Submitted: 07 August, 2022 Accepted: 08 November, 2022 Published: 03 November, 2023 DOI:10.22514/jocpd.2023.092

CASE REPORT

Journal of Clinical Pediatric Dentistry

Two-phase orthodontic treatment of a patient with a low-angle skeletal class II malocclusion: a 7-year follow-up

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Abstract

Low-angle skeletal class II malocclusions are often observed with sagittal and vertical developmental abnormalities of the mandible. Two-phase orthodontic treatment of functional orthopedic therapy combined with fixed correction is one of the most common methods to treat of skeletal class II malocclusions. This case report describes the two-phase orthodontic treatment of a patient with severe low-angle skeletal class II malocclusion. A Twin Block orthodontic appliance was used to improve mandibular growth, and the adjustment of the occlusal relationship using a fixed appliance after functional therapy. After treatment, a significant improvement was observed in the patient's facial appearance and occlusal relationship. Additionally, a 7-year follow-up confirmed the stability of the treatment results. Although a vertical facial growth direction is difficult to control, the Twin Block orthodontic appliance in adolescents might effectively improve the difference in the sagittal growth of the mandible. Whilst the growth pattern could not be fully controlled, the treatment significantly improved the patient's facial profile and occlusion.

Keywords

Two-phase orthodontic treatment; Skeletal class II malocclusion; Low-angle

1. Introduction

Skeletal class II malocclusions are a common type of malocclusion. The prevalence of malocclusion among children and adolescents is approximately 48% in Asia, with more than half of the patients classified as class II malocclusions [1]. Although these malocclusions may occur due to various skeletal and dental combinations, it was reported to be mostly caused by mandibular retrognathism [2]. It is often accompanied by anterior teeth proclination, which may affect esthetics and increase the risk of incisor trauma [3]. Treatment options for these patients include functional orthopedic, fixed camouflage orthodontic, and combined orthodontic-orthognathic surgical treatment. A low-angle facial type, also known as "brachyfacial", is used to describe an individual with a short anterior face height and a wide face [4, 5]. Low-angle skeletal class II malocclusions are often accompanied by a deep bite and overjet, leading to a short, wide and square facial pattern [6, 7]. These patients present with high muscle tension, and difficulty in teeth movement. However, a previous study showed that Twin Block appliance could significantly alter mandibular growth [8]. Though this is debatable based on current evidence, some evidence suggests that Twin Block appliances may significantly influence mandibular growth when used appropriately [9, 10]. The pubertal growth spurt is considered a key period for orthopedic treatment.

Twin Block appliances are one of the most commonly used functional appliances for treating skeletal class II malocclusions in adolescents [11]. Previous studies found that they could effectively increase the length of the mandible by an average of 0.23 mm/month [12]. Increasing the height of the lower face is an important therapeutic goal for patients with a "brachyfacial" appearance. This case report aimed to describe the treatment of a patient whose facial skeleton was growing in a forward and downward direction, the occlusal relationship change under a two-phase orthodontic treatment for this patient with a low-angle skeletal class II malocclusion, and the findings following a 7-year follow-up.

2. Case report

A 12-year-old boy visited the orthodontics department with his parents for orthodontic treatment, with complaints of maxillary anterior tooth and lip protrusion. The initial clinical examination revealed a convex facial profile, a short and wide face with a prominent mandibular angle, and incompetent lip seal in the resting position (Fig. 1A1–3). Intraoral examination revealed that the patient had an early permanent dentition period (Fig. 2A1–3). The patient's upper incisors were labially inclined. We also observed that tooth 17 did not erupt and tooth 41 was congenitally missing. The patient presented with a class II molar relationship and showed a deep overjet and a deep

FIGURE 1. Facial photographs of the patient. (A1–A3) before treatment; (B1–B3) at posttreatment of phase I; (C1–C3) at posttreatment of phase II; and (D1–D3) at 7-year follow-up.

overbite of 14.3 mm and 5.3 mm, respectively. The patient had mild anterior crowding in both arches: upper and lower arch crowding of 2.5 mm and 2 mm, respectively. His facial and intraoral photographs are shown in Figs. 1,2, and his panoramic radiographs and cephalograms are shown in Figs. 3,4.

