# Nonsurgical treatment of Brodie bite assisted by 3-dimensional planning and assessment

**Guangying Song, Huizhong Chen, and Tianmin Xu**
*Beijing, China*

This case report describes the nonsurgical treatment of an adolescent patient with a severe transverse discrepancy presented as a Brodie bite and retrognathic mandible. Distraction osteogenesis has been often used for similar cases in the literature. However, in this patient, a fixed appliance with 1 maxillary extraction combined with a functional appliance was used to resolve the transverse discrepancy with natural growth. After the orthodontic treatment, the impinging teeth and Brodie bite were corrected with a favorable occlusion and profile. Retention at the 3-year follow-up showed improved occlusal interdigitation and good stability. (Am J Orthod Dentofacial Orthop 2018;154:421-32)

A bilateral buccal posterior crossbite, also called a Brodie bite, is a severe transverse discrepancy, when all buccal cusps of the mandibular molars are telescoped within the lingual cusps of the maxillary molars. The reported morbidity due to a Brodie bite is approximately 1.0% to 1.5%.[1] The associated unilateral or bilateral posterior crossbite can be corrected by distraction osteogenesis, depending on the severity of the skeletal problem.[2-5] In some cases, nonsurgical treatments such as maxillary contraction[6] and mandibular expansion[7] have been used to correct the discrepancy. Furthermore, many adults with a scissors-bite have been treated with miniscrew anchorage.[8,9] Since the etiology of the Brodie bite varies with each patient, the main problem may result from maxillary hypergenesis, mandibular hypogenesis, or both, and could be accompanied by tooth compensation. Therefore, the diagnosis and treatment planning need more consideration, especially for teenagers who still have growth potential. In this report, we describe an adolescent patient with a Brodie bite and a Class II skeletal problem who was treated nonsurgically with a functional appliance and monomaxillary extraction.

From the Department of Orthodontics, Peking University School and Hospital of Stomatology, Beijing, China.
All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and none were reported.
Address correspondence to: Tianmin Xu, No. 22 Zhongguancun S Ave, Haidian District, Beijing 100081, China; e-mail, tmxuortho@163.com.
Submitted, November 2016; revised and accepted, May 2017.
0889-5406/$36.00

https://doi.org/10.1016/j.ajodo.2017.05.039

## DIAGNOSIS AND ETIOLOGY

The patient was a 12.4-year-old Chinese boy. His chief complaints were crooked teeth and difficulty in chewing. He was told by his mother to push his maxillary incisors inward with his fingers because both his mother and grandmother had protruded incisors (Fig 1). The lateral view of his facial photographs showed a convex facial profile and a retrognathic mandible. The frontal view of the patient's face showed no evident asymmetry and a diminished inferior third of the face. There were no temporomandibular joint symptoms.

The intraoral examination and dental casts showed an Angle Class II Division 2 malocclusion, with mild crowding in both arches. The maxillary and mandibular dental midlines were shifted 0.5 mm to the right of the facial midline. The mandibular dental arch showed atresia with retroinclined maxillary incisors. In addition, a bilateral scissors-bite was noted in the posterior region on both sides, called a Brodie bite, with the mandible telescoped completely inside the maxilla, resulting in the total absence of occlusal contacts in centric occlusion. The patient had a 100% overbite, with the mandibular anterior teeth biting on the palatal gingiva. Both arches were symmetrical (Fig 2). The maxillary intermolar width was much larger than the normal range, whereas the mandibular intermolar width was within normal limits; the intercanine width in both arches was a little larger than the normal range (Table I).[10] Furthermore, generalized mild gingivitis associated with fair oral hygiene was noted, with probing depths within normal limits.

