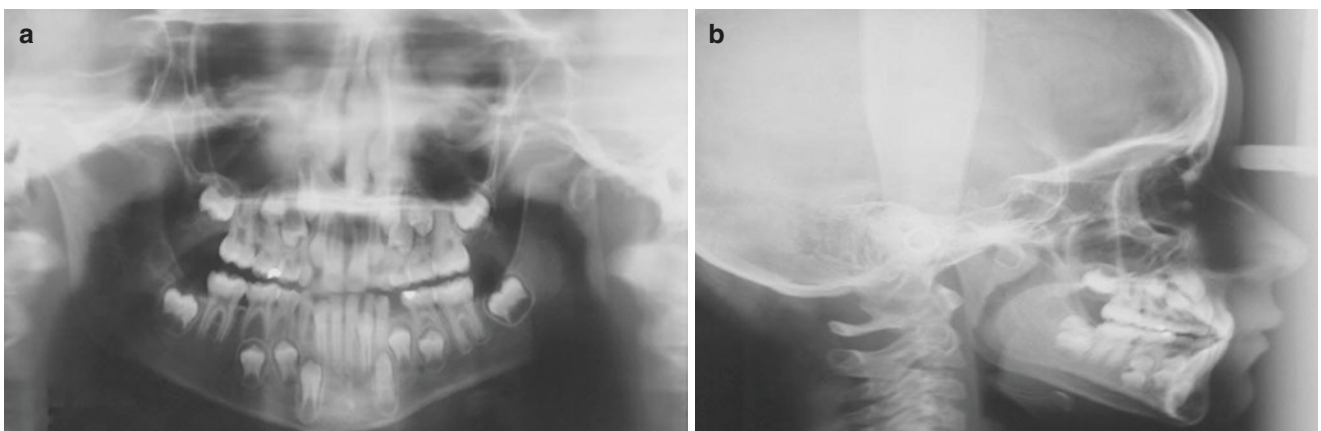


Fig. 9.25 (a and b) Pretreatment panoramic and lateral radiographic images. The fracture of the condyle and a significant mandibular asymmetry were confirmed



Fig. 9.26 (a and b) The significant deviation to the left side when the mouth was opened remained. No pain or clicking was present

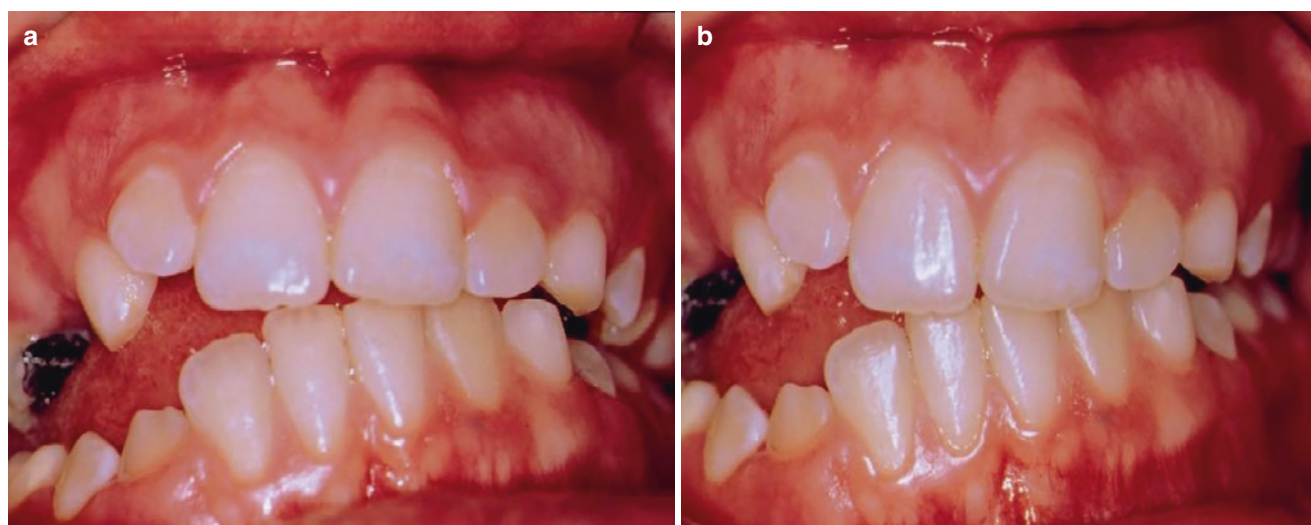


Fig. 9.27 (a and b) Frontal photographs one year later without treatment. The midlines are almost coincident, but a significant right open bite was present

It is well known that form and function are intimately related. With this in mind, a functional appliance was designed in order to improve musculature function.

Clinical observations have shown large adaptive changes in condyle fractures that can cause functional disturbances and alterations during the growth period. For this reason, it is important to treat the patient as soon as

he/she is diagnosed (Tavares). A conservative orthodontic treatment was recommended with an Andreasen-Haulp activator that was controlled every 6–8 weeks. The patient cooperated very well by using it almost all day (Fig. 9.28a and b).

Upon detailed analysis of the following X-ray images, an improvement of the shape of the left condyle was observed

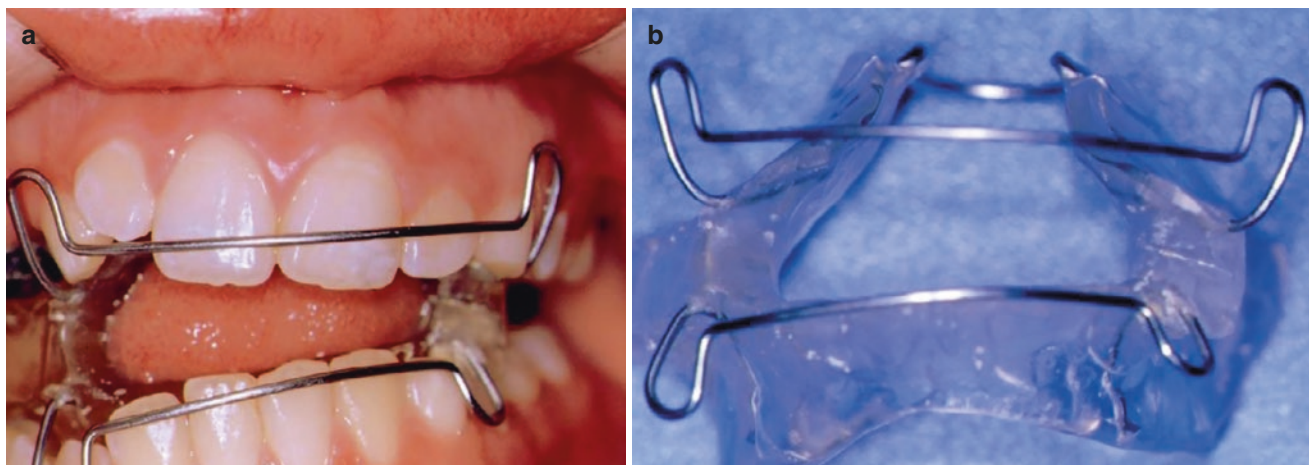
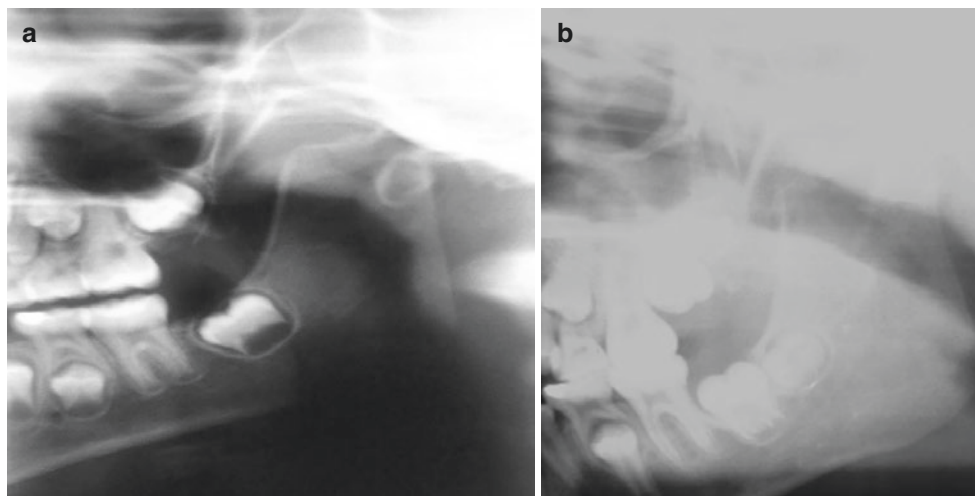


Fig. 9.28 (a and b) An Andreasen-Haulp activator was recommended that was controlled every 6–8 weeks

Fig. 9.29 (a and b) A significant remodelling in the condylar area was visible



with satisfactory remodelling of the condylar fracture region. The second left lower molar continued its eruption path (Fig. 9.29a and b).

To correct the lateral open bite, metallic preprogrammed brackets (0.022" slot) with bands on the first molars were bonded on the upper arch with a 0.016" Ni-Ti-Cu archwire. Slow and controlled forces were recommended to extrude the right side with bone and not through it. The help of the speech therapist was essential to normalize tongue function and position (Fig. 9.30a and b).

The lateral views corroborate the beginning of the alignment of the upper arch (Fig. 9.31a and b). A 6-week control was advisable. No brackets were bonded on the canines until that point.

When the alignment and leveling of the arches were completed, a rectangular wire SS 0.016" $\times$ 0.022" was placed on the upper arch and a 0.017" $\times$ 0.025" turbo-wire was ligated in the lower arch (Fig. 9.32a and b).

The use of triangular elastics (1/8 heavy) was important to normalize the occlusal plane and help maintain the correct position of the tongue. Ideally, elastics have to be used 22–23 hours a day. When the expected results were achieved, reinforcement was recommended during the night for 4–6 months (Fig. 9.33a and b).

At the end of the orthodontic treatment, excellent functional and esthetic results were achieved. The midlines were coincident and the gingival line and occlusal plane were parallel. Overjet and overbite were within the normal range (Fig. 9.34a and b).

Intraoral examination revealed Class I canine and molar on the right and left sides. Overjet and overbite were within the normal ranges and there was no pain or clicking in the TMJ (Fig. 9.35a and b). It was important to continue the treatment with the speech therapist to control the position of the tongue at rest and in function in order to avoid any type of relapse.

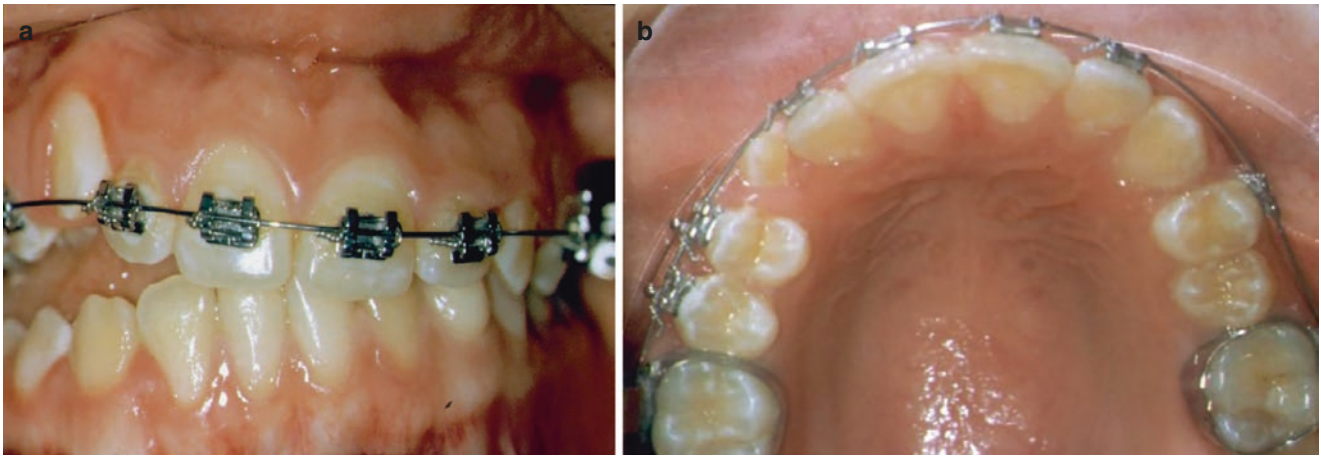


Fig. 9.30 (a and b) A Ni-Ti-Cu 0.016" archwire was placed to begin alignment and leveling in the upper arch with preprogrammed 0.022" brackets

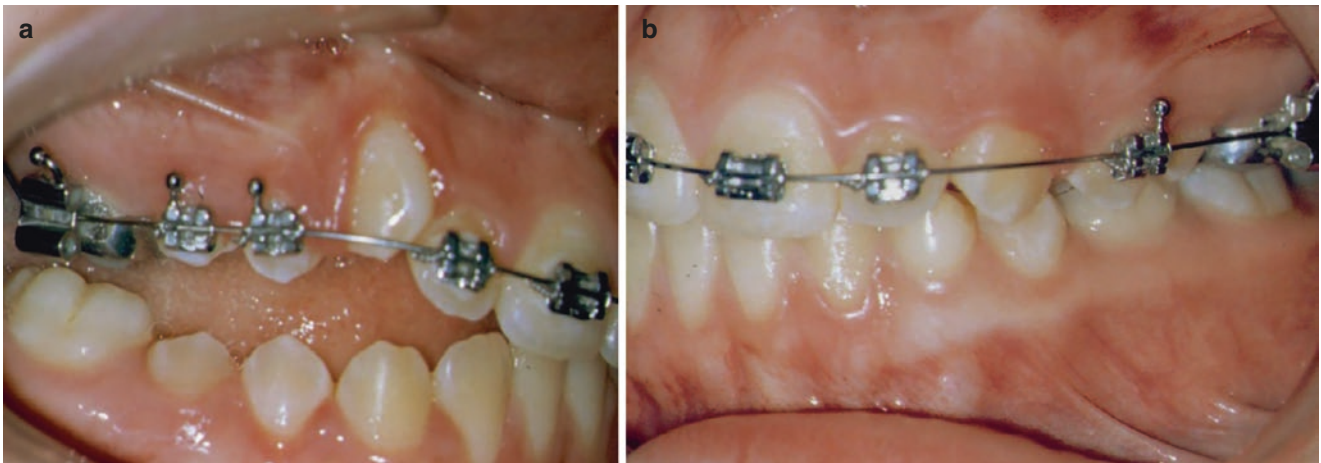


Fig. 9.31 (a and b) Lateral views at the beginning of the treatment with a 0.016" Ni-Ti-Cu archwire in place

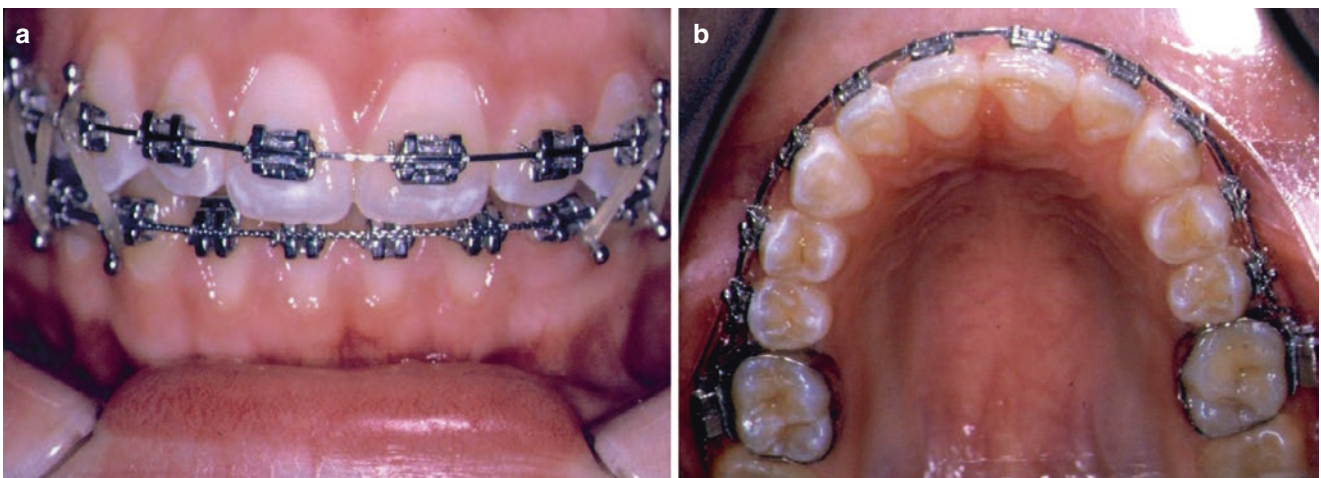


Fig. 9.32 (a and b) To achieve better torque control, rectangular wires were placed in the upper and lower arches

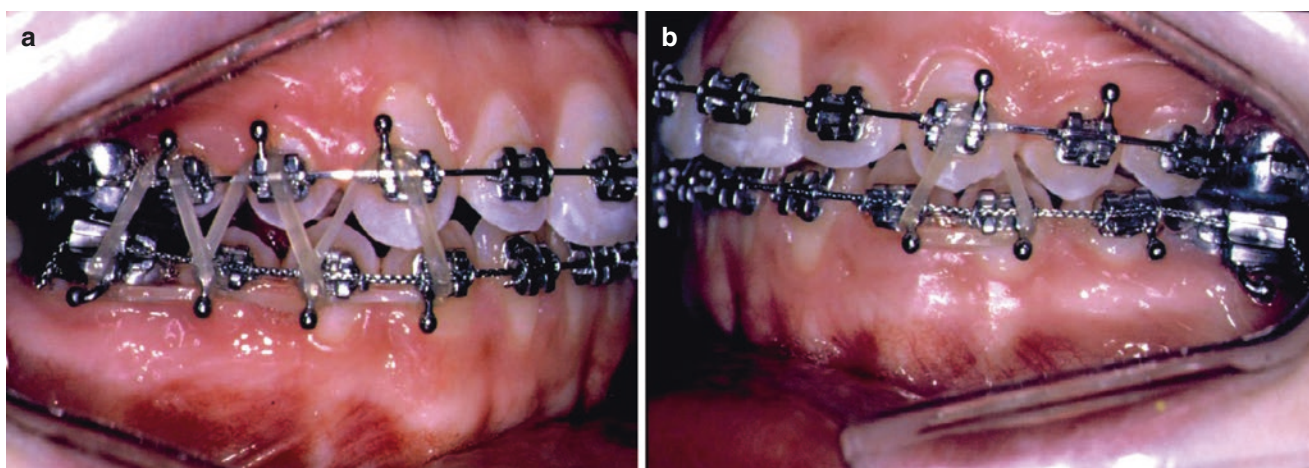


Fig. 9.33 (a and b) Triangular elastics were recommended to improve lateral occlusion (1/8 heavy)

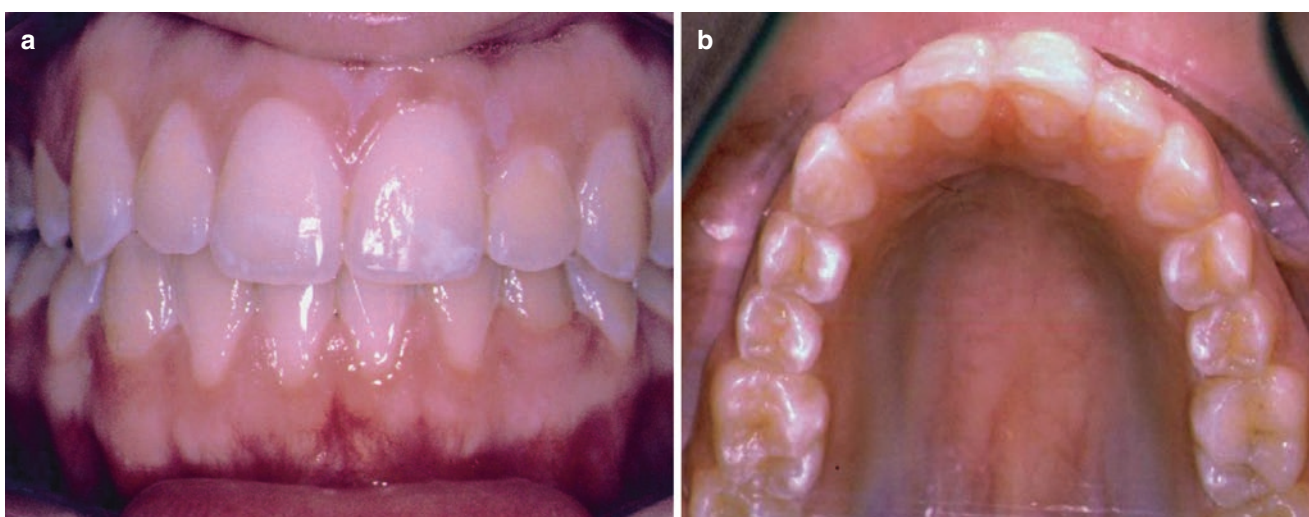


Fig. 9.34 (a and b) Frontal and occlusal view at the end of the active orthodontic treatment. Midlines, overjet, and overbite were normalized

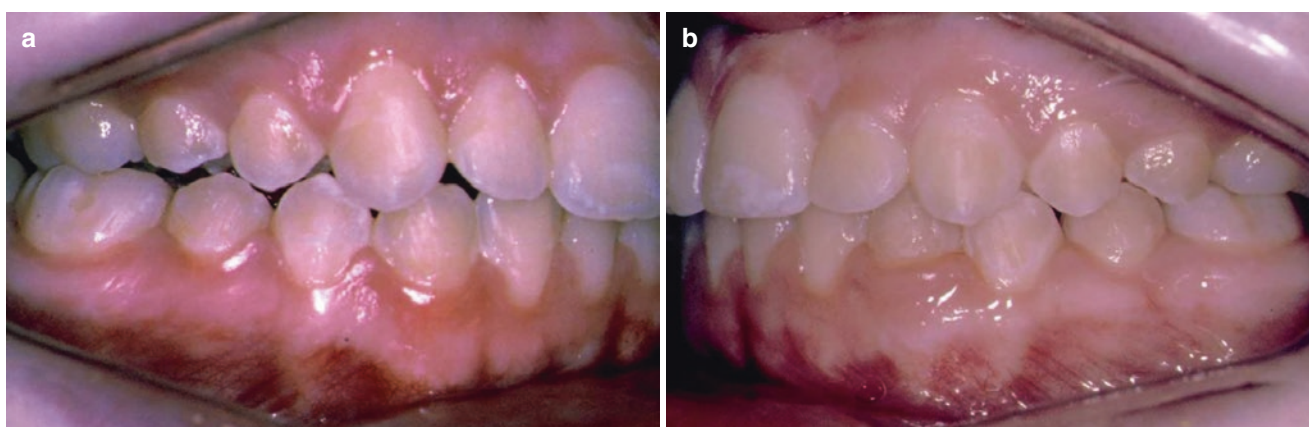
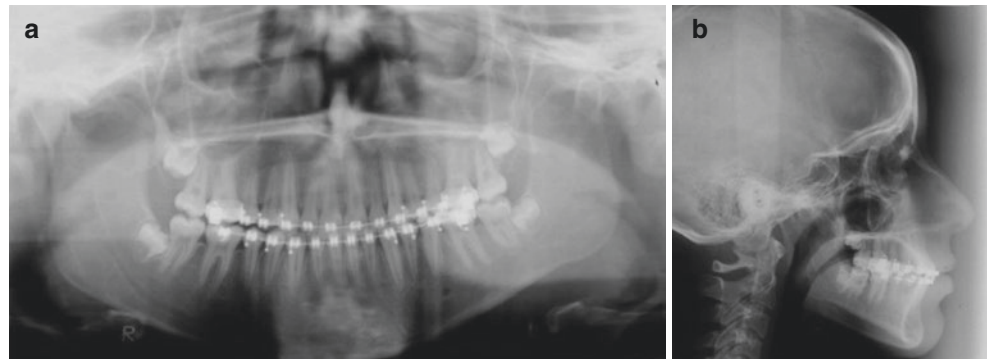


Fig. 9.35 (a and b) Lateral views at the end of the active orthodontic treatment



Fig. 9.36 (a and b) Frontal and smiling photographs at the end of orthodontic treatment

Fig. 9.37 (a and b) Panoramic and lateral radiographic images at the end of the treatment. All measurements were within the normal ranges



At the end of the treatment, facial proportions and natural lip closure improved (Fig. 9.36a and b).

The radiographic images at the end of the treatment demonstrated the results obtained. No disturbances in dental development were found. All teeth were well aligned and there was an evident improvement in the condyle zone. On the lateral radiographic image, a considerable asymmetry was confirmed in the mandibular region in the inferior and posterior borders of the mandible (Fig. 9.37a and b).

The comparison between the pre- and posttreatment frontal photographs showed that facial asymmetry seemed to be enhanced. A conservative treatment approach for unilateral condylar fracture using a functional appliance during the growth period can lead to the restoration of the fracture area

with the reestablishment of the function (Chatzistaourou) (Fig. 9.38a and b).

The comparison among the pre-, mid-, and posttreatment radiographic images confirmed that improvement in the condylar region was better than expected at the beginning of the treatment (Fig. 9.39a, b, and c). Long-term control with functional appliances was necessary to maintain or even improve the excellent results achieved.

It is very interesting to highlight that remodelling of the condylar fracture was highly satisfactory. In addition, improvement of the occlusion was also obtained.

Similar results were desired in a 7-year, 6-month-old patient that was sent to the orthodontic department due to a great latero-deviation while opening the mouth. The chin



Fig. 9.38 (a and b) Comparison between pre- and posttreatment frontal photographs

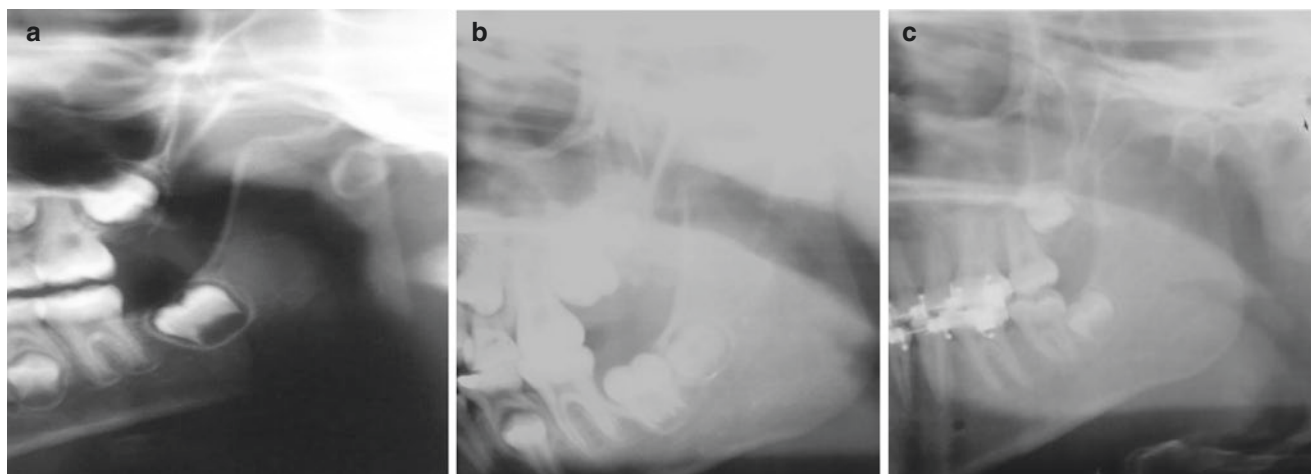


Fig. 9.39 (a, b, and c) Comparison of the pre-, mid-, and posttreatment radiographic images in the condyle area. The results were better than expected at the beginning

was shifted toward the right side and TMJ evaluation did not show pain or clicking during function (Fig. 9.40a and b). Facial asymmetry was visible in the middle and lower third of the face. The mother did not remember when this problem began, but the teacher at school was worried about the patient's situation. The lips were incompetent, and a day and night mouth breathing habit was present. No other important issues were present in the medical history.

The frontal dental photographs showed a considerable midline deviation in conjunction with a significant overbite. Gingival margins were uneven (Fig. 9.41a and b).

Class I canine and molar were present on the right side, whereas on the left side, Class II molar with a normal eruption process was seen (Fig. 9.42a and b).

Upper and lower dental arches showed an ovoid shape with very slight crowding. No cavities or gingivo-periodontal



Fig. 9.40 (a and b) Important latero-deviation at rest and when opening the mouth was observed in the pretreatment photographs. Day and night mouth breathing was present

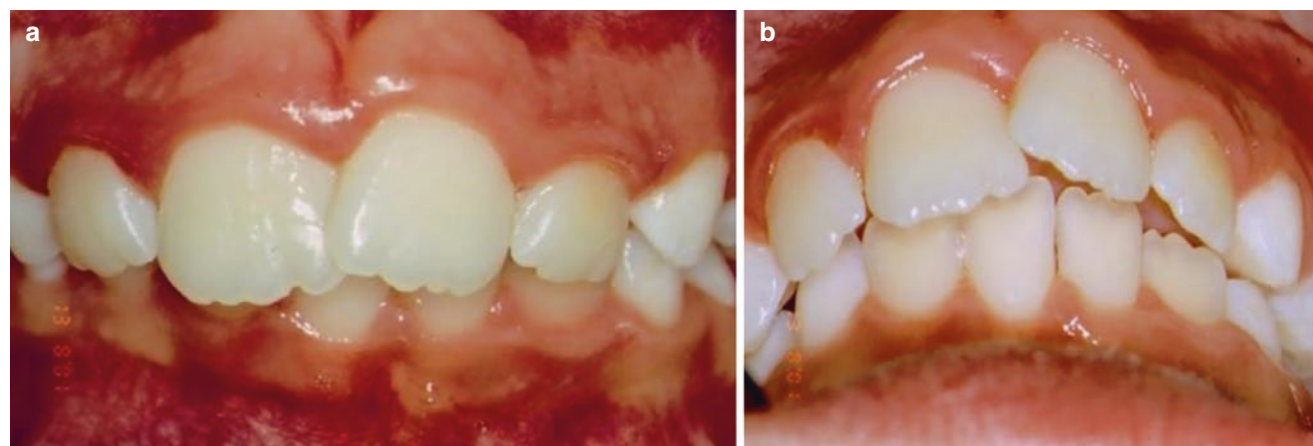


Fig. 9.41 (a and b) Pretreatment frontal and overbite photographs. An important overbite was present along with the overlapping of the upper central incisors

problems were observed. The upper and lower second temporary molars were still present (Fig. 9.43a and b).

Unfortunately, no radiographic images were taken at this time. The mother consulted a traumatologist who recommended some physical exercises, twice a week. The patient returned 14 months later without any orthodontic or orthope-

dic treatment, and as expected, no major changes were observed (Fig. 9.44a and b). Clinically, the midline shift when opening the mouth remained.

The most important treatment objective was the reestablishment of normal skeletal and muscle growth. A functional appliance was suggested to improve patient's problems,

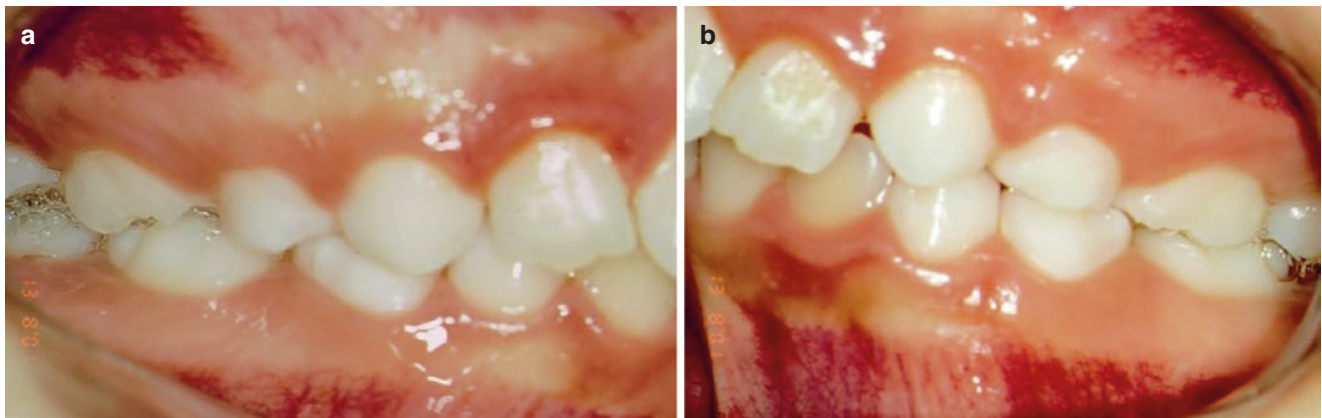


Fig. 9.42 (a and b) Lateral views at the beginning of the treatment. A significant overbite was present in the anterior and canine regions

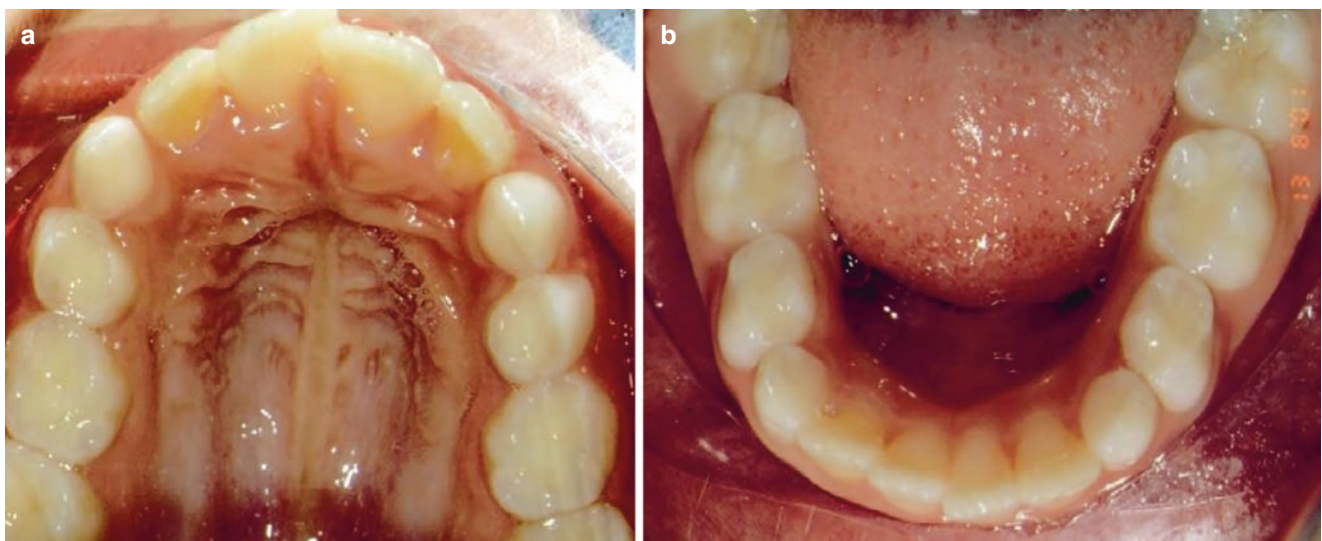


Fig. 9.43 (a and b) The upper and lower dental arches. The upper and lower second temporary molars were present

bearing in mind that oral physiologic function such as mastication, swallowing, or speech is highly coordinated with neuromuscular function. An individualized double activator was specially designed for the patient (Fig. 9.45a and b). It was highly recommended that the patient use the appliance 20–22 hours a day.

Ideally, this appliance should be used nearly 20 hours a day but the patient was uncooperative. The arguments were difficulties in speech and swallowing, and she was supported by her parents. After 10 months, the decision to perform an orthodontic treatment was permitted by the parents, and the patient's intraoral photos at the beginning of the orthodontic treatment were obtained. The midlines were not coincident and a considerable overbite was still present (Fig. 9.46a and b).

The lateral photographs confirmed Class I canine and molar on the right side and Class II canine and molar on the left side. All permanent teeth had erupted (Fig. 9.47a and b).

The panoramic radiographic image confirmed the normal eruption of the permanent teeth, and no agenesis or supernumerary teeth were present. Moreover, no root resorption was observed (Fig. 9.48).

The asymmetry was clearly confirmed in the frontal radiographic image where the differences between the right and left sides were evident. The lateral radiographic image confirmed that the patient had a mesofacial biotype with significant protrusion of the upper incisors ($+11^\circ$) and a diminished interincisal angle (112°). The lower facial height was normal (47°) (Fig. 9.49a and b).

Since in this patient the asymmetry was a combination of skeletal, muscular, and soft tissue discrepancies, an individualized treatment protocol had to be designed in order to achieve the best results. Metallic preprogrammed brackets with 0.022" slots were bonded with 0.016" SS archwires to align and level the arches (Fig. 9.50a and b).

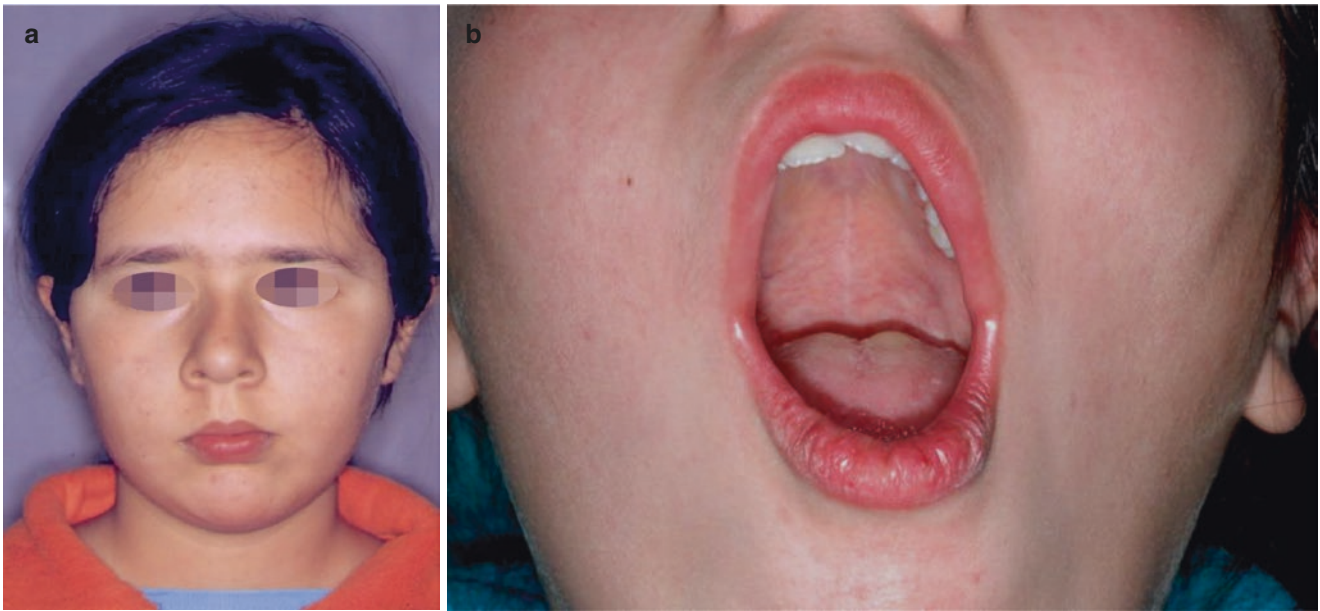


Fig. 9.44 (a and b) Frontal photographs 14 months later without any orthopedic/orthodontic treatment



Fig. 9.45 (a and b) An individualized activator was designed to improve muscle activity

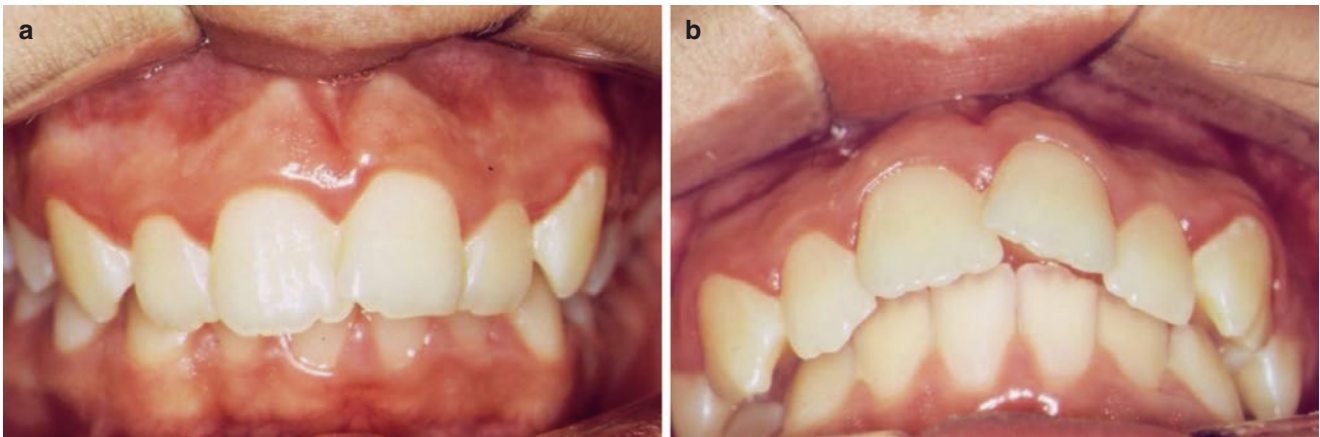


Fig. 9.46 (a and b) Frontal photographs before the beginning of the orthodontic treatment

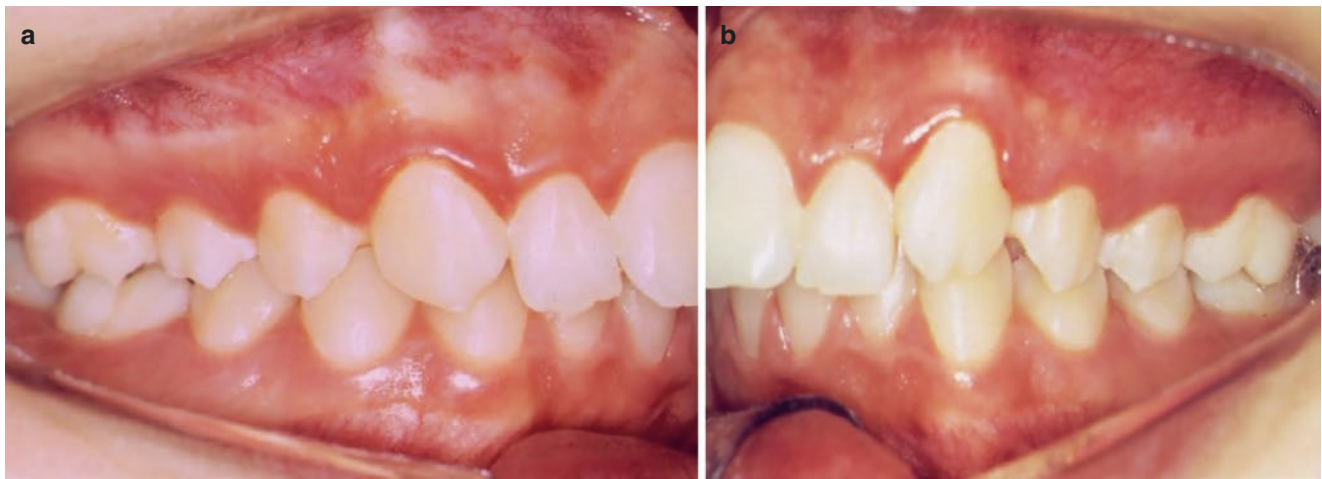


Fig. 9.47 (a and b) Right and left occlusion before orthodontic treatment



Fig. 9.48 Panoramic radiographic image preorthodontic treatment

Class II elastics were suggested to improve lateral occlusion. Overjet and overbite were in within the normal range and the midlines were still noncoincident. According to the clinical and radiographic diagnosis, it was very difficult to achieve Class I molar and canine on the left side due to the presence of a skeletal asymmetry (Fig. 9.51a and b).

The upper and lower occlusal arches were well rounded and all the rotations were corrected. In general, it is advisable that the last archwire be maintained in place for at least 5–6 months to obtain mature bone around the new position of the teeth (Fig. 9.52a and b).

Photographs at the end of the treatment showed that all objectives were fulfilled in the 2-year, 6-month orthodontic treatment. The midlines were coincident, and overjet and

overbite were within the normal ranges. Occlusal plane and gingival lines were parallel (Fig. 9.53a and b).

Perfect Class I canine and molar were achieved on the right side and, as expected, Class II on the left side. Good oral hygiene was maintained (Fig. 9.54a and b).

Upper and lower fixed retention wires were bonded in order to maintain the position of the upper and lower incisors. To maintain the achieved results, another functional appliance similar to the one made by Trainers was recommended for a long period (4–5 years) since the normalization of the musculature activity takes several years (Fig. 9.55a and b).

Subtle soft tissue facial asymmetry can be observed at the end of the active orthodontic treatment (Fig. 9.56a and b). A functional appliance was recommended as a retainer for a long period of time.

After a careful analysis of the panoramic radiographic images, a good parallelism of the roots without resorption was observed. The second molars had completely erupted and the third molars were in their normal process of eruption (Fig. 9.57a). The lateral radiographic image confirmed the substantial improvement in the profile (Fig. 9.57b).

The comparison between the pre- and posttreatment photographs clearly showed that the treatment objectives were reached. Although some asymmetry was observed, it was less visible (Fig. 9.58a and b). No TMJ pain or dysfunction was present.

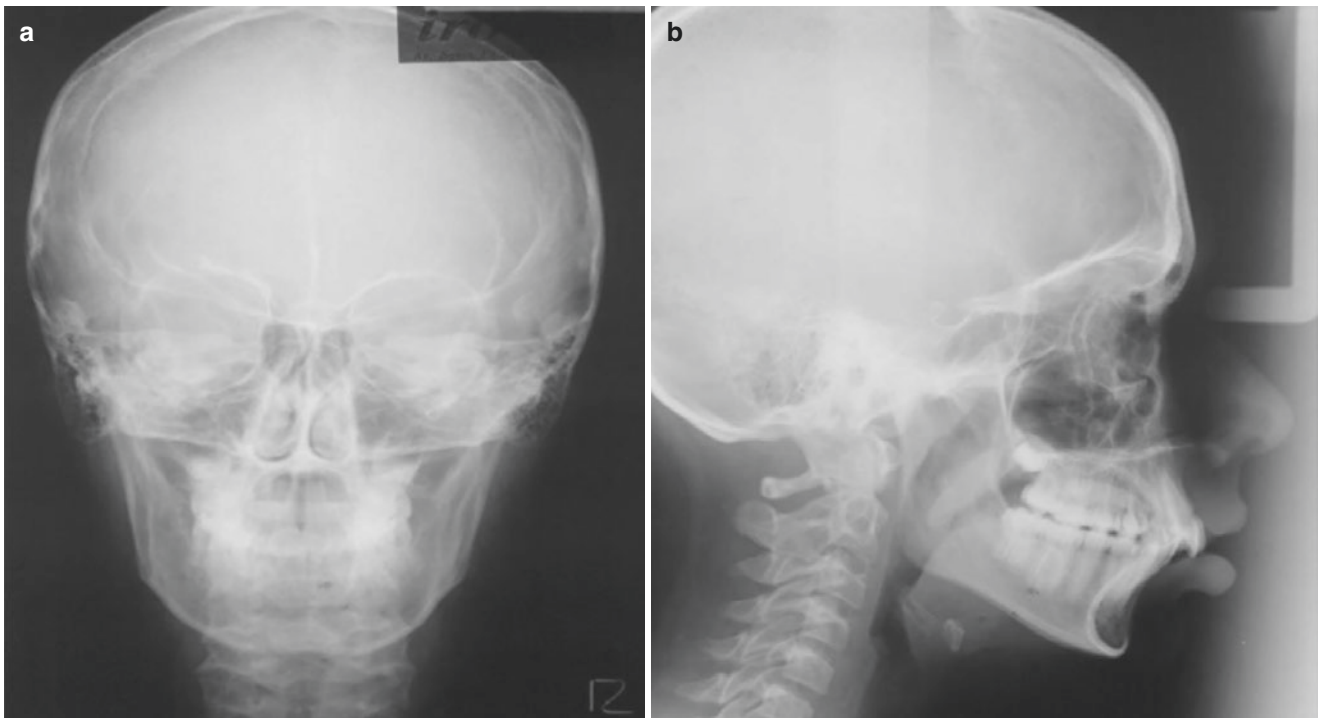


Fig. 9.49 (a and b) Pretreatment frontal and lateral radiographic images. The asymmetry and the protrusion of the upper incisors were evident

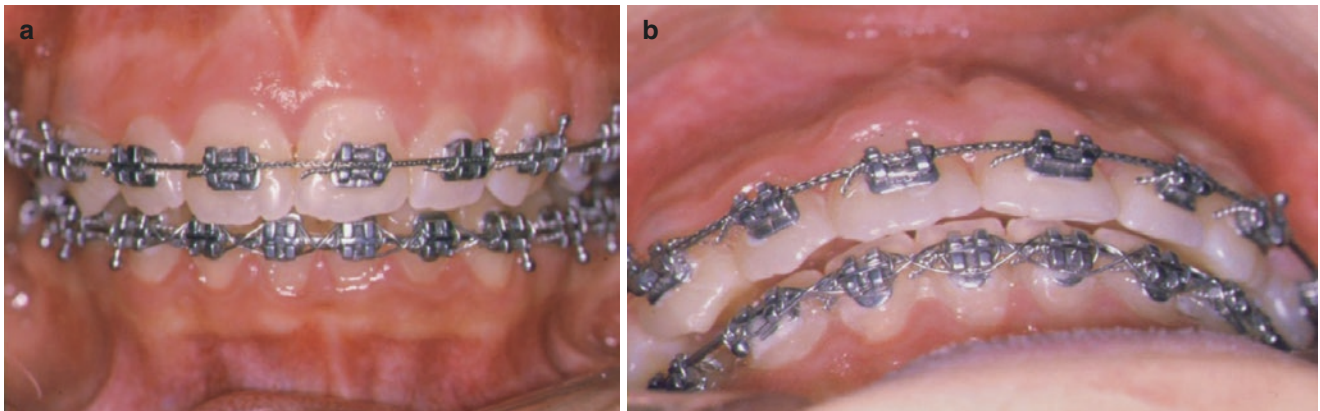


Fig. 9.50 (a and b) Frontal view after 20 months in active orthodontic treatment with preprogrammed 0.022" metal brackets. Gingival line was parallel to the occlusal plane

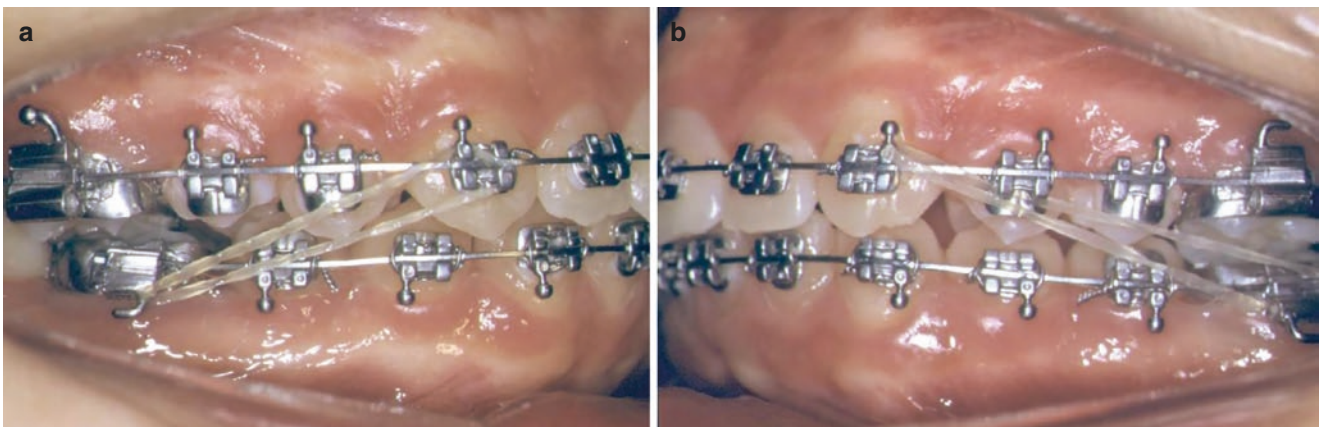


Fig. 9.51 (a and b) Class II elastics were recommended 20 hours a day to improve occlusion

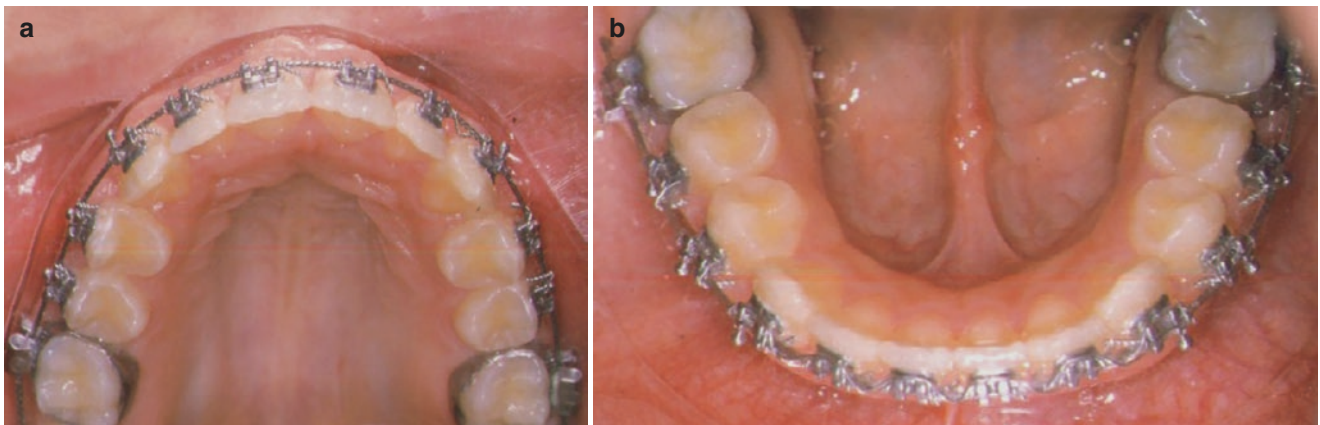


Fig. 9.52 (a and b) Upper and lower arches before the end of the orthodontic treatment

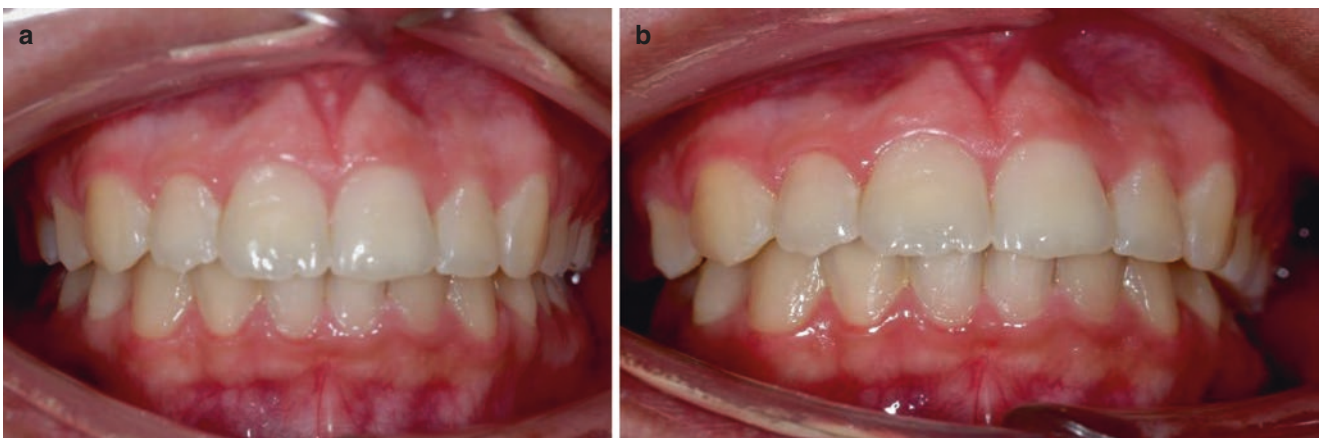


Fig. 9.53 (a and b) Posttreatment frontal photographs. All objectives were fulfilled with no extractions

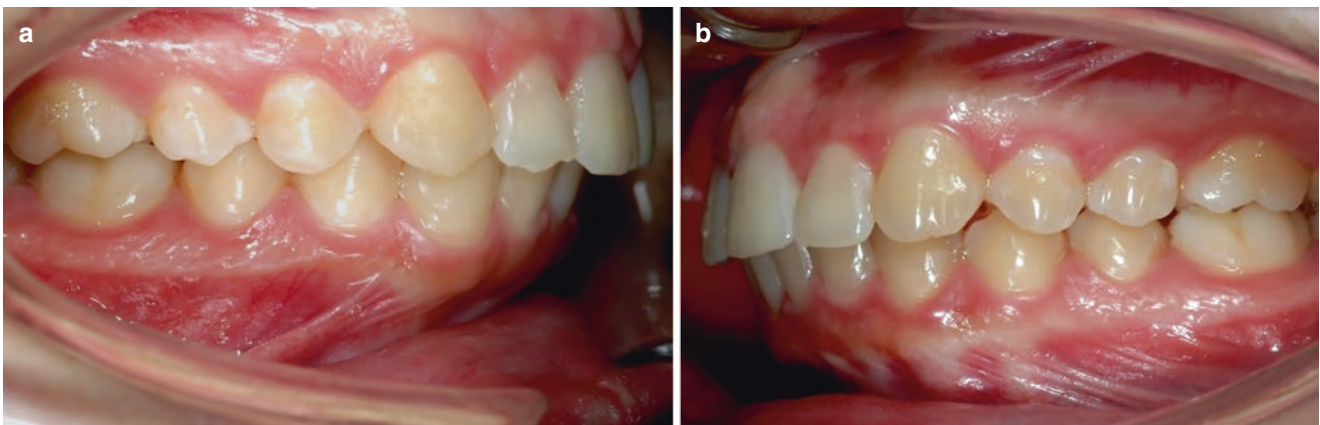


Fig. 9.54 (a and b) Lateral views at the end of the orthodontic treatment

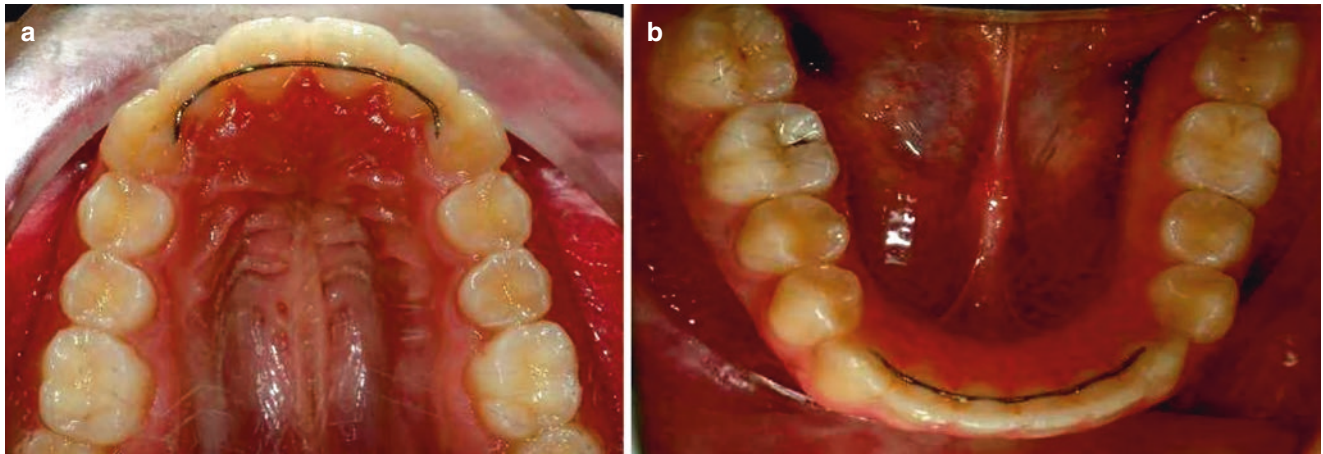


Fig. 9.55 (a and b) Upper and lower fixed retainers were bonded on the anterior teeth along with a functional appliance to maintain the results

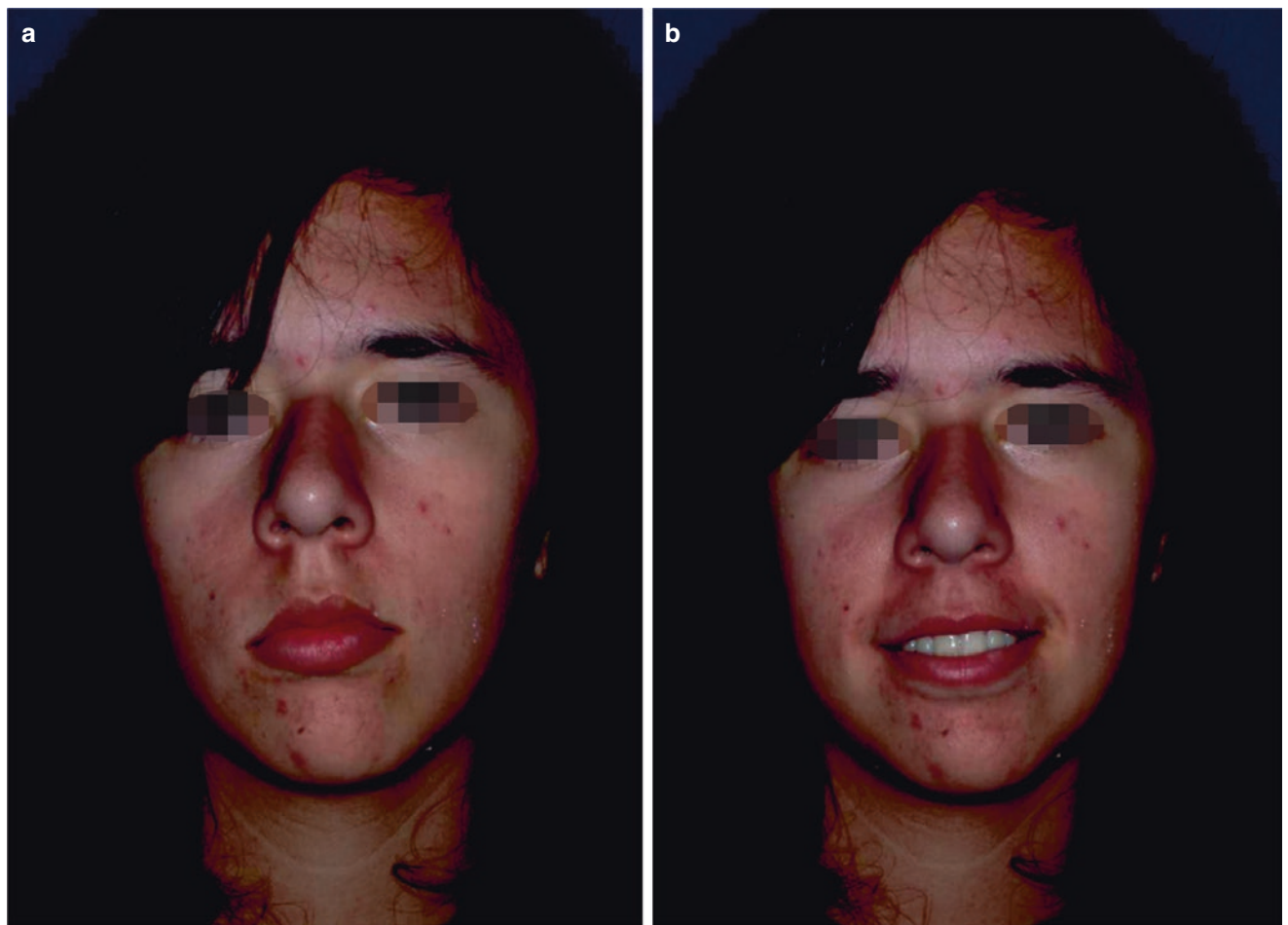


Fig. 9.56 (a and b) Frontal and smiling photos at the end of the treatment. The asymmetry is less noticeable

Fig. 9.57 (a and b) Panoramic and lateral radiographic images at the end of the active orthodontic treatment

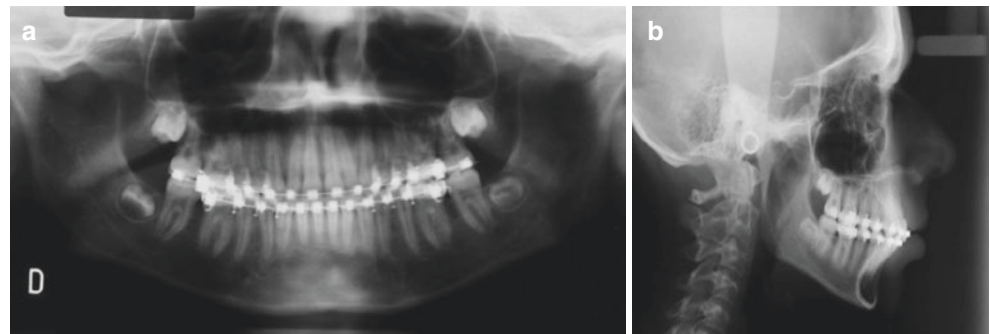


Fig. 9.58 (a and b) Frontal photographs pre- and post-orthodontic treatment. A substantial esthetic and functional improvement were achieved

9.1 Conclusions

One of the biggest challenges for the orthodontist is the treatment of dentoalveolar and skeletal asymmetries. It is crucial to determine the real factors that cause the asymmetry and, in this way, to define the best treatment and long-term retention plan.

The treatment of asymmetries in temporary and early mixed dentition requires a detailed study of all the available records (radiographic images, cast models, tomographic images, photographs, etc.) to determine the location, extent, and causes that produce these results (Thilander). To obtain an accurate diagnosis, all the frontal, transverse, and lateral

asymmetries have to be diagnosed in centric relation. A panoramic radiograph is useful to survey dental and bone structures of the maxilla and the mandible and to determine the presence of gross pathologic condition or the shape of the mandibular ramus and condyles on both sides. Clinical observations have shown large adaptive changes in fractured condyles than can cause functional disturbances and alterations in dentofacial growth.

The retention plan has to be individualized for each patient and be determined at the same time as the treatment plan. A long-term retention plan with functional appliances is always recommendable in all patients. Unfortunately, there is no particular bracket or wire that can solve all the

different types of asymmetries that could be present in all patients. Taking into account that unilateral posterior crossbite can alter the stomatognathic system, it could be interesting to study the relationship between this problem, the size of the condyles, and the height of the ramus.

Normally, in temporary dentition, there is premature contact in the temporary canine area (Fig. 9.8b) in centric relation since a functional mandibular shift is the consequence not the cause (primary etiology). Moreover, this mandibular

shift is responsible for some asymmetries in the temporo-mandibular region and can change the normal growth pattern, as observed in adolescents or young adults.

As a result, it is highly recommended to correct unilateral posterior crossbite in temporary or early mixed dentition since it is not self-corrected during growth. Further studies should be conducted to analyze whether the use of this treatment protocol for a longer period of time would have a significant skeletal effect in growing patients with asymmetries.

Mandibular Incisor Agenesis

10

Julia Harfin

Upper and lower incisor agenesis is one of the most common anomalies in children with permanent dentition (Ingervall et al., 1972). The most common congenitally missing incisors are the upper lateral ones and then one or two central lower incisors (Davis, 1987). Niswander, Sujaku, and Davis showed that the mandibular incisors were the most commonly missing teeth in Japanese as well as Chinese populations (Niswander & Sujaku, 1963). Till date, it is not clear whether a close relationship exists between craniofacial morphology and lower incisors agenesis, and this etiology is totally uncertain.

Moreover, hereditary, environmental, and endocrine patterns can play an important role. More clinical trials are necessary to confirm these theories. Since tooth eruption plays a critical role in the continuous growth of the mandibular symphysis, the absence of mandibular central incisors can exhibit a smaller mandibular symphysis area with a greater incisor retroclination than that in normal patients.

In contrast, the absence of the lower central incisors can cause some disturbances in the tongue position in conjunction with a significant anterior deepbite, as observed in the first example. As first reported by Newman in 1967, the mandibular central incisors are frequently prone to bilateral agenesis (Newman & Newman, 1998) (Fig. 10.1a and b).

Lower incisor agenesis can be diagnosed using orthodontic records, including orthopantomographic and periapical radiographic images.

The real dilemma is to close or open the space to replace uni- or bilateral absent teeth by implants or fixed or removable prosthesis. A multidisciplinary approach is important to provide the most appropriate and comprehensive treatment and retention plan.

A 9-year, 10-month-old patient was referred to the orthodontic department due to malposition of the lateral incisors. The frontal photograph showed mild asymmetry along with a straight profile and a thin upper lip. He can close his mouth without effort (Fig. 10.2a and b).

The frontal dental photograph showed a significant overbite of approximately 100% at the central incisal area and an uneven gingival line. Analyzing the lower arch, only three incisors have erupted (Fig. 10.3a and b).

The panoramic radiographic image confirmed that only 3 lower incisors were present, and no dental agenesis was seen. Since the Panorex image was taken in the occlusion site, the important overbite was clearly visible (Fig. 10.4).

In order to align and level the upper arch, preprogrammed brackets were bonded on the upper incisors along with bands on the first molars and a low deflection arch as the first arch (Fig. 10.5a and b).

When the right and left sides were examined, significant gingivitis was observed. No brackets adhered to the temporary canines and molars (Fig. 10.6a and b).

These were the results after 11 months of treatment. Excessive overbite was almost normalized and oral hygiene improved. A Ni-Ti coil spring was added to gain space for the second right bicuspid eruption, not only has it rotated, but it was also in a palatal position (Fig. 10.7a and b).

Eight months later, overbite and overjet were completely restored. Gingival line and occlusal plane were parallel. An upper and lower SS 0.016" × 0.022" was used to complete alignment and maintain torque (Fig. 10.8a and b).

The lateral views showed that even though one lower incisor was missing, Class I canine and molar were achieved. No stripping was performed on the upper arch (Fig. 10.9a and b).

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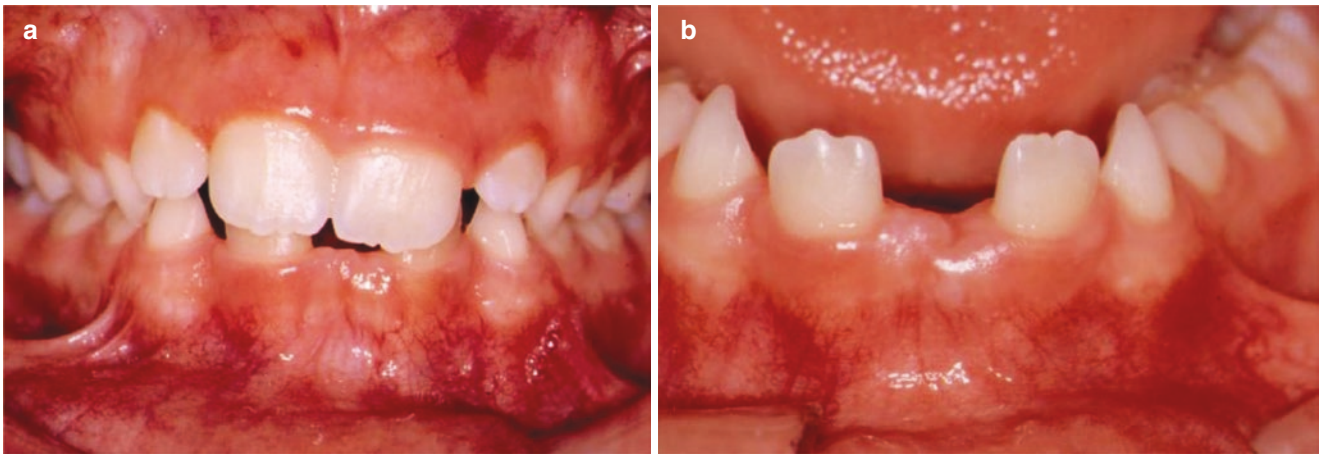


Fig. 10.1 (a and b) Agenesis of the lower central incisors

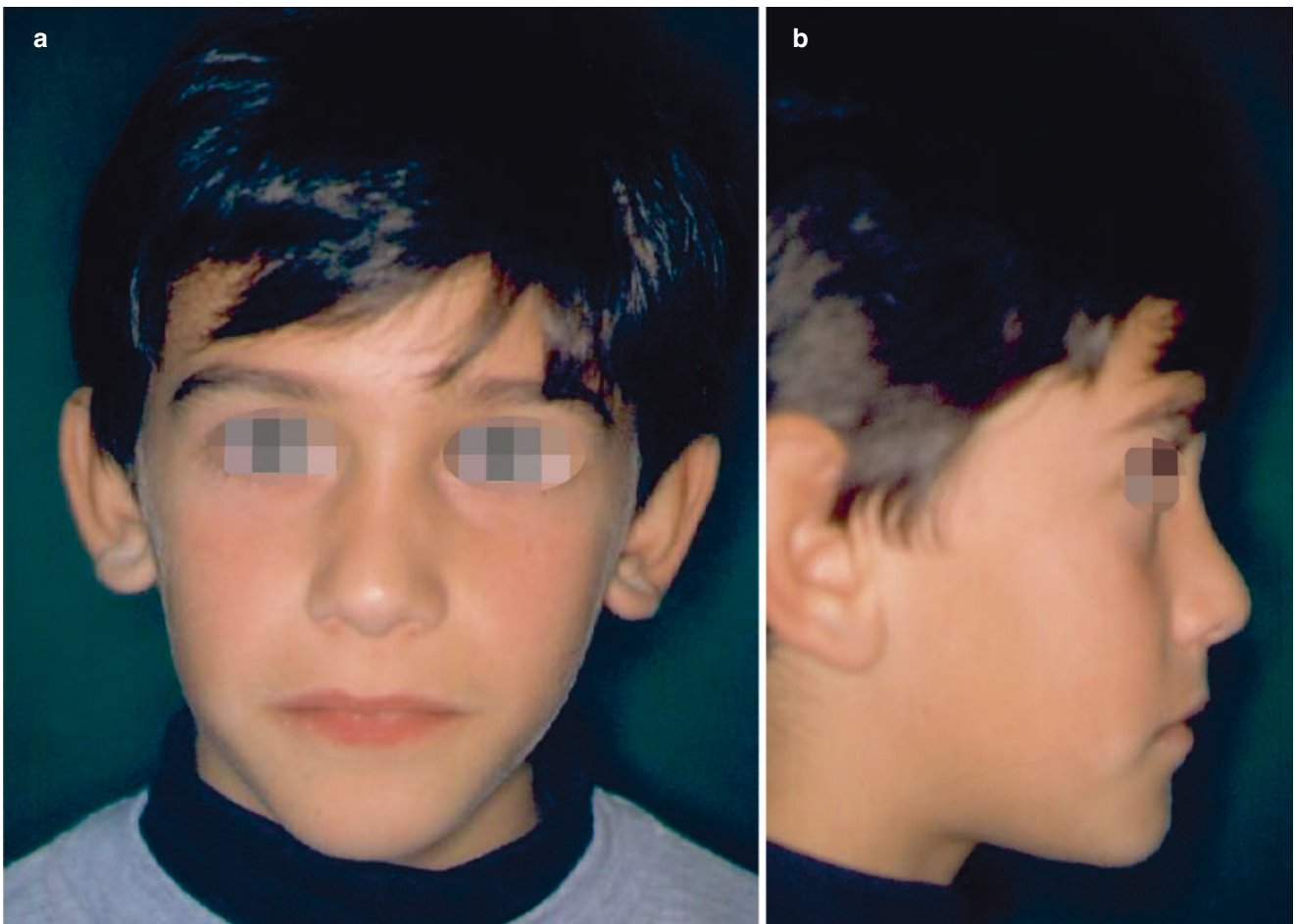


Fig. 10.2 (a and b) Pretreatment frontal and profile photographs

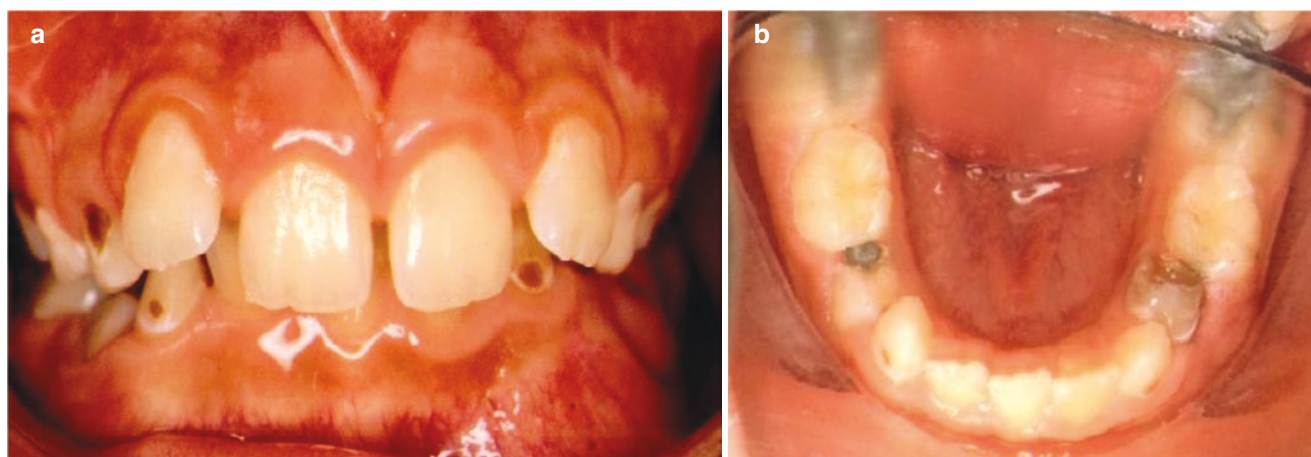


Fig. 10.3 (a and b) Pretreatment frontal and lower arch photographs

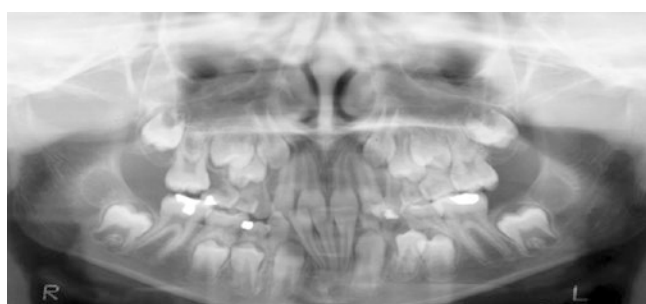


Fig. 10.4 Pretreatment panoramic radiographic image

The normalization of the anterior and posterior teeth position was confirmed when the upper and lower arches were analyzed (Fig. 10.10a and b).

