

Treatment of a severe skeletal Class II malocclusion through growth modification: a problem-oriented case report

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A skeletal Class II malocclusion is an anteroposterior discrepancy resulting from a combination of skeletal and dental factors. In adolescent patients, it is possible to leverage their growth potential to address bone deformities and minimise the need for future surgical interventions. In the present case report, a combination treatment approach was adopted which included a functional appliance, fixed appliances, and temporary anchorage support, to treat a 13-year-old Chinese male with a severe skeletal Class II malocclusion. After a treatment duration of 36 months, the patient achieved a favourable occlusion and an improved facial profile. Subsequently, a stable occlusal relationship and balanced facial proportions were maintained during a 2-year retention period.

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Introduction

The development of a skeletal Class II malocclusion is attributed to mandibular retrognathism, maxillary prognathism, or both. When these two conditions co-exist, the patient's facial convexity tends to be more severe, therefore making treatment more complex.^{1,2} In the case of adolescent patients, it is possible to improve a bony discrepancy by taking advantage of their growth potential. Failure to intervene in a timely manner greatly increases the likelihood of requiring orthognathic surgery in adulthood.³ However, many families find it difficult to accept surgical treatment due to its high risk and cost. As a result, more patients are turning to non-surgical treatment methods, such as a functional appliance or fixed appliance correction. Functional appliances can stimulate mandibular growth and modify its direction to correct a skeletal discrepancy caused by mandibular retrusion.⁴ In the case of maxillary

protrusion, excessive maxillary development should be restricted through methods like headgear-activator or the use of implant anchorage. The present patient study describes an adolescent who presented with a significant skeletal Class II malocclusion as a result of mandibular retrognathism and maxillary prognathism. Consequently, the treatment plan adopted a two-phase strategy implemented periodically and aligning with the underlying pathogenesis.

The case presentation demonstrates the successful orthodontic treatment of a 13-year-old Chinese male who presented with a severe skeletal Class II malocclusion characterised by a retrognathic mandible and a protrusive maxilla. The treatment approach involved the use of a Twin-Block appliance followed by fixed appliances, which resulted in a favourable occlusion and an improved facial profile through growth modification.



Figure 1. Pretreatment extraoral and intraoral photographs showing the convex profile and Class II molar relation.

Diagnosis and aetiology

The patient was a 13-year-old Chinese male who presented with the chief complaints of maxillary protrusion and a recessive chin similar to his mother. The patient had a habit of oral breathing and his facial profile was highly convex, due to the skeletal dysplasia. Intraorally, he bilaterally displayed an end-on Class II molar and canine relationship, mild crowding in both arches, and a severe overbite and overjet. In addition, the patient's gummy smile was also obvious (Figures 1 and 2).

A pretreatment lateral cephalometric analysis revealed a Class II skeletal pattern resulting from a retrognathic mandible and a protrusive maxilla

(SNA, 87.3°; SNB, 77.9°; ANB, 9.4°). The mandibular plane angle was within the average range (FMA, 25.0°). The maxillary and mandibular incisors were proclined (U1-SN, 108.8°; IMPA, 111.0°). The facial profile was convex (Z-angle, 52.8°) (Figure 3; Table I). A panoramic radiograph indicated normal root morphology and the presence of the four third molars, but no other abnormal sign was found. The patient denied experiencing significant symptoms of a temporomandibular joint disorder.

Based on the examination results, the patient was diagnosed with an Angle Class II division 1 malocclusion as a result of an underlying skeletal mismatch. All photographs and information

