Treatment of a Class II Division 1 malocclusion with the combination of a myofunctional trainer and fixed appliances

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This case report describes the combined use of a myofunctional Trainer for Braces and fixed appliances to treat a 10-year-old girl with a Class II Division 1 malocclusion that featured severe maxillary incisor protrusion, a large overjet, and a V-shaped maxillary arch. She had a convex profile with an underdeveloped mandible. The superiority of myofunctional training in the case was to eliminate mouth breathing and lip sucking habits, train the oral musculature, stimulate mandibular growth, and make braces work more efficiently. The posttreatment facial photographs show improvement in the facial profile. Proper occlusion and facial balance were created, which were quite stable as demonstrated by the patient's 4-year follow-up records. (Am J Orthod Dentofacial Orthop 2019;156:545-54)

Orthodontists in a clinical practice are frequently confronted with Class II Division 1 malocclusions.[1] Functional appliances such as activator,[2] Twin-block,[3,4] Bionator,[5,6] Herbst,[7,8] Forsus,[9,10] and Jasper jumper[11] have been reported to stimulate mandibular growth for growing patients. However, many patients reject these functional appliances because they can be very uncomfortable, but the success of this treatment modality depends on patient cooperation.[12] Moreover, few of these conventional appliances can achieve the effect of muscular training. Getting rid of muscular dysfunction plays a crucial role for the long-term stability of the treatment.

In this case report, we introduce a Trainer for Braces (T4B, Myofunctional Research Co, Queensland, Australia) for the fixed orthodontic treatment of a girl with mandibular deficiency and poor oral habits. The appliance achieved muscular functional exercises, expanded the maxilla transversely, retracted maxillary incisors, and stimulated growth of the mandible, providing optimum patient comfort with minimum appliance thickness.

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Our objective in this case report is to demonstrate the advantages of treatment with the combination of a myofunctional trainer and fixed appliances in a growing patient with a Class II Division 1 malocclusion.

DIAGNOSIS AND ETIOLOGY

The patient was a 10-year-old Chinese girl with a chief complaint of her convex facial profile with marked anterior teeth protrusion. She had a habit of mouth breathing and lower lip sucking.

The facial photographs showed a convex facial appearance, a protruded upper lip with an incompetent lip seal, and a slightly retrusive mandible with a deep labiomental fold (Fig 1).

The intraoral examination (Fig 1) and dental casts (Fig 2) exhibited severe maxillary protrusion with a large overjet up to 13 mm, deep overbite, and transverse deficiency with narrow maxillary dental arch. The mandibular second primary molars were not replaced, and the crowns were intact and not loose. The molar and canine relationships were Angle Class II on both sides. The amounts of space were 6 mm in the maxillary arch and 4 mm in the mandibular arch. The mandibular midline was off to the left by 0.5 mm. Her periodontal health was good, and no symptoms of temporomandibular disorder were detected.

The lateral cephalometric (Fig 3; Table) analysis indicated a skeletal Class II jaw deformity (ANB, 4.2°; APDI, 72.6°; Wits, 6.7 mm) with mandibular retrusion (SNB,

Fig 1. Pretreatment facial and intraoral photographs.

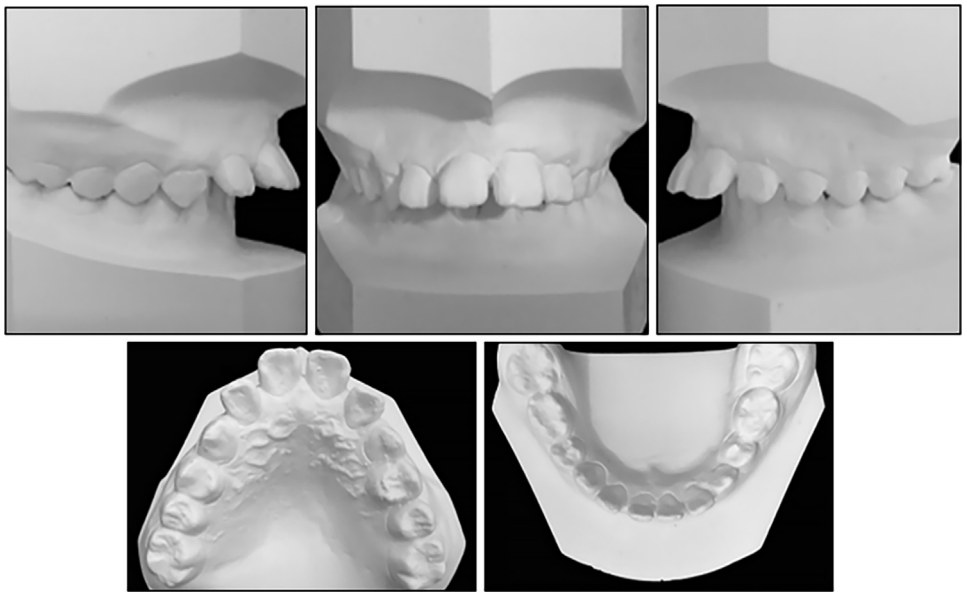

Fig 2. Pretreatment dental casts.