Frontal and upper arch photographs at the end of the treatment show that since the patient presented with one lower incisor agenesis, the midlines were not coincident, but the other treatment objectives were achieved (Fig. 10.11a and b).

A fixed retention wire was bonded between the right and left canines. The periapical radiographic image confirmed the parallelism of the lower incisor roots (Fig. 10.12a and b).

Lateral views at the end of the active orthodontic treatment. Class I canine was maintained as well as a normal occlusal plane (Fig. 10.13a and b).

The final photographs posttreatment showed that facial features were maintained with a clear improvement on the lower third of the face (Fig. 10.14a and b).

The patient returned 5 years later to control the fixed wire retainers.

His frontal and profile photographs demonstrated that his facial biotype was maintained (Fig. 10.15a and b).

Five years later, the position of the teeth was totally maintained and a new retention wire was bonded (Fig. 10.16a and b).

The case of a 7-year-old patient is a clear example of how congenitally central lower incisors agenesis should be managed. He was sent to the office by the dentist's family. No relevant medical history and no trauma or infections in the anterior region were present, and there was no history of lower incisor agenesis in the family.

The frontal pretreatment photographs showed a symmetrical face, but when he smiled, the absence of the central lower incisors was visible (Fig. 10.17a and b).

The lateral photographs exhibited a convex profile that was almost normal in a 7-year-old patient (Fig. 10.18a and b).

Analyzing the frontal dental photographs, a significant overbite and the absence of the lower central incisors were confirmed (Fig. 10.19a and b).

Despite the agenesis of the lower central incisors, Class I molar on the right and left sides was confirmed (Fig. 10.20a and b).

The pretreatment panoramic radiographic image confirmed the agenesis of the lower central incisors and the lower right second bicuspid (Fig. 10.21).

Considering the age of the patient, a control every 6 months was decided. However, the patient returned 4 years later without any type of treatment. Analyzing the panoramic radiographic image, agenesis of the second lower right bicuspid was confirmed. The canines erupted following its normal path (Fig. 10.22).

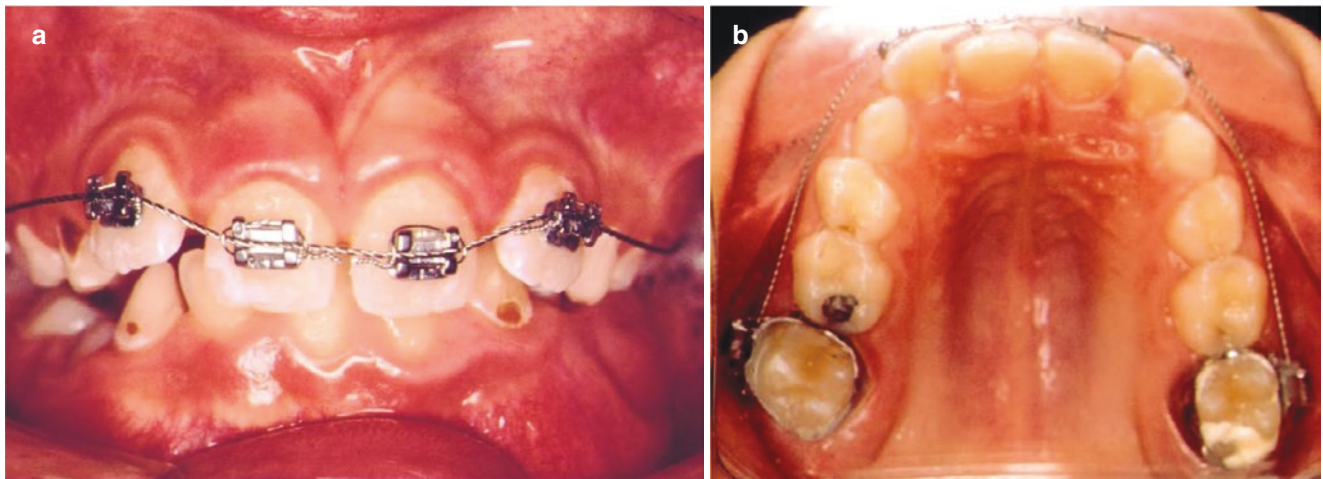


Fig. 10.5 (a and b) Brackets bonded on the upper incisors with a low deflection arch to align the upper arch

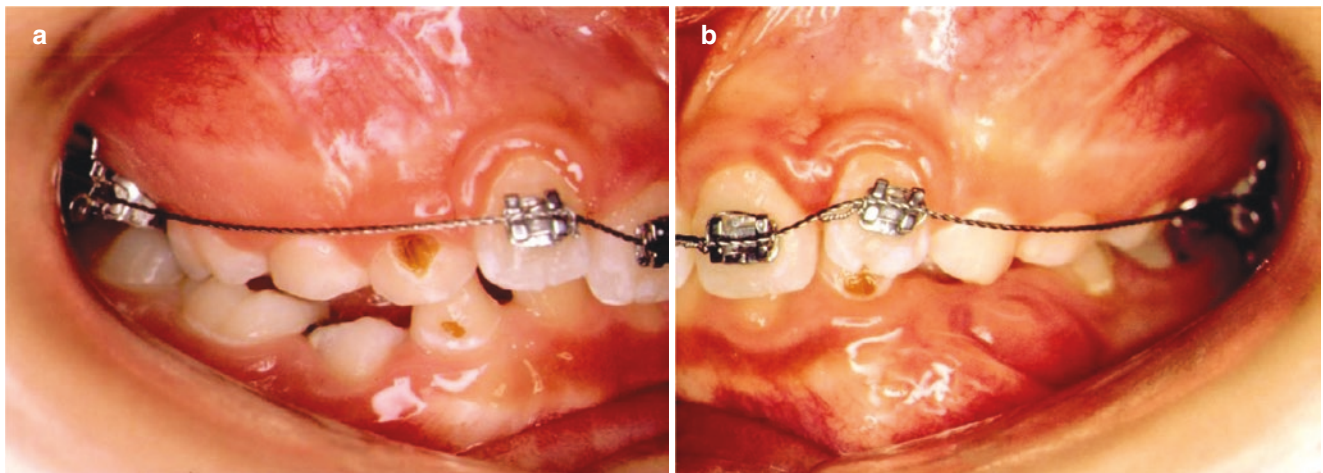


Fig. 10.6 (a and b) Lateral views at the beginning of treatment

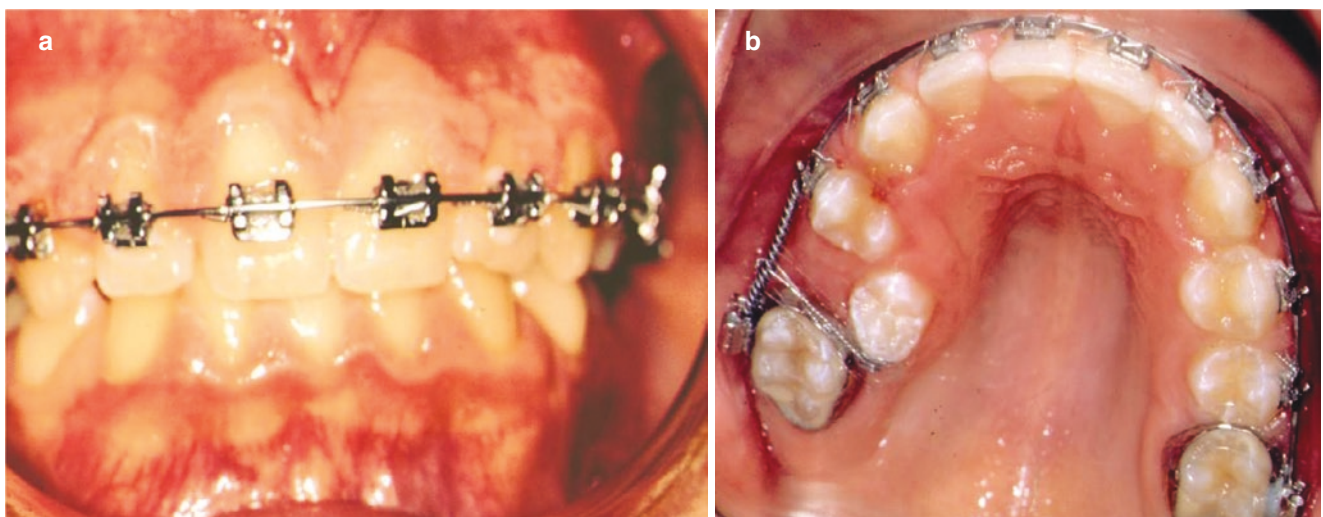


Fig. 10.7 (a and b) Alignment after 11 months of treatment

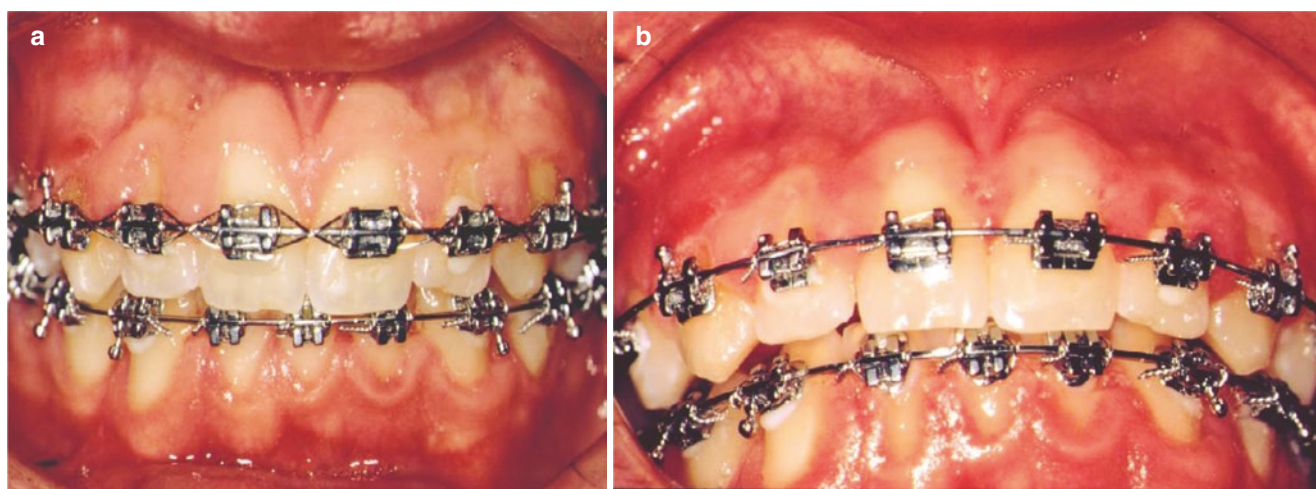


Fig. 10.8 (a and b) Frontal and overbite view after 15 months of treatment

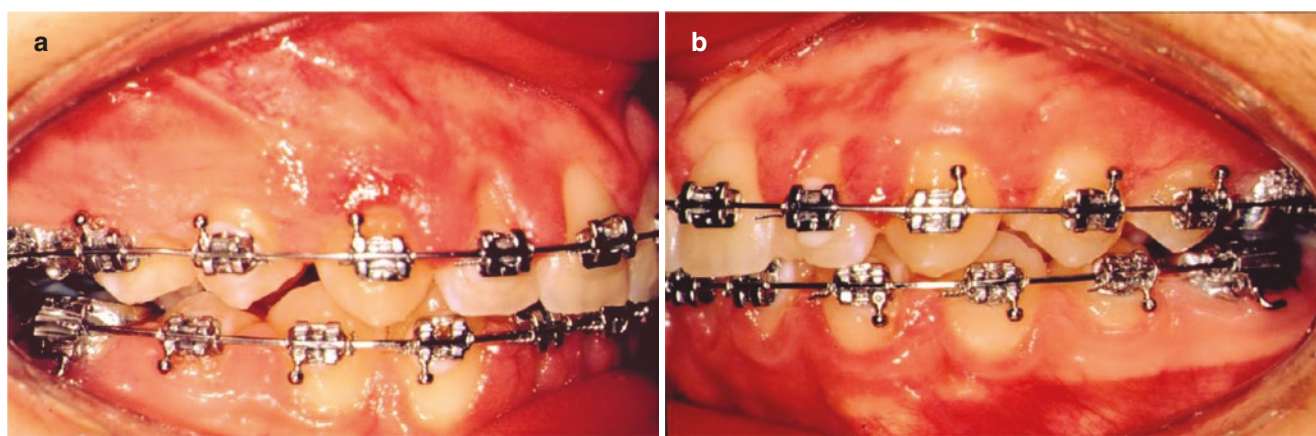


Fig. 10.9 (a and b) Lateral views at this stage of treatment

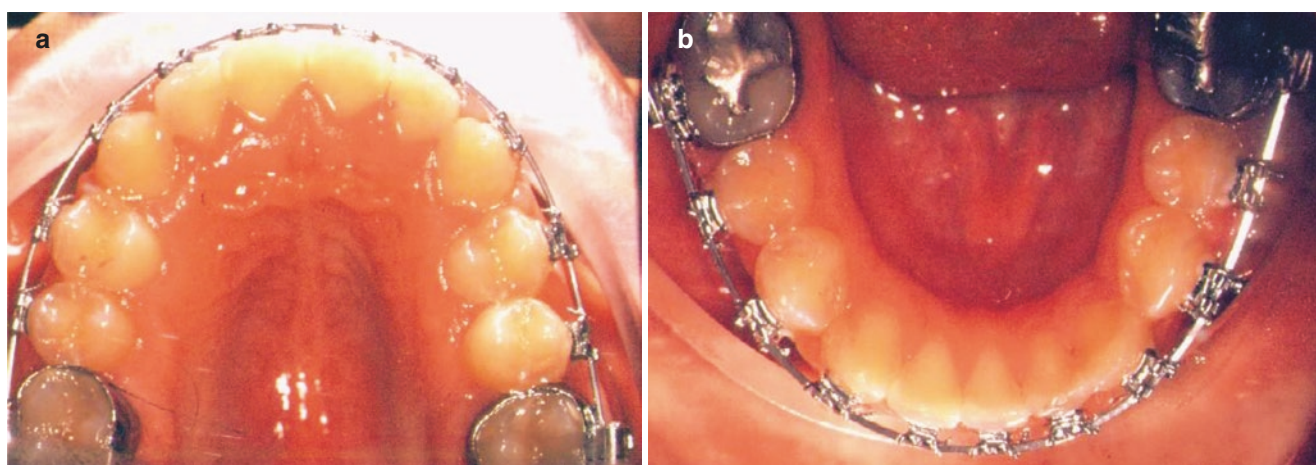


Fig. 10.10 (a and b) Upper and lower arches

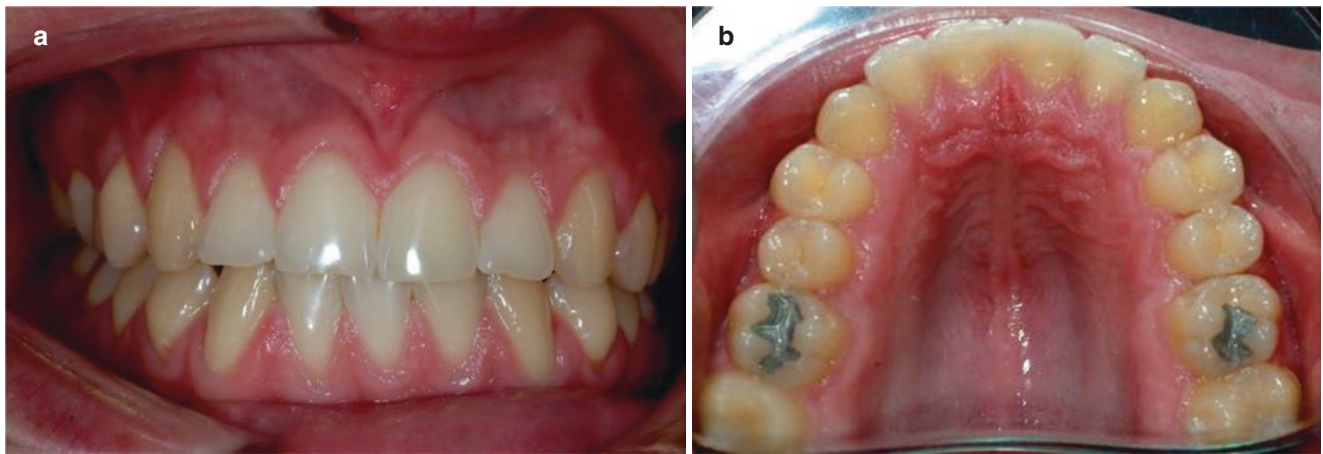


Fig. 10.11 (a and b) Final photographs. All objectives were achieved

Fig. 10.12 (a and b) Retention wire in place and radiographic image of the final lower incisors

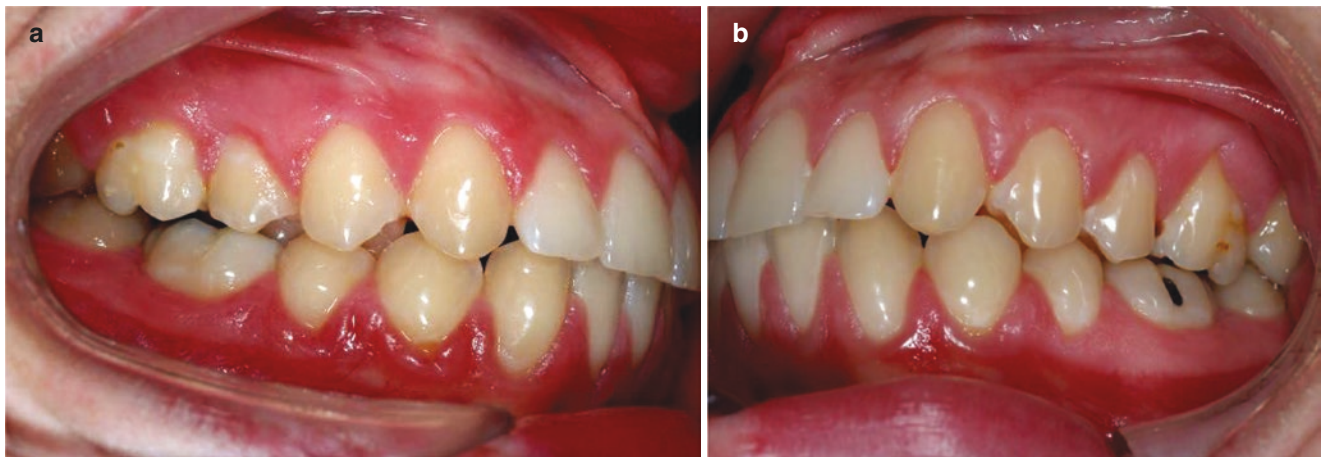
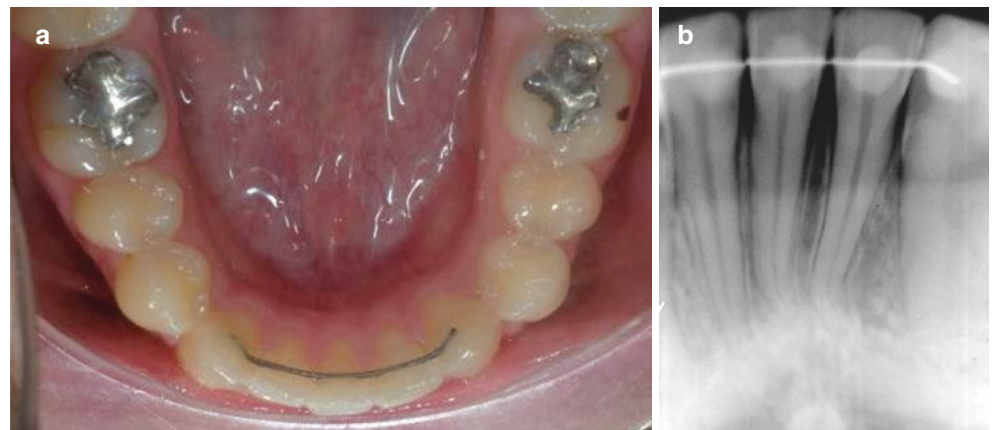


Fig. 10.13 (a and b) Final lateral photographs. Class I canine was achieved despite the agenesis of a lower incisor



Fig. 10.14 (a and b) Frontal and profile photographs at the end of active treatment



Fig. 10.15 (a and b) Control 5 years later

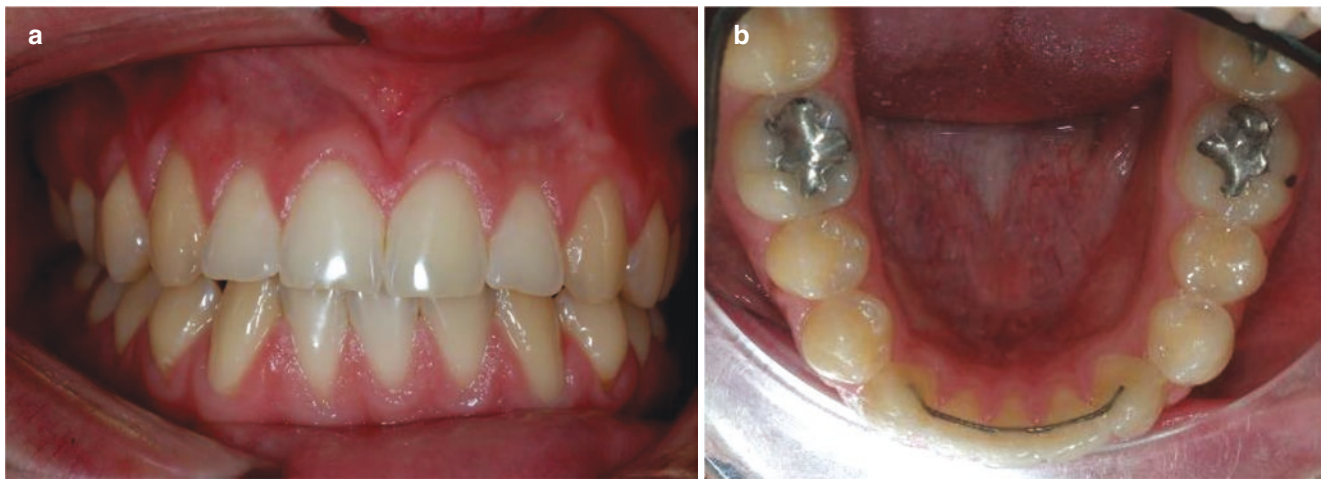


Fig. 10.16 (a and b) Five-year follow-up images

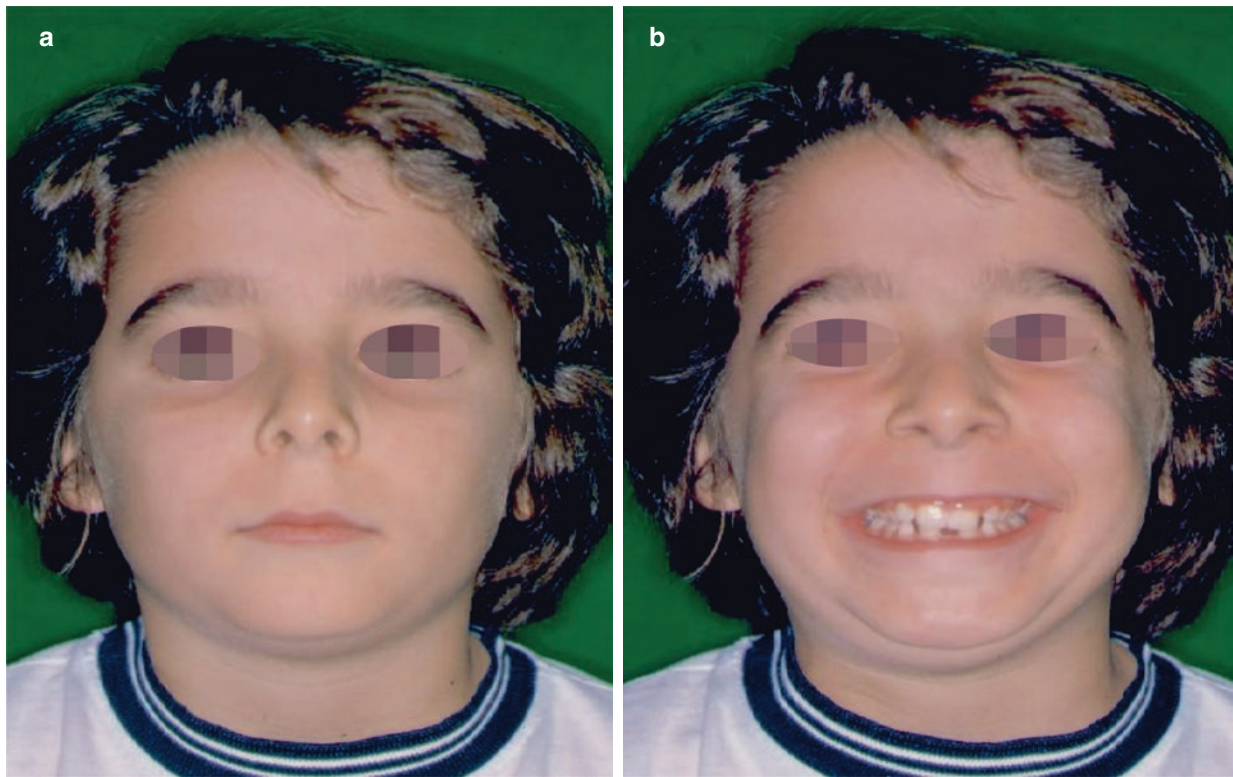


Fig. 10.17 (a and b) Pretreatment frontal photographs



Fig. 10.18 (a and b) Profile photographs at the beginning of treatment

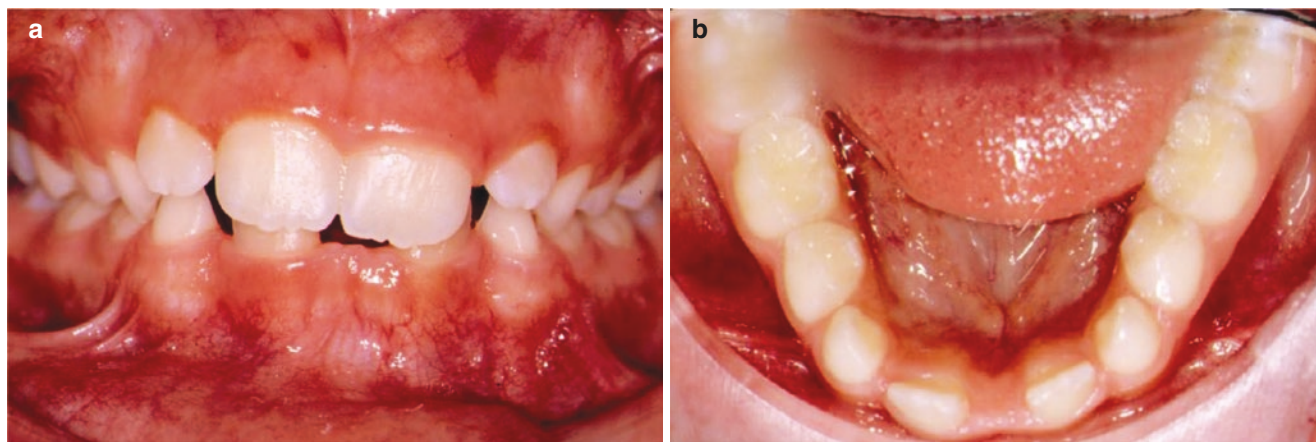


Fig. 10.19 (a and b) Pretreatment frontal and lower arch photographs

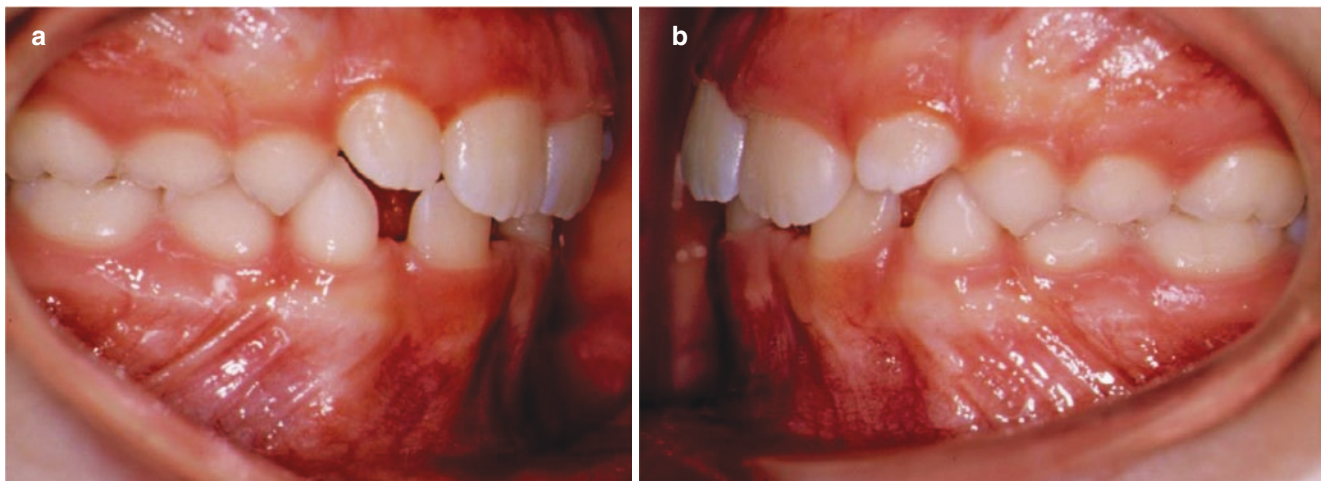


Fig. 10.20 (a and b) Pretreatment lateral views



Fig. 10.21 Pretreatment panoramic radiographic image



Fig. 10.22 Panoramic radiographic image 4 years later without any type of treatment

Four years later, the facial photographs showed a straight profile and the patient can close his lips without effort (Fig. 10.23a and b).

The frontal dental photograph confirmed the presence of a significant overbite. The gingival line and the occlusal plane were not parallel. More extrusion on the left side was present. The lower lateral incisors were partially mesialized on its own (Fig. 10.24a and b).

In spite of the agenesis of the central lower incisors, Class I molar was maintained. An important diastema between the lower right canine and first bicuspid was present (Fig. 10.25a and b).

To normalize the increased anterior overbite, the treatment plan included lingual brackets on the upper arch. Among all the lingual brackets, those with a bite plane were the most recommendable.

The front photograph demonstrated the normalization of the deepbite 2 months later (Fig. 10.26a and b).

When the lateral views were examined, Class I molar on the right and left sides was maintained. The gingival line and occlusal plane were almost parallel (Fig. 10.27a and b).

To close all the remnant anterior space, labial preprogrammed esthetic brackets (0.022" slot) were used along with a Ni-Ti coil open spring to mesialize the lower canines (Fig. 10.28a and b).



Fig. 10.23 (a and b) Facial photographs 4 years later

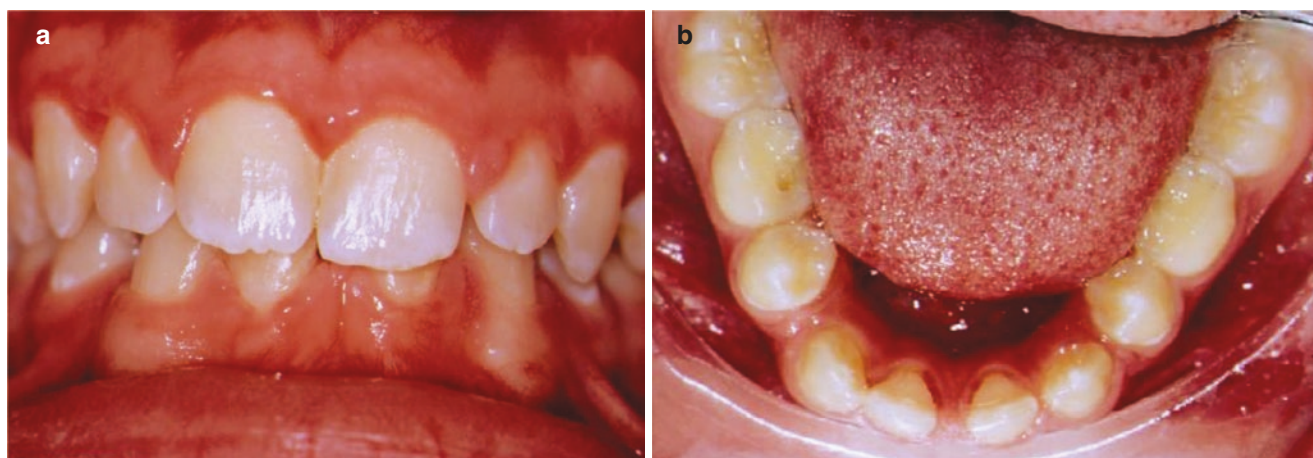


Fig. 10.24 (a and b) Frontal dental and lower arch photographs 4 years later without treatment

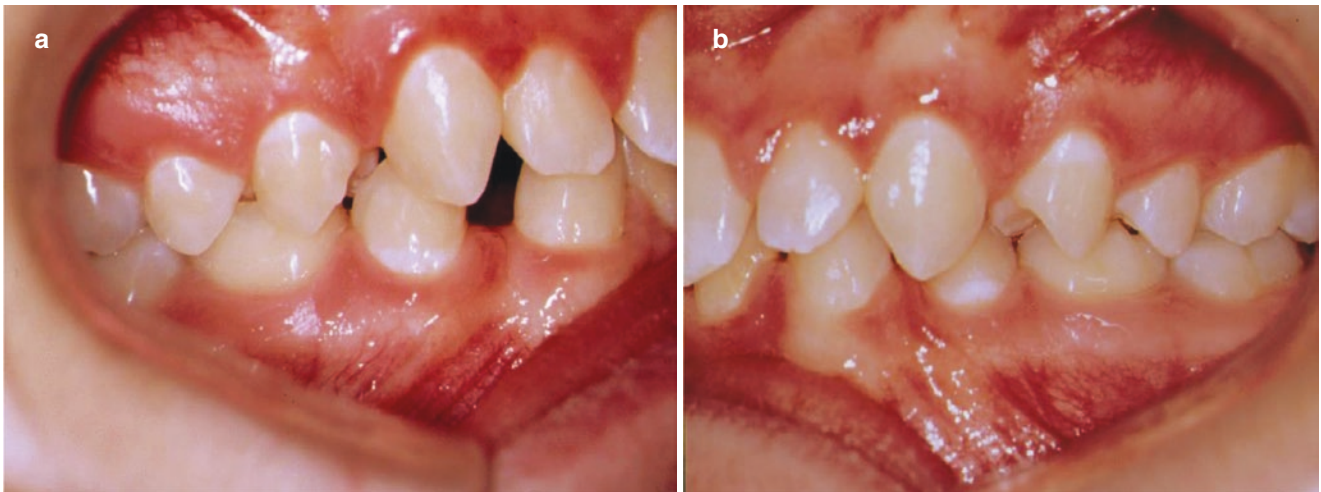


Fig. 10.25 (a and b) Pretreatment lateral views

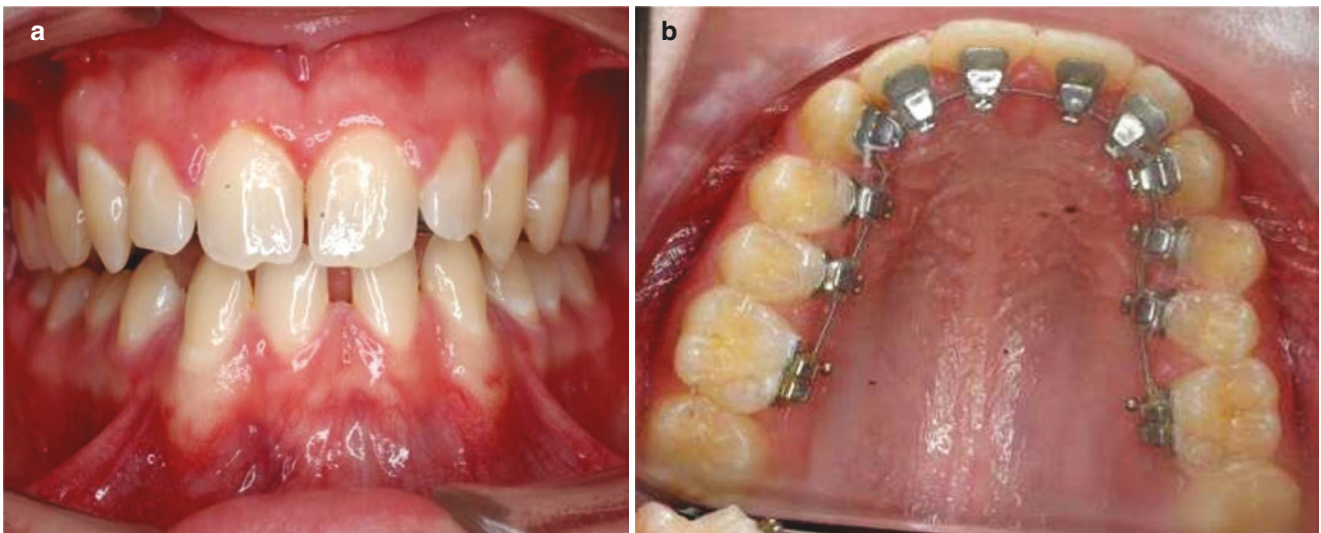


Fig. 10.26 (a and b) Lingual brackets were bonded on the upper arch

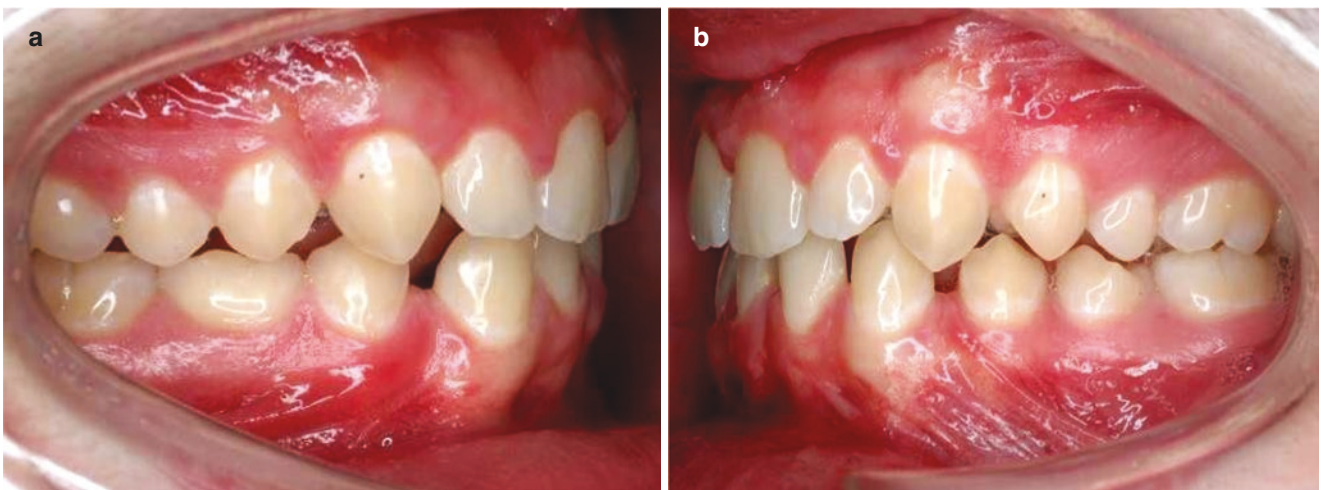


Fig. 10.27 (a and b) Lateral views after 2 months with lingual brackets

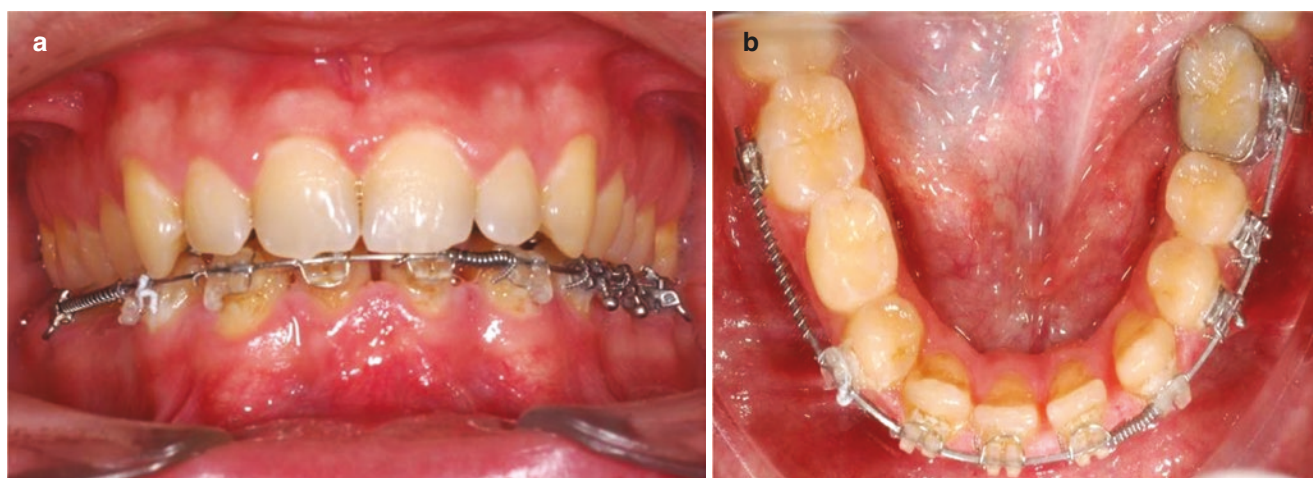


Fig. 10.28 (a and b) Esthetic lower brackets with a Ni-Ti open coil spring to mesialize the lower canines

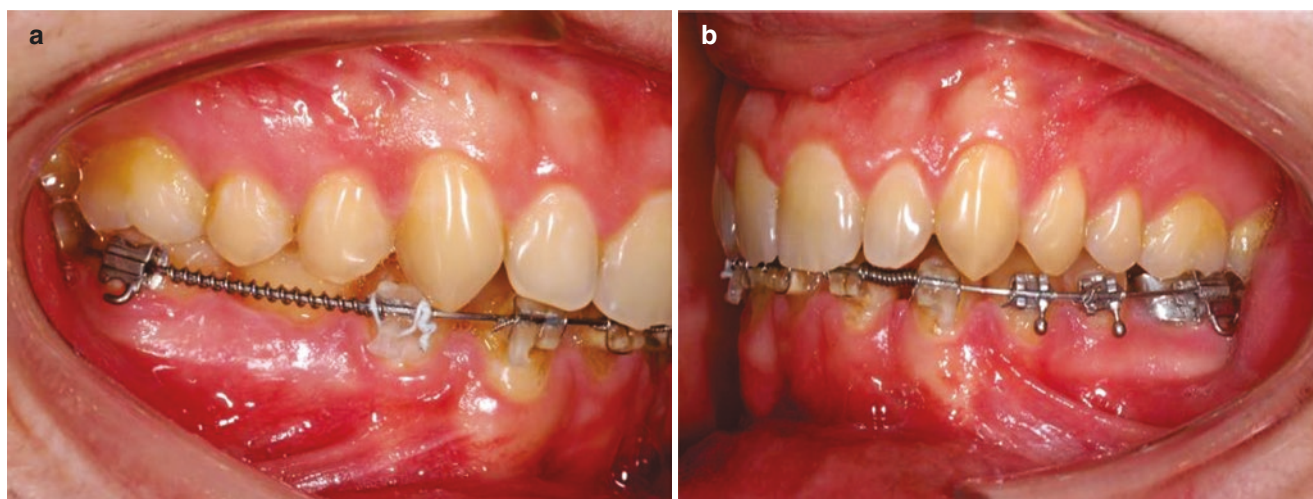


Fig. 10.29 (a and b) Right and left dental photographs 4 months later

Lateral views at this stage of treatment. Mesialization of the right and left Class I canines was accomplished (Fig. 10.29a and b).

A fixed retention wire was bonded on the upper arch between the right and left first bicuspid, while the left first bicuspid was mesialized in order to close the lateral diastema (Fig. 10.30a and b).

The facial photographs at the end of active orthodontic treatment confirmed a relaxed smile (Fig. 10.31a and b).

Profile photographs at the end of treatment. Facial biotype was maintained (Fig. 10.32a and b).

At the end of treatment, all spaces were closed, although the midlines were not completely centered. A long-term fixed retention wire was recommended (Fig. 10.33a and b).

A 3-year follow-up later confirmed that the results were stable. Good oral hygiene was maintained (Fig. 10.34a and b).

Lateral views at 3 years of follow-up show that the right and left Class I molars as well as the Class I left canine were

maintained. On the right side, some relapse on the canine zone was observed (Fig. 10.35a and b).

Taking into account that long-term retention was the best option when agenesis of one or two lower incisors was present, fixed retention wires were bonded on the upper and lower arches (Fig. 10.36a and b).

The control panoramic radiographic image confirmed the upper and lower fixed retention wires and the complete closure of the interincisal lower space (Fig. 10.37).

Complete closure of the anterior space due the agenesis of the central lower incisors was confirmed when pre- and posttreatment lower arch photographs were compared. No implants were required in the lower arch (Fig. 10.38a and b).

The comparison of the pre- and posttreatment frontal photographs confirmed the significant improvement achieved. Overbite and overjet were completely normalized (Fig. 10.39a and b).

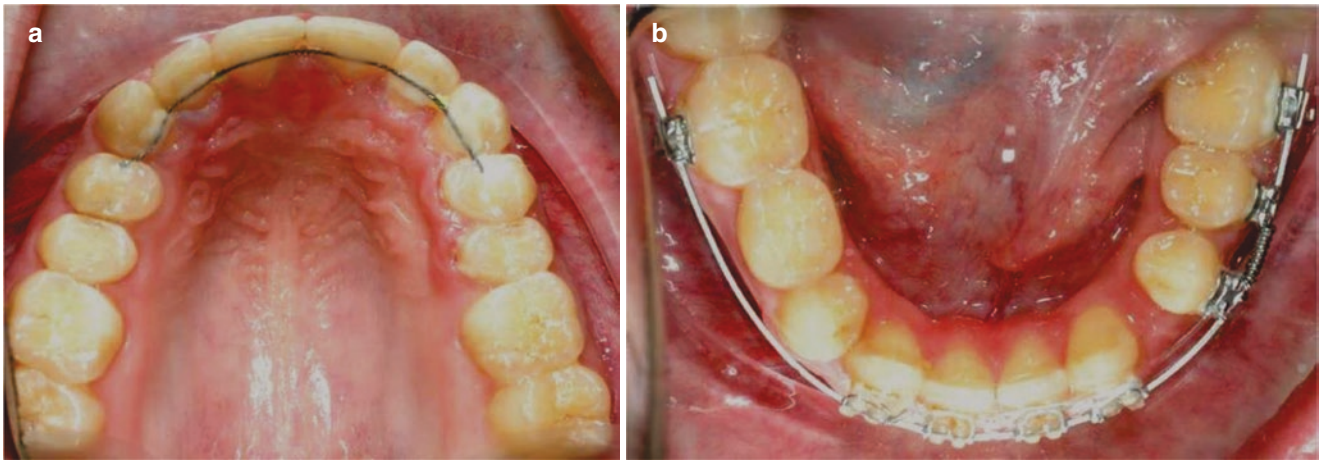


Fig. 10.30 (a and b) Upper and lower occlusal photographs at this stage of treatment



Fig. 10.31 (a and b) Final facial photographs



Fig. 10.32 (a and b) Final profile photographs

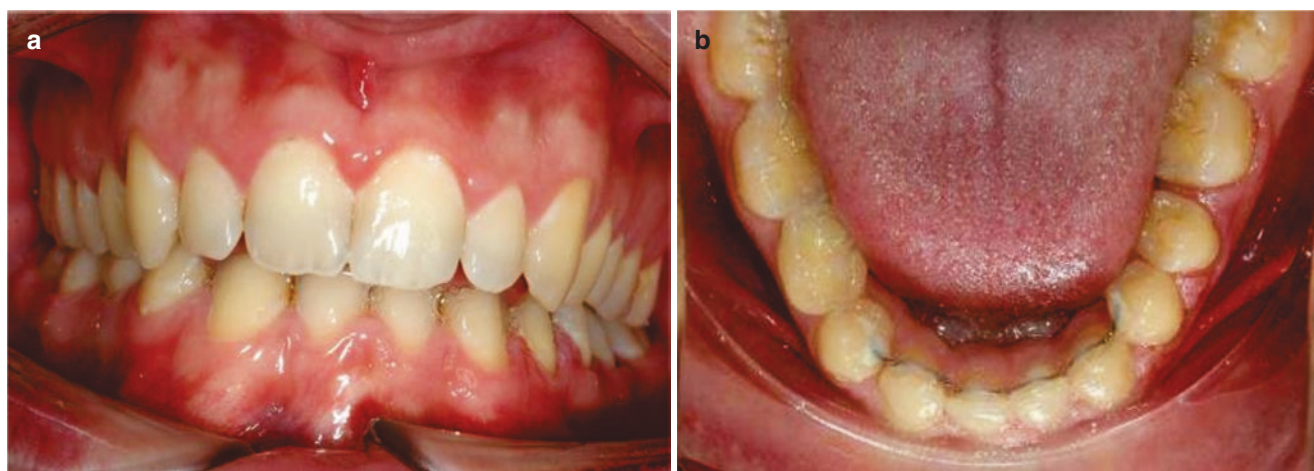


Fig. 10.33 (a and b) Frontal dental and lower occlusal photographs at the end of treatment

Fig. 10.34 (a and b) After the 3-year follow-up

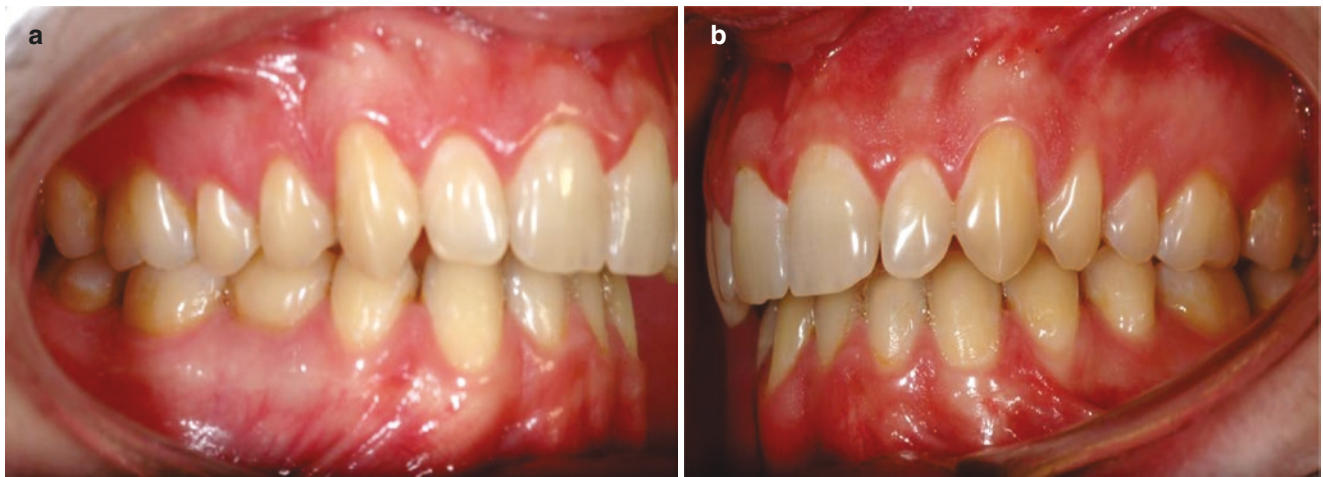
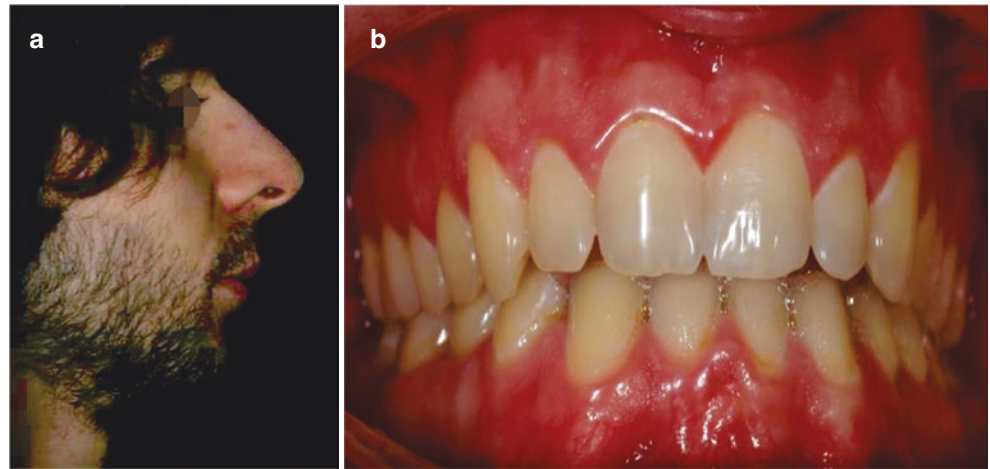


Fig. 10.35 (a and b) Right and left views

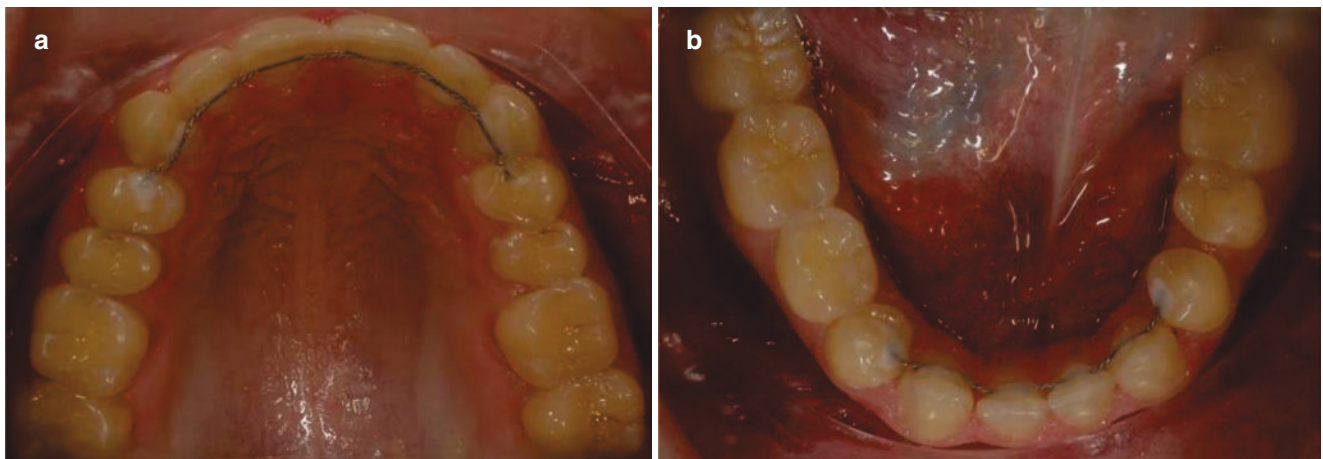


Fig. 10.36 (a and b) Fixed retention wires were bonded to the upper and lower arches



Fig. 10.37 Panoramic radiographic image at the control stage

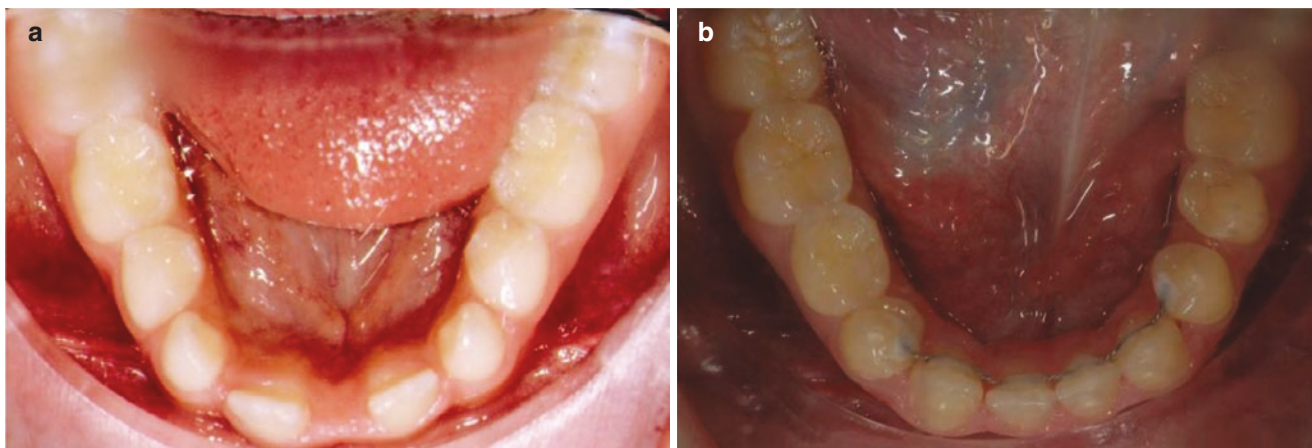


Fig. 10.38 (a and b) Comparison of pre- and posttreatment photographs

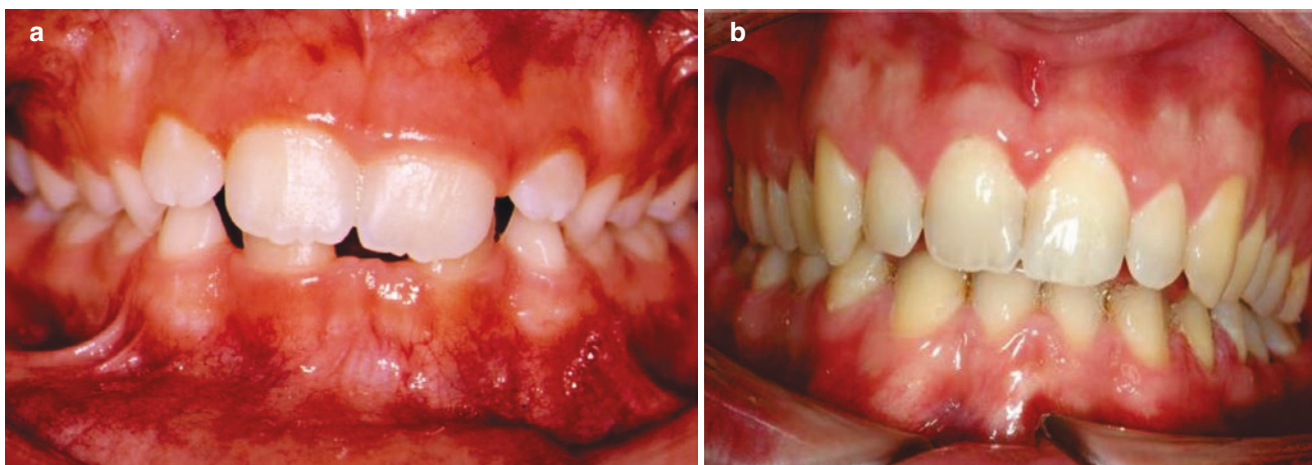


Fig. 10.39 (a and b) Comparison of pre- and posttreatment photographs

10.1 Conclusions

The number of patients exhibiting congenitally missing mandibular incisors is low. Although the exact etiology of congenital agenesis is unknown, several factors such as heredity, infections, or endocrine alterations are possible causes (Endo et al., 2007).

There are few studies of lower incisor agenesis in temporary dentition.

In some cases, hypodontia can affect the anterior mandibular growth, particularly at the symphysis area.

An individualized treatment plan is mandatory for each patient according the number of absent teeth, facial and gingival biotype, and amount of remaining growth. In spite the improvement of implants during the last decade, closing space during mixed or early permanent dentition continued to be the best option until now. Consistently, the retention

plan included the installation of a lower fixed retention wire for a long period of time.

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Impacted Central Incisors: Different Options for Treatment

11

Julia Harfin

According to the literature, the prevalence of impacted central incisors is less than 1% (Machado); however, for the patient, it is quite disturbing from an esthetic and functional point of view. Normally, the upper incisors erupt between 6 and 10 years of age. Nevertheless, when a lateral incisor erupts before the central incisor, impaction of the central incisor could result (Kurol).

Tooth impaction may result as a consequence of different conditions, such as mesiodens, supernumerary teeth, ectopic position of the tooth bud, odontoma, cysts, local tumor, scar tissue, lack of space ankylosis of the primary teeth, trauma on the deciduous incisors, loss of or inadequate space, and delayed resorption of the primary roots.

Trauma in primary dentition, especially traumatic incisor intrusion, may result in the crown or root dilaceration of the developing permanent incisors (Uematsu) (Fig. 11.1a, b), as shown in the following radiographic images. The consequence will depend on the stage of development of the root at the moment of trauma. The angulation between the crown and the root will determine the prognosis of the result. In general, pulp vitality is preserved but in some cases necrosis is the consequence.

Traumatic intrusion is a dental injury that involves the upper anterior teeth and is often associated with a comminution or fracture of the alveolar bone (Turley). Some accidents during early childhood can have consequences due to the proximity to the temporary incisor roots on the permanent teeth. An early diagnosis is very important for the clinician, the parents, and, above all, the patient. If the contralateral incisor erupts 6–8 months earlier, a panoramic radiograph is mandatory. Some patients require complementary studies such as a periapical and occlusal radiograph and a cone beam

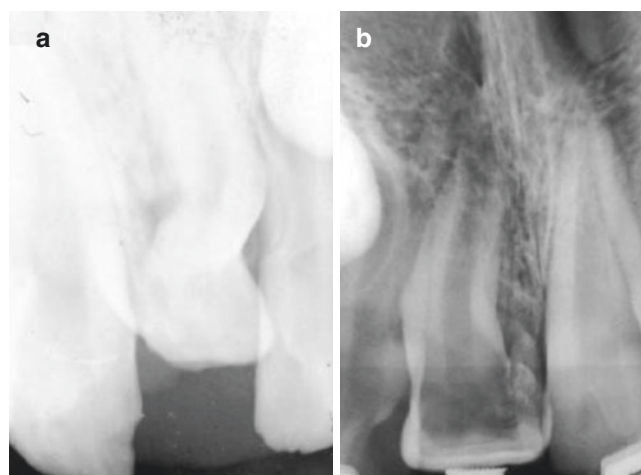


Fig. 11.1 (a, b) Root and crown dilaceration after primary incisor trauma

CT to accurately define the position of the incisor and its relation with the roots of the adjacent teeth.

A careful treatment plan is required to obtain a reasonable result. It is important to consider the angle between the crown axis and the root. Sometimes, one of the major problems is the recovery of the space for the incisor, in conjunction with the elimination of functional interferences that can alter the path of the eruption.

In general, the prognosis is the result of several factors such as etiology, quantity of bone, root length and shape, and dilaceration of the crown. Treatment timing also plays an important role. Different orthodontic techniques can be used, and in some cases, spontaneous eruption can be observed when the space is recovered (Becker), but in other patients, orthodontic traction may be required.

In 28% to 60% of cases, mesiodens and odontomas cause incisor impaction (Suri.Batra). Their extraction is necessary before initiating the extrusion process. If an impacted incisor is associated with a cyst, a conservative approach is preferred to prevent the loss of the incisor. When the preservation of

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the tooth is desired in a young patient where the lesion is isolated, marsupialization is the treatment of choice. When the intrusion is severe, ankylosis of the tooth could result. Till now, orthodontic treatment to move the tooth to its correct position is not possible. Moreover, attempts show the undesirable movement of the adjacent tooth.

Determining the duration of treatment is difficult since it depends a lot on circumstances, such as residual eruption potential, localization of the impacted tooth, bone density, surgical procedures, root dilaceration, and missed appointments. The higher the position of an impacted incisor, the longer the duration of the orthodontic treatment (Tanaka).

The treatment plan includes three steps: presurgical orthodontics, exposure and bonding, and postsurgical orthodontics.

During the surgical procedure, at least one-half or two-thirds of the crown has to be uncovered. Gingivectomy would be the most conservative procedure when a normal attached gingiva is present, but when its width is compromised, an apically positioned flap is required (open eruption) (Vermette).

However, in some patients, a close eruption technique would be the best option. During this procedure, the attached gingiva is raised, and after placement of a button or a bracket on the impacted incisor, it is fully replaced to its original position. Studies have shown less recession, better bone support, and superior periodontal parameters with the closed-eruption method (Becker).

The patient should be aware that some problems can appear during the surgical-orthodontic treatment, such as some root canal obliteration, devitalization of the tooth, or ankylosis (Chaushu). Unfortunately, there is no single and specific bracket available to treat all of these patients. Nonetheless, a controlled and light force is highly recommended to erupt the tooth with bone and normal gingivo-periodontal tissues. In addition, controlled oral hygiene is fundamental for this purpose.

The following patients are clear examples of some of these circumstances. The parents of this 9-year-old patient asked for a second opinion regarding the right upper central incisor that had not erupted. The family dentist told them that they had to wait until the patient was 12 years old, but they were worried about waiting so long.

The left central incisor erupted 20 months earlier without any inconvenience, and now a mild crown mesial inclination was present without enough room for the right intruding incisor (Fig. 11.2a, b). The occlusal view confirmed that there was no room for the right incisor and the buccal-palatal width was diminished.

Lateral views showed Class I right and left canine and molar with a normal path of eruption. The mesio-inclination of the left upper central incisor was clearly evident. There was a significant overbite in the left central incisor region. The patient had a good oral hygiene (Fig. 11.3a, b).

According to studies by Becker and Chaushu, the first phase of treatment is to achieve sufficient mesiodistal space to have room for the intruding incisor. Esthetic brackets at 0.022" were bonded on the upper laterals and the left central incisor along with an esthetic Ni-Ti 0.014" archwire. To have better anchorage, brackets were also placed on the temporary canines (Fig. 11.4a).

The periapical X-ray images showed the position and inclination of the right central incisor and an open coil spring to recover the right central incisor space (Fig. 11.4b).

After 5 months of treatment, the space was achieved and the midlines were normalized. A 0.016" × 0.016" Elgiloy archwire was placed and a control radiographic image was taken (Fig. 11.5a, b).

Since the intruding incisor did not erupt by itself, the patient was referred to an oral surgeon for a closed surgical procedure and bracket bonding at the same time. However, the surgeon decided to perform an open procedure. When the patient returned 3 weeks later, an esthetic bracket was bonded

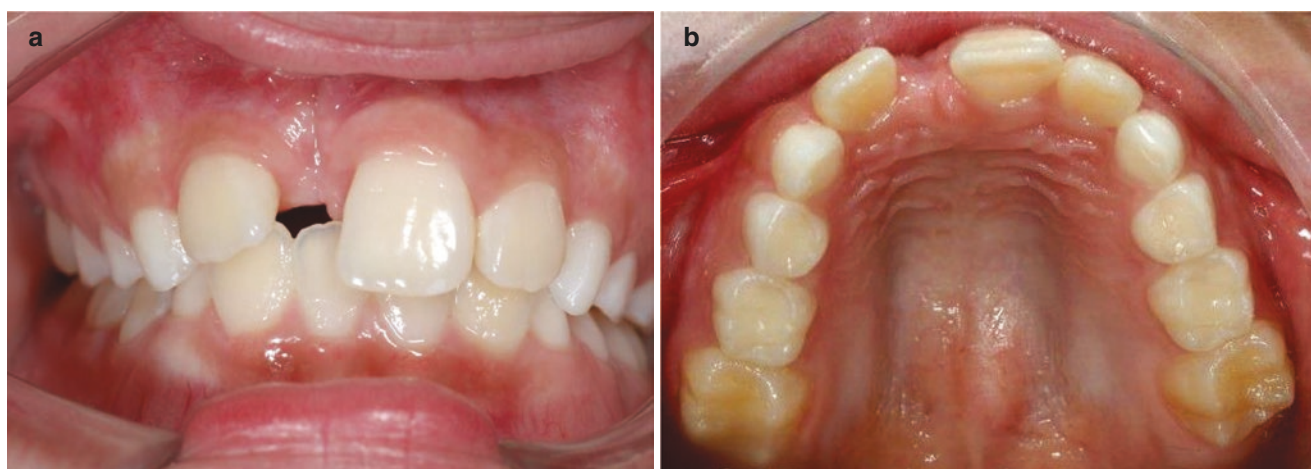


Fig. 11.2 (a, b) Impaction of the right maxillary central incisor caused by trauma on the primary incisor

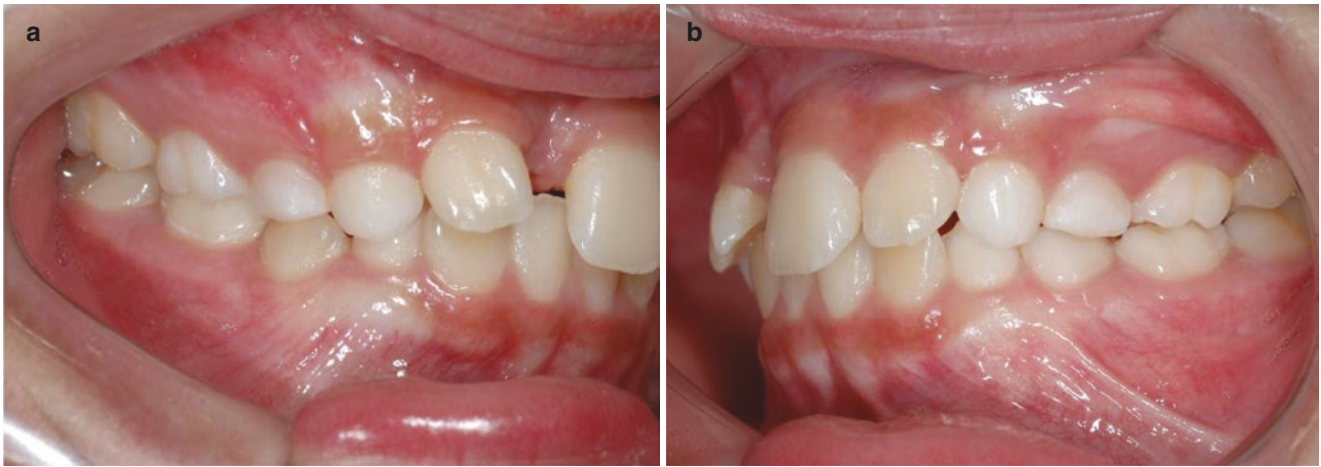


Fig. 11.3 (a, b) Pretreatment lateral views. Class I molar was observed along with lack of space for the eruption of the right central incisor

Fig. 11.4 (a, b) Esthetic brackets were bonded on the upper anterior teeth. X-ray image showed the impacted right central incisor and the coil spring to recover the space

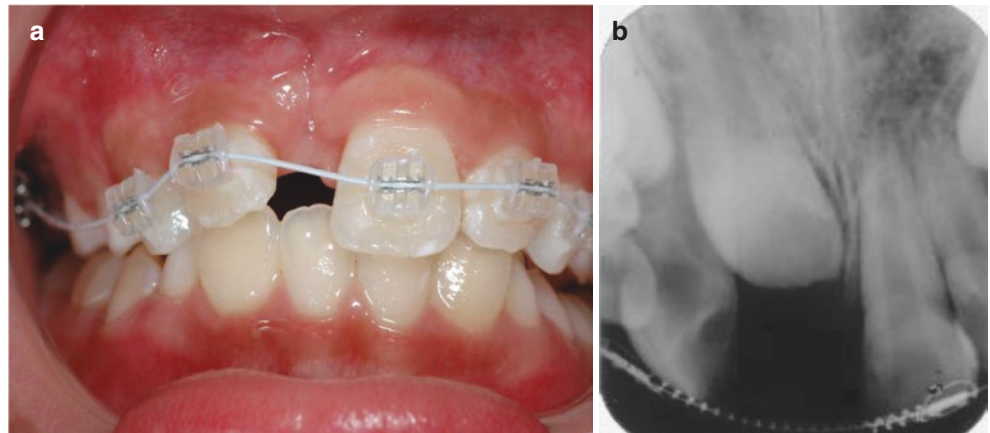
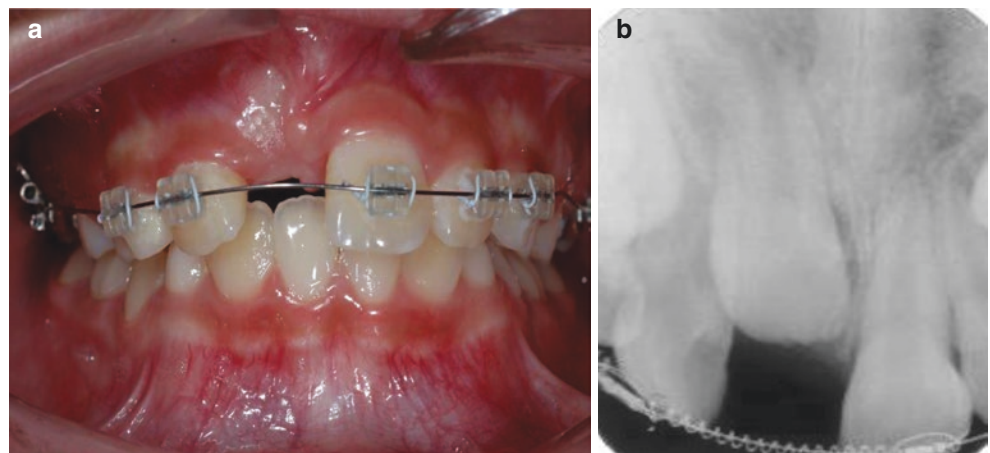


Fig. 11.5 (a, b) Frontal photograph and periapical X-ray image after 5 months of treatment



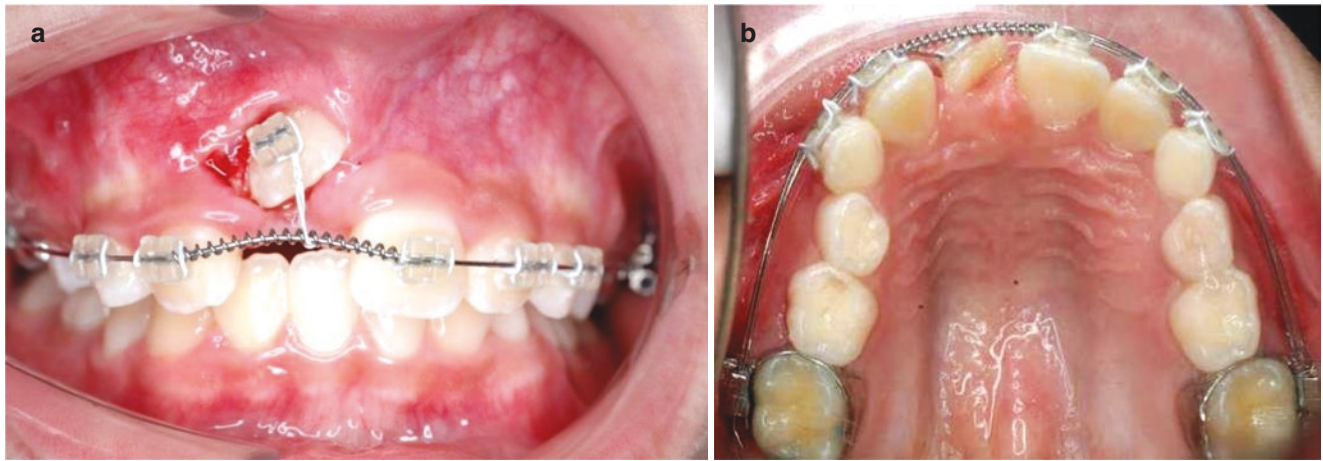


Fig. 11.6 (a, b) Frontal and occlusal photographs 1 month after the surgical incisor exposure

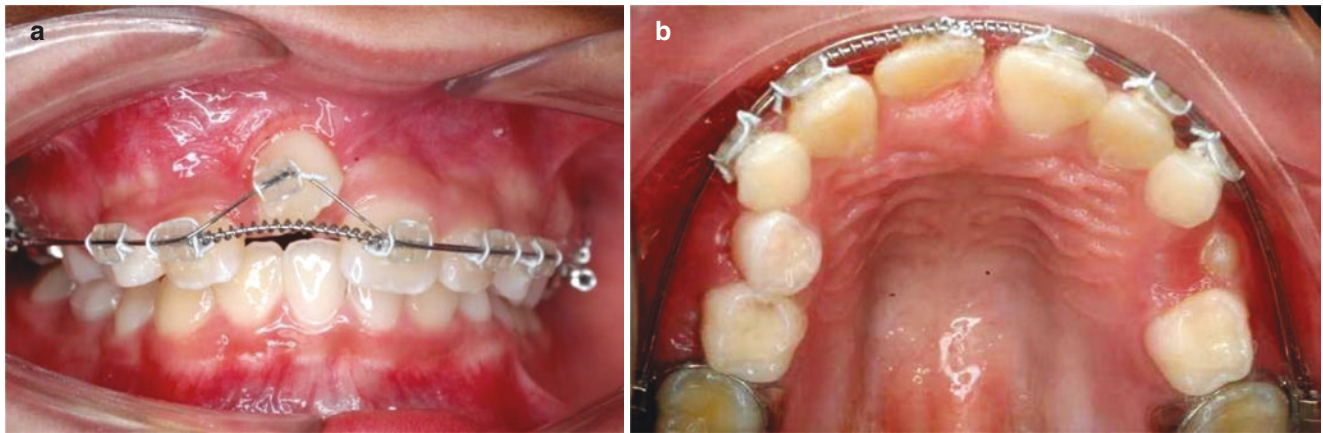


Fig. 11.7 (a, b) A second arch (Ni-Ti 0.012'') was placed to control eruption with very low forces

on the labial surface of the central incisor along with a ligature to the main arch. The occlusal photographs confirmed the recovered space and the biomechanics used (Fig. 11.6a, b).