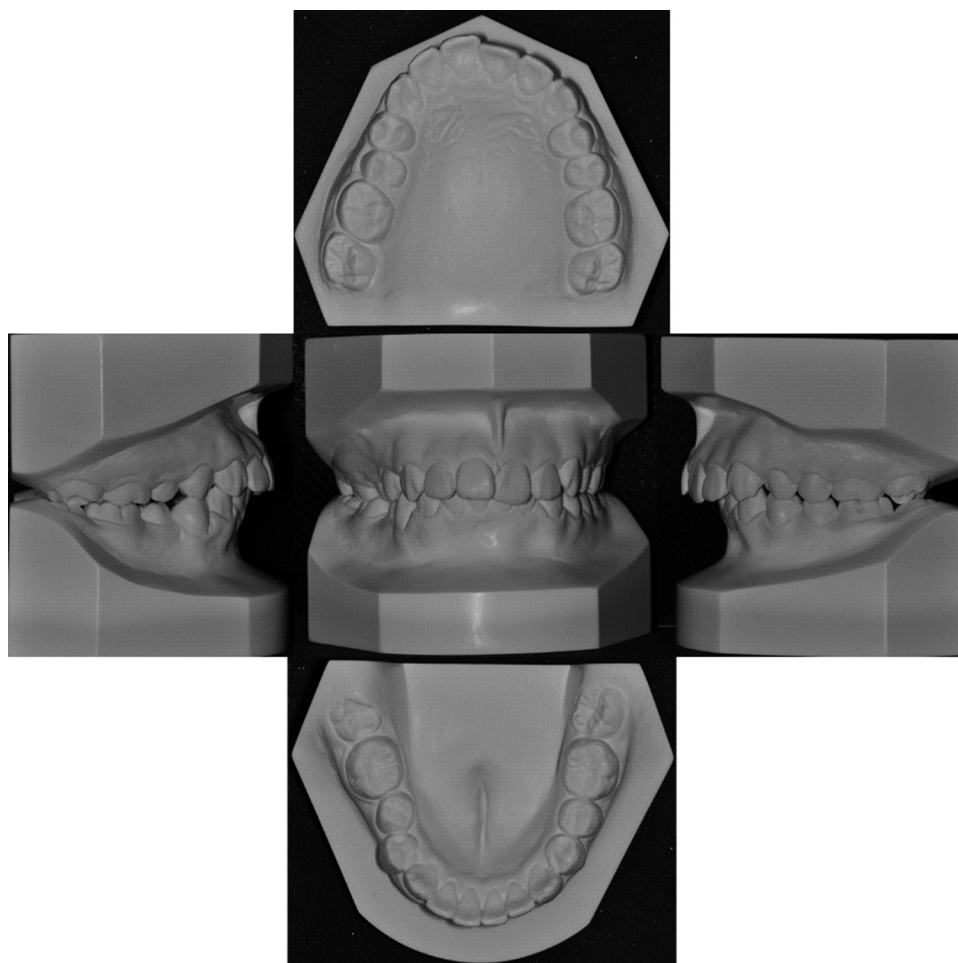


Figure 2. Model scanning photos of pretreatment.

pertaining to the patient were obtained with informed consent from the patient and his family.

Treatment objectives

In line with the patient's main problems, the treatment objectives were: (1) to restrain maxillary development and promote mandibular growth to improve the patient's skeletal Class II pattern; (2) to establish a Class I canine and molar relationship; (3) to enhance the patient's profile; (4) to adjust the overjet and overbite relationships; (5) to level and align the upper and lower dentitions; (6) and to alleviate the crowding.

Treatment alternatives

Cephalometric and cervical vertebral examinations indicated that the patient was at CVS4, denoting

an optimal time for early intervention. At this stage, functional appliances may promote mandibular growth and development and therefore, the initial approach involved growth modification. Subsequently, depending on the corrective outcome, fixed orthodontic treatment would be considered. The treatment plan and associated risks were explained to the patient and his mother, and after mutual consultation, the Twin-Block was chosen as the functional appliance.⁵

Treatment process

Before commencing orthodontic treatment, the patient was referred to a general dentist to ensure the absence of dental caries and to assess the periodontal condition. Following a routine dental cleaning, study casts were obtained and photographs captured of the patient. A week later, the Twin-Block appliance

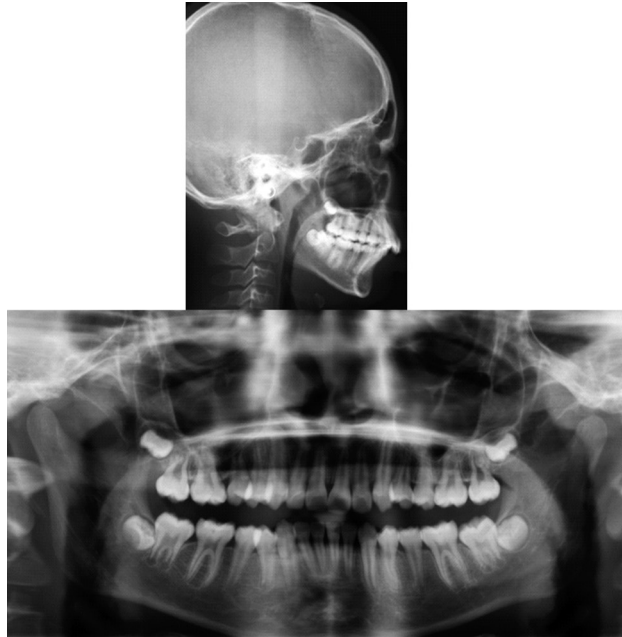


Figure 3. Pretreatment cephalogram and panoramic radiograph.

(Figure 4) was inserted and instructions provided. The contact surfaces of the appliance bite blocks were set at a 70° angle, with an occlusal gap of 3 to 4 mm from the central incisor and, in a closed mouth position, the appliance promoted forward positioning of the mandible. The patient was instructed to wear the Twin-Block for nearly 24 hours a day, and adjustments were made once per month for approximately 12 months. After three months, overlying occlusal acrylic material was gradually removed to facilitate occlusion change. The 70° inclined plane contact was maintained when grinding the bite blocks. A functional correction was realised after one year.

Following Twin-Block therapy, improvements were observed in the patient's oral breathing habits, in the correction of the anterior occlusion involving the deep overbite and overjet, and an improvement in the mandibular retrognathism. However, the occlusal

relationship of the buccal segments remained unsatisfactory, and the patient's facial profile was still convex (Figures 5 and 6).

Superimpositions demonstrated vertical condylar growth, an extrusion of the upper posterior teeth, and intrusion of the lower posterior teeth, contributing to the correction of the Class II molar relationship (Figures 7 and 8). The lateral cephalometric analysis indicated lingual inclination of the maxillary incisors and a labial inclination of the mandibular incisors (U1-SN, 101.3° ; IMPA, 113.2°). These dental effects are commonly observed following functional appliance treatment. Notably, the maxillary protrusion and mandibular retrusion tendencies decreased (SNA, 86.8° ; SNB, 79.6° ; ANB, 7.2°), while the mandible exhibited forward and downward spatial change (Figures 7 and 8). There was also a positive improvement in mandibular



Figure 4. Intraoral display of Twin-block appliance.