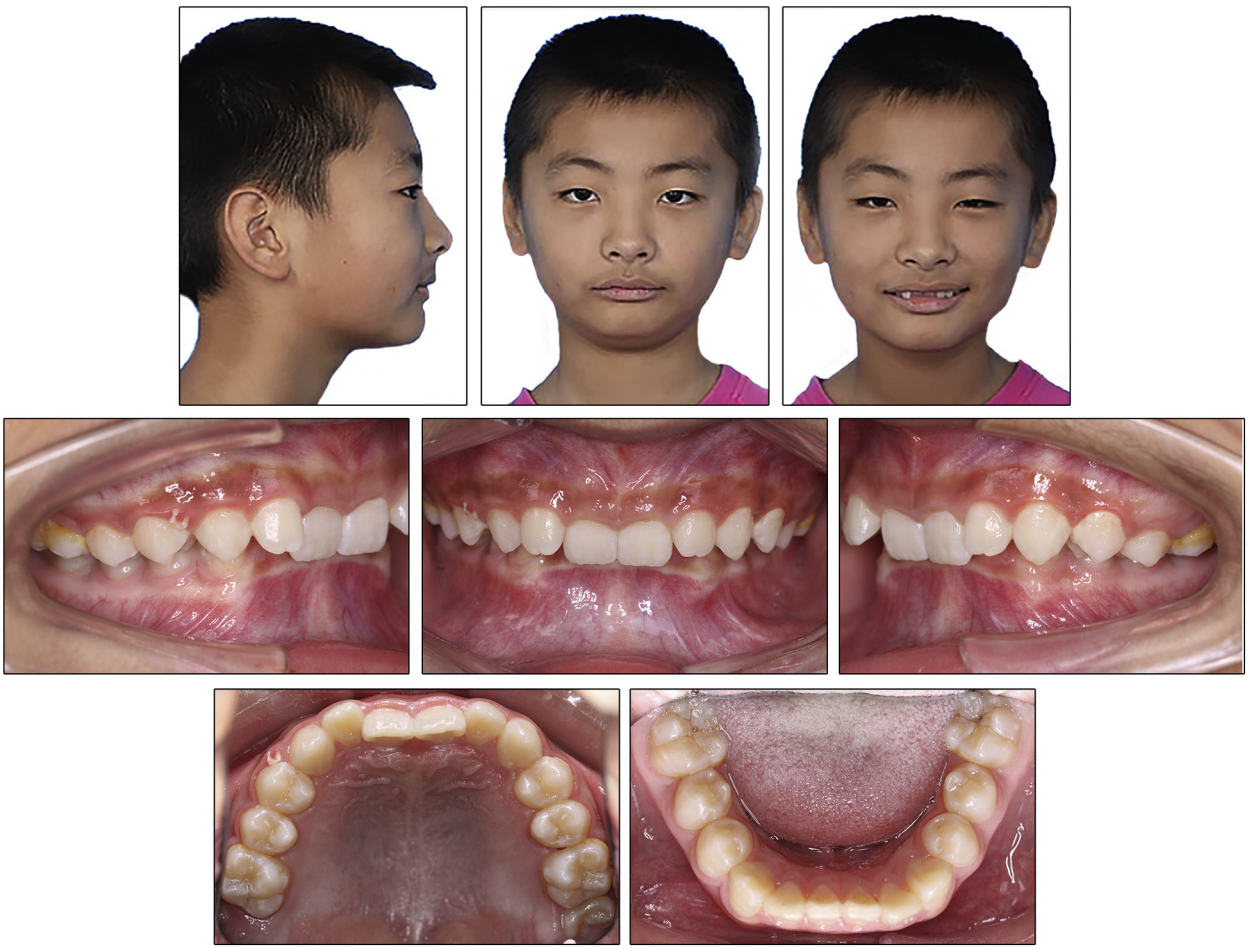

**Fig 1.** Pretreatment facial and intraoral photographs.

The panoramic radiograph showed a complete permanent dentition, with erupting second molars, impacted third molars, and 2 supernumerary teeth inverted above the maxillary incisors. Cone-beam computed tomography (CBCT) images showed that the supernumerary teeth were highly impacted on the palatal side. The torque of the maxillary molars exhibited a buccal inclination, and the mandibular posterior teeth tipped lingually. The maxillary palatal width was greater than the normal value, and the mandibular lingual width was almost normal (Table II[11]). The basal arch width shown by the WALA ridge was measured and had the same tendency as the arch width (Table III[12]). The cephalometric analysis (Table IV) showed a moderate skeletal Class II discrepancy with a mandibular deficiency (SNA angle, 82.58°; SNB angle, 74.41°; ANB angle, 8.17°) and a hypodivergent skeletal pattern (SN-GoGn angle, 27.92°). The maxillary incisors were retroinclined (U1-SN angle, 82.63°). On the basis of these findings, the patient was diagnosed with a Class II malocclusion and a Class II skeletal pattern with a low mandibular plane angle (Fig 3).

The lateral cervical vertebrae on the cephalometric radiograph showed concavity at the lower border of the second cervical vertebrae, whereas the bodies of both the third and fourth cervical vertebrae were still trapezoidal, indicating that the peak in mandibular growth would occur within approximately 1 year after this stage. The etiology of this malocclusion was unclear. The tooth germ positions and erupted directions of the maxillary incisors might have been influenced by the inverted, impacted supernumerary teeth. Furthermore, the severe transverse discrepancy may have involved neurologic and muscular mechanisms, leading to certain oral habits that were not possible to detect.[13]

## TREATMENT OBJECTIVES

The treatment objectives were to reduce the arch width of the maxillary dentition and upright the mandibular posterior teeth to resolve the Brodie bite

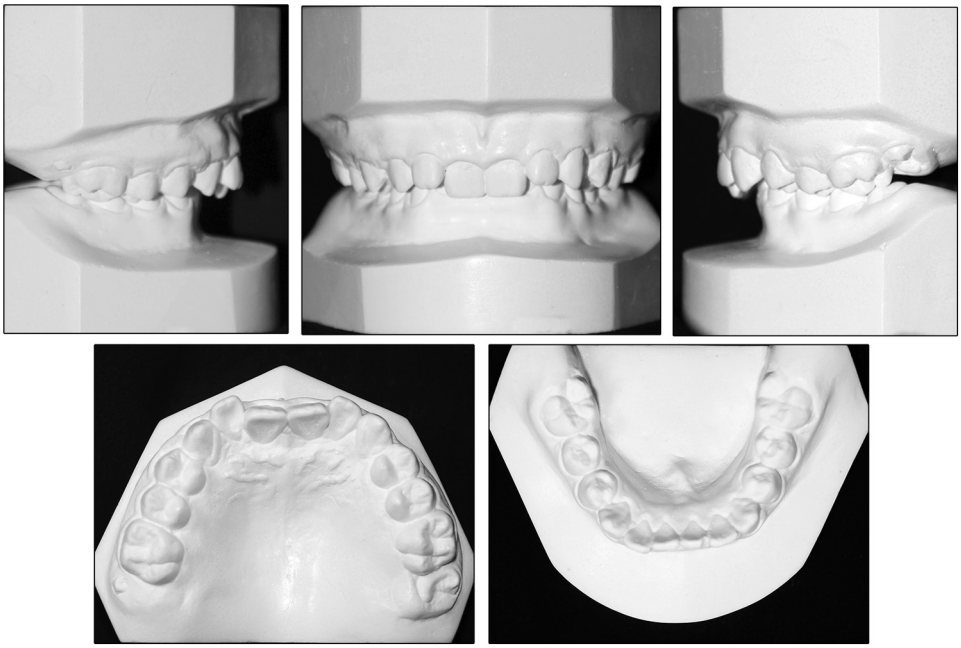

**Fig 2.** Pretreatment dental casts.

**Table I.** Dental arch dimensions and digital setup results (mm)

| | *Maxilla* | | | | *Mandible* | | | |
|---|---|---|---|---|---|---|---|---|
| | *3-3* | *4-4* | *5-5* | *6-6* | *3-3* | *4-4* | *5-5* | *6-6* |
| Pretreatment | 37.0 | 48.0 | 55.5 | 62.6 | 29.1 | 35.9 | 40.2 | 44.2 |
| Nonextraction | 36.7 | 46.5 | 53.8 | 59.1 | 30.1 | 35.4 | 43.3 | 50.4 |
| U5 | 36.5 | 46.3 | | 53.4 | 30.0 | 37.5 | 45.0 | 50.2 |
| U4 | 36.1 | | 46.1 | 54.7 | 29.9 | 37.1 | 44.6 | 50.2 |
| U4L5 | 36.1 | | 44.7 | 51.7 | 28.6 | 37.5 | | 44.2 |
| Posttreatment | 36.4 | 46.4 | | 52.5 | 29.7 | 38.0 | 45.2 | 50.6 |

*3*, Canine; *4*, first premolar; *5*, second premolar; *6*, first molar; *U*, maxillary; *L*, mandibular.