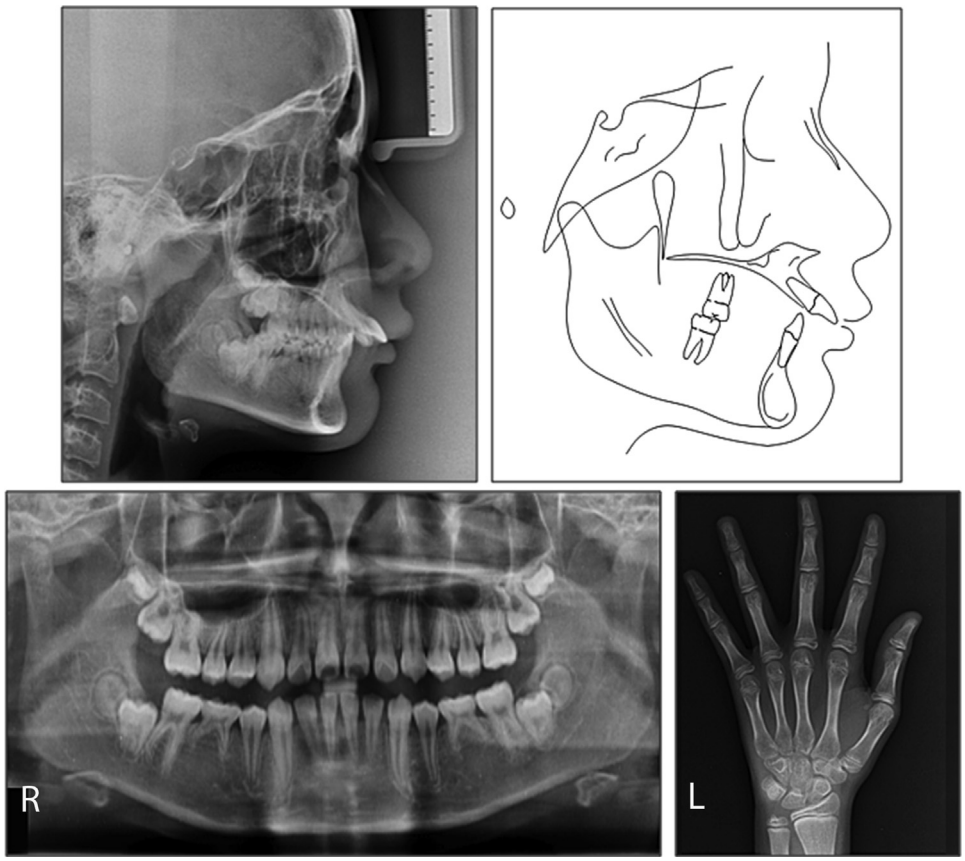

Fig 3. Pretreatment lateral cephalometric, hand-wrist, and panoramic radiographs.

76.4°; facial angle, 80.4°) and a severe low mandibular plane angle (FMA, 22.7°). The maxillary incisors were proclined labially (U1-SN angle, 131.5°; U1-NA angle, 51.0°; U1-NA length, 9.5 mm). An inspection of skeletal maturation by the cervical vertebrae and hand-wrist suggested the patient was in the peak of growth and development (Fig 3). The panoramic radiograph showed that the second and third molars were under development and the mandibular second premolars were congenitally missing (Fig 3).

TREATMENT OBJECTIVES

The treatment objectives for this patient were to (1) correct the poor oral habits, (2) align and level the arches, (3) establish normal overjet and overbite, (4) stimulate the growth of the mandible, and (5) obtain a balanced facial profile with improved smile esthetics.

TREATMENT ALTERNATIVES

To accomplish these objectives, we identified 3 treatment alternatives. All 3 alternatives called for a functional appliance to reduce overjet, achieve Class I canine relationships, and gain growth of the mandible. Considering the patient's oral habits and mild bone deformity and good comfort and cooperation of the

Table. Cephalometric analysis from lateral radiographs

Variables	*Normal (SD)*	*Pretreatment*	*Posttreatment*
SNA (°)	82.8 ± 4.0	80.6	80.0
SNB (°)	80.1 ± 3.9	76.4	78.2
ANB (°)	2.7 ± 2.0	4.2	1.9
FMA (°)	31.3 ± 5.0	22.7	23.4
IMPA (°)	93.9 ± 6.2	96.3	100.6
FH-Na-Pog (°)	85.4 ± 3.7	80.4	81.8
APDI (°)	81.1 ± 4.0	72.6	77.0
ODI (°)	72.8 ± 5.0	89.7	80.4
Wits (mm)	−1.1 ± 2.9	6.7	1.5
U1-SN (°)	105.7 ± 6.3	131.5	107.1
U1-NA (mm)	5.1 ± 2.4	9.5	6.8
U1-NA (°)	22.8 ± 5.7	51.0	27.09
L1-NB (mm)	6.7 ± 2.1	4.1	4.8
L1-NB (°)	30.3 ± 5.8	17.1	23.6
U1-L1 (°)	125.4 ± 7.9	107.8	127.4

APDI, anteroposterior dysplasia indicator; *ODI*, overbite depth indicator.

