CASE REPORT

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Management of Class II Malocclusion with Fixed and Removable Functional Appliances: 3 Case Reports

Sabit ve Hareketli Fonksiyonel Apareyler ile Sınıf II Maloklüzyonun Tedavisi: 3 Olgu Sunumu

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ABSTRACT

Objectives: This case report presents the treatment outcomes of 3 patients with skeletal Class II malocclusion managed using different functional appliances followed by fixed orthodontic treatment.

Case Report: Three patients diagnosed with skeletal Class II malocclusion were treated with different functional appliances according to their individual clinical characteristics. After completion of the functional phase, comprehensive fixed orthodontic treatment was performed. Treatment outcomes were evaluated using clinical photographs, dental models, radiographs, and cephalometric analyses.

Conclusion: All treatment protocols resulted in improvement of the sagittal skeletal relationship, correction of the Class II malocclusion, and achievement of functional occlusion with satisfactory facial esthetics. These cases suggest that individualized selection of functional appliances combined with fixed orthodontic treatment can provide successful outcomes in patients with skeletal Class II malocclusion.

Keywords*: Bionator, Class II malocclusion, Fixed functional appliance, Herbst appliance.*

ÖZET

Amaç: Bu olgu sunumunun amacı, farklı fonksiyonel apareylerle tedavi edilen ve ardından sabit ortodontik tedavi uygulanan iskeletsel Sınıf II maloklüzyonlu 3 hastanın tedavi sonuçlarını sunmaktır.

Olgu Sunumu: İskeletsel Sınıf II maloklüzyon tanısı alan 3 hasta, bireysel klinik özellikleri doğrultusunda farklı fonksiyonel apareylerle tedavi edildi. Fonksiyonel tedavi fazının tamamlanmasının ardından tüm hastalara kapsamlı sabit ortodontik tedavi uygulandı. Tedavi sonuçları; klinik fotoğraflar, dental modeller, radyografiler ve sefalometrik analizler kullanılarak değerlendirildi.

Sonuç: Tüm tedavi protokolleri sagittal iskeletsel ilişkide iyileşme, Sınıf II maloklüzyonun düzeltilmesi ve tatmin edici yüz estetiği ile fonksiyonel oklüzyonun elde edilmesini sağladı. Bu olgular, hasta özelliklerine göre bireyselleştirilerek seçilen fonksiyonel apareylerin sabit ortodontik tedavi ile kombine edildiğinde, iskeletsel Sınıf II maloklüzyonların tedavisinde başarılı sonuçlar sağlayabileceğini göstermektedir.

Anahtar Kelimeler: *Bionatör, Herbst apareyi, Sabit fonksiyonel aparey, Sınıf II maloklüzyon.*

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Introduction

Class II malocclusion is defined by an anteroposterior discrepancy between the dental arches, which originated from skeletal, dentoalveolar, or a combination of these.[1] Various skeletal patterns can contribute to the development of Class II malocclusion, including mandibular retrusion, maxillary protrusion, or posterior position of the glenoid fossa.[2,3] The most common etiological factor in skeletal Class II malocclusion is mandibular retrusion. To correct this malocclusion in growing patients, functional appliances are often used, as they promote forward movement of the mandible and stimulate sagittal growth.[4,5]

Functional appliances are generally classified into two categories: removable and fixed functional appliances.[6] In the early 1900s, removable functional appliances were introduced with Pierre Robin's Monoblock and Andreasen's Activator. Over the years, various types such as the Bionator, Frankel, Twin-block, Bimler appliance, Propulsor, Karwetzky appliance, and Vestibular plate have been developed.[6,7] Fixed functional appliances, first represented in the literature by the Emil Herbst appliance and developed by American researchers, can be categorized into three types: rigid intermaxillary appliances, flexible intermaxillary appliances, and hybrid intermaxillary appliances.[8]

The following case reports describe the management of Class II malocclusion in patients using Herbst, Forsus, and Twin Block appliances.

Figure 1. Pretreatment records of Case 1 included intraoral and extraoral photographs, panoramic and cephalometric radiographs, and hand–wrist radiographs.