Lateral cephalometric analysis indicated that the patient had a skeletal class II relationship, with normal maxillary growth, hypoplasia of the mandible, a low-angle growth pattern, and proclined maxillary incisors. Further examination revealed lip protrusion to the esthetic line. Before treatment, the growth and development stage of the patient was evaluated by cephalometric radiographs. According to the Baccetti cervical spine maturity analysis, the patient was in the cerebral vascular malformations (CVMS) II stage and at the peak of growth and development. Therefore, a two-phase orthodontic treatment comprising a Twin Block functional orthopedic treatment in phase I (T1) and fixed orthodontic treatment in phase II (T2) was planned. The patient and his guardian signed an informed consent form.

After 9 months of Twin Block functional appliance treatment, there was significant sagittal forward growth of the mandible and a significant reduction in overjet. However, since the patient's second molars had not erupted and had some remaining growth potential, we decreased the bite pad of the Twin Block appliance to allow the posterior teeth to erupt vertically and to further guide the mandible forward. Twin Block functional appliance treatment was performed for 21 months during phase I of treatment, following which significant treatment efficacy was observed (Fig. 1B1–3, Fig. 2B1–3). Additionally, the patient's overjet and overbite were significantly reduced. Occlusal views showed a class I canine and molar relationship was acquired from T0 to T1. The patient's facial profile esthetics improved due to sagittal growth of the mandible. From T0 to T1, the SNA (∠Sella-Nasion-A.supramental) angle decreased from 83.3° to 82.6°, and the SNB (∠Sella-Nasion-B.supramental) angle increased from 78.2° to 79.0°, resulting in a decrease in the ANB angle from 5.1° to 3.6°. At the same time, the upper anterior teeth were significantly retracted, with U1-SN decreasing from 126.9° to 116.4°. However, the lower anterior teeth were proclined, with an increase in IMPA (Lower incisor to occlusal plane) (L1-MP) increasing from 108.5° to 111.6°.

After 21 months of Twin Block treatment, phase II of fixed orthodontic appliance treatment was implemented to correct the occlusion. Of note, no teeth were extracted. After 13 months of fixed orthodontic correction, facial photographs

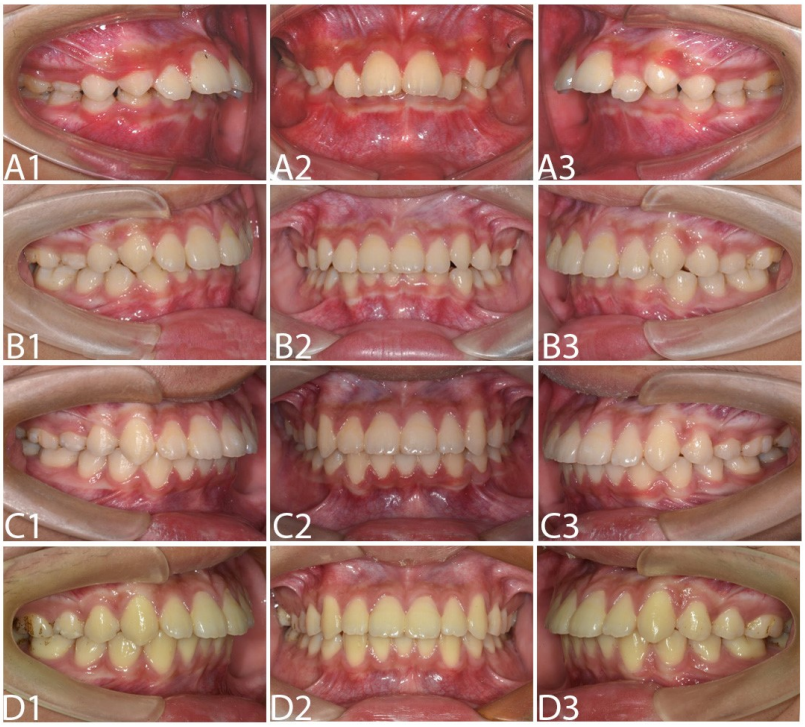

FIGURE 2. Oral photographs of the patient. (A1–A3) before treatment; (B1–B3) at posttreatment of phase I; (C1–C3) at posttreatment of phase II; and (D1–D3) at 7-year follow-up.

