

ORTHODONTICS

✚ Myofunctional appliances

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❖ Definition

Myofunctional appliances use the facial muscles and masticatory muscles to produce changes in the relation of teeth or arches. This means that these appliances aim to utilize, eliminate or guide the forces arising from muscle function, tooth eruption and growth in order to alter skeletal and dental relationships.

❖ Types of functional appliances

When Myofunctional appliances were removable, Tom Graber classified them into:

- 1- **Group A-Teeth supported appliances**, e.g. catlans appliance, inclined planes, etc.
- 2- **Group B-Teeth/tissue supported appliances**, e.g. activator, bionator, etc.
- 3- **Group C-Vestibular positioned appliances with isolated support from tooth/tissue**, e.g. Frankel appliance, lip bumpers.

With the advent of fixed functional appliances, a new classification evolved:

- 1- Removable functional appliances, e.g. activator, bionator, Frankel, monoblock, twin block etc.
- 2- Fixed (non-compliance) functional appliances: These appliances have the advantage of requiring less patient compliance and enabling the clinician to undertake concurrent fixed appliance therapy. As the patient cannot remove them, these appliances offer the advantage of 24-hour wear; this does mean that they are subject to the forces of mastication, with an associated heightened risk of fatigue and breakage.

Fixed functional appliances can be grouped into two categories:

- a- **Rigid fixed functional appliances** (e.g. Herbst, mandibular anterior repositioning appliance; MARA), meaning those that posture the mandible into

one fixed position without any flexibility in the system, often but not exclusively used prior to comprehensive fixed appliance in a two-phase approach.

- b- **Flexible fixed functional appliances** (e.g. Eureka spring, Forsus FRD (fatigue resistant device), Jasper Jumper) encompassing those that have a component such as a spring allowing some flexibility in the system when posturing the mandible forward, usually used concomitantly with fixed appliances in one comprehensive phase of treatment.

Types of functional appliances

A simple easily understandable classification is to divide them into removable functional appliances or fixed functional appliances.

Removable functional appliances can further be classified into removable tooth-borne functional and removable tissue-borne functional appliances. The fixed functional appliances are tooth-borne.

- **Removable Tooth-Borne Appliances**

These appliances depend on the stretch of the soft tissues caused by the mandible being positioned downward and forward, as well as by the muscle activity generated by the mandible attempting to return to its original position. E.g., Activator, Bionator, and Twin block appliance.

- **Removable Tissue-Borne Functional Appliances**

These appliances are used to recontour the facial soft tissue adjacent to the teeth as well as posture the mandible downward and forward.

Example: Functional regulator/Frankel appliance.

- **Fixed Tooth-Borne Functional Appliances**

The fixed tooth-borne functional appliances are fitted on the teeth and cannot be removed by the patient at will.

Example: Herbst appliances.

- **Advantages**

- They are effective in vertical control of increased overbite.
- They can be used in mixed dentition.
- They require minimal chairside adjustment.

➤ **Disadvantages**

- The success of functional appliances therapy solely depends on patient cooperation.
- Precise tooth movement is not possible with functional appliances.
- Treatment duration of functional appliances is often prolonged.

❖ **Indications and designs of functional appliances**

There are various indications and designs of functional appliances. The most common indication is to correct Class II malocclusion by posturing the mandible forward in growing patients in an attempt to utilize the individual's growth potential.

Although the use of functional appliances is synonymous with the treatment of an increased overjet and a Class II malocclusion. This, however, does not mean that they have not been used in the treatment of Class III malocclusion. Indeed, for every functional appliance for Class II correction, there is usually a version for the treatment of Class III malocclusion.

It has been suggested that the treatment time should not be less than 12 months, followed by a retention period of the same length, before the commencement of the second - phase treatment with a fixed appliance.

❖ **Functional appliances and Class II malocclusion**

The effect of functional appliances therapy in the correction of Class II can be divided as follows:

▪ **On the skeletal pattern:**

- 1- Induce a temporary acceleration in mandibular growth rate.
- 2- Induce an artificial forward positioning of the condyles.
- 3- Remodelling of the glenoid fossa.
- 4- Restrain of the forward maxillary growth.
- 5- Increase lower anterior facial height.

- **On the dentition:**

- 1- Retroclination of maxillary incisors.
- 2- Distal tipping of the maxillary posteriors.
- 3- Proclination of mandibular incisors.
- 4- Mesial tipping of the lower dentition.