Taking into account that it is very important to maintain healthy gingivo-periodontal tissues, a controlled extrusion force was applied. A second Ni-Ti 0.012'' archwire was placed between the upper canines. An 8-week activation period was recommended (Frank) (Fig. 11.7a, b).

Four months later, the incisor was extruded very slowly. When analyzing the frontal photograph, a ligature-of-eight was placed on the left side to correct the midline to the left. Moreover, the bracket on the right central incisor had to be repositioned to improve its alignment (Fig. 11.8a, b).

To control leveling and alignment, a 0.018'' SS archwire was placed. No brackets were bonded on the bicuspids until that point (Fig. 11.9a, b). A slight difference was still present on the gingival margin of the incisors along with a mild inflammation on the right side. The interincisal diastema had to be closed very smoothly to achieve complete closure with normal dental papillae.

The following were the results after 23 months of treatment. All treatment objectives were completed: the upper right central incisor and midlines were corrected (Fig. 11.10a, b). No important root resorption was seen and the upper right central incisor pulp was still vital. Since there was a slight difference in the gingival height, no further mucogingival surgery was recommended. A fixed retainer wire was recommended for a long period of time, in conjunction with a night vacuum maxillary retainer.

The bilateral Class I canine and molar relationship with normal overjet and overbite were achieved. Gingivo-periodontal tissues were almost normal (Fig. 11.11a, b).

The patient returned after 30 months for a control of the retainer. The results were almost maintained although the fixed retention wire was lost 1 year earlier. The gingival tissues were normal and a subtle relapse could be observed on the right upper central incisor (Fig. 11.12a, b).

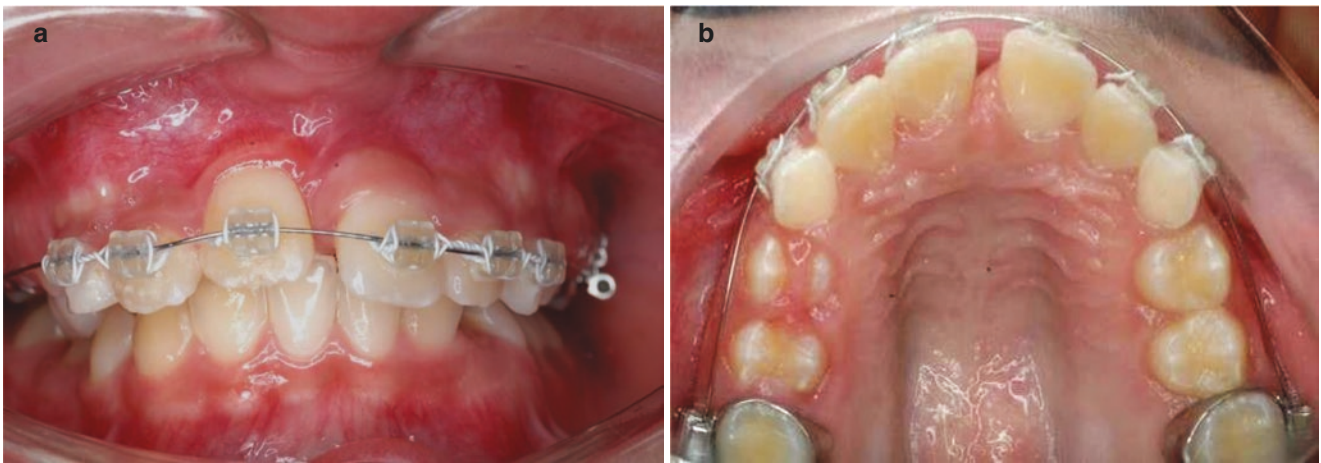


Fig. 11.8 (a, b) Frontal and occlusal photographs 4 months after the open flap surgery

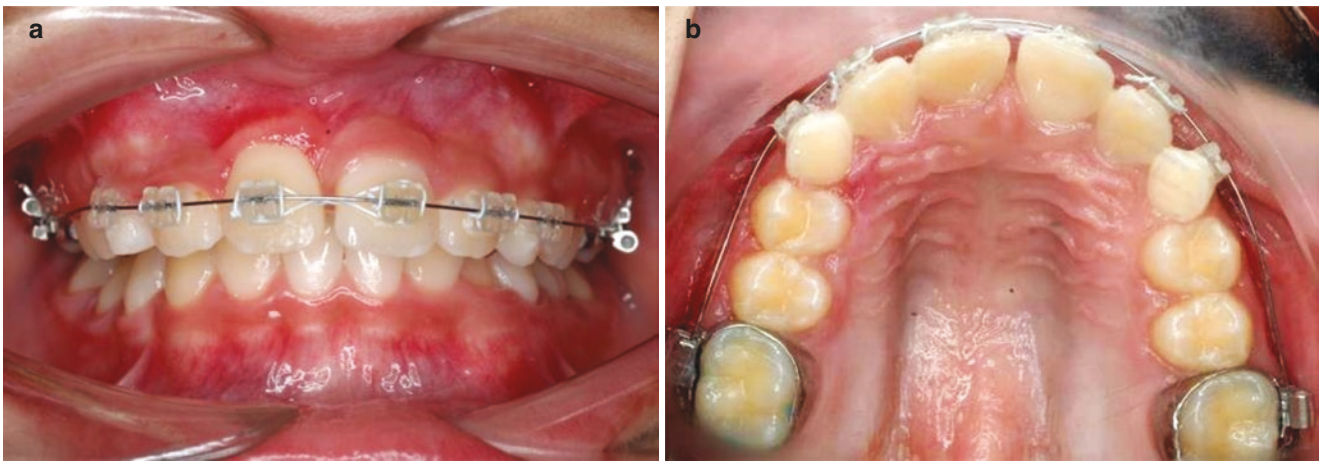


Fig. 11.9 (a, b) Frontal and occlusal photographs at the end of the phase I treatment

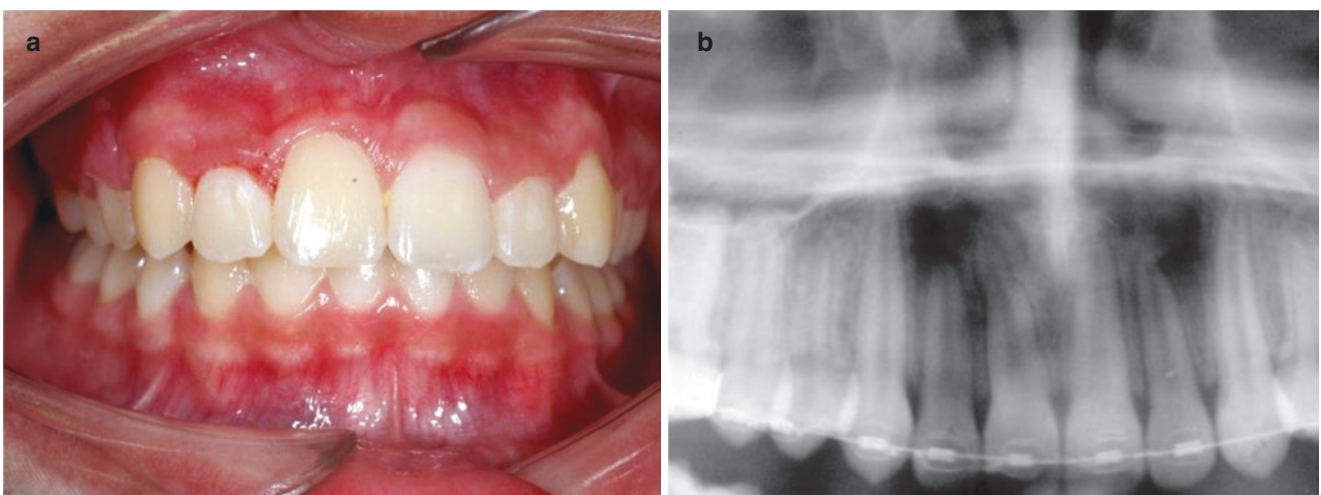


Fig. 11.10 (a, b) Final records after 23 months of treatment. The upper and lower midlines were almost normal and no significant root resorption was seen

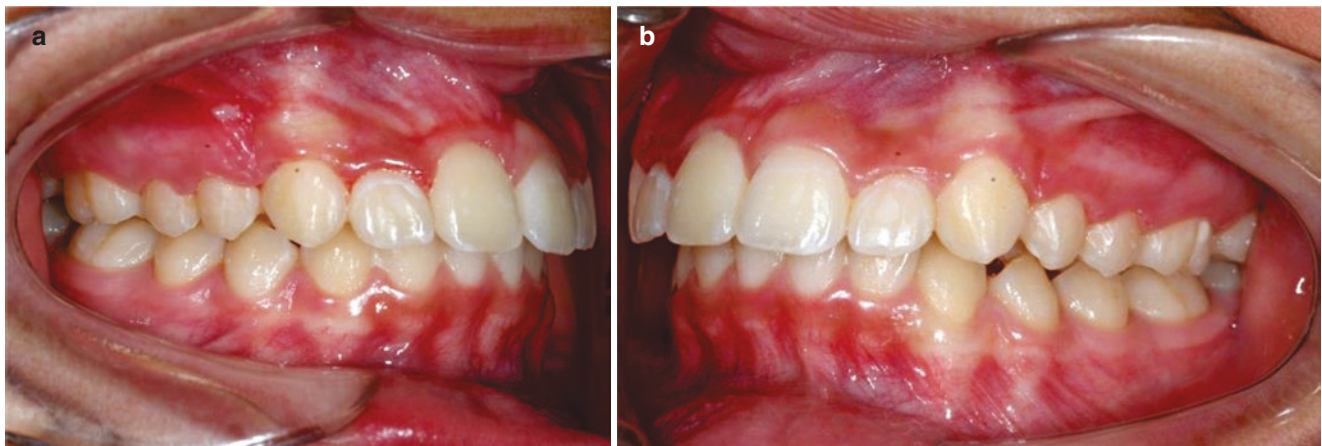


Fig. 11.11 (a and b) Lateral views at the end of treatment. Class I molar was maintained

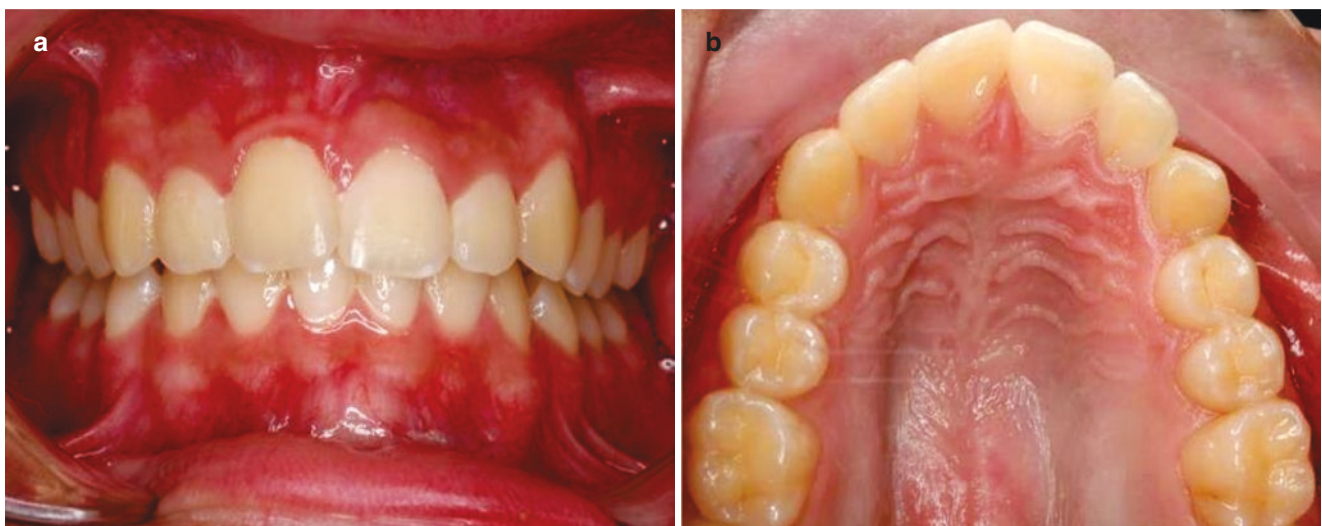


Fig. 11.12 (a, b) A control 12 months later. The results were almost maintained

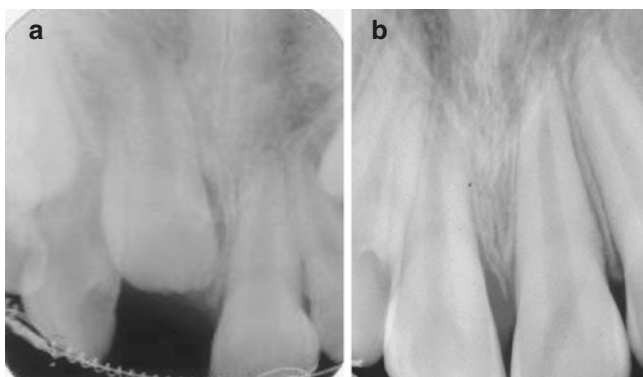


Fig. 11.13 (a, b) Pre- and posttreatment periapical radiographic images. No root resorption was visible

A comparison between the pre- and posttreatment radiographic images confirmed the achieved results. No important root resorption was visible (Fig. 11.13a, b).

Delayed eruption has to be monitored very closely to avoid major inconveniences that can produce impactation or ankylosis of the incisor and can have direct effects on the development of the occlusion.

The next case provides a visible example. A 10-year, 10-month-old girl was sent for a second opinion since her upper central right incisor was absent. She was in good health and no history of supernumerary teeth, mesiodens, or odontoma. Although she had a history of dental trauma when she was 4 years old and she had the habit of nail biting from the age of 5, the etiology of the impacted incisor was mainly due to

Fig. 11.14 (a, b) Frontal photograph and X-ray image showing the right impacted incisor with a rounded and short root

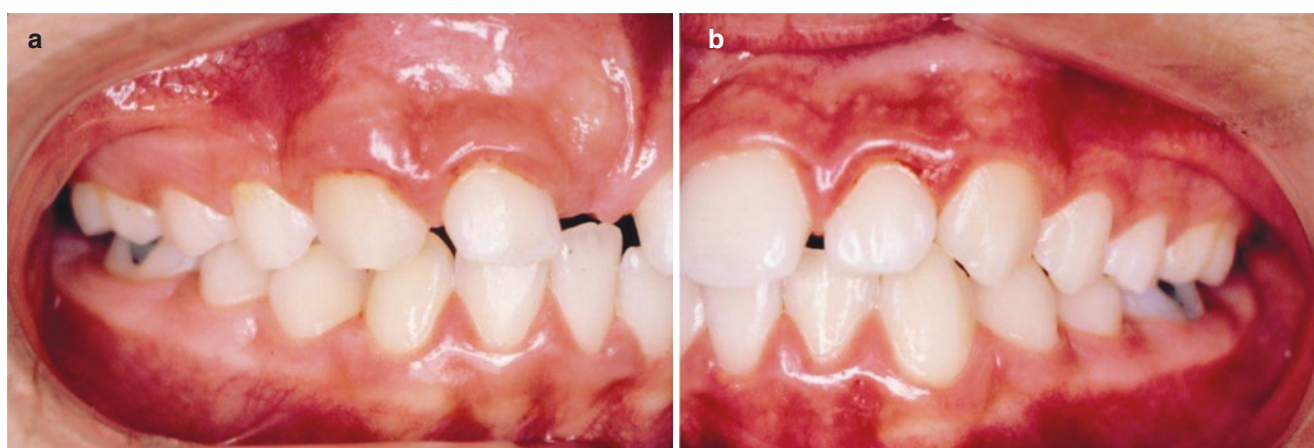
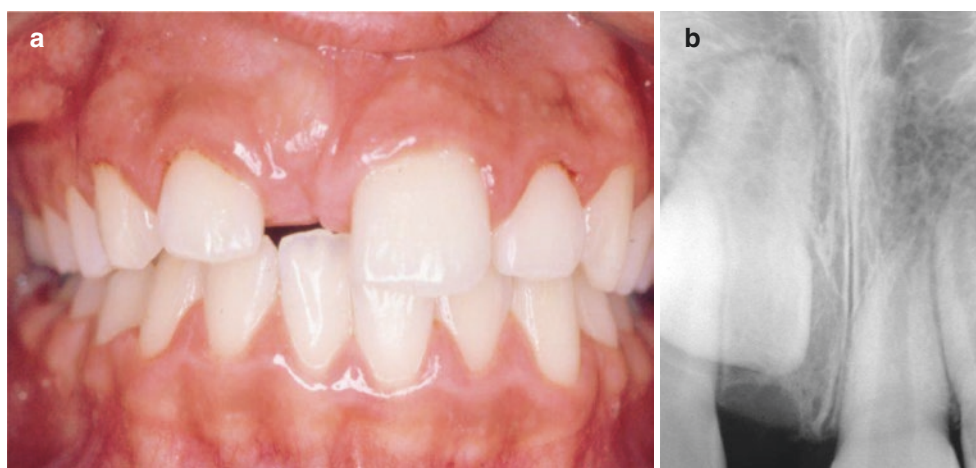


Fig. 11.15 (a, b) Lateral views at the beginning of the treatment. Class I molar and cuspid are present

trauma. The periapical radiographic image showed the impacted incisor with a short and rounded root (Fig. 11.14a, b).

Upon analyzing the lateral views, a skeletal Class I malocclusion with a balanced facial pattern was observed. Although she was almost 11 years old, all the canines and bicusps had erupted. Intraoral examination revealed a Class I molar relationship with an overbite of 2 mm and an overjet of 1.5 mm. A mild diastema distal to the right and left lateral incisors was present (Fig. 11.15a, b).

The surgeon decided on an open flap surgery, and the bracket was bonded 2 weeks after the surgery. Ideally, bonding has to take place during the surgical procedure, but if for any reason it is not possible, a wide exposure must be performed and a surgical pack may be placed, to prevent wound closure. It is important to prevent damage to the cementum-enamel junction (Becker). An open coil spring was placed to open the space and, at the same time, to hold a metallic ligature. The extrusion has to be performed very slowly to protect the rounded root and to obtain normal gingivo-periodontal tissues. Due to the high position of the tooth, it was very

difficult for the patient to maintain good oral hygiene in this zone (Fig. 11.16a, b).

After 7 months, the incisor erupted but in a rotated position. A 0.016" $\times$ 0.016" TMA archwire with some bends was placed to normalize the position of the right incisor. The periapical radiographic images confirmed that the extrusion was performed with no more root resorption (Fig. 11.17a, b).

The following photographs show the results of orthodontic treatment. A slight recession was present on the gingival margin of the upper central right incisor. Overjet and overbite were almost normal, and at the end of treatment, the midlines were coincident (Fig. 11.18a, b).

The comparison between the pre- and posttreatment frontal photographs demonstrated that the results obtained were excellent. All treatment objectives were achieved: extrusion of the impacted central right incisor, normalized overjet and overbite, and an occlusal plane parallel to the gingival plane (Fig. 11.19a, b). It is very interesting to see how the interincisal papillae were totally recovered with normal color and shape. Moreover, the periodontal status of the exposed inci-

Fig. 11.16 (a, b) Frontal photograph and X-ray image 2 weeks after the open flap surgery

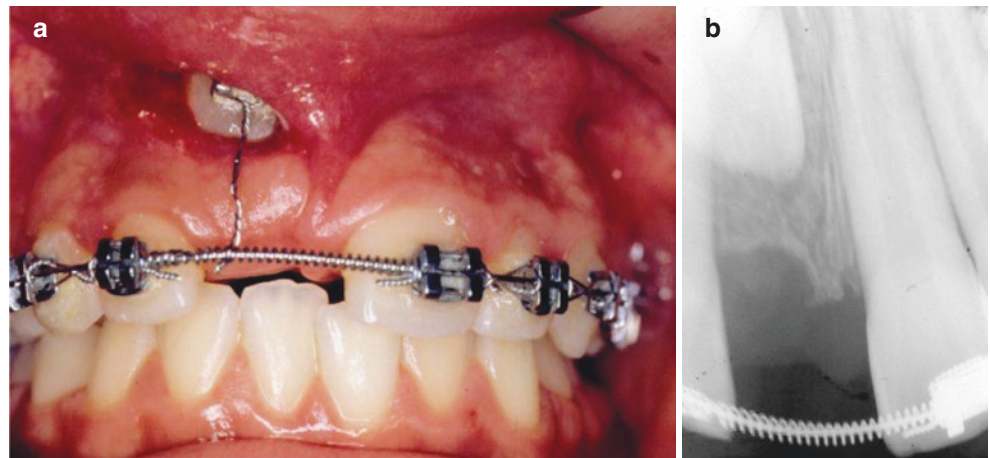


Fig. 11.17 (a, b) Seven months of treatment. Root resorption was not present

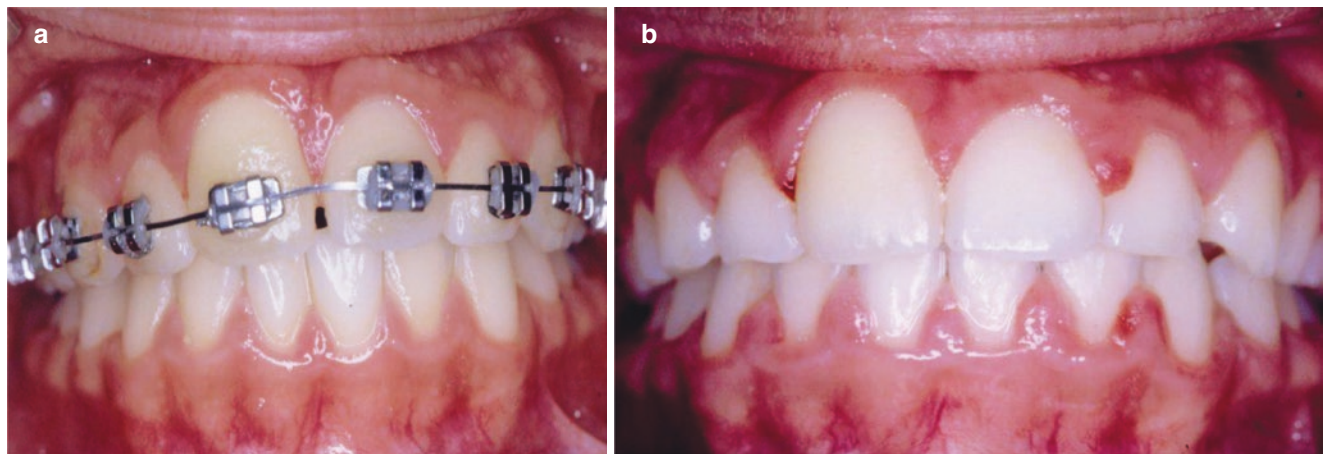
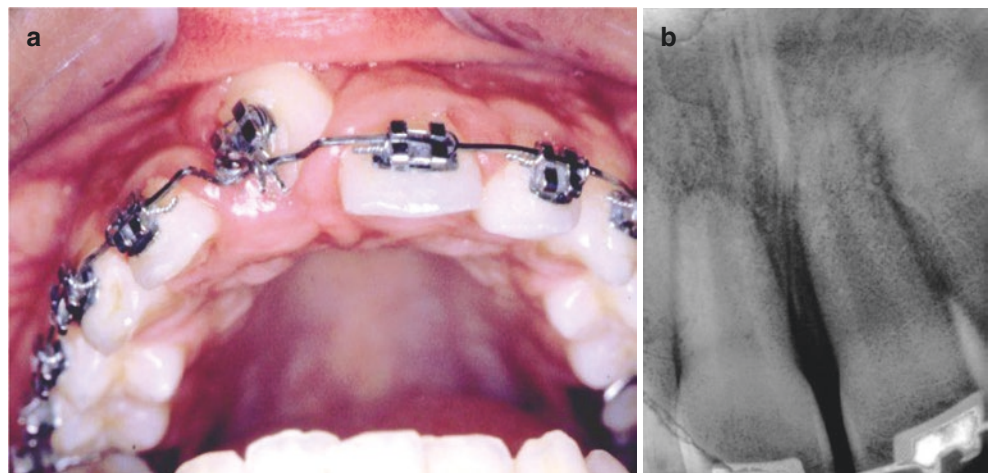


Fig. 11.18 (a, b) Frontal photographs with the last archwire and at the end of treatment

sor after orthodontic treatment showed a normal gingival contour. No further mucogingival surgery was recommended.

The following case was a 12-year-old patient and the most challenging in reference to impacted incisors. He was worried about his smile. The temporary upper right central

incisor had fallen 6 months earlier and the permanent incisor had not erupted. The panoramic radiographic images confirmed distal inclination of the crown and lack of space. Some mild crowding in the lower arch was also present (Fig. 11.20a, b).

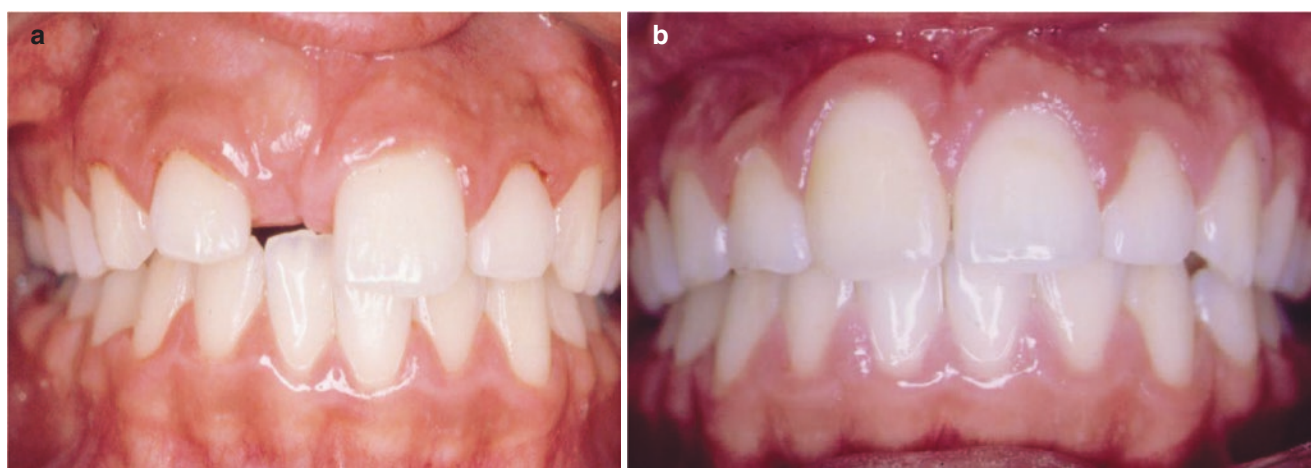


Fig. 11.19 (a, b) Pre- and posttreatment comparison. The gingival line is almost normal

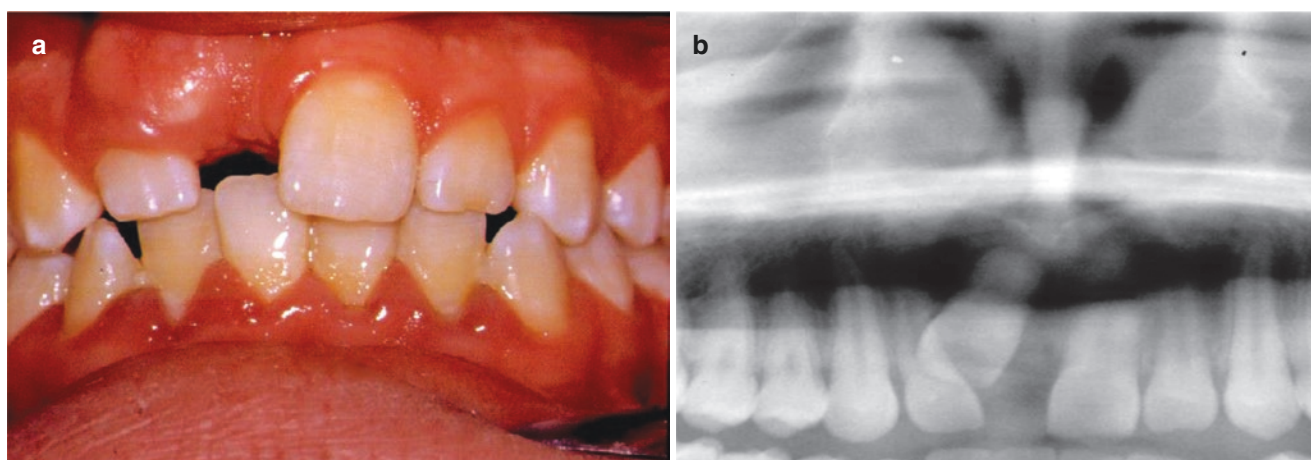


Fig. 11.20 (a, b) Pretreatment frontal photograph and panoramic radiographic image. An important disto-inclination of the right central impacted incisor is visible

Preprogrammed brackets were bonded on the upper arch along with a Ni-Ti Cu 0.016" broad arch to begin the alignment and to obtain sufficient space for the impacted incisor. The surgeon decided on an open flap surgery and the bracket was placed on the right central incisor in the same procedure. No bracket was bonded on the upper right lateral incisor to protect it. A wire ligature between the right central incisor and the left canine was placed to improve its position. An activation was recommended every 3 weeks (Fig. 11.21a, b).

These are the results after 6 and 9 months of treatment. A 0.014" Ni-Ti archwire was ligated and light forces were used with the intention of extruding the incisor with bone and not through it (Fig. 11.22a). There were significant results after 3 months (Fig. 11.22b).

When the upper right central incisor reached the occlusal plane, a bracket was bonded on the upper right lateral incisor along with an open coil spring to recover enough space for the central and lateral incisors (Fig. 11.23a). A 0.016" SS archwire was placed to finish the leveling and alignment of the upper arch. At the same time, brackets were bonded on the lower teeth to correct the mild lower anterior crowding (Fig. 11.23b).

Six months later, lower anterior crowding as well as the midlines was normalized (Fig. 11.24a). Since the patient decided to continue his studies abroad, two fixed retention wires were bonded between the canines (Fig. 11.24b). Oral hygiene needed improvement.

Although the patient was 12 years old, at the beginning of treatment, the normalization of the position of the upper

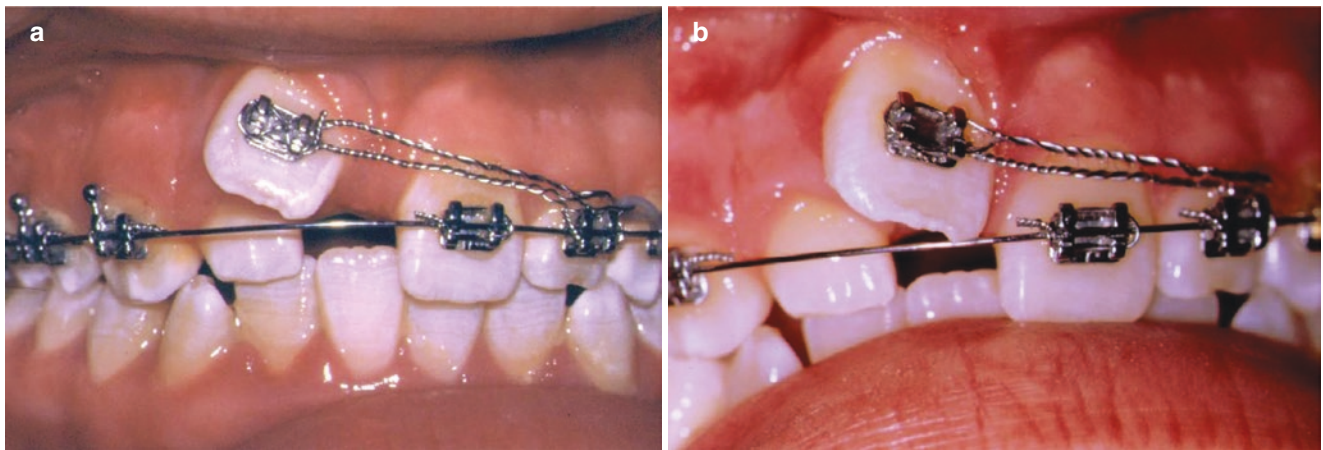


Fig. 11.21 (a, b) A control 2 and 6 weeks postsurgery. Very low forces were recommended to move the incisor with bone

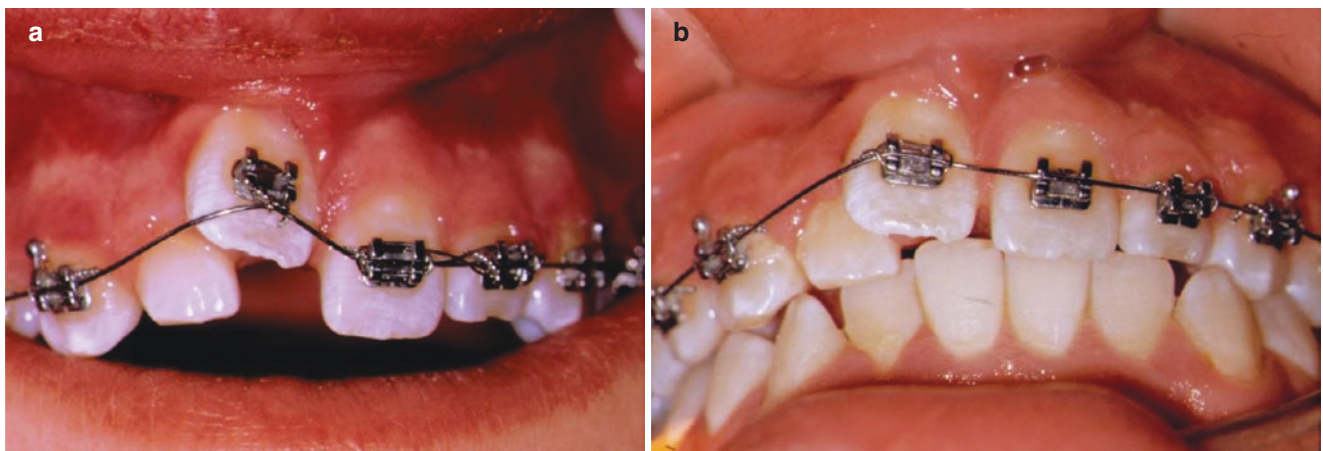


Fig. 11.22 (a, b) A Ni-Ti 0.014" was placed to extrude the incisor very slowly with bone

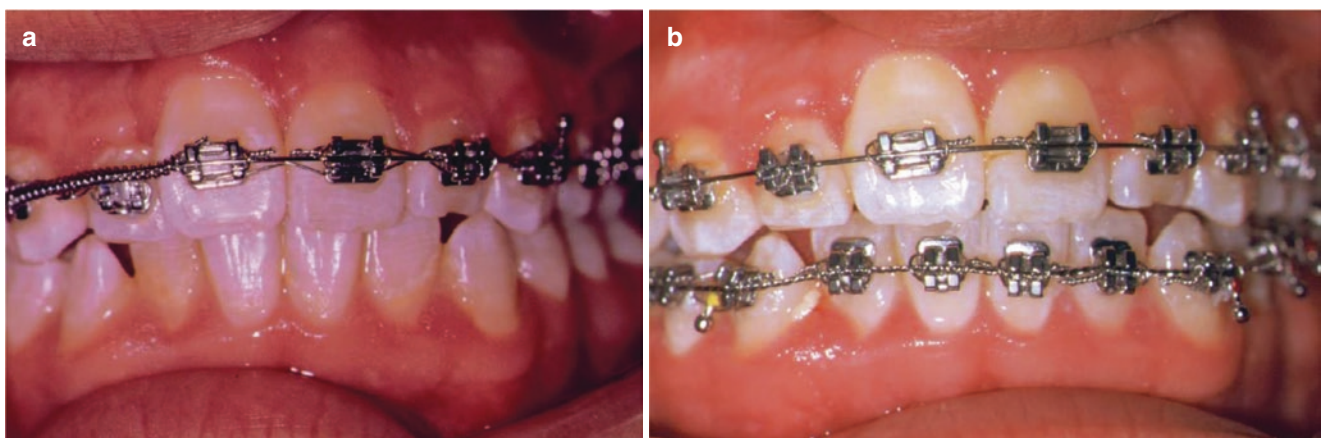


Fig. 11.23 (a, b) A bracket was bonded on the upper right lateral incisor when enough space was achieved with brackets on the lower arch to correct mild crowding

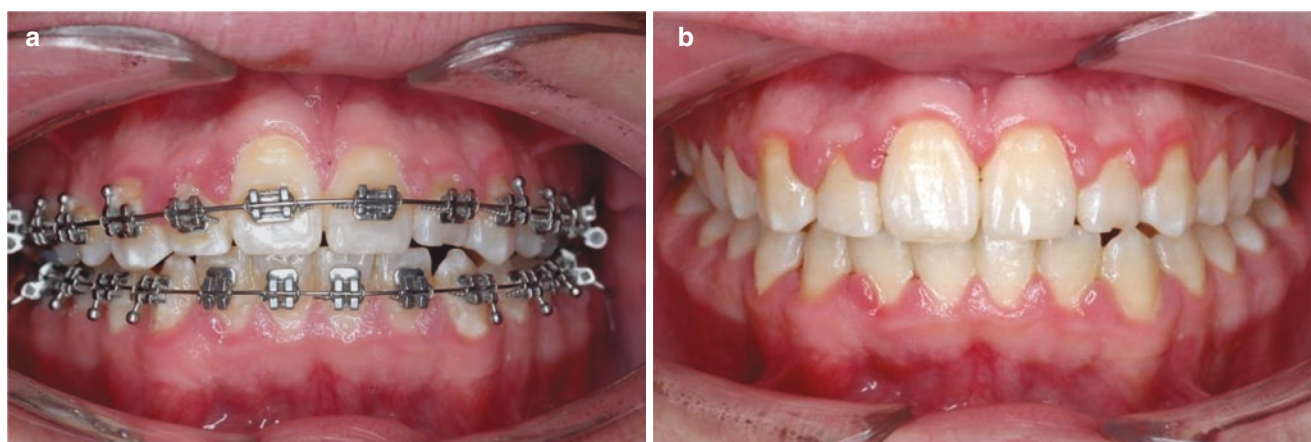


Fig. 11.24 (a, b) Frontal photographs before and after debonding. Oral hygiene had to be improved

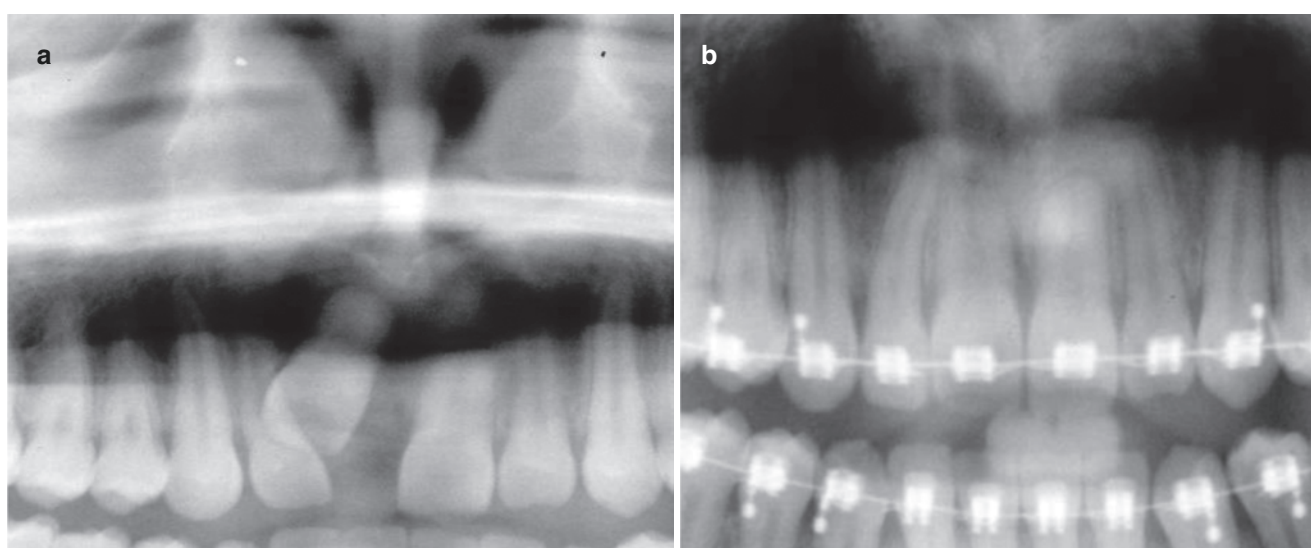


Fig. 11.25 (a, b) Comparison of pre- and posttreatment panoramic radiographic images. Root resorption was not present

right central incisor was clearly demonstrated when the pre- and posttreatment radiographic images were compared. No major root resorption was observed but a slight mesio-inclination of the root of the upper right lateral incisor was present (Fig. 11.25a, b).

11.1 Conclusions

Early diagnosis is critical for the success of the treatment. Each clinical case must be treated with an individualized treatment plan to achieve the best functional and esthetic result. Light and controlled extrusive forces are mostly recommended to bring the tooth down to the occlusal plane. A careful soft-tissue management is necessary to achieve a successful long-term esthetic outcome. The incisor has to be

extruded with a normal quantity of attached gingiva and the maintenance of excellent oral hygiene is crucial to obtain normal interincisal papillae.

It is important to consider that the preservation of the vitality of the tooth during the surgical and orthodontic procedures is mandatory. The duration of the surgical-orthodontic treatment of an impacted maxillary incisor varies widely since the etiology as well as the position and inclination of the impacted incisor could be different.

Unfortunately, there are no specific brackets or wires available to treat these patients. The most important issue to consider is to apply light and continuous forces during the entire active treatment. It is highly recommended that the last arch be maintained a minimum of 6 months before the finishing process begins. A long-term fixed retention wire is also recommended in all clinical cases.

How Orthodontic Movement Can Avoid Future Periodontal Problems in Children

12

Julia Harfin

Patients with a nice and attractive smile, white teeth, and normal gingivo-periodontal tissues are the gold standard for all orthodontists. To obtain this goal, a complete and profound understanding of the histology and physiology of periodontal tissues is fundamental. It is essential to be aware of its pathology, especially in young patients.

The periodontium is a complex tissue that includes the gingiva and the gingival attachment to the tooth, cementum, periodontal ligament, and alveolar bone. It is important to take into account that these tissues constantly change during the growth period and its health maintenance is crucial before, during, and after all the orthodontic movements.

Clinical observation demonstrates that teeth in lingual position have wider bands of keratinized and attached gingiva than teeth in facial position. Labial displacement of the central lower incisors during eruption is more predisposed to having localized gingival recession and loss of periodontal attachment in concordance to an uneven gingival line.

A complete and exhaustive diagnosis is fundamental in every patient. It is well known that gingivitis is a gingival inflammation without loss of connective tissue attachment (Armitage). Although it is a reversible process, it could easily lead to periodontitis with apical migration of the junctional epithelium and loss of the connective tissue and alveolar bone. The presence of gingivitis and local recessions in the lower anterior region is a challenging condition. In general, it is more prevalent in older patients than that in children and frequently observed in mandibular teeth than that in maxillary teeth. It also has a close relationship with alveolar bone dehiscences. Approximately 80% of the mandibular incisors with recession are positioned labially (Andlin-Sobocki). It can negatively affect the smile and may cause pain and hypersensitivity on the affected teeth. The

prevalence of this recession ranges from 4% to 8% in children between 7 and 12 years old (Seehra). The etiology is multifactorial, but ectopic tooth eruption may play an important role in conjunction with localized gingivitis in this zone. Patients with thin periodontal biotype are more prone to this problem than those with thick periodontal biotype. It is mostly prevalent in the central mandibular incisors as the lateral incisors tend to erupt more lingually (Vasconcelos).

It is important to establish the difference between true and pseudo-recession. True recession is an exposure of cementum with apical migration of the junctional epithelium (Song). The predisposing factors include excessive labial position of the lower incisors, minor width of the attached gingiva, gingiva trauma, and poor oral hygiene. On the contrary, lingually positioned incisors have more keratinized gingival width and reduced crown length. Crowding is an important factor that can accelerate this process and its association with occlusal trauma can lead to an important gingival recession (Fig. 12.1a, b). In these circumstances, this recession never improves by itself, but worsens every year and can lead to the loss of the tooth.

Careful oral hygiene plays an important role in the maintenance of the results, and it has to be reinforced constantly through distribution of patient leaflets as well as verbal instructions. A close relationship between the orthodontist and periodontist is crucial in order to minimize and control the lower incisor recession. It was demonstrated that the normalization of the position of the upper and lower incisors can improve and/or normalize the position and height of the gingivo-periodontal tissues (Seehra).

When necessary, the surgical treatment choice is a free gingival graft and it is recommended that this graft be placed after the orthodontic treatment when the position of the lower incisors returns to normal. In some adult patients and in certain circumstances, a previous free gingival graft is suggested but is not recommended in young patients since some normalization is achieved when the position of the teeth is corrected. A long junctional epithelium attachment is the most common result. Predisposing factors include the

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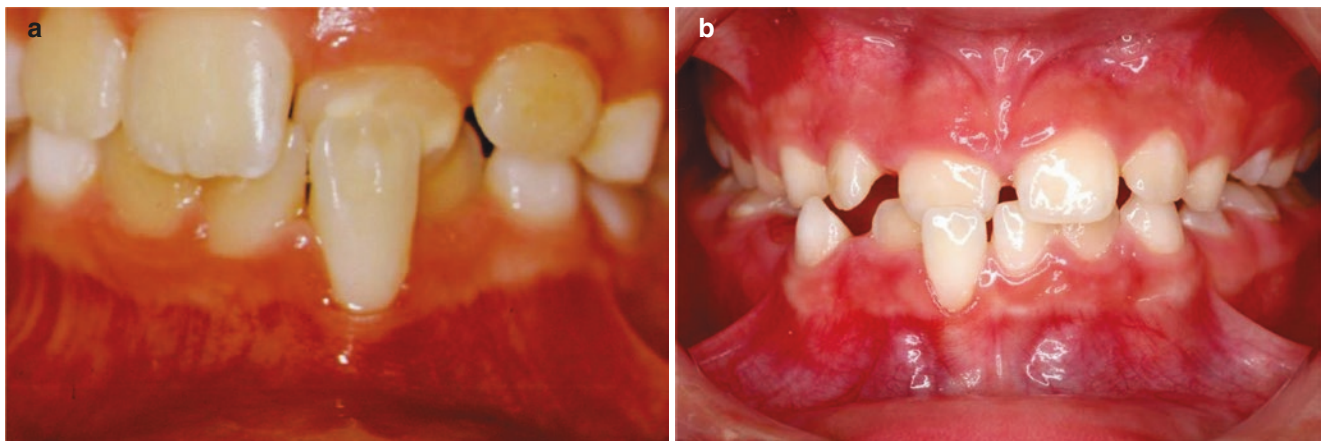


Fig. 12.1 (a, b) Examples of gingival recession in labially positioned lower incisors during early mixed dentition with less width of attached gingiva

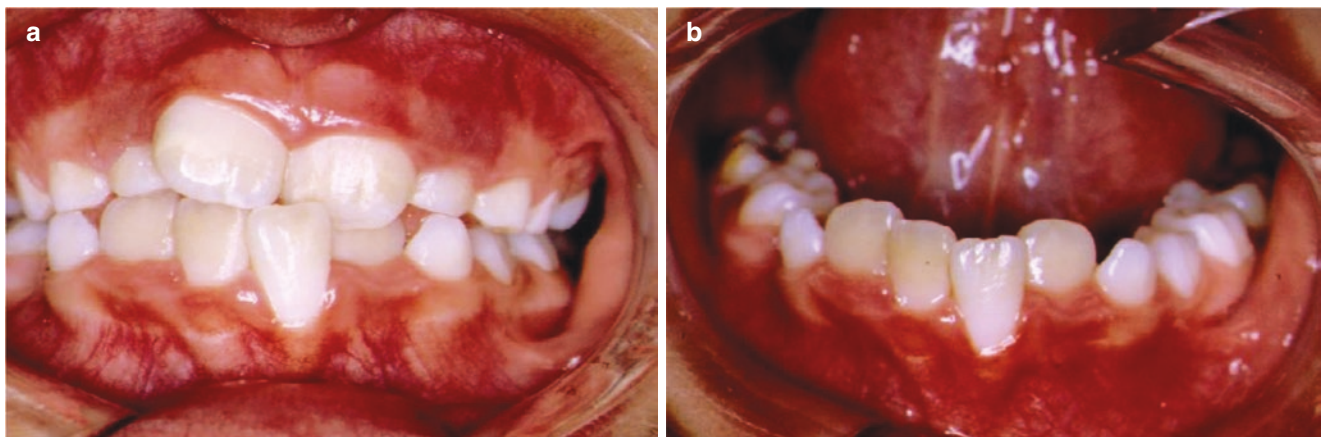


Fig. 12.2 (a, b) Significant lower anterior gingival recession in an 8-year-old boy along with mild crowding in the upper and lower gingival line

prominent anterior position of the lower incisors and the minor width of the gingival attachment. The position of the localized lower anterior recession in conjunction with a plaque-induced gingival inflammation due to the malposition of the incisors acts as a determining factor in these patients (Parfit and Mjör).

It is important to consider that dental hygiene plays an important role in the maintenance and improvement of the gingivo-periodontal status. Long-term observations of early correction of this condition demonstrate that normalization of the anterior crossbite should be constantly maintained. Some patients will need a second phase of treatment, but others will not. There is no doubt that these problems should be treated as early as possible to avoid more complex problems.

The following two patients clearly demonstrate these concepts. The first patient is an 8-year-old boy with severe localized gingival recession in conjunction with anterior crossbite in the incisor region (Fig. 12.2a, b). His mother's chief com-

plaint was the position of the central upper incisors. No relevant medical history was present. He also had 5 mm of crowding at the lower arch and an uneven upper and lower gingival line.

The lateral photographs confirmed the anterior position of the lower central incisor with significant loss of periodontal attachment and the absence of the right first temporary molar that was extracted due to important caries (Fig. 12.3a, b). The patient's oral hygiene was fairly good. The right and left Class I molar was present although the right one was in crossbite position.

After analyzing the models, X-ray images, and photos, the treatment objectives for the first phase of treatment were as follows:

1. Align and level the arches.
2. Maintain Class I molar.
3. Achieve Class I canine.
4. Improve gingival conditions at the lower anterior region.

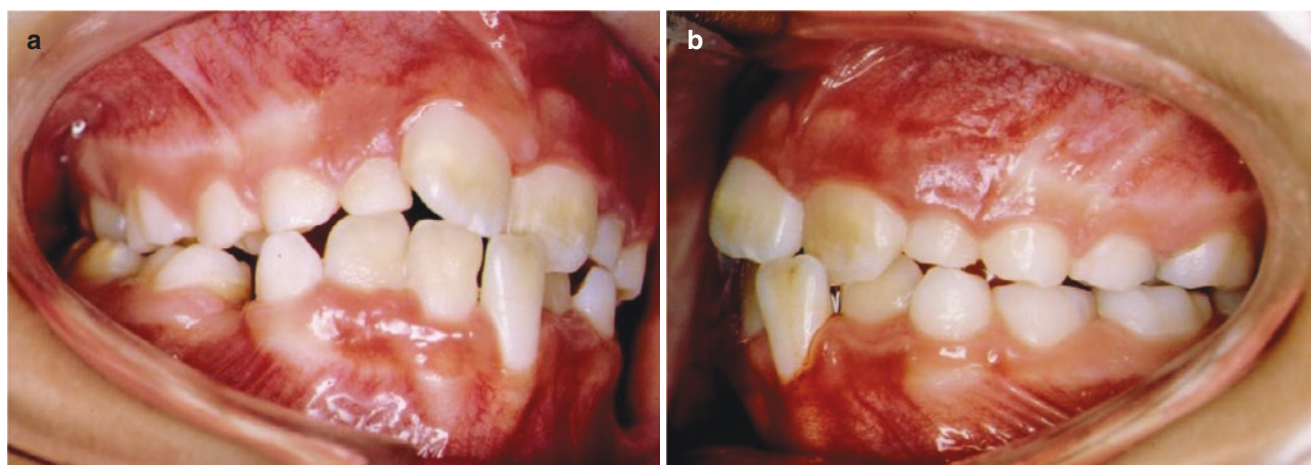


Fig. 12.3 (a, b) Pretreatment lateral views. The anterior position of the right central incisor and the periodontal attachment loss were confirmed

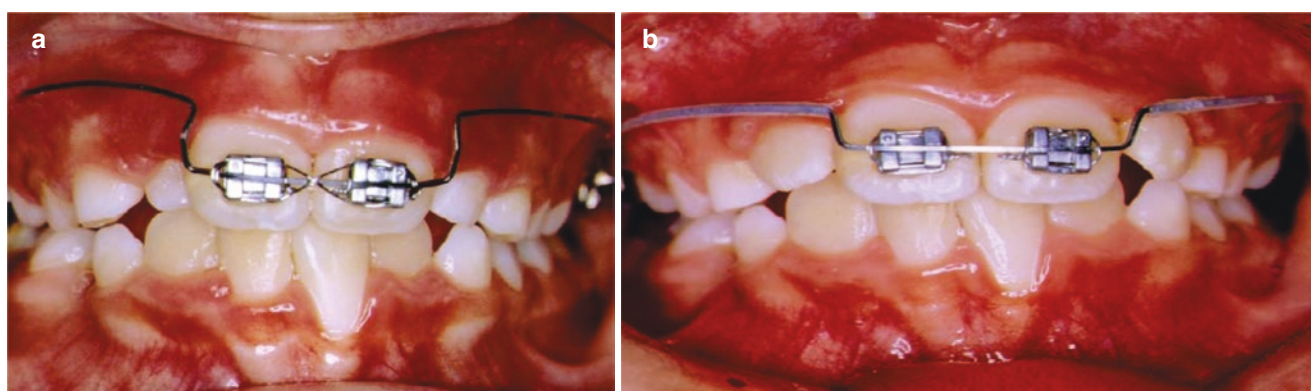


Fig. 12.4 (a, b) Brackets were placed on the central upper incisors with a utility arch (0.016" × 0.016" Elgiloy wire) to normalize overjet and overbite

5. Normalize overjet and overbite.
6. Long-term stability.

To achieve these objectives, a utility arch (0.016" × 0.016" Elgiloy wire) was placed with preprogrammed brackets with 0.022" slot. No brackets were bonded to the lower arch during this phase of treatment (Fig. 12.4a, b).

Seven months later, the position of the central and lateral upper incisors was normalized. An exhaustive dental plaque control was recommended with special emphasis at the lower anterior region, in order to improve gingival condition. No brackets were bonded to the lower arch until that point (Fig. 12.5a, b).

The lateral photographs confirmed the actual status. A fixed lower inner arch (SS 0.036") with two mesial loops was placed to maintain the anteroposterior position of the first lower molars and to avoid the mesialization of the right first molar. A 0.016" × 0.022" SS wire was placed on the upper arch to control the inclination and torque of the upper incisors (Fig. 12.6a, b).

No brackets were bonded to the lower teeth since normal eruption of the cuspids and bicuspid was expected. Due to work-related reasons, his parents moved abroad for approximately 24 months.

Two years after debonding, the position and inclination of the upper and lower incisors were almost normal. The midlines were coincident, the occlusal plane was parallel to the gingival plane, and overjet and overbite were normalized. The recovery of the gingiva in the lower central incisor area was noticeable. No type of gingival graft was necessary (Fig. 12.7a, b).

The lateral photographs confirmed that Class I molar and canine were achieved with acceptable overjet and overbite not only in the front region but also in the lateral areas (Fig. 12.8a, b).

The occlusal views confirmed the obtained results. A fixed retention wire was bonded on each tooth in the lower arch to prevent any kind of relapse, even though no brackets had been bonded on them. A long-term follow-up was recommended every 6 months (Fig. 12.9a, b).

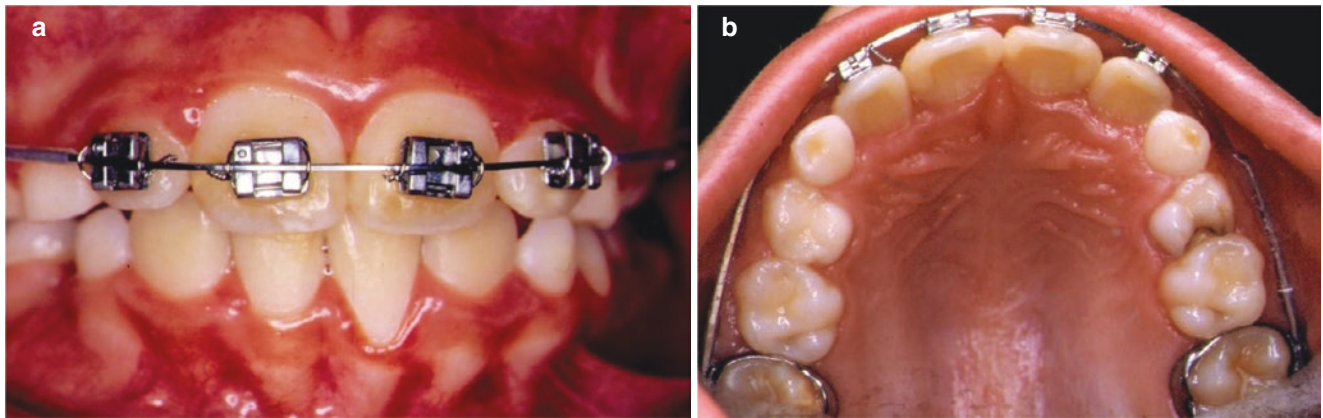


Fig. 12.5 (a, b) After 7 months of treatment, the position of the upper incisors was normalized with a 0.016" SS archwire

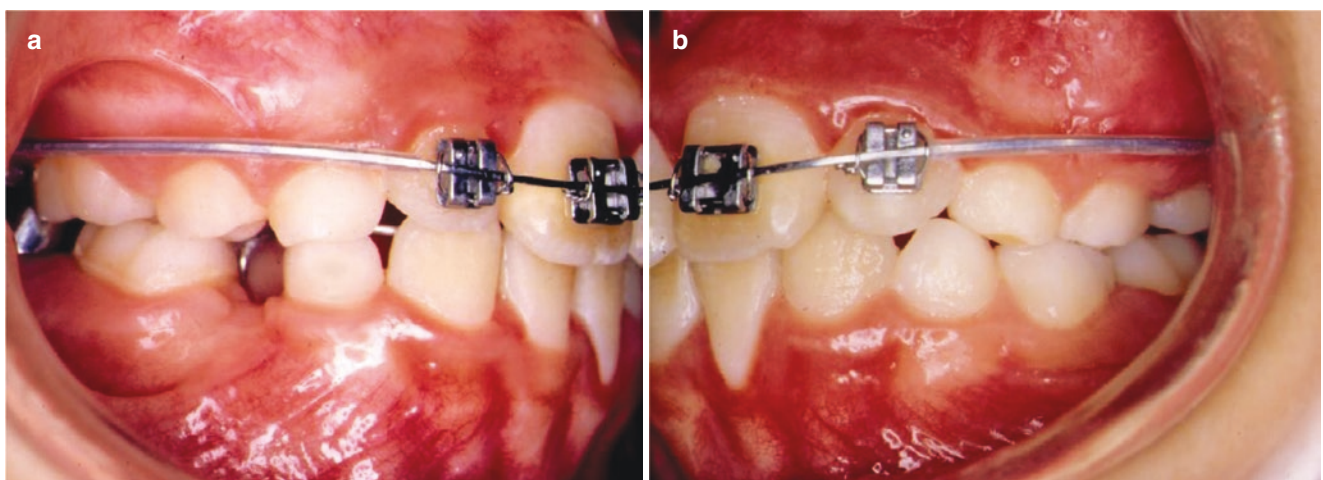


Fig. 12.6 (a and b) Lateral views with a lower inner arch to maintain the anteroposterior position of the lower molars

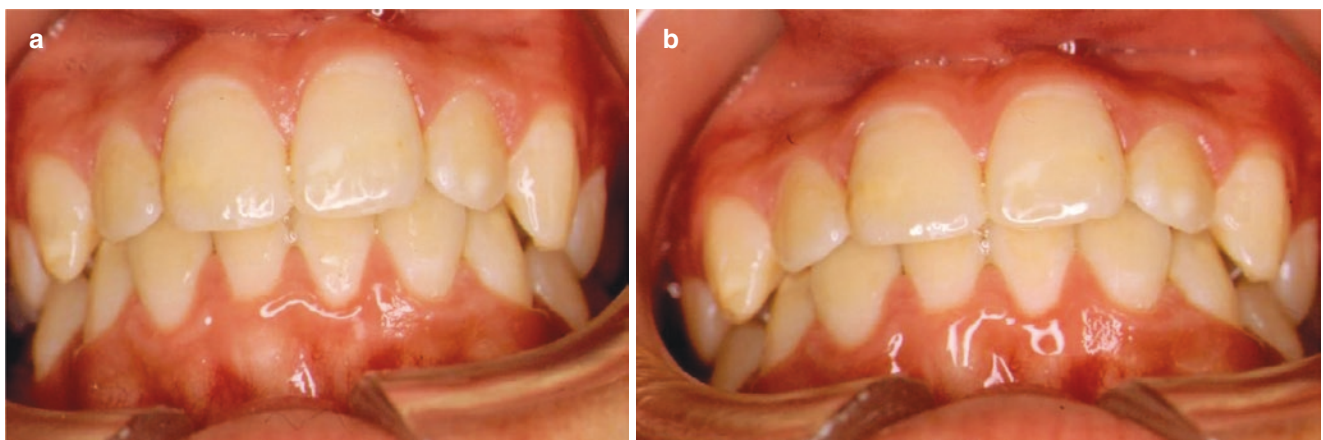


Fig. 12.7 (a, b) Two years after the end of treatment, the results were maintained or even improved. The midlines were coincident and overjet and overbite were within normal ranges

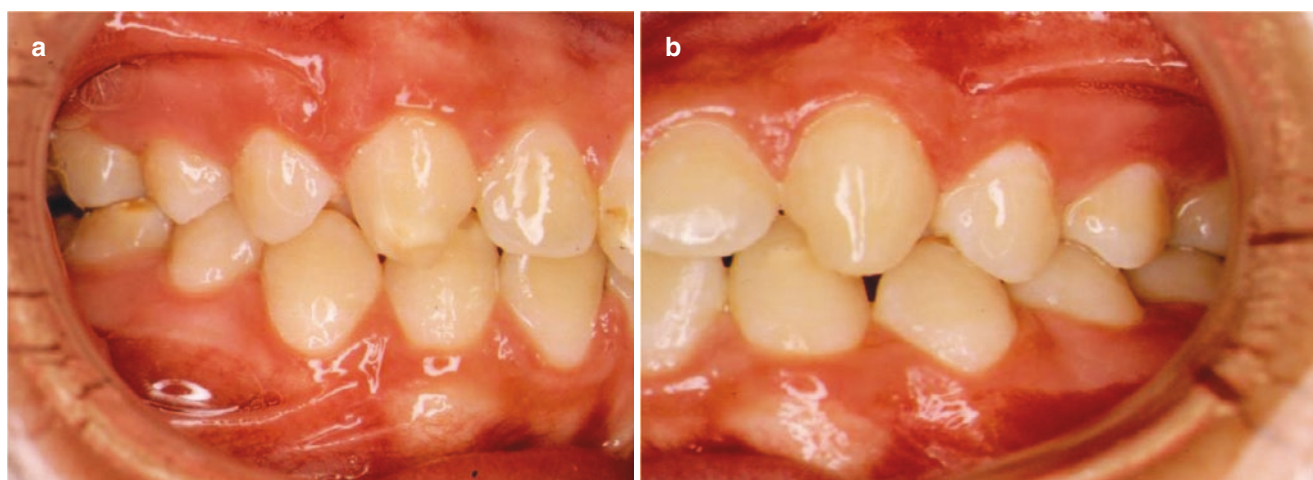


Fig. 12.8 (a, b) Lateral views at the end of treatment. Class I canine and molar were achieved

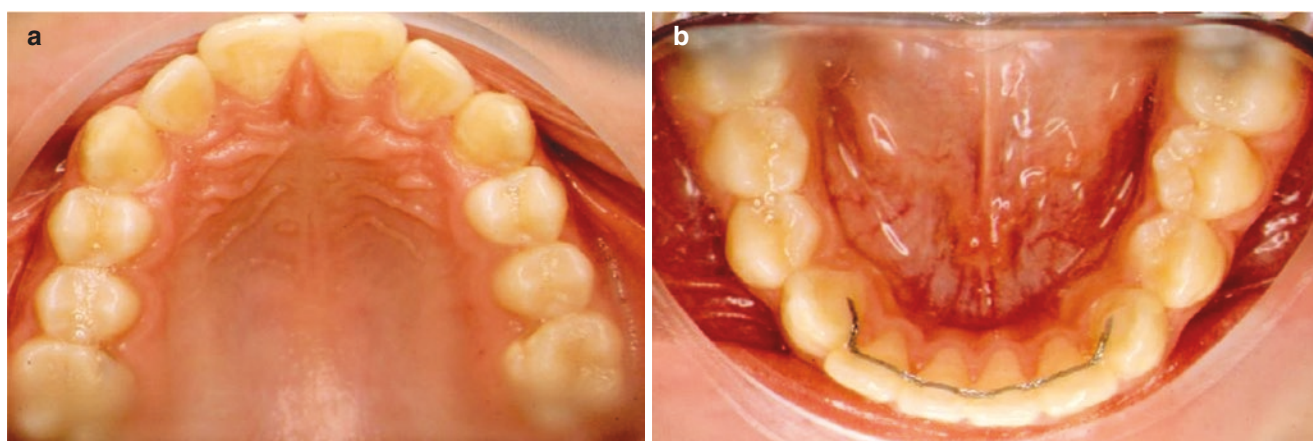


Fig. 12.9 (a, b) Upper and lower occlusal views 2 years after the end of treatment

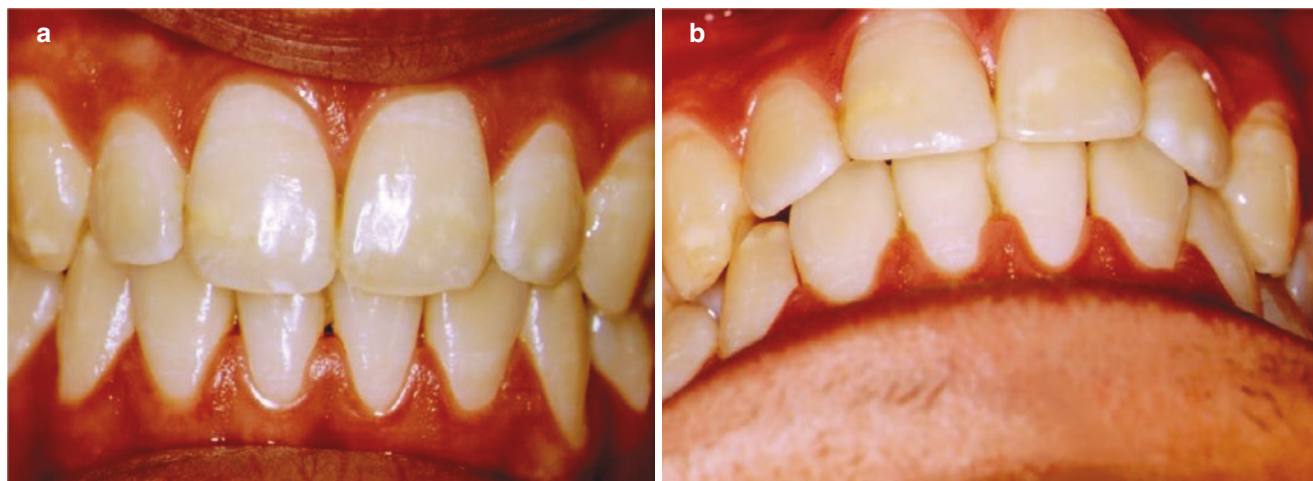


Fig. 12.10 (a, b) Follow-up 4 years and 9 months later. The results were maintained and the gingival tissues were totally normalized

The patient returned for follow-up after 4 years and 9 months for the retention wire. The results were maintained or even improved. The gingival margin was still normal (Fig. 12.10a, b).

The lateral views confirmed that Class I canine and molar were maintained with normal overjet and overbite (Fig. 12.11a, b).

The comparison of the pre- and posttreatment frontal photographs clearly demonstrates the huge improvement not only of the left central lower incisor gingival position but also of the occlusion plane. Bone recession at the central lower incisor was self-corrected, and no further periodontal treatment was required. The gingival status of the upper and lower incisors was totally normal (Fig. 12.12a, b).

The next case is yet another good example of why it is important to begin treatment early. The second patient was a 9-year, 8-month-old girl who was sent to the office by her pediatric dentist who wanted a second opinion regarding the best time to begin the correction of the palatal position of the upper right central incisor. Her mother was confused by the completely different opinions she received. Some of them

recommended waiting for the eruption of the second molars, another suggested the extraction of the left central lower incisor to improve occlusion, and another proposed that the only way was the use of micro-implants (Fig. 12.13a, b).

To lower her mother's anxiety, some similar clinical cases were shown to her and her daughter to explain different alternatives of treatment. It was very important that the parents understand the importance of early correction of the position of the incisors to prevent more dental and periodontal complications in the future.

It is essential that patients and their parents be fully aware that excellent oral hygiene is fundamental to achieve and maintain normal gingivo-periodontal tissues. It is important to highlight that this patient had diastemas in the upper teeth due a positive discrepancy with an uneven gingival line (Fig. 12.13a, b).

The lateral views confirmed Class I canine and molar and excessive proclination of the left central lower incisor. Although she was a very young girl, some loss of periodontal attachment was seen in this area. The upper left central incisor was palatinized and extruded (Fig. 12.14a, b).