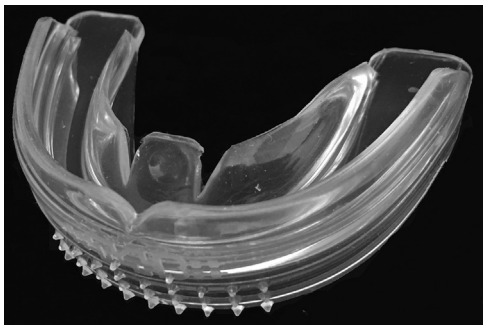

Fig 4. The Trainer for Braces.

treatment, we chose the T4B (Fig 4) for phase I treatment because it can be used simultaneously with fixed appliances.

The first alternative was to extract the mandibular second primary molars and close the space by moving molars mesially with temporary anchorage devices. Her parents refused this option because of the long treatment time and adverse impact on mandibular growth.

The second alternative was to hemisection the deciduous second molars, extract their distal halves, and close the space. The mesial halves can be extracted until the patient is old enough for implants. This option was not adopted because the patient did not want these surgical procedures.

The third option was to maintain the deciduous teeth as long as possible. If those teeth fall out during treatment, the edentulous space would be reduced to the width of a second premolar and retained until the end of growth for implants. This alternative would reduce treatment duration and not affect the mandibular growth. However, a Class I molar relationship could not be achieved, and the patient would need implant restoration after the deciduous teeth are lost. Because of the conditions of the deciduous molars, mandibular growth, orthodontic treatment time, and the complexity of therapy, the patient and her parents consented to this plan.

TREATMENT PROGRESS

Straight-wire appliances (Mini Uni-Twin brackets; 3M Unitek, Monrovia, Calif) were placed in both arches for initial alignment and leveling. Meanwhile, T4B was worn at least 2 hours each day and overnight while sleeping. After 3 months of treatment, the maxillary incisors were retracted, and the facial profile was improved (Fig 5). At the same time, the maxillary diastema was closed and the maxillary arch was expanded. The dental sagittal relationship was gradually improved with time (Fig 6). This phase of treatment with T4B was completed over 8 months.

After initial leveling and alignment, the 0.018 × 0.025 in and 0.018 in stainless steel archwires were separately placed in both the maxillary and mandibular arches. Class II elastics (3/16 in, 3.5 oz; 3M Unitek) were worn full time to close the remaining spaces in the mandibular arch and achieve Class I canine relationship. Fourteen months after the start of the treatment, ideal overbite and overjet were established (Fig 7).

The mandibular second molars fully erupted 21 months into treatment. After final arch alignment and interdigitation detailing, all appliances were debonded. The overall active treatment time was 27 months. For retention, the patient was instructed to wear removable retainers full-time.

TREATMENT RESULTS

The posttreatment facial photographs (Fig 8) showed improvement in the facial profile. Ideal overbite and overjet were created, and an Angle Class I canine relationship was achieved (Figs 8 and 9). The dental midline deviation was corrected to become consistent with the facial midline (Figs 8 and 9). The cephalometric analysis (Fig 10; Table) showed that the ANB angle was 1.9°, the APDI angle was 77.0°, and the Wits appraisal was 1.5 mm. All these demonstrated the change from a skeletal Class II pattern to a skeletal Class I pattern. The regional superimpositions (Fig 11) indicated that the maxillary incisors were retracted about 24°, the mandibular incisors proclined, and the growth of the mandible achieved. The panoramic radiograph showed no obvious apical root resorption, and root parallelism was acceptable. Model analysis showed that the inter-canine, inter-premolar, and inter-molar widths increased by 1.4, 2.5, and 2.7 mm, respectively. The patient's 4-year follow-up records showed that the occlusion was stable, and the improved facial harmony had been retained (Fig 12).

DISCUSSION

Deleterious oral habits are a common problem during childhood; they can include mouth breathing, tongue thrusting, digit sucking, and lip biting.[13] Persistent oral habits may be 1 etiologic factor for abnormal dentofacial growth. Anterior open bite is an occlusal anomaly commonly associated with pacifier sucking, thumb sucking, and tongue thrust.[14] Mouth breathing has been reported to have serious effects on the development of occlusions and skeleton by way of altering muscular balance.[15-17] Previous studies had confirmed that mouth breathing causes a narrower maxillary width,[18] a greater overjet,[19] a higher palatal height,[20] and a Class II malocclusion.[21] Changes in mode of breathing for children who breathe through their mouth