- **On the soft tissue:**

Soft tissue changes commensurate with functional appliance therapy typically reflect underlying skeletal and dento-alveolar changes. In particular, overjet reduction is likely to enhance lip competence, while increases in lower anterior facial height typically result in unfurling of the lower lip, with a decrease in the depth of the labio-mental fold.

- ❖ **Indication and case selection for functional appliance therapy to correct Class II malocclusion**

There are a number of accepted indications for successful functional appliance therapy as well as indications for a particular appliance or modification. These are:

- 1- **Age**

Functional appliance therapy is typically undertaken in a growing Class II patient, ideally during the period of maximal pre-pubertal growth. The importance of timing reflects the ability of a functional appliance to modify mandibular growth. This growth modification effect is enough to address significant class II dental relationship and has been shown to produce skeletal changes which appear to diminish by skeletal maturity.

Prediction of the peak timing of mandibular growth has proven complex, with limited correlation between chronological age and rate of growth, however, arbitrarily, chronological age of 10 to 13 years in females and 11 to 14 years in males are typically regarded as conducive to successful functional therapy.

To assess patients' maturity status and if the pubertal growth spurt has happened yet or is in progress, the followings have been advocated as tools to predict the maximal rate of mandibular growth:

- a- **Standing height measurements:** They involve recording the standing height at four monthly intervals from 9 years of age.
- b- **Hand-wrist radiographs.**
- c- **Cervical vertebrae maturation (CVM) status.**
- d- **Secondary sex characteristics.**

2- Growth pattern:

It can be divided into the following:

a- Vertical skeletal pattern:

Functional appliances are typically indicated in the presence of average to reduced lower anterior facial height.

b- Antero-posterior skeletal pattern:

The amount of change in the antero-posterior projection of the mandible has been shown to be positively correlated with the extent of the initial inter-maxillary skeletal discrepancy and SNB value in isolation. With lower SNB values likely to increase more significant during treatment than higher values. This finding may reflect the requirement for a greater degree of skeletal change in those with more significant skeletal discrepancy. The majority of studies have demonstrated forward movement of Pogonion of approximately 1-3mm during functional appliance therapy.

c- Transverse skeletal pattern:

Most functional appliances are capable of a degree of transverse correction. Fixed variants, such as Herbst appliance, may incorporated rapid palatal expansion. Removable variants typically rely on midline expansion screws or springs (e.g. coffin spring) to achieve transverse improvement through tipping movements.

3- Patient and family cooperation.

❖ Examples of functional appliances used for correction Class II Malocclusion

1- Removable functional appliances:

a- Activator:

This removable appliance was developed by Andresen in 1908 and subsequently popularized as the Andresen–Häupl appliance (Figure 1.1). The original Andresen activator was rigid, tooth-borne and loosely fitting. It was a bulky appliance, with acrylic blocks covering the palate and both arches. Also, it was constructed to hold the mandible in a protrusive position, or to cause the mandible to occlude in a protrusive position. It had been successfully used by many generations of orthodontists. The activator is generally used for the treatment of Class II division I malocclusion.

Dental Changes Produced by Activator

1. Incisor Changes

The activator helps in successful overjet and overbite reduction by retroclination of upper incisors and proclination of lower incisors.

2. Vertical Molar Changes

The design of the activator permits removal of occlusal acrylic above the lower molar and premolars. This facilitates upward and forward eruption of the lower molars and makes the activator a logical choice for low angle class II division 1, where there is a need for the molars to be free to erupt into the freeway space. Lower molar eruption of this kind is assumed to be a favorable factor in correcting the class II molar relationship and reducing the deep incisor overbite.

3. Changes In Lower Facial Height

The activator produces an increase in lower facial height by encouraging eruption of lower molars when acrylic is trimmed above the lower molars.

1. **Indications**

- _ Class I malocclusion with deep bite
- _ Class II malocclusion with open bite
- _ Class II division 1 malocclusion
- _ Class II division 2 malocclusion after aligning the incisors

_ Used for treating patients who snore during sleep.

2. Contraindications

- _ Crowded arch
- _ Increased lower facial height
- _ Extreme vertical mandibular growth
- _ Severe proclined lower incisors
- _ Retroclined upper incisors
- _ Crossbite tendency
- _ Gross intra-arch irregularities.