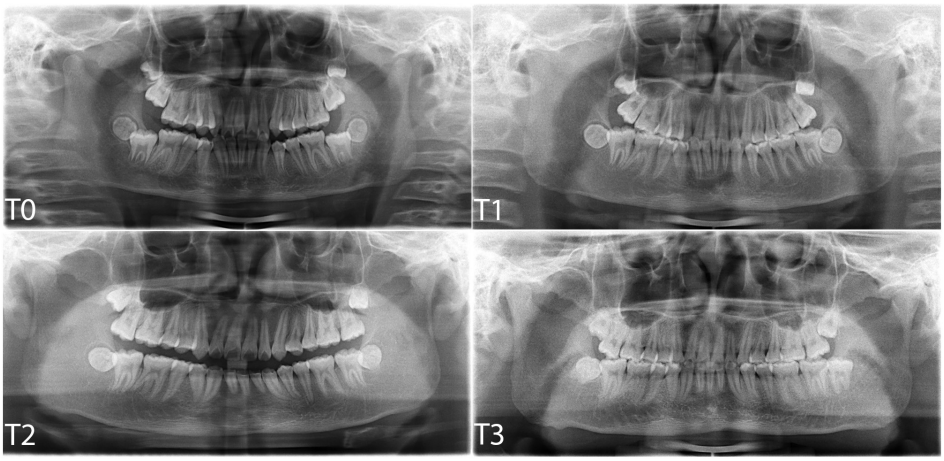

FIGURE 3. Panoramic radiograph of the patient. (T0) before treatment; (T1) at posttreatment of phase I; (T2) at posttreatment of phase II; and (T3) at 7-year follow-up.

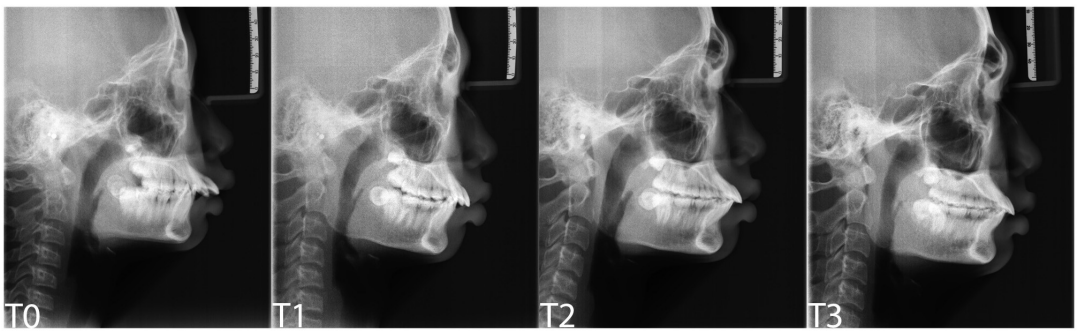

FIGURE 4. Lateral cephalogram of the patient. (T0) before treatment; (T1) at posttreatment of phase I; (T2) at posttreatment of phase II; and (T3) at 7-year follow-up.

demonstrated significant improvements in the patient's soft tissue profile, and his upper and lower lips could be closed naturally. From T1 to T2, there was no significant change in the skeletal appearance; the major change was reflected in the intense adjustment of the occlusal relationship. At the end of treatment, with total treatment course were 34 months, the patient exhibited a class I canine and molar relationship. From T0 to T2, the overjet reduced from 14.3 mm to 5 mm, and the overbite decreased from 5.3 mm to 1.3 mm, indicating a 65.03% reduction in overjet and a 75.47% decrease in overbite. Considering the congenital absence of a lower incisor, a 5 mm overjet was considered to be acceptable. The reduction of overjet was due to the sagittal upward growth of the mandible, and the labial tilt effect of the lower anterior teeth, which increased the IMPA (L1-MP) from 108.5° to 125.2°, from T0 to T2. However, from T1 to T2, the labial inclination of the upper anterior teeth increased, with an increase in U1-SN from 116.4° to 124.1°. Further proclination occurred in the anterior teeth from T1 to T2 (fixed orthodontic phase), possibly because no extraction was performed, and space was needed for alignment and leveling.

