

Therapeutic Effects of Removable Intraoral Class III Appliances on Dentofacial Structures: A Comprehensive Literature Review

Hareketli Ağız İçi Sınıf III Apareylerin Dentofasiyal Yapılar Üzerindeki Terapötik Etkileri: Kapsamlı Bir Literatür Taraması

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ABSTRACT

The aim of this comprehensive review was to shed light on removable intraoral Class III appliances and their dentoskeletal effects in growing Class III subjects. Recently, intraoral Class III appliances have been recommended in cases of Class III malocclusions arising from maxillary retrusion instead of the Facemask appliance, which is commonly used in children at development age, due to its disadvantages including large volume and non-esthetic design, lack of cooperation, and its contribution to the irritation in the anchorage site. For these reasons, the appliances used in the treatment of Class II malocclusions have been modified for the treatment of Class III malocclusions. Among these, Fränkel Appliance III, which was introduced by Rolf Fränkel, is the most well-known modified appliance and the other well-known examples include Bionator III, Reverse Twin Block, and Magnetic Appliance III. Additionally, the other removable intraoral appliances introduced in the literature include Modified Tandem and Double-plate Appliance. The present review examined the designs of these appliances reported in the literature as well as their skeletal and dentoalveolar effects on the maxilla and mandible.

Keywords: Class III malocclusion, Intraoral appliance, Orthodontics

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Ö Z E T

Bu kapsamlı derlemenin amacı, Sınıf III maloklüzyona sahip büyüyen bireylerin tedavisinde kullanılan hareketli intraoral Sınıf III apearelere ve bunların dento iskeletsel etkilerine ışık tutmaktır. Maksiller retrüzyon kaynaklı Sınıf III maloklüzyon görülen gelişim çağındaki çocuklarda sıklıkla kullanılan yüz maskesi gibi ekstraoral apearelerin; büyük hacimli olmaları ve estetik görünmemeleri, hastaların kullanımda kooperasyon göstermemesi ve ankraj bölgesinde irritasyon yaratmaları gibi dezavantajları nedeniyle son zamanlarda intraoral Sınıf III apearelerin kullanımı gündeme gelmiştir. Bu amaçla, Sınıf II maloklüzyonların tedavisinde kullanılan apeareler Sınıf III maloklüzyonların tedavisi için modifiye edilmiştir. Bunlar arasında en bilineni Rolf Fränkel tarafından geliştirilen Fränkel III apeareyi olmak üzere; Bionator III, Ters Twin Block ve Manyetik apeare III gibi apeareler vardır. Ayrıca literatürde Modifiye Tandem ve Double-plate apeareyi de geçmektedir. Bu derlemede, literatürde bildirilen tüm apearelerin tasarımlarının yanı sıra maksilla ve mandibula üzerindeki iskelet ve dentoalveolar etkileri incelenmiştir.

Anahtar Kelimeler: Sınıf III maloklüzyon, İtraoral apeare, Ortodonti



1.Introduction

Class III malocclusions represent the most difficult deformities for orthodontists in terms of diagnosis and treatment [1]. Determining whether these malocclusions have a dental, functional, or skeletal etiology is of paramount importance. Skeletal Class III anomalies may occur due to growth retardation in the maxilla, overdevelopment of the mandible, or both. In children with developmental delay in the maxilla, maxillary growth may be facilitated using an orthopedic force with a protraction device [2,3]. Maxillary protraction facemask treatment is the most commonly preferred method for maxillary protraction in children in developmental period. Moreover, this method has been shown to stimulate the growth in circum-maxillary sutures and to activate the anterior and inferior translation of the maxilla by means of force [4].

In Class III malocclusions, mandibular anterior displacement is commonly seen when transitioning from the postural rest position to the occlusal position, which is detected by functional analysis [5]. On the other hand, researchers have recently focused their attention on intraoral treatment approaches considering that facemask is not esthetic and comfortable and also leads to difficulties in patient cooperation [6,7]. The aim of this comprehensive review is to introduce clinicians to the dentoskeletal effects of different removable appliances designed as an alternative to face masks.