Case-1

An 11-year-old female patient was admitted to our clinic with a complaint of a retruded lower jaw. Intraoral findings were as follows: Class II molar and canine relation, 2.8 mm overjet, 4.8 mm overbite, and lower dental midline shifted to the right side by 1.5 mm. Radiologic examination revealed that SNA: 82.0°, SNB: 78.4°, ANB: 3. Upper incisor inclination (U1-NA) was 20.9° and 1.6 mm, and mandibular plane-lower incisor inclination (IMPA) was 95.1°, and L1-NB was 2.7 mm. According to the hand wrist radiograph, the patient was in the stage of DP3u (Figure 1).

Treatment Objectives
The primary treatment goals were to achieve an ideal overbite, establish Class I molar and canine relationships, and enhance the facial profile.

Treatment Plan
Because the patient was approaching the completion of growth, a fixed functional appliance (Herbst) was used to achieve a Class I relationship. Due to the insufficient overjet and retroclination of upper incisors, braces were bonded to the upper incisors to increase the overjet before the Herbst treatment.

Table 1. Cephalometric measurements of the Herbst, Forsus FRD, and Twin Block treatment

	Herbst		**Forsus FRD EZ2**		**Twin Block**	
Cephalometric Measurements	T0	T1	T0	T1	T0	T1
SNA (°)	82.5	84.6	81.6	83.6	78.7	77.6
SNB (°)	78.4	82	76.5	81	73.9	74.6
ANB (°)	3.6	2.6	5.1	2.7	4.7	3
U1-NA (mm)	1.6	2.6	4.8	3.3	3.7	4.4
U1-NA (°)	20.9	28.8	21.2	20.9	20.7	21
L1-NB (mm)	2.7	2.8	5.2	3.4	5.4	5.6
L1-NB (°)	22.5	23.1	31.3	26.6	28.9	25.1
IMPA (°)	95.1	96.2	109.1	106.2	99.5	99.6
SNGoMe (°)	29	29.1	25.7	19.5	35.5	38.9
FMA (°)	21.4	22.4	18.6	17.1	27.9	30.6
SN-OP (°)	6.5	3.8	16.1	12.4	19.3	17.2
Overjet (mm)	2.8	2.7	6.6	3.5	4.8	2.8
Overbite (mm)	4.8	1.7	5.4	3.8	5.7	2.5
U-Lip/E line (mm)	-0.2	-0.7	-4.5	-6.7	0.5	-1
L-Lip/E line (mm)	-0.9	2.2	-2.2	-3.7	1.4	0.7

T0: Pretreatment, T1: Posttreatment.

Treatment Progress
After the informed consent was obtained from the patient, the upper part of the Herbst appliance was fabricated. Brackets were requested to be added in the premolar region of the upper part of the Herbst appliance to procline the upper incisors and advance the mandible. Once the maxillary part of the Herbst appliance was cemented, 0.022-inch MBT brackets (American Orthodontics, Sheboygan, WI) were bonded to the maxillary incisors, and leveling and alignment were carried out using a 0.014-inch Ni-Ti archwire. During the levelling and alignment stage, maxillary incisors were proclined using an open coil spring. After the ideal incisor inclination was achieved, a wax bite registration was taken with the mandibular arch positioned 5 mm forward, and the lower part of the Herbst appliance was fabricated and cemented.

After 6 months of Herbst treatment, an overcorrected Class I relationship was obtained, and the appliance was removed. In the second phase, treatment was continued with a fixed orthodontic appliance.

From the initial archwires, light Class II elastics (5/16”, 2.5 oz) were used only to maintain the anteroposterior occlusal correction obtained with the Herbst appliance. After 0.017x0.025” Stainless-Steel (SS) wire was placed in the lower arch, diastemas were closed using a power chain. In the upper arch, incisor retraction was performed using a 0.019x0.025” Beta-titanium (TMA) archwire.