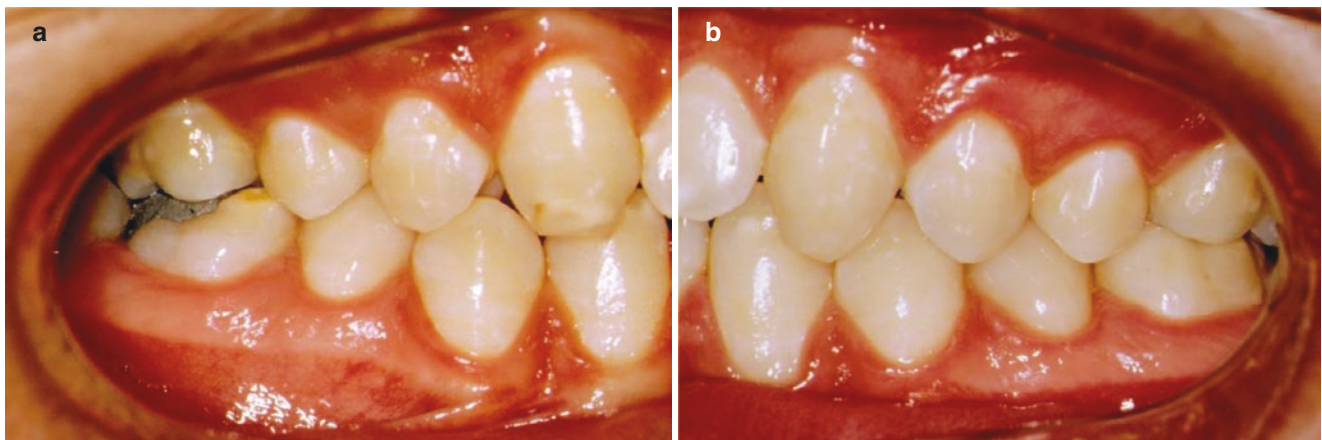


Fig. 12.11 (a, b) Right and left side occlusion after 4 years and 9 months of active orthodontic treatment

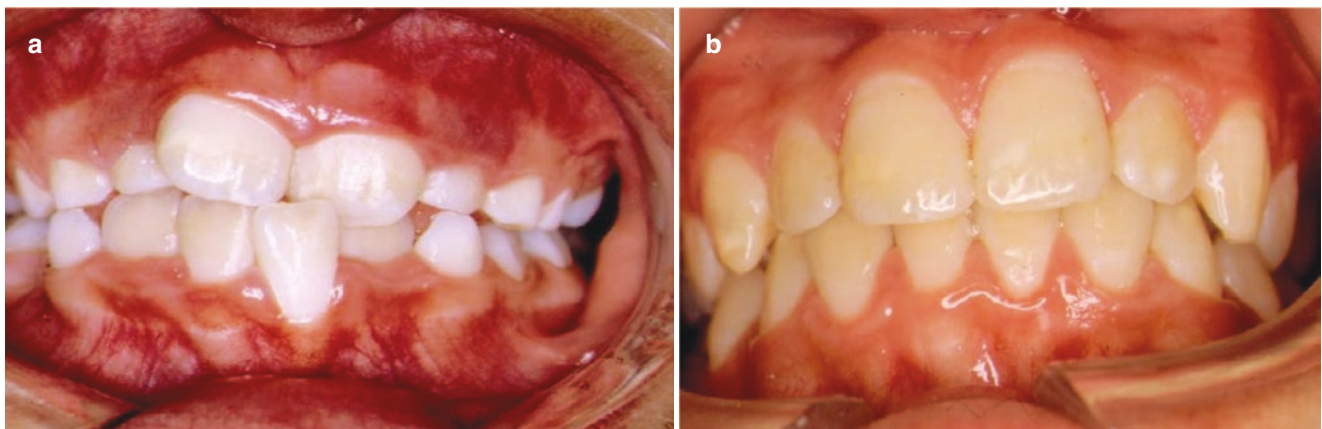


Fig. 12.12 (a, b) Comparison of pre- and posttreatment images. Upper and lower midlines and gingival margins are totally normal

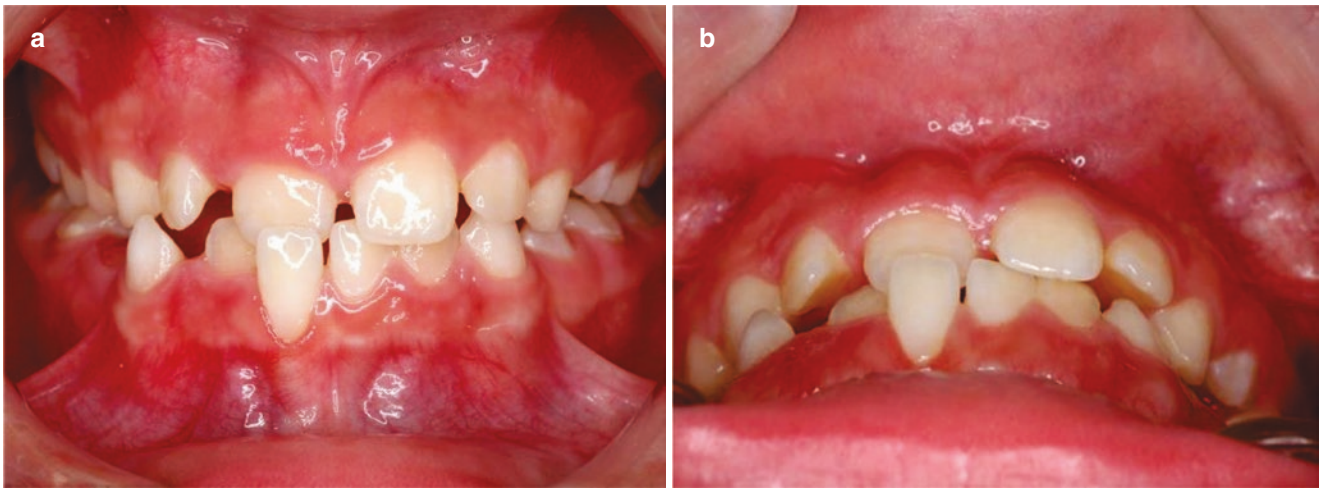


Fig. 12.13 (a, b) Pretreatment frontal photographs. The labial position of the central left lower incisor is clearly observed

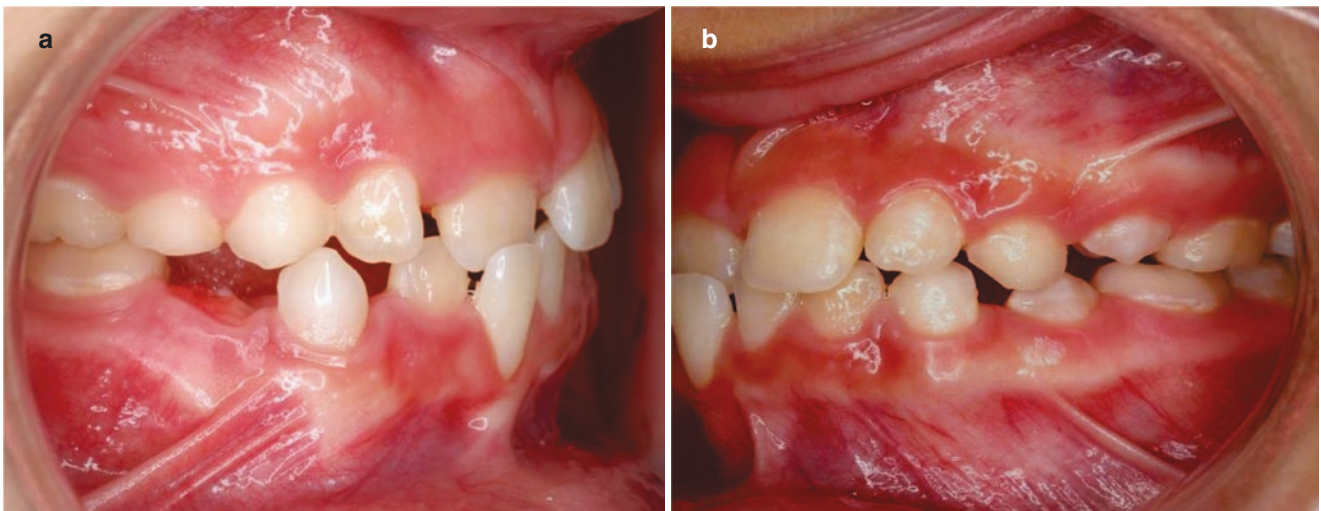


Fig. 12.14 (a, b) Class I molar along with an excessive labial position of the central left lower incisor was present

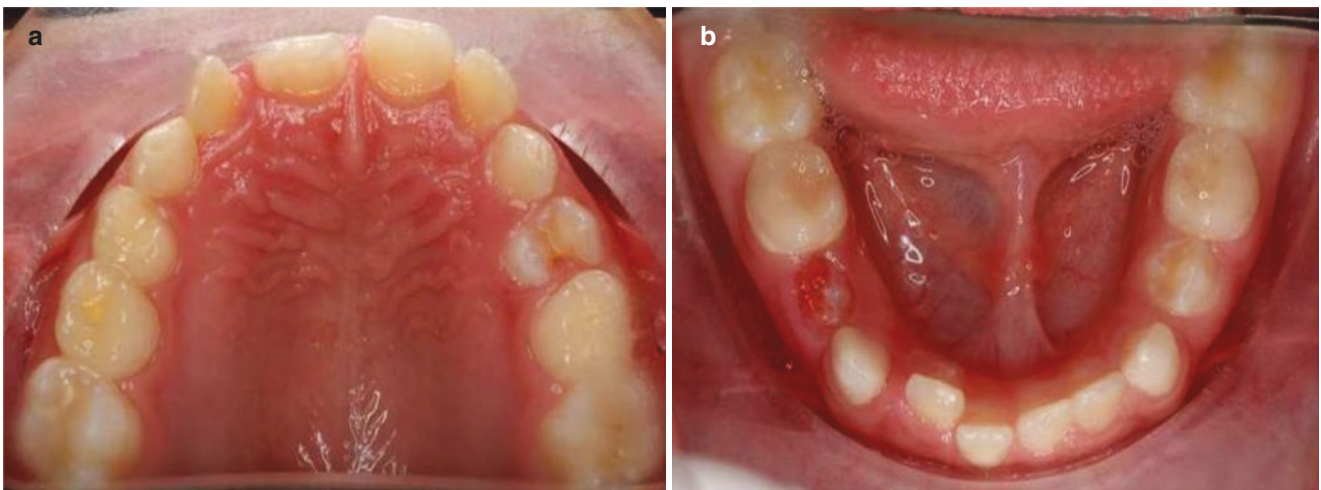


Fig. 12.15 (a, b) Pretreatment images of the upper and lower arches. The malposition of the lower left central incisor was confirmed

The occlusal photographs showed a positive discrepancy of 2.5 mm in the upper arch and + 2 mm in the mandible (Fig. 12.15a, b). Oral hygiene was fairly good and no cavities were seen.

After analyzing the models, X-ray images, and photos, the treatment objectives for the first phase of treatment were as follows:

1. Normalize the position of the right upper and lower central incisor.
2. Align and level the arches.
3. Maintain Class I canine and molar.
4. Improve gingiva-periodontal condition.
5. Long-term stability.

To achieve these treatment objectives, 0.022" esthetic pre-programmed brackets were bonded to the upper incisors in conjunction with a SS 0.014" wire and bands on the upper first molars (Fig. 12.16a, b).

The lateral views confirmed the achieved results after 5 months of treatment. Temporary right and left molars

maintained their normal position (Fig. 12.17a, b). Oral hygiene was checked regularly.

A figure-of-eight ligature was placed between the central incisors to close the anterior diastema. Overjet and overbite were almost normal and bicuspid were erupting normally (Fig. 12.18a, b).

When all the bicuspid and right canine erupted, a 0.018" SS archwire was used to complete alignment and leveling of the upper arch with an open coil spring to obtain sufficient space for the left canine. A 0.014" NiTi wire as a double arch was suggested to level the canine without alterations of the adjacent teeth (Fig. 12.19a, b).

Esthetic brackets with a 0.022" slot were also bonded to the lower arch and a 0.016" SS archwire was placed to correct anterior crowding in the anterior region and rotations in the bicuspid area (Fig. 12.20a, b).

The following were the results at the end of the active orthodontic treatment: The midlines were coincident and the gingival line and occlusal plane were parallel. Overjet and overbite were within the normal parameters (Fig. 12.21a, b).

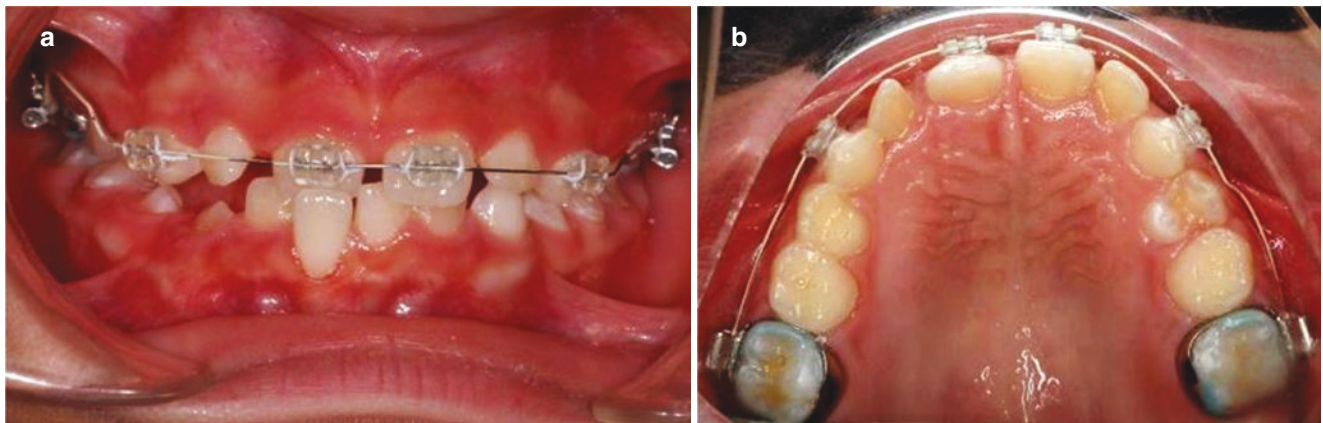


Fig. 12.16 (a, b) Esthetic preprogrammed brackets with a 0.016" SS wire at the beginning of treatment

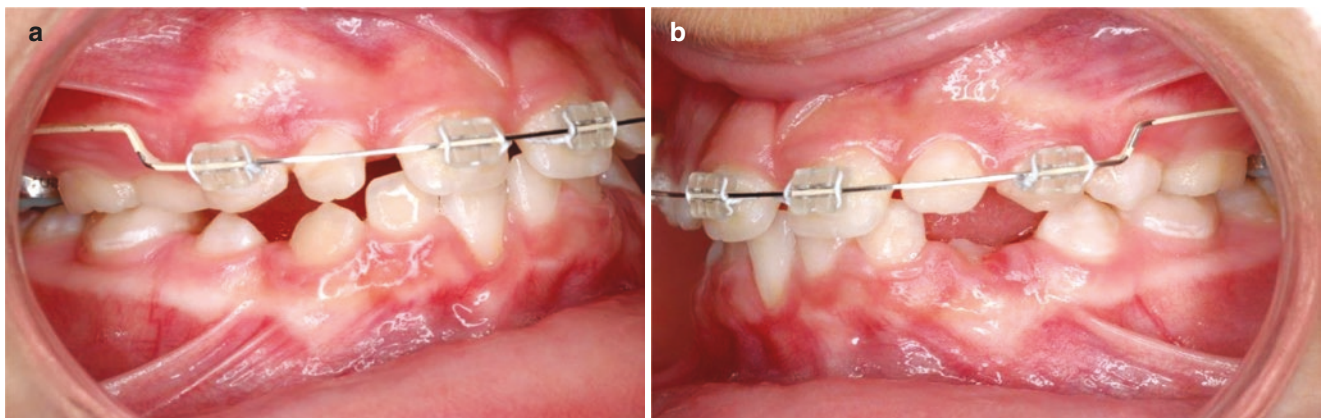


Fig. 12.17 (a, b) Lateral photographs with a 0.016" SS arch in place

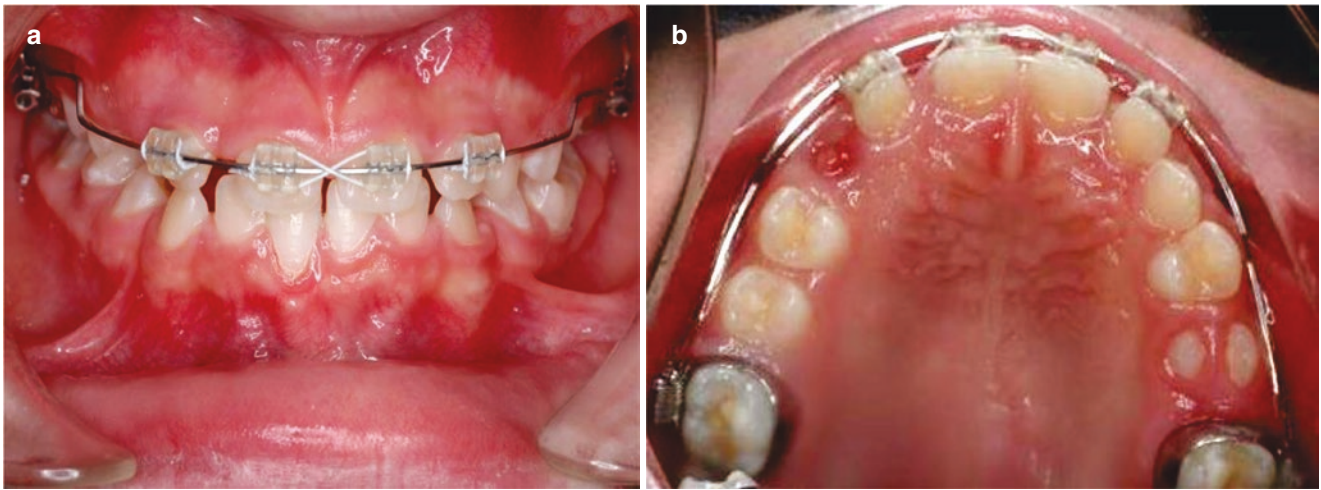


Fig. 12.18 (a, b) A figure-of-eight ligature was placed between the central incisors to close the anterior diastema

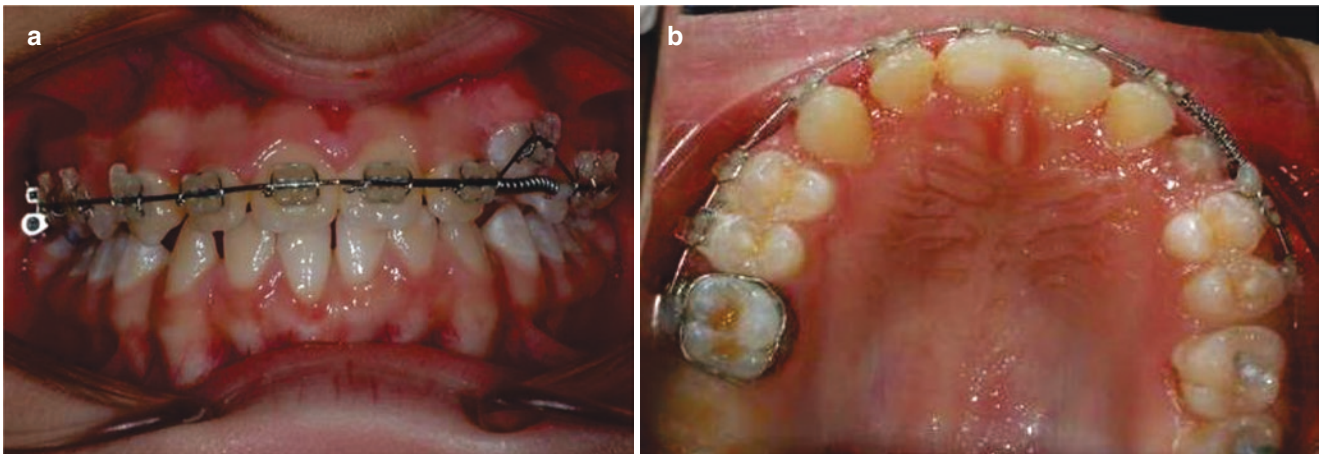


Fig. 12.19 (a, b) Frontal and occlusal photos with an open coil spring and a 0.014" NiTi wire as a double arch

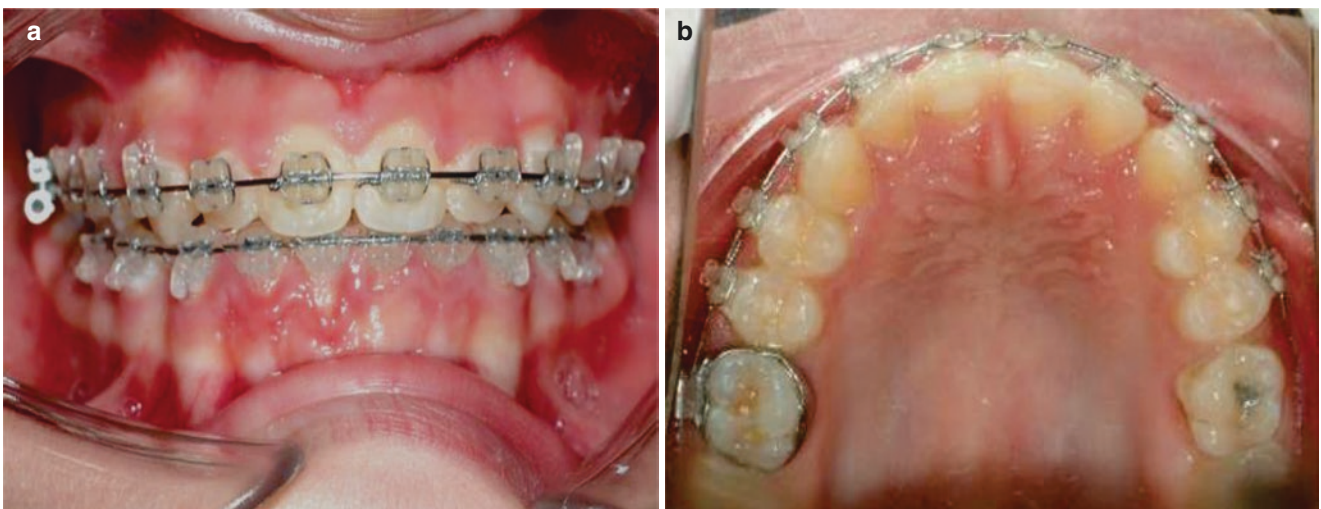


Fig. 12.20 (a, b) Frontal and occlusal photographs at this stage of treatment. The upper left canine has totally erupted

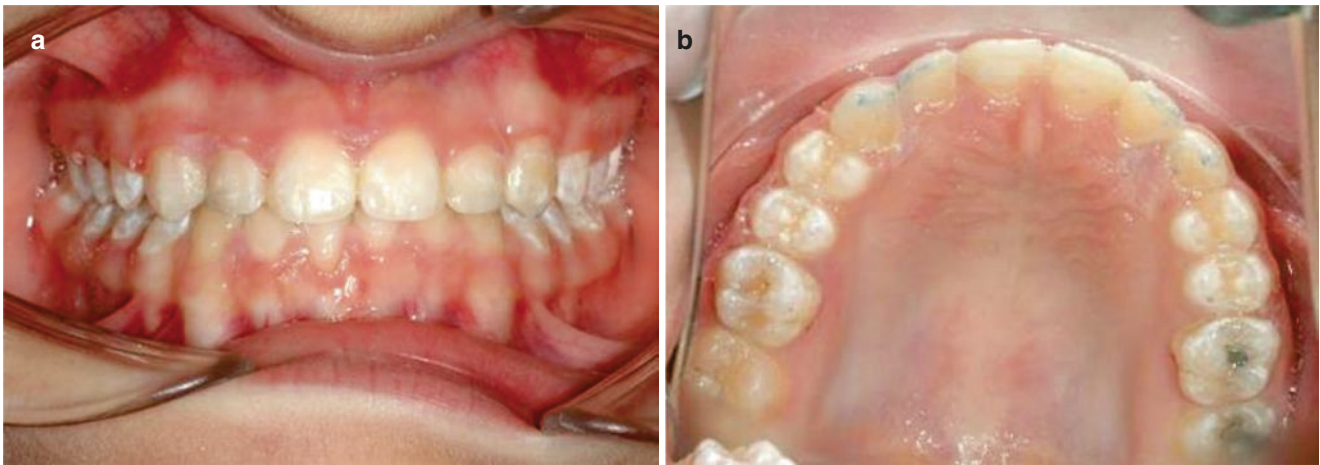


Fig. 12.21 (a, b) End of the active orthodontic treatment. All treatment objectives were fulfilled



Fig. 12.22 (a, b) At 18-month follow-up. The results were maintained and the lower gingival margin continued to be normal

A follow-up 18 months later showed that the results were maintained. Overjet and overbite in the upper and lower central and lateral incisor regions were almost normal. The oral hygiene was much better (Fig. 12.22a, b).

The lateral photographs confirmed that Class I canine and molar were maintained. The position of the incisors as well as the gingival recession at the left lower central incisor was improved (Fig. 12.23a, b).

Improvement in the position and inclination of the upper and lower incisors was noticeable. A long-term fixed retention wire on the lower arch was advisable (Fig. 12.24a, b).

The comparison between the pre- and posttreatment outcomes with frontal photographs clearly showed enhancement of the occlusion in the anterior region. All treatment objectives were achieved and normalization of the gingivo-periodontal tissues was noticeable (Fig. 12.25a, b).

Similar results were achieved in this 9-year-old patient with the same problem. The comparison between the pre- and 5-year posttreatment frontal photos was the best example after using the same treatment protocol without the aid of any surgical procedures. The malposition of the anterior teeth was normalized and the interincisal papillae were totally recovered. Dental occlusion was signifi-

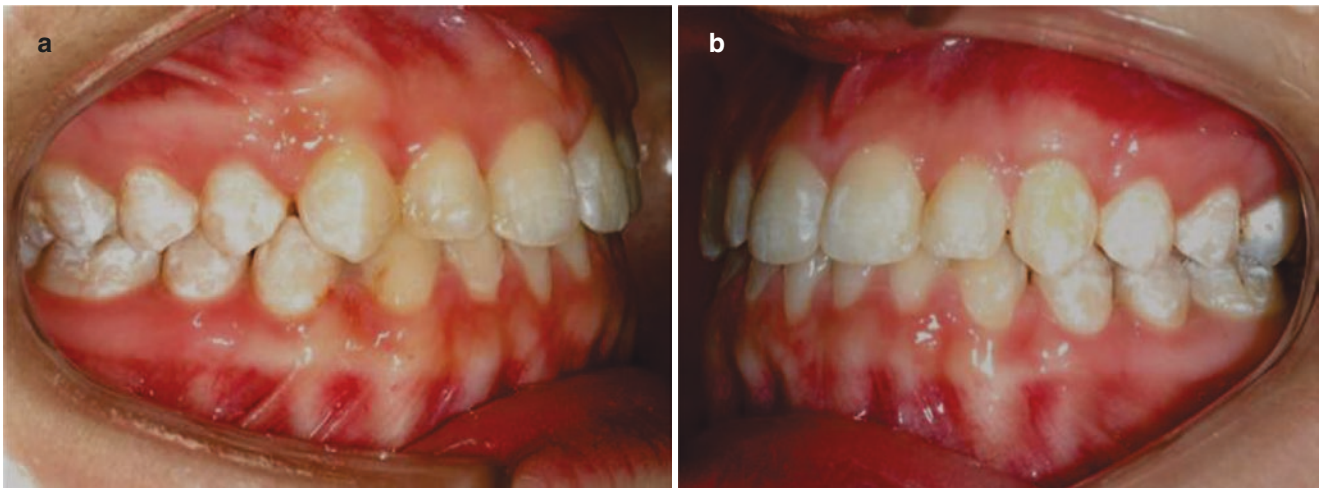


Fig. 12.23 (a, b) Right and left occlusion 18 months after ending the active treatment. Class I molar and canine were maintained

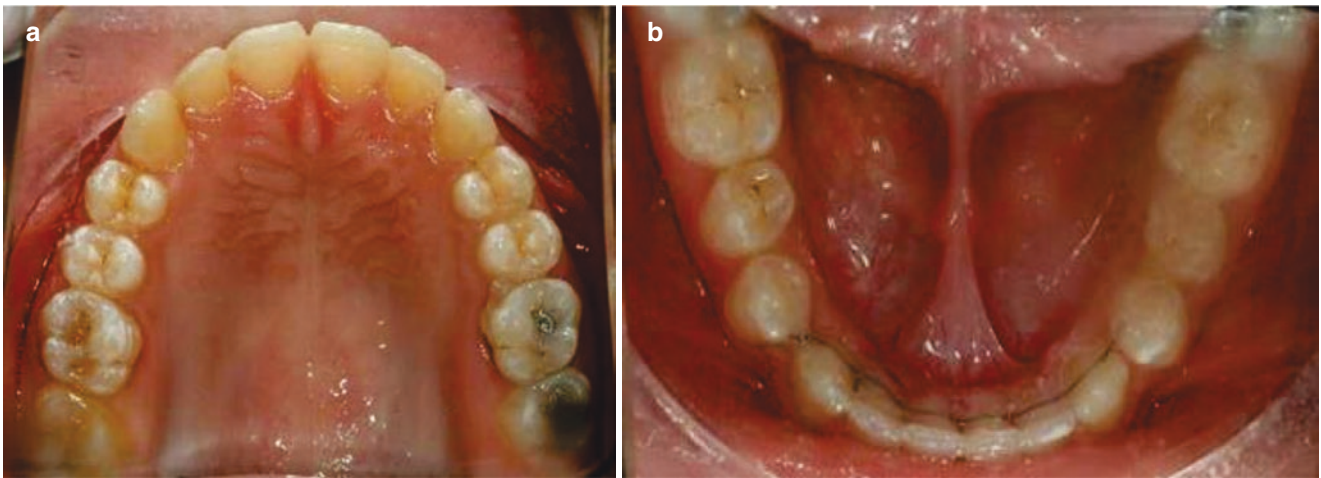


Fig. 12.24 (a, b) A long-term fixed retention on the arch was recommended

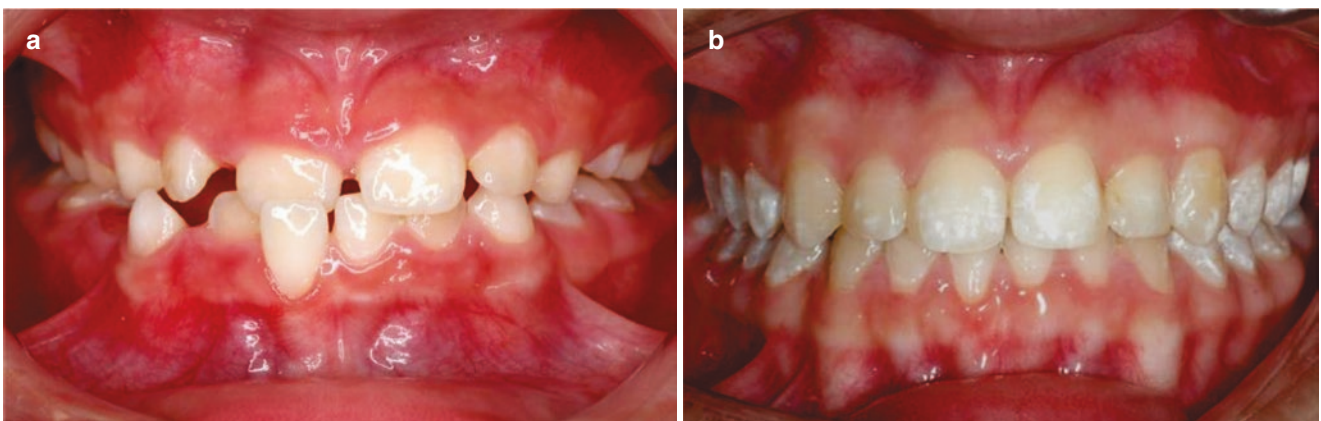


Fig. 12.25 (a, b) Comparison of pre- and posttreatment frontal photographs. Improvement of the position of the central incisors and the gingival tissues was clearly visible

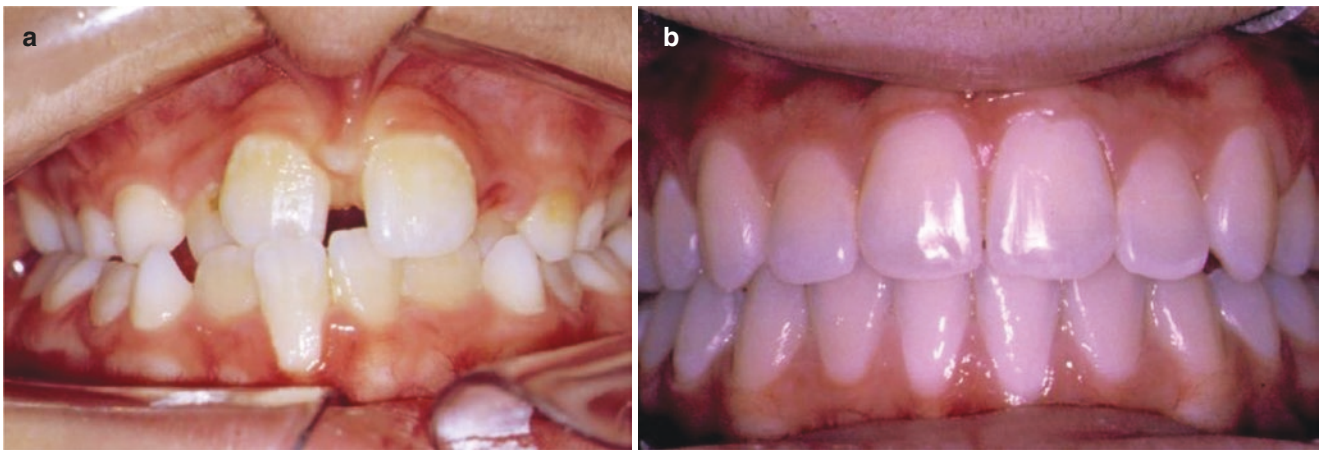


Fig. 12.26 (a, b) Comparison of pre- and 5-year posttreatment frontal photos using a similar protocol. The normalization of the gingival tissues was remarkable

cantly improved and the gold standard was achieved only through the use of orthodontic movements. No signs of relapse was seen during the 5-year follow-up and the gingival and periodontal tissues were completely normalized (Fig. 12.26a, b).

12.1 Conclusions

It is well accepted that proclined incisors have a higher incidence of severe labial gingival recession when compared to that of less proclined ones. The results showed that significant alterations in the widths of the keratinized and attached gingiva took place when the teeth changed positions in facial or lingual directions (Bimstein).

The clinical cases presented in this chapter demonstrated that excellent results can be achieved using fixed orthodontic appliances at an early age and, in this way, reverse the recession process. No reparative surgical procedures are neces-

sary before orthodontic treatment since the total recovery of the gingival tissues is clearly visible. It is advisable to normalize the proclination of the lower incisors as soon as possible, since the improvement in their position helps in the normalization of the gingival tissues.

A multi- and interdisciplinary treatment is the only way to achieve optimal results for a long period of time. There is no doubt that the gold standard is to keep the gingiva as healthy as possible during and after the orthodontic treatment. Strict plaque control is important to maintain and improve the achieved results as gingivo-periodontal inflammation is a very important detrimental factor that causes irreversible loss of periodontal attachment. Special attention should be given to the zone of attached gingiva and its relationship with the proclination of the lower incisors since it could be an etiologic factor in the development of mucogingival recessions in this area. There is no doubt about the treatment efficiency (result vs. treatment time), and the long-term results confirm this approach.

Early Orthodontic Treatment in Cleft Lip / Palate Patients

13

Somchai Satravaha

It is well-known among orthodontists that cases with cleft lip/palate (CLP) are unique and difficult to treat (Figs. 13.1, 13.2, 13.3, 13.4, 13.5, and 13.6). The treatment could be complicated with multifactorial causes and require much more different approaches than in non-CLP patients. The treatment time could take a long, long time. Anyhow, like all other orthodontic treatments, the treatment objectives are to

achieve good function, good esthetics, and good stability for the individual cases.

There are many problems associated with CLP cases (Fig. 13.7):

1. Collapse maxilla segments.
2. Protruded premaxilla.
3. Nasal deformity.
4. Malocclusions.
5. Esthetic problem.
6. Speech problem.
7. Ear problem.
8. Other associated problems, e.g., psychological problem.

These problems should be dealt by interdisciplinary team; orthodontist belongs to this team.



Fig. 13.1 A 12-year-old boy with bilateral cleft lip and cleft palate



Fig. 13.2 He had a large cleft site both at alveolar ridge and palate

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Fig. 13.3 A 9-year-old-boy with unilateral cleft lip and cleft palate



Fig. 13.5 A 10-year-old girl with unilateral cleft lip and cleft palate



Fig. 13.4 He had anterior crossbite. Cleft site can be seen in the picture



Fig. 13.6 A cleft site and a decayed #63 can be seen in her intraoral picture



Fig. 13.7 Multiple problems associated with CLP



Fig. 13.7 (continued)

Most CLP cases exhibit both skeletal and dental problems (Figs. 13.8, 13.9, 13.10, 13.11, and 13.12). Sagittal discrepancy between the maxilla and the mandible is the most prominent problem of all problems in three dimensions (Fig. 13.13).

Treatment objectives in CLP treatment are the same as the treatment objectives of other orthodontic treatment, which are to achieve good function, good esthetics, and good stability. We must then begin with the end in mind, knowing the treatment result before starting of the treatment. Therefore, we must carefully do comprehensive analysis, diagnosis, and treatment planning and then start with proper treatment with proper appliances and retain the treatment outcome to obtain stability.

As mentioned previously that sagittal discrepancy between the maxilla and the mandible is the most prominent problem of all problems in three dimensions, correction of sagittal discrepancy should be done first as at the early age facial growth can still be modified. To correct sagittal discrepancy in CLP patients, Class III Activator of Thomas Rakosi (Figs. 13.14 and 13.15) is recommended for early Class III treatment (for details, see Chap. 6) (Rakosi 1985; Graber et al. 1997; Rakosi and Graber 2010; Satravaha 1993; Satravaha and Taweedsdt 1996a; Satravaha and Taweedsdt 1996b; Satravaha and Taweedsdt 1999).



Fig. 13.8 A 9-year-old boy with a unilateral cleft lip/palate



Fig. 13.9 He had a concave facial profile



Fig. 13.10 He had anterior crossbite



Fig. 13.11 Crowding and malalignment of upper teeth



Fig. 13.12 Crowding of teeth in the lower arch and bifid uvula



Fig. 13.13 A 9-year-old boy and 10-year-old girl with cleft lip/palate, both had concave facial profiles resulting from sagittal discrepancy between the maxilla and the mandible



Fig. 13.14 Class III Activator for non-CLP patient



Fig. 13.15 Class III Activator for CLP patient

13.1 Example of Treated CLP Cases

Case #1 (Figs. 13.16, 13.17, 13.18, 13.19, 13.20 and 13.21)

3 Types of Smile

1. Children smile, showing gum (Fig. 13.22).
2. Teenager smile, showing upper teeth (Fig. 13.23).
3. Elderly smile, showing lower teeth (Figs. 13.24).



Fig. 13.16 A 9-year-old boy presented at our CLP center with a unilateral cleft lip/palate. The lip was already repaired alio loco. He was in the early mixed dentition, and he had anterior crossbite; cleft site could be seen in the intraoral picture



Fig. 13.17 He had obviously protruding lower lip, which is esthetically not good



Fig. 13.18 At smile he showed mostly his lower anterior teeth



Fig. 13.19 His cephalometric head film showed large negative overjet, negative overbite, and positive lip step (protruding lower lip)

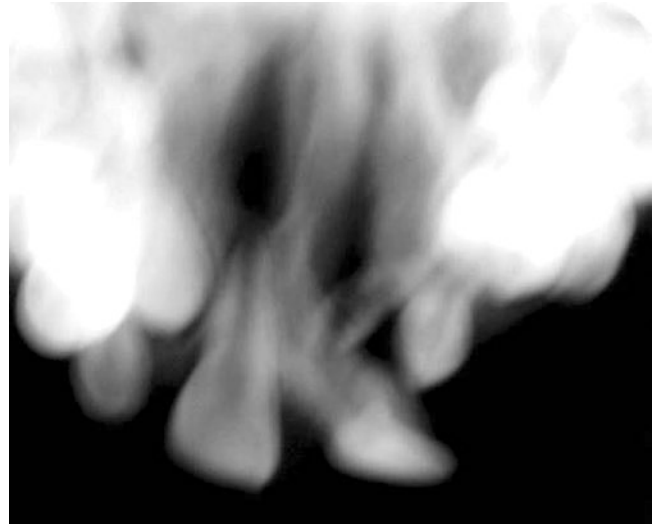


Fig. 13.21 Cleft site can be seen here



Fig. 13.20 He had two missing upper lateral incisors



Fig. 13.22 Children smile



Fig. 13.23 Teenager smile



Fig. 13.24 Elderly smile

Class III Activator was used to minimize sagittal discrepancy between the maxilla and the mandible (Fig. 13.25).

Class III Activator are often used in combination with other orthodontic appliances in attempt to achieve positive overjet and positive overbite (Figs. 13.26, 13.27, 13.28, 13.29, 13.30, 13.31, 13.32, 13.33, 13.34, 13.35, 13.36, and 13.37).

It would have been easier to achieve positive overjet and positive overbite if we can do extraction in the lower arch but the patient was not a good cooperative, having loosed brackets at almost every visit and did not follow instructions. It was decided not to do extraction in the lower arch, being afraid of not being able to close the



Fig. 13.25 Class III Activator in situ. Mandible was pushed backward into a new position. It is clearly seen that his lower lip became less protrusive



Fig. 13.26 Class III Activator was used to correct sagittal discrepancy in this case

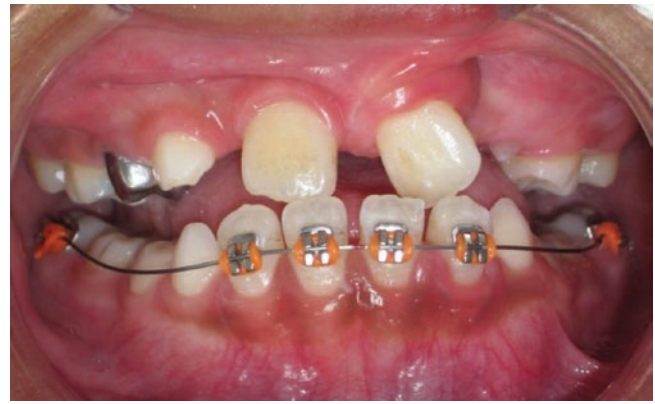


Fig. 13.27 Additional 2 × 4 fixed appliance was used to close spaces at the lower anterior region



Fig. 13.28 Combined usage of Class III Activator and 2 × 4 fixed appliance

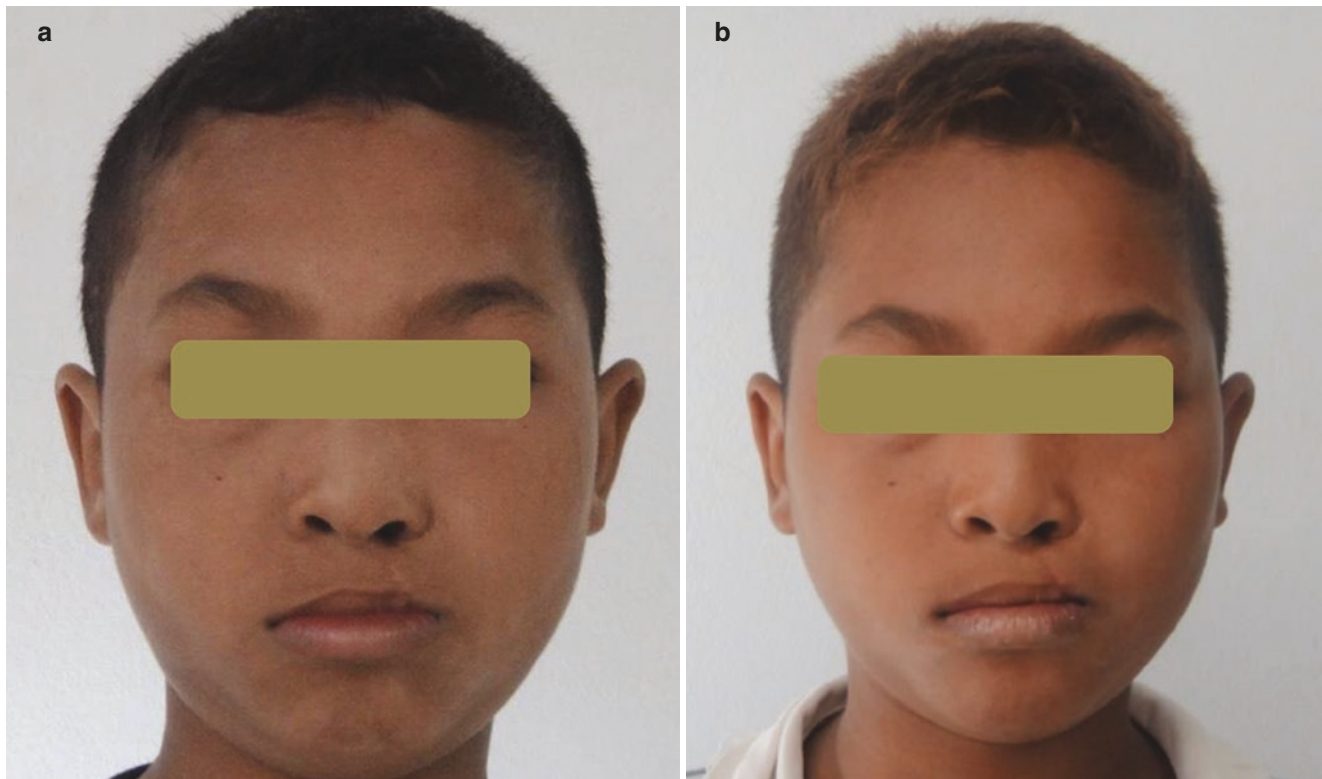


Fig. 13.29 (a and b): Facial change after the use of Class III Activator

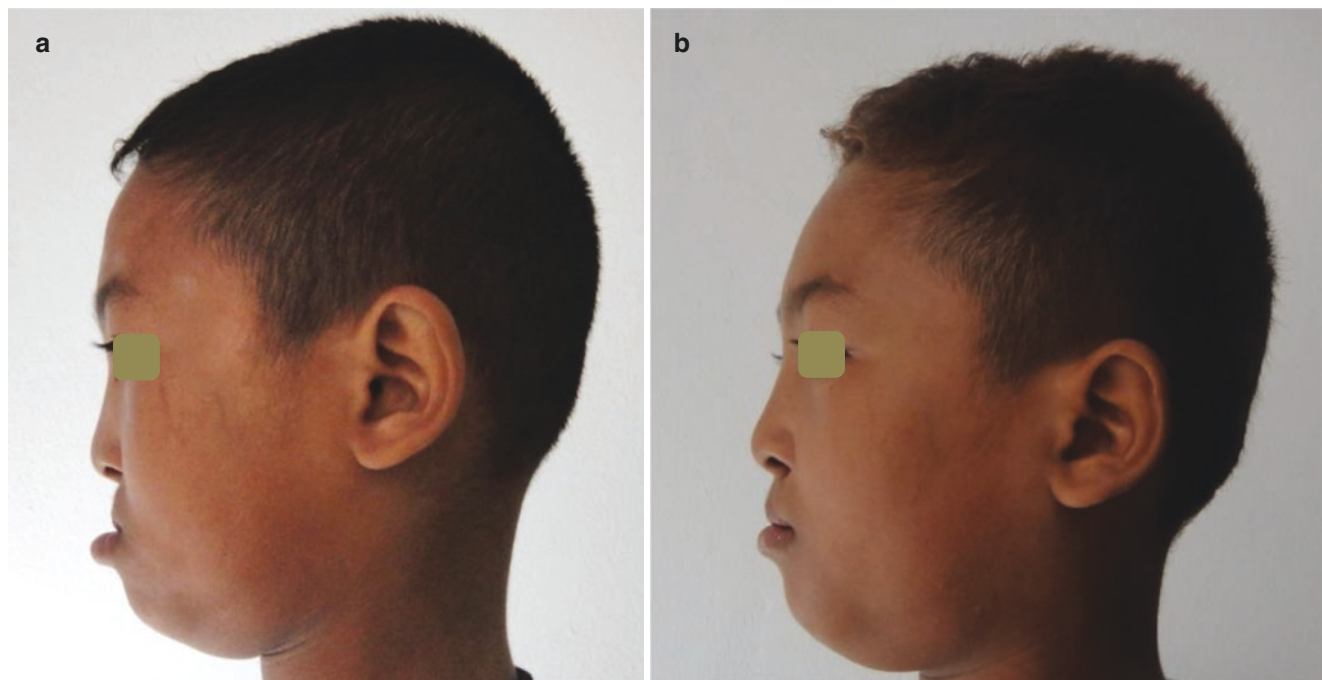


Fig. 13.30 (a and b): Change in lateral profile was obvious, the lower lip became less protrusive

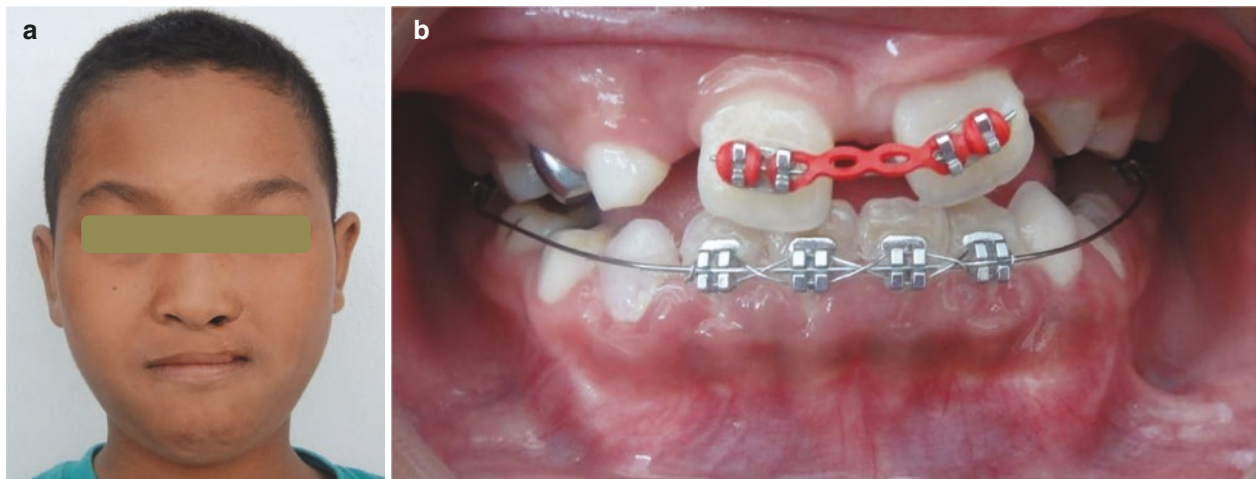


Fig. 13.31 (a and b): After achieving positive overjet and positive overbite, brackets were placed on #11 and #21, and C-chain was used to close the gap and to clear paths of eruption for #13 and #23



Fig. 13.32 1 year and 9 months after starting of the treatment, it was difficult to maintain positive overjet and positive overbite due to the large tongue which forcefully push the lower anterior teeth forward. Cleft site was still present

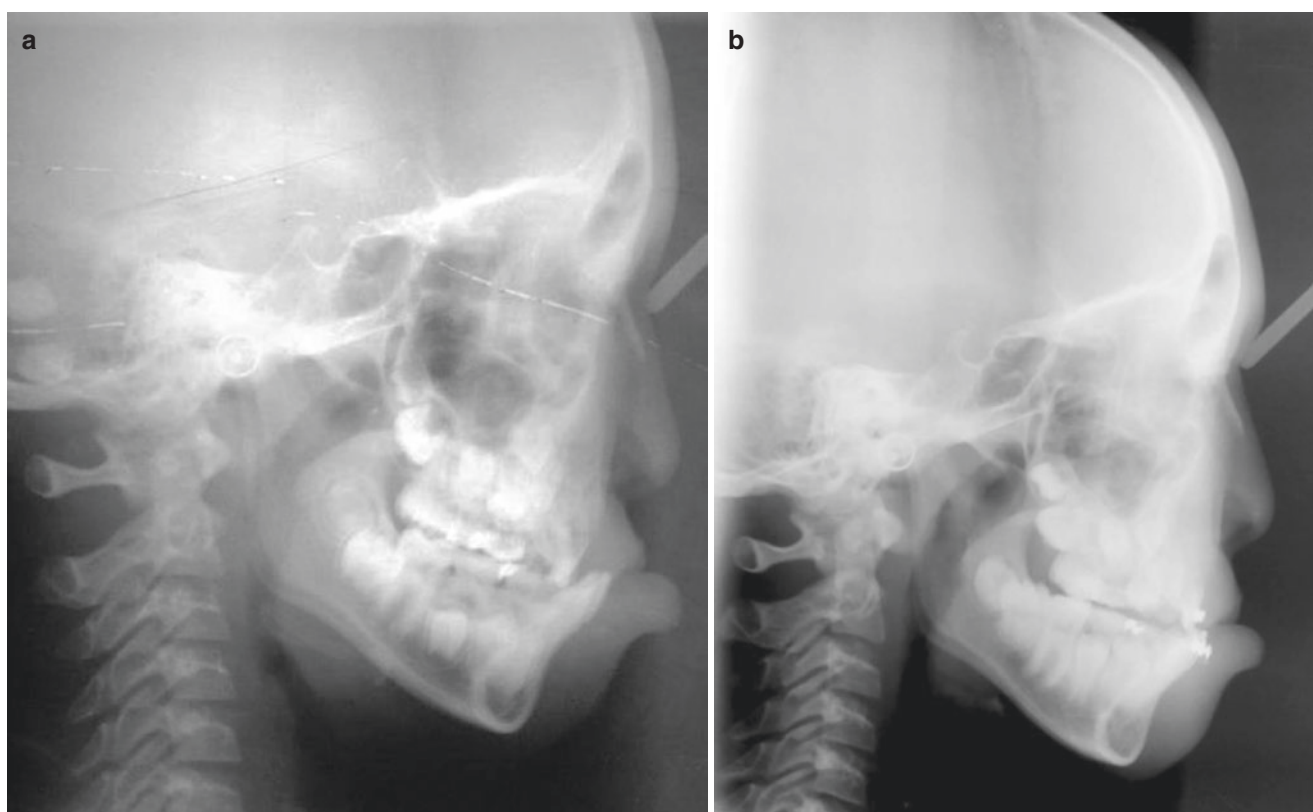


Fig. 13.33 Comparison of the cephalograms at start of the treatment (a) and after treatment with Class III Activator, the mandible was in a more posterior position after the treatment (b)



Fig. 13.34 At age 11 years 2 months, his cephalogram showed missing of teeth #12 and #22; teeth #53 and #63 were present. Tooth #13 was about to erupt and #23 was seen at root apex of #63



Fig. 13.35 Alveolar bone graft was done at age 11 years 2 months; tooth #63 was extracted before bone grating



Fig. 13.36 3 years after start of the treatment, positive overjet and positive overbite were achieved. #13 erupted into occlusion, #15 palatally erupted, and #23 not yet seen in the oral cavity



Fig. 13.37 Comparison of intraoral pictures at start of treatment and 3 years after, positive overjet and positive overbite were achieved

extraction spaces due to lack of patient cooperation. Inter proximal reduction (IPR) of the lower anterior teeth and of lower canines was the only mean to correct tooth size discrepancy (Figs. 13.38, 13.39, 13.40, 13.41, 13.42, 13.43, 13.44, 13.45, 13.46, 13.47, 13.48, 13.49, 13.50, 13.51, 13.52, 13.53, 13.54, 13.55, 13.56, 13.57, 13.58, 13.59, 13.60 and 13.61).

The patient was informed that the open bite at #23 and #33 could lead to relapse and instability of the treatment outcomes. The debonding of the brackets was a must as the patient did not maintain good oral hygiene and he had to move to another city to further his education (Figs. 13.62, 13.63, 13.64, 13.65, 13.66, 13.67, 13.68, 13.69, 13.70, 13.71, 13.72, 13.73 and 13.74).

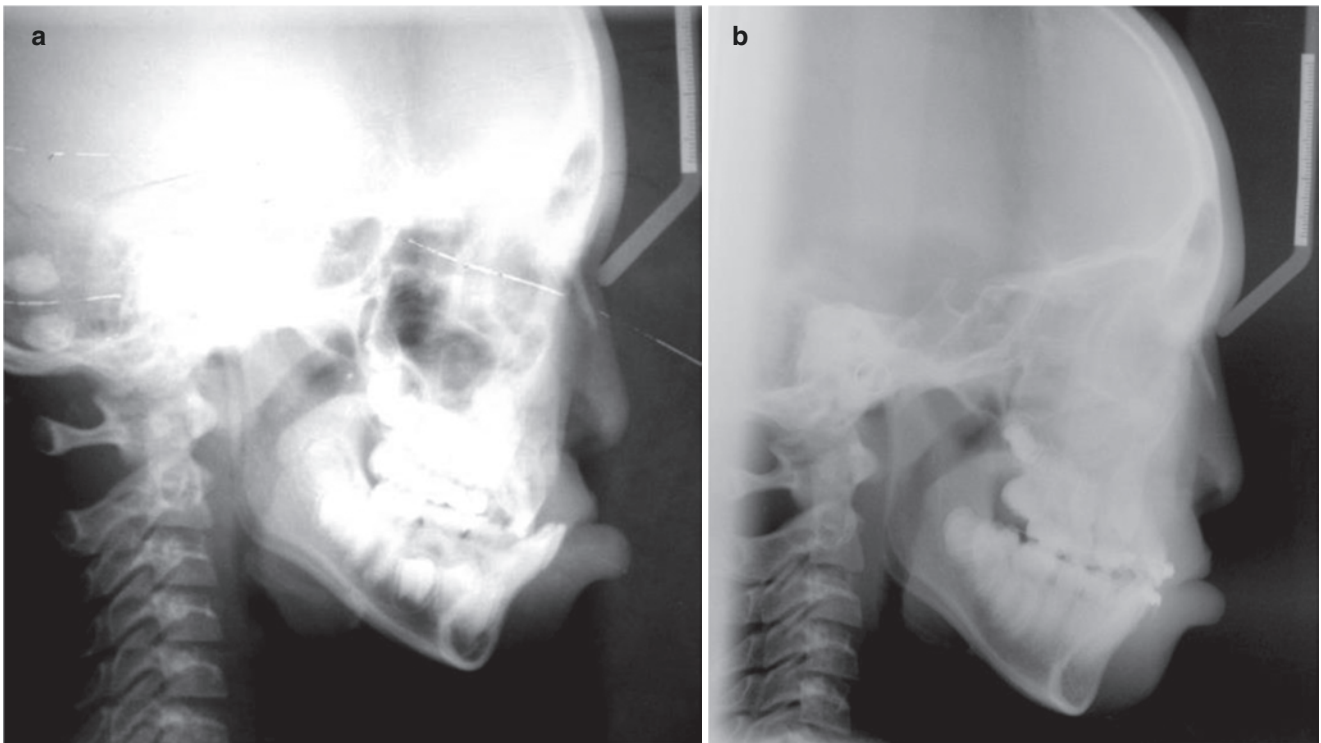


Fig. 13.38 (a and b): Comparison of cephalograms at start of the treatment (a) and 3 years after (b)



Fig. 13.39 Cephalogram 3 years after start of the treatment, #13 was already present in oral cavity. #23 had unfavorable path of eruption



Fig. 13.40 From the upper occlusal film, it was obvious that #23 had unfavorable path of eruption



Fig. 13.41 Intraoral pictures 3 years and 5 months after start of the treatment; #23 not yet erupted into oral cavity



Fig. 13.42 (a and b): Large tongue combined with abnormal oral habit can play role in preventing eruption of tooth #23 into occlusion, the patient was instructed to do myofunction exercises. (Graber 1963; Garliner 1981; Satravaha 1990)

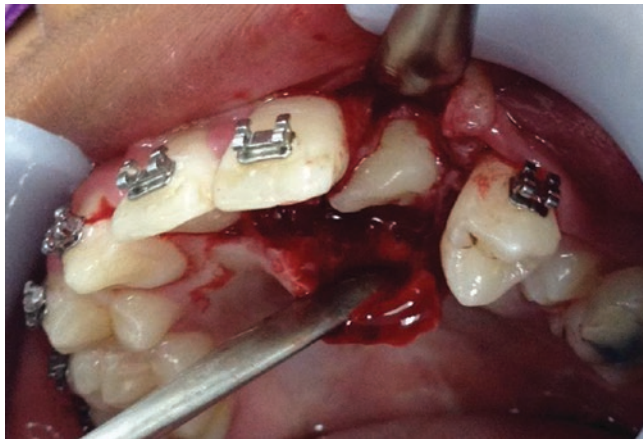


Fig. 13.43 Surgically assisted mobilization of #23



Fig. 13.44 Bracket was placed on #23



Fig. 13.45 Extraoral pictures taken at 4 years and 5 months after start of the treatment, 1 year after mobilization of #23



Fig. 13.46 (a–c): At smile he showed both upper and lower anterior teeth



Fig. 13.47 After 1 year of mobilization, #23 was mobilized into oral cavity



Fig. 13.49 Lingual buttons were placed on #23, #24, and #25 to help correct posterior crossbite



Fig. 13.48 Bilateral posterior crossbites could be clearly seen as well as his large flat tongue in (a) when the patient was unaware about his tongue position but not seen in (b) when he was aware



Fig. 13.50 Spikes were also built on #33 and #34 to eliminate tongue thrusting habit



Fig. 13.51 Extraoral pictures at age 15; 6 years after the start of the treatment, the pictures showed improvement of both frontal and lateral facial profiles. At smile, he showed mostly upper teeth resulting from the treatment and smile training



Fig. 13.51 (continued)



Fig. 13.52 Intraoral pictures at age 15; #13 and #23 were not reshaped. Positive overbite and positive overjet were achieved at minimal due to missing of teeth #12 and #22



Fig. 13.53 Crossbite at posterior right was present. #13 and #43 region had open bite tendency



Fig. 13.54 Open bite at #23, #33



Fig. 13.55 Intra oral pictures at age 15, missing teeth #12 and #22 were replaced by eruption of #13 and #23. No teeth in the lower arch was extracted



Fig. 13.56 Cephalogram at age 15 showed slight open bite tendency



Fig. 13.57 In the orthopantomogram, all teeth were present; except teeth #12, #22, #38, and #48. Teeth #38 and #48 were surgically removed



Fig. 13.58 Extraoral pictures at age 17, at rest position and at smile after debonding of the brackets



Fig. 13.59 At age 17, after debonding of the brackets in both upper and lower arches, teeth #13 and #23 replaced missing teeth #12 and #22. Slight open bite at #23 and #33



Fig. 13.60 No open bite at #13 and #43; right posterior crossbite was corrected



Fig. 13.61 Open bite was clearly seen at #23 and #33



Fig. 13.62 Upper arch after debonding of brackets; malformed teeth #15 and #25 could be clearly seen here



Fig. 13.63 Lower arch after debonding



Fig. 13.64 Cephalogram at the end of the treatment



Fig. 13.65 Orthopantomogram at the end of the treatment



Fig. 13.66 Extraoral pictures at recall; 8 months after the end of the treatment, at rest and at smile



Fig. 13.67 Intraoral picture at recall, 8 months after the end of the treatment. The treatment result was stable; the open bite at #23 and #33 improved



Fig. 13.70 Stable result in the upper arch



Fig. 13.68 Stable result



Fig. 13.71 Stable result; picture was taken unaware, note the tongue position!



Fig. 13.69 Improvement of the open bite at #23 and #33 due to more patient awareness of tongue thrusting habit and myofunction therapy

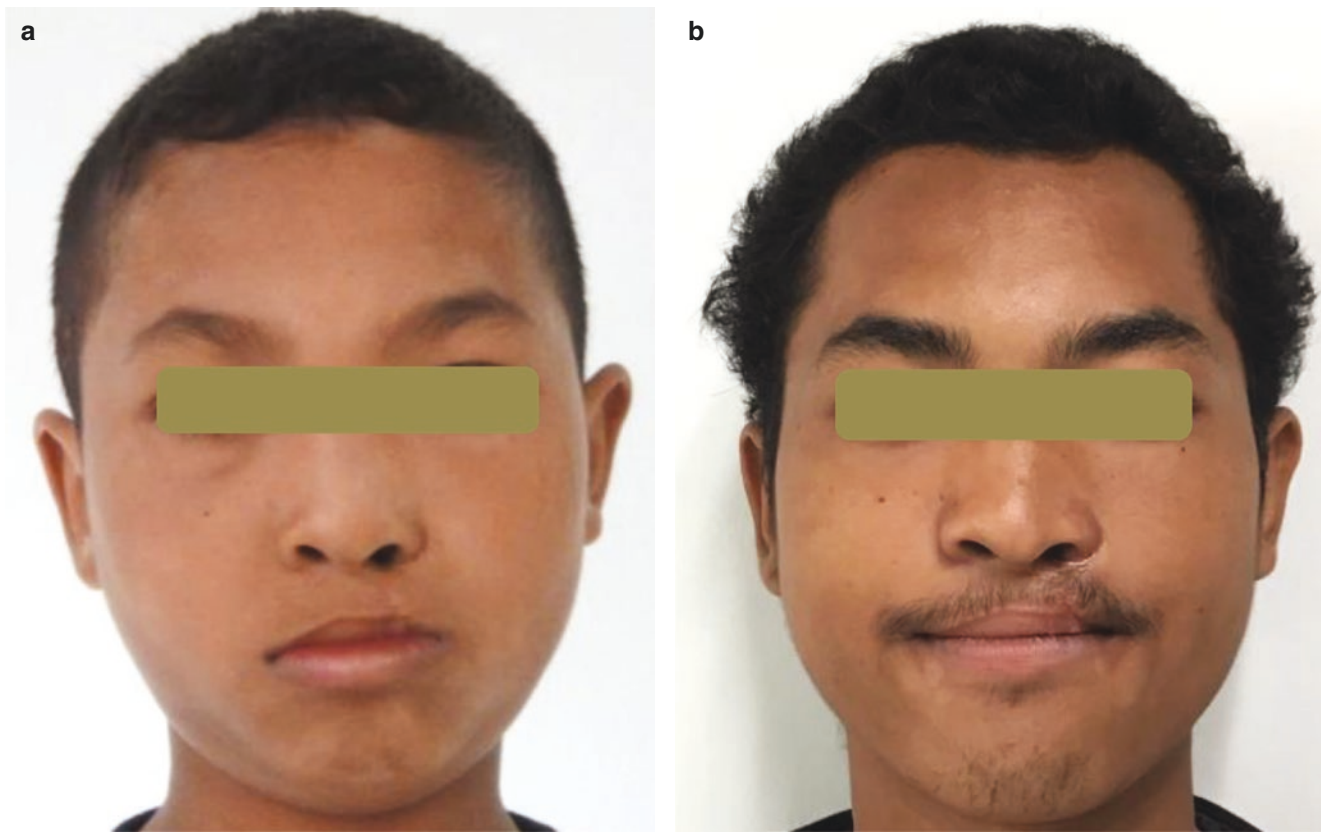


Fig. 13.72 (a and b): Extraoral pictures, taken before start of the treatment (a) and at recall (b)



Fig. 13.73 (a and b): At smile; before the treatment he showed only lower anterior teeth, which was less esthetic (a), compared to the more beautiful smile at recall showing just only his upper teeth (b)

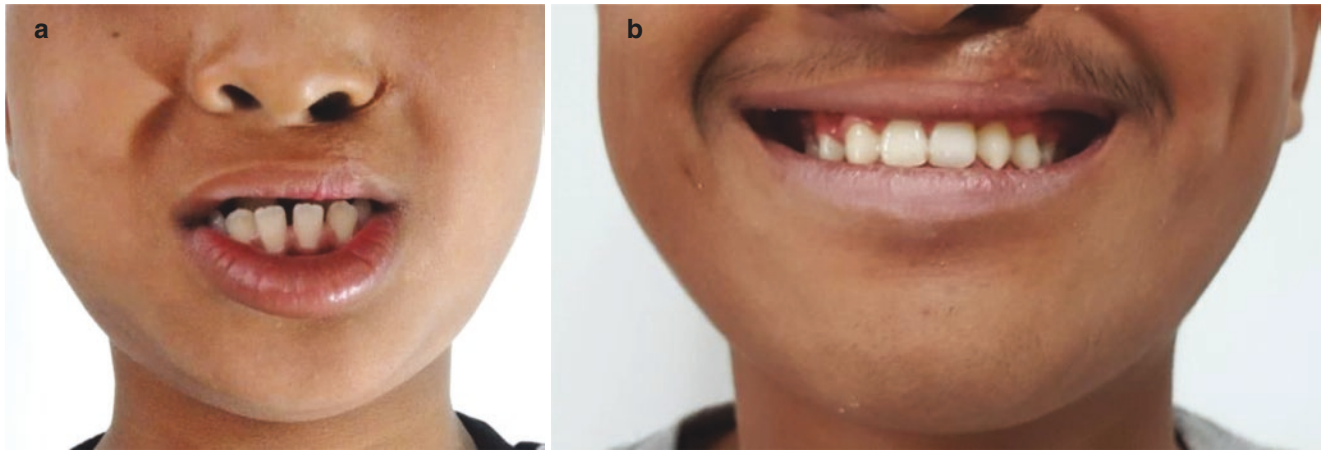


Fig. 13.74 (a and b): Closer look at his smiles before start of the treatment (a) and at recall (b)

Case #2 (Figs. 13.75, 13.76, 13.77, 13.78, 13.79, 13.80, 13.81, 13.82, 13.83, 13.84, 13.85, 13.86, 13.87, 13.88, 13.89, 13.90, 13.91, 13.92, 13.93, 13.94, 13.95, 13.96, 13.97, 13.98, 13.99, 13.100, 13.101, 13.102, 13.103, 13.104, 13.105, 13.106, 13.107, 13.108, 13.109, 13.110, 13.111, 13.112, 13.113, 13.114, 13.115, 13.116, 13.117, 13.118, 13.119, 13.120, 13.121, 13.122, 13.123, 13.124, 13.125, 13.126, 13.127, 13.128 and 13.129)



Fig. 13.75 A 10-year-old girl presented at our CLP center with unilateral cleft lip/palate; the lip was already repaired alio logo. She had concave facial profile



Fig. 13.76 At smile she showed mostly lower anterior teeth



Fig. 13.77 Intraoral picture at start of the treatment, she was in the mixed dentition. She had deep anterior crossbite. Cleft site was present

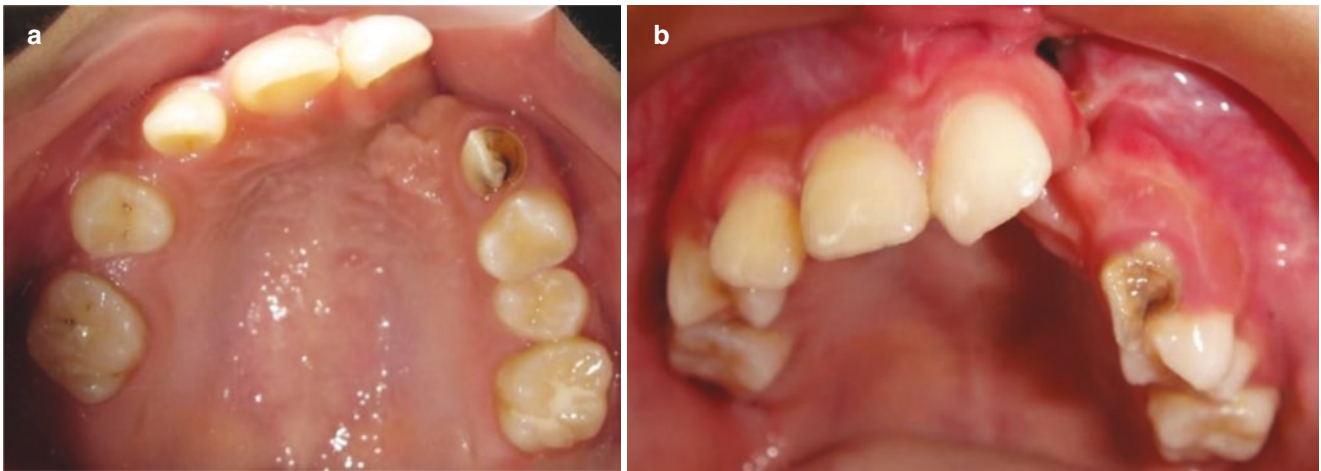


Fig. 13.78 (a and b): Upper arch at start of the treatment; early loss of some deciduous teeth, carious #63 was present. Cleft site was also present



Fig. 13.79 Lower arch at start of the treatment



Fig. 13.80 Her cephalogram at start showed anterior crossbite, protrusive lower lip



Fig. 13.81 All teeth were present. Cleft site was clearly seen



Fig. 13.83 Class III Activator was used to correct sagittal discrepancy



Fig. 13.82 Cleft site could be seen from the upper occlusal film



Fig. 13.84 Class III Activator in situ, mandible was push backward into a new position, and lower lip became less protrusive



Fig. 13.85 (a and b): Difference of smiles at start of Class III Activator treatment (a) and 1 month after (b). She smiled showed more upper teeth after 1 month of Class III Activator treatment



Fig. 13.86 At smile; 9 months after Class III Activator treatment, she showed more upper anterior teeth than at start of the treatment



Fig. 13.87 She could almost bite edge to edge; teeth #11, #12, and #21 were still retroclined



Fig. 13.88 Cleft site was clearly seen here

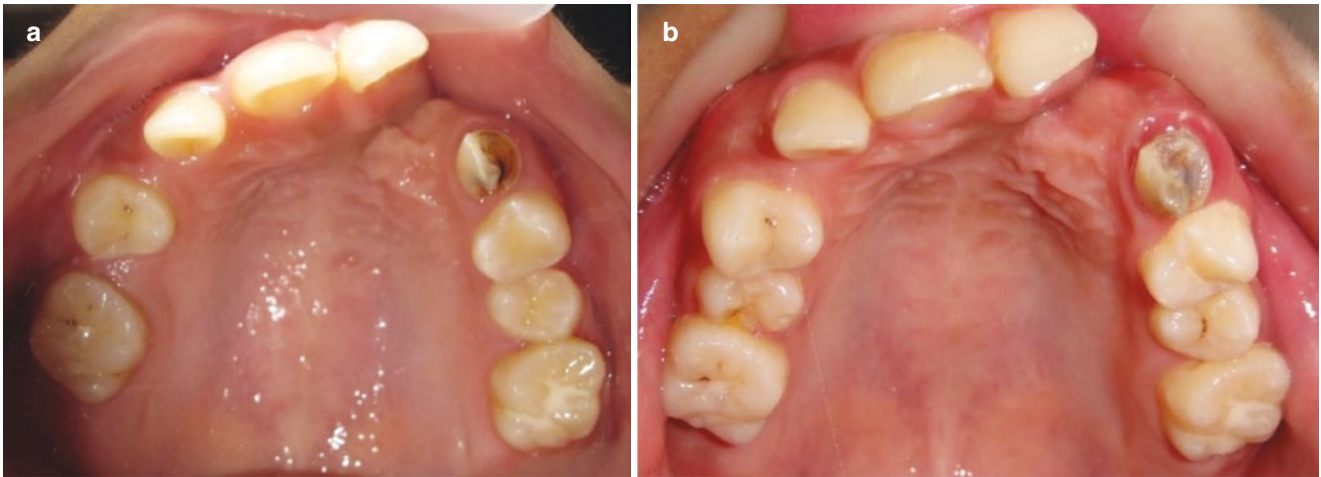


Fig. 13.89 (a and b): Comparison of the upper arch at start of the treatment (a) and 9 months after Class III Activator treatment (b)