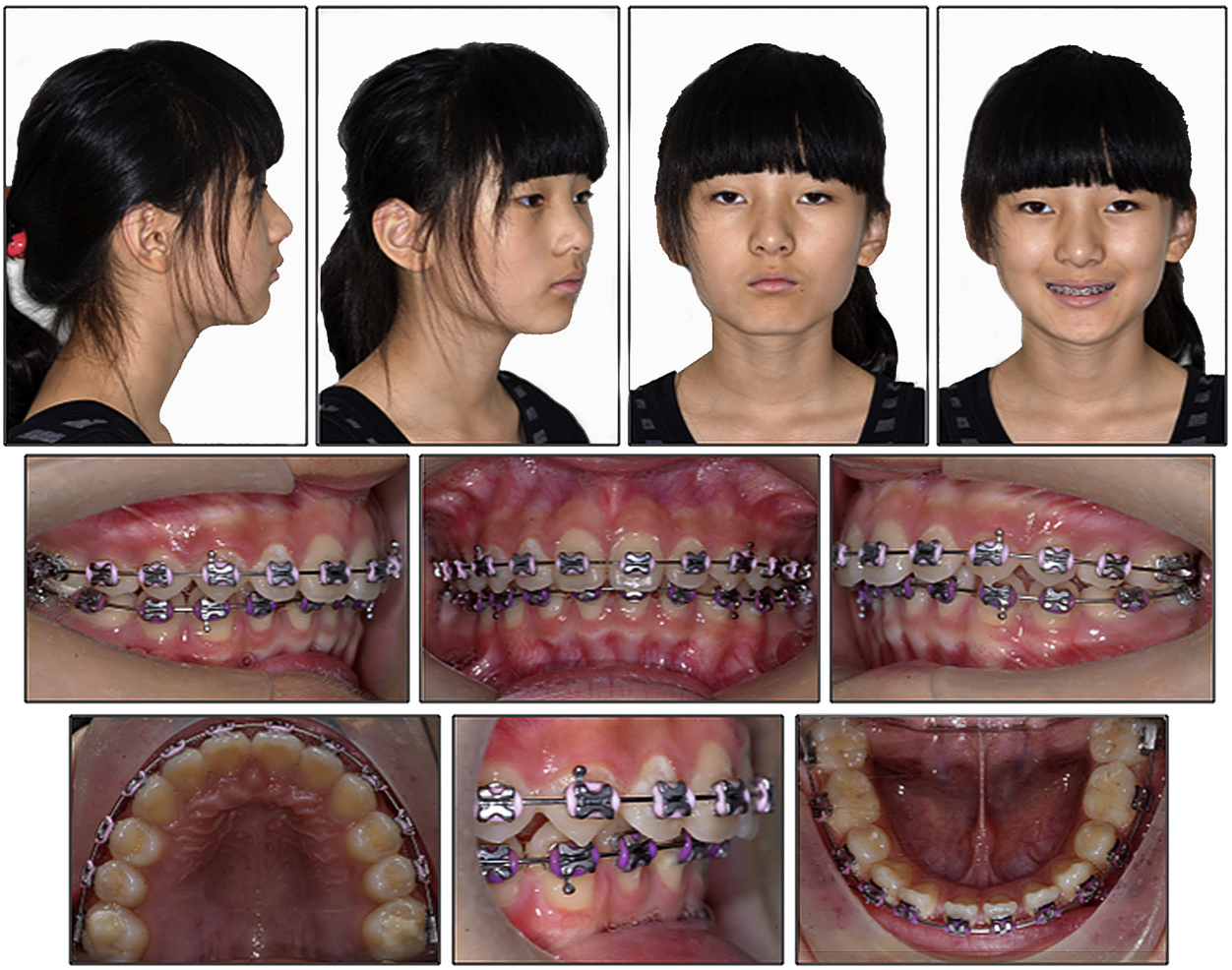

Fig 5. Three months into treatment: effective maxillary arch expansion and maxillary incisors retraction.

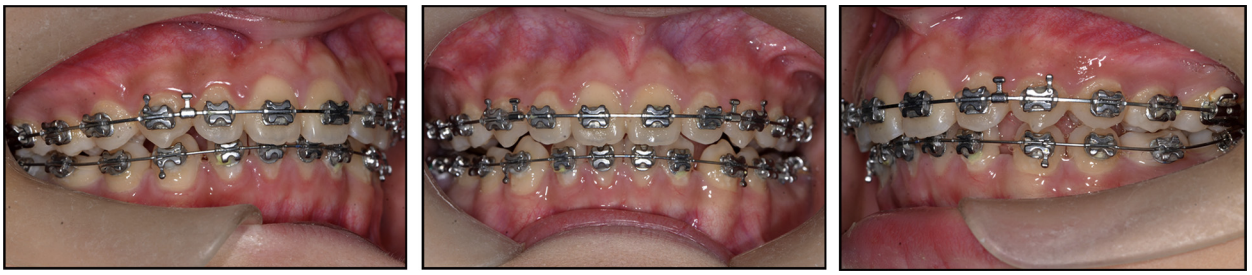

Fig 6. Six months into treatment: further improvement of sagittal relationship.

after adenoidectomy and tonsillectomy brought greater maxillary transverse development[21] and greater mandibular growth.[22,23] Therefore, this habit should be diagnosed early, and proper clinical intervention should be done to avoid orofacial alterations.