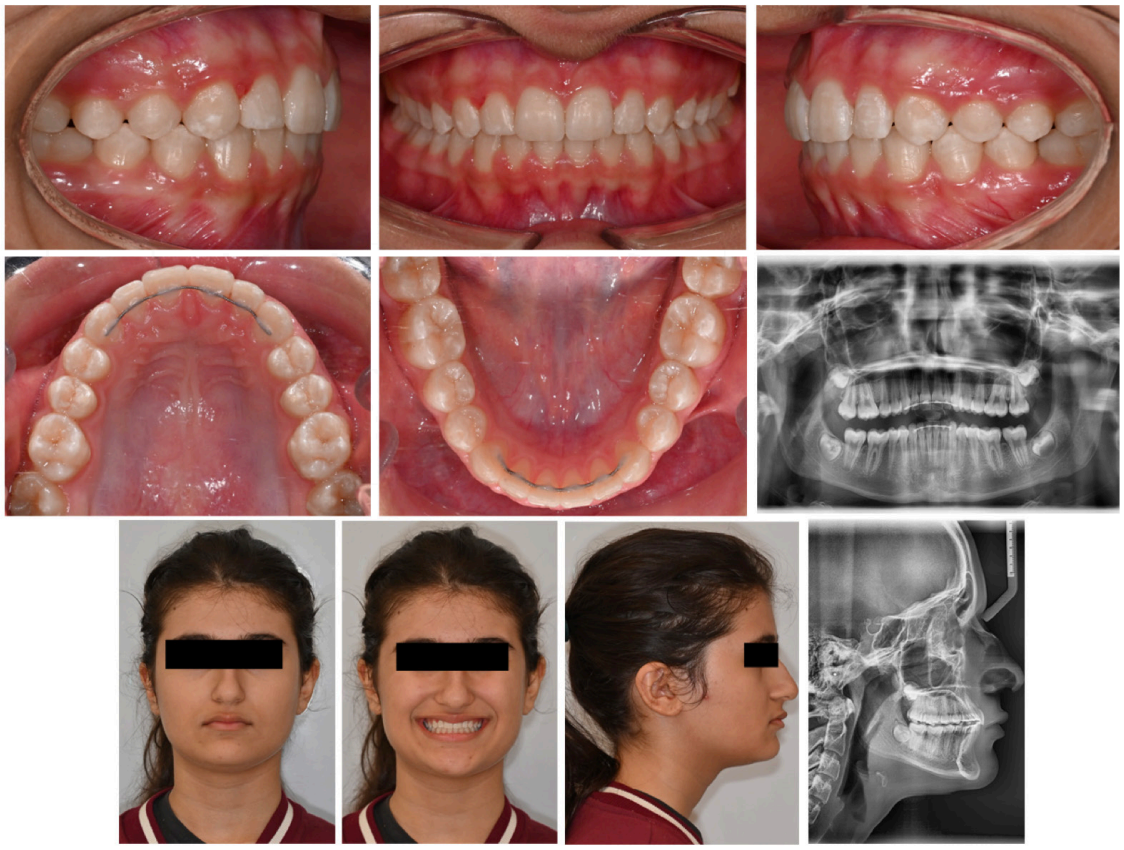

Figure 2. Posttreatment intraoral and extraoral photographs, panoramic radiograph, and cephalometric records of Case 1.

Treatment Results

Following 24 months of treatment, a Class I occlusion was established, and the fixed appliances were removed. A fixed retainer (multistranded wire) was placed for retention purposes, and an Essix appliance was provided for nighttime wear. (Figure 2). Notable enhancement of the patient's soft tissue profile was achieved. Class I molar and canine relationship was obtained. The panoramic radiograph displayed acceptable root angulations, no signs of root resorption, and stable bone levels. Additionally, there were no signs or symptoms of muscle or joint involvement. Cephalometric measurements of the treatment were presented in Table 1.

Case-2

A 15-year-old female patient presented with a complaint of "crowded teeth". On extraoral examination, the patient had a convex profile, a retruded chin, and a moderately deep mentolabial sulcus. Intraoral findings were as follows: Overjet: 6.6 mm, Overbite: 5.4 mm, Class II canine and molar relation on both sides (Figure 3).