**Table II.** CBCT transverse analysis linear and angular values

| *Measurement* | *Pretreatment* | *Posttreatment* | *Reference** |
|---|---|---|---|
| Molar torque, UR (°) | 81.7 | 92.9 | 97.8 ± 2.7 |
| Molar torque, UL (°) | 80.1 | 100.7 | 98.3 ± 2.56 |
| Molar torque, LR (°) | 112.4 | 93.3 | 104.2 ± 2.67 |
| Molar torque, LL (°) | 119.9 | 92.6 | 103.9 ± 2.47 |
| Maxillary palatal width (mm) | 34.4 | 32.1 | 27.7 ± 2.08 |
| Mandibular lingual width (mm) | 31.0 | 31.1 | 29.0 ± 2.79 |

*UR*, Maxillary right; *UL*, maxillary left; *LR*, mandibular right; *LL*, mandibular left.
*From the study of Miner et al.[11]

and impinging teeth, alleviate crowding, achieve appropriate overbite and overjet, establish a Class I canine relationship, and stabilize the occlusal interdigitation. The aim was to protrude the retrognathic mandible and improve the short lower face height and convex facial profile.

## TREATMENT ALTERNATIVES

The combined results of computed tomography measurements and dental model analysis showed that the patient's maxillary base bone and arch were too wide, and the torque of the maxillary molars exhibited a buccal inclination. The widths of the mandibular base bone and arch were almost normal, with the mandibular posterior teeth tipped lingually. Since the patient's parents refused to consider surgery as an option, the only alternative was orthodontic treatment. We needed to contract the maxillary arch, upright the mandibular posterior teeth, move the mandible forward, and coordinate both arch forms. There were 4 options to achieve our aims: (1) nonextraction, (2) extraction of the maxillary right and left second premolars, (3) extraction of the maxillary right and left first premolars, and (4) extraction of the maxillary right and left first premolars and the mandibular left and right second premolars.

Our digital setup made it feasible to compare the 4 options before moving the teeth (Table I). In the nonextraction treatment plan, the width between the maxillary right and left first molars needed to be decreased by

**Table III.** Comparison of the means of basal arch dimensions before and after treatment

| *Measurement (mm)* | *Pretreatment* | *Posttreatment* | *Reference** |
|---|---|---|---|
| Maxillary intercanine width | 40.6 | 42.5 | 37.45 ± 2.46 |
| Maxillary intermolar width | 70.4 | 63.8 | 61.3 ± 2.11 |
| Mandibular intercanine width | 32.1 | 30.5 | 29.7 ± 2.09 |
| Mandibular intermolar width | 59.8 | 62.8 | 57.66 ± 2.06 |

*From the study by Kim et al.[12]

**Table IV.** Cephalometric measurements

| *Measurement* | *Norm* (mean)* | *SD* | *Pretreatment (12 y 5 mo)* | *Posttreatment (15 y 2 mo)* |
|---|---|---|---|---|
| SNA (°) | 82.80 | 4.00 | 82.58 | 81.03 |
| SNB (°) | 80.10 | 3.90 | 74.41 | 76.74 |
| ANB (°) | 2.70 | 2.00 | 8.17 | 4.29 |
| Facial angle (°) | 6.00 | 4.40 | 16.00 | 6.35 |
| Wits (mm) | −1.10 | 2.90 | 6.18 | 4.55 |
| A-NFH (°) | 0.00 | 3.70 | −1.57 | −3.49 |
| Pg-NFH (°) | −5.70 | 3.80 | −14.48 | −11.63 |
| MP/SN (°) | 32.50 | 5.20 | 27.92 | 26.37 |
| MP/PP (°) | 27.60 | 4.60 | 16.90 | 15.15 |
| SN/OP (°) | 16.10 | 5.00 | 17.98 | 6.30 |
| U1-AP (mm) | 7.20 | 2.20 | 1.34 | 3.95 |
| L1-AP (mm) | 4.90 | 2.10 | 4.97 | 0.90 |
| U1/PP (°) | 115.80 | 5.70 | 89.86 | 112.12 |
| L1/MP (°) | 93.90 | 6.20 | 101.04 | 111.86 |
| U1/L1 (°) | 124.20 | 8.20 | 148.41 | 117.85 |

*Reference norms of Chinese men.

3.5 mm and that between the mandibular right and left first molars needed to be increased by 6.2 mm. As mentioned above, the maxillary molars were inclined buccally, whereas the mandibular molars were tipped lingually before treatment. Therefore, the expansion could be realized by uprighting the molars in the mandibular arch. For the maxillary arch, which had no spaces because the second molars were erupting, the width contraction would be difficult to accomplish and maintain. According to the digital setup results, if the maxillary first premolars were extracted, the posttreatment maxillary intersecond-premolar width would have to be decreased to 46.1 mm, which was less than the pretreatment maxillary interfirst premolar width. This could be achieved only if the extraction spaces were all filled by the posterior teeth moving forward, which would be quite difficult in the first premolar extraction protocol. Furthermore, if the mandibular second premolars were extracted, it would be tough to upright the mandibular molars and increase the mandibular intermolar width. However, if the maxillary second premolars were extracted, the maxillary intermolar width would have to be decreased by 9.2 mm, which would be possible by moving the maxillary molars forward and lingually.

With regard to moving the mandible forward to improve the profile, the impinging incisors should be proclined to the normal angulation and maintained in the right position. By extracting the maxillary second premolars, the molars could be allowed to move forward to the maximum extent, and the intermaxillary transverse discrepancy could be resolved. Therefore, we decided on option 2 as our final treatment plan, which the patient and his parents accepted.

## TREATMENT PROGRESS

We initially extracted the patient's maxillary supernumerary teeth and sequentially extracted the maxillary second premolars. Thereafter, 0.022 × 0.028-in straight-wire preadjusted appliances (Shinya, Hangzhou, China) were placed in the maxillary arch for leveling and alignment. Archwire reformation was performed from the initial nickel-titanium archwire to constrict the maxillary wire. Five months later, an Andresen activator appliance was adapted to allow advancement of the mandible (Fig 4). This appliance was made according to a protrusion-bite registration, and the vertical dimensions opened 4 and 1 mm in the anterior overjet. The patient was instructed to wear the appliance 24 hours a day. Every 4 to 6 weeks, the activator was adjusted. The acrylic plane facing the palatal and mesial surfaces of the maxillary first molar was trimmed to allow palatal adjustment and natural growth of the molar. Additionally, we decreased the vertical dimension of the posterior plane to help the mandibular molars erupt into the intercuspal occlusion to establish a stable position. After 8 months, the new mandibular position seemed to be stabilized according to the repeatable protrusive occlusion. The molar relationship was stabilized in a Class II relationship, with a 2.5-mm vertical space in the posterior area (Fig 4). Although protrusion of the mandible and the natural growth greatly improved the posterior overjet, it was still larger than normal. To obtain a better transverse relationship, posterior intermaxillary traction was used to correct the buccal posterior crossbite.