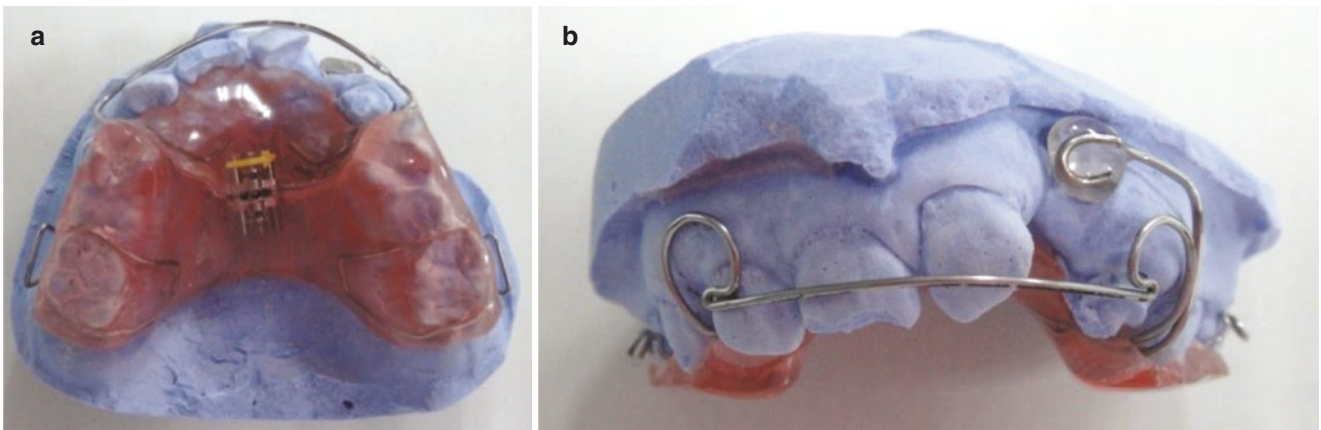


Fig. 13.90 (a and b): Upper protrusion plate with raised bite and protrusion screw was used to procline upper anterior teeth (a). Upper labial pad was added to the plate to create periosteal pull at the cleft site to stimulate bone formation (b)



Fig. 13.92 Orthopantomogram taken before alveolar bone grafting; all teeth were present including tooth #63. #22 was still located very high in the alveolar bone near cleft site

Fig. 13.91 Cephalograms taken 9 months after Class III Activator treatment

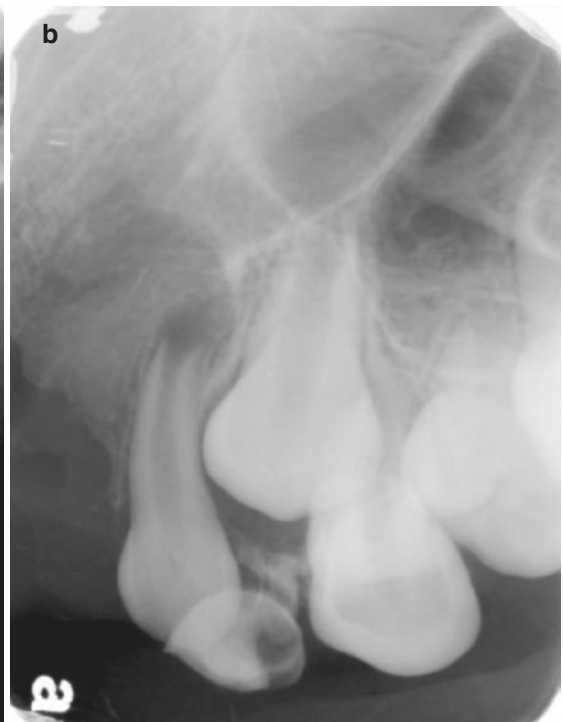


Fig. 13.93 (a and b): Cleft site, teeth #22, and #63 were present; tooth #63 was extracted during alveolar bone grafting



Fig. 13.94 Alveolar bone graft was performed in the operative theater

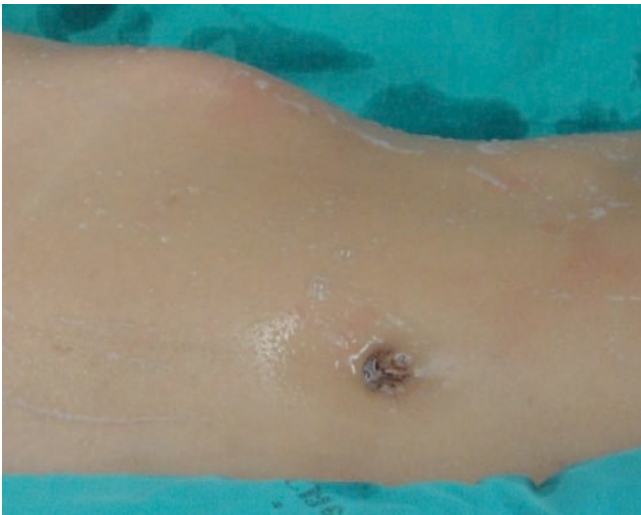


Fig. 13.95 Preparation of the donor site

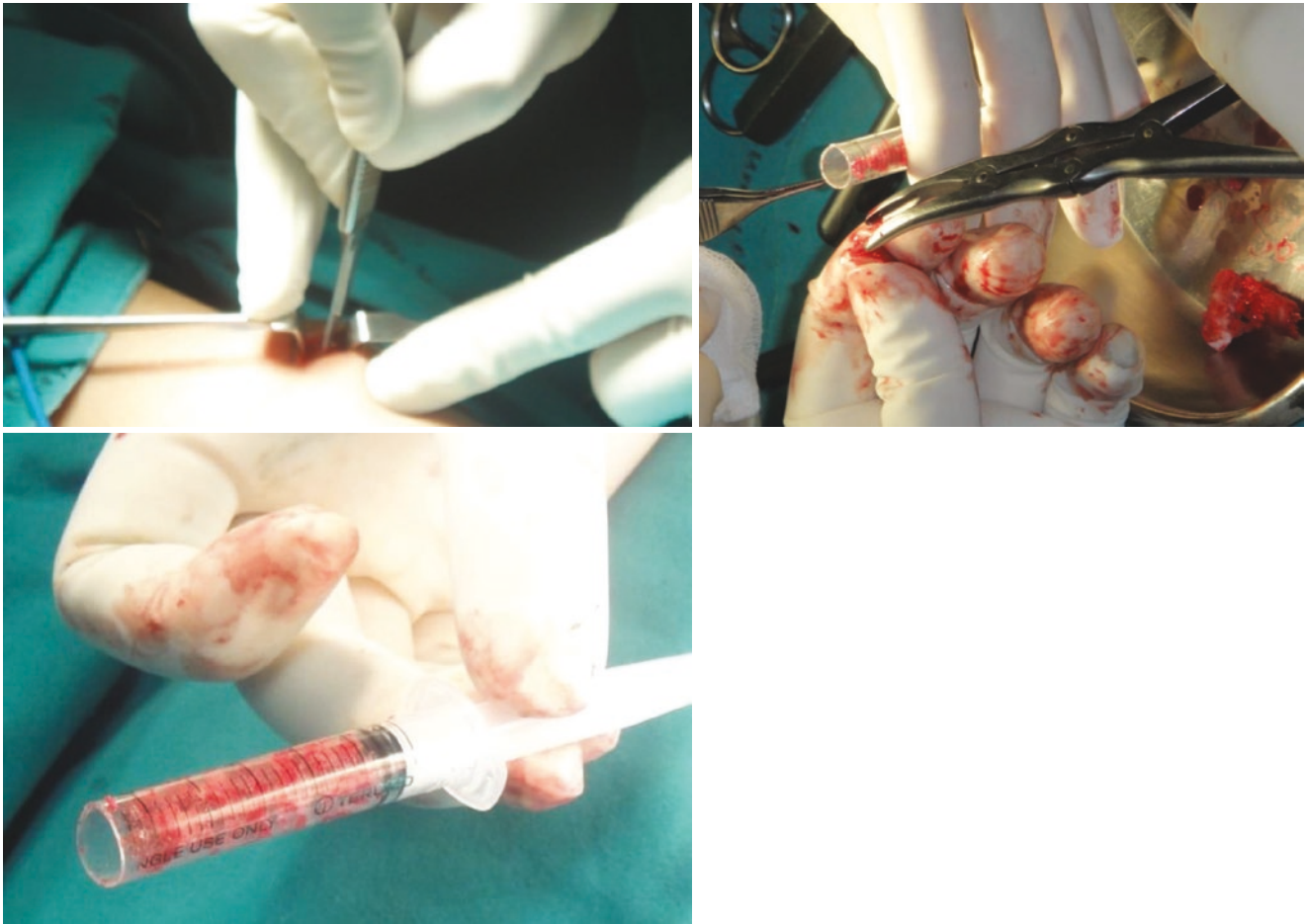


Fig. 13.96 Bone was taken from the iliac crest



Fig. 13.97 Cleft site filled with bone from the iliac crest

Fig. 13.98 Alveolar bone graft, ready for suture

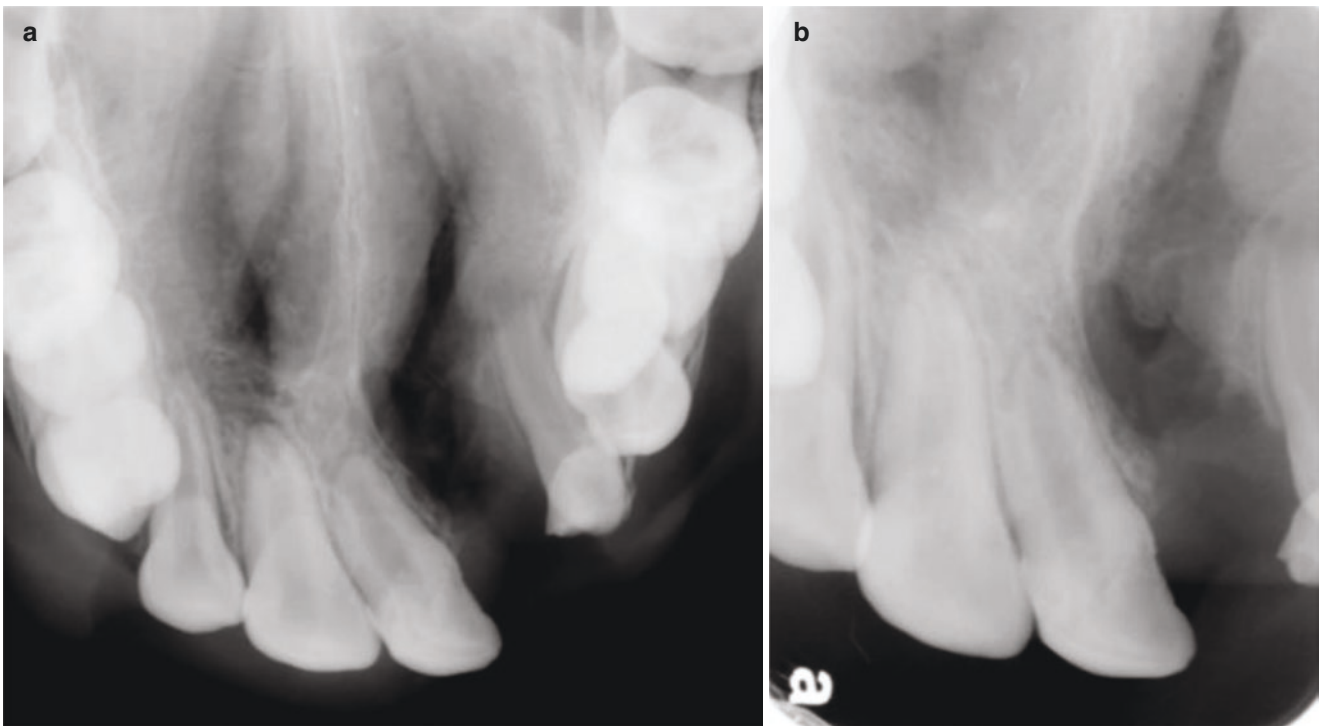


Fig. 13.99 (a and b): Comparison of cleft site before bone graft (a) and after bone graft where new bone formation could be seen (b)

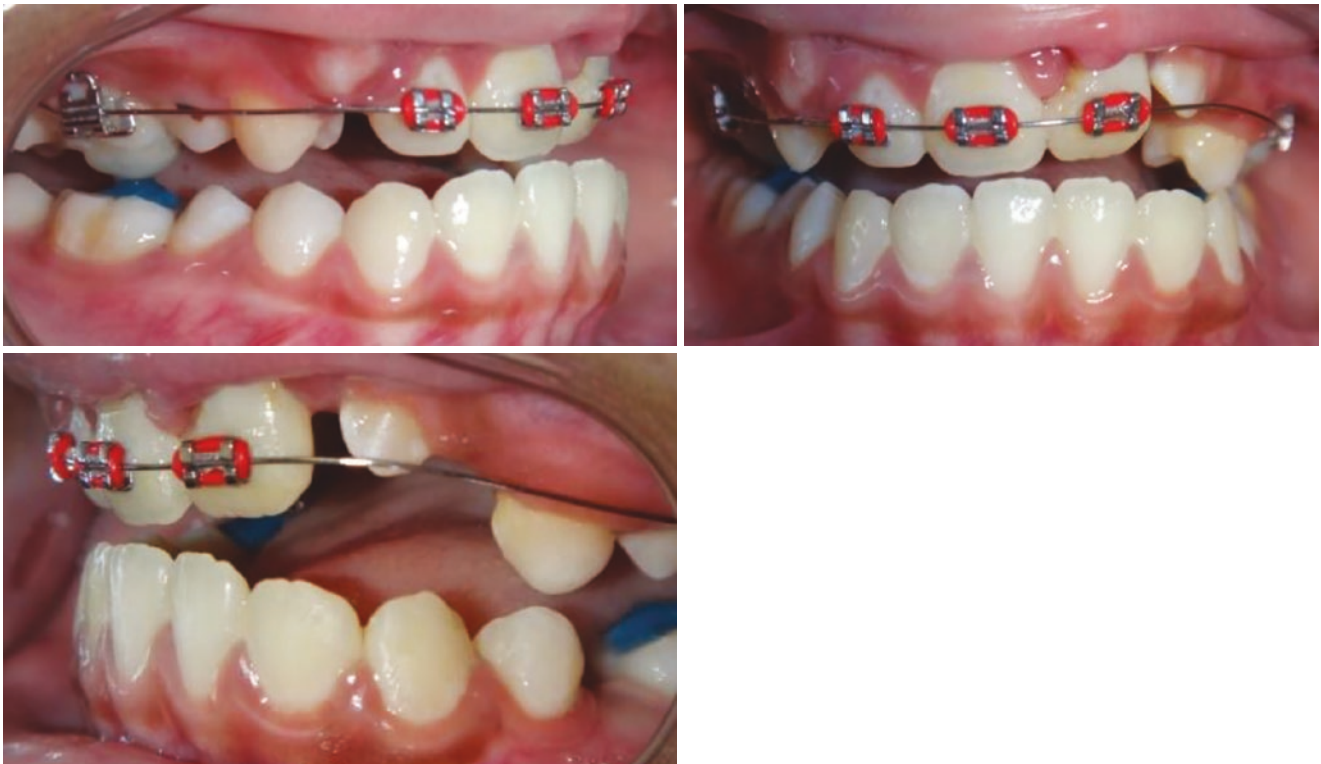


Fig. 13.100 Fixed appliance was used to align the upper teeth as well as to procline upper anterior teeth; tooth #22 erupted into cleft site



Fig. 13.101 Tooth #22 erupted into cleft site, #13 was about to erupt. All the upper premolars were present and palatally inclined



Fig. 13.102 Tooth #35 not yet erupted, raised bites on #36 and #46



Fig. 13.103 (a and b): Comparison intraoral conditions before start of the treatment (a) and 2 years and 9 month afterward (b)



Fig. 13.104 (a and b): Before the start of the treatment (a). Bite was raised in effort to gain positive overjet and positive overbite with fixed appliances during the treatment (b)

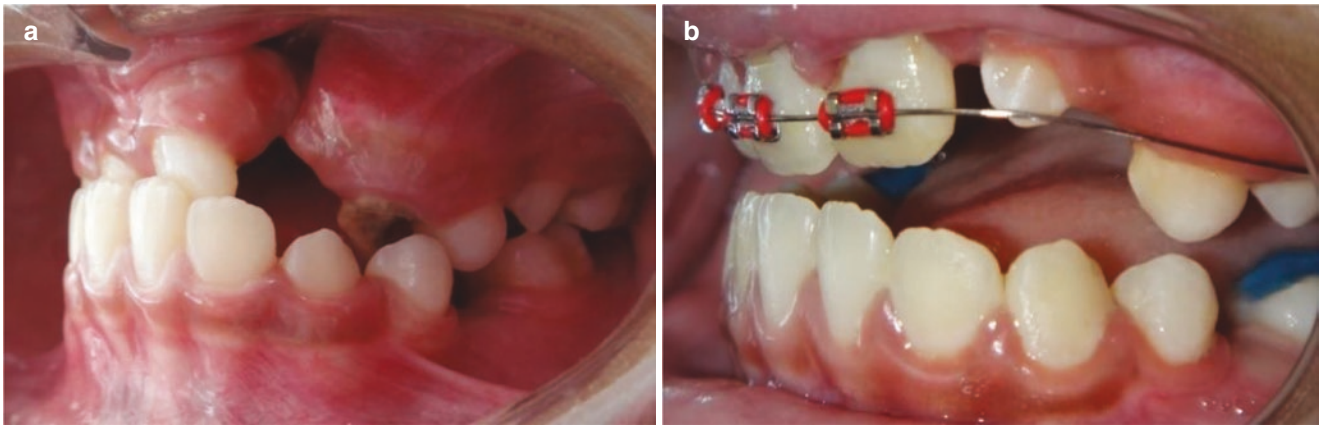


Fig. 13.105 (a and b): Cleft site was present at start of the treatment (a) and closed by alveolar bone grafting; #22 erupted gradually into the cleft site (b)

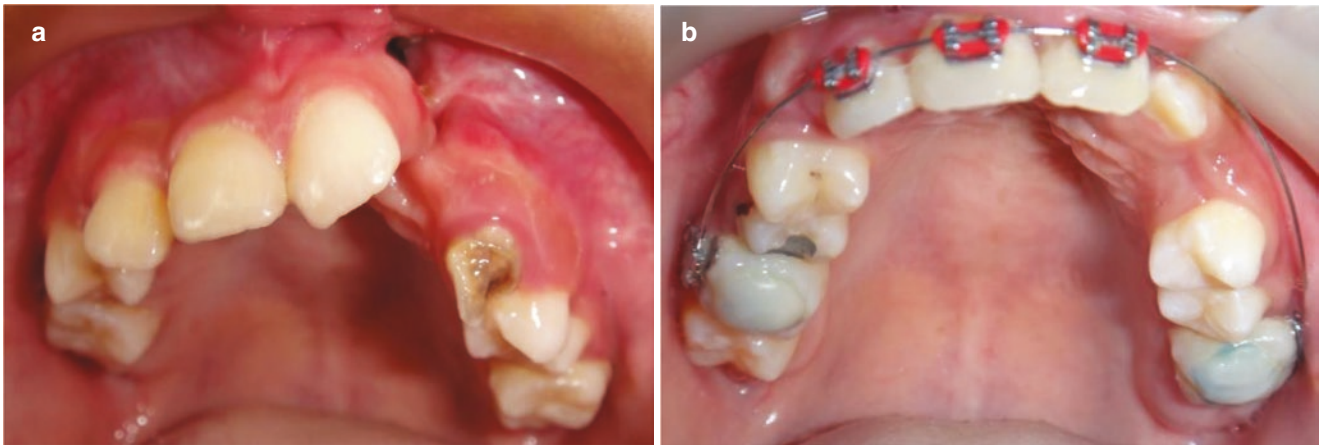


Fig. 13.106 (a and b): Cleft site was present at start of the treatment (a) and was closed during the treatment, #22 erupted into the cleft site, #13 was erupting, and upper premolar teeth almost fully erupted

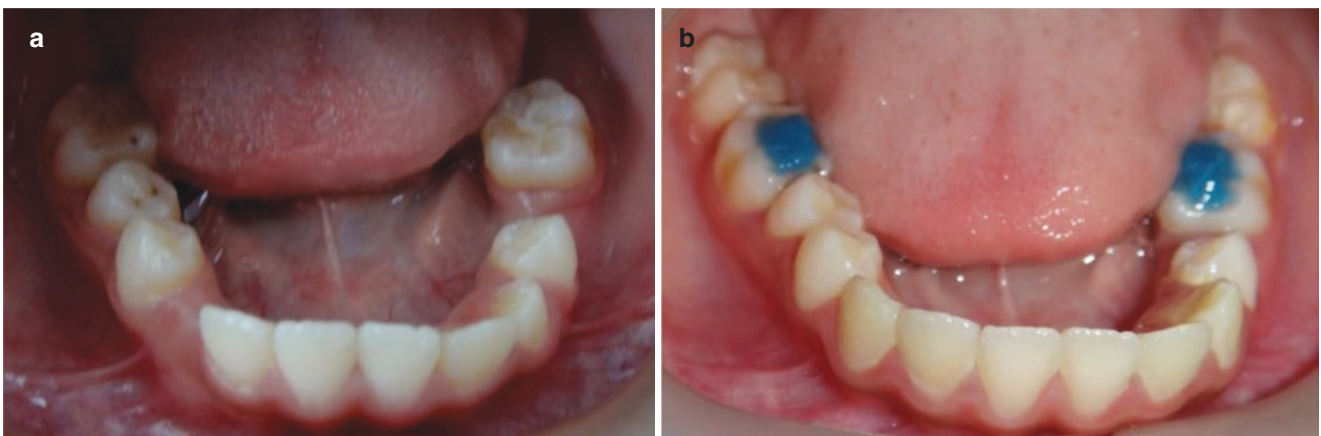


Fig. 13.107 (a and b): Comparison of lower arch at start of the treatment and 2 years and 9 months afterward



Fig. 13.108 Cephalogram at 2 years and 9 months after the treatment started

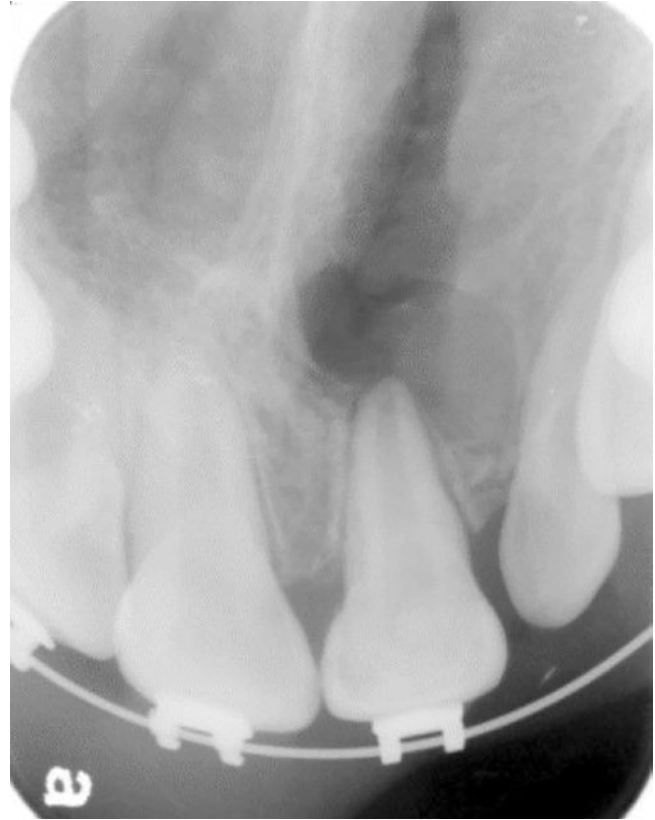


Fig. 13.110 Tooth #22 erupted into cleft site



Fig. 13.109 Orthopantomogram at 2 years and 9 months after the treatment started



Fig. 13.111 (a and b): Filler injection on the upper lip done by a dermatologist

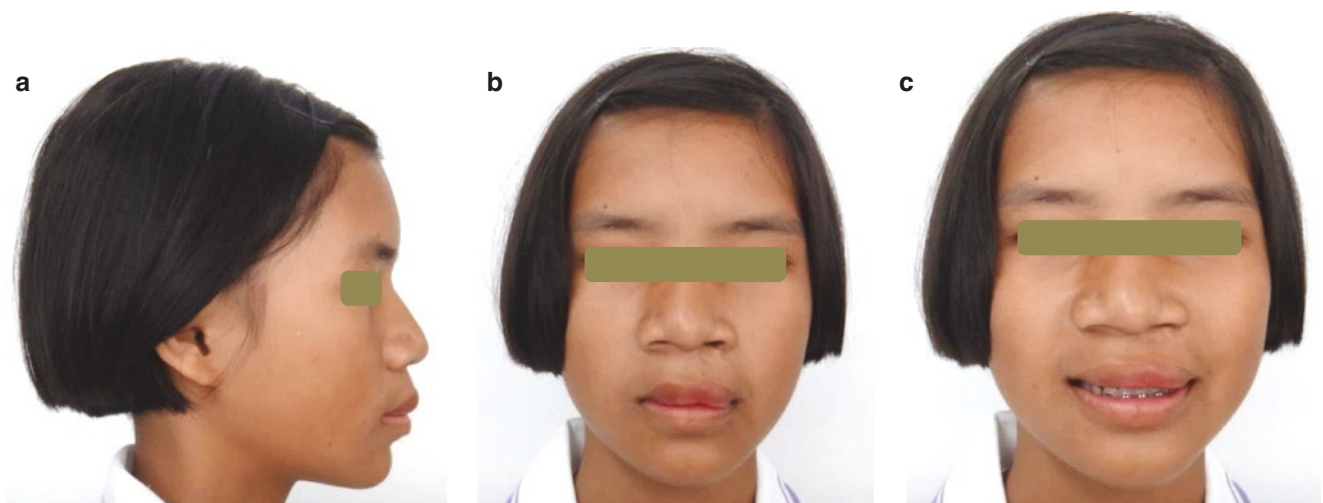


Fig. 13.112 (a, b and c): 7 months after filler injection on the upper lip; the upper lip became very thick and only lower anterior teeth could be seen at smile



Fig. 13.113 (a, b, and c): Thick upper lip as a result from filler injection

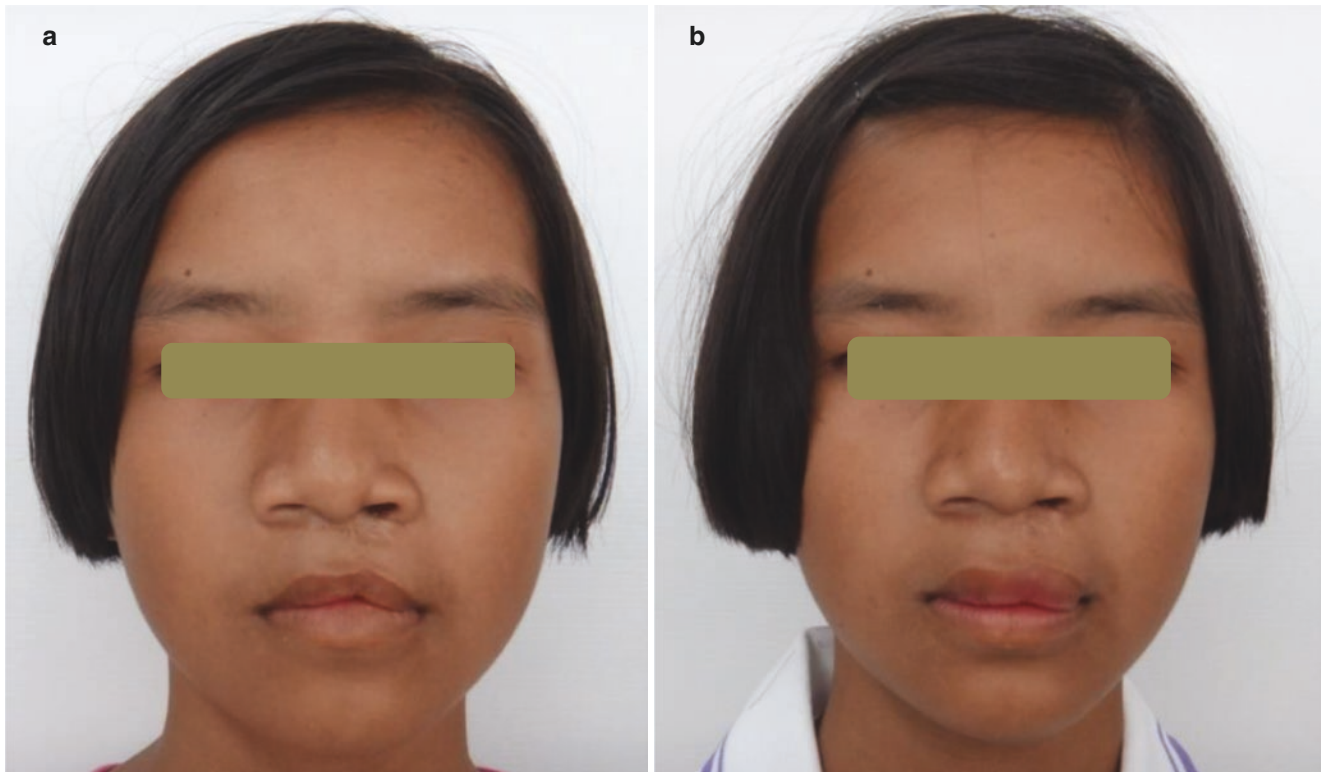


Fig. 13.114 (a and b): Changes at the ala of nose and upper lip before (a) and 7 months after the filler injection (b)



Fig. 13.115 (a and b): Change of smile before (a) and 7 months after the filler injection (b), she showed both upper and lower anterior teeth at smile before receiving the filler injection on the upper lip; later she could only show the lower anterior teeth when smiled

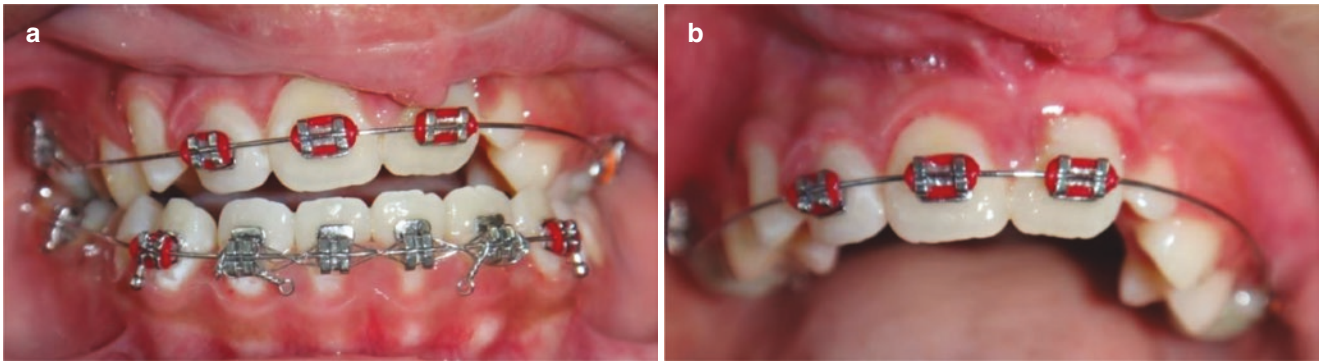


Fig. 13.116 (a and b): Tooth #22 erupted more into oral cavity, linguoversion of all upper premolar teeth

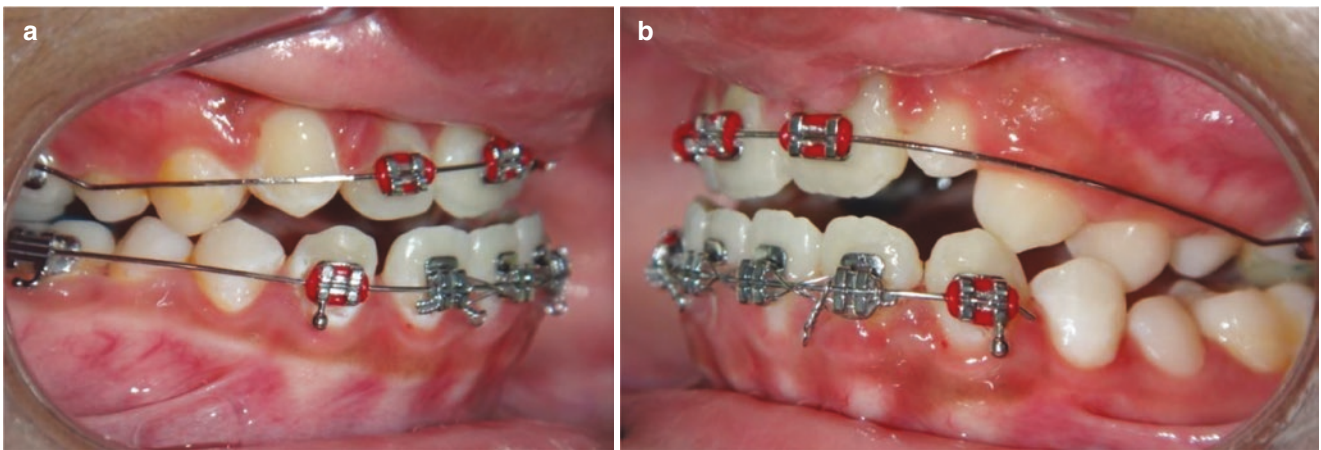


Fig. 13.117 (a and b): Tooth #22 erupted into cleft site, bilateral posterior crossbites, bite was opened due to raised bites at molars

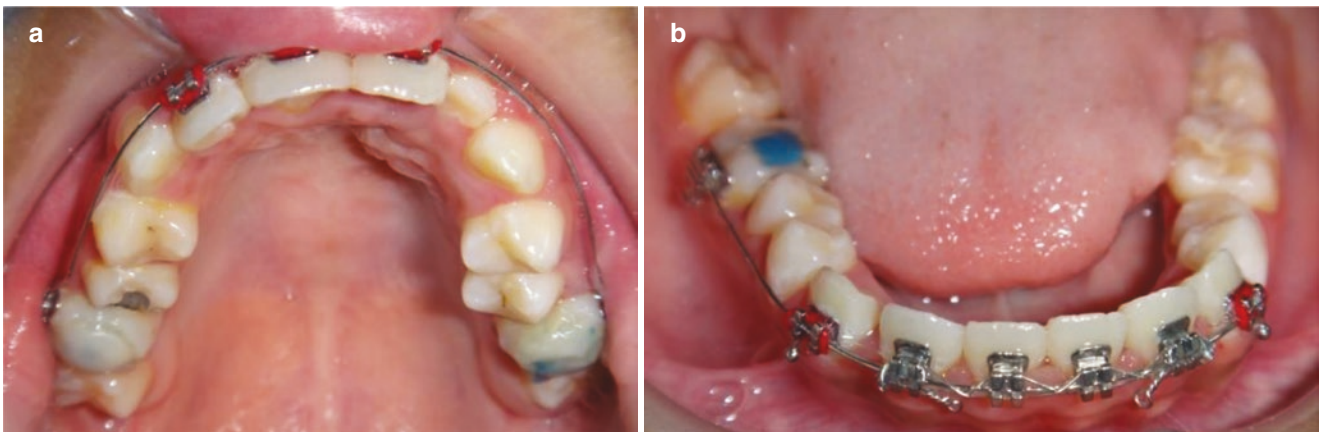


Fig. 13.118 (a and b): Tooth #22 erupted into the cleft site, linguoversion of all upper premolars, raised bite on #36 was lost

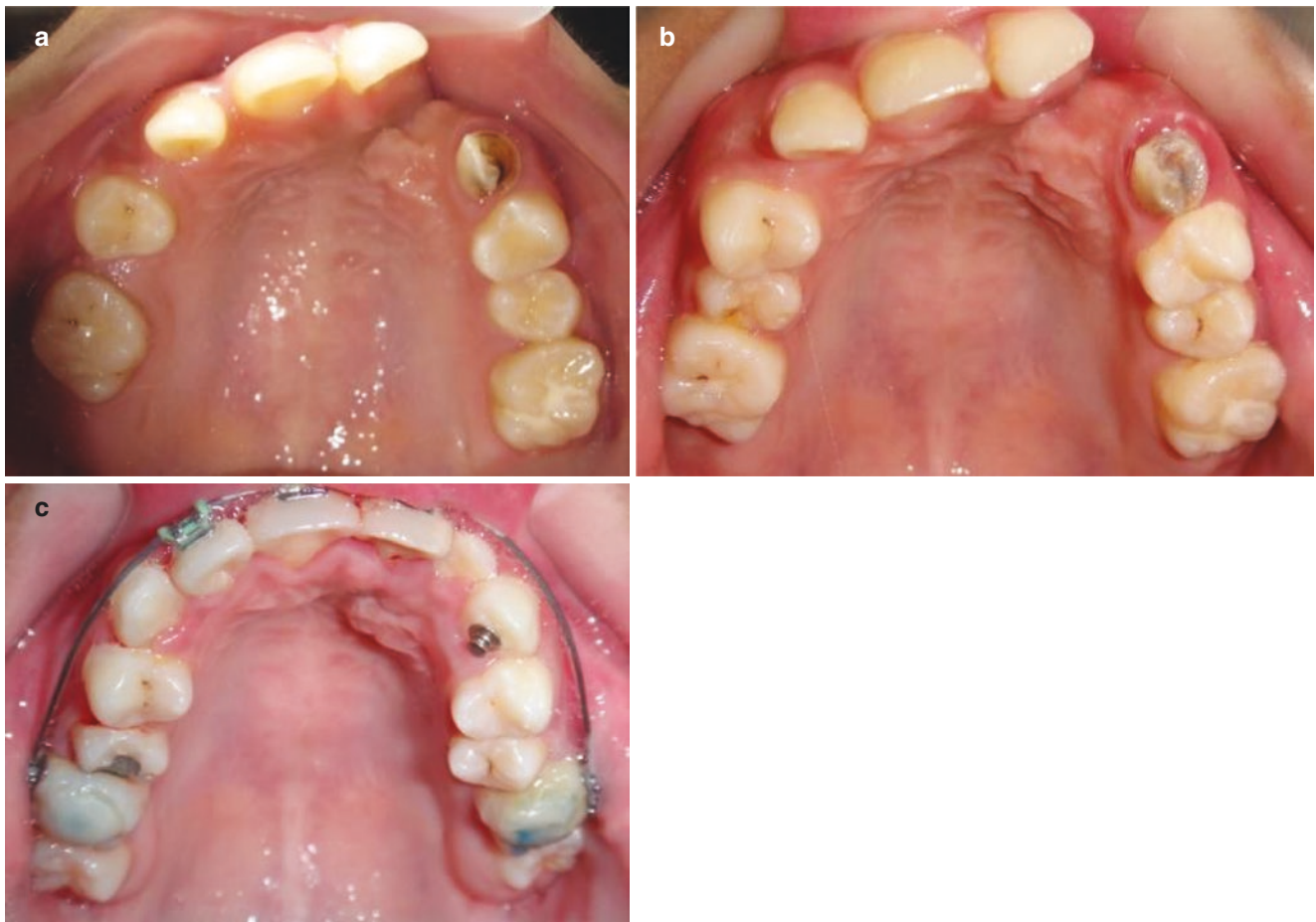


Fig. 13.119 (a, b and c): Comparison of the upper arch forms at different timelines; at start of the treatment (a), 9 months after Class III Activator treatment (b) and 2 years and 9 months after start of the treatment when alveolar bone graft was done and # 22 erupted into cleft site (c)

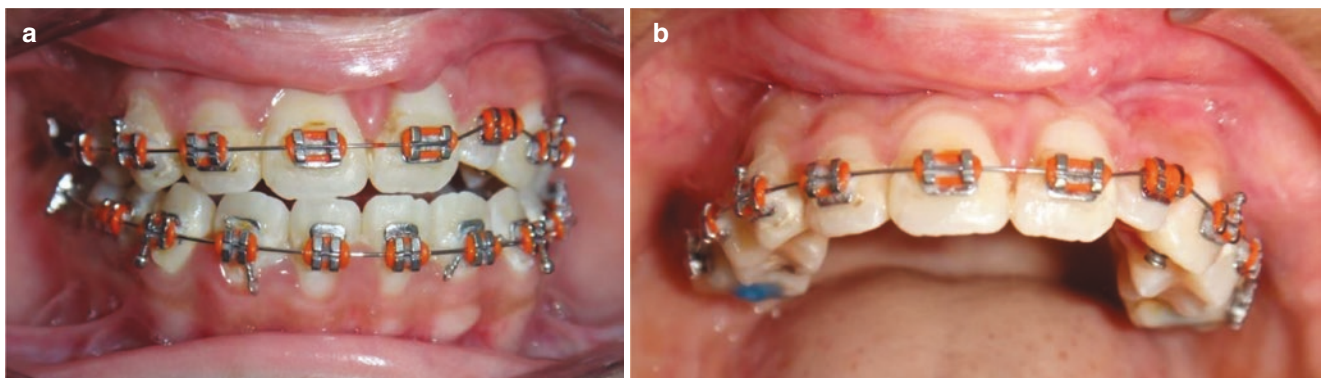


Fig. 13.120 (a and b): Engaged #22 to arch wire to bring it into occlusion

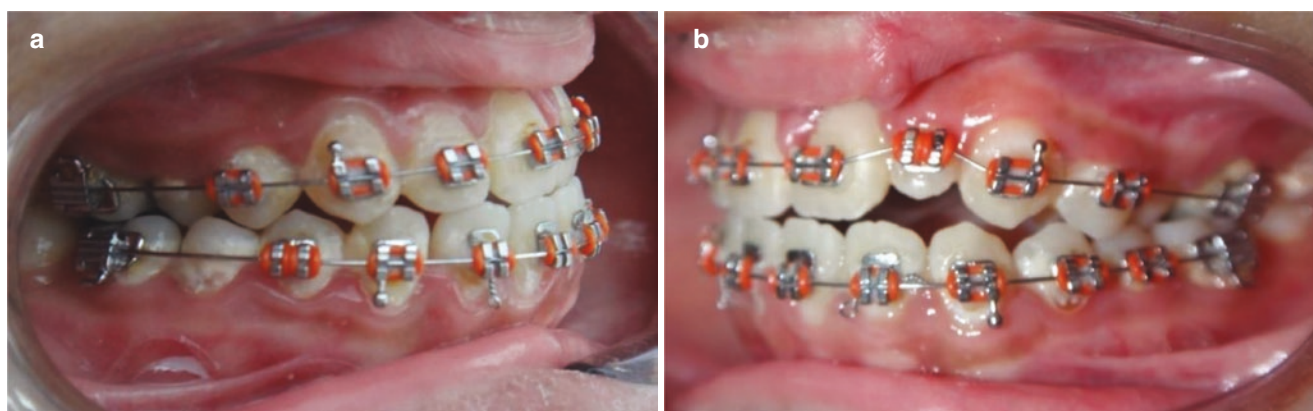


Fig. 13.121 (a and b): Tooth #22 was engaged to arch wire; posterior bilateral crossbites were still present

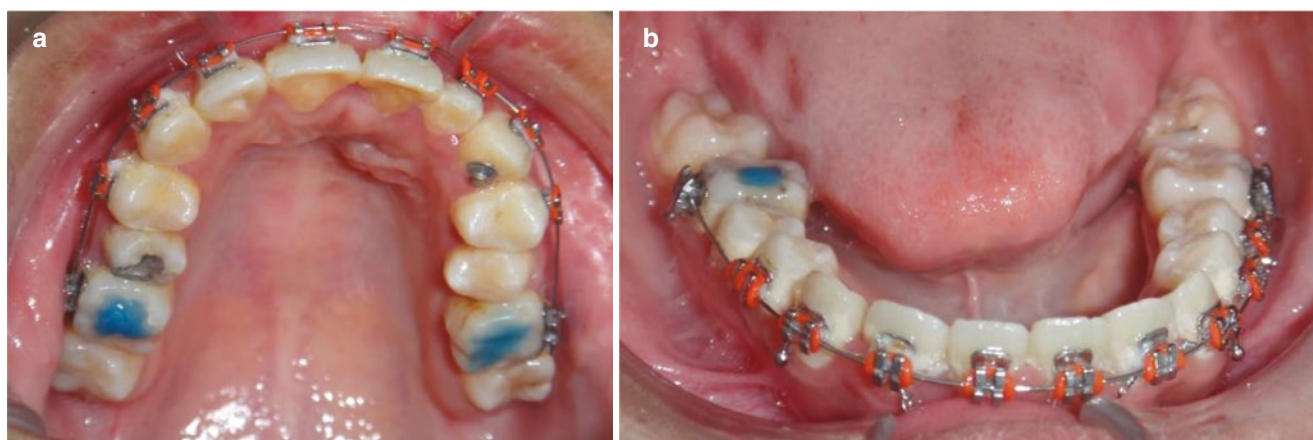


Fig. 13.122 (a and b): Teeth #15 and #25 were not bonded yet; raised bite on #36 was lost due to occlusal force from mastication



Fig. 13.123 Extraoral pictures of the patient at rest and at smile at the end of dentofacial orthopedic and orthodontic treatment; she was 16 years old. The treatment time was 6 years



Fig. 13.123 (continued)



Fig. 13.124 Intraoral pictures at the end of dentofacial orthopedic and orthodontic treatment, acceptable treatment results

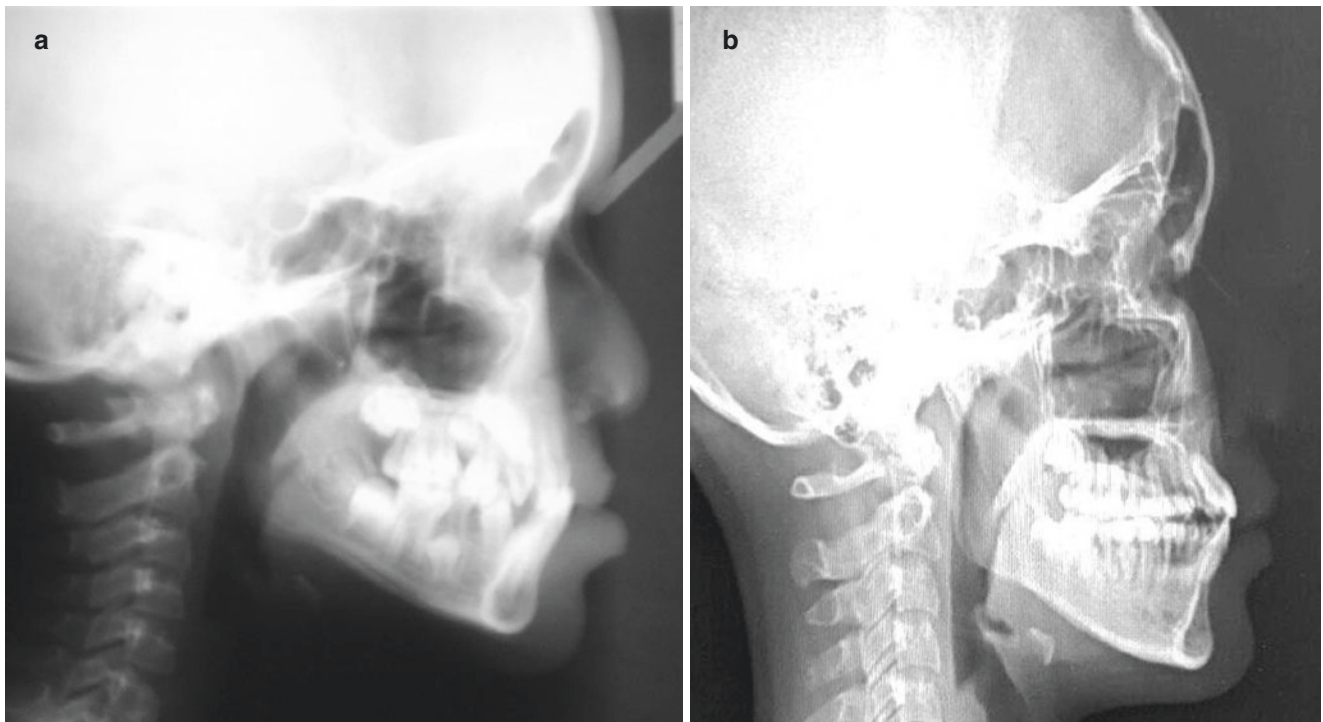


Fig. 13.125 (a and b): Comparison of cephalograms at start of the treatment (a) and at the end of the treatment (b)

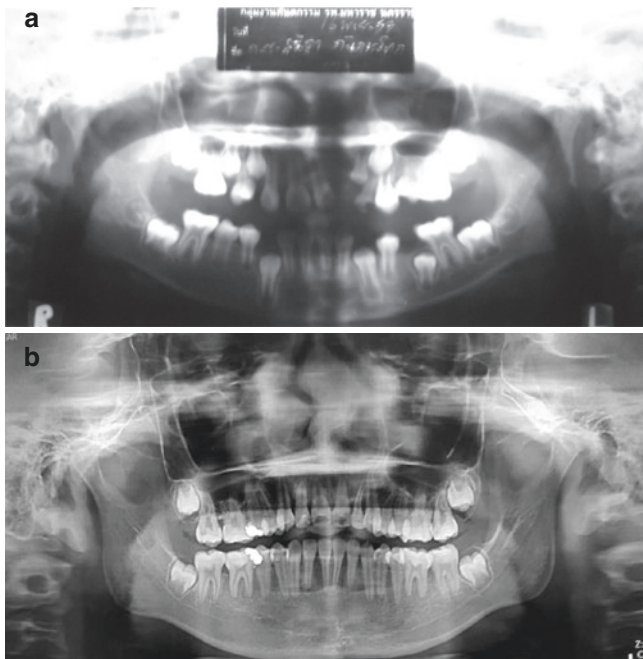


Fig. 13.126 (a and b): Comparison of orthopantomograms of the patient at start (a) and at the end of the treatment (b)



Fig. 13.127 (a, b and c): Comparison of upper lip at rest and ala of nose at start (a), at the end of the treatment (b) and after the upper lip surgery (c)

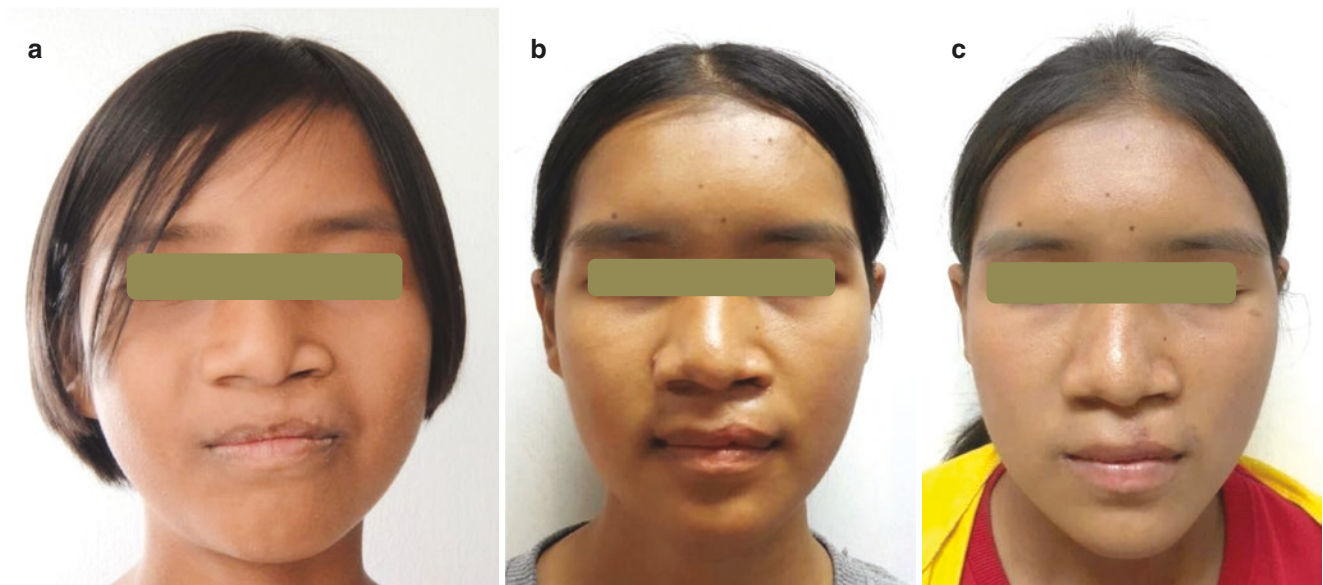


Fig. 13.128 (a, b and c): Straight facial profiles at start (a), at the end of the treatment (b) and after the upper lip surgery (c); note esthetic improvement at the upper lip and ala of nose



Fig. 13.129 (a, b, and c): At smile; at start of the treatment (a), at the end of the treatment (b) and after surgery on the upper lip (c)

13.2 Conclusion

Cleft lip/cleft palate (CLP) cases are caused by multifactorial factors. All cases are unique; the problems are both skeletal and dental and in three dimensions. Therefore, the treatment is more complicated than in the non-CLP cases. An interdisciplinary team composes of gynecologist, pediatrician, nurse, dentist, orthodontist, oral-maxillofacial surgeon, plastic surgeon, ENT doctor, audiologist, otolaryngologist, speech therapist, psychiatrist, social worker, and patient's family, play important role in giving CLP care and treatment. Clinical Practice Guidelines (CPG) will indicate how the team works.

Orthodontists can start dentofacial orthopedic and orthodontic treatment in CLP patients during active growth period. To treat early and if successfully will be advantageous as major surgeries such as orthognathic surgery and distraction osteogenesis can likely be avoided. These major surgeries certainly cause much pain to the patients and cost a lot of money. The author suggests the use of Class III Activator of Thomas Rakosi in the initial stage of the treatment in combination with the use of removable and/or fixed appliances in later stage.

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Olga Ramos

14.1 Introduction

Diabetes mellitus (DM) is a group of metabolic diseases characterized by hyperglycemia, resulting from defects in insulin secretion, insulin action in tissues, or both. Diabetes mellitus (DM) is the most common endocrine disease and one of the most common chronic conditions in children. Diabetes mellitus is classified into type 1 diabetes mellitus (T1DM), type 2 diabetes mellitus (T2DM), other types of DM, and gestational diabetes. T1DM is the most common form of DM in children and adolescents and the presentation age start from the first year of life that increases during puberty.

T1DM is an autoimmune illness, characterized by multiple autoimmune markers even in the preclinical period, with partial or total destruction of the pancreatic islet B-cell and deficiency in insulin secretion. Consistently, genetic markers (HLA) are present, increasing or decreasing the risk of patients and their families. Potential triggers are environmental factors such as congenital rubella, enteroviral infections, casein, and cereals. Insulin is the treatment of choice to be given immediately upon diagnosis (American Diabetes Association 2018).

T2DM is an emerging disorder in children and adolescents, leaving large gaps in knowledge on the pathophysiology and treatment optimization. Patients with T2DM have insulin resistance and non-autoimmune B-cell failure. Familial T2DM, obesity, and physical inactivity are the principal risk factors.

There are other multiple types of DM: neonatal DM, endocrine and genetic illnesses, etc.

Gestational DM, is characterized by the appearance of hyperglycemia during pregnancy and should be treated immediately (Mayer-Davis et al. 2018).

14.2 Type 1 Diabetes: Diagnostics

Type 1 diabetes is characterized by the chronic immune-mediated destruction of pancreatic B-cells, leading to partial or absolute insulin deficiency. This destruction occurs at a variable rate and becomes clinically symptomatic when approximately 90% of pancreatic B-cells are destroyed. The illness progresses through three stages at variable rates:

- Stage 1: autoimmunity with normoglycemia and without clinical symptoms.
- Stage 2: dysglycemia, but asymptomatic.
- Stage 3: the symptomatic phase of the disease (Insel et al. 2015).

Type 1 diabetes mellitus in young people is usually shows characterized by polyuria, polydipsia, nocturia, enuresis, weight loss with polyphagia, and blurred vision. A plasma blood glucose level (BGL) measurement on laboratory glucose oxidase estimation is required to confirm the diagnosis, rather than a capillary blood glucose monitor. In the absence of unequivocal hyperglycemia, diagnosis must be confirmed by repeat testing with an oral glucose tolerance test (OGTT) and the diabetes-associated autoantibodies glutamic acid decarboxylase 65 (GAD), tyrosine phosphatase-like insulinoma antigen 2 (IA2), insulin autoantibodies (IAA), and

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B-cell-specific zinc transporter 8 (ZnT8). The presence of one or more of these antibodies confirms the diagnosis of type 1 diabetes (Watkins et al. 2014). In its more severe form, ketoacidosis may develop and lead to stupor, coma, and, in the absence of treatment, death.

14.3 Criteria for the Diagnosis of Diabetes Mellitus

14.3.1 Glycemic Diagnostic Values (OGTT)

	Fasting blood glucose level (BGL)	2 h postload glucose level	Glycated hemoglobin (HbA1c) level
Normal	≤100 mg/dL	<140 mg/dL	<5.6%
Prediabetes IFG and/or IGT	>100 to <126 mg/dL	>140 to <200 mg/dL	5.7% to 6.4%
Diabetes mellitus	≥126 mg/dL	≥200 mg/dL + Polyuria, polydipsia, weight loss	HbA1c ≥6.5% ≥200 mg/dL casual

Information source: Diabetes Care, 2018 (American Diabetes Association 2018)

IFG: impaired fasting glucose

IGT: impaired glucose tolerance

OGTT test: The test should be performed using a glucose load containing the equivalent of 1.75 g/kg of body weight to a maximum of 75 g

14.3.2 Impaired Glucose Tolerance (IGT) and Impaired Fasting Glucose (IFG) Levels (American Diabetes Association 2018)

Impaired glucose tolerance and impaired fasting glucose levels are intermediate stages in the natural history between normal glucose homeostasis and diabetes. Patients with IFG levels and/or IGT are referred to as having “prediabetes,” indicating their relatively high risk for the development of diabetes:

- FPG <100 mg/dL: normal fasting glucose.
- FPG >100 mg/dL to 125 mg/dL: IFG.
- FPG >126 mg/dL (provisional diagnosis of diabetes).
- 2-hour post-load plasma glucose level: 140 mg/dL, normal glucose tolerance.
- 2-hour post-load plasma glucose level: 140–200 mg/dL, IGT.
- 2-hour post-load plasma glucose level: >200 mg/dL, diabetes.

14.3.3 Epidemiology of Type 1 Diabetes

Overall, approximately 96,000 children under 15 years of age are estimated to develop type 1 diabetes annually worldwide.

The incidence varies between different countries, within countries, and between ethnic populations with the highest incidence rates observed in Finland (50/100,000), Europe (10–20/100,000), Northern Europe (30/100,000), and Canada (45/100,000). In Asia, the incidence is very low in Japan (2/100,000) and China (1/100,000) (Harjutsalo et al. 2013; Karvonen et al. 2000).

14.4 Treatment of Children and Adolescents with Diabetes

14.4.1 Treatment Consists of Insulin, Nutrition, Education, Exercise, and Psychosocial Support

14.4.1.1 Insulin

Children and adolescents with type 1 diabetes are dependent on insulin for survival and should have access to adequate amounts of at least regular insulin (short acting) and NPH insulin (intermediate-acting insulin).

Human insulins. Currently, children are administered human insulins instead of porcine or bovine insulin due to their low immunogenicity.

Regular insulin (short acting). Usually identical to human insulin, it is still used as premeal bolus injections, given 20–30 min before meals together with intermediate-acting insulin NPH, twice daily (Danne et al. 2002).

14.4.1.2 Insulin Analog: Basal Insulin and Rapid Acting Insulin

Basal insulin analogs include glargine and detemir. They have a more predictable effect compared to that of NPH, with less variations in its effect, but they are more expensive (50% to 100%). In general, it is possible to use them once or twice daily.

Rapid-acting insulin analogs include aspartic, glulisine, and lispro. They have a rapid and shorter duration of action than that of regular insulin.

They can be used immediately before or after meals, and nocturnal hypoglycemia may also be reduced due to its short duration of action.

Regular and rapid-acting insulins can be given subcutaneously or intravenously, but NPH and basal analogs should only be administered subcutaneously.

Injection Site. The usual sites of injection are the lateral aspect of the arm, buttocks, lateral thigh, and abdomen. The abdomen has faster absorption, but lipohypertrophy (accumulation of fat) is very frequent.

Storage of Insulin. Unused insulin should be stored in a refrigerator (4–8 °C) and never be frozen or receive direct sunlight or warming.

Devices for Insulin Administration. Disposable insulin syringes and pen injectors containing insulin in prefilled cartridges, in small size (5–6 mm), are available.

Continuous subcutaneous insulin infusion is possible with the use of external pumps (DCCT 1994). This method permits a more physiological insulin replacement therapy. Motivation appears to be the most important factor for the success of this form of therapy (Danne et al. 2018).

Daily insulin dosage depends on several factors: age, weight, puberty, monitoring of blood glucose and glycated hemoglobin levels, nutritional intake and distribution, exercise, intercurrent illness, etc.

Initially, the total daily insulin dose is often <0.5 IU/kg/day, prepubertal children require 0.6–1 IU/kg/day, and during puberty, requirements are above 1–2 IU/kg/day. The “best” dose of insulin is that which achieves the best glycemic control (70–180 mg/dL) without hypoglycemia and good growth, weight, and height according to the children’s chart.

There are different regimens of distributing the insulin dose in relation to the type of insulin, lifestyle (diet, exercise, school, work, commitments, etc.), and residual insulin secretion.

The most frequently used regimens are as follows: one or two injections of human insulin such as intermediate-action NPH or long-acting insulin analogue, glargine or detemir, and human regular or analogue rapid-acting insulin, such as lispro and aspartic, before each main meal (breakfast, lunch, and main evening meal).

Insulin adjustments should be made until target blood glucose (BG) and HbA1c levels are achieved (Neu et al. 2015).

Hypoglycemia should be avoided in children <6 years old, which could induce severe cognitive impairment. Children with persistently poor glycemic control (HbA1c >9%) should be assessed by a specialized pediatric diabetes team aimed at improving glycemic control should be consider to enhance chronically poor metabolic control and prevent acute and chronic complications. (Canadian Diabetes Association Clinical Practice Guidelines Expert Committee) (Delahanty and Halford 1993).

14.4.1.3 Nutrition

Nutritional management is one of the cornerstones of diabetes care and education. Children with type 1 diabetes should follow a healthy diet; this involves consuming a variety of

foods from the four food groups (grain products, vegetables, fruits, milk and alternatives, and meat and alternatives). Appropriate matching of insulin to carbohydrate content may allow increased flexibility and improved glycemic control (Cameron et al. 2013).

Nutrition therapy should be individualized based on the child’s nutritional needs, eating habits, and lifestyle and must ensure normal growth and development without compromising glycemic control.

Features suggestive of eating disorders and celiac disease should be systematically studied.

Evidence suggests that it is possible to improve diabetes outcomes through attention to nutritional management and an individualized approach to education (Martin et al. 2012).

14.4.1.4 Education

Children with new-onset type 1 diabetes and their families require education regarding diabetes. Education must include insulin action and administration, blood glucose and ketone testing, dosage adjustment, prevention of diabetic ketoacidosis, and preventive treatment of hypoglycemia, nutrition therapy, and exercise.

Health care providers should initiate conversations with children and their families about school, career choices, psychological issues, etc.

Interdisciplinary teams providing education should include, as a minimum, a pediatric endocrinologist/diabetologist, diabetes specialist nurse, a dietician, and a psychologist (Komatsu et al. 2005).

14.4.1.5 Exercise

Physical activity is an essential component of treatment. Playing games and sports offer psychological benefits for all age groups with type 1 diabetes. Unfortunately, exercise can increase the risk of hypoglycemia. The management of hypoglycemia during and after doing exercise adds to the complexity of the treatment (Braatvedt et al. 1997).

The goal of hypoglycemia treatment is to prevent it, reducing the doses of insulin or consuming more carbohydrates. In mild or moderate hypoglycemia, some juice or liquid with sugar is enough to restore the blood glucose level to 100 mg/dL.

Diabetes should not limit the patient’s ability to excel in a chosen sport. Many famous athletes have proved this. Camps for children with diabetes that include counseling on nutrition and insulin adjustment for exercise can result in improved glycemic control (Hilliard et al. 2013).

14.4.1.6 Psychosocial Support

Psychosocial support must be provided at diagnosis and regularly thereafter. The treatment will only be effective if the

family and patient are able to implement it. For the impact of psychosocial factors on the treatment plan, it is necessary to work with the individual and family to overcome barriers or redefine goals as appropriate, especially as the youth grows, develops, and acquires the need for greater independent self-care (Reynolds and Helgeson 2011).

Young people with DM appear to have a greater incidence of depression, anxiety, psychological distress, and eating disorders compared to their healthy peers (Young et al. 2013; Winkley et al. 2006).

Mental health professionals should be available not only to interact with patients and families at clinic visits to conduct screening and more complete assessment of psychosocial functioning, but also to support the diabetes team in the recognition and management of mental health and behavior problems (Cryer 2008).

14.5 Complications

14.5.1 Acute Complications

14.5.1.1 Hypoglycemia

Hypoglycemia is the most common acute complication of type 1 diabetes. Its risk presents a major physiological and psychological barrier to achieving optimal glycemic control (Rewers et al. 2014). A blood glucose of 65 mg/dL has been accepted as a level for defining hypoglycemia; however, 70 mg/dL is used as the threshold value for initiating treatment because of the potential for glucose to fall further (Jones 2018).

Hypoglycemia is classified as symptomatic and asymptomatic, mild, moderate, or severe. The symptoms result from adrenergic activation (shakiness, pounding heart, and sweatiness) and neuroglycopenia (headache, drowsiness, and difficulty concentrating), and behavioral changes (irritability, agitation, quietness, and tantrums). In children, severe hypoglycemia is most often defined as an event associated with a seizure or loss of consciousness (Karges et al. 2017). Common clinical precipitants for hypoglycemia are excessive insulin doses, missed meals, exercise in adolescents, and alcohol ingestion. Risk factors include young age, previous severe hypoglycemic events, and hypoglycemic awareness. A lower HbA1c level is a risk factor, but now is less common with contemporary therapy (Clarke et al. 2008). Severe hypoglycemia requires urgent treatment in a hospital with intravenous glucose administration (10% glucose, 2–3 mL/kg). At home, IM or SC glucagon injection should be given (<12 years old, 0.5 mg; >12 years old, 1 mg). If the blood glucose level is nearly 70 mg/dL, glucose control can be accomplished by giving glucose tablets or sweetened fluids. In 10 or 15 min, the blood glucose level should be retested

and the treatment repeated if there is no response. Milder hypoglycemia should be treated with oral glucose (10–15 g) or 100 mL of sweet drink or juice, followed by additional carbohydrates (bread, cookies) (Willi et al. 2003). New technologies including continuous glucose monitoring (CGM) and pump therapies offer the potential to reduce the impact of hypoglycemia (Bui et al. 2010).

14.5.1.2 Ketoacidosis (DKA)

Diabetic ketoacidosis (DKA) is the leading cause of morbidity and mortality in children with type 1 diabetes mellitus (T1DM). Among the different types of diabetes, the prevalence of type 1 diabetes in youth did not significantly change over time (30.2%). The overall prevalence was highest in the 0- to 4-year age group and lowest in the 15- to 19-year age group. The high prevalence at diagnosis in many countries indicate a need for increased awareness of the signs and symptoms of type 1 diabetes and better access to health care (Neu et al. 2009).

Mortality is predominantly related to the occurrence of cerebral edema; only a minority of deaths in DKA is attributed to other causes. Cerebral edema occurs in 0.3% to 1% of all episodes of DKA, and its etiology, pathophysiology, and ideal method of treatment are poorly understood.

Definition

Diabetic ketoacidosis (DKA) is a metabolic derangement characterized by the triad hyperglycemia, acidosis, and ketosis that occurs in the presence of very low levels of effective insulin action, together with elevations in counterregulatory hormones including glucagon, catecholamine, cortisol, and growth hormone (Roche et al. 2005). This leads to increased glucose production by the liver and kidney and impaired peripheral glucose utilization resulting in hyperglycemia and hyperosmolarity. The increased lipolysis, with ketone body production, causes ketonemia, metabolic acidosis, and loss of electrolytes and water that can lead to dehydration, shock, and death.

Diagnosis

Early recognition of the classical triage of polydipsia, polyuria, and polyphagia with weight loss is essential; vomiting, pain in the stomach, and rapid breathing (Kussmaul), together with compromised circulation and decreased level of consciousness, are early signs. The biochemical criteria for the diagnosis of DKA include hyperglycemia >200 mg/dL, with bicarbonate level < 15 mmol/L, and/or pH <7.30 (venous). DKA is generally categorized by the severity of the acidosis, varying from mild pH <7.30 and bicarbonate level 15 mmol/L to moderate pH <7.2 and then severe pH <7.1 and bicarbonate level < 5 mmol/L, associated with glycosuria, ketonuria, and ketonemia (Savage et al. 2011).

Treatment

In general, it is necessary to use 0.9% saline during the first 2 h but at different infusion rates, from 10 mL/kg/L to 20 mL/kg/h. After the first 2 h, the amount of fluids to be infused should not exceed 3 L/m²/day. The fluid infused is saline, either 0.9% or 0.45%, and 5%–10% glucose solution, corresponding to the glycemic value. Potassium supplementation is performed at different rates at 20–40 mEq/L. Bicarbonate is exceptionally used according to the pH DKA severity (Metzger 2010).

Regular or rapid-acting insulin analogue is infused using an automated syringe injected directly in the fluid solution starting from the second to third hour, mostly according to the DKA severity. The insulin infusion rate is 0.05–0.1 U/kg/h to rate DKA severity and to evaluate DKA management follow-up needs. The administration of insulin could also be done subcutaneously (Control and Complications Trial Research Group 1994).

14.6 Microvascular and Macrovascular Complications

Childhood and adolescence are periods during which intensive education and treatment may prevent or delay the onset and progression of complications in later adult life (Mogensen et al. 1995). Clinically evident diabetes-related vascular complications are rare in childhood and adolescence. However, early functional and structural abnormalities may be present a few years after the onset of the disease. Longer duration of diabetes at older age and puberty are risk factors for complications.

The long-term complications of diabetes include micro- and macrovascular complications. The microvascular complications are nephropathy, retinopathy, and neuropathy.

14.6.1 Nephropathy

Nephropathy is defined as persistent proteinuria >500 mg/24 h or albuminuria >300 mg/24 h and is usually associated with hypertension and a diminishing glomerular filtration rate (GFR). End-stage renal failure may occur many years later and requires dialysis or kidney transplantation. Early detection of diabetic nephropathy and timely treatment of blood pressure have a pivotal role in the prevention of end-stage renal failure in young people and adults with diabetes (Schultz et al. 2000).

Annual screening for albuminuria with a random spot urine sample for albumin to creatinine ratio should be considered once the child has type 1 diabetes for 5 years (Hietala et al. 2010). The estimated glomerular filtration rate should

be evaluated initially and then based on age, diabetes duration, and treatment.

14.6.2 Treatment

When persistently elevated, urinary albumin to creatinine ratio (>30 mg/g) should be evaluated with at least two or three urine samples, and treatment with an ACE inhibitor should be considered and the dose titrated to maintain blood pressure within the age-appropriate normal range.

14.6.3 Retinopathy

Adolescents have a higher risk of progression to vision-threatening retinopathy (severe nonproliferative retinopathy or proliferative retinopathy) compared with that of adults (Bragge et al. 2011). The progression may be rapid, especially in those with poor glycemic control. Biomicroscopy fundus slit examination through dilated pupils by an ophthalmologist and mydriatic seven-field stereoscopic retinal photography and fluorescein angiography OCT specifically reveal macular edema (Mohamed et al. 2007).

Once sight-threatening retinopathy is detected, laser therapy consists of multiple discrete outer retinal burns throughout the mid- and far peripheral area, sparing the central macula (Šimunović et al. 2018). Diabetic cataracts have been reported in patients with type 1 diabetes close to or even preceding diagnosis. Surgical removal may be required (Russell and Zilliox 2014).

14.6.4 Neuropathy

Neuropathy is a polyneuropathy caused by diffused damage to all peripheral nerve fibers—motor, sensory, and autonomic. Patients usually complain of numbness, prickling, burning, and/or paresthesia of the hands or feet (Guy et al. 2009).

14.6.5 Macrovascular Disease (CVD)

The mortality and morbidity of CVD are markedly increased in diabetic individuals compared with that in the nondiabetic population. Hypertension has a greater impact on CVD, and blood pressure control to <130/80 mmHg reduces cardiovascular morbidity. Atherosclerosis starts in childhood and adolescence and cardiovascular events are strongly associated with poor glycemic control. Cholesterol plays an important role in the initiation and progression of atherosclerosis. High

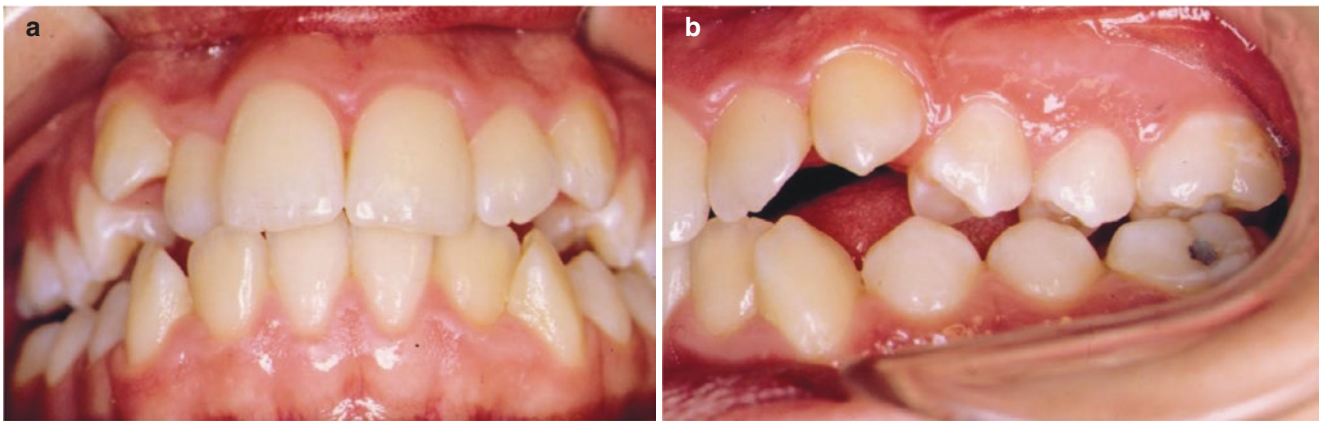


Fig. 14.1 (a, b) The following case is a 12-year-old patient diagnosed with type 1 diabetes since she was 6 years old

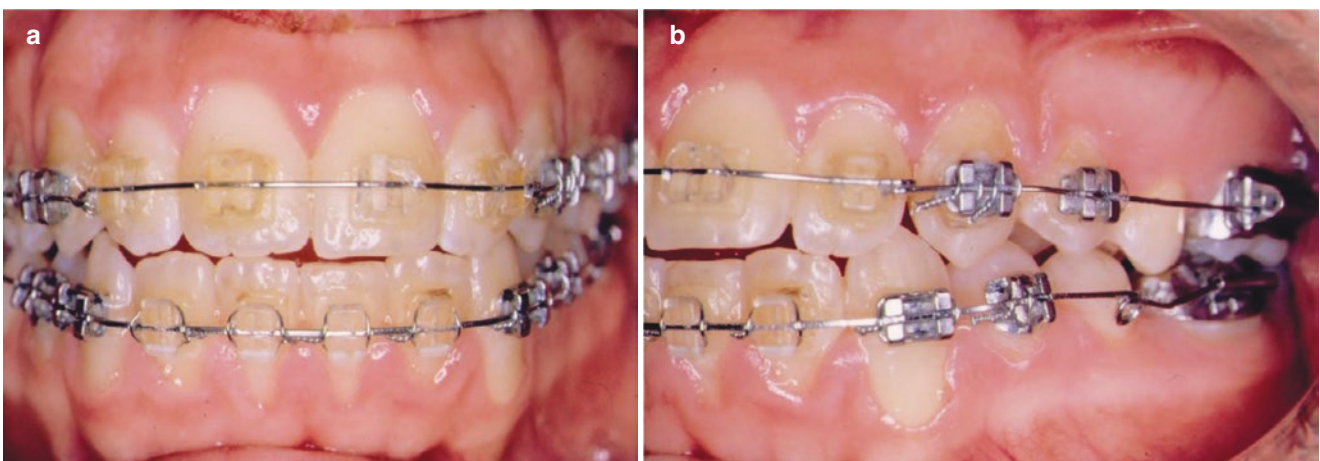


Fig. 14.2 (a and b) Although the periodontal inflammation of the gums was constantly controlled, it was present throughout the entire treatment

LDL cholesterol is defined as >100 mg/dL and triglycerides >150 mg. If present, then interventions to improve metabolic control, dietary changes, and increased exercise should be instituted. If the above interventions do not lower the LDL cholesterol to <130 mg/dL, statins should be considered in children aged >10 years (42).