Cephalometric analysis revealed that SNA: 81.6°, SNB: 76.5°, ANB: 5.5. Upper incisor inclination (U1-NA) was 21.2° and 4.8 mm, and mandibular plane-lower incisor inclination (IMPA) was 109.1°, and L1-NB was 5.2 mm. The patient was in the CS4 stage.

Figure 3. Pretreatment records of Case 2 included intraoral and extraoral photographs, panoramic and cephalometric radiographs, and hand–wrist radiographs.

Treatment Objectives

The treatment objectives were to correct the skeletal Class II relation to improve profile convexity and achieve Class 1 occlusion.

Treatment Progress

At the beginning of the treatment, informed consent was obtained from the patient. Leveling and alignment were performed in both the upper and lower arches until a 0.019 × 0.025" Stainless Steel wire could be placed passively. The anchorage was enhanced using a transpalatal arch in the maxillary arch. Arch was consolidated from molar to molar using a figure-eight ligature tie, and a cinch-back was applied to the archwire distal to the molar tube. The prefunctional phase of treatment lasted for 7 months. The distance between the distal of the lower canine bracket and the distal of the upper molar tube was measured using a special ruler, and the Forsus Fatigue Resistant Device EZ2 appliance was applied.

A power chain was applied between the lower canine to canine to close the diastema in the anterior region. This helped to close the diastema while preventing excessive proclination of the incisors. The Forsus FRD EZ2 appliance was actively used for 8 months, and activated every 2 months by adding a 1 mm crimpable stop to the pushrod. The occlusion was corrected to an edge-to-edge incisor relationship before the Forsus FRD EZ2 appliance was removed. Final occlusal finishing and detailing were completed in approximately 2 months. At the end of 17 months of treatment, the fixed appliances were removed, and fixed retainers were placed in both arches (Figure 4).

Treatment Results

The patient's soft tissue profile showed noticeable improvement. Spacings in the lower arch were closed, and crowding of the maxillary anterior teeth was resolved. A normal overbite and overjet were established, and a Class I canine and molar relationship was achieved bilaterally.

Post-orthodontic retention was achieved using a bonded multistranded wire, supplemented by an Essix retainer for nighttime use. Cephalometric measurements of the treatment were presented in Table 1.