Class II Division 1 malocclusion, particularly with an underdeveloped mandibular jaw, is one of the most difficult orthodontic problems to deal with. Various functional appliances are available to correct this type of skeletal and occlusal abnormality. Franchi et al[2] found

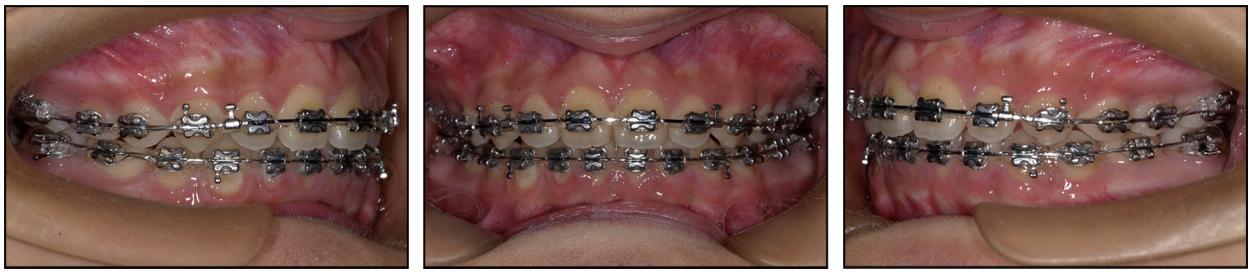

Fig 7. Fourteen months into treatment: ideal overbite and overjet were created, and Class I canine relationship was achieved. Waiting the eruption of mandibular second molars.

Fig 8. Posttreatment facial and intraoral photographs.

that treatment of Class II malocclusion with an activator or Bionator could produce significant improvement of skeletal sagittal relationship and mandibular growth. Bigliazzi et al[5] evaluated the long-term effects of a Bionator in growing patients with mandibular retrusion and concluded that a Bionator could induce skeletal and dentoalveolar shape changes. Compared with removable appliances, fixed functional appliances have the advantage of not relying on patient compliance. Systematic reviews about skeletal and dental changes produced by Herbst had been done by Flores-Mir et al[8] and showed significant changes in the anteroposterior

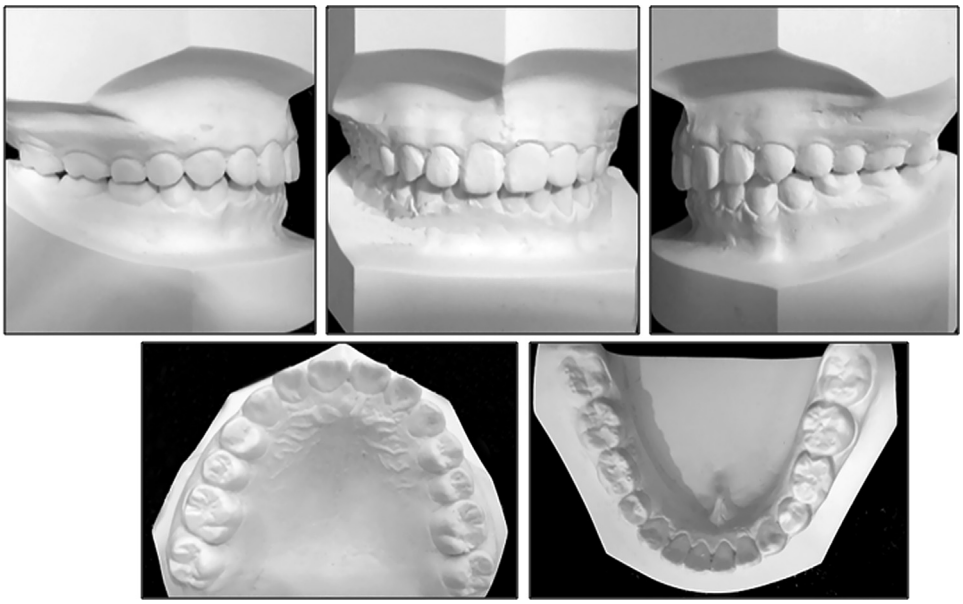

Fig 9. Posttreatment dental casts.

length of the mandible and mandibular facial height. Similar findings were also reported by Elkordy et al[9] who found patients with skeletal Class II were highly satisfied with the treatment results with the use of the Forsus Fatigue Resistant Device. However, it has been reported that the Herbst appliance is prone to debonding and breakage,[24] and the Forsus Fatigue Resistant Device is much more likely to induce cheek irritation.[10]

In recent years, myofunctional appliances have attracted extensive attention, mostly because of their simple structure and comfortable fit. In addition, it has been reported that myofunctional appliances can help patients eliminate oral habits, establish muscular balance, and retract maxillary incisors.[25-27] It is important to consider the etiology of Angle Class II Division 1 malocclusion before starting orthodontic treatment. The malocclusion of this patient was caused by both functional and dental factors. Her skeletal problem was not serious. Therefore, the treatment plan, which included treatment of rhinitis, eliminating mouth breathing and lip sucking, and myofunctional training, was suitable for the patient. We chose the T4B combined with fixed appliances in the treatment because of the following reasons: the T4B provided optimum patient comfort with minimum appliance thickness and best flexibility. Compared with basic fixed orthodontic appliances, the braces channels of the T4B could prevent soft tissue trauma from braces and archwires. The labial bows of the T4B could help braces work more efficiently by reducing the pressure of the tongue, cheeks, and lips against the braces. Furthermore, the tongue tag and lip bumpers could eliminate oral habits and train the oral musculature. In our case, the records of 3 months into treatment showed effective maxillary arch expansion, maxillary incisors retraction, and bite opening. Therefore, the mandible obtained enough space to develop. Meanwhile, the T4B stimulated the growth of the mandible and helped the patient achieve more stable results in less time by establishing muscular balance. The 2-year follow-up records of our case showed good facial harmony and occlusal stability with no obvious relapse.