In the present review, studies, case series and case reports that included syndrome-free patients, intraoral anchorage, clinically and epidemiologically consistent cephalometric measurements, and definitive clinical records were examined and among them, articles that reported on appliances were selected. The appliances noted in those studies included Fränkel Appliance III [8], Bionator III Appliance [9], Double-Plate Appliance [10], Magnetic Appliance III [11], Modified Tandem Appliance [6] and Reverse Twin Block [7].

1. Fränkel Appliance III (FR-3)

The Fränkel function regulator III appliance (FR-3) was introduced by Fränkel and is used in the treatment of Class III malocclusions to achieve targeted morphological changes in the jaw bones by affecting the masticatory muscles [12]. FR-3 (Figure 1) can be used for treating children with Class III

growth pattern who present with a mandible that can be positioned posteriorly along with a retrognathic maxilla in functional examination [12,13]. This appliance eliminates the pressure of cheek and lip muscles as well as mental, buccinator, and orbicularis oris muscles. With this appliance, the apposition in the dentoalveolar region is increased according to the functional matrix theory to move the maxilla forward and to restrain mandibular growth [13].

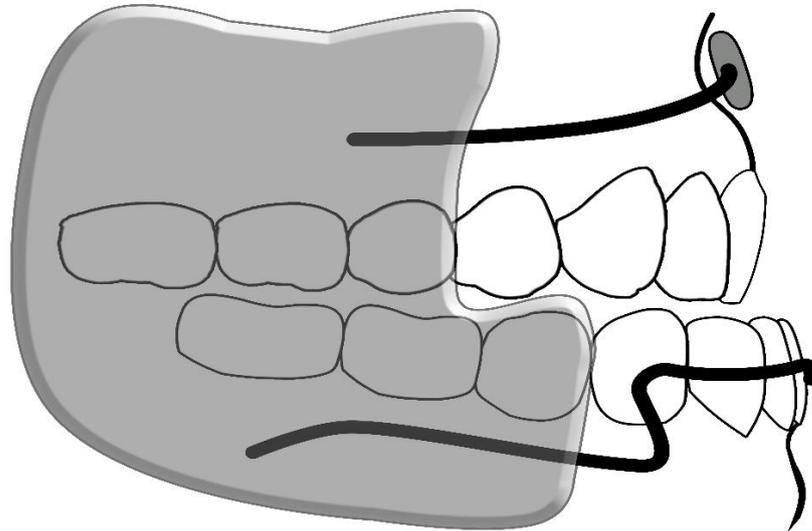


Figure 1: Schematic view of Fränkel Appliance III

Literature indicates a consensus that FR-3 leads to inferior and posterior mandibular dislocation [14,15]. However, there is some conflict about the effects of FR-3 in the maxilla [8]. Frankel [12] originally concluded that the use of the FR-3 leads to increased bone apposition at point A, while McNamara and Hugu reported that it caused forward and downward move of the maxilla [16]. On the other hand, Kohmura et al. [17] reported a remarkable anterior movement of point A and transversal expansion of both arches. Additionally, Graber et al. [14] indicated that bone proliferation increased due to the indirect tension of the shields on the periosteum. Nevertheless, Ulgen and Firatlı [13] suggested that the improvement is mostly due to the downward and posterior rotation of the mandible and retroclination of the mandibular incisors, and that the forward movement of the maxilla is not very important.

Baik et al. [8] applied FR-3 in children with Class III malocclusions at development age and compared them with the control group. The authors reported that although FR-3 provided no significant skeletal or dental effect in the maxilla, it led to clockwise rotation in the mandible and to linguoversion of the mandibular incisors. Biren and Erverdi [18] showed that the use of FR-3 led to increased total and lower anterior facial height as well as decreased overbite. Similarly, Kalavritinos et al. [19] reported that the use of FR-3 resulted in a significant increase in the facial convexity angle. In contrast, McNamara and Hugu [16] suggested that although the treatment can be completed within six months by the use of an orthopedic facemask, a minimum of 12-24 months are required for FR-3 to exert the same effect.