Two months later, the left posterior overjet reached the normal level, and the right posterior overjet was edge to edge. Thus, the intermaxillary traction was paused, and 0.022 × 0.028-in straight-wire appliances (Shinya) were bonded in the mandibular arch for leveling

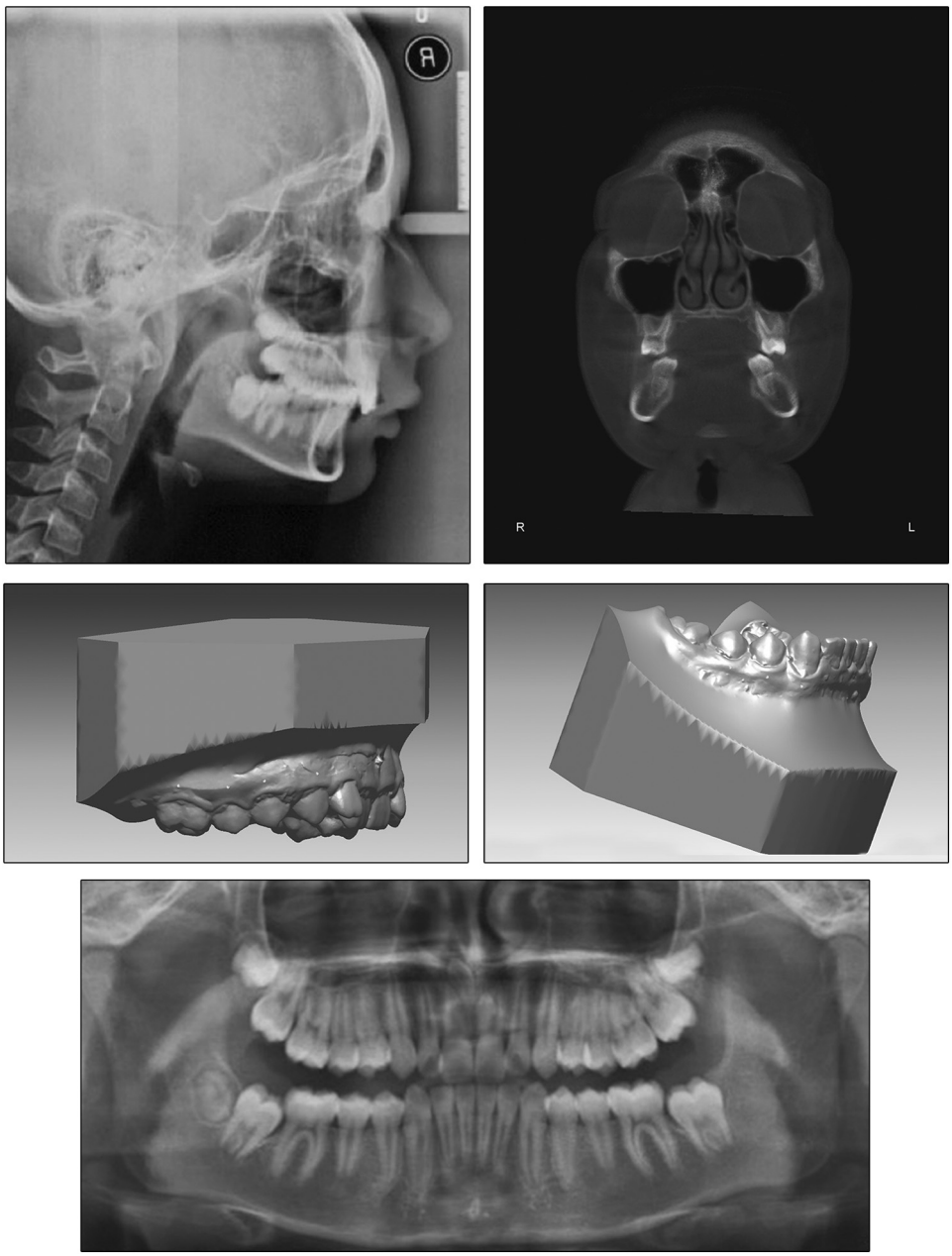


**Fig 3.** Pretreatment radiographs.

and alignment. After 4 months, the mild crowding was resolved, and a normal bilateral posterior overjet was achieved. A set of 0.019 × 0.025-in stainless steel archwires (Orsu, Beijing, China) with matched arch forms were engaged in both arches. Since the patient had only the monomaxillary extraction, and the space in the posterior region was closed by molar mesial drifting, a small space remained in the anterior area of the maxilla. Thereafter, Class II elastics were used to close the residual space and improve the anterior overjet. Furthermore, due to the skeletal Class II relationship, the mandibular incisors were proclined to compensate for the sagittal discrepancy. To achieve better anterior overjet and prevent excessive labial inclination of the mandibular anterior teeth, interproximal enamel reduction was carried out in the mandibular anterior region.

Second molar tubes were bonded before refinement. Both arches were realigned, and the torque of the teeth

**Fig 4.** Activator photographs.

**Fig 5.** Posttreatment facial and intraoral photographs.

**Fig 6.** Posttreatment dental casts.

was adjusted elaborately. The refinement took an additional 6 months. Finally, after 33 months of treatment, the severe transverse discrepancy was resolved, and normal overjet and overbite were achieved in both the anterior and posterior areas. The appliances were removed after treatment, and invisible retainers were delivered for retention.

## TREATMENT RESULTS

After 33 months of treatment, the crowding was resolved. The posttreatment photographs and dental casts showed that the teeth were well aligned and interdigitated with Class I canine and Class II molar relationships. The severe transverse discrepancy was corrected, and the arch forms were matched appropriately (Fig 5). The clinical examination showed a consistent outcome with the digital models. The lip-teeth relationship was evidently improved, and the patient's smile looked more attractive. In addition, the profile improved because of mandibular protrusion and natural growth (Fig 6).