Compared to the pretreatment period, the lower anterior face height (ANS-Me) was increased from 49.2 mm to 54.2 mm, and the posterior face height (Go-Co) was increased from 59.5 mm to 64.1 mm. The length of the mandibular body (Go-Po) increased from 67.0 mm to 72.4 mm, and the effective mandibular length (Co-Gn) increased significantly from 92.5 mm to 102.4 mm. However, we observed that although the lower anterior face height was increased, the posterior face height was also increased. Thus, the ratio of the anterior face height to the posterior face height did not change significantly, with an S-Go/N-Me (P-A face height) at 78.4% at T0 and 77.8% at T2, respectively.

A 7-year follow-up after phase II of treatment showed no significant changes in skeletal, soft tissues, and tooth properties compared with T2, which indicated that the effects of the treatment were stable. The cephalometric analysis results are shown in Table 1. Superimposed lateral cephalograms are shown in Fig. 5.

3. Discussion

A systematic study by Nicole *et al.* [13] showed that Twin Block effectively reduced the ANB angle by an average of 2.37° in patients with skeletal class 2 malocclusion. Patient in this present study showed a 2.5° reduction in ANB angle after treatment, indicating that Twin Block could also be effective in treating patients with low-angle skeletal class 2 malocclusion. A low-angle skeletal pattern indicates that the FMA (FH-MP) (normal value 26° ± 4°) was less than 22°, and our patient had an FMA of 9.5°. A low-angle skeletal class II malocclusion often presents as undergrowth of the mandible in the sagittal direction, with a high masticatory force. Since a low-angle facial pattern is often accompanied by a counterclockwise rotation of the mandible, it often manifests as an excessive overjet and a deep overbite intraorally [14]. Twin Block appliances are commonly used for adolescent patients with mandibular retrognathism of class II division 1 malocclusion. Skeletal maturity was shown to be more closely related to facial growth rates than chronological age. The morphology of the cervical vertebrae is a useful indicator of skeletal age and can assist orthodontists in determining the remaining body growth space of patients. CVM cervical spine maturity staging divides cervical spine maturity into 6 stages, with CVM 1–6 cervical spine maturity progressively increasing. Studies have shown that functional orthopedic treatment results in greater growth when performed in early adolescence, with maximum growth in patients treated at the CVM1 stage and the average amounts of growth diminishing monotonically across the 6 stages [15]. Comparatively, as little facial growth occurs in the functional orthopedic treatment of patients older than 15 years, growth modification therapy should be performed cautiously in them. Previous studies showed that early or late treatment in adolescents with functional appliances could effectively reduce the prominence of upper front teeth [13]. In our patient, the labial inclination of the upper anterior teeth was reduced after the first phase of Twin Block treatment, and the overjet was also significantly reduced. However, tooth extraction should be performed cautiously in patients with low-angle skeletal class II malocclusion because their teeth are difficult to move due to strong masticatory forces. Compared with orthodontic treatment, orthognathic surgery can significantly improve facial profile esthetics [16, 17]. Early correction of class II malocclusions with functional appliances provides an opportunity to adjust skeletal relations and avoid orthognathic surgery [18].