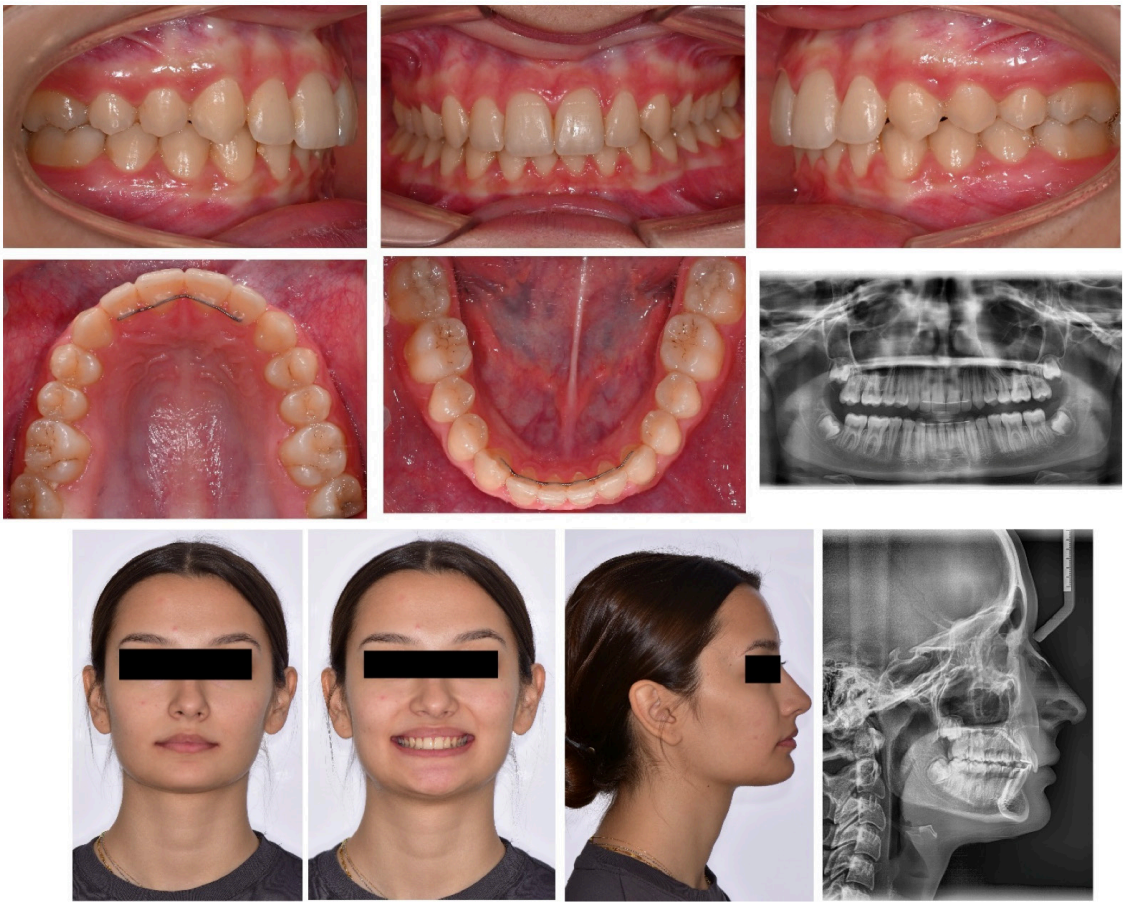

Figure 4. Posttreatment intraoral and extraoral photographs, panoramic radiograph, and cephalometric records of Case 2.

Case-3

An 11-year-old female patient was referred to our clinic due to a retruded mandible. Intraoral findings were as follows: Class II molar and canine relation, 4.8 mm overjet, 5.7 mm overbite, and lower dental midline shifted to the left side by 2 mm. Radiographic evaluation demonstrated that SNA: 78.7°, SNB: 73.9°, ANB: 4.7. Upper incisor inclination (U1-NA) was 20.4° and 3.7 mm, and mandibular plane-lower incisor inclination (IMPA) was 99.5°, and L1-NB was 5.4 mm (Figure 5).

Figure 5. Pretreatment documentation of Case 3 consisted of intraoral and extraoral photographs, panoramic and cephalometric radiographs, and hand–wrist records.

Treatment Objectives

The main objectives were to improve the convexity of the facial profile and retruded chin, improve the skeletal Class II relationship, and achieve optimum overjet and overbite.

Treatment Plan

Since the patient was in her active growth stage (MP3 cap) and exhibited both skeletal and dental Class II relationships, a two-phase treatment was planned. Phase I: Growth modification with a functional appliance (Twin Block); Phase II: Fixed mechanotherapy for occlusal refinement.

Treatment Progress

After informed consent was obtained from the patient, a wax bite registration was taken with the mandibular arch positioned 6 mm forward, and a twin block appliance was fabricated. The patient was instructed to wear the appliance for 24 hours a day. The duration of treatment with the functional appliance lasted 14 months. Patient cooperation was satisfactory throughout the course of treatment.

Once the functional appliance treatment was completed, multi-bracket treatment was initiated with the bonding of 0.022” MBT brackets (American Orthodontics, Sheboygan, WI), and 0.014” NiTi wires were placed in both arches. Light Class II 5/16 (2.5 oz) elastics were used from the initial arches for the stabilization of the anteroposterior occlusal correction achieved with the Twin-Block appliance. The second phase of treatment with a fixed orthodontic appliance lasted for 10 months.

Treatment Results

A harmonious facial profile was achieved. Class I molar and canine relationship was obtained. A normal overbite and overjet were established (Figure 6). Fixed retainer (multistranded wire) was fabricated for post-treatment stability, complemented by an Essix plate for nighttime wear. Cephalometric measurements of the treatment were presented in Table 1.