The congenital absence of the mandibular second premolars is a challenge for many orthodontists. The orthodontist must make the proper decision depending on the patient's age, bimaxillary development, facial fullness, dental crowding and protrusion, stage of development of the adjacent teeth, and ankylosis of deciduous second molars. Several different treatment options are available to solve this problem.

(1) Extract the deciduous second molars to allow spontaneous space closure or close space orthodontically. Lindqvist[28] reported that the first molars were easier to drift mesially as long as the deciduous second molars were extracted before complete root development of the first molars. In our case, orthodontic space closure might not have been a viable approach because the patient possessed the

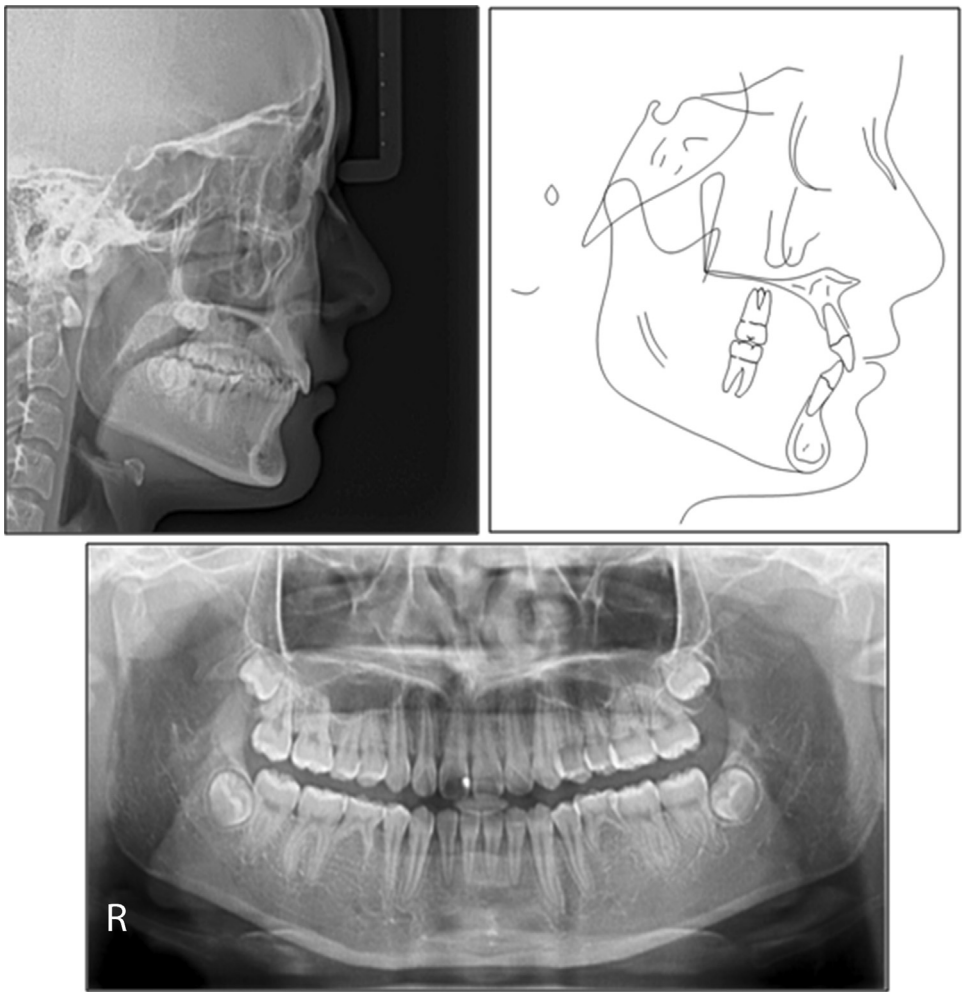

Fig 10. Posttreatment lateral cephalometric and panoramic radiographs.

features of an underdeveloped mandibular jaw and an absence of dental crowding. Closing space completely might diminish facial fullness and affect mandibular growth.

(2) Extract the deciduous second molars and maintain the edentulous space until the end of growth for implants. It is recommended that the edentulous space should be reduced to the width of a second premolar. A previous study by Ostler and Kokich[29] revealed that the ridge width of the edentulous space narrowed by 25% within 3 years after extracting deciduous molars. We did not choose this option because the deciduous second molars had intact crowns and long roots.

