

Review Article

Fixed functional appliances for correction of Class II malocclusion: A review

ABSTRACT

This review article presents various fixed functional appliances that have been developed all these years with the aim of correcting Class II malocclusion. Class II malocclusion though multifactorial in etiology, but the main cause is mandibular retrognathia. The treatment aims to modify the direction and amount of mandibular growth rather than restricting the development of the maxilla. Hence, the various appliances were developed removable and fixed with the aim to correct Class II malocclusion. Fixed functional appliances were developed with the aim to correct Class II malocclusion without the need of patient compliance, which was a major concern toward removable functional appliances.

Keywords: Class II, fixed functional, malocclusion, retrognathic mandible

INTRODUCTION

Correcting Class II malocclusion has always been a challenge to an orthodontist owing to the complex and multifactorial etiology. It has been suggested in various studies that the main cause of Class II malocclusion is mandibular retrognathia. Treatment of Class II malocclusion aims to modify the direction and amount of mandibular growth rather than restricting the development of maxilla. This concept plays a primary role in functional jaw orthopedics. Various appliances have been developed over the past century, removable and fixed. The main drawback of the removable appliances is that they require very good patient cooperation. Due to noncompliance of the patient, which in general is increasing, alternate treatment strategies of functional appliances had been devised, broadly grouped as fixed functional appliances.^[1] The ideal time for the treatment with fixed functional appliances takes the advantage of the pubertal growth. Being a 24-h wear appliance, it produces rapid sagittal correction utilizing the short span of remaining growth to maximum advantage.

HISTORY OF EVOLUTION

Norman W. Kinsley who first (1879) used forward positioning of the mandible in orthodontic treatment. Wilhelm Roux is credited as the first to study the influences of natural forces and functional stimulation on form (1883) (Wolff's law). His work became the foundation of both general orthopedics and functional dental orthopedic principles. Viggo Andresen's Activator was the first functional appliance to gain the widespread clinical use. Fixed functional appliance was introduced by Dr. Emil Herbst of Germany at the 5th International Dental Congress in Berlin in the year 1909 which was later discovered by Pancherz in the late 1970s. Since then various functional appliances have been introduced, removable and fixed, with the basis of correcting Class II malocclusion by bringing the mandible in a forward position.^[2]

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A.K. CHAUHAN, FATIMA ALAM, SANTOSH VERMA, SYED SHAFIQ

Department of Orthodontics and Dentofacial Orthopedics, Kothiwal Dental College and Research Centre, Moradabad, Uttar Pradesh, India

Address for correspondence: Dr. Fatima Alam, Abul Hasan House, Galshaheed, Prince Road, Moradabad, Uttar Pradesh, India.
E-mail: dr.alam_fatima@icloud.com

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Table 1: Indications and contraindications

Indications	Contraindications
Skeletal Class II patients with retrognathic mandible	FFA is contraindicated in patients with vertical growth pattern
Patients having a normal maxilla with convex profile due to small, retro-positioned mandible, and an average or a horizontal growth pattern	FFA are contraindicated in patients with anterior open bite
FFA can be used as mandibular anterior repositioning splint in patients having Temporomandibular disorders	FFA are contraindicated in cases of proclined lower incisors
Postsurgical stabilization of Class II/Class III malocclusions in adult patients	FFA are contraindicated in patients with susceptible root resorption due to extra loading of force generated with FFA
Correction of functional midline shifts by using the appliance unilaterally	

FFA: Fixed functional appliance

Table 2: Classification

Rigid	Flexible	Hybrid	Appliances as a substitute for elastics
Herbst appliance	Jasper jumper	Eureka spring	Calibrated force module
Mandibular protraction appliance	Churro jumper	Forsus fatigue resistant device	Alpern Class II closers
Mandibular anterior repositioning appliance	Adjustable bite corrector	TFBC	Saif springs
Ritto appliance	Flex developer	SUS	
IST appliance	Bite fixer	PowerScope 2	
Biopedic appliance	Amoric torsion coil spring	Advansync 2	
	Scandee tubular jumper		