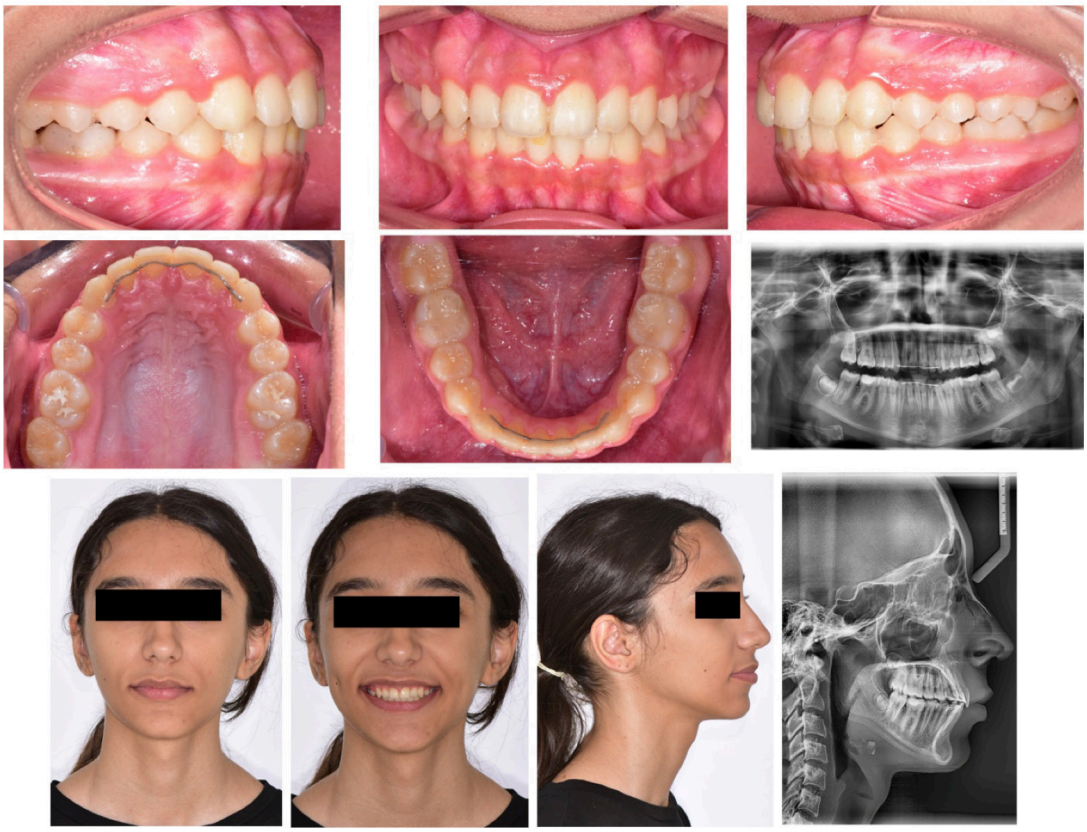

Figure 6. Posttreatment records comprised intraoral and extraoral photographs, panoramic and cephalometric radiographs of Case 3.

Intraoral images of the Herbst, Forsus FRD EZ2, and Twin Block appliances are presented in Figures 7a, 7b, and 7c, respectively.

Figure 7. (a) Case 1: Intraoral photos of Herbst appliance; (b) Case 2: Intraoral photos of Forsus FRD appliance; (c) Case 3: Intraoral photos of Twin Block appliance.

Conclusion

Class II malocclusion can present with different combinations of skeletal and dental discrepancies. Therefore, recognizing and understanding the etiology of Class II malocclusion, along with differential diagnosis, is essential for effective correction.