Finally, studies have shown that FR-3 leads to increase ANB angle as well as a significant increase in the overjet [13, 18-20].

2. Bionator III Appliance

According to Balters' hypothesis, in Class III patients the tongue is more advanced than normal and the goal of this malocclusion treatment is to keep the tongue in a more backward and higher position [21]. It has also been reported that Bionator III appliance (Figure 2) is applied to individuals at development age in whom the skeletal Class III case is not very severe, in order to treat the malocclusion by moving the tongue and mandible backward and by applying neuromuscular modification [21]. Garattini et al. [9] showed that the use of Bionator III therapy resulted in a significant advancement at point A compared to the control group and also led to clockwise movement of the mandible, thereby causing decreased SNB angle and increased ANB angle. The authors also noted that this appliance is highly useful, cost-

effective, and comfortable in individuals with Class III malocclusions that originate from maxillary deficiency and have a hypodivergent growth pattern since it has been shown to cause an increase in both the Sn/GoGn angle and the anterior facial height [9].

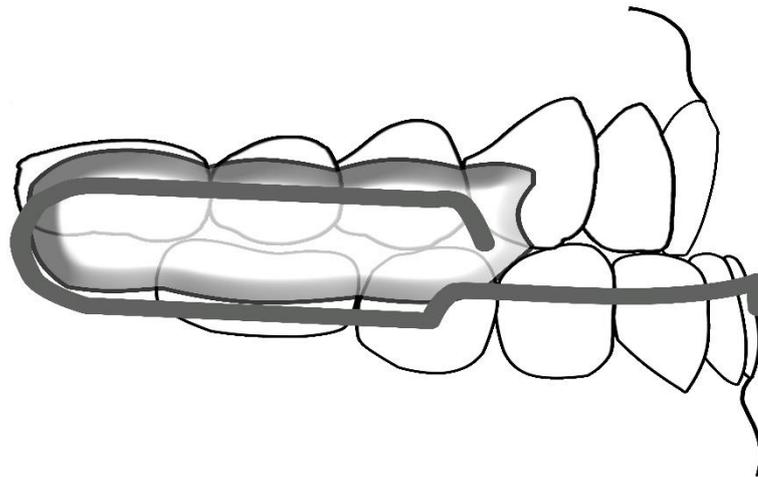


Figure 2: Schematic view of Bionator III Appliance

3. Double-plate Appliance [DPA]

Double-plate Appliance (DPA), which was developed by Planas, is an intraoral appliance used for Class III malocclusions, containing angulated acrylic blocks with Class III elastics that are applied between the upper molars and lower canines [22]. In a previous study, Demirel [22] reported that the use of DPA (Figure 3) in individuals with Class III malocclusions characterized by maxillary deficiency and/or excessive mandibular growth led to the stimulation of forward movement of the maxilla, posterior rotation of the mandible, improvement in ANB, Wits, and convexity measurements, increased lower anterior facial height, protrusion and intrusion in upper incisors, and retrusion in lower incisors. Additionally, the treatment also resulted in skeletal improvement and favorable outcomes in soft tissue [22].