(3) Perform hemisection of the deciduous second molar and remove its distal half,[30] or reduce the mesial and distal surfaces to the size of a second premolar,[31] then close the space followed by placement of implants until the end of growth. Northway[32] reported that patients who underwent hemisection showed less retraction of the incisors and less change of facial profile. In our case, the roots of the primary second molars contacted the roots of the adjacent teeth; thus, the reduction of mesial and distal surfaces might not have been suitable for the patient.

(4) Maintain the deciduous molars as long as possible. A previous study by Bjerklin et al[33] indicated that during the mean 12-years' observation period, only 7 of the 99 deciduous molars were lost because of severe root resorption or caries. Considering the conditions of deciduous molars, mandibular growth, and orthodontic treatment time and the complexity of therapy, the parents of the patient strongly demanded the retention of primary molars. However, this approach could not achieve Class I molar relationship.

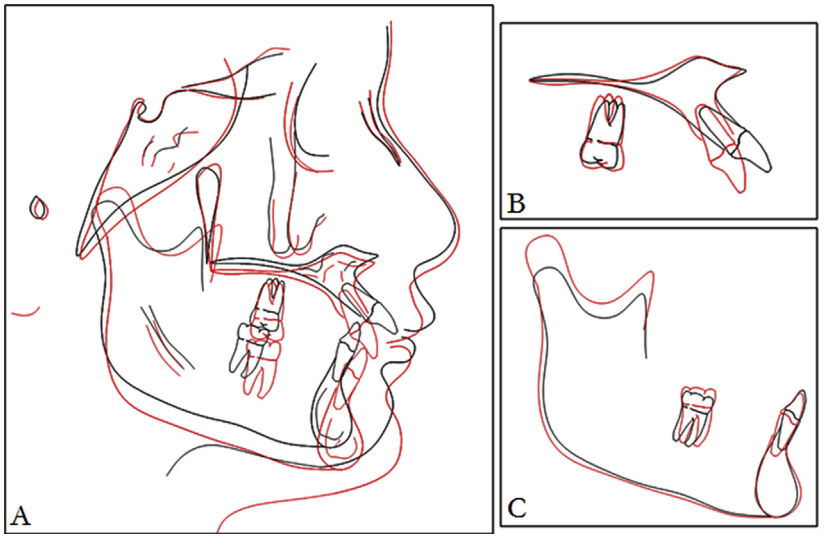

Fig 11. Posttreatment cephalometric superimpositions.

Fig 12. Four-year follow-up facial and intraoral photographs.

Facial esthetics are a major concern of many orthodontic patients and often affect the psychosocial health of patients. Early orthodontic treatment of Class II Division 1 malocclusion is important for stimulating mandibular growth, preventing incisal trauma, and even rebuilding confidence.

CONCLUSIONS

A 10-year-old girl with a Class II Division 1 malocclusion characterized by severe maxillary incisors protrusion and an underdeveloped mandible was successfully treated with a T4B and fixed appliances. Myofunctional training contributed to correcting oral habits and establishing muscular balance. The occlusion and the facial profile were effectively improved with good posttreatment stability.