The posttreatment panoramic radiographs showed overall root parallelism without obvious root and alveolar bone absorption. The superimposition of the pretreatment and posttreatment lateral cephalograms on the sella-nasion plane showed vertical and sagittal growth of the mandible. The superimposition on the palatal plane displayed molar mesialization (Fig 7). The superimposition on the palatal plane showed molar extrusion, and the superimposition of the 3-dimensional (3D) models confirmed this change. The maxillary and mandibular incisors were labially inclined compared with the pretreatment tracing. The impinging maxillary incisors were relieved, and the mandibular incisors were compensatively proclined to establish a normal anterior overjet (Fig 8).

The CBCT image (Fig 9) showed that the torque of the maxillary left molars was corrected from 80.1° to 100.7° (Table II), that of the maxillary right molars was corrected to 92.9°, and that of the mandibular molars was corrected to approximately 93°. Overcorrection was performed for the mandibular molars to improve stability, and the torque of the maxillary molars exhibited a different value to compensate for the facial asymmetry.

After treatment, the patient was recalled at 24 and 40 months (Fig 10). No disalignment or crowding was observed. The digital models of pretreatment (T1), end of treatment (T2), 24 months after treatment (T3), and 40 months after treatment (T4) were superimposed on the stable palatal region (Fig 8).[14] The results showed that the intermolar width increased by 1 mm from T2 to T3 and by 0.5 mm from T3 to T4, whereas the intercanine width increased by 0.7 mm from T2 to T3 and by 1.0 mm from T3 to T4. The maxilla continued to grow laterally and moved downward and forward.

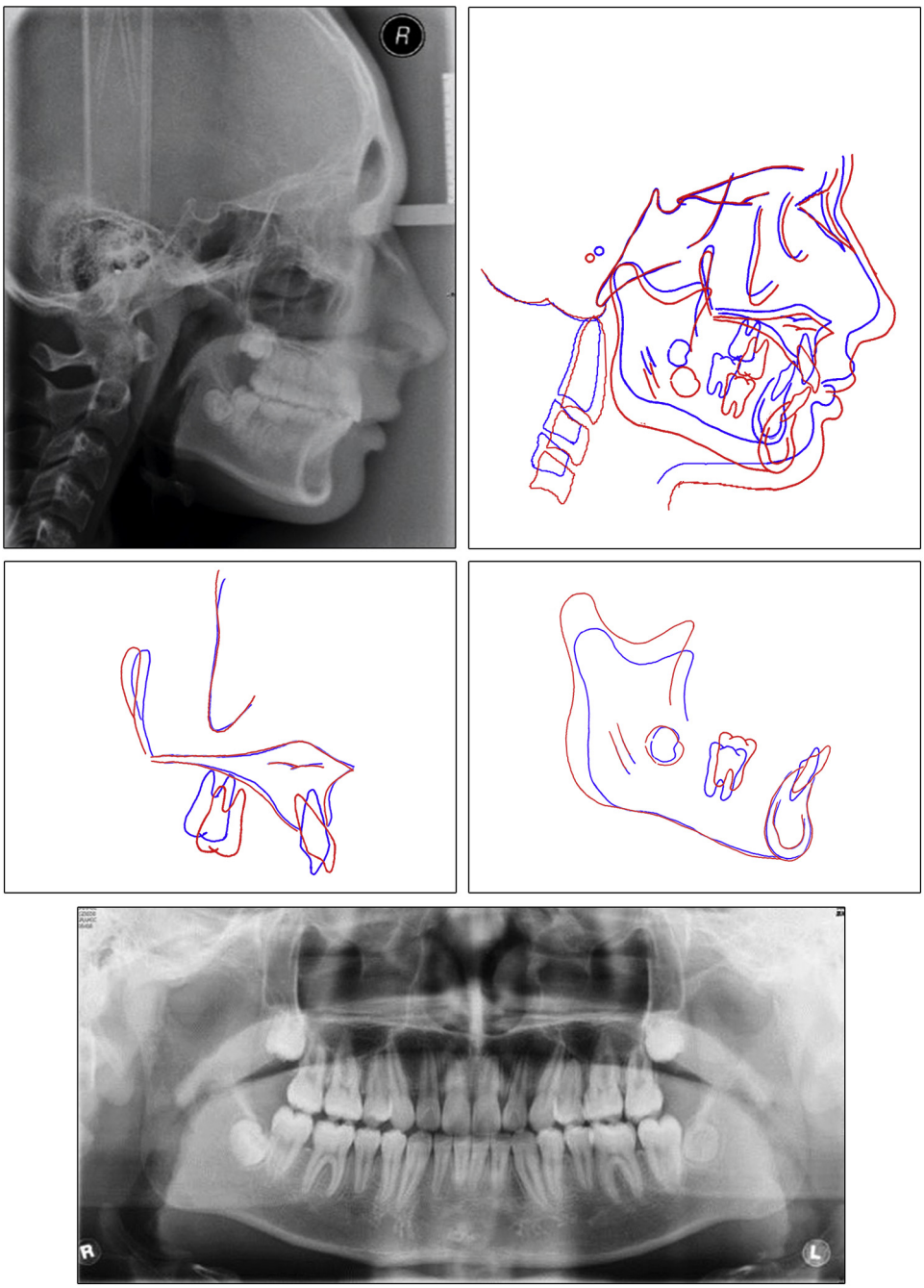

**Fig 7.** Posttreatment radiographs and cephalometric superimpositions.

## DISCUSSION

Brodie bite, also called Brodie syndrome, was first described as a type of occlusion in 1943, in which all buccal cusps of the mandibular molars are telescoped within the lingual cusps of the maxillary molars.[15] This comparatively rare form of malocclusion does not harm the esthetics much; therefore, it is seldom recognized as a patient's chief complaint. However, this malocclusion causes reduced contacts of the occlusal surfaces and excessive vertical overlapping of the posterior teeth. Moreover, normal growth and development of the mandible are hampered, resulting in major skeletal abnormalities in adults. To avoid the physical and psychological burdens of orthognathic