14.6.6 Orthodontic Procedures

It is possible to achieve normalization of tooth position as well as improvements in functional problems in children or teenagers with any type of diabetes. As described previously, this endocrine disorder is typically associated with gingivitis and periodontitis. It is for this reason that a thorough control of dental hygiene is required to lessen the risk of infections

since, in diabetic patients, gingival tissues respond, with difficulty, to pathogens that are normally present in the mouth (Fig. 14.1).

Gingivitis is typically observed in this type of patient. This particular case is worse since there is a lack of space for proper tooth eruption.

After 18 months of treatment, the objectives, sought from the orthodontic perspective, were achieved. What needs to be kept in mind is that, in spite of the parents' efforts, many adolescent patients rebel against treatment for diabetes as well as orthodontics (Fig. 14.2).

From the orthodontic point of view, the objectives decided at the beginning of treatment have been accomplished: correction of dental midline and placement of the upper canines and normalization of crossbite, overjet, and gingival line.

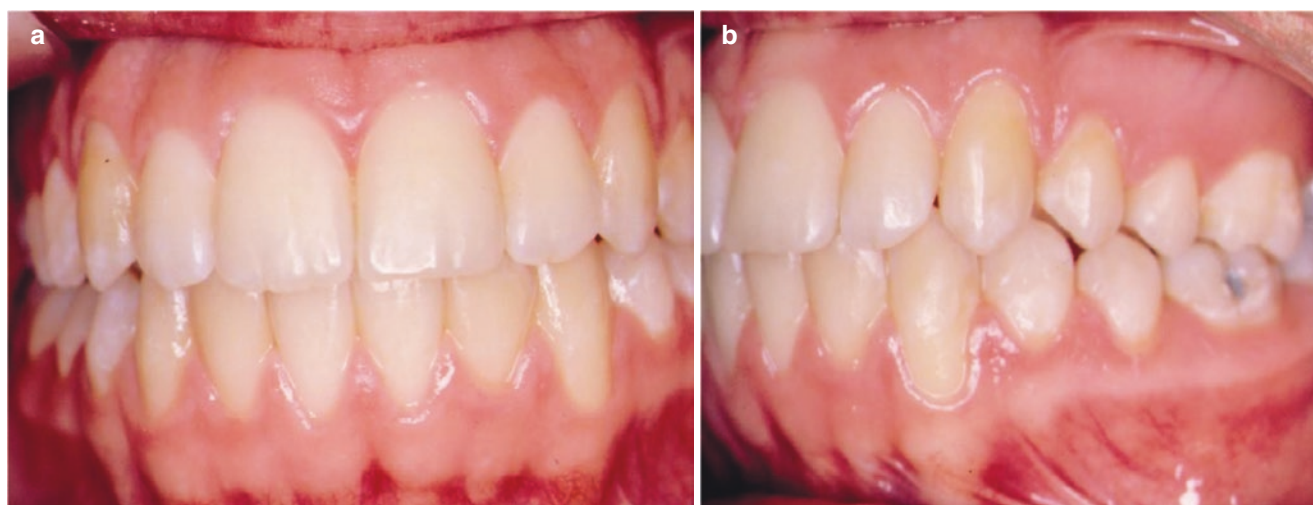


Fig. 14.3 Final photographs confirm the excellent results achieved, even though in a diabetic patient (a, b)

Monthly periodontal follow-up was recommended in order to normalize gingival tissues (Fig. 14.3).

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15.1 Introduction

Hemophilia is a rare bleeding disorder caused by mutations in the X chromosome, which brings about a decrease or absence of activity in factors VIII or IX. About a third of these mutations are spontaneous, lacking family history. It causes the appearance of internal and/or external bleeding of variable severity depending on its location.

The frequency of FVIII deficiency (hemophilia A) is approximately 1 in 5000 to 10,000 births in boys, and for FIX deficiency (hemophilia B), it is approximately 30,000–50,000 births.

The clinical expression of hemophilia is bleeding in different locations in the body: joints, muscles in the lower and upper limbs, internal bleeding, the digestive and urinary systems, and others, but less frequently. Among the aforementioned, bleeding in the central nervous system is the most severe form of hemorrhage in patients with hemophilia that causes the highest morbidity and mortality.

Ninety percent of people with severe hemophilia A or B have bleeding episodes that begin at an early age. The most affected joints are the ankles, knees, and elbows. This causes a characteristic pathology called hemophilic arthropathy, characterized by the presence of progressive joint lesions, which lead to a severe limitation of joint function, arthralgias, and serious disabling sequelae. Due to its frequency and chronic evolution, hemophilic arthropathy is the complication with the highest morbidity, and thus, the main aim of its treatment is the prevention of its development.

The early detection of female carriers is based on a lineage analysis. DNA-based diagnosis is the most accurate one, but it does not provide full information about this group of patients. Prenatal diagnosis can be made by chorionic villus biopsy between weeks 9 and 11 of gestation, or by amniocentesis between weeks 15 and 20, by extracting DNA from fetal cells for a genetic diagnosis.

The diagnosis of postpartum hemophilia is based on the measurement of the plasma level of FVIII/FIX collected from a sample of umbilical cord blood, or a sample of peripheral venous blood from a newborn.

Arterial, jugular, and femoral punctures and circumcision are contraindicated until the patient has an adequate level of the deficient factor. According to the plasma level of FVIII or FIX, hemophilia is classified as follows:

Severe hemophilia

- 1% factor.
- Bleeding can be spontaneous.
- Very frequent bleeding episodes.
- Commitment of various joints.

Moderate hemophilia

- Between 1% and 5%.
- Bleeding from insignificant trauma can be seen.
- Less frequent bleeding. They may present joint compromise.

Mild hemophilia

- 5% factor.
- They can bleed from severe trauma, surgeries, etc.
- Very infrequent hemorrhages. Joint involvement is rare.

Treatment of patients with hemophilia consists of intravenous administration of FVIII or FIX concentrates in order to raise the plasma levels of these factors (replacement therapy). Treatment can be on demand for the bleeding episodes that occur, or prophylactically so as to prevent bleeding. In patients with mild hemophilia A, desmopressin is a therapeutic alternative.

Patients with hemophilia may present, as a treatment complication, the development of an inhibitor (an antibody that blocks the coagulant action of FVIII or FIX). The hematological management of these patients is a great challenge.

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Bleeding is treated with so-called bypassing or bridging agents (recombinant activated FVII and activated prothrombin complex concentrate).

15.1.1 Overview: General Facts

In dentistry, bleeding can be caused by multiple practices. Under normal circumstances, the techniques performed can be carried out without major complications. However, the risk of intra- and postoperative bleeding is potentially higher in patients with hereditary bleeding disorders such as hemophilia, a relatively uncommon disorder, but complex in terms of diagnosis and treatment. The first clinical sign of the disease such as hemorrhage is usually manifested in oral and maxillofacial trauma as well as routine dental care in early childhood.

15.1.2 Is Orthodontic Treatment a Trauma?

It is not.

This chapter aims to provide recommendations to health professionals in different types of orthodontic treatments in order to achieve an optimal state of oral health.

The idea is to reduce dental surgeries as much as possible. However, it is known that sometimes, dental extraction is necessary to continue with the orthodontic treatment. In cases when surgery is fundamentally important, such as in third molar extraction, this kind of indications must be studied carefully in order to continue with the procedure.

Uncontrolled dental hemorrhages can eventually threaten the patient's life. Thus, it is known that people with hemophilia or other bleeding disorders are a priority group for oral and maxillofacial preventive care.

For a better understanding of these procedures in this kind of patients, several things about local anesthesia need to be analyzed.

15.1.3 Local Anesthesia

Local anesthesia technique in patients with hemophilia for pain control has been a challenge for dentists. In fact, infiltration of different types of anesthetics can be performed locally and slowly. Moreover, in order to cause less pain, local anesthesia should be warmed. The techniques that can be used are the following:

Infiltrative technique:

- Terminal: it requires slow infiltration to avoid bruising.
- Troncular of the lower jaw: it requires the administration of substitution treatment to avoid bruising and/or hemorrhage which can cause respiratory problems.

Intrapapillary technique: it is only used as a coadjutant of terminal techniques.

Intraligamentous technique: it is effective in short-term treatments only.

Substitution therapy is vitally important for the regional technique which usually blocks the inferior alveolar and lingual nerve. In general, the application of antihemophilic factor concentrates is not essential in other anesthetic techniques.

The liquid administration of the anesthetic must be slow to prevent bruises. The concentrate should be administered to increase the level of FVIII/FIX to $\geq 50\%$, 10 min before anesthesia, regardless of the type of anesthesia used.

In other types of anesthesia, the hematologist, in consultation with the dentist, can indicate a dose of FVIII/FIX to reach levels $\geq 30\%$.

15.1.3.1 Surgical Treatment

Patients with hemophilia may have hemorrhagic problems, the most severe at the oral level, in terms of bleeding.

In the case of soft tissue trauma in children, local action (suture) must be carried out with special care so as not to cause greater trauma and bleeding.

Substitute treatment such as FVIII or FIX is often necessary.

Spontaneous oral bleeding episodes are usually caused by mobility of temporary tooth. The pericorony sac of a permanent dental piece is the major problem. Thus, the extraction of temporary tooth is necessary. In order to stop the bleeding, a caustic agent (30% trichloroacetic acid) or bismuth subgallate is used for local treatment (Rey et al. n.d., 2000) [21].

Working with the hematologists is essential for planning surgical treatment in order to prevent bleeding complications.

To protect the largest amount of bone wall, atraumatic technique should be carried out.

15.1.3.2 Emergencies

- Upper lip frenulum injury.
- Lower lip frenulum injury.
- Tongue frenulum injury.
- Dorsal tongue face injury.
- Dental replacement.

What Can We Do?

Local compression, placing ice over the region outside the mouth, cold diet, and calling the professional should be carried out.

As for soft tissue traumas, such as the tongue, braces, and lips, their dimension should always be evaluated to determine if suture is essential.

Local Hemostatic Agents

Local hemostasis is an important pillar in the surgical treatment of patients with hemophilia. It is a matter of using the most convenient method from all points of view: low cost, easy instrumentation and application, low infectious risk, etc. In cases of minor surgery, these hemostats are sometimes used as the only prophylactic measure, while in medium or major surgeries, they are used in combination with systemic therapy.

Local hemostats are drugs that participate directly in the mechanism of coagulation. The reason why they stop the bleeding is twofold: they produce an artificial clot or they create a mechanical matrix that facilitates blood clotting when applied directly to the site of the hemorrhage. It is important to highlight that local action is effective.

The application of anesthesia has two benefits. Firstly, it avoids pain on the patient, and secondly, it facilitates to see where the bleeding is coming from.

Examples of Local Hemostatics

(A) Biological Tissue Adhesives.

They are commercial preparations of two components: one is composed of protein concentrates (coagulable proteins, fibrinogen, FXIII, plasminogen) and aprotinin and the other of a solution of thrombin and calcium chloride.

These two components mix and give rise to the transformation of fibrinogen into fibrin *in situ*, which rapidly transforms into a foaming white elastic coagulum that adheres firmly to the tissues. This fixation, which imitates the last phase of normal human coagulation, is what allows the hemostatic, sealing, and adhesive activities that characterize the product. During wound healing, total resorption of the biological adhesive takes place. The commercial preparation is provided with a fast-acting thrombin and a slow-acting one. The rapid one is used for hemostasis and the slow one to adhere to the tissues.

(B) Bismuth Subgallate [28–30].

It is a chemical compound that has been used for several decades by many branches of medicine such as dermatology, gastroenterology, and especially otorhinolaryngology where it is used in tonsillectomies.

It is an intense yellow odorless powder, which is insipid and opaque to the Radiographic study (Rx) (which allows its visualization in radiographic images until its total elimination). Also, it is recognized as an antibacterial and hemostatic.

Its hemostatic principles were studied *in vivo* and *in vitro* and are found in the activation of factor Hageman or FXII, accelerating the coagulation cascade and in its local astringent action, that is, precipitating vascular

proteins that obliterate the light of the glasses of small caliber.

It is economical and easy to be prepared by drug-stores. Its mode of intrasurgical preparation is also simple; it consists of making a mixture of bismuth subgallate with anesthetic liquid with a vasoconstrictor until a mass consistency is obtained, and this preparation is compacted in the bleeding site on the surgical bed. From here arises the need for a conservative exodontia of alveolar cavities. It is rapidly eliminated, showing absence of radiological evidence after approximately 30 days.

(C) Plasma Enriched in Platelets.

At present, there is a great boom in the field of maxillofacial surgery, especially in reconstructive and regenerative surgeries. Once obtained by means of special blood centrifugation techniques, the extracorporeal coagulation of plasma is improved by the application of calcium chloride and thrombin in preestablished concentrations. This technique should only be performed in specialized medical centers and under strict measures of biosafety and blood control. Among its observed advantages are the following:

- (a) It provides adhesion and tensile strength for the stabilization of the coagulum.
- (b) It provides safety since it uses autologous plasma.
- (c) It is biologically acceptable for tissues.
- (d) It contains important healing factors released by platelets.
- (e) It promotes angiogenesis.
- (f) It has a high concentration of leukocytes, which reduces the risk of infections.
- (g) It contains a mesh rich in fibrin, which is osteoconductive.

(D) Microfibrillary Collagen.

They are commercial preparations that act as a mechanical matrix to trigger coagulation. Their function is to attract platelets to trigger aggregation when applied directly to the bleeding site.

(E) Lyophilized Swine Skin.

It is a commercial preparation, whose high content of collagen mimics the action of microfibrillary collagen.

(F) Oxidized Cellulose.

It allows the formation of a matrix that stops the deposition of fibrin and the propagation of the blood clot.

(G) Trichloroacetic Acid 30%.

It is a caustic of local action. It is indicated especially in capillary hemorrhages in mucous membranes. It has the advantage that since it is a self-limiting acid (it is inactivated when combined with a certain amount of substrates), it does not act on the depth of the tissues.

(H) Antifibrinolytic Preparations [25–27].

Antifibrinolytic agents act in molecular form by occupying the sites of plasminogen activation and the plasmin receptor for fibrin. This slows the lysis of the clot and improves its hemostatic properties. The most recognized drugs are aminocaproic acid and tranexamic acid.

Tranexamic acid: The use of 10-mL mouthwash, with tranexamic acid 5%, four times a day, for 7–10 days, as well as 25 mg/kg orally every 6 h for 5–10 days, is recommended to prevent posttreatment hemorrhages. In children, doses should be adjusted according to the age and weight.

E-Aminocaproic acid (EACA): It can be indicated orally at 50–75 mg/kg of weight every 6 h or 2 or 3 ampoules orally every 6 h (Machado de Sousa et al. 1995; Martinez Lage et al. 1983; Marquez et al. 1982; Mulkey 1977; Rey et al. 2002).

Postsurgical suture is performed routinely, without exception, since it offers great advantages in hemostasis and postoperative evolution, preventing the consequent edema separating the lips from the wound.

In the case of outpatient surgery, the patient must remain at rest for a few minutes before leaving once the surgery has been completed, in order to check the definitive hemostasis and explain the postsurgical care. These differ from those given to a normal patient, since all that has been indicated aims for the stability of the clot.

It is indicated that the temperature of the food to be ingested must be of natural temperature or cold, neither hot nor warm. This type of feeding should be followed for approximately 6 or 7 days with controls of the wound by the surgeon.

The gauze dressing that is placed on the wound to protect it should remain in place between 5 and 7 h (by that time, the clot will probably be stabilized).

Suction as well as smoking is contraindicated, but the hygiene of the remaining dental pieces is indicated.

Postsurgical controls of these patients are carried out as often as possible, to follow their evolution and prevent hemostatic alterations.

15.2 Hemophilia Clinical Case

This 9-year-old patient was sent to the orthodontic department by his clinical doctor in search of a second opinion.

The previous orthodontist suggested applying the serial extraction protocol. However, considering that the patient was diagnosed with hemophilia when he was 5 years old, this protocol was not considered the best option.

Up until that moment, he had been treated by the same hematologist, and to date, no major dental bleeding episodes have been observed.

Her mother was worried about the position of the upper and lower central incisors. A significant gingival retraction was confirmed on the labial side of the lower central incisors along with an uneven gingival margin (Fig. 15.1a, b).

The upper discrepancy was –4 mm (Fig. 15.2).

A nonextraction protocol was decided and the treatment plan included aligning and leveling the arches with very low forces.

When treating patients with hemophilia, it is important to maintain a careful hygiene protocol to avoid swollen gums. It is highly recommended to use rounded brackets and a strict control of wires to avoid gingival injuries during the whole active treatment.

Due to his medical conditions, low-load deflection arches were recommended during the entire treatment (Figs. 15.3, 15.4, 15.5, 15.6, 15.7 and 15.8).

The comparison between the pre- and posttreatment frontal photographs shows a significant improvement in the position and inclination of the teeth.

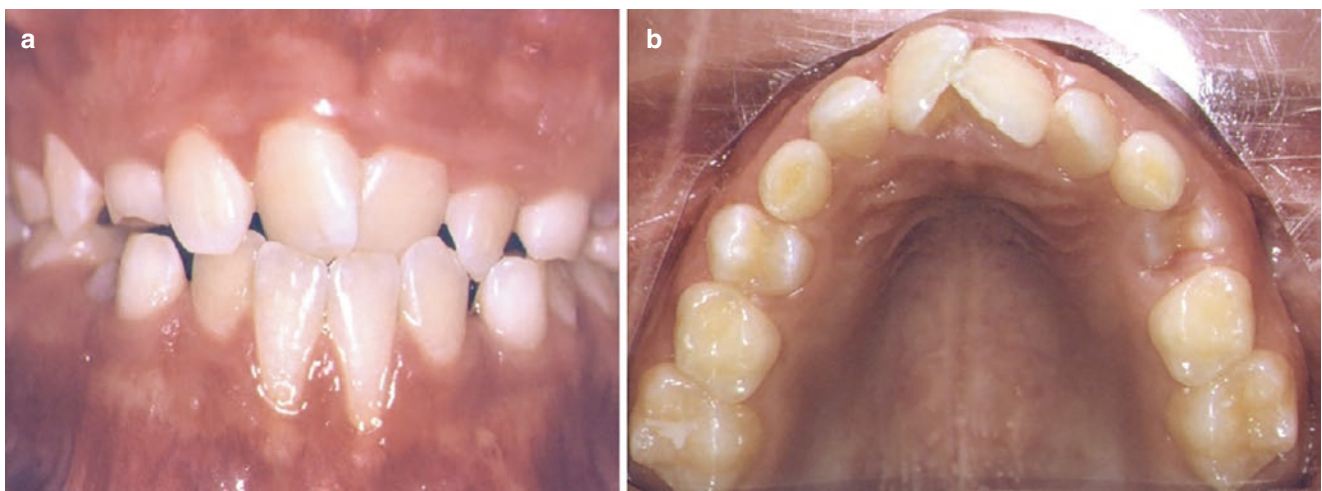


Fig. 15.1 (a and b) Frontal and upper occlusal pretreatment photographs

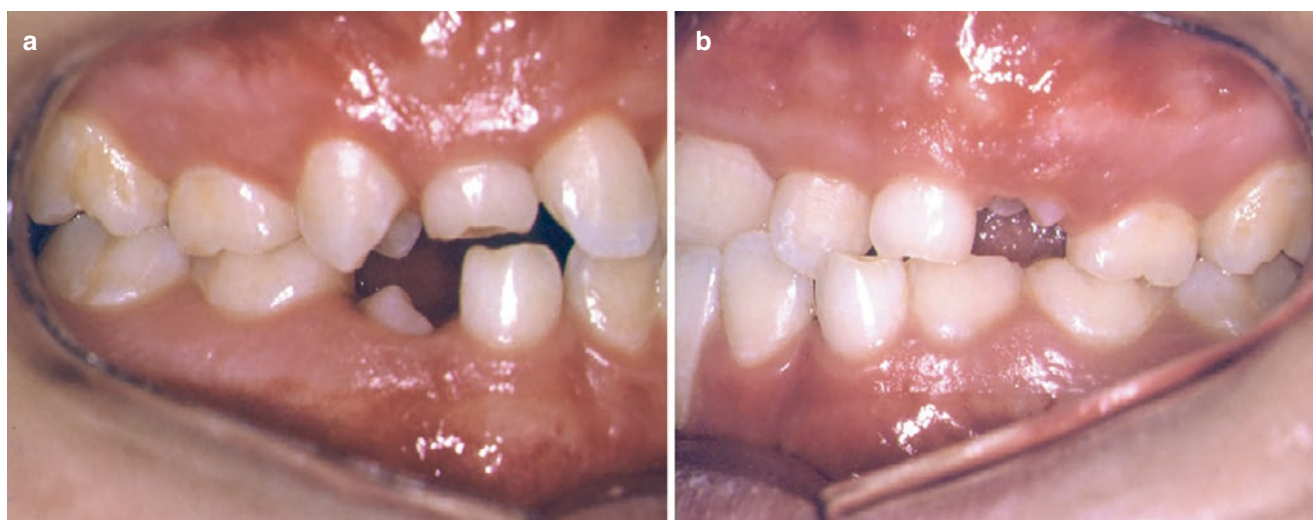


Fig. 15.2 (a, b) Class I molar was observed on the lateral views

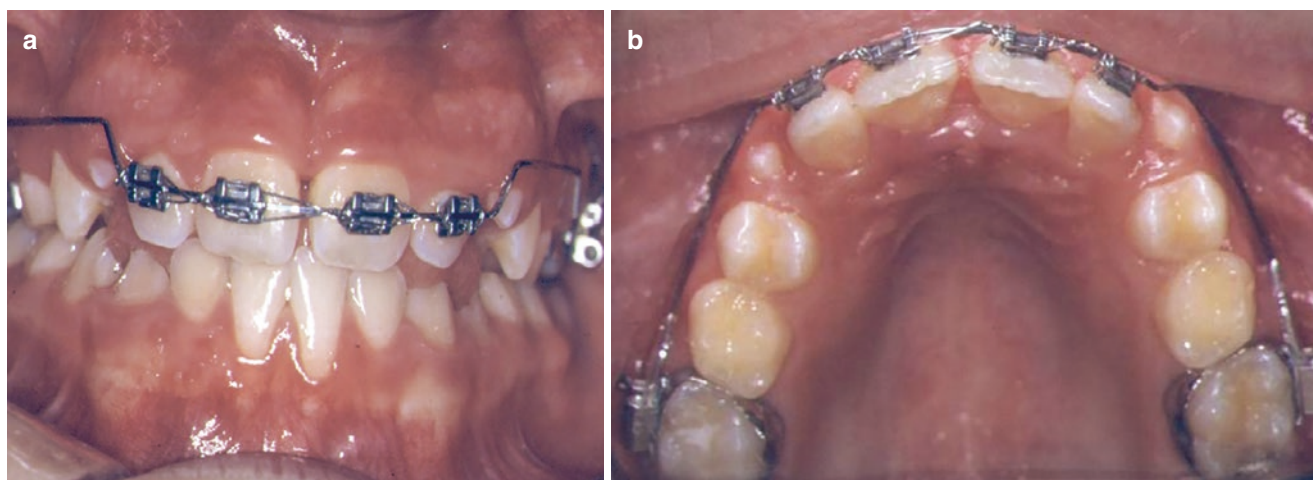


Fig. 15.3 (a, b) A utility arch that was made with a TMA wire was the best option

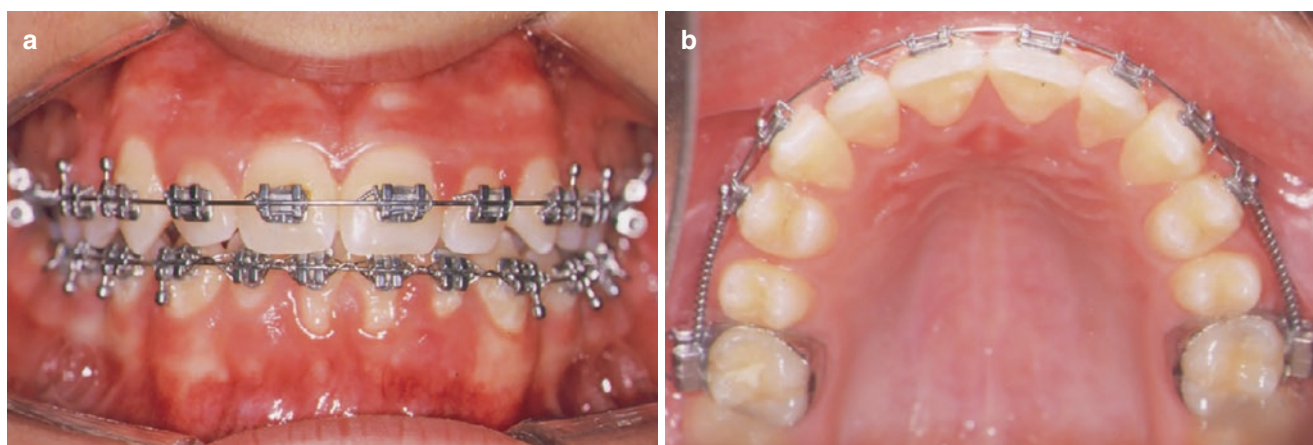


Fig. 15.4 (a, b) These were the results 12 months later when the first phase of treatment was finished

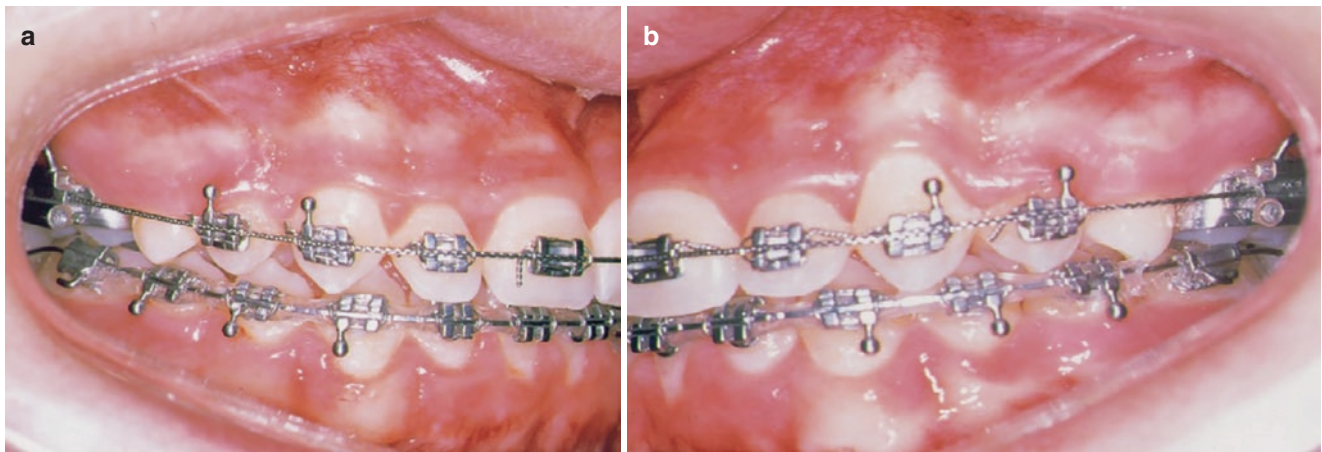


Fig. 15.5 (a, b) The lateral views confirmed that Class I canine and molar were achieved

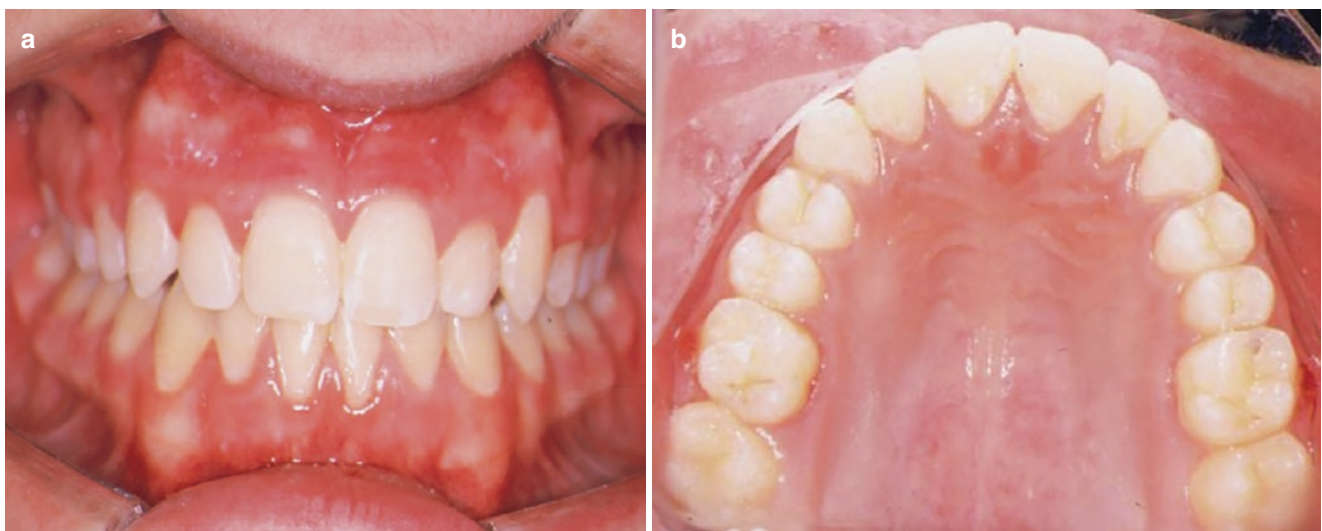


Fig. 15.6 (a, b) These were the results at the end of the active treatment. All objectives were achieved: central incisor midlines were coincident and gingival line and occlusal plane were parallel with normal overjet and overbite

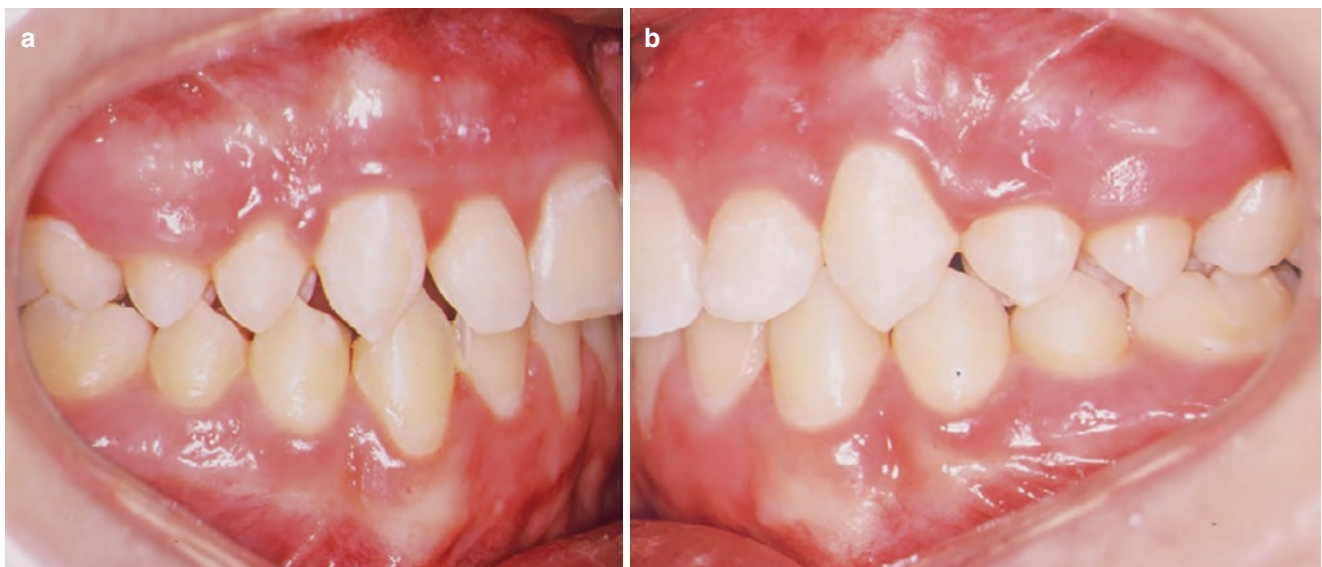


Fig. 15.7 (a, b) The lateral photographs confirmed Class I molar and canine

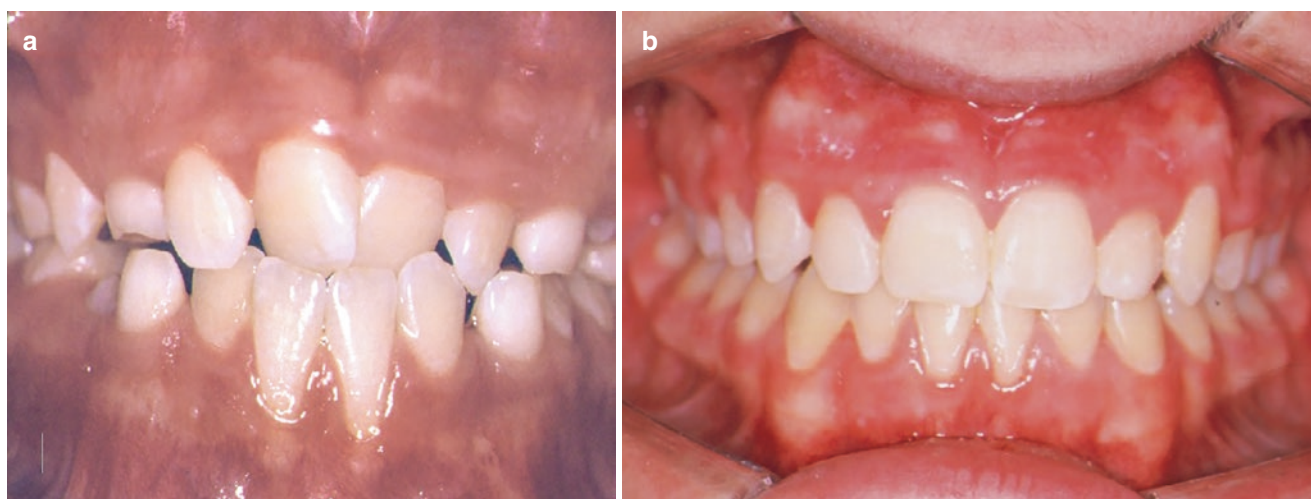


Fig. 15.8 (a, b) Also, the gingival tissues were clearly improved particularly in the lower incisor area

It is important to highlight that no important bleeding episodes were observed during the entire active orthodontic treatment.

15.3 Conclusions

It is possible to treat patients with hemophilia and all types of malocclusions when control and low forces are used. Clearly, dental extractions and minor dental surgeries have to be minimal. Also, treatment objectives may need to be modified to certain limits according to the severity of the disease.

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How to Avoid Long Term Relapse in Early Orthodontic Treatment

16

Julia Harfin

Open bite is one of the most difficult types of malocclusions to treat not only in early or mixed dentition but also in permanent dentition. The real issue is how to avoid long-term relapse.

There is no doubt that there is a close interrelationship between breathing, facial musculature, and the tongue that affects not only facial growth but also the position of the teeth and TMJ function.

The position of the tongue at rest and the normalization of breathing play an important role not only during treatment but also during the retention period. Additionally, they are responsible for all types of relapse (Fig. 16.1a, b).

Since these anomalies are not self-corrected and are the result of multifactorial issues, the advantages of early treatment cannot be denied.

Environmental factors during primary and mixed dentition play an important role in the development of this problem (Cozza et al. 2005). For this reason, the sooner these factors are controlled, the less relapse is present.

Early recognition of the etiology can prevent ongoing problems and the development of worse abnormalities in the future (Fig. 16.2a, b).

The most common local causes of anterior open bite in children are related to tongue thrusting, sucking habits, and mouth breathing (Hepper et al. 2005).

Normally, they are accompanied by a downrotation of the mandible with extrusion of the molars and intrusion of the upper and lower incisors (Fig. 16.3a, b).

All these habits could cause interferences with the circumoral musculature and, of course, cause the abnormal position of the tongue. The sooner they are corrected, the better the results (Castilho and Rocha 2009).

The main strategy is to eliminate these abnormalities as soon as possible (Ramirez Yañez and Paulo 2008).

Sometimes, the child's psychological state plays an important role during this whole process and the help of a specialist is invaluable. Different alternatives (removable or fixed appliances) can be used but the parents' help is priceless.

The frequency and duration of thumb-sucking and tongue thrust swallowing are determinants during deciduous and early mixed dentition. It is important to remember that finger-sucking is one of the worst oral habits present in children, and sometimes, it appears during the intrauterine life (English 2002). When it is prolonged, past the age of 2–3 years, it can alter the normal path of facial growth and dental occlusion (Torres et al. 2012) due to the abnormal force applied on the orofacial muscles and the frontal teeth.

Anterior open bite with maxillary incisor flaring and retrusion of the lower anterior teeth are the common characteristic clinical signs, in addition to a long anterior face, snoring, eye bags, and sleepiness.

The early elimination of these habits is fundamental to recover normal growth. For this reason, parents play an important role in this phase of treatment by accompanying children during this whole process.

There are several appliances that can be used to achieve good results, but it is important to recommend a child-friendly one to obtain the willingness of the child to stop the habit (Huang 2002). The orthodontist has the final decision.

The following examples describe the step-by-step treatment.

This 7-year, 6-month-old patient was sent to the office due to speech problems (Fig. 16.4a, b).

Adeno- and tonsillectomy was performed 8 months earlier, but tongue thrust and abnormal tongue posture were not self-corrected as was visible on the frontal and profile smile photographs.

During spring, she regularly suffered from asthma that was treated with corticoids.

The dental frontal photograph showed a significant open bite, with no midline dental deviation. The anterior position of the tongue is clearly visible. Negative overjet and overbite were present (Fig. 16.5a, b).

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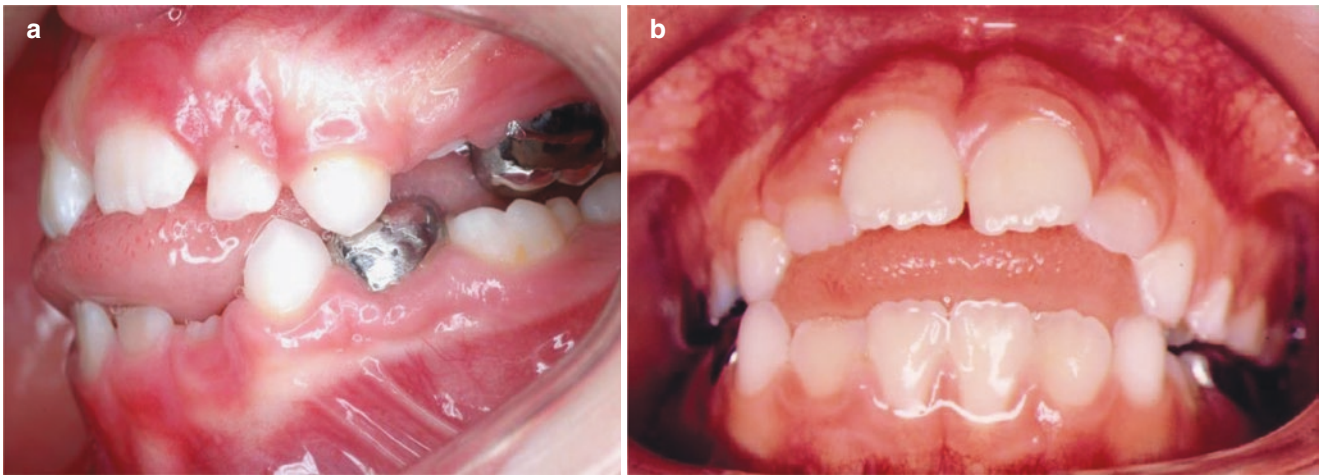


Fig. 16.1 (a, b) Position of the tongue at rest

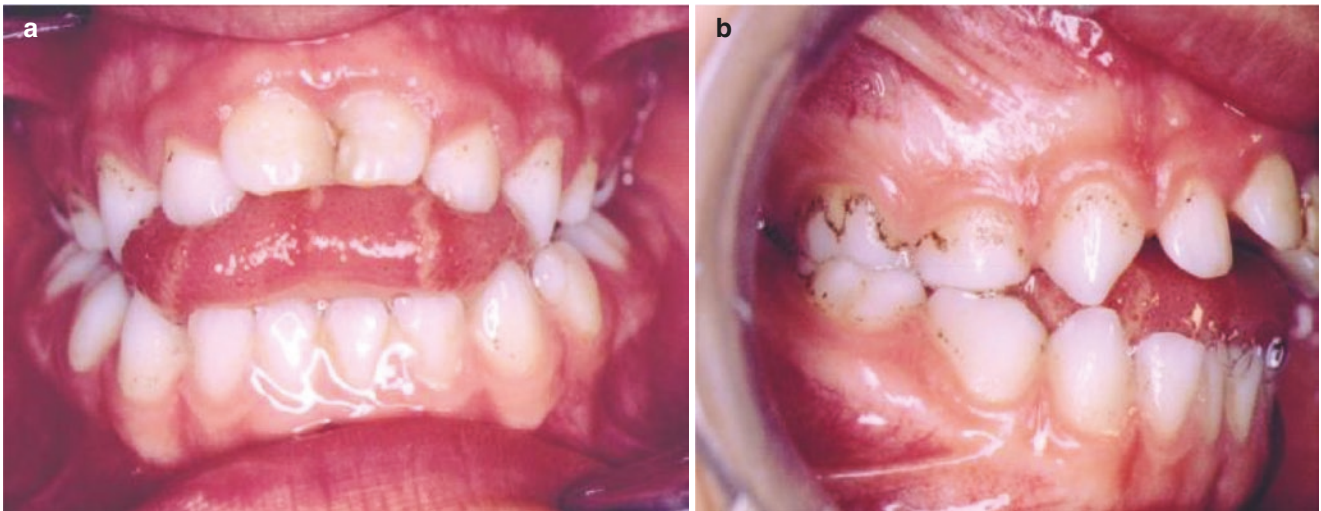


Fig. 16.2 (a, b) Anterior open bite in deciduous dentition (3 years old)

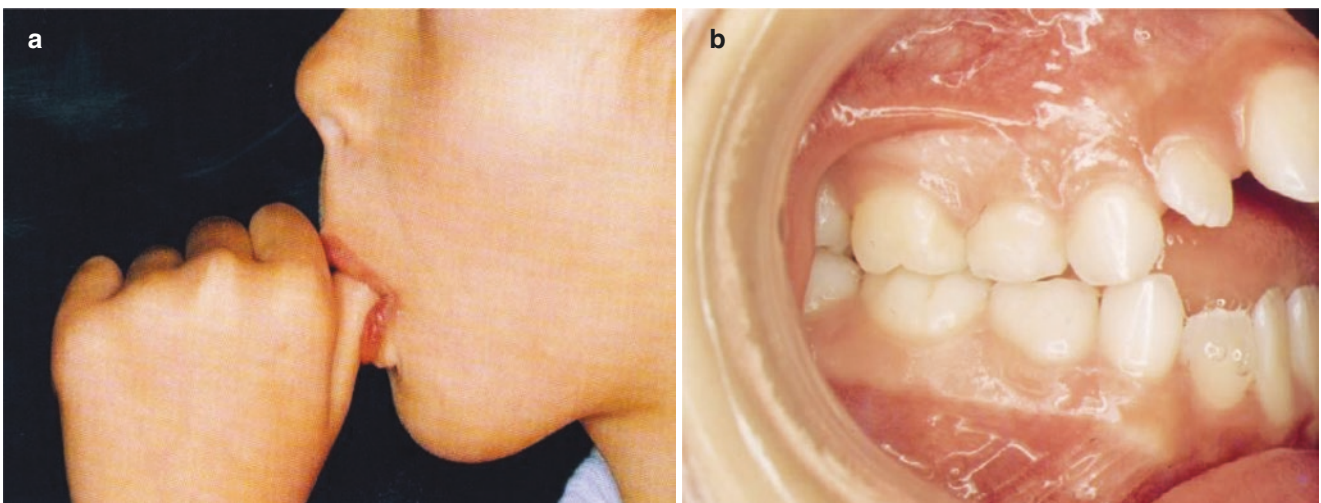


Fig. 16.3 (a, b) Severe open bite due to thumb sucking. Flaring of the upper incisors and retrusion of the lower incisors are clearly visible



Fig. 16.4 (a, b) Pretreatment frontal and profile smile photographs

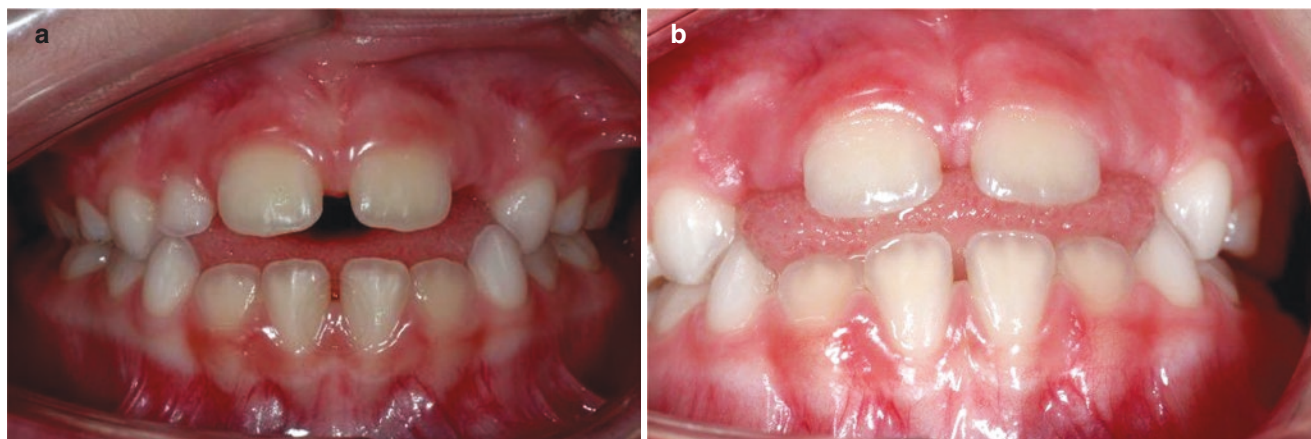


Fig. 16.5 (a, b) Pretreatment frontal dental photographs where the anterior position of the tongue is clearly visible

Class I molar and no posterior crossbite were observed on the lateral views (Fig. 16.6a, b).

The phase I treatment objective was to normalize overjet and overbite, maintain Class I molar, normalize tongue thrust, improve the activity of the lips, and enhance her profile (Torres et al. 2012).

To achieve this objective, the use of a functional appliance was decided. The Myobrace System (Myofunctional Research Co., Australia) was the best option for this patient.

It is fabricated with a special type of polyurethane and helps the correction and normalization of the muscular and tongue dysfunction (Fig. 16.7a, b). Since the material is soft, no major problems of adaptation were present.

It is recommended that the appliance be used 2–3 h during the day and then all night.

These were the results after 7 months of treatment. No more asthma attacks were reported by the mother 4 months prior to that checkup.

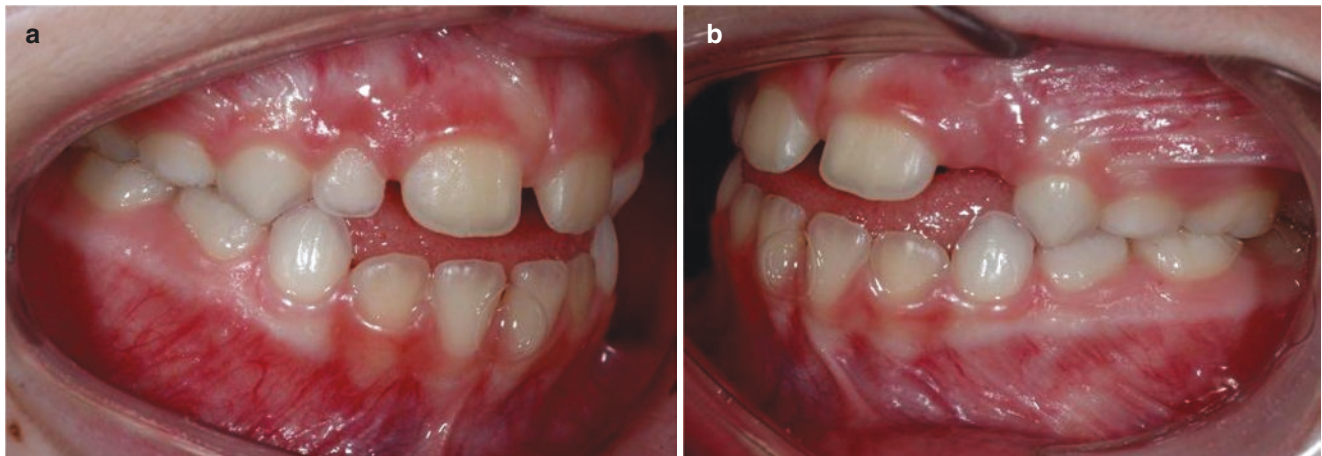


Fig. 16.6 (a, b) Pretreatment lateral views with no posterior crossbite

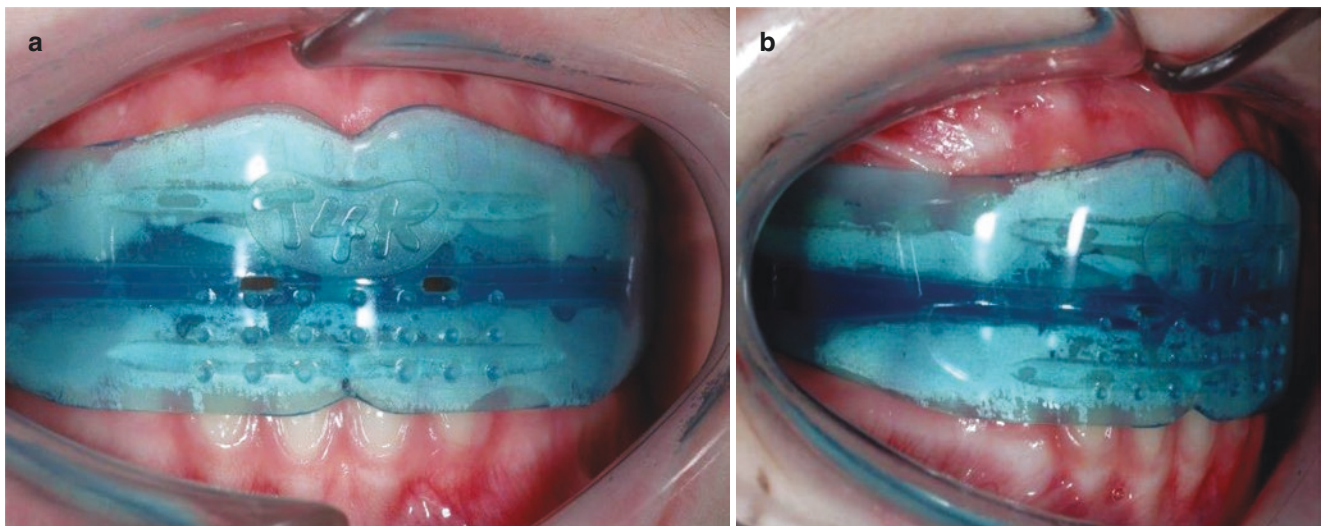


Fig. 16.7 (a, b) Myobrace System in place

The speech problems noticeably improved as well as the anterior position of the tongue during swallowing and in resting position.

These results were confirmed when the smile photograph was observed (Fig. 16.8a, b).

Class I molar and lateral occlusion were maintained. The anterior open bite had improved and midlines were coincident (Fig. 16.9a, b).

Four months later (11 months of treatment), less interincisal diastema was present. Overjet and overbite were improved and nasal breathing was totally recovered (Fig. 16.10a, b).

The patient continued using the functional appliance (Myobrace) for 2–3 h a day and all night plus respiratory and tongue exercises. This appliance is very child-friendly and the results are predictable (Fig. 16.11a, b). Class I molar was

maintained. No other orthodontic appliance was recommended during this phase of treatment.

Facial photographs taken 2 years after treatment during a follow-up appointment showed that the patient could close her lips without tension and a relaxed smile was present (Fig. 16.12a, b).

The profile and lateral smile photographs confirmed the results, and a double chin was not present (Fig. 16.13a, b).

It is important to highlight that all treatment goals were achieved: midlines were coincident with a beautiful smile. Oral hygiene was still good (Fig. 16.14a, b).

Gingival and occlusal planes were parallel and no gingival recessions were present (Fig. 16.15a, b). The treatment goals were totally achieved without the use of other appliances.

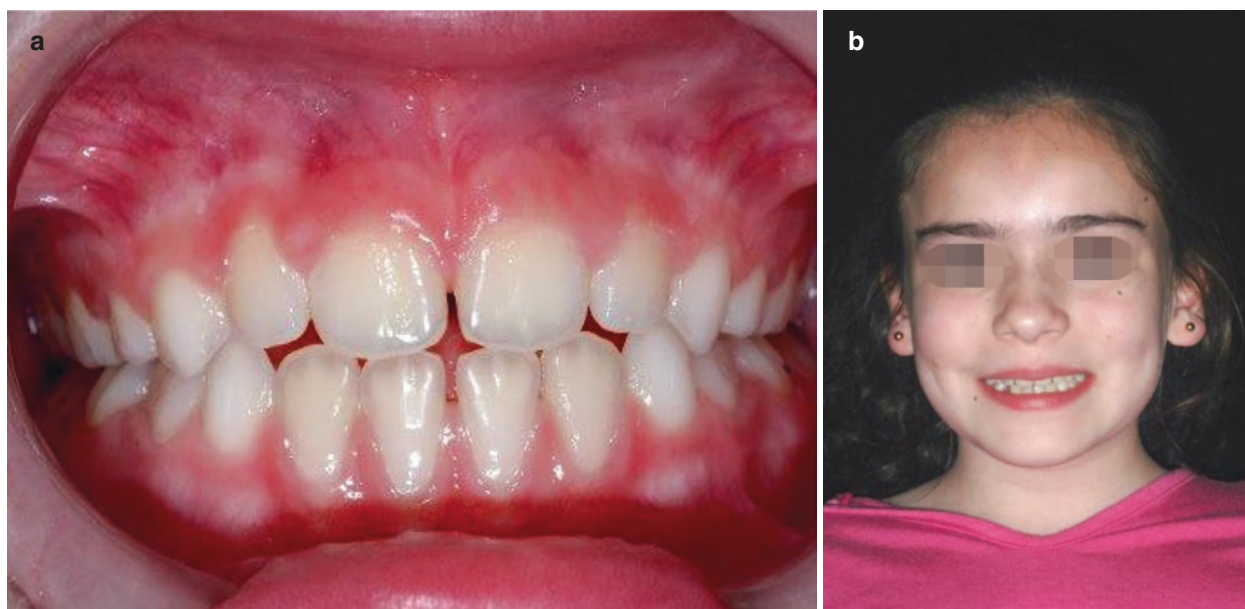


Fig. 16.8 (a, b) After 7 months of treatment

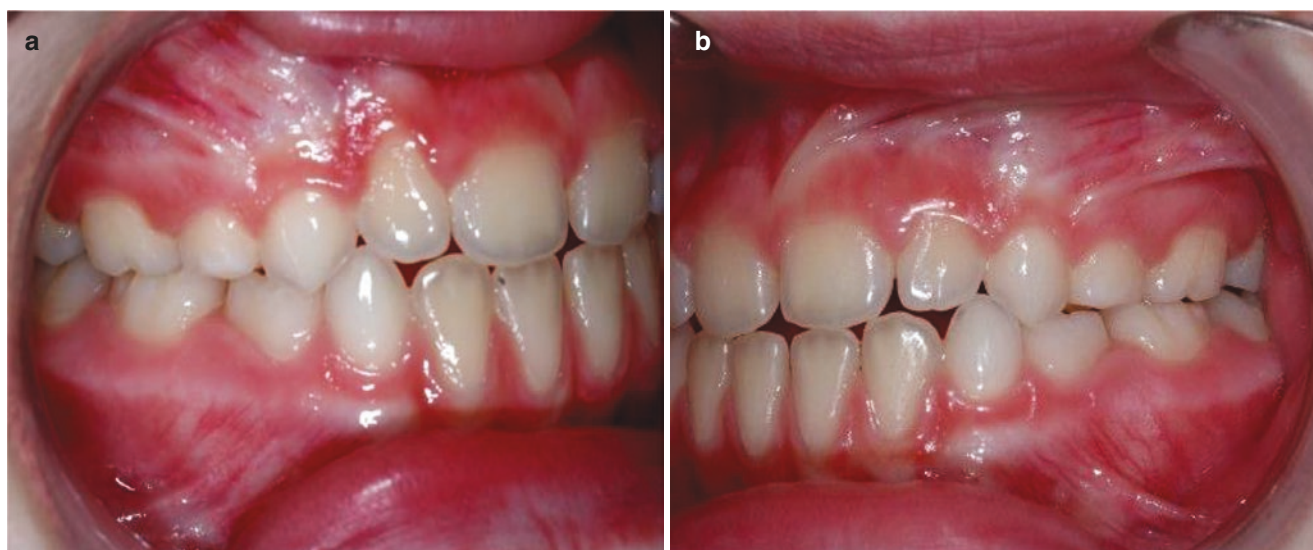


Fig. 16.9 (a, b) Lateral views after 7 months of treatment

All permanent teeth erupted in a normal position at the end of the treatment period (20 months). Upon analyzing the upper and lower occlusal photographs, rounded and normal arches were confirmed. No cavities were present (Fig. 16.16a, b).

The comparison between the pre- and posttreatment frontal dental photographs demonstrates the normalization of the position of the tongue and the correction of the anterior open bite (Fig. 16.17a, b).

No other appliance or brackets were required to achieve the expected results. A similar appliance (Myobrace System)

was recommended during the whole retention period (Fig. 16.18a, b) (Ramirez Yañez and Paulo 2008).

The comparison between the pre- and posttreatment photographs clearly demonstrated that all objectives were obtained. The success achieved is based on the control and monitoring of the breathing difficulties and tongue position in concordance with the establishment of the neuromuscular function (Fig. 16.19a, b).

It is important to treat the causes of the malocclusion rather than only the symptoms. The patient and the parents must understand the real magnitude of the problem, and their

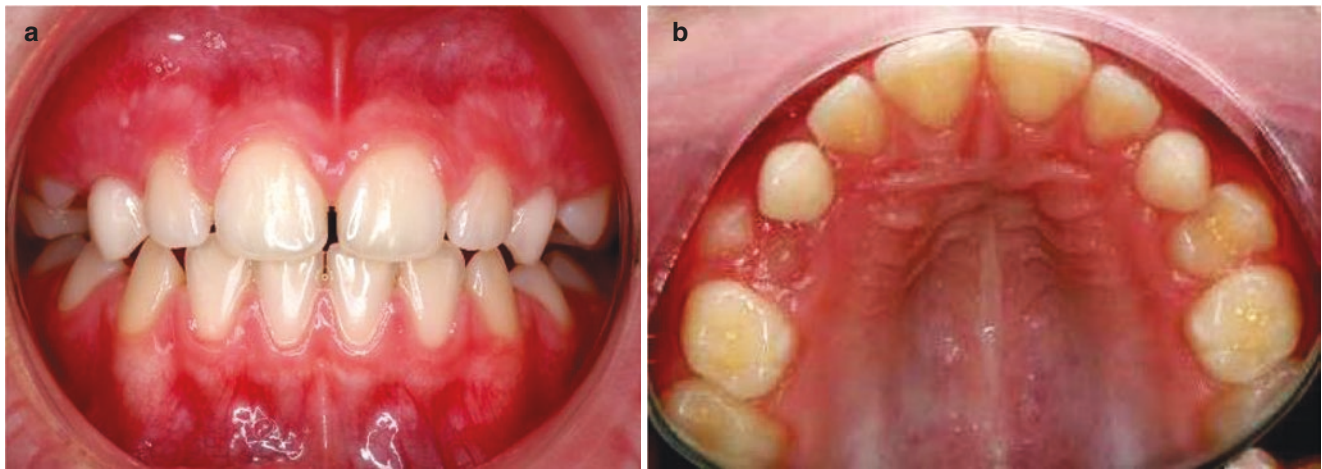


Fig. 16.10 (a, b) Frontal and upper occlusal views after 11 months of treatment

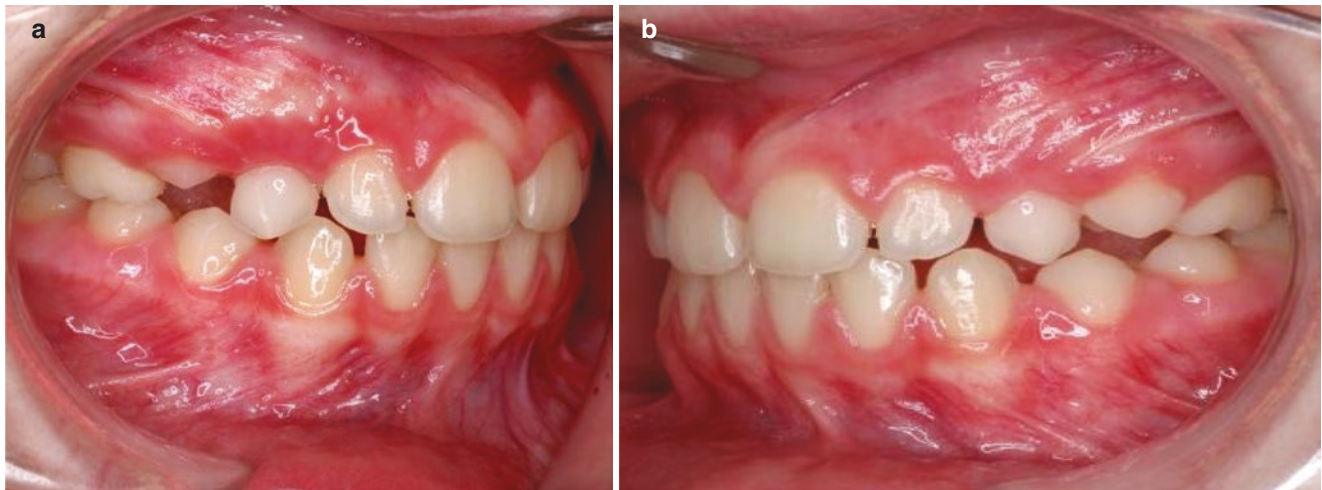


Fig. 16.11 (a, b) Lateral views at this time of treatment

cooperation is a key factor in obtaining stable results and a complete habit control.

In our everyday clinical practice, deep bites are other very common types of malocclusion. The relationship between significant deep bites in children with TMD disturbances is acknowledged worldwide. This cause-effect relationship might cause posterior and superior displacement of the condyle and, as a consequence, dysfunction and headaches, in conjunction with muscular and joint pain (Du and Hagg 2003).

The following patient is a clear example. He is a 7-year, 9-month-old boy who was sent to the office due to some pain and TMJ clicking.

The frontal and profile photographs confirmed a reduced lower third of the face compared to that in the middle side of the face. The right side of the face was wider than that on the left side. The chin seemed to be retruded (Fig. 16.20a, b).

The smile photograph confirmed a significant contraction of the masseter muscles, more evident on the right side. Overbite was almost 100% in the incisor area in conjunction with an uneven gingival line (Fig. 16.21a, b).

The pretreatment lateral views confirmed Class II molar and canine. Retrusion of the upper central incisors were clearly visible. The gingival line and occlusal plane were not parallel (Fig. 16.22a, b).

No crowding was present in the upper and lower arches, although some dental rotations were present in the upper arch (Fig. 16.23a, b).

The treatment objectives included different aspects. It is important to consider not only the position of the teeth but also the muscles and gingival and occlusal plane asymmetry. Since TMD disturbances have a multifactorial etiology, an exhaustive clinical exam is mandatory (Ramirez-Yañez et al. 2007).



Fig. 16.12 (a, b) Final facial frontal photographs



Fig. 16.13 (a, b) Profile and lateral smile photographs 2 years after treatment

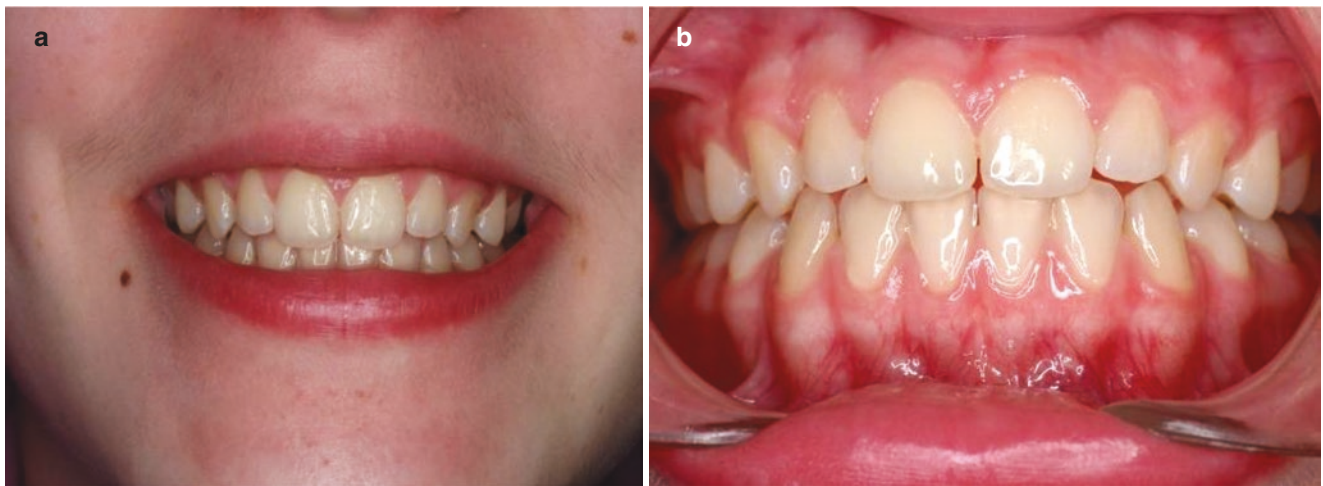


Fig. 16.14 (a, b) Smile and frontal dental photographs after 2 years in retention

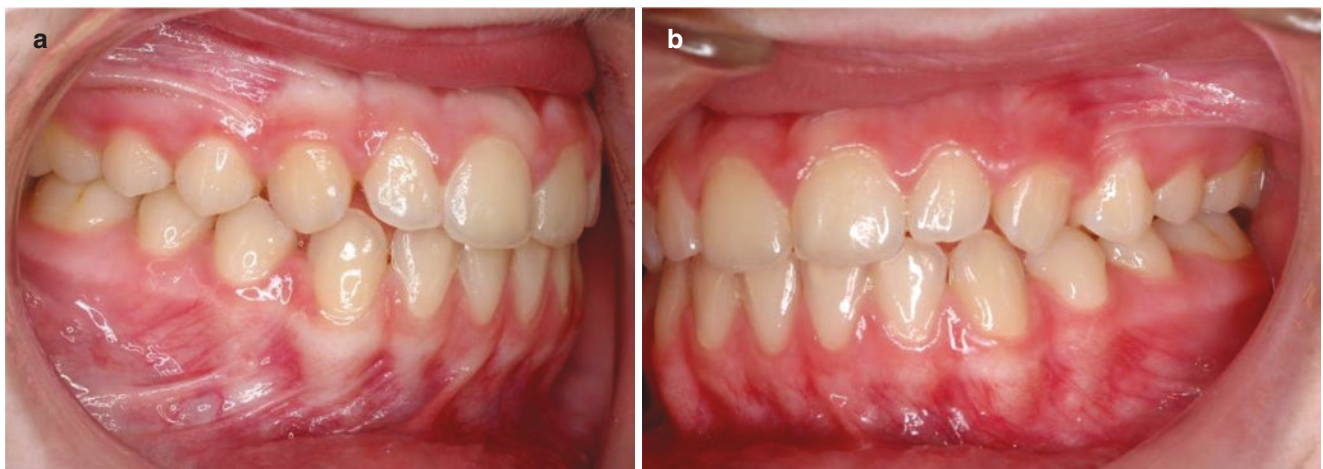


Fig. 16.15 (a, b) Lateral views at the end of treatment. Gingival and occlusal planes were parallel

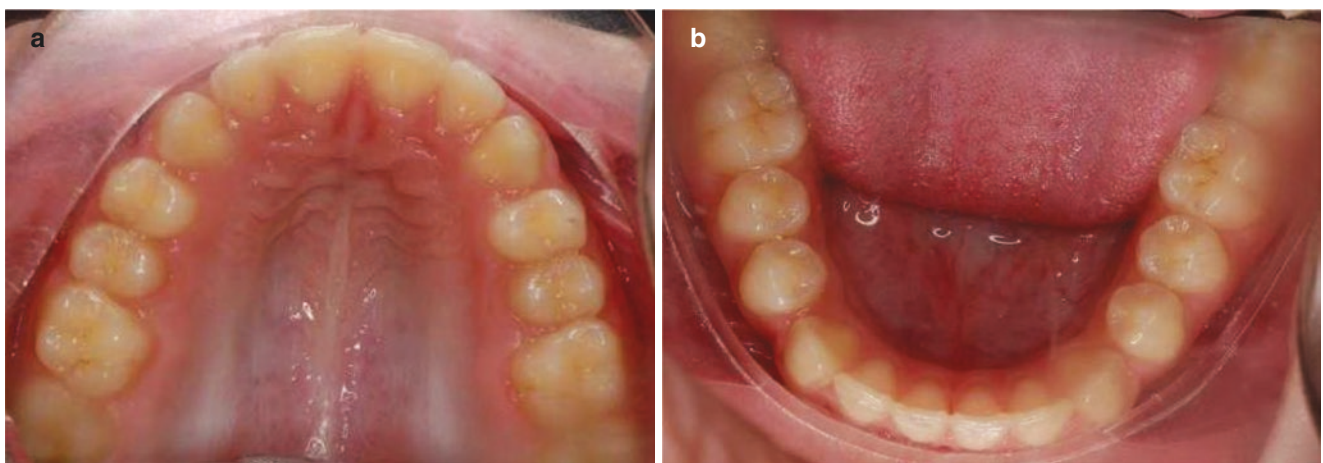


Fig. 16.16 (a, b) Occlusal photographs at the end of treatment

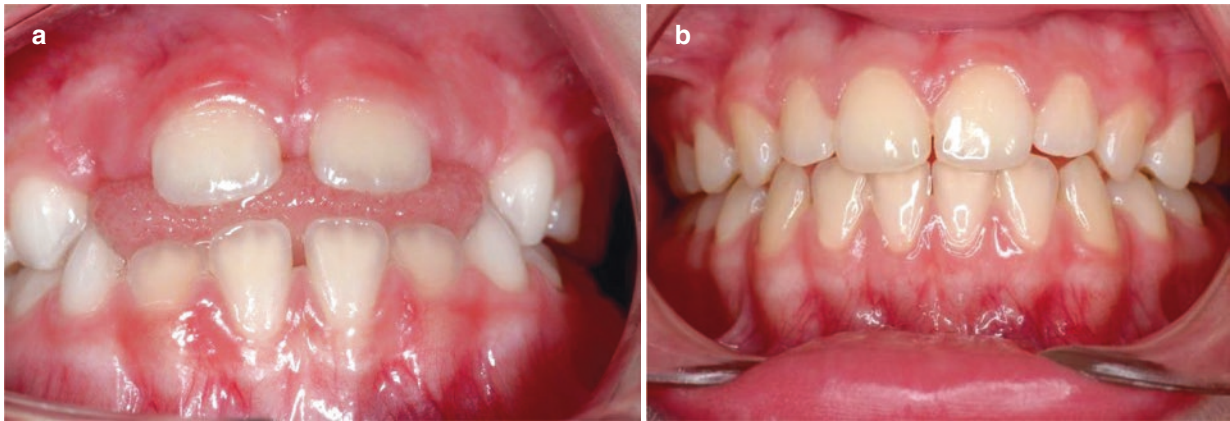


Fig. 16.17 (a, b) Comparison of frontal dental photograph pre- and posttreatment

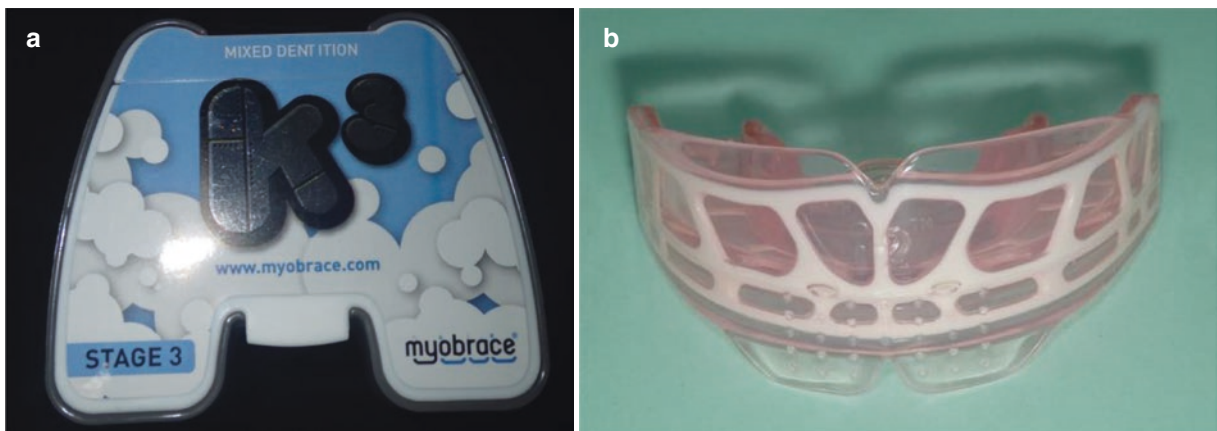


Fig. 16.18 (a, b) Myobrace System for the retention period

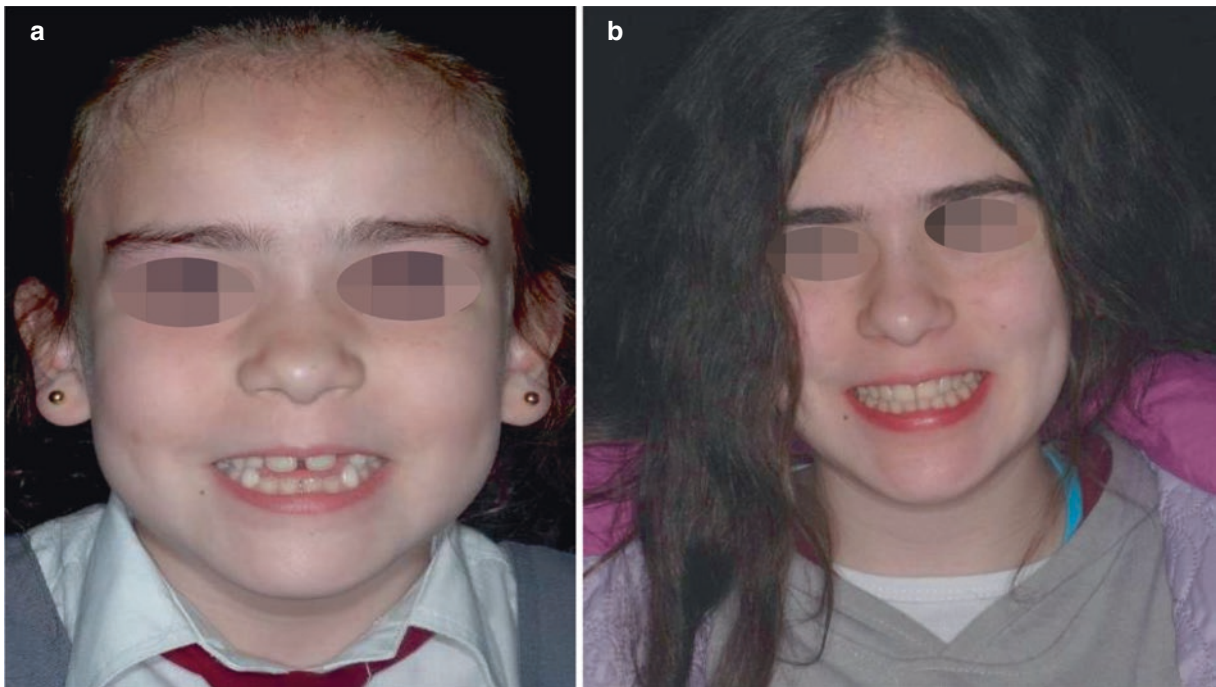


Fig. 16.19 (a, b) Comparison of pre- and posttreatment photographs



Fig. 16.20 (a, b) Pretreatment frontal and profile photographs

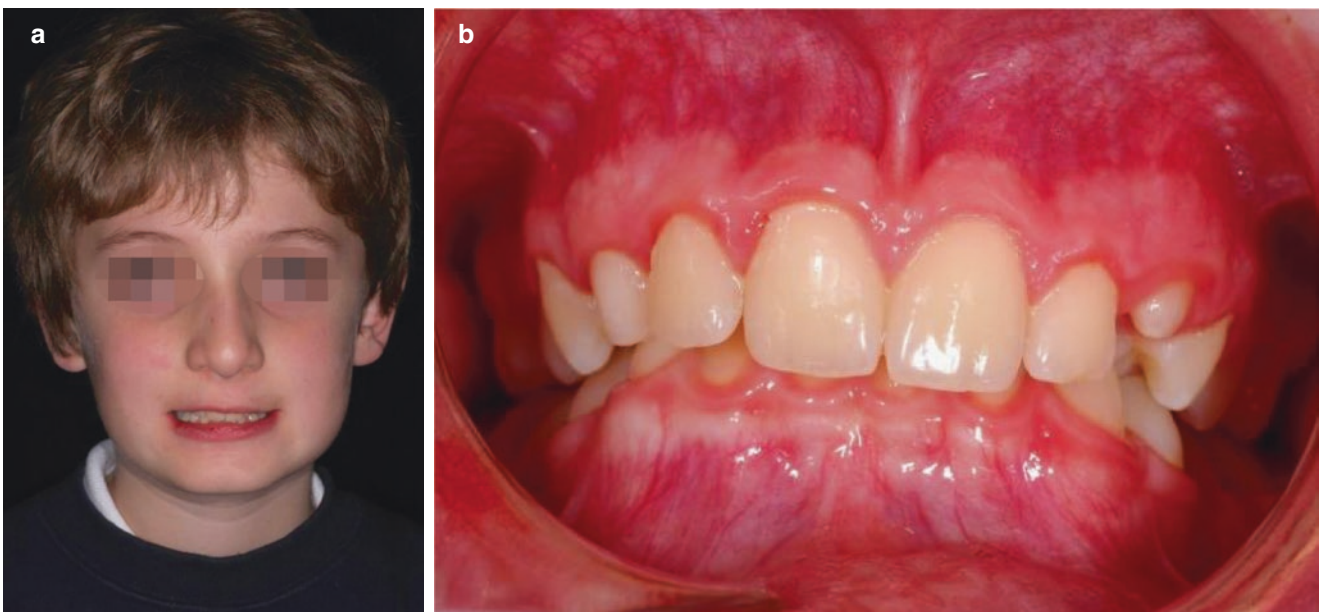


Fig. 16.21 (a, b) Smile and dental frontal photographs



Fig. 16.22 (a, b) Pre lateral views. Retrusion of the central upper incisors was remarkable

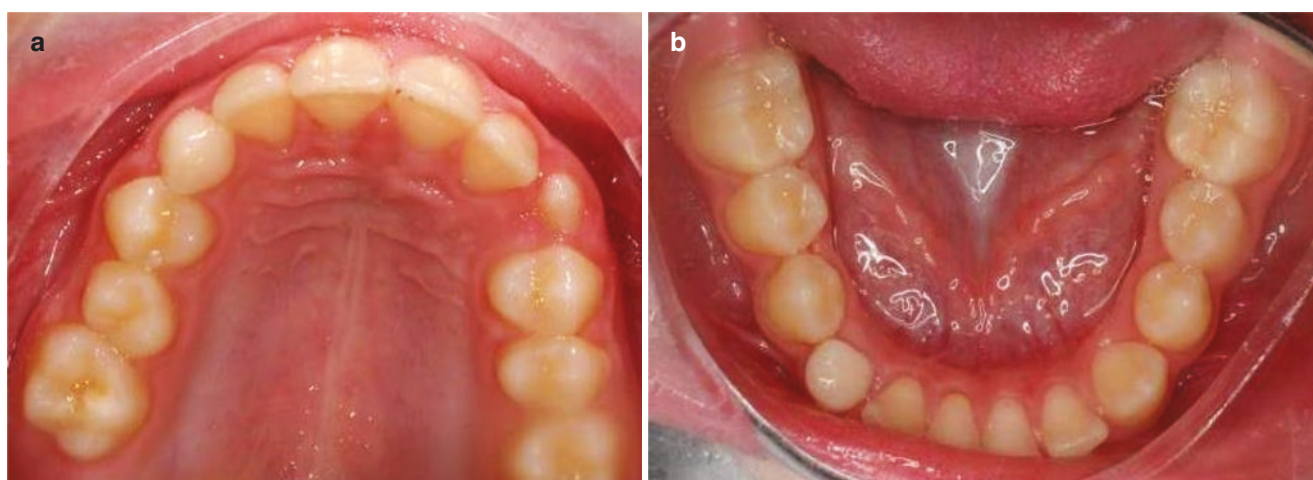


Fig. 16.23 (a, b) Pretreatment photographs of the upper and lower arches

Sometimes, the uneven occlusal plane is the consequence and not the cause of the dental and facial asymmetries.