REFERENCES

1. Proffit WR, Fields HW, Moray LJ. Prevalence of malocclusion and orthodontic treatment need in the United States: estimates from the N-HANES III survey. Int J Adult Orthod Orthog Surg 1998;13:97-106.
2. Franchi L, Pavoni C, Faltin K Jr, McNamara JA Jr, Cozza P. Long-term skeletal and dental effects and treatment timing for functional appliances in Class II malocclusion. Angle Orthod 2013;83:334-40.
3. O'Brien K, Wright J, Conboy F, Sanjie Y, Mandall N, Chadwick S, et al. Effectiveness of early orthodontic treatment with the Twin-block appliance: a multicenter, randomized, controlled trial. Part 1: Dental and skeletal effects. Am J Orthod Dentofacial Orthop 2003;124:234-43: quiz 339.
4. Jena AK, Duggal R, Parkash H. Skeletal and dentoalveolar effects of Twin-block and Bionator appliances in the treatment of Class II malocclusion: a comparative study. Am J Orthod Dentofacial Orthop 2006;130:594-602.
5. Bigliazzi R, Franchi L, de Magalhães Bertoz AP, McNamara JA Jr, Faltin K Jr, Bertoz FA. Morphometric analysis of long-term dentoskeletal effects induced by treatment with Balters Bionator. Angle Orthod 2015;85:790-8.
6. Malta LA, Baccetti T, Franchi L, Faltin K Jr, McNamara JA Jr. Long-term dentoskeletal effects and facial profile changes induced by Bionator therapy. Angle Orthod 2010;80:10-7.
7. Barnett GA, Higgins DW, Major PW, Flores-Mir C. Immediate skeletal and dentoalveolar effects of the crown- or banded type Herbst appliance on Class II division 1 malocclusion. Angle Orthod 2008;78:361-9.
8. Flores-Mir C, Ayeh A, Goswani A, Charkhandeh S. Skeletal and dental changes in Class II division 1 malocclusions treated with splint-type Herbst appliances. A systematic review. Angle Orthod 2007;77:376-81.
9. Elkordy SA, Fayed MM, Abouelezz AM, Attia KH. Comparison of patient acceptance of the Forsus Fatigue Resistant Device with and without mini-implant anchorage: a randomized controlled trial. Am J Orthod Dentofacial Orthop 2015;148:755-64.
10. Bowman AC, Saltaji H, Flores-Mir C, Preston B, Tabbaa S. Patient experiences with the Forsus Fatigue Resistant Device. Angle Orthod 2013;83:437-46.
11. Weiland FJ, Bantleon HP. Treatment of Class II malocclusions with the Jasper Jumper appliance—a preliminary report. Am J Orthod Dentofacial Orthop 1995;108:341-50.
12. Gross AM, Samson G, Dierkes M. Patient cooperation in treatment with removable appliances: a model of patient noncompliance with treatment implications. Am J Orthod 1985;87:392-7.
13. Garde JB, Suryavanshi RK, Jawale BA, Deshmukh V, Dadhe DP, Suryavanshi MK. An epidemiological study to know the prevalence of deleterious oral habits among 6 to 12 year old children. J Int Oral Health 2014;6:39-43.
14. Urzal V, Braga AC, Ferreira AP. Oral habits as risk factors for anterior open bite in the deciduous and mixed dentition—cross-sectional study. Eur J Pediatr Dent 2013;14:299-302.
15. Souki BQ, Pimenta GB, Souki MQ, Franco LP, Becker HM, Pinto JA. Prevalence of malocclusion among mouth breathing children: do expectations meet reality? Int J Pediatr Otorhinolaryngol 2009;73:767-73.
16. Paul JL, Nanda RS. Effect of mouth breathing on dental occlusion. Angle Orthod 1973;43:201-6.
17. Smith RA. The etiology of Angle Class II Division 1 malocclusion. Angle Orthod 1939;9:15-9.
18. Cattoni DM, Fernandes FD, Di Francesco RC, Latorre Mdo R. Characteristics of the stomatognathic system of mouth breathing children: arthroscopic approach. Pro Fono 2007;19:347-51.
19. Bakor SF, Enlow DH, Pontes P, De Biase NG. Craniofacial growth variations in nasal-breathing, oral-breathing, and tracheotomized children. Am J Orthod Dentofacial Orthop 2011;140:486-92.
20. Bresolin D, Shapiro PA, Shapiro GG, Chapko MK, Dassel S. Mouth breathing in allergic children: its relationship to dentofacial development. Am J Orthod 1983;83:334-40.
21. Petraccone Caixeta AC, Andrade I Jr, Bahia Junqueira Pereira T, Franco LP, Becker HM, Souki BQ. Dental arch dimensional changes after adenotonsillectomy in prepubertal children. Am J Orthod Dentofacial Orthop 2014;145:461-8.
22. Woodside DG, Linder-Aronson S, Lundstrom A, McWilliam J. Mandibular and maxillary growth after changed mode of breathing. Am J Orthod Dentofacial Orthop 1991;100:1-18.
23. Peltomäki T. The effect of mode of breathing on craniofacial growth—revisited. Eur J Orthod 2007;29:426-9.
24. O'Brien K, Wright J, Conboy F, Sanjie Y, Mandall N, Chadwick S, et al. Effectiveness of treatment for Class II malocclusion with the Herbst or twin-block appliances: a randomized, controlled trial. Am J Orthod Dentofacial Orthop 2003;124:128-37.
25. Tallgren A, Christiansen RL, Ash M Jr, Miller RL. Effects of a myofunctional appliance on orofacial muscle activity and structures. Angle Orthod 1998;68:249-58.
26. Usumez S, Uysal T, Sari Z, Basciftci FA, Karaman AI, Guray E. The effects of early preorthodontic trainer treatment on Class II, division 1 patients. Angle Orthod 2004;74:605-9.
27. Uysal T, Yagci A, Kara S, Okkesim S. Influence of pre-orthodontic trainer treatment on the perioral and masticatory muscles in patients with Class II division 1 malocclusion. Eur J Orthod 2012;34:96-101.
28. Lindqvist B. Extraction of the deciduous second molar in hypodontia. Eur J Orthod 1980;2:173-81.
29. Ostler MS, Kokich VG. Alveolar ridge changes in patients congenitally missing mandibular second premolars. J Prosthet Dent 1994;71:144-9.
30. Northway WM. The nuts and bolts of hemisection treatment: managing congenitally missing mandibular second premolars. Am J Orthod Dentofacial Orthop 2005;127:606-10.
31. Kokich VG, Kokich VO. Congenitally missing mandibular second premolars: clinical options. Am J Orthod Dentofacial Orthop 2006;130:437-44.
32. Northway W. Hemisection: One large step toward management of congenitally missing lower second premolars. Angle Orthod 2004;74:792-9.
33. Bjerklin K, Al-Najjar M, Kårestedt H, Andrén A. Agenesis of mandibular second premolars with retained primary molars: a longitudinal radiographic study of 99 subjects from 12 years of age to adulthood. Eur J Orthod 2008;30:254-61.