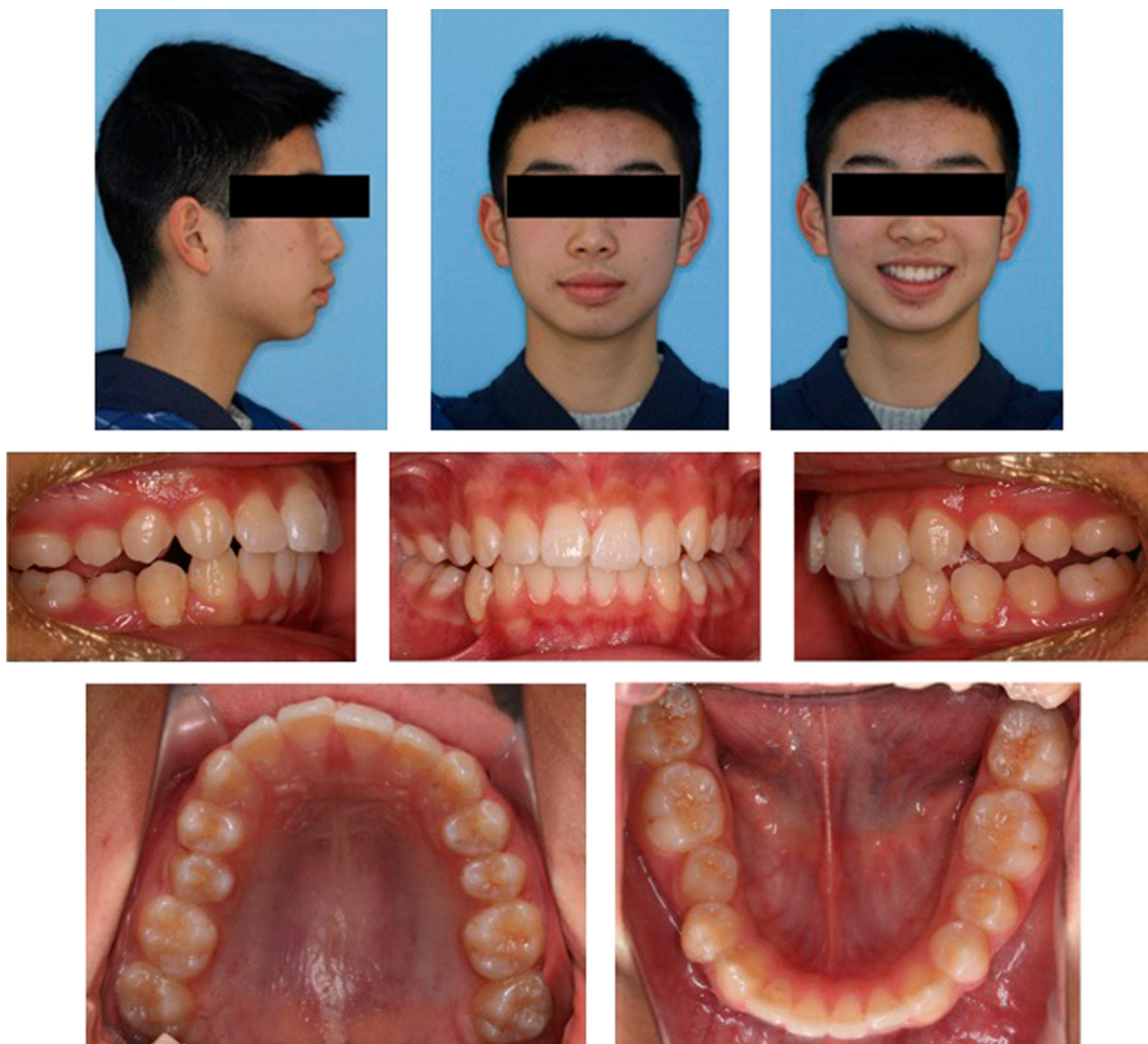


Figure 5. Facial appearance and intraoral photos of patients after functional correction.

length and condylar height (Po-Go, 7.2 mm; Gn-Co, 10.8 mm). However, the patient's facial profile still displayed convexity (Z-angle, 59.7°) (Figures 7 and 8; Table I). Therefore, further correction of the incisal relationship through fixed appliances was necessary to improve the profile.

Following the functional appliance phase, fixed appliances were promptly placed. To achieve a Class I molar relationship, it was decided to extract the upper first premolars and lower second premolars. The arch wires were successively replaced (0.014-in nickel-titanium, 0.016-in nickel-titanium, 0.018-in nickel-titanium, 0.018 × 0.025-in nickel-titanium, and

0.018 × 0.025-in stainless steel) to align the dentition and level both arches. Stainless steel arch wires (0.018 × 0.025-in) were utilised for space closure. To achieve maximum retraction of the upper anterior teeth, under local anaesthesia, mini-screws (diameter, 1.4 mm; length, 8 mm; Absoanchor Orthodontic Micro-implant, Dentos, Korea) were inserted into the posterior buccal alveolus on both sides of the maxilla. Power arms (Shinye Medical Technology Co., Ltd, Hangzhou, China) were employed on the maxillary stainless steel arch wire to reduce the proclination of the anterior teeth during space closure. Elastic tiebacks were applied from the mini-screws to the