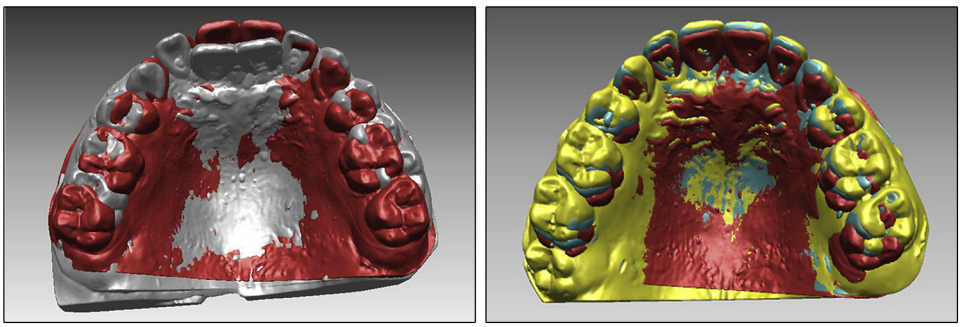

**Fig 8.** Three-dimensional model superimposition: the left image shows the T1-T2 superimposition (*grey*, T1; *red*, T2), and the right image shows the T2-T4 superimposition (*red*, T2; *blue*, T3; *yellow*, T4).


**Fig 9.** CBCT transverse analysis for the torque of the molars.

surgery, it is necessary to correct this malocclusion at an early stage.

Treating a patient with a bilateral scissors-bite involves making a decision about where the discrepancy lies: ie, whether it is skeletal or dental.[16] If it is mainly skeletal, the jaw should be corrected. If it is mainly dental, the posterior teeth, either maxillary or mandibular or both, should be repositioned. Traditionally, it is helpful to evaluate the width of the bone of the maxilla relative to that of the mandible and the buccolingual axial inclination of the posterior teeth, based on the clinical examination, casts, and posteroanterior cephalogram; however, the result may not be exact. Nowadays, with the rapid development of 3D technology, it is possible to perform precise measurements in 3 dimensions and establish the diagnostic digital setup assisted by CBCT and the digital dental model before treatment.

A stable treatment result relies on correct diagnosis and treatment planning. A transverse discrepancy may result from skeletal problems, dental problems, or both. Miner et al[11] showed that in a population with crossbite, a normal dental inclination was mostly found in patients with bilateral crossbite, whereas dental compensation was found on the noncrossbite side in patients with an obvious unilateral crossbite. In addition, there is dental compensation in noncrossbite patients with a severe transverse discrepancy. A similar situation may occur in patients with Brodie bite. Therefore, a clarified analysis of the skeletal and dental problem is the foundation of treatment. For our patient, the transverse and sagittal discrepancies masked by mandibular retrognathia and impinging teeth were detected. Therefore, the transverse discrepancy was affected by the width of the jaw in addition to the hypogenesis of the mandible.

The maxillomandibular width differential in our patient was 3.1 mm. A previous study pointed out that a transverse discrepancy greater than 3 mm is not orthodontically treatable, but it also claimed that the dental tipping and skeletal growth problem must be identified clearly, since the former generally leads to the need for orthodontic treatment.[17] From the torque measurement of the molars, the obvious buccal inclination of the maxillary molars and the lingual inclination of the mandibular molars showed a dental tipping problem without dental compensation. Based on these findings, constriction of the maxillary arch by mesialization of the maxillary molars and coordination of the maxillomandibular arches by promoting mandibular growth were remedies for the dental and skeletal problems, respectively.

For better treatment planning, a 3D digital setup was used to assist the therapy (Fig 11).[18] The diagnostic setup