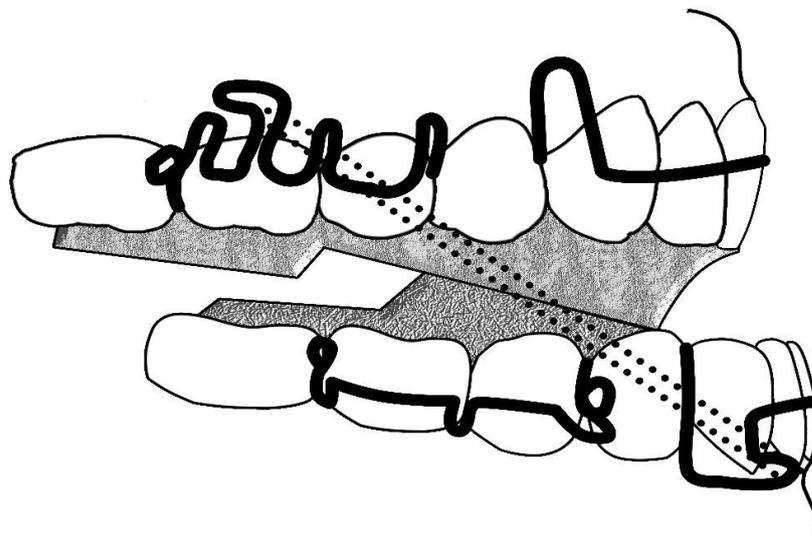


Figure 3: . Schematic view of Double-plate Appliance.

Ucem et al. [10] compared the Facemask therapy and intraoral DPA in 28 cases of skeletal Class III malocclusions and reported that the increases in SNA angles and the skeletal effects in the Facemask group were significantly greater than in the DPA group while the increase in the overjet and the

protrusion of the maxillary incisors and retrusion of the mandibular incisors were significantly greater in the DPA group compared to the Facemask group.

4. Magnetic Appliance

Vardimon et al. [23] designed the Functional Orthopedic Magnetic Appliance (FOMA III) in 1990 by placing a permanent magnet on the upper and lower acrylic plates and first applied it to six female Macaca monkeys. At the end of the application, the maxilla moved anteriorly en bloc and a minimal increase was noted in the mandibular length. Darendeliler et al. [24] developed the Magnetic Activator Device (MAD) III and reported that the use of this device provided successful outcomes, whereby the force exerted by the magnets stimulated forward movement of the maxilla and backward movement of the mandible. Tuncer and Uner [11] investigated the efficacy of a magnetic appliance in 10 functional Class III patients (mean age, 9 years 7 months), in whom the magnetic appliance (Figure 4) placed in the maxilla was at a more posterior location compared to that of mandible. The authors reported that the use of the appliance showed no significant skeletal effect in the maxilla while it led to a posterior rotation of the mandible in addition to maxillary protrusion and mandibular incisor retrusion. Accordingly, it is tempting to consider that although the use of magnets provides solutions for various orthodontic problems, magnets are not commonly used in routine practice due to their disadvantages for periodontal tissues and increased costs [11].

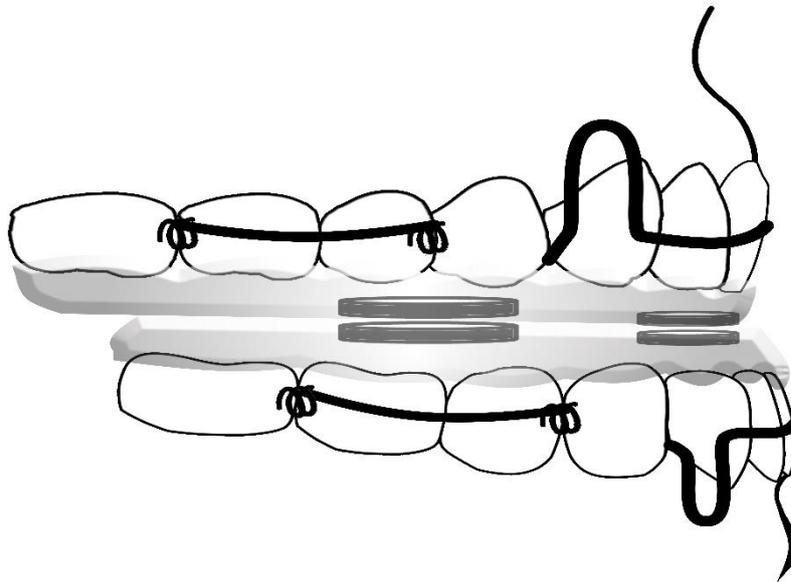


Figure 4: Schematic view of Magnetic Appliance.