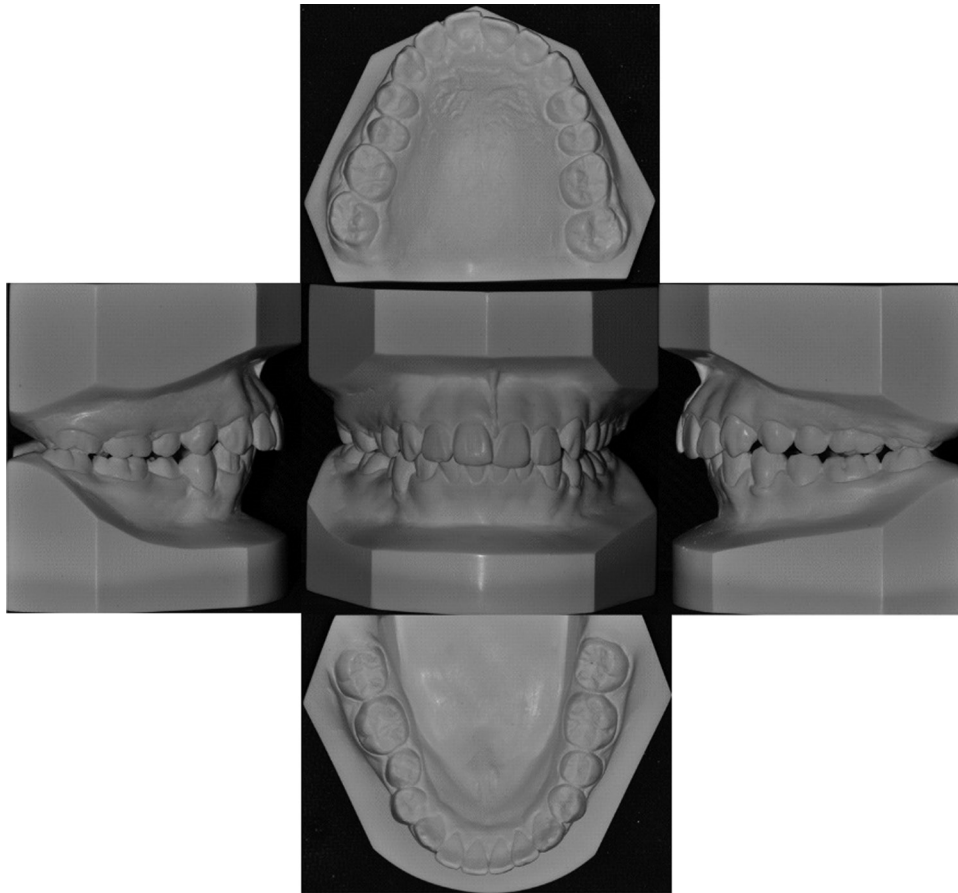


Figure 6. Model scanning photos of 12 months after Twin-block treatment.

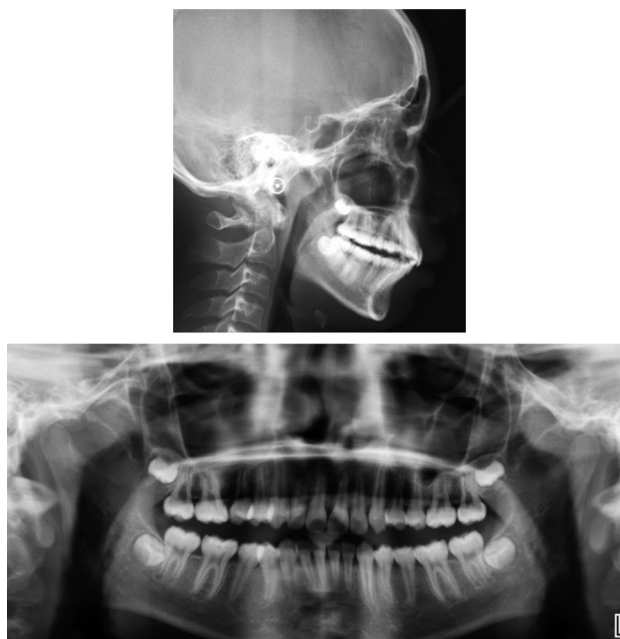


Figure 7. Posttreatment cephalogram, cephalometric superimpositions, and panoramic radiograph.

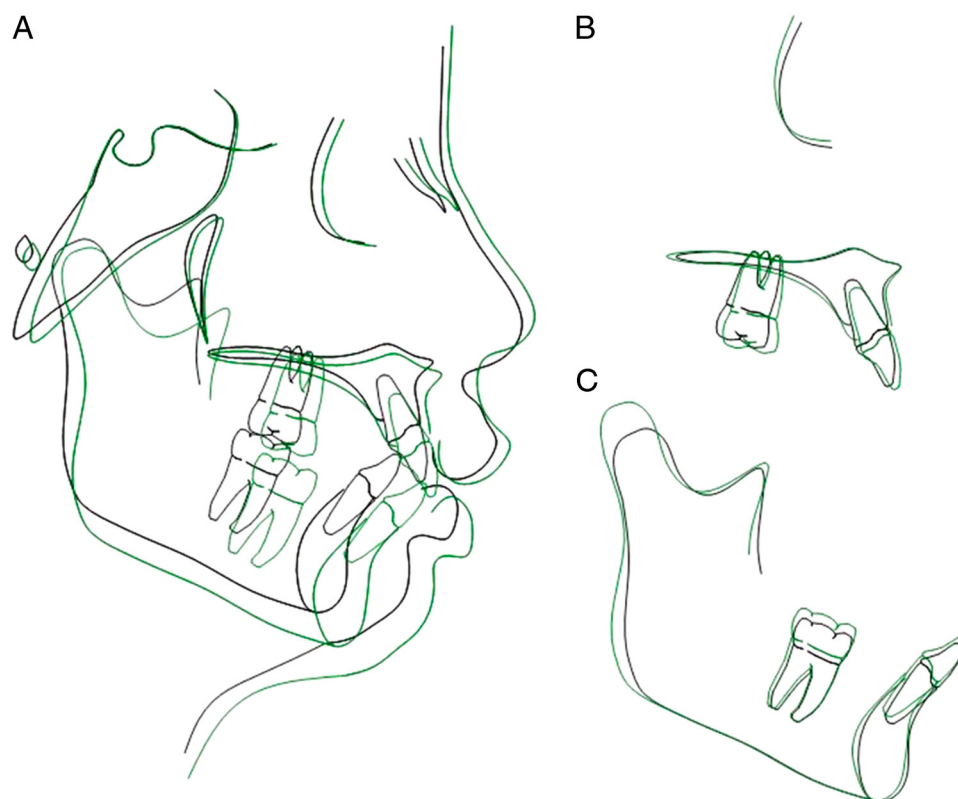


Figure 8. Cephalometric superimpositions after Twin-block treatment. Black line, pretreatment; Green line, after Twin-block treatment. A, The overall superimposition was registered on SN at sella; B, the maxillary superimposition was registered on the palatal plane at ANS; C, the mandibular superimposition was registered on the long axis of the mandible at protuberance menti.

power arms, and delivered a connection force of approximately 120 gN. Closing loops were employed to close the spaces in the mandibular arch.