Treatment planning can vary based on the patient's age, remaining growth potential, severity of the malocclusion, and soft-tissue profile.[9,10] In children and adolescents with Class II malocclusion, growth modification is applied according to their growth and development stage. In young adults, camouflage treatment involving dentoalveolar movements is used, whereas orthognathic surgery is employed in adults. [9] In cases of Class II malocclusion resulting from mandibular deficiency, growth modification is achieved using functional appliances. These appliances position the mandible more anteriorly than its current position, stimulating development in the ramus height and overall mandibular length.[6]

The Herbst appliance is frequently used to treat Class II malocclusion and a retrusive mandible, as it functions effectively without depending on patient cooperation. The appliance advances the mandible forward, acting as an artificial joint between the jaws and inducing a bite-jumping effect.[11] Herbst treatment studies have reported restriction of maxillary growth, mandibular rotation changes, as well as anterior positioning of the glenoid fossa.[12] However, in Case 1, an increase in the SNA angle was observed. We hypothesize that this unexpected finding may be attributed to the protrusion of initially retrusive incisors during the course of treatment.

Constructed of nickel–titanium coil springs, the Forsus FRD EZ2 is a semi-rigid fixed functional appliance that attaches to the maxillary molar headgear tube and the mandibular archwire at the canine bracket. It passively advances the mandible while allowing lateral mandibular movements.[13] The average active treatment duration with Forsus FRD EZ2 is approximately 6.2 months, and it primarily produces dentoalveolar effects for the correction of Class II malocclusion.[14] In Case 2, the increase in the SNB angle from 76.5° to 81.0° (+4.5°) is particularly noteworthy. We hypothesize that this substantial change may be attributed to a posteriorly displaced mandibular position at the beginning of treatment, likely caused by the retrusive position of tooth 11, which may have forced the mandible into a more retruded position than its true functional position. The marked decrease in the SNGoMe angle suggests a counterclockwise rotation of the mandible, resulting in a more horizontal growth pattern. However, given the magnitude of this change, it is likely that this finding reflects a functional repositioning of the mandible rather than a true skeletal alteration. When evaluating the effects of fixed functional appliances, such as the Forsus device, in the treatment of Class II malocclusions, it is observed that skeletal changes remain considerably limited, particularly during the late stages of the pubertal growth spurt (CS4 and beyond).

Twin Block is an appliance that provides functional mandibular protrusion for skeletal Class II correction. The inclinations of the occlusal ramps direct the mandible to a downward and forward position. The aim of the Twin Block is to achieve dental and skeletal correction by utilizing all functional forces, including masticatory forces, with continuous use for 24 hours.[15] Although Twin Block appliances are traditionally recommended for patients with favorable vertical patterns, several studies have demonstrated their successful use in high-angle Class II cases, where the primary treatment objective is the correction of sagittal discrepancy.[16,17] Functional appliances, including Twin Block, primarily act by enhancing mandibular advancement and improving the anteroposterior relationship (increase in SNB and reduction in ANB), even in patients with vertical growth tendencies. Therefore, in selected cases, sagittal correction may be prioritized over vertical considerations, justifying the use of Twin Block therapy in hyperdivergent patients. Removable functional appliances offer advantages such as easier oral hygiene maintenance and lower costs compared to fixed functional appliances. However, their main disadvantage is that treatment success is largely dependent on patient compliance.[7] For

patients who have completed growth, especially those with Class II mandibular retrusion, fixed functional appliances that require limited patient cooperation are the treatment of choice.[18] Fixed functional appliances have the advantages of requiring no patient cooperation and providing continuous force, but they come with drawbacks such as high costs, breakage, limited opening capacity, and potential tissue injuries.[8]

Notwithstanding current controversies surrounding functional appliances and growth modification, these appliances remain effective treatment options for Class II malocclusions. Growth modification may help minimize the need for permanent tooth extractions and future orthognathic surgical intervention.[19]

As a result, this case report shows that the effect of the different functional appliances for the advancement of the mandible depends on patient cooperation and case selection. The use of these devices in the growing phase, with good patient cooperation, creates a positive skeletal and dentoalveolar effect.

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Ethical approval is not necessary. Informed consent forms are available.

Conflict of Interest
The authors declare no conflict of interest.

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