TFBC: Twin force bite corrector, SUS: Sabbagh universal spring

Table 3: Rigid fixed functional appliances

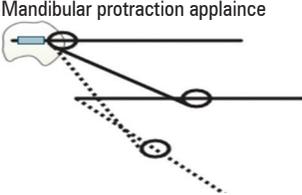
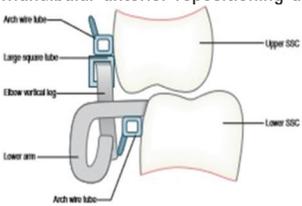
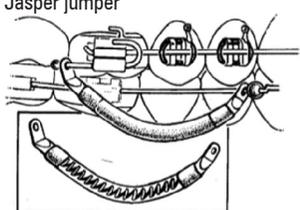
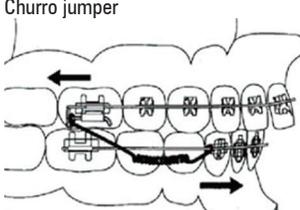
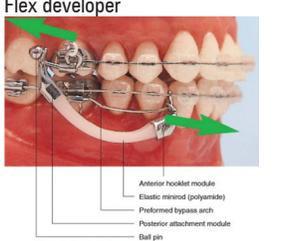
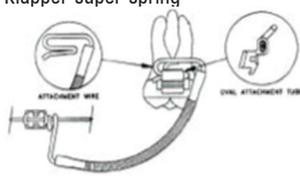
Appliance name and design	Description
<p>Herbst appliance</p> 	<p>Introduced by Emil Herbst at the International Dental Congress in the year 1905 is a fixed bite jumping device for the correction of Class II malocclusion, later reintroduced by Hans Panzerz in the October 1979 issue of American Journal of Orthodontics calling possibilities of stimulating mandibular growth by means of Herbst appliance.^[13] The original design had a bilateral telescopic mechanism attached to orthodontic bands on the maxillary first permanent molars and on mandibular first premolars (or canines); this maintains the mandible in a continuous protruded position. Treatment with the banded Herbst appliance usually lasts 6-8 months resulting in the correction of overjet and Class II molar relation</p>
<p>Mandibular protraction appliance</p> 	<p>Coelho Filho in 1995 introduced the mandibular protraction appliance, a fixed dentofacial orthopaedic noncompliant device that could be fabricated by the clinician thereby permitting easy application to the patient. Due to frequent breakage of the appliance, led him to introduce several modifications until the appliance reached its fourth version, which was more resistant to breakage and much more stable during functioning than the previous ones^[14]</p>
<p>Ritto appliance</p> 	<p>The Ritto Appliance introduced by Antonio Korrodi Ritto, for correction of Class II malocclusion with mandibular deficiency, can be described as a miniaturized telescopic device with simplified intraoral application and activation. It has been developed over a 12-year period with the goal of creating an efficient appliance with a telescopic action. The smaller size facilitates adaptation, it is simple to use, comfortable, cost-effective, fracture resistant, it does not affect esthetic appearance or speech and requires no patient cooperation^[15]</p>
<p>Mandibular anterior repositioning appliance</p> 	<p>Eckhart in the year 1998 introduced the mandibular anterior repositioning appliance, a Class II corrective device which is considered to be a fixed twin block, similar to a twin block in that it has two opposing vertical surfaces positioned to keep the lower jaw in a forward position.^[16] Crowding is usually treated with arch expansion, widening the arches, and advancing the incisors</p>