Considering the patient's gummy smile, intrusion of the anterior maxillary teeth was also indicated and therefore mini-screws were further used to achieve absolute incisor intrusion. To allow for tooth movement and skeletal remodelling, mini-screws (diameter, 1.4 mm; length, 6 mm; Absoanchor Orthodontic Micro-implant, Dentos, Korea) were inserted into the anterior labial alveolus between the maxillary central and lateral incisors. One month after insertion and following a period of consolidation, an orthodontic intrusive force was applied (Figure 9).

Before debonding, the mini-screws were removed, and the upper and lower dentitions were continuously ligated for one month. The overall treatment duration was 48 months, including 12 months of functional appliance correction. Upon removing the brackets, the patient was instructed to wear clear thermoplastic

Table I. Cephalometric measurements (T1 Pretreatment; T2 12 months after Twin-block treatment; T3 36 months after fixed orthodontic treatment)

Measurement	Norm	T1	T2	T3
SNA(°)	83.0	87.3	86.8	86.1
SNB(°)	80.0	77.9	79.6	81.6
ANB(°)	3.0	9.4	7.2	4.5
NP-FH(°)	85.0	81.5	84.5	84.4
NA-PA(°)	6.0	19.8	16.5	10.0
U1-SN(°)	105.0	108.8	101.3	107.9
U1-NA(°)	22.0	21.6	14.5	21.9
L1-NB(°)	30.0	37.3	41.4	25.6
IMPA(°)	88.0	111.0	113.2	98.7
FMIA(°)	67.0	44.0	43.1	59.0
FMA(°)	25.0	25.0	23.7	22.3
Y-axis angle (°)	65.8	65.8	64.2	64.0
Z-angle(°)	75.0	52.8	59.7	65.3
Po-Go(mm)	—	6.9	7.2	7.3
Gn-Co(mm)	—	10.2	10.8	11.1

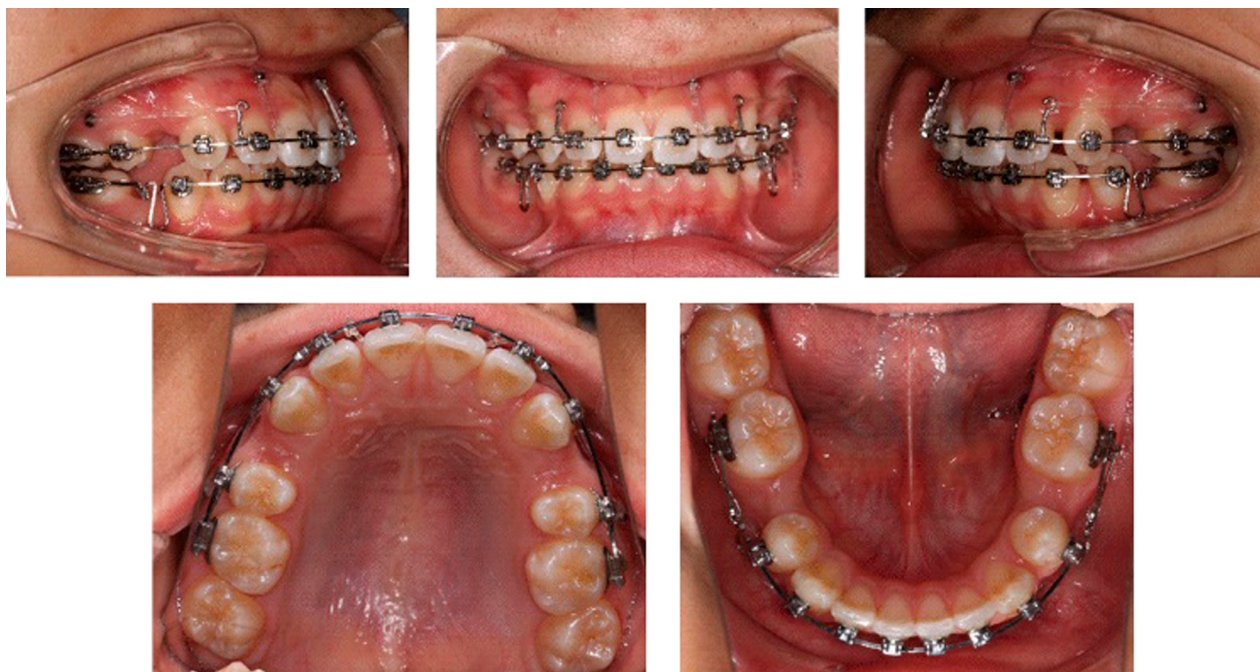


Figure 9. In the 6th month of fixed treatment when the 0.018 × 0.025-in stainless steel archwires were placed in both arches, microimplant anchorages were placed to lower the upper anterior teeth.

retainers. During the first year, the retainers were worn throughout the day, except while eating and brushing. During the second year, the retainers were worn exclusively at night.

Treatment results

After treatment, the patient displayed improved facial proportions, a charming smile, and well-aligned dentitions. The overjet and overbite relationships were corrected. Both sides achieved Class I canine and molar relationships. The manipulation of the maxilla and mandible significantly improved the patient's profile (Figures 10 and 11).

