

A COMPREHENSIVE REVIEW ON FIXED FUNCTIONAL APPLIANCES IN ORTHODONTICS

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ABSTRACT

In the realm of orthodontics, fixed functional appliances have drawn a lot of interest because of their capacity to correct Class II malocclusions and encourage healthy mandibular growth and development. This review article attempts to give a thorough overview of fixed functional appliances by going through their many categories, modes of operation, clinical applications, benefits, drawbacks, and outcomes supported by data. The controversy surrounding using these appliances for orthodontic therapy is also covered in this article, along with potential future developments.

Keywords: Fixed functional appliances, orthodontics, Class II malocclusion, Herbst appliance, Forsus Fatigue Resistant Device, MARA, Twin Block, treatment outcomes..

INTRODUCTION

Orthodontic treatment plays a pivotal role in achieving proper occlusion, functional harmony, and enhanced facial aesthetics. Among the diverse array of orthodontic interventions, fixed functional appliances have emerged as a significant therapeutic tool, particularly for addressing Class II malocclusions.¹ These malocclusions, characterized by a retruded mandible relative to the maxilla, present challenges not only in terms of aesthetics but also in terms of functional occlusion and oral health. Fixed functional appliances represent a dynamic branch of orthodontics that focuses on modifying mandibular growth patterns and achieving a harmonious dentofacial relationship. The historical progression of orthodontics reveals a continuous pursuit of innovative techniques to correct malocclusions. The inception of fixed functional appliances can be traced back to the pioneering work of Edward Angle, who introduced the concept of functional appliances to influence mandibular growth.² Over the years, these appliances have undergone significant advancements in design, biomechanics, and clinical application. This comprehensive review aims to shed light on the diverse facets of fixed functional appliances in orthodontics. By exploring the different types of fixed functional appliances, their mechanisms of action, clinical applications, advantages, limitations, and evidence-based outcomes, we endeavor to provide orthodontists and researchers with an encompassing understanding of this specialized treatment modality. Additionally, we will delve into the controversies surrounding their use and the potential directions that this field might take in the future.³

CLASSIFICATION

Fixed functional appliances represent a diverse range of orthodontic devices designed to address Class II malocclusions by influencing mandibular growth and position. These appliances are divided into two categories depending on their mode of action and type of anchorage; which include (1) Intramaxillary noncompliance appliances and (2) Intramaxillary noncompliance appliance^{4,5}

Rigid Intermaxillary Appliances (RIMA) include following;

• Herbst Appliance
• Biopedic Appliance
• Ritto Appliance®
• Mandibular Protraction Appliance (MPA)
• Mandibular Anterior Repositioning Appliance (MARA™)
• Functional Mandibular Advancer (FMA)

Flexible Intermaxillary Appliances (FIMA) are:

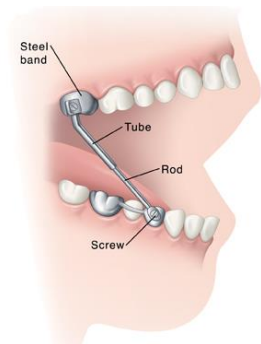
• Jasper Jumper™
• Scandee Tubular Jumper
• Flex Developer (FD)
• Amoric Torsion Coils
• Adjustable Bite Corrector (ABC)
• Bite Fixer
• Gentle Jumper
• Klapper SUPERspring II
• Churro Jumper
• Forsus Nitinol Flat Spring
• The Ribbon Jumper

Hybrid Appliances (Combination of RIMA and FIMA) are as follows:

• Eureka Spring™
• Sabbagh Universal Spring (SUS)
• Forsus™ Fatigue-Resistant Device
• Twin Force Bite Corrector (TFBC)

Appliances Acting as Substitutes for Elastics includes:

• Calibrated Force Module
• Alpern Class II Closers

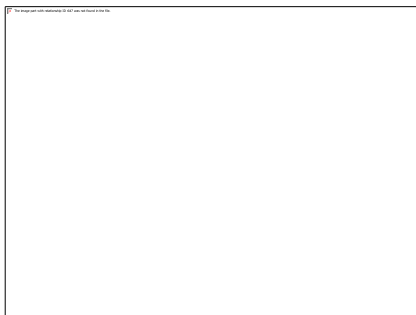


Herbst appliance was reintroduced in 1979 by Hans Panzerz. The Herbst appliance functions as a simulated joint between the maxilla and the mandible, with the primary goal of correcting Class II malocclusions. It employs a bilateral telescopic mechanism connected to orthodontic bands on specific teeth. This appliance maintains the mandible in a continuously protruded position, encouraging mandibular growth. The telescopic mechanism consists of tubes and plungers attached with pivots and locking screws. Careful attention to the length of these components is essential to prevent potential issues such as slipping or mucosal irritation. The Herbst appliance allows for substantial opening and limited lateral movements of the mandible due to the loose fit of the telescopic components. Modifications, like the Herbst telescope with balls, offer greater freedom of lateral movement. Several design variations of the Herbst appliance exist, such as banded, cast splint, stainless steel crowns, and acrylic resin splints, each tailored to specific clinical scenarios. Anchorage strategies vary from partial to total anchorage, impacting the stability of the anchorage teeth. The appliance exerts posterior force on the

maxilla and anterior force on the mandible. The resultant mandibular advancement stimulates condylar growth and remodeling, leading to enhanced mandibular length. The Herbst appliance generally starts with an edge-to-edge incisal position, followed by adjustments to achieve ideal occlusion. Treatment with the banded Herbst appliance typically lasts 6-8 months, though longer durations might yield better results. A retention phase is essential post-treatment to prevent relapse. The appliance's advantages include standardized treatment duration, reduced reliance on patient compliance, easy acceptance, and fixed 24-hour function. However, there are also limitations, including potential anchorage loss and soft tissue impingement. Modifications and variations of the Herbst appliance have been proposed to address specific clinical scenarios and enhance its efficacy. Indications for the Herbst appliance encompass Class II malocclusions, high-angle vertical growth patterns, deep anterior overbite, midline deviations, mouth breathing, and cases involving anterior disk displacement. The appliance offers advantages such as profile improvement, short treatment duration, and minimal patient compliance requirements.

Nonetheless, disadvantages include potential anchorage challenges and initial chewing discomfort. Numerous modifications of the Herbst appliance have been introduced to refine its design and address specific challenges in treatment. These modifications aim to enhance treatment outcomes, patient comfort, and appliance functionality.^{6,7}

BIOPEDIC APPLIANCE



The Biopedic Appliance is a type of bite jumping appliance utilized in orthodontics to encourage the advancement of the mandible relative to the maxilla. It involves engagement with both the maxillary and mandibular molars, employing a cantilever-style system. This appliance is then connected to a specialized BioPedic buccal tube. Activation is achieved by moving the appliance along the buccal tube and securing it in place using a screw. Notably, the appliance is designed to be universally sized, accommodating both the left and right sides of the mouth. The appliance's ends feature two pivots, enabling its rotation when the patient opens their mouth.⁷

THE RITTO APPLIANCE



The Ritto Appliance is characterized as a compact telescopic device designed for straightforward

intraoral application and activation. Unlike competing appliances, the Ritto Appliance is designed to remain intact even after reaching its maximum extension. This eliminates the need for disengagement, simplifying the treatment process. The smaller dimensions of the Ritto Appliance allow for easy adaptation without compromising aesthetics or speech. It is discreet in appearance. The appliance is available in a single format suitable for use on both sides of the mouth, offering flexibility and convenience. The Ritto Appliance is known for its user-friendly nature, comfort, affordability, and durability. It requires minimal patient cooperation. One of the significant advantages of the Ritto Appliance is its non-disengagement feature. This eliminates the need to measure length before fitting, which is common with competitor appliances. Consequently, the appliance can be fitted in approximately 5 minutes, with removal taking even less time. It's even possible to utilize the Ritto Appliance for treating Class II retromandibular issues in mixed or permanent dentition. This can be achieved using conventional bands on the upper molars and employing two tubes on the lower molars along with brackets on the lower incisors. The appliance's fixation components consist of a steel ball pin and a lock. The upper fixation involves placing a steel ball pin into the tube, positioned .045" from the upper molar band, and then bending it over the appliance.⁸