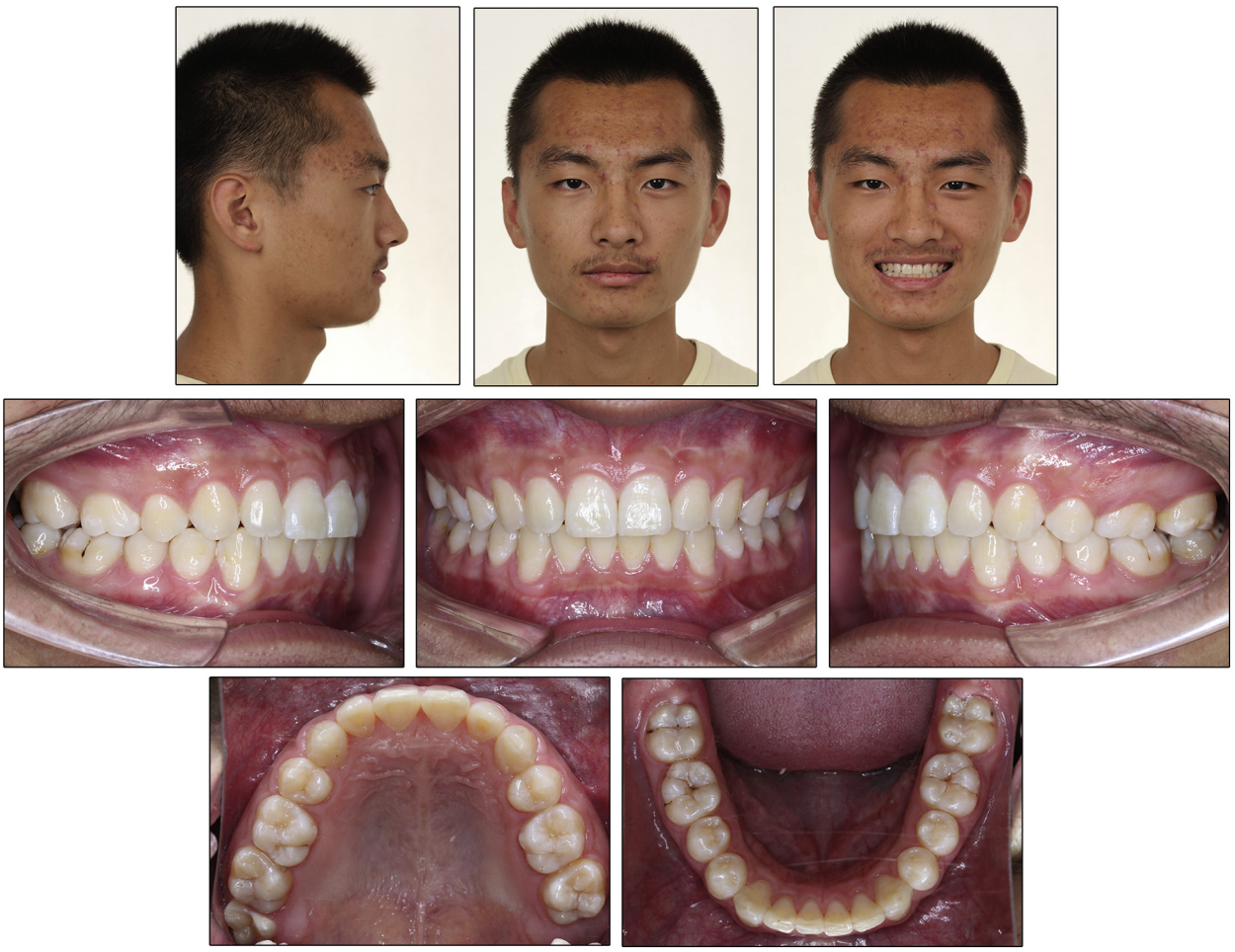

**Fig 10.** Postretention (3 years) facial and intraoral photographs.

was introduced by Kesling[19] to help clinicians determine various alternatives. To determine the extraction pattern, the distance between the mesiobuccal cusp tips of the maxillary molars was measured under different simulated methods including the nonextraction method and extraction of the first and second premolars. The nonextraction treatment could only constrict the arch width for 3 mm by changing the dental axis. In contrast, the extraction orthodontic treatment could reduce the width of the maxillary molars from approximately 62.6 to 54.0 mm. The width of the mandibular molars was adjusted from 44.2 to 50.2 mm by growth and torque control. Apparently, the extraction orthodontic treatment resulted in greater stability and feasibility. Furthermore, the second premolar extraction plan seemed better than the first premolar extraction plan, since the patient did not need strong anchorage because of the torque control in the anterior teeth. After the treatment, the practical widths of the maxillary and mandibular molars were measured as 52.5 and 50.6 mm, respectively. In addition to the overcorrection, the measured results were considerably consistent.

The functional appliance—Andresen activator—was used to stimulate mandibular growth. The maxillary teeth were directed distally and buccally by the traditional activator.[20] However, the activator was modified by trimming the palatal and mesial surfaces of the interocclusal acrylic guide planes to provide enough space for maxillary molar mesialization and torque regulation during natural growth. It is reported that aggressive use of a removable biteplate or functional appliance is helpful to manage the correction of occlusal function and promote vertical growth in the posterior region of similar malocclusions.[21-23] As long as the treatment was consistent with natural growth, the gain in long-term stability could be assured.

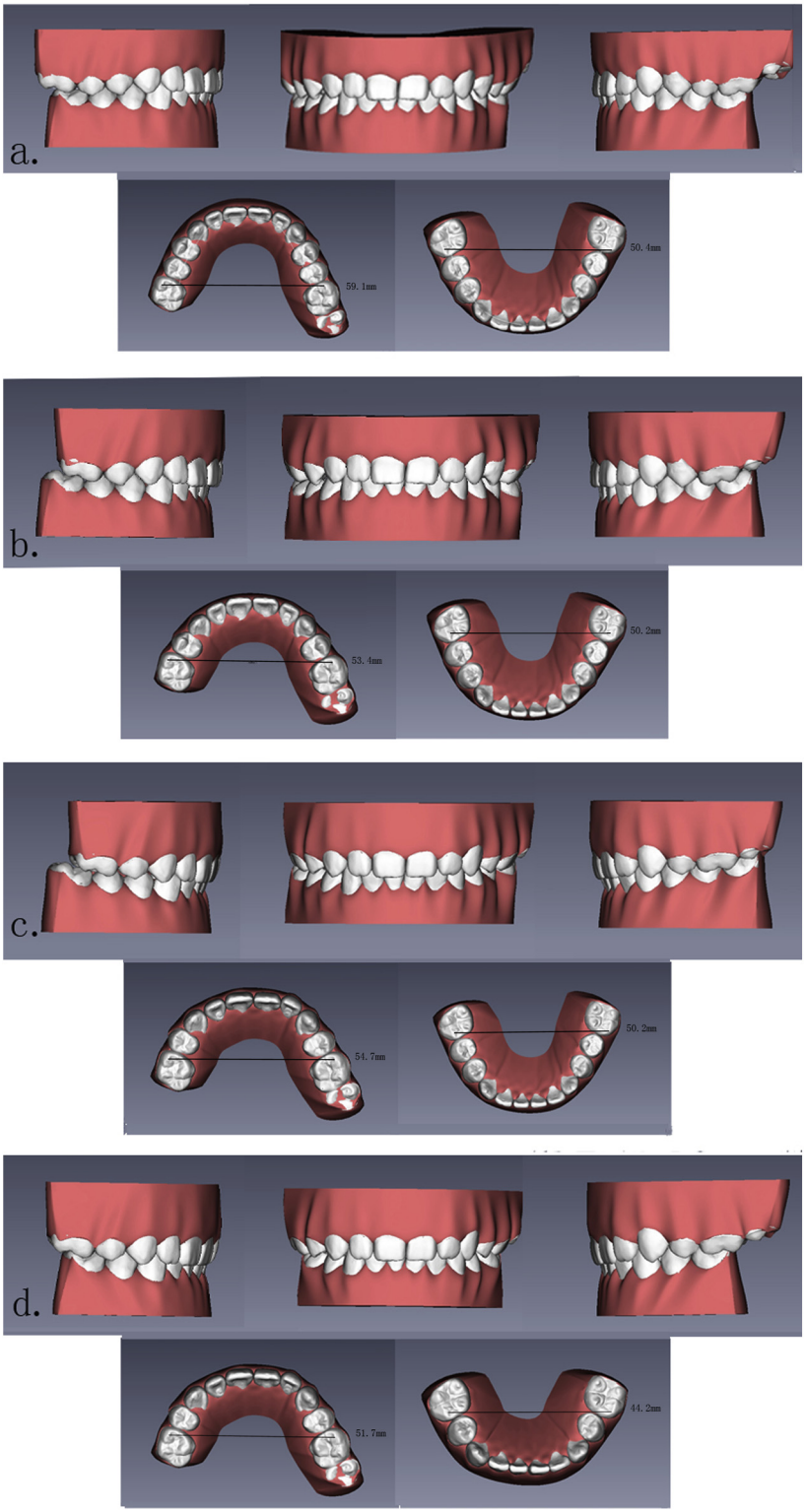


**Fig 11.** Digital setups for the alternative treatment plans and measurements of intermolar width: **A,** digital setup for nonextraction treatment; **B,** digital setup for extraction of the maxillary right and left second premolars; **C,** digital setup for extraction of the maxillary right and left first premolars; **D,** digital setup for extraction of the maxillary right and left first premolars and mandibular right and left second premolars.