The lateral cephalometric analysis revealed skeletal changes (SNA, 86.1°; SNB, 81.6°; ANB, 4.5°). The maxillary incisors' proclination was maintained (U1 to SN, 107.9°) and the mandibular incisors' proclination improved (IMPA, 98.7°) to camouflage the skeletal Class II discrepancy. Notably, the patient's facial profile, particularly the protrusion of the lips (Z-angle, 65.3°), showed improvement (Figure 12; Table I). Cephalometric superimpositions demonstrated the profile and occlusal height maintenance for the upper and lower molars. Mandibular length and condylar height indicated

ongoing growth (Po-Go, 7.3 mm; Gn-Co, 11.1 mm). The upper anterior teeth were intruded, while the lower anterior teeth extruded, contributing to the improvement of the gummy smile.

The posttreatment panoramic radiograph indicated satisfactory root parallelism and no apparent root resorption. However, further reviews were required to monitor the eruption of the third molars (Figure 13).

The achieved correction remained stable after two years, with the patient displaying a confident and charming smile (Figure 14).

Discussion

The treatment of a skeletal Class II malocclusion in adolescents necessitates careful diagnosis and treatment planning. Functional appliances have been widely studied and demonstrated to be highly effective in improving the maxillo-mandible relationship in growing skeletal Class II patients.^{6,7} According to the literature, mandibular length typically reaches its final growth stage approximately 2 to 3 years after the onset of menstruation in females and 4 years after sexual maturity in males. The attainment of final mandibular height occurs during the late teenage years for females and early



Figure 10. Posttreatment extraoral and intraoral photographs showing the improved facial appearance and molar relationship.

twenties for males.⁸ These findings support the tendency for both mandibular length and condylar height to increase during fixed appliance treatment. However, lateral cephalometric analyses have shown that the growth rate involving mandibular length and condylar height during functional appliance treatment surpasses that achieved during fixed appliance treatment, confirming the stimulating effect of functional appliances on mandibular growth.^{9,10} Although additional growth cannot be attributed solely to functional appliances, they have the ability to stimulate growth and optimise jaw position, therefore releasing the patient's inherent growth potential. The existing literature provides evidence that functional appliance correction can stimulate mandibular growth in the short term compared to untreated control patients.^{9,10}

The effects of functional appliances can be categorised into skeletal and dental changes. Giuntini et al.¹¹ highlighted the greater skeletal impact of the Twin-Block appliance compared to the Forsus fatigue-resistant device associated with mandibular forward movement and growth stimulation. The mandible experiences a forward force and is supported by the alveolar bone, resulting in the labial inclination of the lower incisors. Simultaneously, the Twin-Block appliance and the labial muscles exert a reactionary force on the maxilla, leading to the upright positioning of the upper incisors, similar to the effects observed with headgear-activator treatment.¹² Moreover, a randomised controlled trial has demonstrated that the overall treatment outcome is not affected by the presence of a maxillary labial bow.¹³ The cephalometric and cervical vertebral examinations

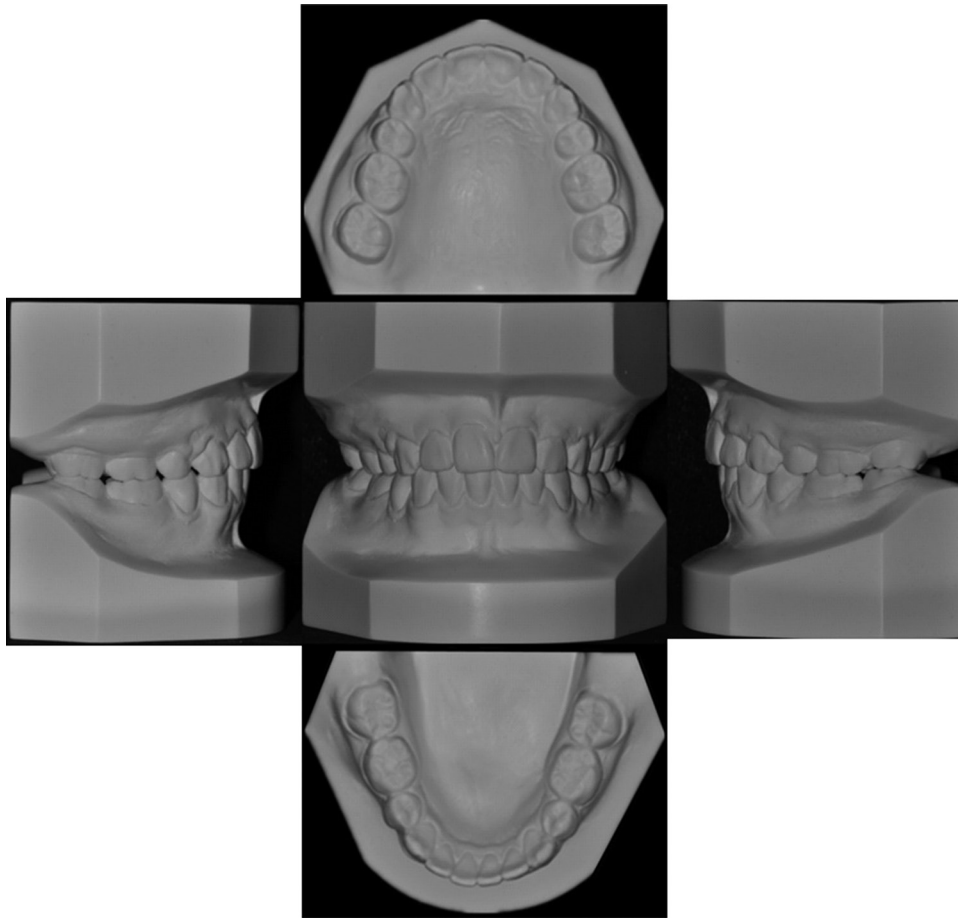


Figure 11. Model scanning photos of 36 months after fixed orthodontic treatment.