The panoramic and lateral radiographs confirmed the clinical observations: The patient had a severe brachycephalic pattern with reduced lower anterior height (35 mm), Class II molar and canine, and significant overbite (7 mm) with no agenesis or supernumerary teeth (Fig. 16.24a, b).

In order to achieve the treatment objectives, a Myofunctional protocol was advisable. The use of the Myobrace System is highly recommended since it allows treatment of the main causes of these disorders.

The time schedule included 2 h during the day and all night. This type of appliance is very child-friendly for the patient (Fig. 16.25).

These are the results after 4 months of treatment: No more pain or TMJ disturbances were present. Improvement in the front area was clearly visible (Fig. 16.26a, b).

When analyzing the right and left sides, some modification in the molar and incisor areas were observed (Fig. 16.27a, b).

Some improvement was visible when the frontal and profile photos were analyzed (Fig. 16.28a, b).

In order to continue his dental alignment and to normalize his overjet and overbite, the Trainer for Alignment Phase 2 was recommended. The time of use was similar to that of the first case: 2–3 h a day and all night (Fig. 16.29a, b).

The following photographs explain how the appliance should be used very clearly. The frontal and lateral shields are useful to exercise the orofacial muscles and can improve the potential of growth (Fig. 16.30a, b).

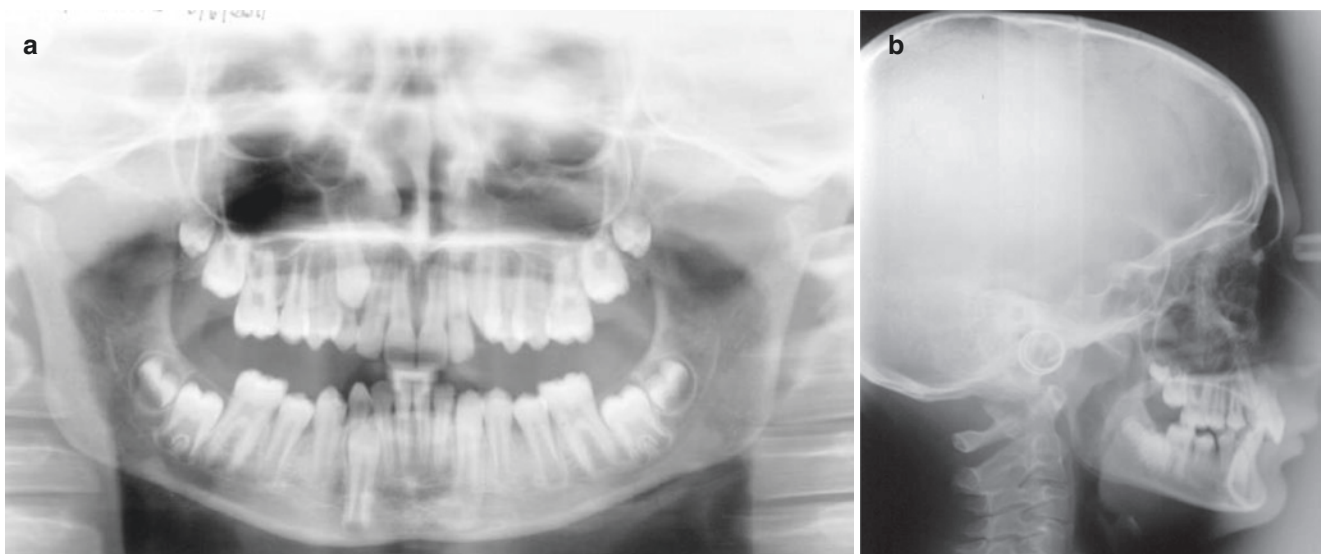


Fig. 16.24 (a, b) Pretreatment radiographic images



Fig. 16.25 Myobrace at the first stage

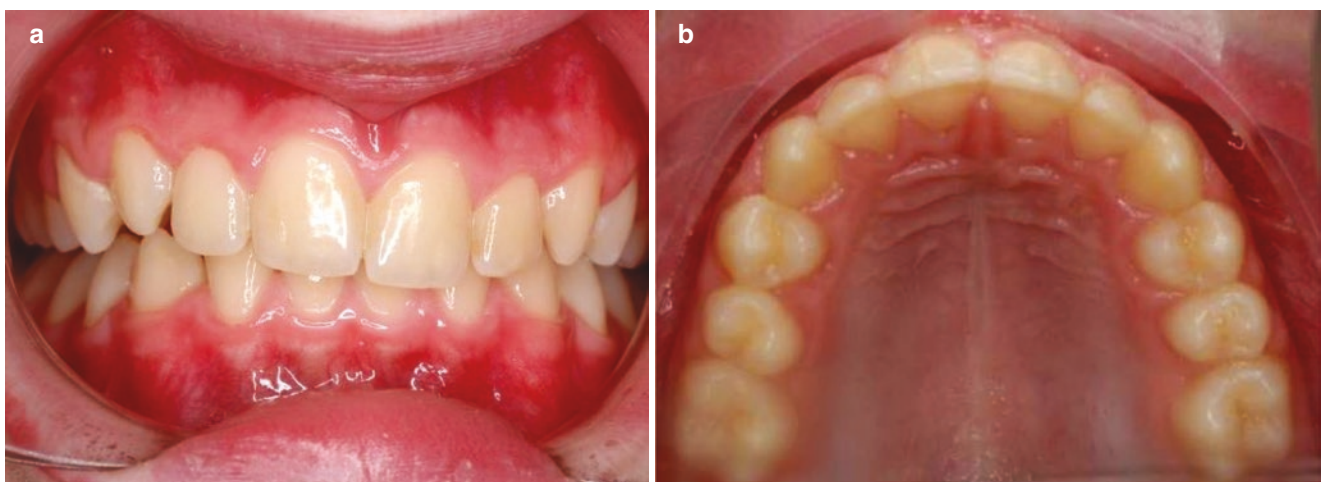


Fig. 16.26 (a, b) Frontal and occlusal photographs after 4 months of treatment

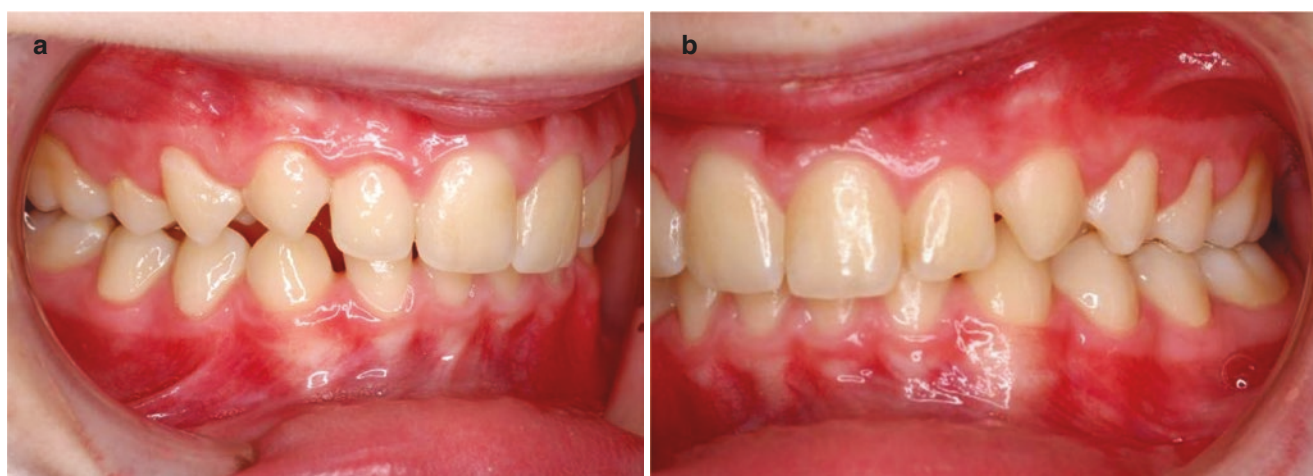


Fig. 16.27 (a, b) Lateral views after 4 months of treatment

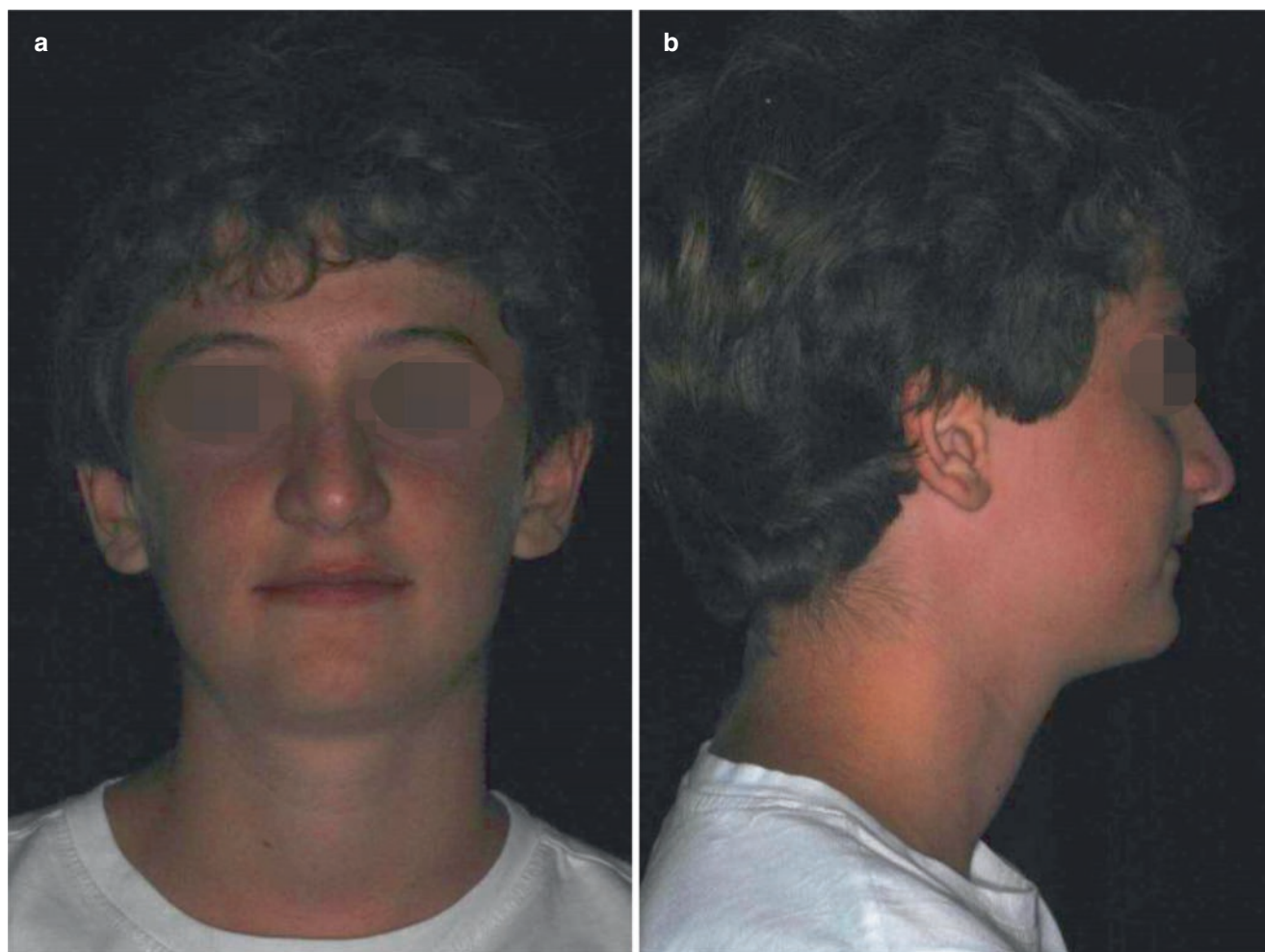


Fig. 16.28 (a, b) Frontal and profile photographs after 4 months of treatment

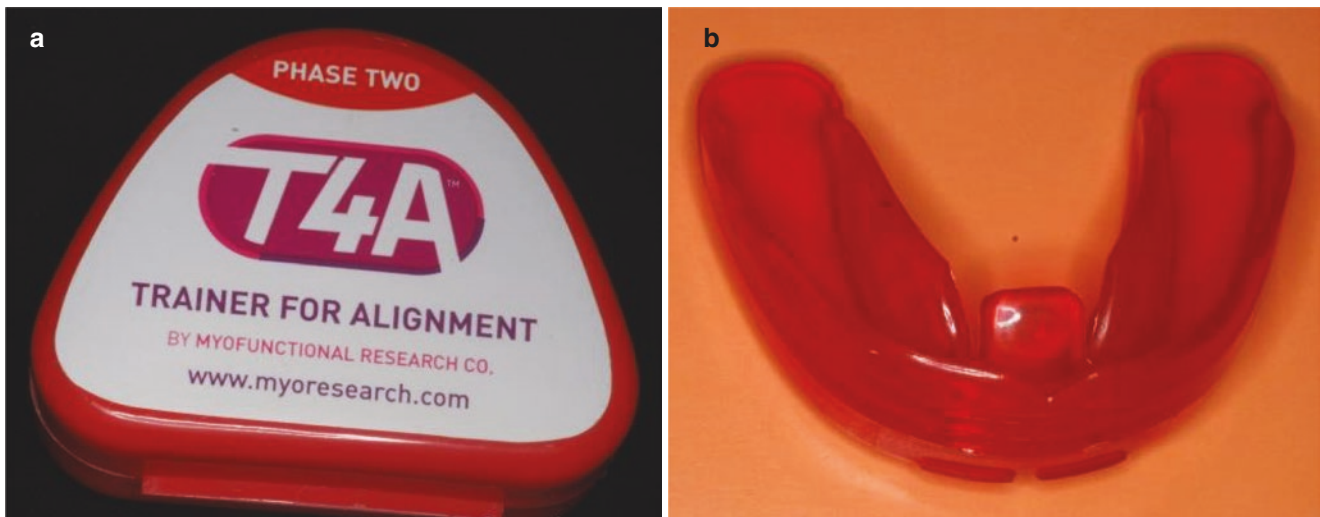


Fig. 16.29 (a, b) Trainer for Alignment (Myofunctional Research Co.)

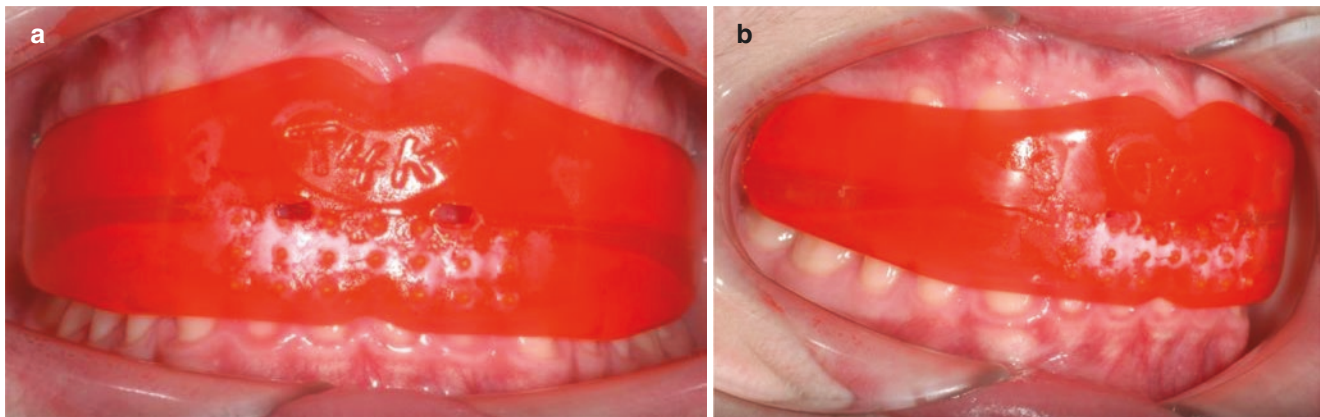


Fig. 16.30 (a, b) Frontal and lateral views with the T4A appliance in place

The following photographs showed the improvement after 12 months of treatment. Clinical enhancement of the vertical dimension was advisable (Fig. 16.31a, b).

The following photographs showed improvement after 20 months of treatment using the same time protocol: 2–3 h during the day and all night (including phase I and phase II). Complete normalization of the overjet and overbite was achieved (Fig. 16.31a, b).

Since his family had moved, the patient returned to the office 3 years later. He had lost his last appliance weeks earlier. Although mild asymmetry was visible, TMJ problems nor important headaches were not present (Fig. 16.32a, b). Normalization of the overjet and overbite was maintained. In order to maintain these positive results, a new Myobrace appliance was suggested (Bakke and Moller 1991) (Fig. 16.32a, b).

The lateral facial photographs showed a significantly concave profile with tension of the upper lip when the patient smiles. The lower third of the face was almost normal (Fig. 16.33a, b).

At this time, a new appliance was recommended in order to maintain the results and control the musculature. The occlusion was stable (Fig. 16.34a, b).

The lateral views confirmed that Class I canine and molar were maintained as well as a normal overjet and overbite (Fig. 16.35a, b).

The occlusal photographs showed a normal arch form with no cavities nor periodontal problems (Fig. 16.36a, b).

It is interesting when pre- and 3 years' posttreatment frontal photographs are analyzed. Complete correction of the uneven gingival line was achieved and a significant overbite and midlines were normalized with the use of the Myofunctional appliances (Fig. 16.37a, b).

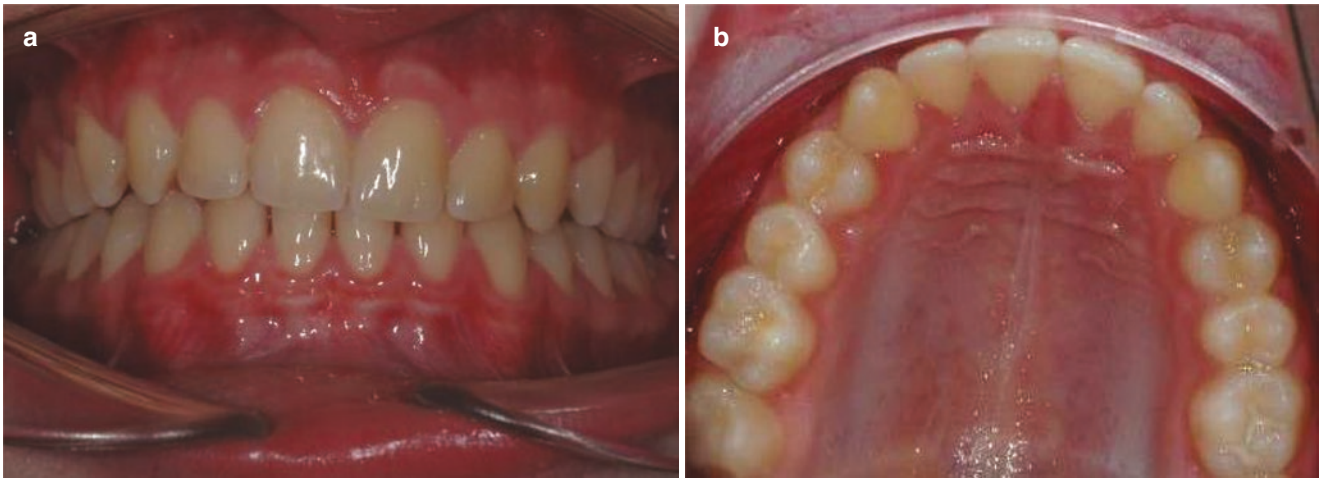


Fig. 16.31 (a, b) Posttreatment frontal and occlusal maxillary photographs

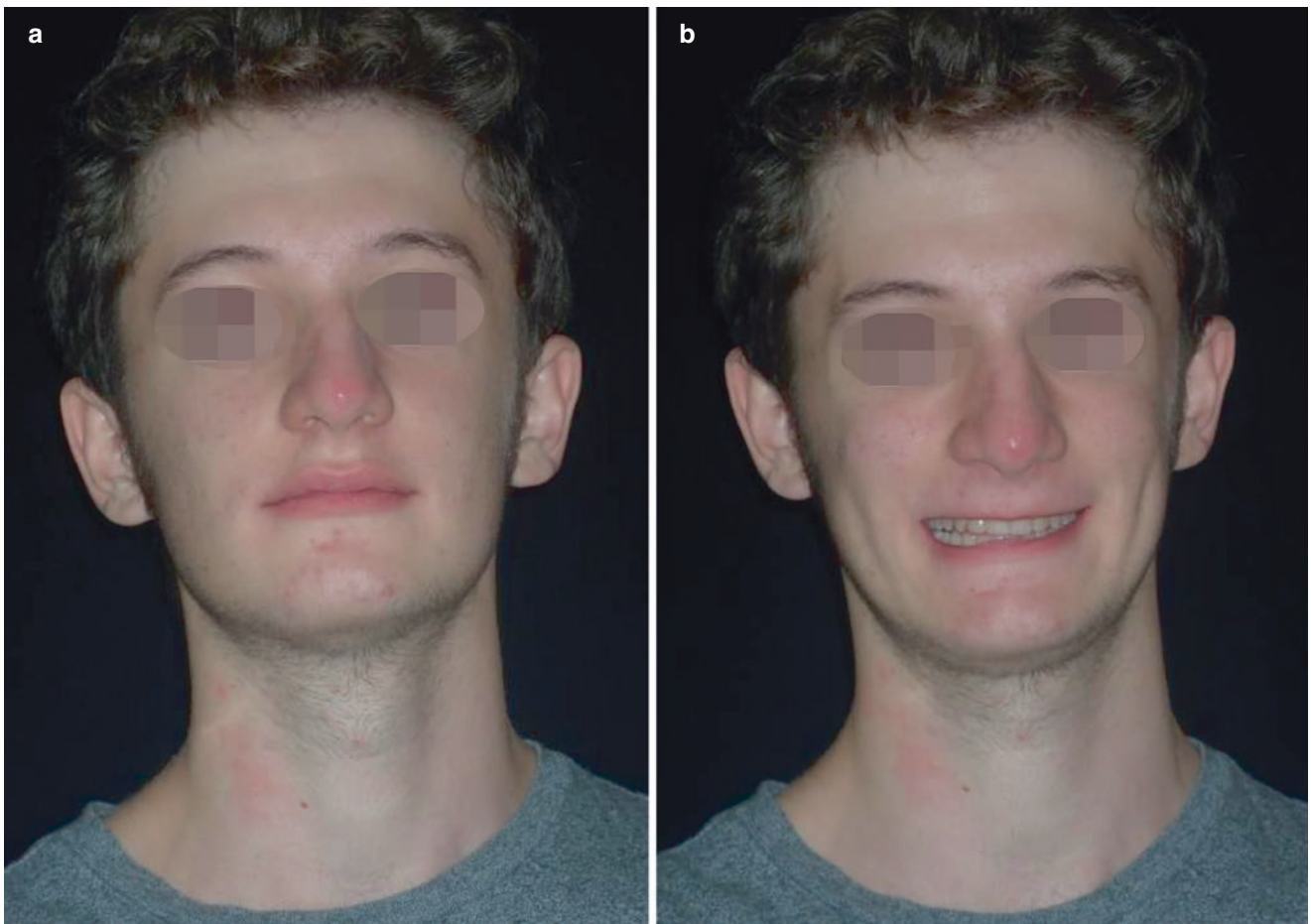


Fig. 16.32 (a, b) Front and smile photographs 3 years posttreatment



Fig. 16.33 (a, b) Lateral and smile photographs 3 years after treatment

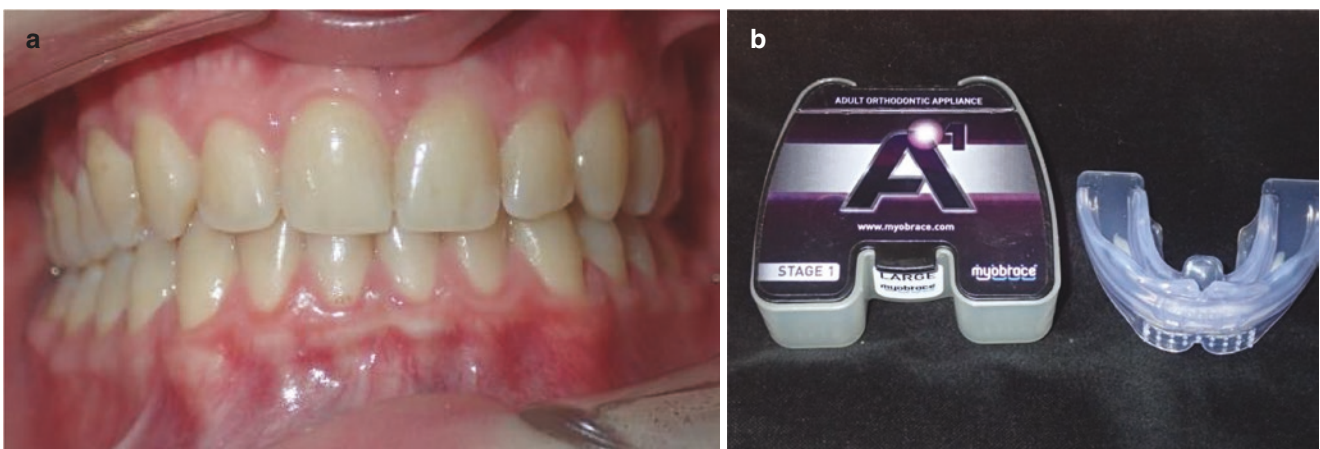


Fig. 16.34 (a, b) An adult Myobrace stage 1 was recommended to maintain the results



Fig. 16.35 (a, b) Follow-up 3 years later

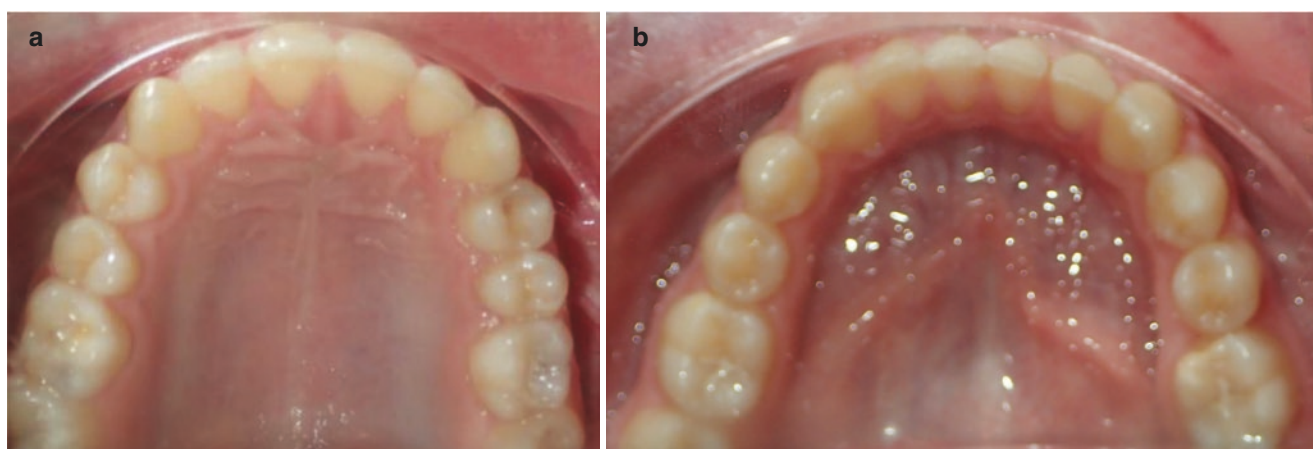


Fig. 16.36 (a, b) Upper and lower occlusal arches

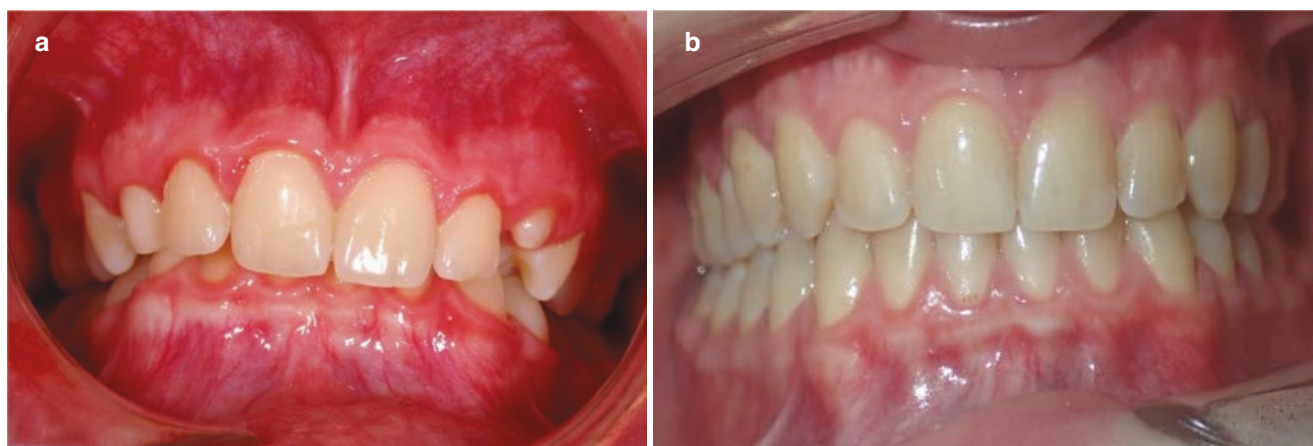


Fig. 16.37 (a, b) Comparison pre- and 3 years' posttreatment photographs

16.1 Conclusion

Ideally, open bite should be treated as early as possible. It is important to consider that reminder therapy has to be applied during the whole treatment and also during the retention period (Graber 1963).

Patients with open bite also have TMJ problems, episodes of snoring, and sleep apnea disorders. The child can stop breathing several times during the night (20–40 times per hour). As a consequence, he or she would feel daytime fatigue, sleepiness, headaches, changes in personality, lack of attention at school in the morning, etc.

Since sleep apnea is a progressive disorder, consultation with the specialist is very important from the first day in order to perform a multi- and interdisciplinary treatment and avoid relapse.

There is no doubt that early intervention of all oral habits can reduce or prevent major problems in the future. It is advisable that open bites be treated as soon as possible to reinstate normal breathing function and reduce the possibility of relapse (Urzal et al. 2013). The parents and the children have to be aware and cooperate to achieve excellent results. There is no complete evidence between the relationship of deepbite malocclusion and TMD problems, but clinical association is inevitable.

Despite the type of appliance used, the orthodontist has to bear in mind the importance of the multifactorial etiology of temporomandibular problems and to normalize its function to achieve long-term results (Posen 1972).

There is strong evidence that the earlier the open bite and deep bite problem is corrected, the better the prognosis will be.

Habit elimination is mandatory to prevent not only open bite but deep bite relapse (Ngan and Fields 1997). It is important to look for an effective protocol that should be individu-

alized for each patient. Long-term control is fundamental to confirm the achieved results (Ramirez Yañez and Paulo 2008).

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Controversies in Cleft Lip / Palate Patients

17

Julia Harfin

Different controversies are present during the cleft lip palate treatment. Some are related to pre- and postsurgical issues and others to the individualized treatment plan.

Treatment alternatives for uni- or bilateral missing lateral incisors in patients with cleft palate are space closure or opening for their replacement by fixed or removable prosthesis. Due to the lack of bone in this, area implants without bone graft are not always the best option. Closing the alveolar bone defect is a necessary step in order to restore the alveolar arch and achieve a normal occlusal pattern. An exhaustive and individualized diagnosis and treatment plan significantly improves the results with more predictable outcomes.

It is recognized that secondary alveolar bone grafting is usually done before the eruption of the permanent maxillary lateral incisor or canine in order to achieve alveolar continuity and adequate closure of the fistula. The rate of success varies between 35 and 86%. The rate of complications includes exposure of the graft associated with infections or resorption, and more than 50% of patients require a reoperation procedure (Meireles Borba et al. 2014; Feichtinger et al. 2007).

This new protocol was designed to avoid another surgery such as iliac crest bone or other types of grafts using the same concepts periodontists use to gain osseous height and width before implants are placed (Zachrisson 2003).

This procedure also increases the efficiency of treatment by reducing the number of surgeries. Bearing in mind that closing the alveolar bone defect is one of the outcomes to achieve and knowing all the consequences that these surgical procedures can produce, the new protocol plays an important role. This protocol is very easy to manage and control in all patients no matter the age or sex. No further surgeries are

required and expected long-term results are achieved (Yen et al. 2005). This new protocol is recommended as the first option to avoid failures when different surgeries to close important palatal clefts with a secondary bone graft were performed.

The following clinical case is presented to illustrate this protocol. A 14-year-old patient was sent to the office in search of a second opinion to improve the substantial palatal cleft. His dental clinical records showed five previous surgeries: at 5 months, 14 months, 4 years, 6 years, and 12 years of age, including two bone grafting procedures. Two months earlier, another soft palatal tissue surgery was performed and some sutures were still in place (Fig. 17.1a).

Figure 17.1a shows the situation at that time: the upper midline was completely displaced to the left along with the central and lateral upper incisors.

The lateral photograph confirmed the significant cleft present on the right side (Fig. 17.1b).

A new treatment plan was designed taking into account studies from Allan Fontanelle and Bjorn Zachrisson about moving teeth into an edentulous region. Bearing in mind that teeth can move with bone when lower forces are used and through bone when high forces are planned and considering that some bone was present mesial to the upper right canine, the following biomechanics was decided.

A Ni-Ti coil spring on a TMA rectangular wire (0.016" × 0.022") was placed with a very low load activation to promote its mesialization along with bone (Fig. 17.2a, b).

A very low 2-month activation was recommended. Analyzing the occlusal photo, it is easy to observe that new bone is formed distal to the canine with new soft tissue that is clearly recognizable due to its texture and color. Despite some canine mesialization, a substantial palatal cleft is still present. Brackets were bonded on the lower arch to align the occlusal plane (Fig. 17.3a, b).

Using the same biomechanics, the canine continued moving mesially after 10 months of treatment. The gingivo-periodontal tissue accompanied the mesial canine movement, and as a result, the cleft size decreased (Fig. 17.4a, b).

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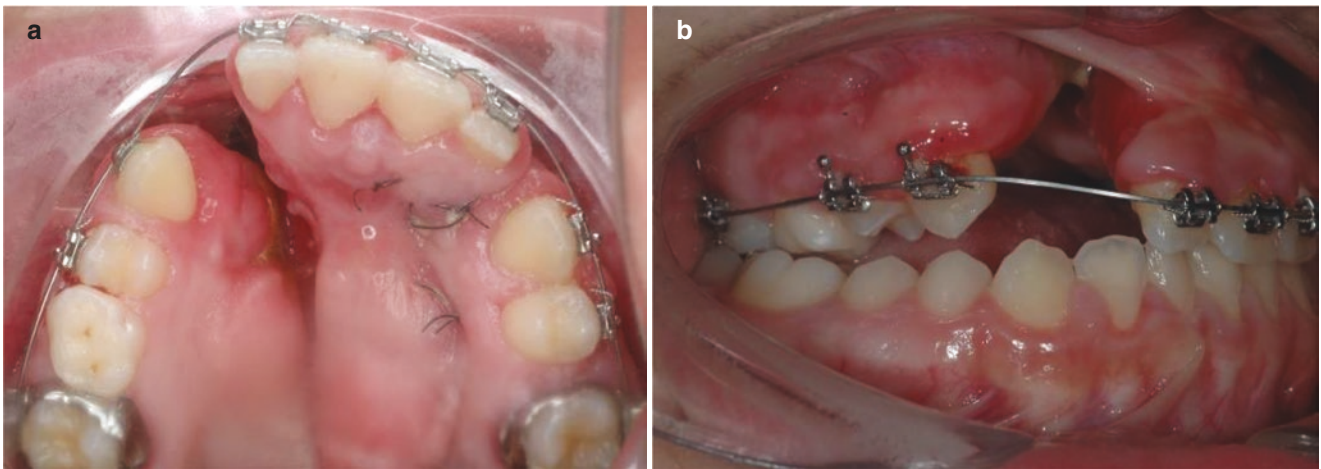


Fig. 17.1 (a, b) Significant palatal cleft with a severe midline displacement to the left side

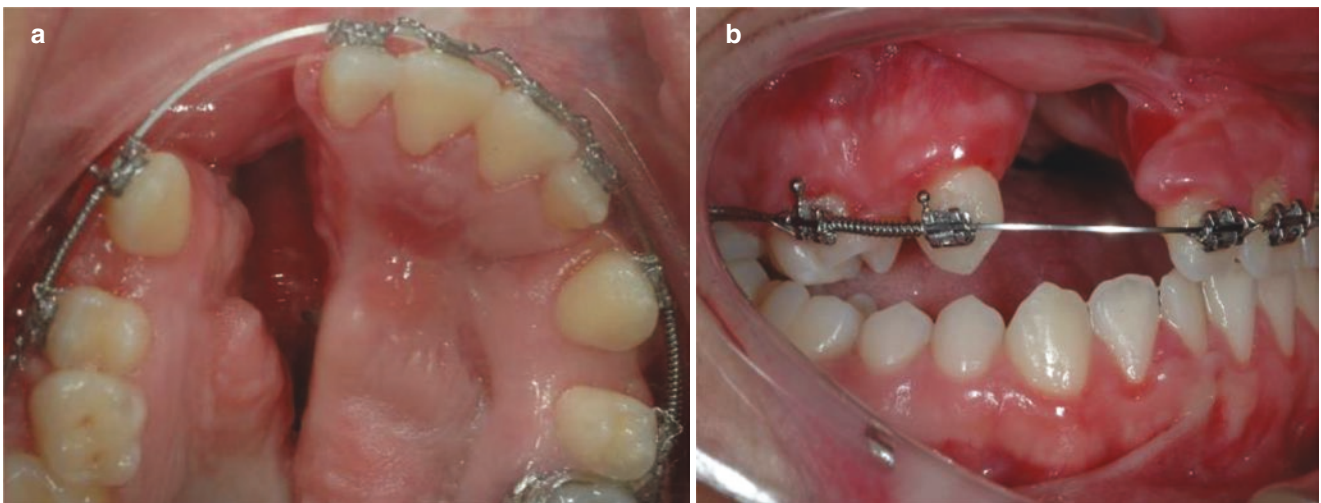


Fig. 17.2 (a, b) Use of a coil spring to mesialize the canine

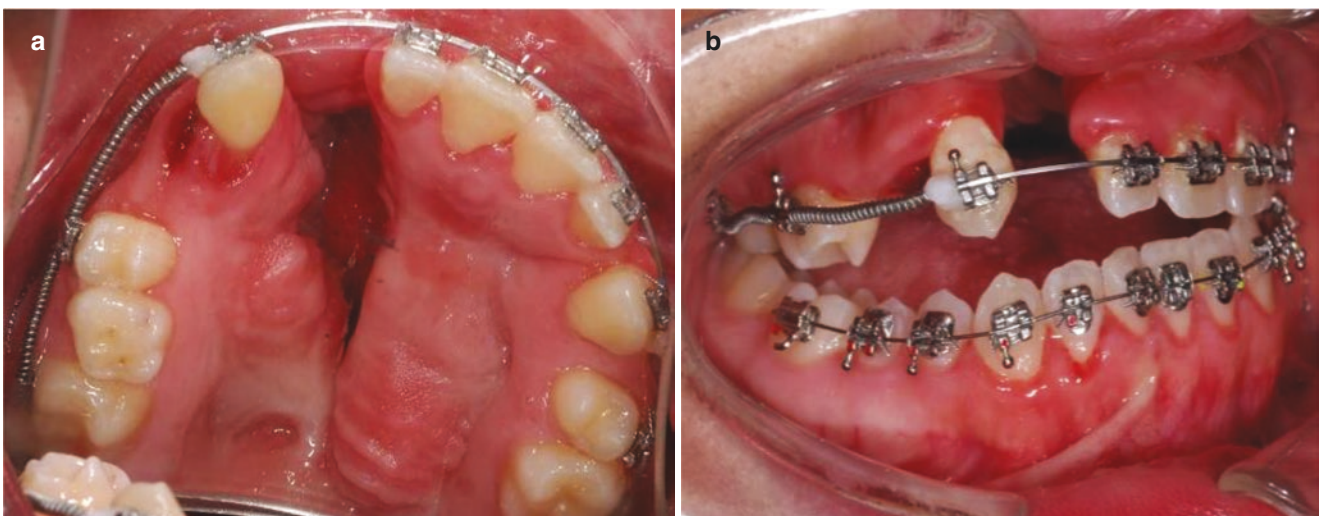


Fig. 17.3 (a, b) Occlusal and lateral views after 5 months of treatment

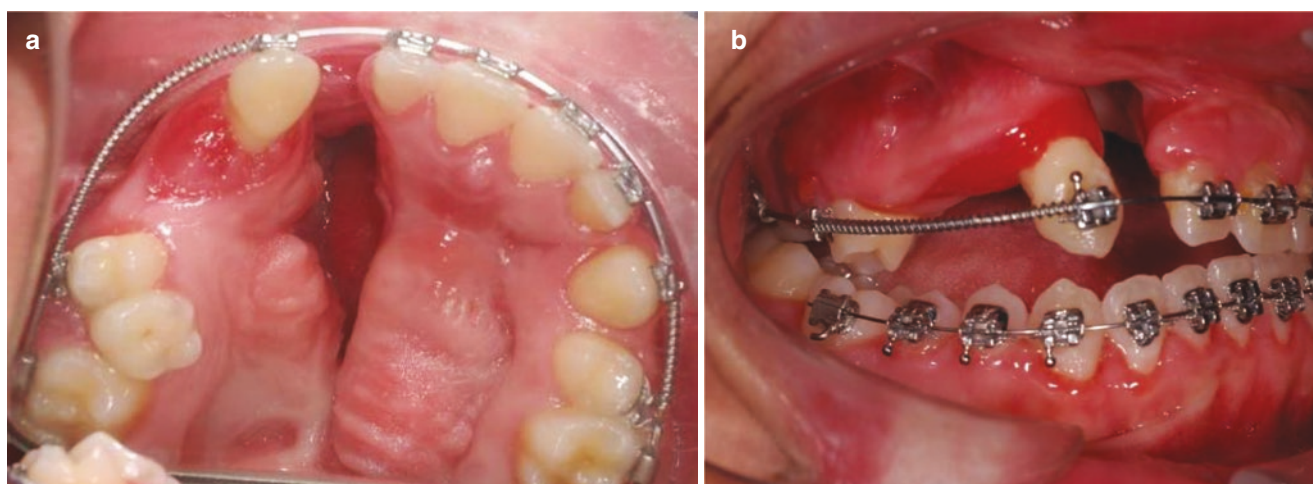


Fig. 17.4 (a, b) After 10 months in treatment

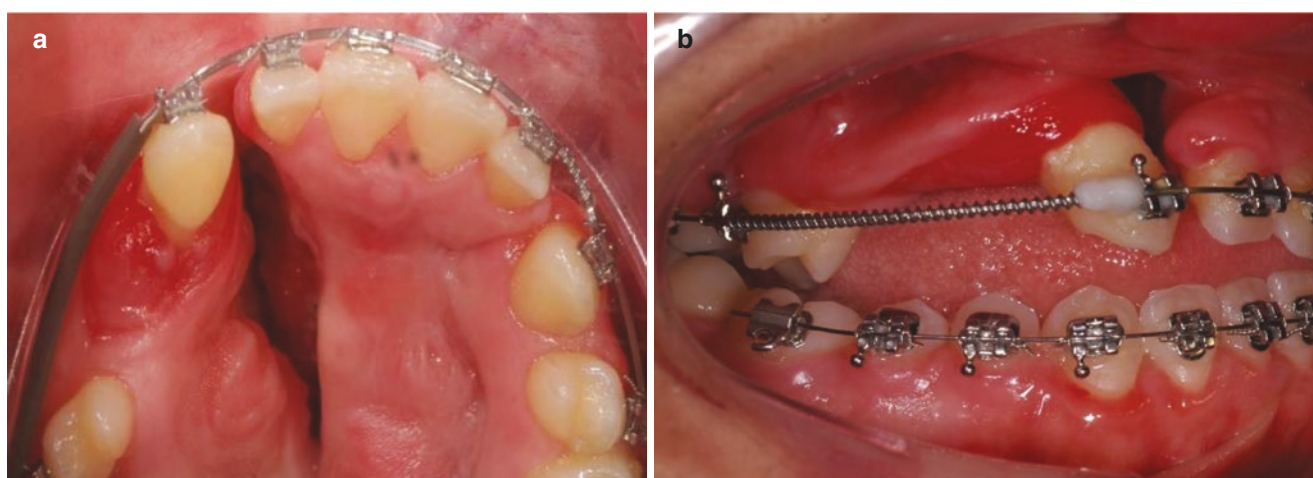


Fig. 17.5 (a, b) Occlusal and lateral views after 15 months

After 15 months of treatment, the canine is near the lateral incisor and there is a significant improvement in the palatal cleft area (Fig. 17.5a, b).

Four months later, almost the whole alveolar cleft was closed, and new bone, surrounded by normal gingivo-periodontal tissue, was created (Fig. 17.6a, b).

The comparison between pretreatment and current palatal photographs clearly demonstrates how the palatal cleft was closed. Also, it confirms the total mesialization of the right canine and the new bone that was developed distally. This new bone has an ideal height and width that are necessary for future implants or prosthesis. A new soft tissue surgery was performed to close the remaining cleft (Fig. 17.7a, b).

It should be noted that orthodontic tooth movement is a process by which the tooth is moved by the application of a force that induces bone deposition on the tension side and resorption on the compression side.

These results are clearly visible when pre- and posttreatment panoramic radiographic images are compared. It is interesting to observe the shape of the roots of the right and left upper lateral incisors. A complete alignment and leveling of the occlusal plane was achieved (Fig. 17.8a, b).

Normal bone width and height were created distal to the upper right canine without any other bone graft procedure and in a very predictable way. The following radiographic images confirm the results (Fig. 17.9a, b).

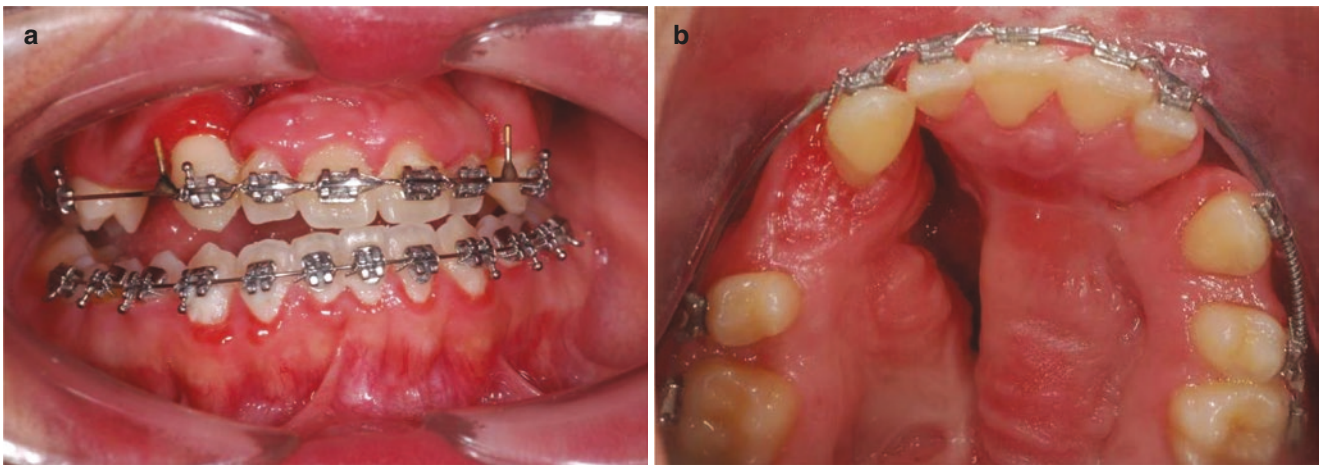


Fig. 17.6 (a, b) After 14 months, the alveolar cleft was closed

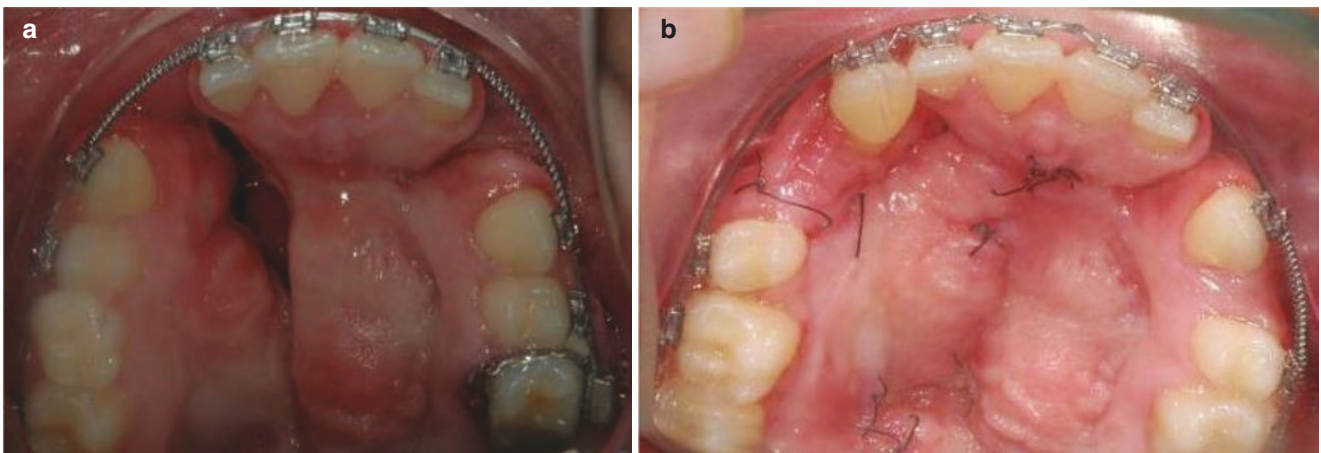


Fig. 17.7 (a, b) Occlusal view of pre- and post-mesialization of the canine and after the last soft tissue surgery

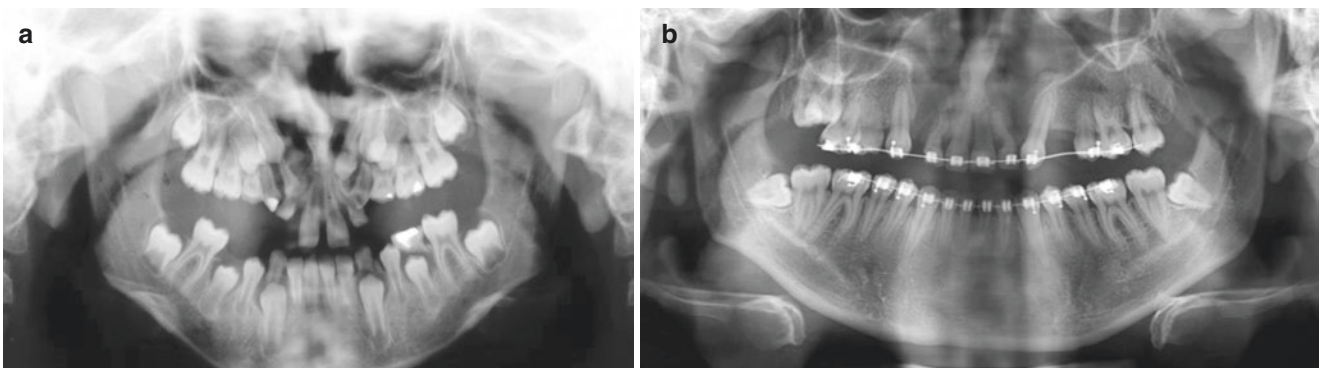


Fig. 17.8 (a, b) Comparison pre- and posttreatment panoramic radiographic images. The alignment and levelling of the occlusal plane were accomplished

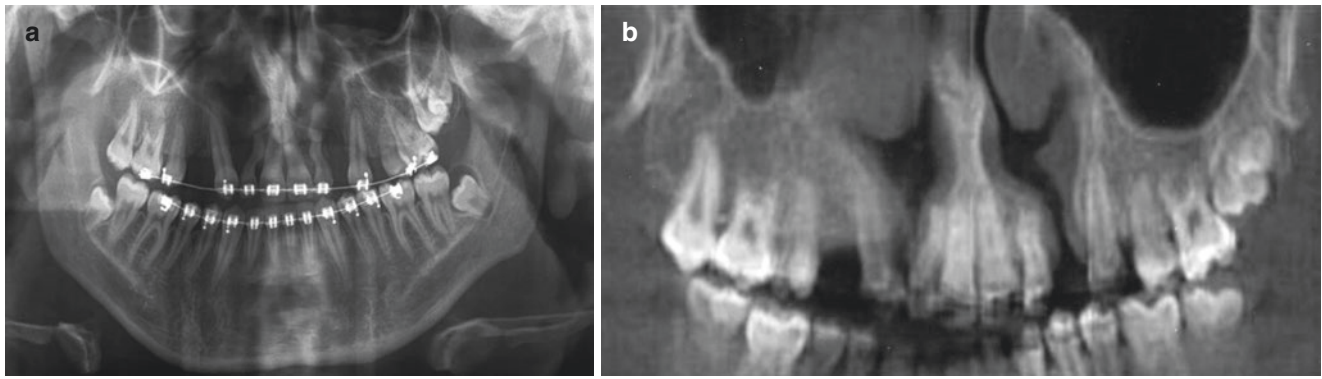


Fig. 17.9 (a, b) Posttreatment radiographic images. The achieved new bone distal to the upper right canine as well as the closure of the right cleft was confirmed

It is important to highlight all the improvements seen when the right and left side clefts were compared. Closure of the right cleft is almost complete. The cone beam clearly showed the amount of bone distal to the canine.

17.1 Conclusions

This new protocol is very useful to treat patients with severe cleft palate deformities along with large cleft spaces. There are few complications and many benefits. No morbidity associated with grafting large alveolar clefts and new and healthy bone is generated.

The treatment of patients with cleft lip and palate requires a multidisciplinary team beginning at pregnancy and continuing during childhood and adolescence. This approach introduces a new paradigm in treating this type of patients, since it is possible to create new bone surrounded by normal

gingivo-periodontal tissues that otherwise are very difficult to obtain. Long-term follow-up is needed to maintain the achieved results.

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Controversies Concerning Early Treatment

18

Julia Harfin and Kurt Faltin Jr

Why are controversies in early treatment a continuous topic in all worldwide meetings after more than 100 years? Will it be solved in the next 10 years? The first question to answer would be: Is it really an efficient and effective method of treatment? Yes, it is, respecting the biological sequence of priorities established through a complete diagnosis. Unfortunately, there is not only one answer, since every patient is unique. Their malocclusion is the result of the deviation of skeletal, dental, and neurophysiological problems along with different directions and amount of growth.

An individualized diagnosis is the criteria of decision for which type of cases should be treated by the clinician to offer the best option for each individual patient. Since a considerable amount of growth occurs during the transitional period, it is a real advantage to begin skeletal correction during this period and avoid worsening of the problem, especially when craniofacial dysfunctions are present.

It is important to emphasize that the early treatment stage does not avoid a second phase of treatment but surely reduces its length and complications. Therefore, many incipient malocclusions could be prevented since they are affected by environmental factors. The interaction between the perioral musculature and orofacial structures determines the future occlusion.

The need to control oral habits such as mouth breathing, tongue thrust swallowing, and finger or lip interposition during rest or function plays an important role. Cooperation between the patient and the parents in combination with the speech therapist is fundamental when the treatment plan has to be determined. Unfortunately, there is no single appliance

that can suit all patients alike. Nonetheless, different approaches of treatment are available depending on etiological factors.

What are the risks, costs, and benefits of early orthodontic treatment? The answer for this question is a correct diagnosis and a profound knowledge of craniofacial and dental development. It is important to remember that some malocclusions are best treated early for biological, functional, and social reasons. The normalization of function and the possibility to redirect growth is the best option. One of the most common controversies in the early mixed dentition is how, when, and why patients should be treated in one, two, three, or more phases.

The problem in orthodontics is to move teeth in harmony with the face and keep them stable after treatment. (Horn) The transition from mixed to permanent dentition is an important period in orthodontic decision-making. This stage is the most important due to the unique opportunity in using the prepubertal growth spurt.

There are no doubts about the early correction of anterior or posterior crossbite in order to prevent further and more complicated malocclusions. The normalization of the position and inclination of the incisors and molars are closely related to the direction of growth of the maxilla and mandible, no matter the type of appliance used. Numerous papers confirmed this approach, (Mandal, Sugawara) although others suggested waiting until the post-peak of growth to solve all problems in only one stage. More extractions or orthognathic procedures would be the answer.

Before deciding on the final treatment plan, it is important to determine the etiology, severity, and nature of the problem. It is important to determine how long the child has had this habit, when the habit took place (day, night, or all day), and the willingness of the child to correct it. The following examples show the importance of beginning the treatment as soon as possible and, in this way, to reduce further inconveniences and, in some cases, avoid extractions and/or orthognathic surgery, no matter the severity of the initial Class II or III problem.

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The next clinical case is a clear example of the importance of a two-stage treatment. She was 8 years, 9 months old and was sent to the office for a second opinion regarding the best moment to begin the correction of her occlusion. She had recurring colds in concordance with episodes of high fever and asthma attacks. The odontopediatrician recommended that the best time to begin orthodontic treatment was when the second molars have erupted, and with this protocol, only one phase would be needed. Early consultation with the maxillofacial surgeon was also recommended.

The facial photographs showed a convex profile with a short upper lip and the impossibility to close her mouth at rest position. The lower lip was behind the upper incisors. The nasolabial angle was acute and the mandible was totally retruded. An early consultation with the otorhinolaryngologist is strongly advisable, since oral respiration and nasal obstruction are common findings among orthodontic patients. An abnormal respiratory function can affect craniofacial growth and produce or enhance malocclusions. Early intervention is mandatory to reduce the risk of fracture of the upper incisors and from the psychological aspect too (Fig. 18.1a, b).

The upper and lower incisors had fully erupted and some diastemas were present in the upper arch. The interincisal upper papillae was absent (Fig. 18.2a, b) and oral hygiene

was fairly good. The lower lateral incisors were lingually positioned in the lower arch.

The lateral photographs confirmed a significant overjet (8 mm), which is an important risk factor in the fracture of maxillary incisors at school or at home (Fig. 18.3a, b). A considerable overbite was also present. The lower incisors were in contact with the palatal tissues.

The pretreatment occlusal photographs showed rounded arcades with diastemas in the upper arch and slight crowding in the lower arch. No caries or periodontal problems were present (Fig. 18.4a, b).

The panoramic radiographic image demonstrated normal sequence of eruption of the permanent teeth according to her age. No agenesis or supernumerary teeth were present (Fig. 18.5a). The lateral radiographic image clearly showed considerable protrusion of the upper incisors in concordance with the protrusion of the upper lip (Fig. 18.5b).

Taking into account that functional problems had to be normalized first, the following treatment plan was designed: (a) normalization of the position of the first molar since it is easier before the eruption of the second molar and (b) correction of habits as soon as possible to facilitate tooth eruption in a normal position and allow the normal development of the mandible. Habits needed to be corrected as early as pos-

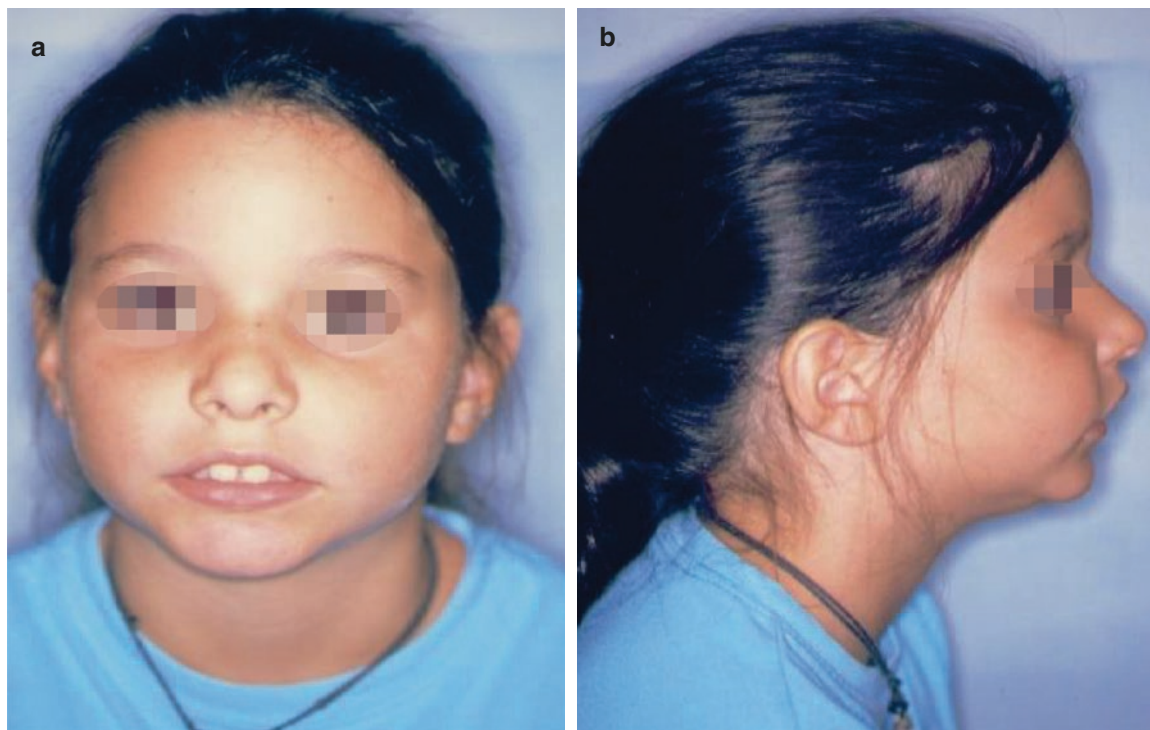


Fig. 18.1 (a, b) Pretreatment frontal and profile photographs. A significant convex profile with a short upper lip was confirmed in concordance with the position of the lower lip behind the upper incisors

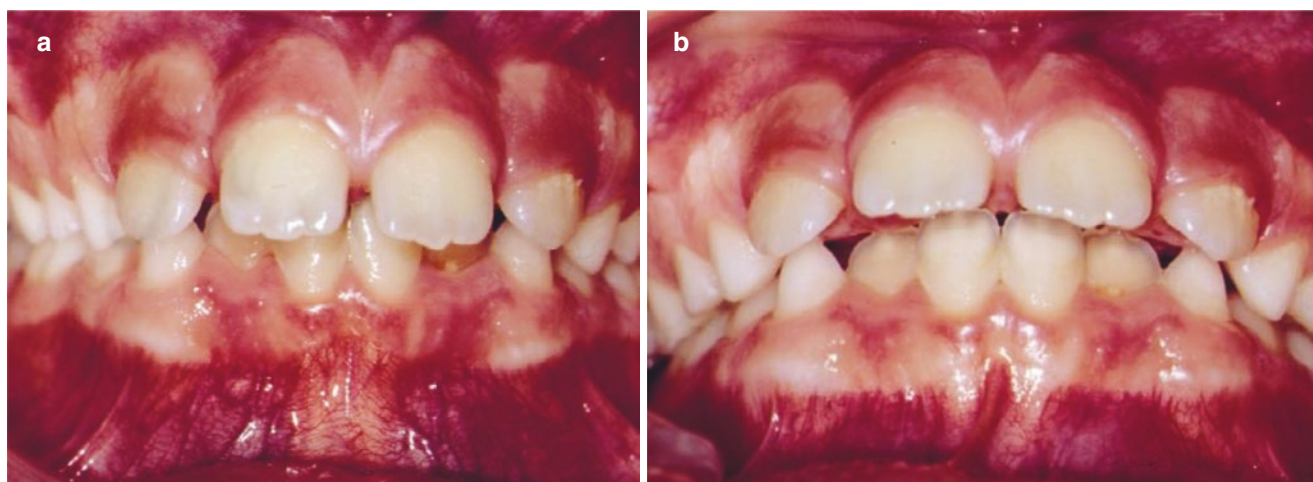


Fig. 18.2 (a, b) Frontal photographs at the beginning of treatment. An upper interincisal diastema was present

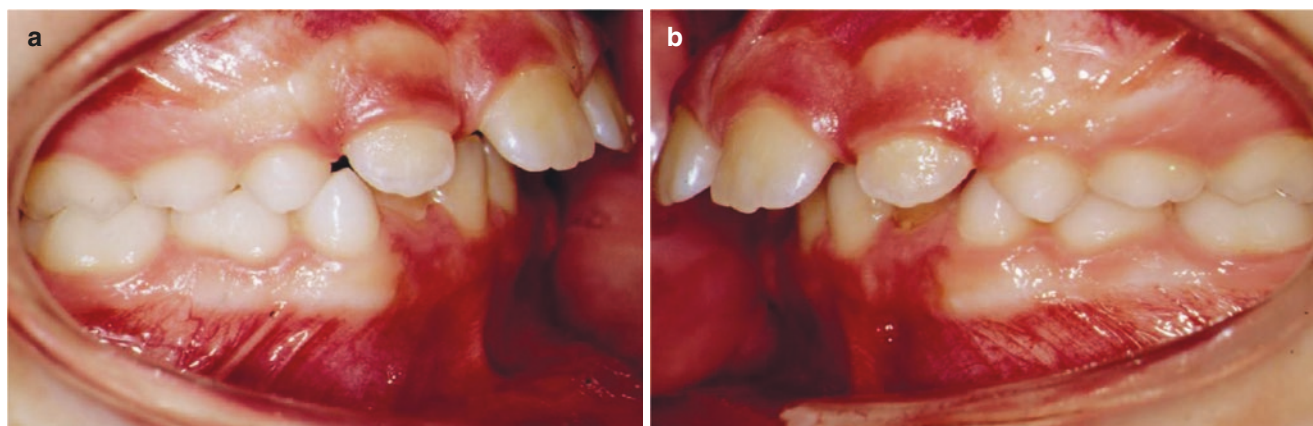


Fig. 18.3 (a, b) Significant overjet and overbite were confirmed along with Class I molar and a significant overbite with repositioning of the lower incisors

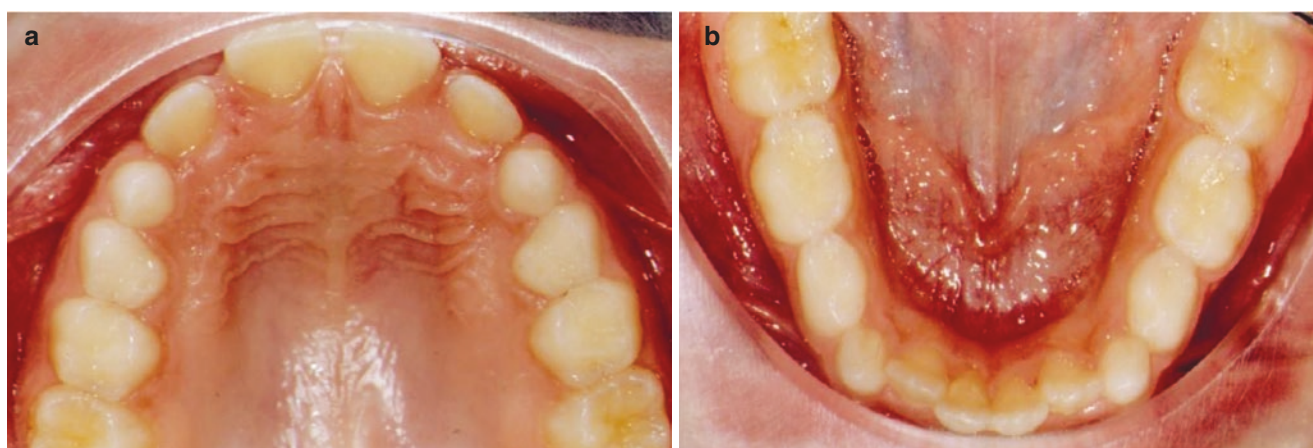


Fig. 18.4 (a, b) Upper and lower pretreatment rounded arches

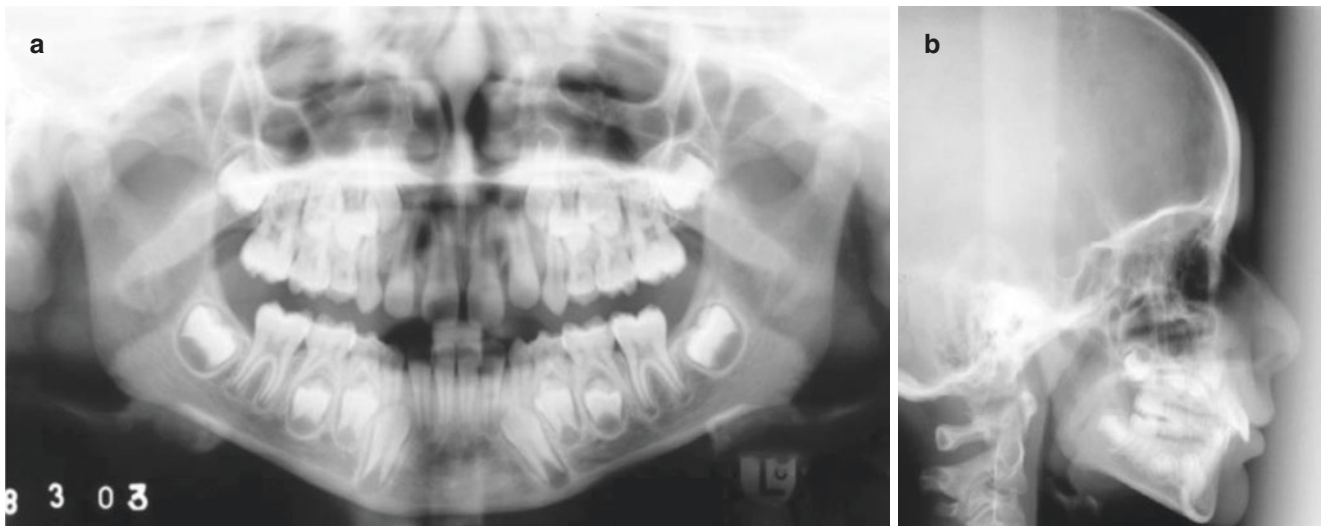


Fig. 18.5 (a, b) Pretreatment panoramic and lateral radiographic images. The protrusion of the upper incisors was confirmed as well as the significant overbite

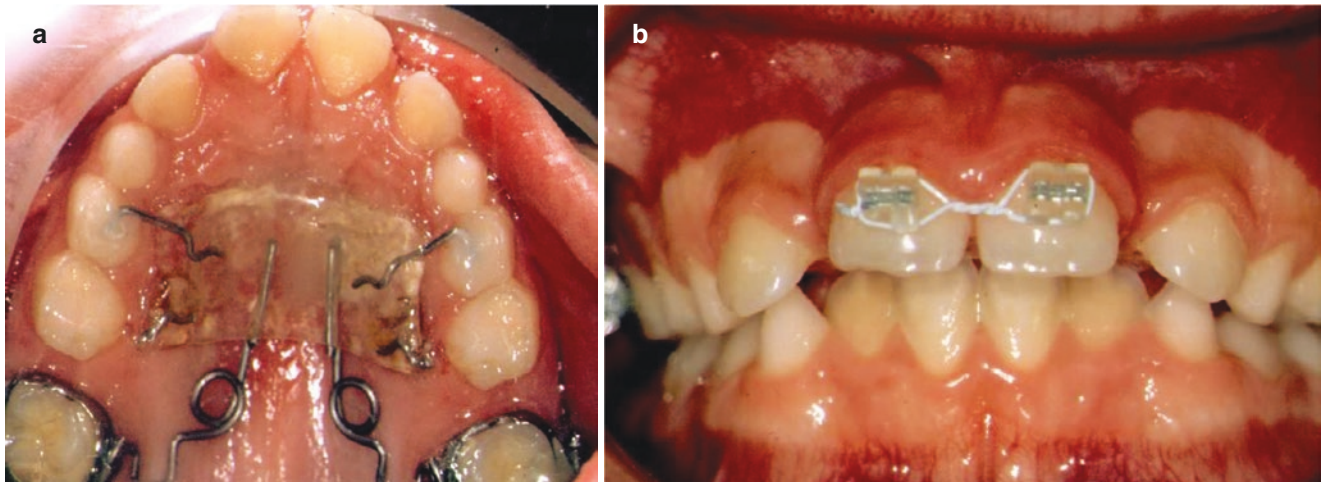


Fig. 18.6 (a, b) A pendulum was bonded to normalize the position of the first molars in conjunction with esthetic brackets on the central incisors to close the interincisal diastema

sible to reestablish the normality in the maxilla and mandibular direction of growth, as well as reduce the length of the second phase of treatment. Among all the factors that had to be considered, the most significant were determining the best treatment plan and the enhancement of the profile with facial balance and long-term stability.