Studies have shown that Twin Block, a functional orthopedic appliance, can promote the sagittal growth of the mandible and retract proclined upper anterior teeth to some extent to reduce the possibility of trauma to the protruding anterior teeth [19, 20]. In this case, we noted that the patient's ANB was significantly reduced. This effect was related to not only the sagittal growth of the mandible but also the limited growth of the maxilla. It can be observed from the measurement results that SNB increased from 78.2° to 80.1° and the SNA decreased from 83.3° to 82.7°, indicating that ANB was significantly reduced from 5.1° to 2.6°. Some studies suggested that the mechanism of Twin Block appliances could move the maxilla and the mandible teeth through opposite forces, pushing the mandible forward and having a rearward force on the maxilla, thus limiting the growth of the maxilla and therefore harmonizing the relationship between the maxilla and mandible [21].

It is usually considered that the clockwise rotation of the mandible is one of the adverse effects of using Twin Block appliances, so it should be used with caution in patients with high mandibular plane angle. It is worth noting that the anterior lower facial height increased by 4.7 mm from T0 to T1, and the posterior facial height also increased. Due to the simultaneous growth of the anterior and posterior facial heights, there was no significant change in the ratio of the posterior facial height to the anterior facial height, thus, indicating that the Twin Block functional appliance might have limited therapeutic efficacy in terms of the vertical direction of growth. A possible reason for the increase in lower facial height might be that the bite-opening effect caused a clockwise rotation of the mandible, thus changing the growth direction of the mandible and causing the mandible to grow in a forward and downward direction.

Some studies have found that the Twin Block treatment also

TABLE 1. Cephalometric analysis results.

Measurement	T0 (initial)	T1 (21 months)	T2 (34 months)	Norm (The normal average)	Std Dev (Standard deviation)
SNA (∠Sella-Nasion-A.supramental) (°)	83.3	82.6	82.7	83	±4
SNB (∠Sella-Nasion-B.supramental) (°)	78.2	79.0	80.1	80	±4
ANB (∠A.supramental-Nasion-B.supramental) (°)	5.1	3.6	2.6	3	±2
Go-Po (Gonion to Pogonion) (mm)	67.0	72.2	72.4	73	±4
Go-Co (Gonion to Condylion) (mm)	59.5	64.1	64.1	59	±3
FMA (∠Frankfore horizontal plane-Mandibular plane) (FH-MP) (°)	9.5	12.1	11.7	26	±4
Co-Gn (Condylion to Gnathion) (mm)	92.5	101.3	102.4	106	±2
ANS-Me (Anterior nasal spine to Menton) (mm)	49.2	53.9	54.2	61	±3
S-Go (Sella to Gonion) (mm)	78.9	84.7	84.3	77	±7
S-Go/N-Me (Sella to Gonion/Nasion to Menton) (%)	78.4	78.1	77.8	64	±2
U1-SN (∠Upper incisor-Sella nasion plane) (°)	126.9	116.4	124.1	106	±6
IMPA (Lower incisor to occlusal plane)	108.5	111.6	125.2	97	±6
LL-EP (Lower lips to Esthetic line plane) (mm)	3.6	5.6	4.9	1	±2
UL-EP (Upper lips to Esthetic line plane) (mm)	4.3	3.5	1.4	−1	±1
Overjet (mm)	14.3	7.8	5.0	2	±1
Overbite (mm)	5.3	4.1	1.3	3	±2
N‘-Sn-Pg (∠nasion of soft tissue-Subnasale-Pogonion of soft tissue) (°)	155	154.6	156.8	168	±4

Abbreviations: Norm: the normal average; Std Dev: standard deviation.