suggested that the patient was at CVS4,¹⁴ which indicated that the growth and development peak would end at this stage. The headgear-activator is typically worn only at night, whereas the Twin-Block appliance may be worn for nearly 24 hours a day, and therefore provide a continuous force. Twin-Block appliances have proven to be effective for correcting a Class II malocclusion by stimulating mandibular growth and producing mild dentoalveolar effects. They are also known for their comfort, aesthetics, and efficiency^{11,15} and in a consideration of these factors, the Twin-Block appliance was selected for use in the present case. Current evidence suggests that the optimal timing for correcting a Class II malocclusion is during adolescence, at an average age of 12.4 years, rather than during the mixed dentition stage (8–9 years).¹⁶ Considering both the patient's age and the results of the cephalometric and cervical vertebral examinations, it was determined that this was the optimal time to utilise the Twin-Block appliance for the patient's benefit.

After 12 months of Twin-Block treatment, significant improvements were observed in the anterior occlusion, and seen as the correction of the deep overbite and overjet and an improvement in mandibular retrognathism. A common drawback of Twin-Block treatment is the potential increase in the mandibular plane angle, which may be unfavourable in patients possessing a steep plane angle at the outset. However, in the present case, although the mandibular incisors did show a level of proclination after the Twin-Block phase, the mandibular plane angle was well controlled. This favourable outcome may be attributed to the careful selection of appropriate treatment methods based on the patient's growth stage and the horizontal growth pattern observed (S-Go/N-Me, 71.61%). Past research has suggested that if the Jarabak ratio exceeds 65%, a horizontal growth pattern exists, whereas a ratio below 62% suggests a vertical growth pattern.¹⁷ However, after the functional phase, it was noted that the upper anterior teeth were relatively upright.

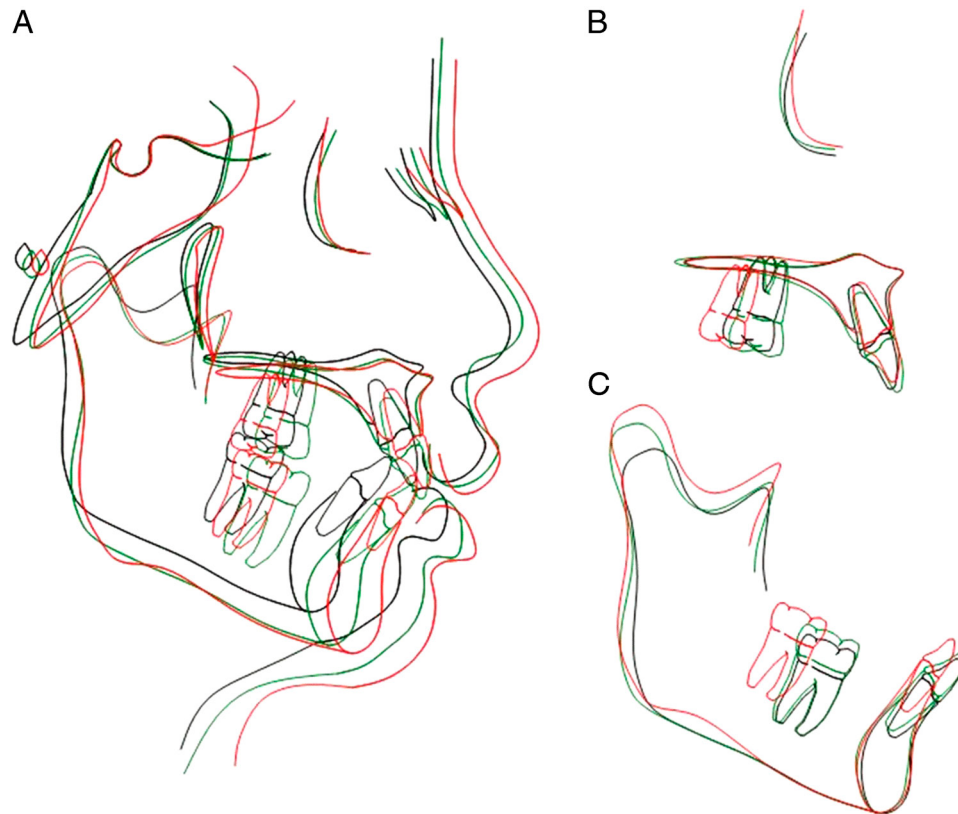


Figure 12. Posttreatment cephalometric superimpositions. Black line, pretreatment; Green line, after Twin-block treatment; Red line, posttreatment. A, The overall superimposition was registered on SN at sella; B, the maxillary superimposition was registered on the palatal plane at ANS; C, the mandibular superimposition was registered on the long axis of the mandible at protuberance menti.

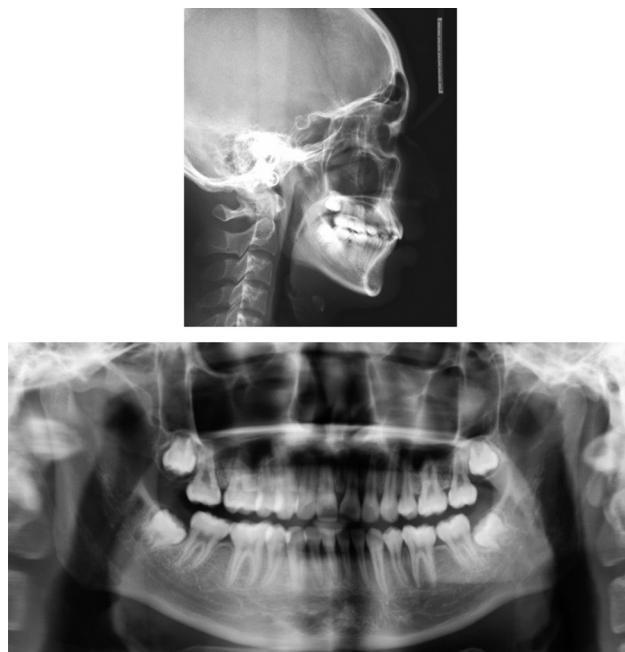


Figure 13. Posttreatment cephalogram and panoramic radiograph.