It is well known that normalization of the position of the first molar is easier before the eruption of the second molar. To achieve this objective, a pendulum was bonded along with esthetic brackets on the central incisors to close the interincisal diastema that was one of her parents' concerns. An 8-week activation period was suggested (Fig. 18.6a, b).

After the distalization of the second temporary molars, brackets were bonded on the upper lateral incisors with a

0.016" SS archwire to normalize their position and inclination (Fig. 18.7a, b).

In order to maintain the anteroposterior position of the upper first molars, a Nance button was recommended. Upper and lower utility arches (Elgiloy 0.016" × 0.016") were placed to normalize overjet and overbite. All anterior diastemas were closed and the position and inclination of the upper incisors improved (Fig. 18.8a, b).

After the eruption of the bicuspid, two lingual brackets were bonded on the palatal surfaces of the upper central incisors along with an 0.018" SS archwire with two vertical loops distal to the upper lateral incisors to improve the pretreatment overjet and overbite (Fig. 18.9a, b).

Lateral views with the same arch in place. Class I molar and canine were achieved. To maintain Class I canine and

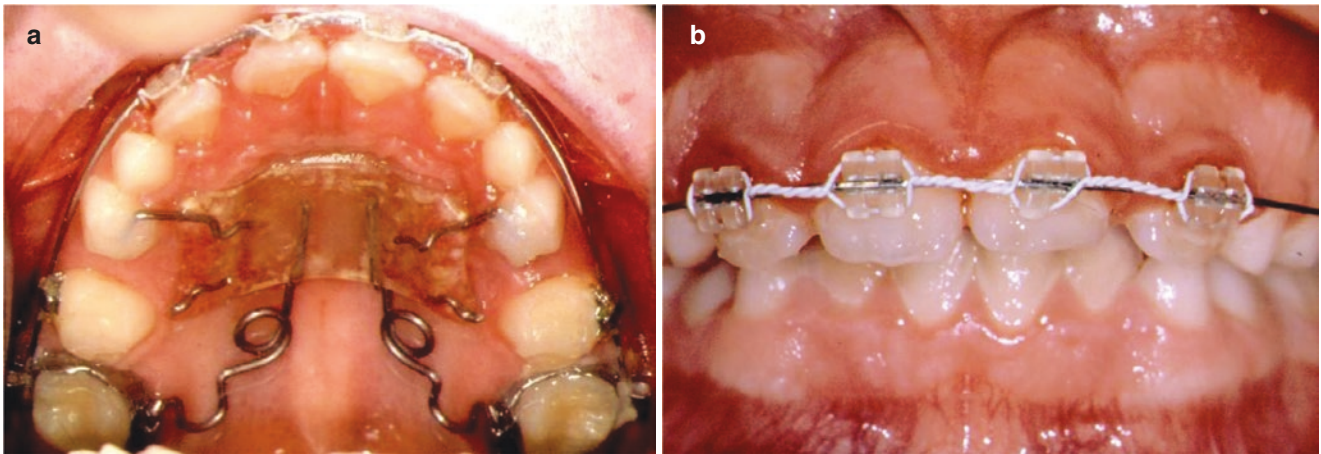


Fig. 18.7 (a, b) The second temporary molars were completely distalized and the anterior diastemas were closed with a ligature-of-eight on a 0.016" SS archwire

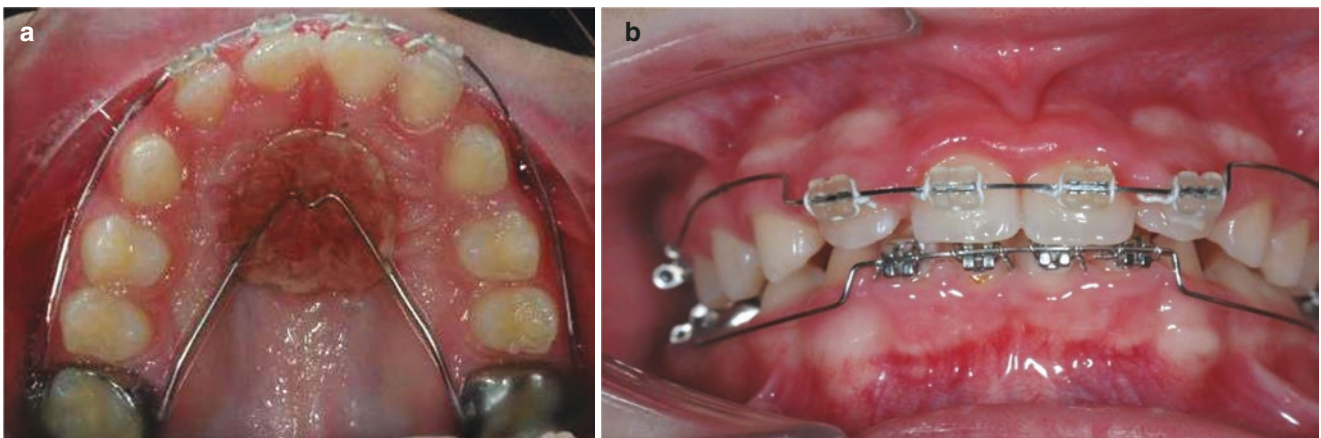


Fig. 18.8 (a, b) A Nance button in place to maintain the new position of the right and left first molars with upper and lower utility arches to help the normalization of the overjet and overbite

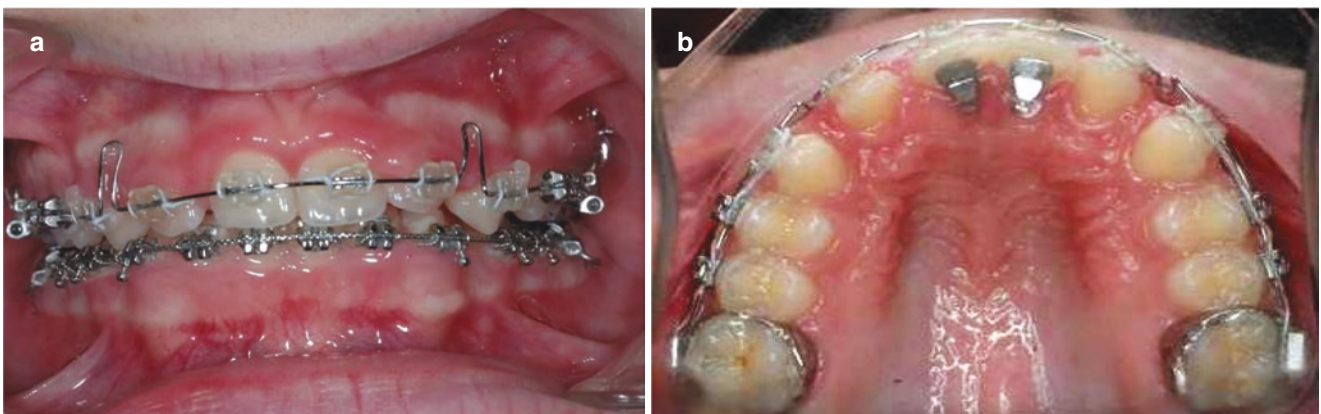


Fig. 18.9 (a, b) An 0.018" SS archwire with two vertical loops was placed to achieve normal overjet and overbite after the eruption of the bicuspids. Also, two lingual brackets were bonded on the palatal surfaces of the central incisors

molar, ligature-of-eight was used between the cuspids and first molars (Fig. 18.10a, b).

The results after the active orthodontic treatment confirmed the normalization of the overjet and overbite. All the diastemas were closed and midlines were coincident. The gingival line and occlusal plane were parallel (Fig. 18.11a, b).

Class I canine and molar were achieved with normal occlusion in the bicuspid area. The patient maintained good oral hygiene during the entire treatment process (Fig. 18.12a, b).

At final frontal and lateral photographs taken 2 years after treatment, the patient was able to close her lips without any muscular strain. She had a straight profile with a normal nasolabial angle, as a consequence she became a nose breather (Fig. 18.13a, b).

The comparison of the pre- and posttreatment photographs clearly demonstrates the importance of early treatment with better patient and parent compliance. Improvement

of the lower third of the face was remarkable (Fig. 18.14a, b). All treatment objectives were fulfilled.

The same results were observed when the profile photographs were compared. Since the orofacial functions were normalized, the change in the position and length of the upper lip was remarkable (Fig. 18.15a, b).

The pre- and posttreatment lateral radiographic images confirmed the theory that when function is normalized, the soft and hard tissues will develop in the normal direction. Since the radiographic images were taken in different institutes, it was impossible to compare the tracings of the two cephalographic images (Fig. 18.16a, b).

It is highly recommended to correct deepbite malocclusion early on because the unfavorable consequences of an untreated deepbite include an increase in lower anterior crowding, maxillary dental flaring, and associated periodontal breakdown. (Franchi) In this patient, the normalization of

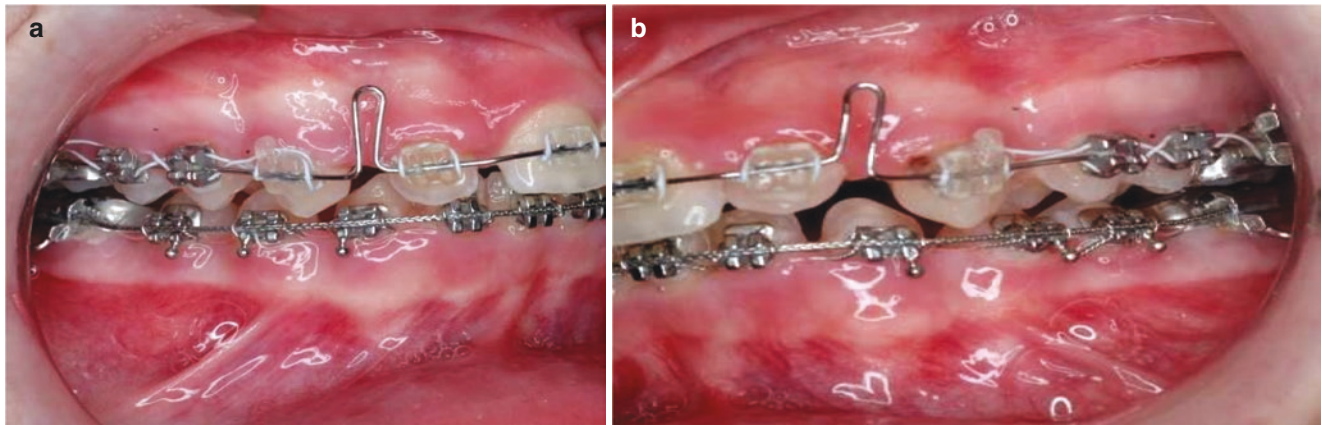


Fig. 18.10 (a, b) Right and left sides with the double-loop arch in place. Class I canine and molar were maintained

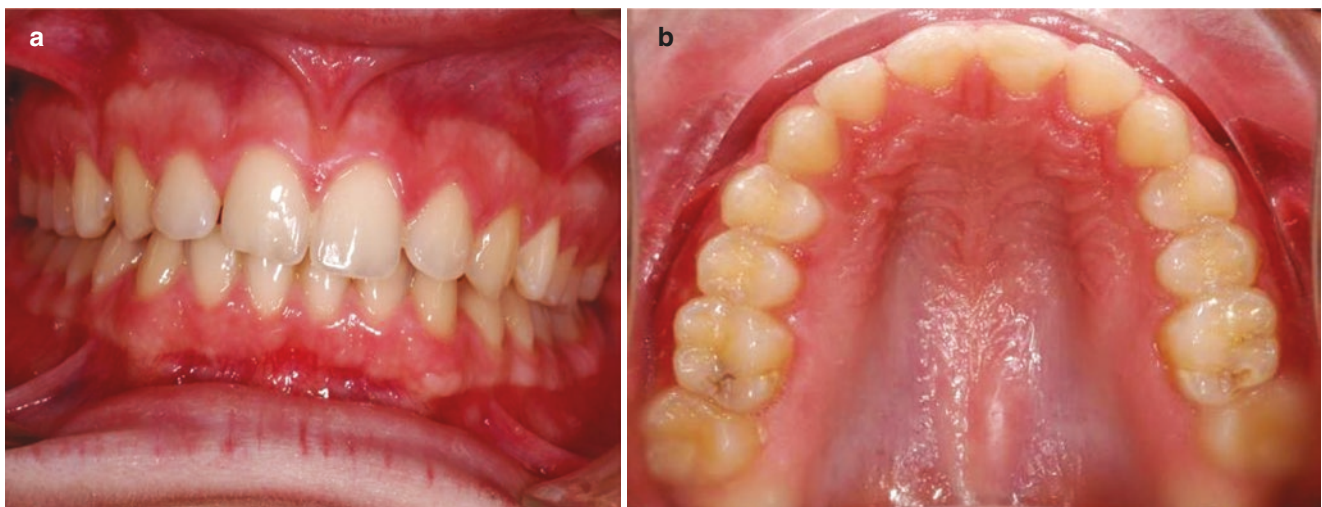


Fig. 18.11 (a, b) Final frontal and occlusal photographs. All treatment objectives were fulfilled, and midlines were almost coincident

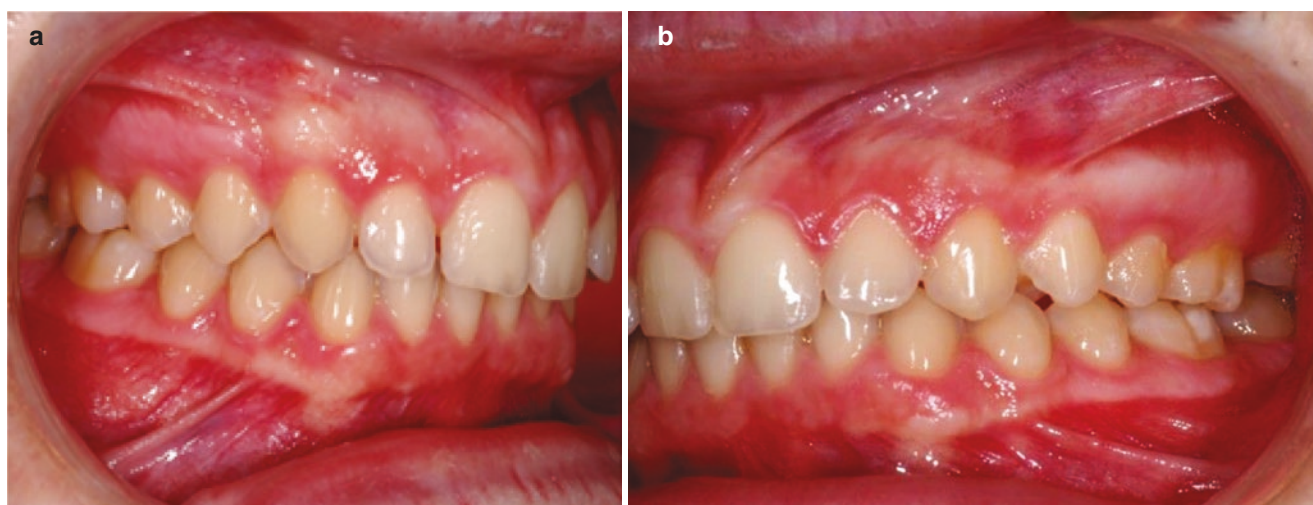


Fig. 18.12 (a, b) Right and left Class I molar and canine at the end of the active treatment

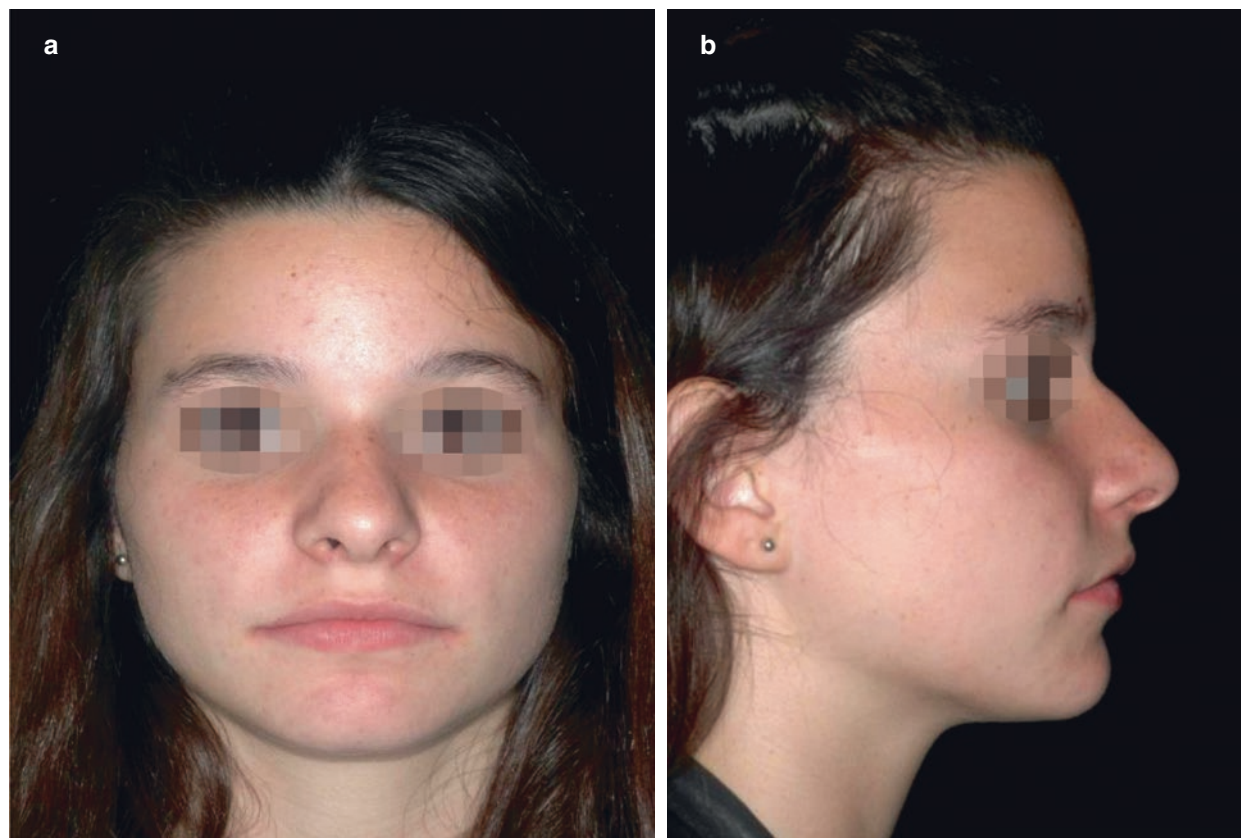


Fig. 18.13 (a, b) Frontal and profile photographs 2 years after treatment. The patient was able to close her lips without any strain

the deepbite and the correction of lower anterior crowding were noticeable (Fig. 18.17a, b).

Follow-up 2 years later confirmed that the achieved results were maintained. As expected, the profile was slightly straighter and she could easily close her mouth. Not only was there a significant improvement in function, but also in facial esthetics (Fig. 18.18a, b).

After 24 months, the frontal and lateral dental photographs confirmed that all treatment objectives were fulfilled: the overjet and overbite as well as the frontal and lateral occlusion were normalized (Fig. 18.19a, b).

One of the main objectives of early treatment is the correction of abnormal oral habits since oral function and the growth and development of the face are closely interrelated.

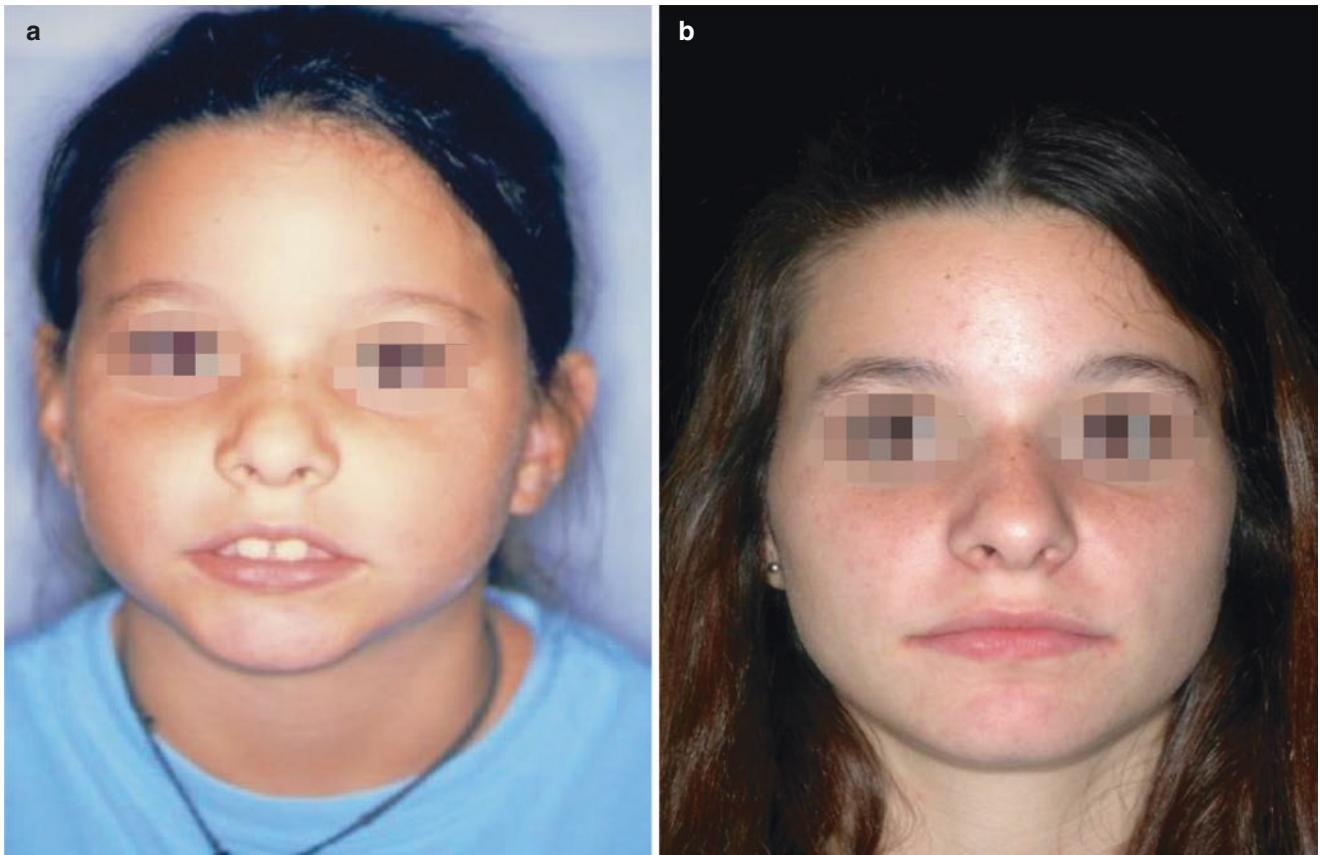


Fig. 18.14 (a, b) Comparison of frontal photographs pre- and posttreatment. The normalization of the lip seal, as well as the musculature in the lower third of the face, was significant



Fig. 18.15 (a, b) Pre- and posttreatment profile photographs. There was considerable improvement in the middle and lower third of the face

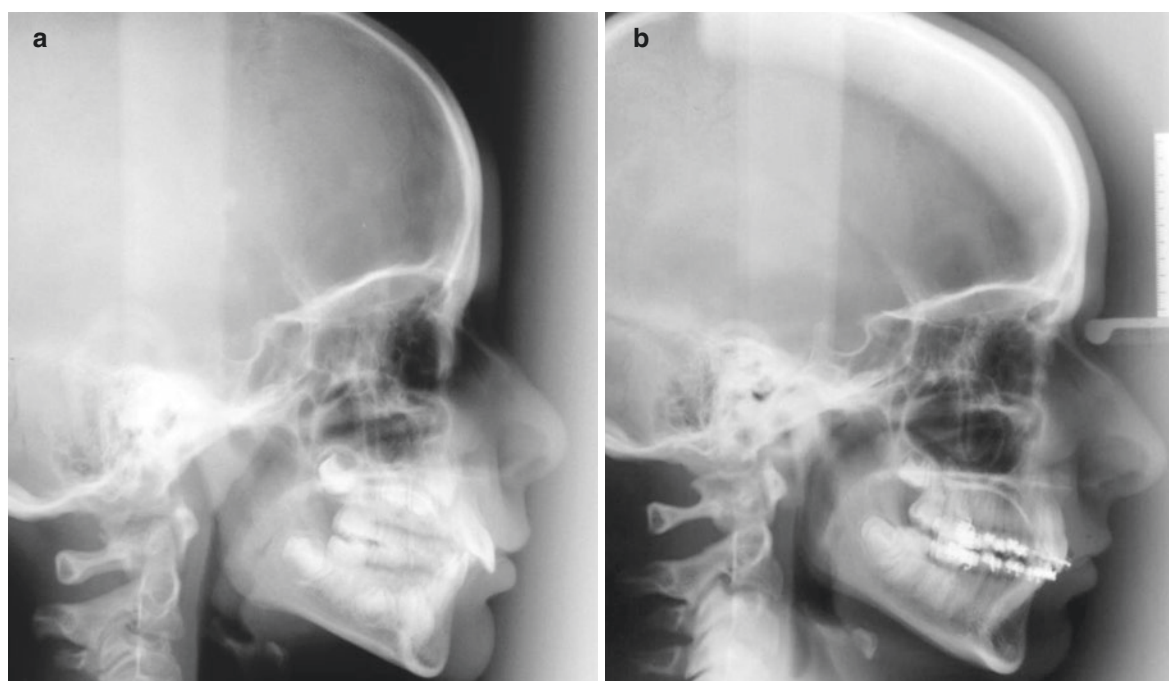


Fig. 18.16 (a, b) Pre- and posttreatment lateral radiographic images. The changes in the anterior occlusion and profile were evident

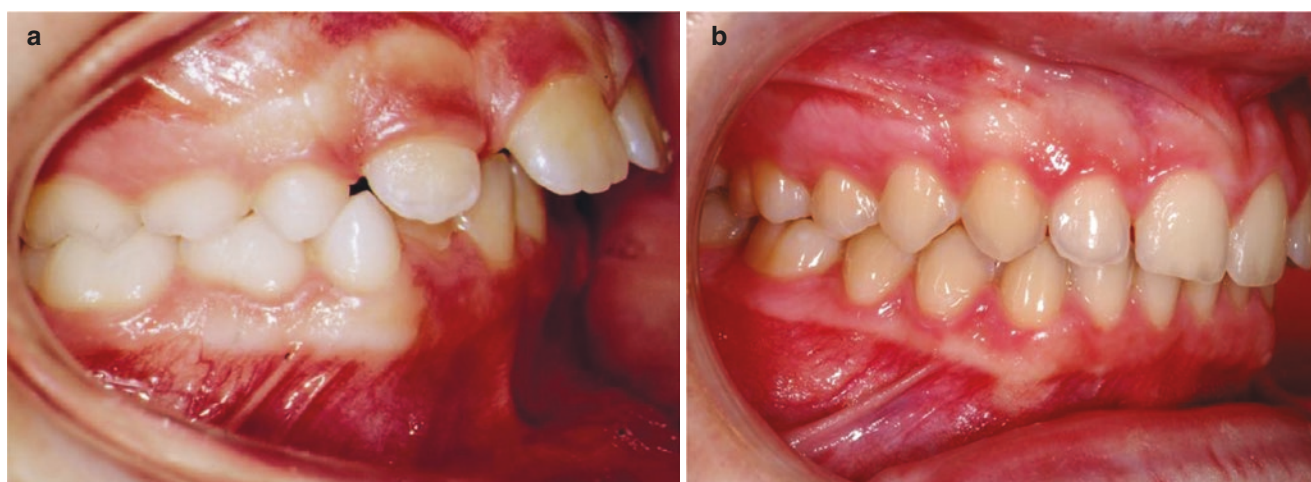


Fig. 18.17 (a, b) Class I molar and canine were maintained and overjet and overbite were clearly normalized

(Bahreman) It has been shown that many deformities caused by muscle dysfunction during primary and mixed dentition are not self-corrected and become worse during permanent dentition.

It is important to remember that the early elimination of bad habits is one of the most significant treatment objectives to achieve during this stage. Finger- and lip-sucking habits have to be corrected as soon as possible. Their persistence beyond 4 years of age is considered a chronic nonnutritive habit and needs to be corrected before it causes a negative impact on dental occlusion and facial esthetics (Bahreman).

The following patient is a clear example of this protocol. She was an 8-year, 3-month-old girl who was sent to the office looking for an appliance to protect her upper incisors since they had been chipped in a bicycle-related accident. No significant medical history was present until that point. One of the most important things to consider was the interposition of the lower lip behind the upper incisors along with a convex profile. Also, she was a mouth breather with a short upper lip and a slight facial asymmetry (Fig. 18.20a, b). It is well known that mouth breathing can have an adverse effect on the maxillary structure and its relation with the position of

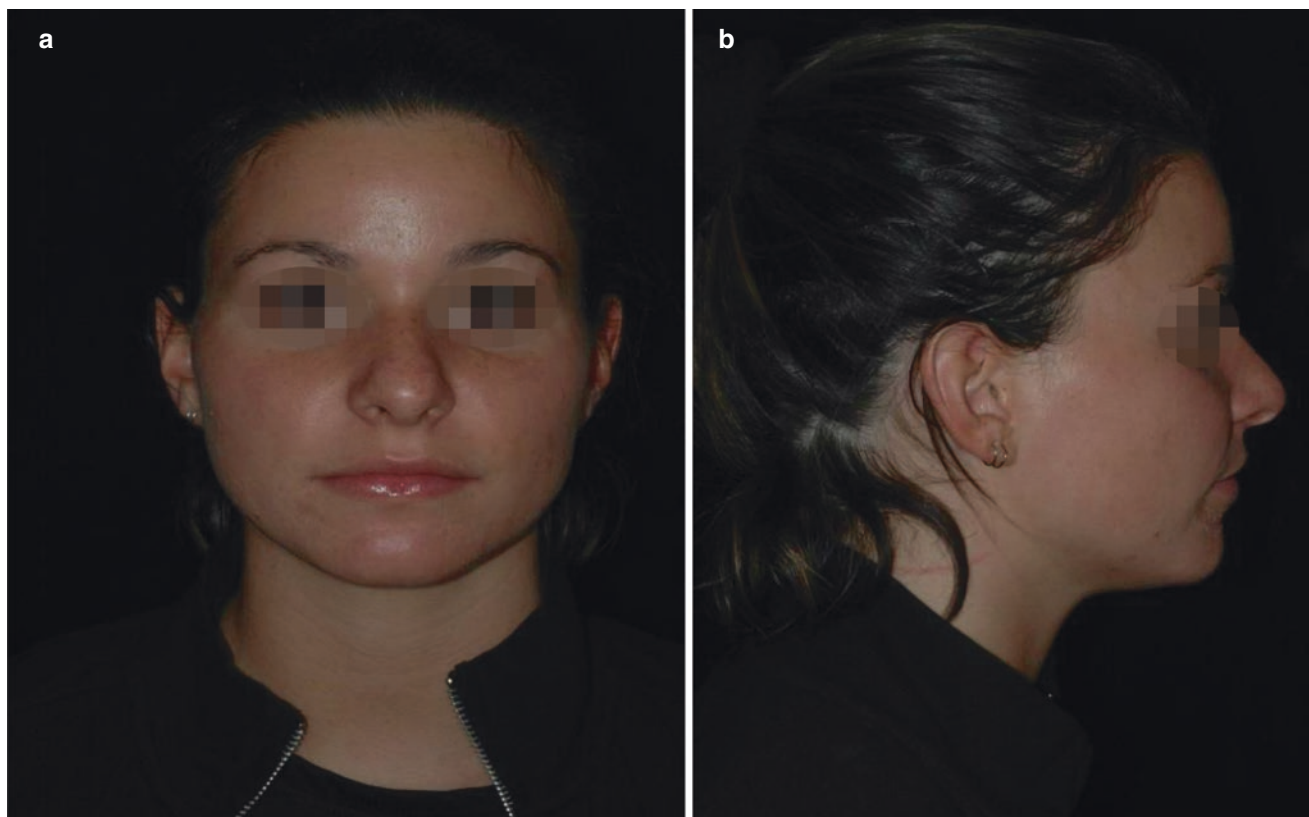


Fig. 18.18 (a, b) Results 2 years after treatment. The patient easily closed her mouth and the lip seal was totally relaxed

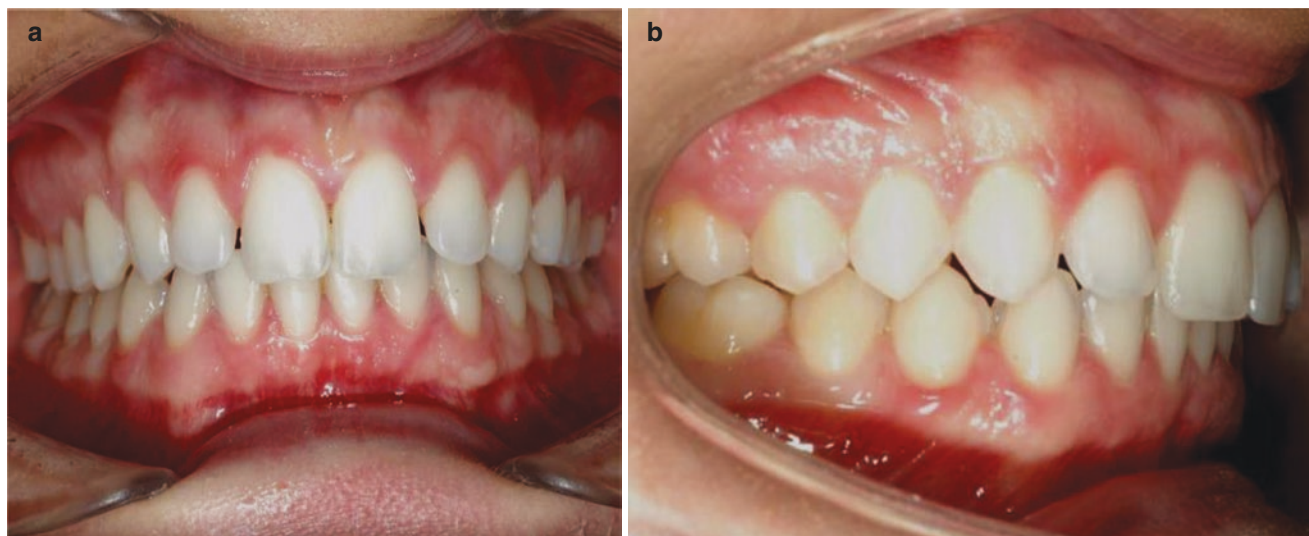


Fig. 18.19 (a, b) Follow-up after 24 months corroborated that all treatment objectives were maintained

the mandible. Also, the reduction of the protrusion of maxillary incisors reduces the chance of incisor trauma. Dry lips and dark circles under the eyes are also visible. The treatment plan was determined considering the correction of bad habits, improvement in oral function, and facial esthetics.

The frontal dental photographs confirmed a considerable overbite and proclination in the central incisor region and extrusion of the lower incisors. Midlines were not coincident (Fig. 18.21a, b). Excessive anterior overlap of the incisors is a common malocclusion that is difficult to



Fig. 18.20 (a, b) Pretreatment frontal and profile photographs. Mouth breathing and the interposition of the lower lip behind the upper incisors were visible

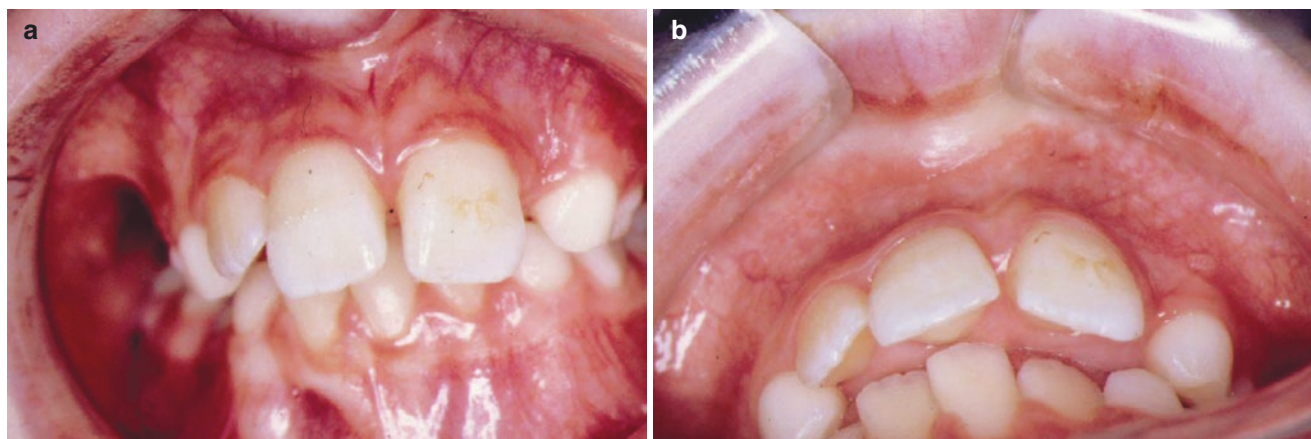


Fig. 18.21 (a, b) A considerable overbite and overjet were confirmed in the central incisor region with no coincident midlines

solve and causes delays in treatment as well as skeletal problems.

Upon observing the periapical radiographic image, the transposition of the lower lateral incisor and temporary right canine was confirmed. Extraction of the temporary right

lower canine was suggested to normalize the position of the lower right lateral incisor (Fig. 18.22a, b).

To improve the position of the partially transposed right lateral incisor, a Ni-Ti open coil spring was used with bands on the temporary second molars and preprogrammed brack-

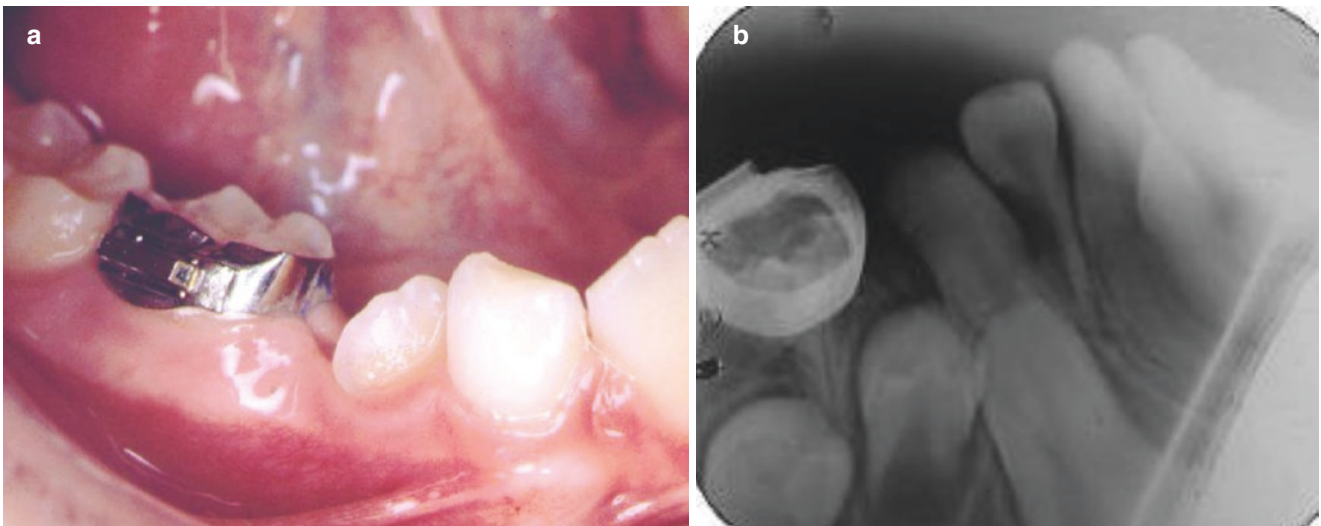


Fig. 18.22 (a, b) The transposition of the right lateral and right canine is clearly visible

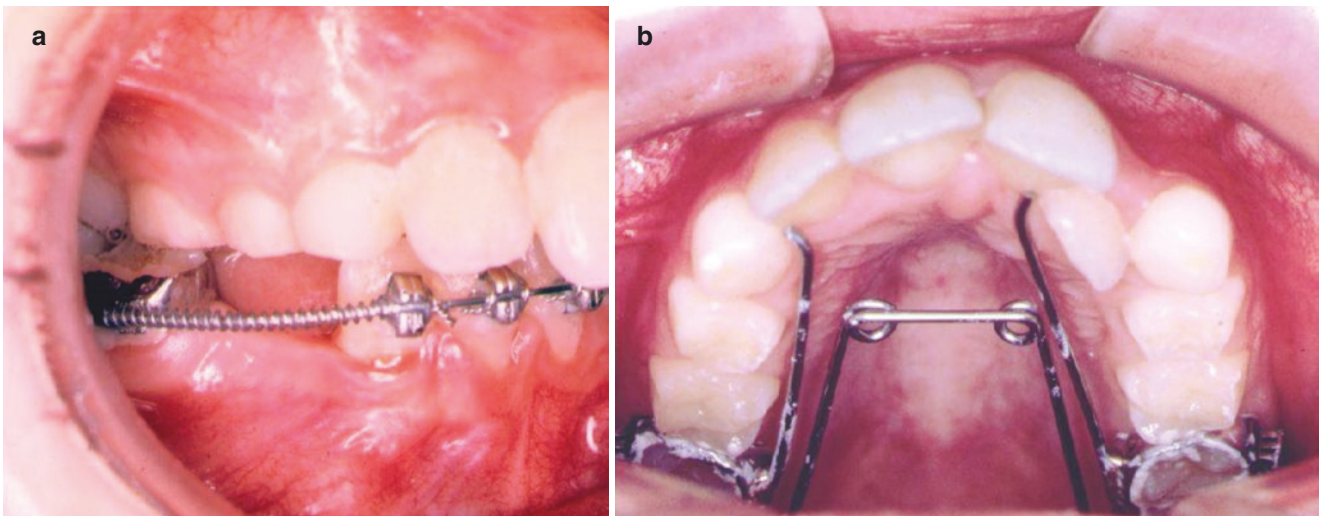


Fig. 18.23 (a, b) To mesialize the crown of the lateral right lower incisor, an open coil spring was placed on the lower right side in conjunction with an upper quad helix to improve the position of the upper left lateral incisor

ets were placed on the lower incisors (Fig. 18.23a). An upper quad helix was placed to normalize the upper arch size and the position of the upper left lateral incisor, with a monthly activation (Fig. 18.23b).

Six months later, preprogrammed 0.022" brackets were used along with upper and lower utility arches (Elgiloy 0.016" × 0.016") to correct incisor protrusion and excessive overbite (Fig. 18.24a, b).

These were the results 9 months later. Class I canine and molar were achieved and overjet and overbite were normalized. Midlines were coincident and occlusal plane and gingival lines were parallel (Fig. 18.25a, b). Also, oral hygiene improved.

The posttreatment facial photographs clearly showed how the soft tissues accompanied the positive upper and lower dental changes. The patient could close her lips properly and her profile was straight (Fig. 18.26a, b). The advantage of early treatment is to enable the normal eruption of the upper and lower canines and bicuspids in order to minimize the dentoalveolar discrepancies that can affect normal growth and development. No extraction was needed to achieve Class I molar and canine with a normal overjet and overbite.

There were no major changes in follow-up 3 years later. Overjet and overbite, as well as Class I canine and molar, were maintained stable (Fig. 18.27a, b). The gingival line

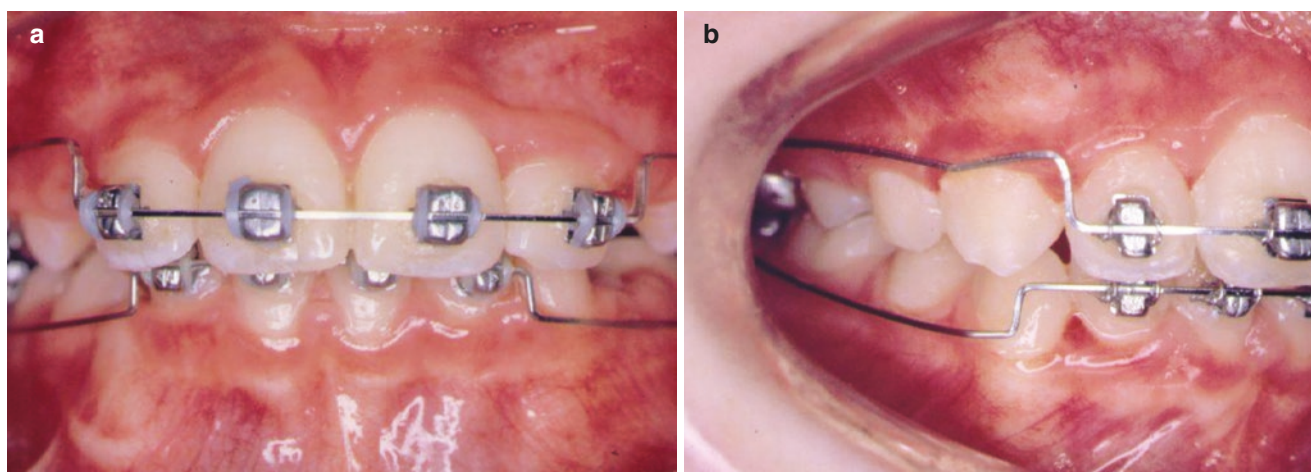


Fig. 18.24 (a, b) Upper and lower utility arches (0.016" $\times$ 0.016" Elgiloy wire) to normalize anterior overjet and overbite

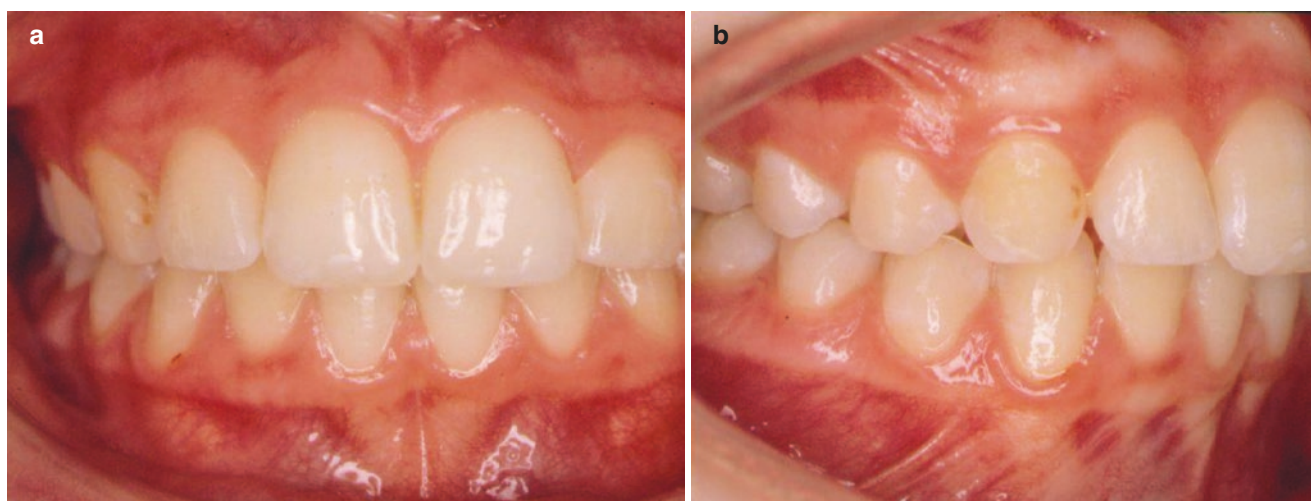


Fig. 18.25 (a, b) Results at the end of the active orthodontic treatment. All treatment objectives were achieved including the parallelism of the occlusal plane

and occlusal plane maintained their parallelism and excellent oral hygiene was present.

The facial photographs accompanied the normal growth according to her age and facial biotype (Fig. 18.28a, b).

The comparison between the pre- and posttreatment profiles demonstrated the significant reduction in lip protrusion and decreased mentalis strain. Another benefit of early orthodontic intervention in these patients is improved self-esteem (Fig. 18.29a, b).

These findings clearly demonstrated that excellent long-term results were achieved when orthodontic treatment was provided to patients who were 6–9 years old and had prominent front teeth. The best time for early intervention is during the early mixed dentition.

The Rickets cephalometric superimposition demonstrated the differences pre- and posttreatment (Fig. 18.30).

Anterior crowding is another malocclusion that should be treated in mixed dentition, especially when it is present in the lower arch. One of the primary reasons could be a negative discrepancy between the primary and permanent teeth, which could be the result of different morphologic and etiological factors.

The space deficiency can be divided into slight, mild, or severe and is the result of the tooth size-arch size discrepancy. One of most common situations is when a temporary canine falls out as a consequence of the distal eruption of the lateral incisor. The lower incisors erupt without apparent crowding but result in the shifting of the midline to the side.

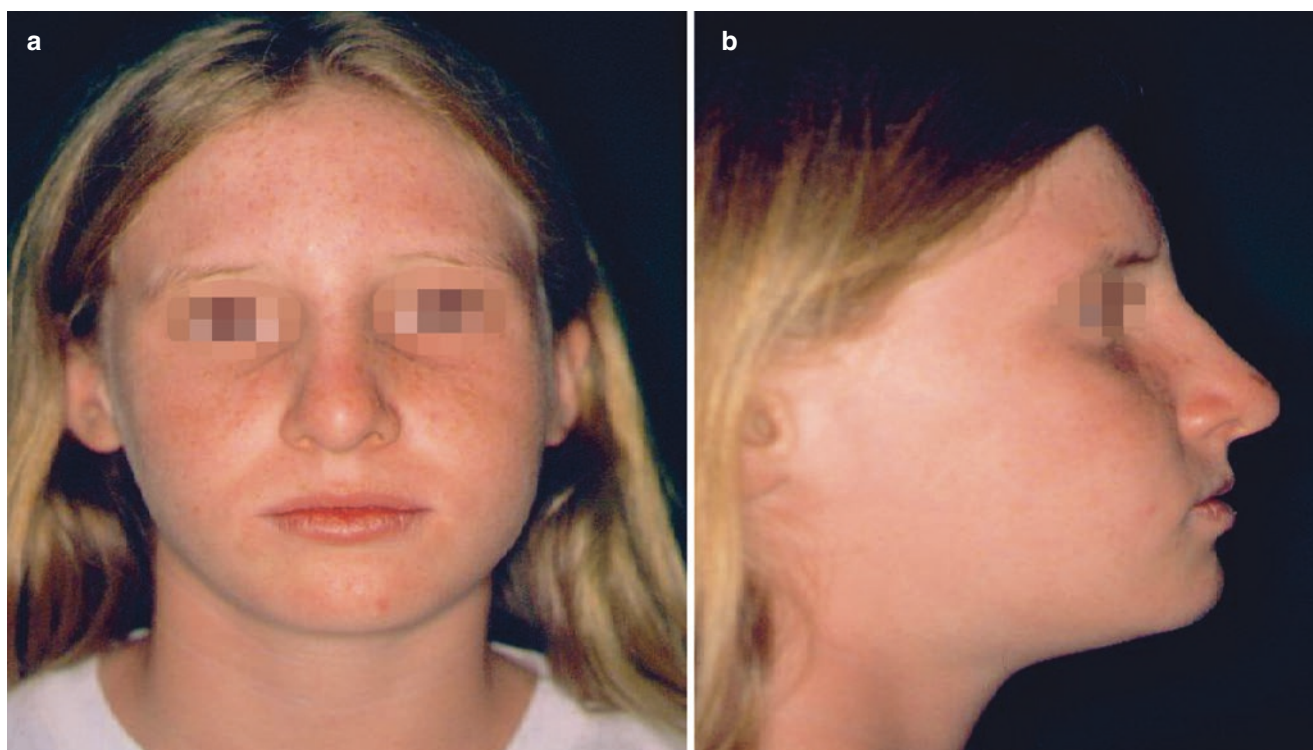


Fig. 18.26 (a, b) Frontal and profile photographs at the end of the active orthodontic treatment. The patient could close her lips without any tension

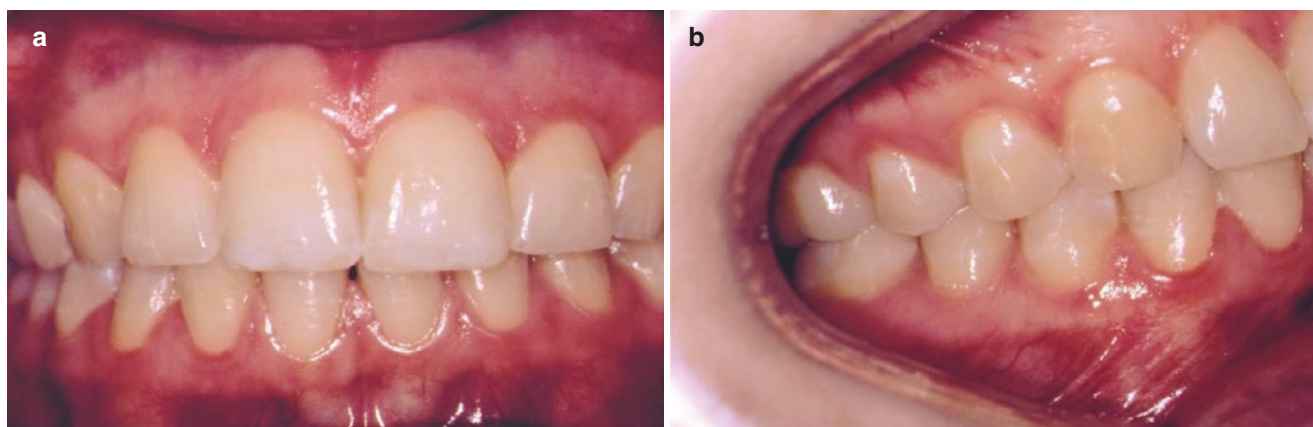


Fig. 18.27 (a, b) Frontal and right lateral photographs during a follow-up 3 years later

Controversy exists on the best time to begin treatment, to avoid major problems such as the mesialization of the posterior teeth in combination with the distalization of the anterior teeth and the consequent loss of space for the permanent canines and bicuspids.

A guided eruption protocol would be the best option according to the individual facial biotype and quantity of growth. Soft tissue analysis plays an important role too. The decision is always based on what is best for the patient with efficient mechanotherapy and long-term stable results. Moreover, through knowledge on tooth formation and devel-

opment is vital for timing interceptive procedures. (Graber) It is recommended that every child have orthodontic appointment at 7 years of age for the diagnostic assessment of a potential malocclusion. As soon the lack of space is detected, it is important to determine the best treatment option for the patient.

The next patient is a clear example of this protocol. He was sent to the orthodontic office for left temporary canine extraction for the central midlines to coincide. Lack of space for the eruption of the right lower canine was clearly observed in the panoramic radiographic image (Fig. 18.31) along with



Fig. 18.28 (a, b) Facial photographs 3 years later confirming normal maxillary and mandibular development



Fig. 18.29 (a, b) Significant changes were achieved in the dentoskeletal and soft tissues. The results were better than expected. No upper extractions were needed to improve the profile

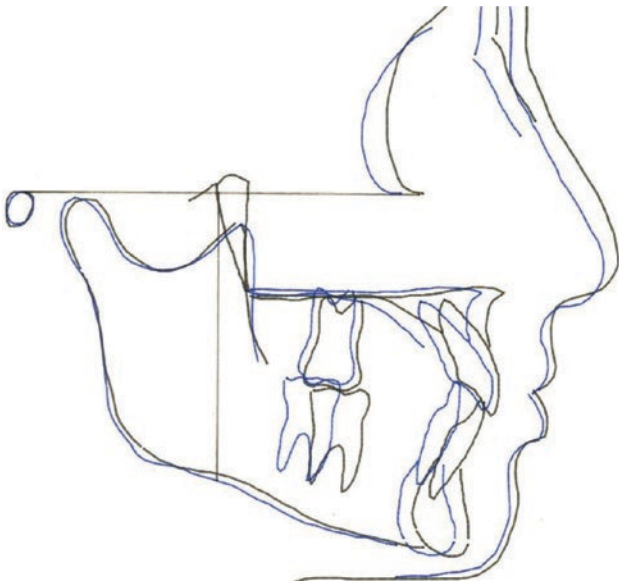


Fig. 18.30 Pre- and posttreatment Ricketts superimposition where the changes were clearly visible



Fig. 18.31 Pretreatment panoramic radiographic image. The lack of space for the eruption of the lower right canine was confirmed

a significant overbite. A careful study of the leeway space (difference between the primary and permanent teeth in the lateral region) was performed.

The right lateral and lower occlusal photographs showed Class I molar on the right side with midline displacement of the permanent mandibular incisors to the right (Fig. 18.32a, b).

In order to recover the necessary space for the lower right canine and bicusps, sequential stripping of the temporary molars helped control the leeway space. The second temporary molars were banded to protect the permanent first molars (Fig. 18.33a). Three months later, the right canine and first bicuspid began their path of eruption (Fig. 18.33b). A 0.016" SS archwire was placed to maintain the lower arch length.

There are several approaches to improve or maintain the lower arch length and, as a consequence, to avoid future permanent extractions. The following protocol was chosen since it is considered to be the most conservative in this particular patient. To normalize the discrepancy between the temporary and permanent bicusps and canine, a 0.016" $\times$ 0.016" SS archwire with active Ni-Ti coil springs was placed on the right and left sides (Fig. 18.34a, b). A 6-week activation was highly recommended.

Six months later, all the lower cuspids and bicusps erupted and bands were placed on the permanent first molars in conjunction with brackets on the canines to normalize their position (Fig. 18.35a, b).

Class I molar and canine were achieved 6 months later. Overjet and overbite were within normal parameters. No brackets were bonded to the upper arch during the whole treatment (Fig. 18.36a, b). It is advisable to place a fixed retainer wire between the right and left lower canines and maintain it in place for a long period of time in order to avoid anterior crowding relapse.

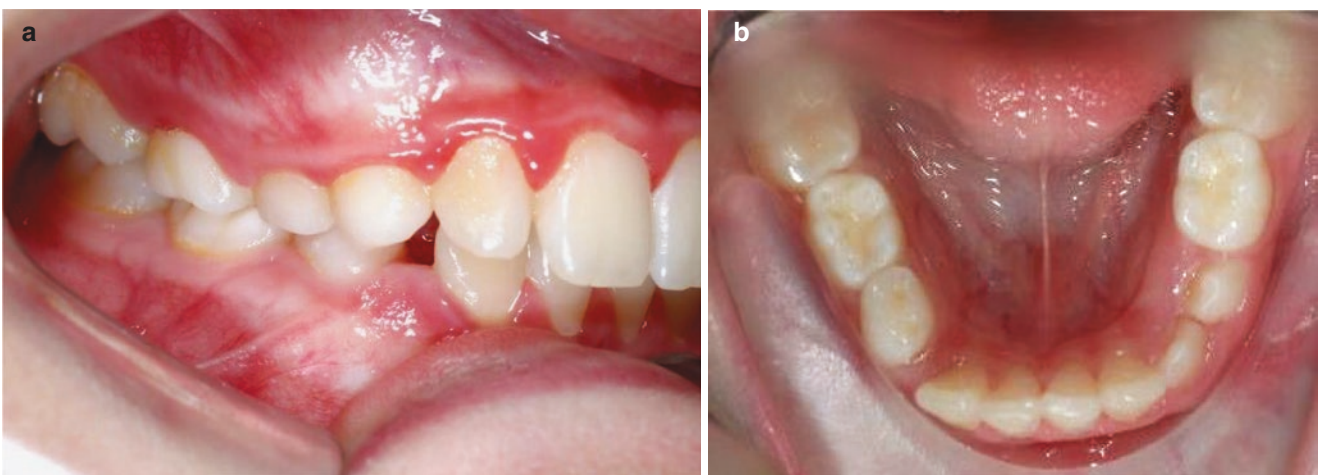


Fig. 18.32 (a, b) Pretreatment lateral and lower occlusal photographs. The lack of space for the eruption of the right lower canine was evident

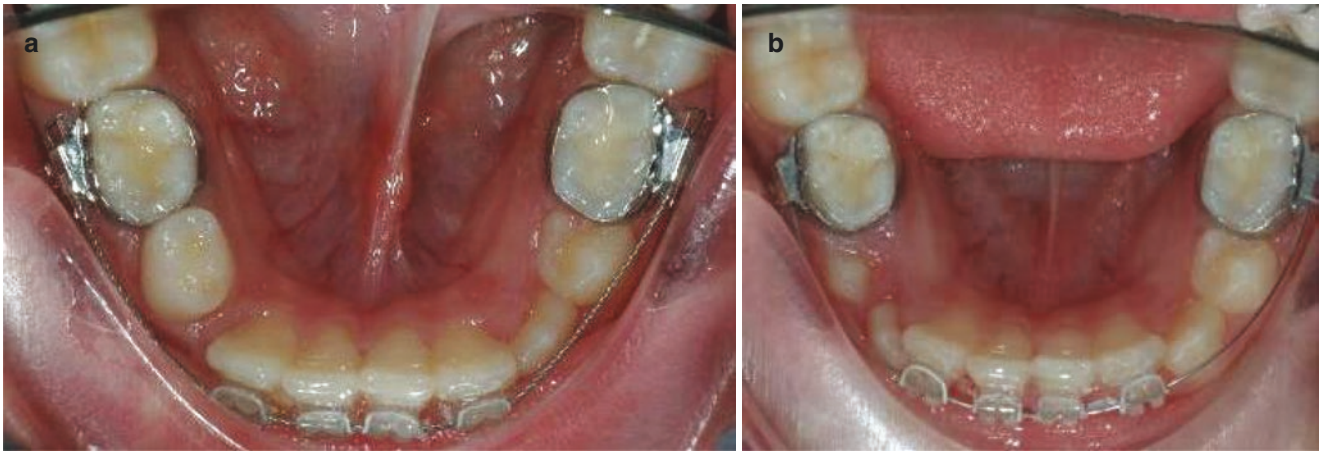


Fig. 18.33 (a, b) Comparison between the two stages of treatment. Bands on the secondary temporary molars were placed to maintain the lower initial arch length. Right canine and first bicuspid during their eruption path

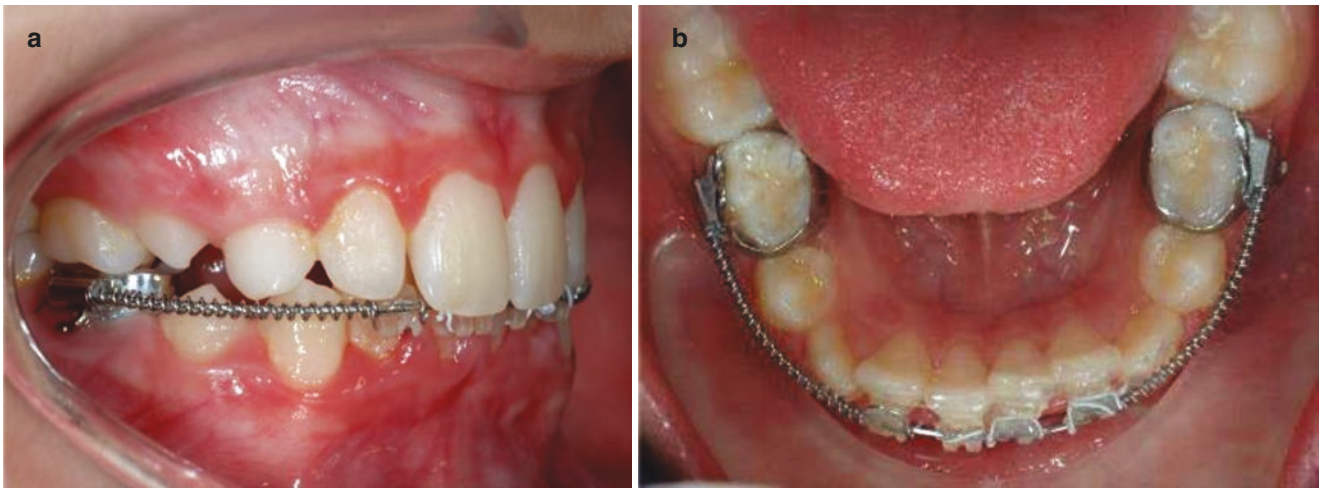


Fig. 18.34 (a, b) A 0.016" $\times$ 0.016" SS archwire with a right and left Ni-Ti coil spring activated every 6 weeks was placed to maintain lower arch length

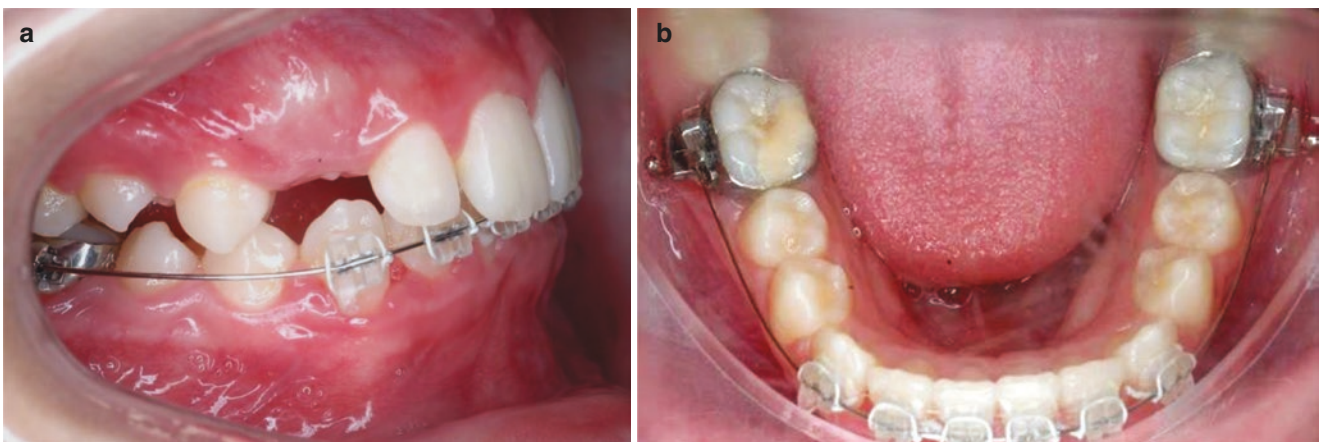


Fig. 18.35 (a, b) Esthetic brackets were bonded on the right and left canines to normalize their position

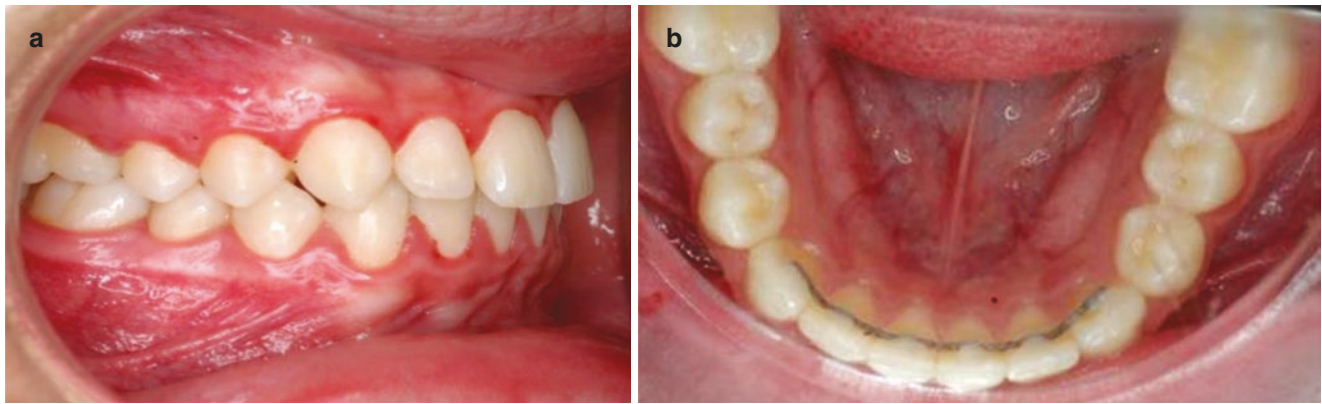


Fig. 18.36 (a, b) Lateral and lower occlusal photographs at the end of treatment. Class I molar and canine with normal overjet and overbite were achieved

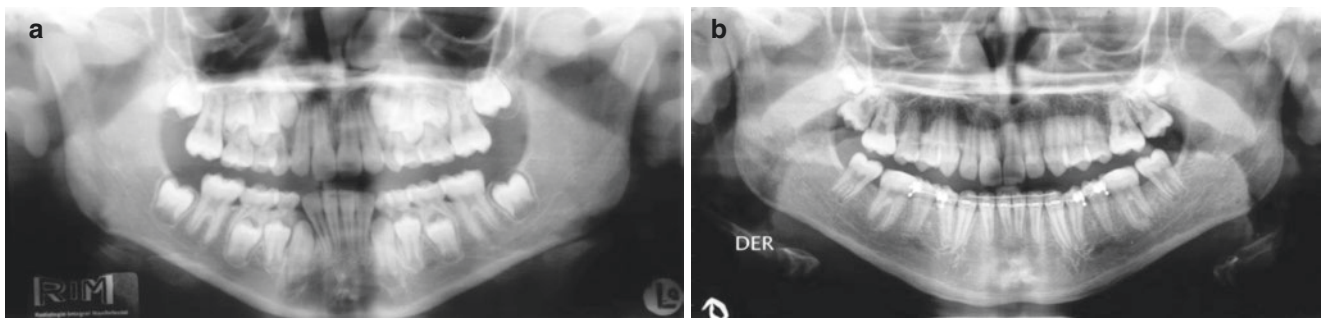


Fig. 18.37 (a, b) Pre- and posttreatment panoramic radiographic images. All treatment objectives were fulfilled

The comparison between the pre- and posttreatment panoramic radiographic images clearly demonstrated the obtained results. All spaces for the right canine were recovered and midlines normalized (Fig. 18.37a, b).

Treatment planning is the result of a profound diagnosis for each particular patient. Some crowding can be corrected with occlusal guidance and space supervision. The real question is how to identify the problem and manage the different situations to effectively obtain the best result. The preservation of the e-space to maintain or even improve the length of the lower arch and guide the eruption of the cuspids and bicuspid is highly essential. The protocol has to be individualized for each patient according to the facial biotype and amount of skeletal and dental discrepancies in concordance with facial esthetics. The early mixed dentition period plays an important role in the first phase of treatment since major changes occur during this period. There are no doubts about the importance of the normalization of the direction of growth during this phase of treatment.

18.1 Conclusions

It is widely accepted that early treatment does not avoid a second phase of treatment. However, it reduces its length and complications. The timing of treatment interventions was influenced by the severity of the malocclusion and the age and maturation of the patient at the start of treatment. (JANG) Although some support the idea that all treatment goals can be accomplished in only one phase of treatment, it was demonstrated by the authors that in some clinical cases, early intervention may reduce treatment time and the need for complex orthodontic treatment, which includes permanent tooth extraction or orthognathic surgery. Unfortunately, there is no single bracket that produces more growth than others, and it is confirmed that early treatment is the best option to improve some malocclusions from a functional and esthetic point of view.

Orthodontists need to understand that the timing to initiate orthodontic treatment is different based on the type of malocclusion and in this way maximize the effectiveness of the long-

term results. (DiBiase) There are no “recipes” that can be used for all patients alike, since the answer is an individualized treatment plan no matter the type of appliance that is chosen by the orthodontist. More consensus among clinicians about one- or two-stage treatment is necessary, but it is important to remember that the answer is an accurate diagnosis. It is important to note that over the past three decades, parents are more involved and more interested in early treatment, especially in orthodontic patients. The family dentist has a substantial role during this challenging phase. The keys to success in early treatment include a correct diagnosis, comprehensive treatment plan, and continued active supervision until the eruption of the permanent dentition (Dugoni). The more dentition is monitored, the better long-term results can be achieved.

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