MANDIBULAR APPLIANCE (MPA)

PROTRACTION



The Mandibular Protraction Appliance (MPA), also known as the Herbst MPA, is a specialized orthodontic device designed to promote mandibular growth and correct Class II malocclusions. It serves as an effective non-surgical approach to addressing retruded mandibles and creating a harmonious dentofacial relationship. The MPA functions by applying continuous forces that encourage the advancement of the mandible, leading to skeletal and dental changes that correct the malocclusion. Unlike traditional Herbst appliances that work on both the maxilla and mandible, the Mandibular Protraction Appliance focuses exclusively on mandibular advancement. This makes it a suitable option for cases where the main concern is a retruded lower jaw relative to the upper jaw. The appliance is customized for each patient and is typically constructed using bands attached to specific teeth, usually the molars and premolars. The Mandibular Protraction Appliance consists of a telescopic mechanism, similar to the original Herbst appliance. The telescopic design allows for controlled and gradual mandibular advancement. By consistently stimulating the growth of the mandible, the appliance helps achieve improved facial aesthetics, a balanced profile, and functional occlusion. Clinical application of the Mandibular Protraction Appliance involves careful patient selection and treatment planning. It is particularly effective in growing individuals who exhibit Class II malocclusions due to mandibular deficiency. The appliance's design and activation protocol are tailored to each patient's needs, ensuring a personalized approach to treatment.^{10,11}



The Mandibular Anterior Repositioning Appliance (MARA™) is a distinctive orthodontic device designed to address Class II malocclusions by repositioning the mandible forward in relation to the maxilla. Developed to facilitate both skeletal and dental changes, the MARA™ appliance offers a comprehensive solution for patients with retruded mandibles and accompanying malocclusions. The MARA™ appliance consists of a combination of acrylic components that interact to achieve its repositioning effects. It typically includes an upper splint and lower mandibular arms. The appliance is designed to guide the condyles of the mandible within the glenoid fossa, encouraging mandibular advancement while simultaneously promoting appropriate dental alignment. The mechanism of action involves the patient wearing the MARA™ appliance, which allows for the anterior repositioning of the mandible over time. The interaction between the upper and lower components encourages favorable growth patterns and helps align the occlusion. By encouraging mandibular growth and improving the occlusal relationship, the MARA™ appliance aims to harmonize both the skeletal and dental components of the malocclusion. The clinical application of the MARA™ appliance requires precise treatment planning, including patient selection based on the type and severity of the malocclusion. It is commonly used in growing patients with Class II malocclusions, often during the pubertal growth spurt when mandibular growth potential is maximized. The appliance is custom-made for each patient, ensuring a tailored approach to treatment. Advantages of the MARA™ appliance include its potential to correct both skeletal and dental aspects of the malocclusion, leading to improved facial aesthetics, functional occlusion, and overall patient satisfaction. Additionally, the appliance's design encourages patient compliance, as it is fixed within the mouth.^{12,13}