The patient was instructed to wear the removable retainers full time for the first 2 years, and then he was to wear them at night for 2 to 3 years until the third molars erupt. Records taken at 24 and 40 months after treatment indicated promising stability at the maintaining stage. Marshall et al[24] evaluated the changes in molar crown torque and intermolar arch width from eruption of the permanent first molar to early adulthood. The results of their study showed that, on average, the buccal crown torque of the maxillary molars decreased by 3.3°, and the buccal crown torque of the mandibular molars increased by 5.0° with age; this was consistent with the molar-movement direction for this patient. Moreover, the superimposition of digital models showed that the maxillary intermolar and intercanine widths increased slightly with age; this is also consistent with the results of the study by Marshall et al. Therefore, the coordination between treatment results and natural growth, and appropriate overcorrection, were essential factors for good stability. Moreover, from T2 to T3, a more satisfactory bilateral occlusion balance was observed. This autoregulation is a result of the equilibrium-achieving occlusal force, which is more gentle and stable than the orthodontic force.

## CONCLUSIONS

A Class II adolescent patient with severe transverse discrepancy, bilateral scissors-bite, short lower-face height, and mandibular retrognathia was successfully treated by a 2-stage orthodontic treatment. The good and stable treatment outcome was closely related to a proper treatment plan based on an accurate 3D diagnosis and the effective use of growth potential for solving the skeletal problems nonsurgically.

## REFERENCES


1. Harper DL. A case report of a Brodie bite. Am J Orthod Dentofacial Orthop 1995;108:201-6.
2. Legan HL. Orthodontic planning and biomechanics for transverse distraction osteogenesis. Semin Orthod 2001;7:160-8.
3. King JW, Wallace JC. Unilateral Brodie bite treated with distraction osteogenesis. Am J Orthod Dentofacial Orthop 2004;125:500-9.
4. Guerrero C. Expansion mandibular quirúrgica. Rev Venez Ortod 1990;7:48-50.
5. Ramsay DS, Wallen TR, Bloomquist DS. Case report MM: surgical-orthodontic correction of bilateral buccal crossbite (Brodie syndrome). Angle Orthod 1990;60:305-11.
6. Hua X, Xiong H, Han G, Cheng X. Correction of a dental arch-width asymmetric discrepancy with a slow maxillary contraction appliance. Am J Orthod Dentofacial Orthop 2012;142:842-53.
7. Ogihara K, Nakahara R, Koyanagi S, Suda M. Treatment of a Brodie bite by lower lateral expansion: a case report and fourth year follow-up. J Clin Pediatr Dent 1998;23:17-21.
8. Kim KA, Yu JJ, Chen Y, Kim SJ, Kim SH, Nelson G. Surgery versus nonsurgery option for scissors bite treatment. J Craniofac Surg 2015;26:726-9.
9. Ishihara Y, Kuroda S, Sugawara Y, Kurosaka H, Takano-Yamamoto T, Yamashiro T. Long-term stability of implant-anchored orthodontics in an adult patient with a Class II Division 2 malocclusion and a unilateral molar scissors-bite. Am J Orthod Dentofacial Orthop 2014;145:100-13.
10. Uysal T, Memili B, Usumez S, Sari Z. Dental and alveolar arch widths in normal occlusion, class II division 1 and class II division 2. Angle Orthod 2005;75:941-7.
11. Miner RM, Al QS, Rigali PH, Will LA. Cone-beam computed tomography transverse analysis. Part 1: normative data. Am J Orthod Dentofacial Orthop 2012;142:300-7.
12. Kim KY, Bayome M, Kim KT, Han SH, Kim Y, Baek SH, et al. Three-dimensional evaluation of the relationship between dental and basal arch forms in normal occlusion. Korean J Orthod 2011;41:288-96.
13. Tomonari H, Kubota T, Yagi T, Kuninori T, Kitashima F, Uehara S, et al. Posterior scissors-bite: masticatory jaw movement and muscle activity. J Oral Rehabil 2014;41:257-65.
14. Chen G, Chen S, Zhang XY, Jiang RP, Liu Y, Shi FH, et al. Stable region for maxillary dental cast superimposition in adults, studied with the aid of stable miniscrews. Orthod Craniofac Res 2011;14:70-9.
15. Valencia RM. Treatment of unilateral buccal crossbites in the primary, early mixed, and permanent dentitions: case reports. J Clin Pediatr Dent 2007;31:214-8.
16. Marcotte MR. Arch form and dimension: posterior widths. In: Burstone CJ, Marcotte MR, editors. Problem solving in orthodontics: goal-oriented treatment strategies. Chicago: Quintessence; 2000. p. 56-68.
17. Squire D, Best AM, Lindauer SJ, Laskin DM. Determining the limits of orthodontic treatment of overbite, overjet, and transverse discrepancy: a pilot study. Am J Orthod Dentofacial Orthop 2006;129:804-8.
18. Chen S, Xu TM. Treatment of a severe transverse dental arch discrepancy assisted by 3-dimensional planning. Am J Orthod Dentofacial Orthop 2013;143:105-15.
19. Kesling HD. The diagnostic setup with consideration of the third dimension. Am J Orthod 1956;42:740-8.
20. Graber TM, Neumann B. Removable orthodontic appliances. 2nd ed. Philadelphia: W. B. Saunders; 1984.
21. Yogosawa F. Case report AE: non-surgical correction of a severe Class II malocclusion (Brodie syndrome). Angle Orthod 1990;60:299-304.
22. Chugh VK, Sharma VP, Tandon P, Singh GP. Brodie bite with an extracted mandibular first molar in a young adult: a case report. Am J Orthod Dentofacial Orthop 2010;137:694-700.
23. Ohmori H, Ono T. Unilateral scissors bite treated with a removable plate that incorporates a Ti-Ni wire. Orthodontics (Chic.) 2013;14:e222-6.
24. Marshall S, Dawson D, Southard KA, Lee AN, Casko JS, Southard TE. Transverse molar movements during growth. Am J Orthod Dentofacial Orthop 2003;124:615-24.