Figure 14. Follow-up after 2 years of retention.

In cases in which the anterior teeth are retracted following tooth extraction, force transmission through the centre of resistance is challenging, leading to a potential further lingual inclination of the upper anterior teeth, and a complication of subsequent occlusal adjustment. To address this issue, two solutions were devised. Firstly, mini-screws were placed between the second premolar and the first molar and a power arm used on the rectangular wire between the lateral incisor and the canine. The mini-screws provided necessary anchorage for the posterior teeth to assist correction of the molar relationship, while the power arm approached the centre of resistance of the anterior teeth to facilitate bodily movement. However, considering that bodily movement alone may not be sufficient to correct the torque of the anterior teeth, additional force

was actively applied to generate positive torque and counteract possible elongation of the incisors. By utilising anterior mini-screws and elastics, an upward force was applied in addition to positive torque by the stainless steel rectangular wire, thereby resisting elongation of the anterior teeth and achieving palatal root torque. This approach effectively prevented further lingual inclination and elongation of the anterior teeth (the specific biomechanical analysis is shown in Figure 15).

During the fixed appliance correction phase of the patient's treatment, the relatively upright position of the upper incisors was considered along with bodily movement of the teeth to facilitate further dentoalveolar remodelling.¹⁸ The literature suggests that orthodontic treatment, including the movement of the incisors following premolar extraction, can

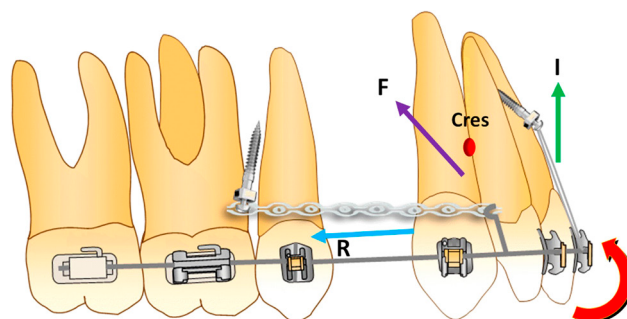


Figure 15. Biomechanical design for closing the space, where I=intrusive force, R=distal force, F=resultant force and Cres=Centre of resistance of the anterior teeth, the anterior mini-screws and elastics can give the stainless steel rectangular wire an upward force and positive torque, the posterior mini-screws and power arm can achieve body movement of the anterior teeth, the red curve represents counterclockwise rotation of maxillary anterior teeth.

induce morphological changes in the alveolar bone.^{19,20} Despite the improvement in the patient's convex facial profile, the patient still had a moderately gummy smile. To address this concern, the intrusion of the anterior maxillary teeth was deemed necessary.²¹ Mini-screws have become increasingly popular in recent years to provide stable anchorage and achieve vertical control. By inserting anterior mini-screws and applying elastics, incisor intrusion was achieved as well as palatal root torque while ensuring that the roots remained centered within the alveolar bone to minimise the risk of periodontal damage. Additionally, as the patient aged, it was noted that the SNA angle did not increase but rather decreased. This observation indicated that the movement of the teeth resulted in dentoalveolar remodelling of the maxilla using a technique that requires relatively low patient compliance and is particularly suitable for correcting a gummy smile.²² In cases in which excessive gingival exposure and the prevention of incisor tipping have been observed, a combination of classical sliding mechanics was employed using a straight-wire technique coupled with implant anchorage support.

The patient presented with adenoid hypertrophy and airway stenosis prior to treatment. This condition contributed to the habit of oral breathing which impacted on the severe mandibular retrusion. Functional appliance treatment that promotes mandibular advancement can expand the airway and improve respiratory function and has been recognised as a viable treatment option for managing obstructive sleep apnoea.²³ The patient experienced forward mandibular growth and further airway expansion following functional treatment. Following fixed appliance treatment, the adenoids experienced

atrophy, and the airway further expanded, which may be attributed to the physiological changes involving the adenoids. According to the literature, the adenoids start to atrophy by the age of 10 years, and the process is completed by the age of 20.²⁴ The expanded airway, combined with oral health education and respiratory correction patches, ultimately helped the patient discontinue the habit of oral breathing.

The angulations of the third molars were considered acceptable, suggesting later uneventful eruption into their correct positions. From an evidence-based perspective, the presence of the third molar is unlikely to cause relapse.²⁵ Through close monitoring and regular follow-up, it was intended that the eruption of the patient's third molars would be tracked in a timely manner.

Patient co-operation is crucial throughout orthodontic treatment. If patients do not adhere to the prescribed regimen and timelines, the desired outcomes may not be achieved, and the critical window for growth manipulation may be missed. Fortunately, in the present case, the patient demonstrated good compliance and a strong desire to improve their facial profile, which played a significant role in the successful outcome of treatment.

Conclusions

A severe skeletal Class II growing patient presenting with mandibular retrognathism and maxillary prognathism, underwent a growth modification-focused treatment strategy. A Twin-Block functional appliance, stimulated mandibular growth and altered its direction. Temporary anchorage techniques were employed to control the upper anterior teeth and

facilitate additional maxillary remodelling. As a result, there was a significant improvement in the convex facial profile and correction of a gummy smile, ultimately leading to a normalised occlusion.

Conflict of interest

The authors declare that there is no conflict of interest.

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