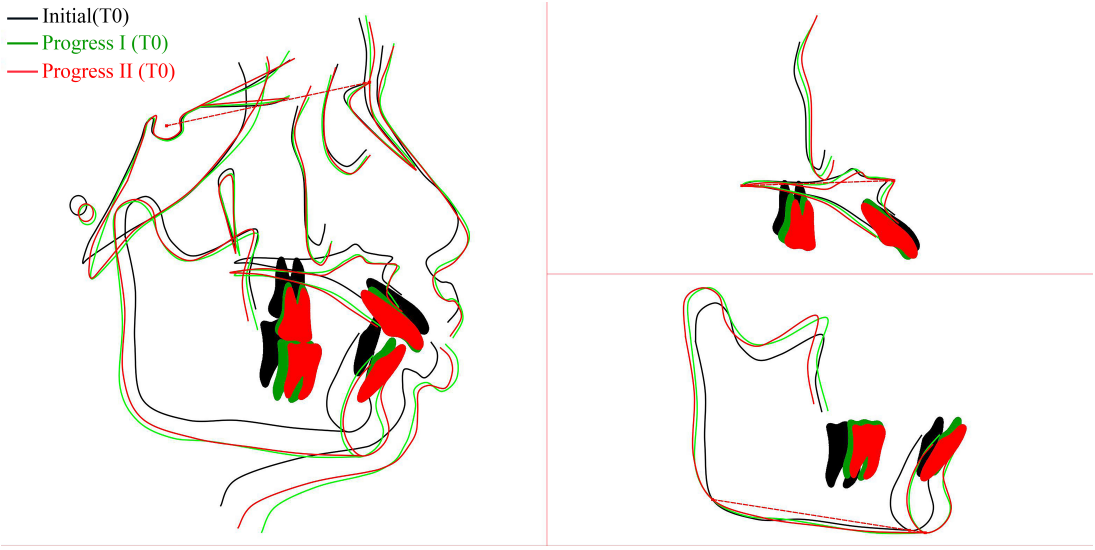

FIGURE 5. Superimposed lateral cephalograms.

increased the mandibular plane angle by changing the underlying skeletal and dentoalveolar structures [22]. In our presented case, we observed no significant change in the mandibular plane angle before and after treatment. We hypothesized that this could be because when the Twin Block promoted sagittal growth of the mandible, it failed to inhibit the growth of the mandibular ascending ramus.

Functional orthopedic treatment is a type of early correction oriented by facial type [23]. The main treatment objectives are to expand the maxillary arch and enhance the growth of the mandible. A systematic review by Cozza *et al.* [12] showed that Twin Block orthodontics had a success rate of over 66%, with an average mandibular growth of 2.3 mm/month. We observed that the mandible grew significantly in the sagittal plane during functional orthopedic treatment. From T0 to T1, due to the sagittal growth of the mandible and improvement in tooth inclination, the patient's overjet was significantly reduced, his lips could be closed naturally, and his facial appearance improved. We used a Twin Block appliance as a retainer for this patient to maintain the mandibular growth direction during 2 years of retention, and no relapse occurred at the 7-year follow-up.

4. Conclusions and limitation

This case report demonstrates that a two-phase orthodontic treatment (functional orthopedic therapy combined with fixed correction) could effectively improve the appearance and occlusal relationship. However, it was difficult to adjust the mandibular plane angle due to the patient's auto-growth capacity. Altogether, our approach showed satisfactory treatment efficacy and patient follow-up of 7 years demonstrated stable treatment effects. Despite the promising results observed, a larger number of cases is needed to confirm the efficacy of Twin Block in patients with low-angle skeletal class II malocclusion and the effect on changes in the angle of the mandibular plane.

AVAILABILITY OF DATA AND MATERIALS

All data during this study are included in this published article.

AUTHOR CONTRIBUTIONS

SM—designed the research study. SF—performed the research. ZC—analyzed the data. XF—wrote the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This work was reviewed and approved by the Ethics Committee of the Affiliated Stomatological Hospital of Guangxi Medical University (No. 2021016). The study protocol followed the Declaration of Helsinki ethical standards for research involving human subjects. Informed consent was obtained from the patient and his guardian.

ACKNOWLEDGMENT

Not applicable.

FUNDING

This study was supported by Guangxi Natural Science Foundation Projection (grant number: 03201219096D) and Guangxi Medical and Health Appropriate Technology Development, Popularization, and Application Project (grant number: S2021086).

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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How to cite this article: Xuemin Fan, Shanbao Fang, Zhixing Chen, Shuixue Mo. Two-phase orthodontic treatment of a patient with a low-angle skeletal class II malocclusion: a 7-year follow-up. Journal of Clinical Pediatric Dentistry. 2023; 47(6): 178-184. doi: 10.22514/jocpd.2023.092.