Advantages

- Treating mixed and deciduous dentition is possible.
- Appointments can be delayed for over 2 months.
- Tissues not injured.
- Worn at nighttime only.
- Helps to eliminate abnormal habits.
- Oral hygiene is maintained.

Disadvantages:

- Fully rely on patient cooperation.
- Little value in cases with crowding.
- Force on an individual tooth cannot be controlled.
- Little or no response in older patients.
- Bulky and uncomfortable.

Clinical Management

High-quality impressions that record the full extension of the lingual sulci are needed. Bite registration is needed to record the forward posture of the patient. For patients with overjet up to 8 mm, this can be done in one step, while keeping the vertical opening to a minimum of 2-3 mm. This can be performed in one of two ways, either by directly softening a horse-shoe-shaped wax and asking the patient to bite on it or to fabricate two bite plates (upper and lower) then a thin sheet of wax is used in between to record the relation. Either way, the excess wax is trimmed, and the wax is cooled, and checked on the study models and in the mouth whenever possible.

During bite registration, care should be exercised to maintain the patient's mid-line and to have equal advancement on both sides. The patient should be trained to

protrude the mandible and keep it in this position for a few minutes before the actual registration so that the required relation is reproduced without the need to repeat the process.

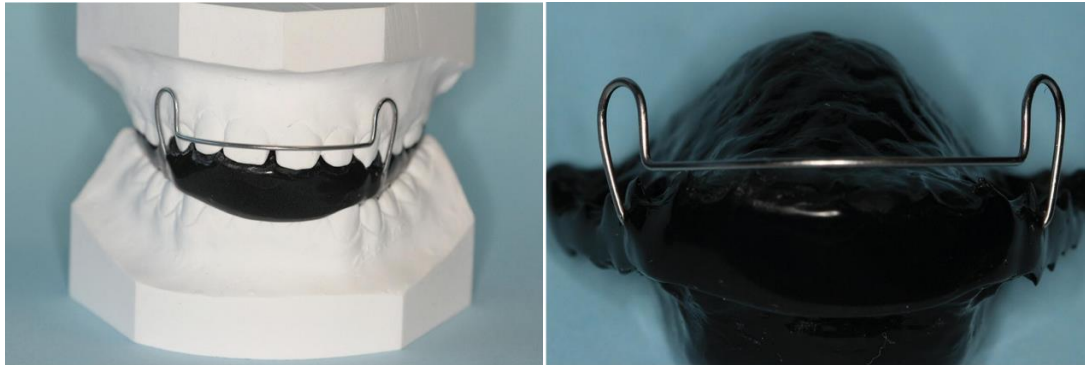


Figure 1.1: Activator

b- Bionator:

Wilhelm Balters has developed activators of reduced bulk, known as bionators (Figure 1.2). The upper and lower components of bionator were connected by a wire, facilitating incremental activation.



Figure 1.2: Bionator

c- Functional regulator 2 (FR2):

It was developed by Dr. Rolf Fränkel. He exhibited records of patients achieving major occlusal changes and improvement of facial appearance with the use of a group of appliances that are referred to as functional regulators (FR). The first version of this appliance, FR1, was used in Class II malocclusion with mal-aligned teeth; the FR2 was used in patients with a large overjet or deep overbite; the FR3 for the correction of Class III malocclusion; and the FR4 for the correction of anterior open bite. The FR2 (Figure 1.3) had vestibular shields to remove the influence of the buccal musculature on the dentition, allowing unopposed expansion due to the position and activity of the tongue. Moreover, by incorporating buccal shields, Fränkel believed that more room was given to the tongue to allow tongue exercises to be undertaken. **It can be difficult to wear, is expensive to make, and is troublesome to repair. As a result, it is now used less frequently.**



Figure 1.3: Frankel functional regulator 2

d- Mono-block appliance:

It was developed by Pierre Robin in 1902. This mono-block appliance (Figure 1.4) was a single vulcanite bite jumping appliance which was used to position the mandible forward in patients with Class II malocclusion due to mandibular deficiency.



Figure 1.4: Monoblock appliance

e- Twin block appliance:

It was first developed by William Clark in 1977. Originally, it was made of acrylic blocks cut at 45 degrees to the occlusal plane; this has since been modified to 70 degrees (Figure 1.5) to provide better engagement of the blocks and more positive forward positioning. Forces are not applied directly to the upper incisors. Retention of the upper appliance is achieved by Adams cribs on the maxillary first molars and additional cribs on maxillary first premolars if they are erupted. The lower appliance has Adam's cribs on the mandibular first premolars and first molars, typically made from 0.7mm stainless steel. Additional retention afforded by ball clasps on the lower incisors. In other words, The Twin-block appliance is composed of maxillary and mandibular retainers that fit tightly against the teeth, alveolus and adjacent supporting structures. The precise clasp configuration depends on the type of deciduous or permanent teeth and number of teeth present at the time of appliance construction.