**MANDIBULAR ANTERIOR
REPOSITIONING APPLIANCE (MARA™)**

**FUNCTIONAL MANDIBULAR ADVANCER
(FMA)**



The Functional Mandibular Advancer (FMA) is a specialized orthodontic appliance designed to address Class II malocclusions by promoting mandibular growth and repositioning. This appliance is part of the functional appliances category, which aims to influence jaw growth and alignment to achieve favorable occlusal and facial outcomes. The FMA operates by harnessing the forces generated by the patient's own musculature, guiding the lower jaw into a more forward position. By encouraging the mandible to grow and develop in a more favorable direction, the FMA helps correct the retrusion commonly associated with Class II malocclusions. The appliance typically consists of a framework that connects the upper and lower dental arches, allowing the mandible to be advanced. This design encourages natural jaw movement during functional activities such as swallowing and speaking. The FMA's unique mechanism utilizes the patient's functional movements to create gentle forces that influence the mandible's growth and positioning. Clinical application of the FMA involves careful patient selection based on factors such as age, growth potential, and severity of the malocclusion. It is often used in growing patients, particularly during periods of active growth, to harness their natural growth potential for optimal results. Proper appliance design and fit are crucial to ensure effective function and patient comfort. Advantages of the FMA include its reliance on natural functional activities, minimizing patient discomfort and enhancing compliance. It offers a non-invasive approach to correcting Class II malocclusions, avoiding the need for surgical intervention. Additionally, the appliance's design promotes favorable skeletal changes and occlusal

improvements.¹⁴

JASPER JUMPER



The Jasper Jumper is a specific type of functional orthodontic appliance that is designed to address Class II malocclusions by promoting mandibular growth and correcting the retruded position of the lower jaw relative to the upper jaw. This appliance falls under the category of functional appliances, which aim to guide the growth and development of the jaws to achieve better occlusal and facial harmony. The Jasper Jumper consists of a framework that connects the upper and lower dental arches. It is typically designed to encourage the lower jaw to move forward during functional activities such as swallowing and speaking. By applying controlled forces to the lower jaw during these activities, the Jasper Jumper stimulates mandibular growth and helps align the upper and lower teeth for a more balanced bite. Jasper Jumper include its non-invasive nature and its reliance on natural functional movements. It provides an alternative to surgical correction of Class II malocclusions and offers the potential for significant skeletal changes and occlusal improvements. Additionally, patient compliance

tends to be higher with functional appliances like the Jasper Jumper, as it requires the patient's own functional activities for its effectiveness. 15,16

SCANDEE TUBULAR JUMPER



The Scandee Tubular Jumper is a complete kit offering a coated intermaxillary torsion spring designed for orthodontic applications. This kit includes all necessary components: the torsion spring itself, the protective covering, connectors, ballpins, and adhesive. Remarkably, the kit doesn't differentiate between left and right sides, enhancing ease of use and assembly. An attractive feature of the Scandee Tubular Jumper is its versatility in appearance. The spring's covering comes in various colors, adding a visually appealing aspect that can resonate well with patients.15

GENTLE JUMPER



The Gentle Jumper typically consists of a framework

that connects the upper and lower dental arches. It operates by utilizing the patient's own functional movements, such as swallowing and speaking, to guide the lower jaw into a more forward position. By applying controlled forces during these natural activities, the Gentle Jumper stimulates mandibular growth and helps to align the upper and lower teeth. It offers an alternative to surgical correction for certain malocclusions and has the potential to achieve significant skeletal and occlusal improvements. Moreover, patient compliance is often higher with functional appliances like the Gentle Jumper, as its effectiveness relies on the patient's own functional movements.17

FLEX DEVELOPER (FD)



The Flex Developer (FD) is a powerful and durable orthodontic treatment device specifically designed for addressing Class II diagnoses. Its primary objective is to advance the mandible's position through muscle retraining and subsequent dental, jaw, and joint reconstruction. The FD is versatile, capable of creating space in the maxilla, closing gaps in the mandible, and even achieving distal movement of the maxilla if needed. This device encourages patients to hold the lower jaw forward, promoting mandibular growth akin to the Herbst device. Unlike conventional elastic bands that exert greater vertical force as the mouth opens wider, the FD generates horizontal force just before mouth closure. It slides passively and harmlessly when the mouth is open, making it particularly advantageous for patients with

minimal jaw growth. The FD is positioned on a bypass arc rather than directly on the main treatment arc. This design prevents undesirable tooth proclination and allows for its use in various cases, including Class II patients and those with an anterior open bite. The Flex Developer's spring rods can be shortened and thinned as needed, offering a broad range of force settings from 50-1000 cN. This flexibility eliminates the need for varied sizes and reduces acquisition costs.⁸