5. Modified Tandem Appliance (MTA)

Klempner [25] and Chun et al. [26] developed the Modified Tandem Appliance (MTA) by modifying the Tandem Traction Bow Appliance. This modification included the addition of a fixed banded appliance with expansion screws to the maxilla and the application of an expansion screw to the lower appliance. The researchers applied MTA in a five-year-old Class III girl with maxillary retrognathism for a period of 12 months and reported that it could be successfully used in cases of maxillary retrognathism with severe skeletal Class III and deep bite malocclusion [26].

Atalay and Tortop [6] divided skeletal Class III subjects into early and late treatment groups based on their ages and applied MTA (Figure 5) in both groups. All the patients were instructed to wear the appliance approximately 14-16 hours a day and the treatment was continued until a minimum overjet of 2 mm was obtained. At the end of the treatment, the maxilla moved forward, molar relationships were improved particularly by the forward advancement of the maxilla, and no significant rotation was observed in the maxilla in both groups. Moreover, the upper incisors were protruded, the lower incisors were significantly retruded and tipped lingually, and the lower molars were distalized. Although no significant difference was observed between the treatment groups, the overjet and molar relationships

improved due to both skeletal and dental changes in the early treatment group while they improved mostly due to skeletal changes in late treatment group.

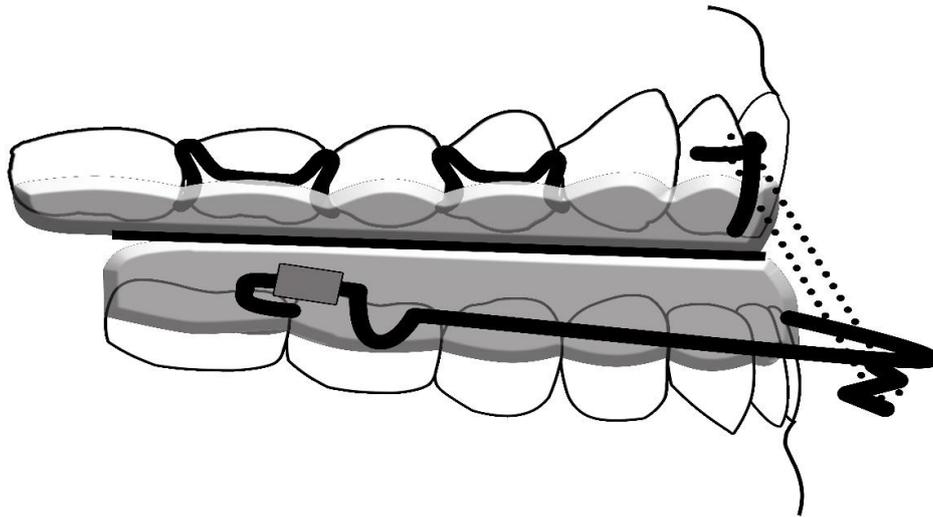


Figure 5: Schematic view of Modified Tandem Traction Bow Appliance.

6. Reverse Twin Block (RTB)

Kidner et al. [27] developed the Reverse Twin Block (RTB) in 2003 by modifying the Twin Block appliance used in Class II patients with mandibular retrognathism that were at development age. In RTB (Figure 6), the acrylic blocks in the upper and lower arches, unlike in Class II treatment, are designed in such a manner that the mandible is held in a more protrusive position.