Table 4: Flexible fixed functional appliances

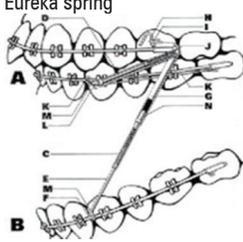
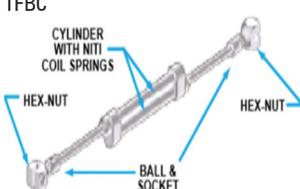
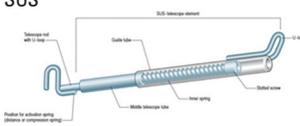
Appliance name and design	Description
<p>Jasper jumper</p> 	<p>The Jasper Jumper introduced in 1987, is a flexible fixed appliance that delivers light, continuous force. It can be used to move single teeth, units of teeth or an entire arch. It can deliver functional, bite jumping forces, headgear-like forces, elastic-like forces, or a combination of these. The appliance offers more directional control than elastics or fixed coil springs, with their extrusive and constrictive forces on the lower molars and extrusive forces on the upper anterior teeth. The Jumper can be easily placed, activated, and removed.^[17] Its flexibility makes oral hygiene easy, and because the appliance curves away from the occlusal table on closing, it does not interfere with chewing</p>
<p>Churro jumper</p> 	<p>Castañón <i>et al.</i> in 1998, developed the Churro jumper as an improvement to the MPA, but it functions more like the Jasper Jumper. The Churro Jumper, unlike many other Class II appliances, can be adapted to provide a well-designed force for correction of Class III malocclusions. The Churro can be fabricated with a minimum of time, effort, expertise, and expense^[18]</p>
<p>Adjustable bite corrector</p> 	<p>An invention of Richard P West is just similar to the Jasper Jumper, but constructed so that it is stretchable and has a degree of flexibility and includes end attachment means which enables it to turn or swivel adjacent its anchor points on the upper and lower jaws of the patient. Thus, a patient can wear a pair of appliances with a minimum of discomfort while retaining the ability to talk, chew food and perform normal oral hygiene procedures^[19]</p>
<p>Flex developer</p> 	<p>In 1995, Dr Williams from the Royal Dental College, University of Aarhus, Denmark, presented for the first time an alternative device for jumping the bite, in which the rubber-coated spring of the Jasper Jumper was replaced by a polyamide mini rod, eliminating the risk of fracture, and named it the Flex Developer. It consisted of an adjustable anterior hooklet module to shorten the polyamide minirod to the patient's individual need. For easier insertion, this hooklet could be opened and relocked by the orthodontist, making the FD adapted to any length^[20]</p>
<p>Bite fixer</p> 	<p>The Bite Fixer (Ormco, Orange, CA) is a prefabricated intermaxillary coil spring, attached and crimped to the end fitting to prevent breakage between the spring and the end fitting. Plastic tubing is inserted in the spring to prevent it from becoming a food trap. The Bite Fixer is supplied in a kit with various sizes for both left and right sides. The appliance can be used only in combination with full bracketed upper and lower arches^[21]</p>
<p>Klapper super spring</p> 	<p>The KLAPPER SUPER spring is a flexible spring element that attaches between the maxillary molar and the mandibular canine. It is designed to rest in the vestibule, making it impervious to occlusal damage and allowing for good hygiene. The hinging action and the flexibility of the spring allow a reasonably full mandibular opening, which makes the appliance suitable for use in adults as well as children. The SUPER spring II can be used in the entire range of Class II cases, from vertical facial patterns with shallow overbites to brachyfacial patterns with deep overbites^[22]</p>

FUNCTIONAL JAW ORTHOPEDICS

The original concept of functional jaw orthopedics is basically encompassing the correction of Class II malocclusion not only active force of the appliance but also by the forces generated from the muscles when the mandible is held forward.^[3] The primary objective of functional jaw orthopedics (FJO) in

Class II patients with mandibular skeletal retrusion is the enhancement of mandibular growth.^[4,5] Greater effects of FJO are expected when the treatment is carried out at the peak in the mandibular growth when compared to the outcomes of treatment performed before or after the growth spurt.^[5] The effectiveness of functional appliance is not only limited to the measurement of the enhanced length of the mandible alone