AMORIC TORSION COILS



Amoric Torsion Coils are specialized orthodontic components used to create torsional forces in orthodontic appliances. These coils play a crucial role in guiding tooth movement and correcting malocclusions.⁸

THE ADJUSTABLE BITE CORRECTOR



The Adjustable Bite Corrector is a customizable orthodontic appliance that orthodontists assemble using various components, including caps, closed

coil springs, and a nickel titanium wire. Its versatile design allows it to be used on either side of the mouth, achieved by a simple 180° rotation of the lower end cap, thereby reducing inventory needs by half. A nickel titanium wire within the central lumen of the spring generates the required "push" force.¹⁸

BITE FIXER



The Bite Fixer introduces a novel intermaxillary spring coil concept. The spring is securely affixed and crimped to the end fitting, offering enhanced durability and preventing breakage between the spring and the end fitting. Incorporating polyurethane tubing within the spring eliminates the risk of food entrapment. This innovative solution ensures hygiene and patient comfort.¹⁹

CHURRO JUMPER



The Churro Jumper offers a cost-effective alternative force mechanism for addressing Class II and Class III malocclusions by providing anteroposterior correction. The jumper comprises circular ends, with

one end attached to the maxillary molars using a pin, and the other end positioned over the mandibular archwire against the canine bracket. Notably, this functional appliance is unique in its flexibility and is crafted by orthodontists in their own labs. The streamlined process leads to reduced expenses and minimal time investment.¹⁹

THE KLAPPER SUPERSRING



The Klapper SUPERSpring II consists of a flexible spring element strategically positioned between the maxillary molar and mandibular canine. Its length allows it to rest in the vestibule upon activation, promoting hygiene while avoiding occlusal surfaces. Notably, the attachment points at each end vary. The spring's open helical loop is twisted in a J-hook fashion onto the mandibular archwire, while on the maxillary end, it connects to either a standard headgear tube (Super Spring I) or a specialized oval tube secured using a stainless steel ligature (Super Spring II). This updated version effectively prevents any lateral movement of the spring within the vestibule. With only two pre-made sizes available, each having left and right versions, adjustments can be made to the spring's length by simply bending the attachment wire. The horizontal configuration of the attachment wire at the maxillary molar tube enables effective distalization while maintaining excellent control over the root. In essence, the Klapper SUPERSpring II utilizes its adaptable spring element to establish a strategic connection between the maxillary molar and mandibular canine. This

configuration ensures hygienic and efficient orthodontic treatment by avoiding occlusal surfaces, maintaining secure attachment points, and enabling controlled adjustments for desired tooth movements.²⁰

THE FORSUS NITINOL FLAT SPRING



The Forsus Nitinol Flat Spring is engineered with a flat profile, which enhances its adaptability and comfort during wear. This spring is designed to address various malocclusions and bite-related issues by exerting controlled forces to encourage the desired tooth and jaw movements. Its utilization of Nitinol's shape memory properties enables the spring to exert consistent forces, providing orthodontists with a reliable tool for bite correction.²⁰

THE RIBBON JUMPER

The Ribbon Jumper is an innovative orthodontic device designed to facilitate effective jaw and tooth movement for correcting malocclusions and bite-related issues. This appliance is distinguished by its unique ribbon-like structure, which plays a crucial role in guiding tooth adjustments and optimizing bite alignment.²⁰