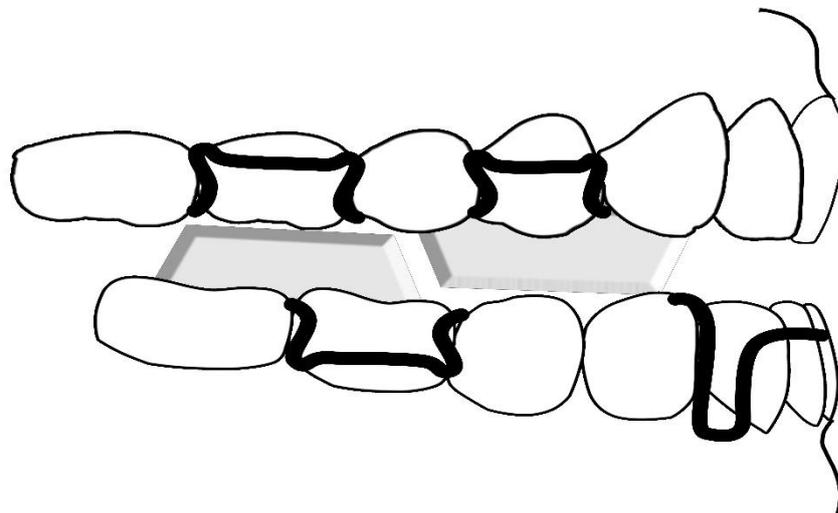


Figure 6: Schematic view of Reverse Twin Block Appliance.

Kidner et al. [27] applied RTB in 14 Class III patients with an average chronological age of 10 years and reported that most of the changes observed after the treatment were of dentoalveolar origin and the changes mostly included proclination of maxillary incisors, retroclination of mandibular incisors, and increased maxillary/mandibular plane angle. The author also noted that RTB could be successfully used in the treatment of early Class III malocclusions.

Seehra et al. [7], on the other hand, applied RTB in 13 Class III subjects with an average chronological age of 9.9 years in 2012 and compared the results with those of subjects that underwent Facemask

therapy and of untreated subjects. The authors indicated that the skeletal changes in the Facemask group were significantly greater than those of RTB group while maxillary incisor proclination and mandibular incisor retroclination were greater in the RTB group compared to the Facemask group.

2. Conclusion

Intraoral Class III appliances including FR-3, Bionator III, RTB, Magnetic Appliance III, MTA, and DPA could be successfully used in the treatment of Class III malocclusions due to their advantages including practicality, esthetic design, and favorable patient cooperation. The primary benefit of these appliances is generally achieving increased ANB angle and overjet as well as downward and backward rotation of the mandible, buccoversion of maxillary incisors, and linguoversion of mandibular incisors. Based on the findings, we suggest that intraoral Class III appliances could be useful alternatives due to their esthetic and hygienic designs particularly in hypodivergent and mild or moderate growing Class III subjects in whom the mandible can be positioned posteriorly.