Table 5: Hybrid fixed functional appliances

Appliance name and design	Description
<p>Eureka spring</p> 	<p>The Eureka Spring was first described in 1997 and treatment results on a variety of noncompliant Class II patients were presented. The impetus behind its development was frustration with the increasing number of noncompliant patients and the frequent breakage of the Jasper Jumper. Eureka Spring is reported to have significant advantages over all the rigid and flexible FFAs. The Eureka spring exerts a push rather than the pull force of Class II elastics, a Class II Eureka Spring attaches in the direction of a Class III elastic^[23]</p>
<p>Forsus fatigue resistant device</p> 	<p>The Forsus FRD is a hybrid fixed functional appliance that was developed to overcome breakage problems seen with the Jasper Jumper. The FRD is a three-piece, telescoping system incorporating a super elastic nickel-titanium coil spring that is easy to install and thus saves chair time. Because the open-coil spring can be compressed about 10 mm, the FRD is capable of moving the maxillary molars a substantial distance over a long period of time^[24]</p>
<p>TFBC</p> 	<p>The TFBC is a new fixed intermaxillary appliance with a built-in constant force for Class II correction. TFBC was developed from a combination of concepts from the Herbst and Jasper Jumper. The TFBC is a fixed, push-type intermaxillary functional appliance with ball-and-socket joint fasteners that allow a wide range of motion and lateral jaw movement. At full compression, the TFBC postures the patient's mandible forward into an edge-to-edge occlusion^[25]</p>
<p>SUS</p> 	<p>SUS was invented and developed by Dr. Aladin Sabbagh in 1997. SUS is a noncompliant, effective 24 hours a day, fixed functional appliance which is a combination of the Herbst appliance and the Jasper Jumper, aiming to increase the efficacy of the treatment and to minimize their disadvantages. It has just one universal size and can be fixed between the upper and lower jaws^[26]</p>
<p>PowerScope 2</p> 	<p>Powerscope, released in 2014, was a new generation of hybrid fixed functional appliance. Just a year later, the appliance was subjected to three changes (stop reinforcement, magnet key, and activation indicator piece), and hence, it was renamed PowerScope 2. It comes as a one-size-fit all appliance, consisting of a telescopic system with three fitting pieces that will not come loose during treatment^[27]</p>
<p>Advansync 2</p> 	<p>The main goal of development of the Advansync 2 appliance was to improve the comfort of orthopedic Class II treatment for our patients. The result was the development with Ormco of the AdvanSync appliance, by Dr. Bill M. Dischinger and his father in 2008, followed by a couple of years later with the AdvanSync 2 appliance with a few modifications from the original design. The appliance is almost half of the size of the MiniScope Herbst appliance. Because of the smaller size, it fits more in the posterior of the mouth. The appliance also does not show in the mouth like previous Herbst designs, so patients are more accepting to having it. A bonus that came out of the smaller design was the ability to bracket every tooth forward of the appliance. It was also not possible to bond the maxillary and the mandibular premolars in other previous appliances. When finished with the Class II correction and the appliance is removed, most of the orthodontics has been accomplished as well and we can quickly move to the end of the treatment. Treatment time reduced by 6 months with advansync 2^[28]</p>

TFBC: Twin force bite corrector, FFA: Fixed functional appliance, SUS: Sabbagh Universal Spring

but also includes the improvement in overall volume of the oral cavity, i.e., housing the dentition, oral structures such as position of the tongue and soft-tissue drape around the face. Forward placement of the mandible is seen as an improvement in the lip seal and improved pattern of breathing.^[6] Functional appliance worn for 24 h, like the Herbst appliance increases mandibular growth as claimed by Pancherz and as suggested by Herbst treatment time not <9 months.^[7-9] Pancherz also suggested that functional appliance like the Herbst worn for

24 h increases mandibular growth, with an increase in arch length as well as proclination of the mandibular incisors along with distalization of the upper molars and mesialization of lower molars.^[7,10] The functional appliances used to treat retrognathic mandible, influence the jaws by remodeling of the mandibular condyle or glenoid fossa, repositioning of the mandibular condyle in the glenoid fossa, and auto-rotation of the mandibular bone, which occurred through intra-articular osseous or soft-tissue remodeling.^[11,12]

Various indications and contraindications for use of fixed functional appliances are listed in Table 1. Fixed functional appliances are classified as Rigid, Flexible, Hybrid and as substitute for elastics. The individual types are listed in Table 2. Further a brief description of each appliance type is given in Tables 3-5.

TREATMENT EFFECTS

According to the study done by Zymperdikas *et al.*, the treatment of Class II malocclusion with Fixed Functional Appliances (FFAs) was associated with small stimulation of mandibular growth, small inhibition of maxillary growth, and with more pronounced dentoalveolar and soft-tissue changes. The treatment effects of FFAs on the skeletal tissues in patients with Class II malocclusion excluding the effects of normal growth were small and probably of minor clinical importance.^[29] In a systematic review presented by Perinetti *et al.*, they concluded that treatment with the fixed functional appliance is effective in treating Class II malocclusion with skeletal effects when performed during the pubertal growth phase. The skeletal effects alone do not account for the whole Class II correction, dentoalveolar effects are always present, even in patients who are treated during puberty.^[30]

CONCLUSION

Class II malocclusion has multifactorial etiology, mandibular retrognathism being the main cause. Various functional appliances have been developed for the correction of class II. Fixed functional appliance has gained widespread popularity as the patient compliance is not needed. Treatment with the fixed functional appliances should not last <6–9 months. Forward positioning of the mandible and increase in mandibular length, as well as distalization of upper molars and mesialization of lower molars lead to the correction of class II malocclusion.

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Conflicts of interest

There are no conflicts of interest.

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