EUREKA SPRING™



Introduced in 1996 and developed by DeVicenzo and Steve Prins, the Eureka Spring™ is a telescopic orthodontic appliance that offers innovative functionality. This three-part system is affixed to the upper arch at the molar band level and to the lower arch distal to the cuspid. Its design incorporates an open coil spring enclosed within a component of the appliance. The placement process is relatively straightforward, ensuring patients can open their mouths without hindrance due to the telescopic mechanism. The Eureka Spring™ is available in two sizes, measuring 20 and 23 mm in length, and boasts a universal design applicable to both sides – right and left.²¹

a functional orthodontic appliance designed to address Class II malocclusion after the alignment and leveling of teeth has been achieved. Originally introduced by Sabbagh in 1997, it has recently been modified as SUS2. This iteration, SUS2, amalgamates the benefits of both the Herbst and Jasper Jumper appliances while aiming to mitigate their respective drawbacks. Unlike its predecessors, SUS2 is produced in a single universal size, with adjustments tailored to each patient's specific requirement for mandibular forward movement. Utilized in conjunction with fixed orthodontic treatment, this appliance effectively rectifies Class II malocclusion. Notably, timely and proper utilization of SUS2 has been reported to induce dental effects, such as the retraction of maxillary anterior teeth and the advancement of mandibular anterior teeth, contributing to bite correction.²²

TWIN FORCE BITE CORRECTOR (TFBC)



SABBAGH UNIVERSAL SPRING (SUS)



The Sabbagh Universal Spring 2 (SUS2) represents

Distinguished by its unique design and composition, this appliance features an innovative approach through the integration of two internal coil springs. Comprising dual joint telescopic systems, it demonstrates distinct placement characteristics at both the upper and lower levels. The upper aspect is affixed via a ball pin inserted into a molar band's buccal tube, while the lower placement employs a fitting-in arrangement secured by a lower arch screw. This appliance's rapid application and removal capabilities are facilitated by its specific attachment methods. With availability in two sizes and accompanied by a screwdriver for screw fixation, it is adaptable for use in Class II and Class III treatment, as well as serving as an anchorage system. Primarily designed for cases necessitating dentoalveolar movement, these appliances excel in scenarios where the correction required involves such movement. However, precautions must be taken to prevent lower incisor protrusion, which may involve employing stronger steel wires or alternate accessories. A notable limitation of this appliance lies in the challenge of force control. Adjusting the force requires bending the mesial aspect of the ball pin, potentially leading to discomfort and impingement issues. Furthermore, the appliance is best suited for cases where the lower dentition is already aligned, as recommended wire sizes ensure the required anchorage.²³

ALPERN CLASS II CLOSERS



Alpern Class II Closers, introduced as a recent addition to the field, display subtle distinctions from their predecessors. Primarily intended for Class II

correction and serving as a replacement for elastics, this appliance emerges as a notable innovation. Comprising a compact telescopic design, it incorporates an interior coil spring along with two hooks for attachment. Operating in a manner analogous to elastics, it is secured to the lower molar and upper cuspid. The appliance's availability in three distinct sizes caters to varying needs.²³

CONCLUSION

In conclusion, the world of orthodontics has witnessed a remarkable evolution in the realm of fixed functional appliances, each designed with the goal of achieving optimal treatment outcomes for various malocclusions and bite discrepancies. These appliances, ranging from the traditional Herbst appliance to the innovative Flex Developer and Alpern Class II Closers, reflect the commitment of orthodontic practitioners to refining treatment approaches and enhancing patient experiences. It is evident that these appliances are not only effective in correcting various malocclusions but also adaptable to the unique needs of individual patients. The emphasis on customization, ease of use, and patient comfort stands as a testament to the dedication of orthodontists to improving treatment modalities. As the field of orthodontics continues to advance, fixed functional appliances will likely continue to evolve, harnessing the power of technological innovation and clinical expertise to provide patients with more efficient, comfortable, and effective treatment options. The range of choices available to orthodontic professionals underscores the importance of tailoring treatments to each patient's specific needs, ensuring that they receive the best possible care on their journey to achieving a healthy and harmonious occlusion.

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