References

- [1] Guyer EC, Ellis III EE, McNamara Jr JA, Behrents RG. Components of Class III malocclusion in juveniles and adolescents. *Angle Orthod.* 1986;56(1):7-30.
- [2] Baik HS. Clinical results of the maxillary protraction in Korean children. *Am J Orthod Dentofacial Orthop.* 1995;108(6):583-92.
- [3] Sung SJ, Baik HS. Assessment of skeletal and dental changes by maxillary protraction. *Am J Orthod Dentofacial Orthop.* 1998;114(5):492-502.
- [4] Macdonald KE, Kapust AJ, Turley PK. Cephalometric changes after the correction of Class III malocclusion with maxillary expansion/facemask therapy. *Am J Orthod Dentofacial Orthop.* 1999;116(1):13-24.
- [5] Rakosi III T. Treatment of Class III malocclusions. *Dentofacial Orthopedics with Functional Appliances US: CV Mosby.* 1997:461-80.
- [6] Atalay Z, Tortop T. Dentofacial effects of a modified tandem traction bow appliance. *Eur J Orthod.* 2010;32(6):655-61.
- [7] Seehra J, Fleming PS, Mandall N, Dibiase AT. A comparison of two different techniques for early correction of Class III malocclusion. *Angle Orthod.* 2012;82(1):96-101.
- [8] Baik HS, Jee SH, Lee KJ, Oh TK. Treatment effects of Fränkel functional regulator III in children with Class III malocclusions. *Am J Orthod Dentofacial Orthop.* 2004;125(3):294-301.
- [9] Garattini G, Levrini L, Crozzoli P, Levrini A. Skeletal and dental modifications produced by the Bionator III appliance. *Am J Orthod Dentofacial Orthop.* 1998;114(1):40-4.
- [10] Ucem TT, Ucuncu N, Yuksel S. Comparison of double-plate appliance and facemask therapy in treating Class III malocclusions. *Am J Orthod Dentofacial Orthop.* 2004;126(6):672-9.
- [11] Tuncer C, Ünler O. Effects of a magnetic appliance in functional Class III patients. *Angle Orthod.* 2005;75(5):768-77.
- [12] Fränkel R, editor. Maxillary retrusion in Class 3 and treatment with the function corrector 3. Report of the congress European Orthodontic Society; 1970.
- [13] Ülgen M, Firatli S. The effects of the Fränkel's function regulator on the Class III malocclusion. *Am J Orthod Dentofacial Orthop.* 1994;105(6):561-7.
- [14] Graber TM, Rakosi T, Petrovic AG. *Dentofacial orthopedics with functional appliances: Mosby Incorporated;* 1997.
- [15] Proffit WR, Fields Jr HW, Sarver DM. *Contemporary orthodontics: Elsevier Health Sciences;* 2006.
- [16] McNamara Jr JA, Hulse SA. The functional regulator [FR-3] of Fränkel. *Am J Orthod.* 1985;88(5):409-24.

- [17] Kohmura T, Tokuda N, Fukamachi H, Hara S, Yamaki M, Hanada K, et al. Effects of therapy using the function regulator (FR III) on cases with reversed occlusion. *Nihon Kyosei Shika Gakkai zasshi= The journal of Japan Orthodontic Society*. 1986;45(4):693.
- [18] Biren S, Erverdi N. Cephalometric evaluation of maxillary retrognathism cases treated with Fr-3 appliance. *Journal of Marmara University Dental Faculty*. 1993;1(4):354-60.
- [19] Kalavritinos M, Papadopoulos MA, Nasiopoulos A. Dental arch and cephalometric changes following treatment for Class III malocclusion by means of the function regulator (FR-3) appliance. *J Orofac Orthop*. 2005;66(2):135-47.
- [20] Levin AS, McNamara Jr JA, Franchi L, Baccetti T, Fränkel C. Short-term and long-term treatment outcomes with the FR-3 appliance of Fränkel. *Am J Orthod Dentofacial Orthop*. 2008;134(4):513-24.
- [21] Balters W. Eine Einführung in die Bionatorheilmmethode: ausgewählte Schriften und Vorträge: Hölzer; 1973.
- [22] Demirel H. Ağız içi çift plak uygulaması ile 3. Sınıf Anomalilerin tedavilerine yeni bir yaklaşım [thesis] Ankara, Turkey: Gazi Üniversitesi. 1999.
- [23] Vardimon AD, Graber TM, Voss LR, Mulfer TP. Functional orthopedic magnetic appliance [FOMA] III—modus operandi. *Am J Orthod Dentofacial Orthop*. 1990;97(2):135-48.
- [24] Darendeliler MA. Early class III treatment with magnetic appliances. *J Clin Orthod*. 1993;27:563-9.
- [25] Klemptner LS. Early orthopedic Class III treatment with a modified tandem appliance. *J Clin Orthod*. 2003;37(4):218-23.
- [26] Chun Y-S, Jeong S-G, Row J, Yang S-J. A new appliance for orthopedic correction of Class III malocclusion. *J Clin Orthod*. 1999;33(12):705.
- [27] Kidner G, DiBiase A, DiBiase D. Class III Twin Blocks: a case series. *J Orthod*. 2003;30(3):197-201.