The lower part of the twin block appliance consists of a horseshoe of acrylic that extends anteriorly from the mesial of the first permanent molars. The inclines on the upper and lower portions are relatively steep, forcing the patient to advance the mandible in order to close. The acrylic covers the lingual aspect of the premolar/

deciduous molars and the canines and incisors. There should not be any acrylic material touching the lower molars, this allows the lower molar to erupt vertically when the acrylic on the maxillary block is trimmed to increase the vertical dimension in patients with a deep bite and accentuated curve of Spee. If the patients have a tendency toward an anterior open bite, the blocks are left untouched. The twin block appliance has been shown to produce an increase in mandibular length, incisor proclination and variations in lower anterior facial height.

Twin-block appliance is most used in the treatment of class II malocclusions. Full time wearing of twin block appliance is advised including while eating and the duration of treatment usually is about (9–12) months.



Figure 1.5: Twin block appliance

f- ORAL SCREEN (VESTIBULAR SCREEN)

It is composed of acrylic base material, which fits in the buccal/labial vestibule of the mouth (Figure 1.6). The oral screen is mostly used for treating oral habits like thumb sucking, mouth breathing, tongue thrusting, and lip biting. The oral screen acts like a mechanical barrier between teeth and lips, tongue, thumb and thereby helps in

correcting the oral habits, such as mouth breathing, thumb sucking, lip biting and tongue thrusting.



Figure 1.6: Oral screen

g- LIP BUMPER

The lip bumper (Figure 1.7) is a fixed functional orthodontic appliance that works by altering the equilibrium between cheeks, lips and tongue and by transmitting forces from perioral muscles to the molars where it is applied. The lip bumper is used to treat the habits of lip suckling and lip biting, provide molar anchorage, and can be used for space gaining in the lower arch.



Figure 1.7: Lip bumper

3. Fixed functional appliances:

a- Rigid fixed functional appliances:

- **Herbst appliance:**

It is the first fixed functional appliance developed by Emil Herbst in 1909. It was later popularized by Pancherz (1979). It consists of a bilateral telescopic mechanism (There is a part attached to the upper buccal segment teeth and a part attached to the lower buccal segment teeth) (Figure 1.8) that maintain the mandible in a protruded position. The Herbst appliance can be banded, cast, and acrylic splint or cantilever bite jumper. It is as successful at reducing overjet. It is, however, slightly better tolerated than the bulkier removable appliance, with patients finding it easier to eat and talk with it in place. The principal disadvantages are the increased breakages and higher cost of the Herbst appliance.

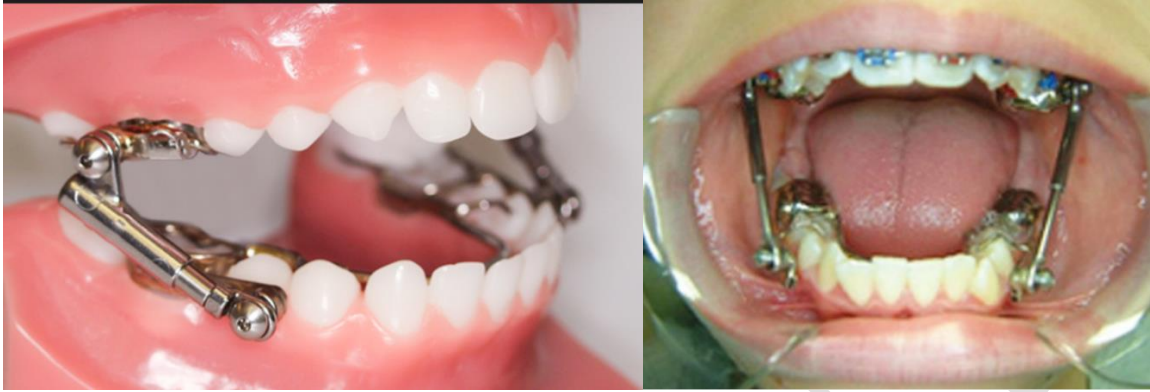


Figure 1.8: Herbst appliance

Note: The functional appliance does not produce an effect:

If there is no progress, this could be due to a number of factors:

- Poor compliance
- Lack of growth or an unfavorable growth rotation
- Problems with the design or fit of the appliance. Poor compliance is the most common potential problem with these appliances. Compliance tends to be better with younger patients and those wearing fixed functionals, such as the Herbst appliance.

b- Flexible fixed functional appliances:

1- Jasper Jumper:

It was developed in 1987 by J.J. Jasper and was popularized thereafter. It was the first flexible fixed functional appliance (Figure 1.9) to apply a distal and intrusive force to the maxillary molars along with a mesial and intrusive force on the lower incisors. It consists of vinyl-coated springs attached to the maxillary molar headgear tubes and attached either directly to the lower arch wire just distal to the canines, or to a sectional bypass wire from an auxiliary tub on the lower molar to just distal to the lower canine.



Figure 1.9: Jasper Jumper

2- Eureka spring:

It was developed by DeVincenz in 1997, similar in action to the other flexible fixed functional appliances. It is an open-wound coil spring encased in a triple-telescoping plunger assembly with flexible ball-and-socket attachments (Figure 1.10).

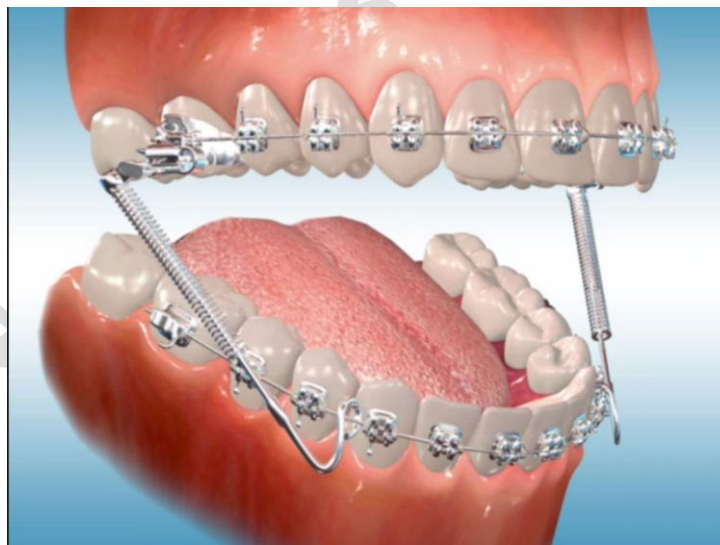


Figure (1.10): Eureka spring

3- Forsus:

The original Forsus was developed by Bill Vogt in 2001 and was attached to the maxillary molar tubes and lower arch wire, similar to the Jasper Jumper but consisting of a Nitinol flat spring or ribbon. The later design of the Forsus FRD (fatigue resistant device) consists of an inter-maxillary push spring attached to the maxillary molar headgear tube and a push rod attached distal to the lower canine or first premolar, in conjunction with fixed appliance (Figure1.11).



Figure 1.11: Forsus FRD (fatigue resistant device)

❖ **Functional appliances and Class III malocclusion**

The effects of functional appliances in Class III correction appear to be primarily dentoalveolar, namely:

- 1- Proclination of the upper incisors.
- 2- Retroclination of the lower incisors.
- 3- Downward and backward rotation of the mandible.
- 4- Increase in lower anterior face height.

❖ **Indication and case selection for functional appliance therapy to correct Class III malocclusion**

The ideal Class III case for correction with a functional appliance will have the following features:

- 1- Mild to moderate skeletal III relationship.
- 2- Average to reduced lower face height and Frankfurt–mandibular planes angle.
- 3- Anterior crossbite with displacement from centric relation to centric occlusion.
- 4- Average or increased overbite.
- 5- Upright or retroclined maxillary incisors.
- 6- Upright or proclined mandibular incisors.

Treatment is usually undertaken in the early mixed dentition following the establishment of a Class III incisor relationship secondary to the eruption of the permanent incisors. This theoretically takes advantage of the potential for greater growth of the maxilla than the mandible during the pre-pubertal period, while also eliminating any functional displacements before they become established.

❖ **Examples of functional appliances used for correction Class III malocclusion**

a- Frankel functional regulator 3 (FR3):

This is probably the most easily recognized and commonly used functional appliance for Class III correction. It is a soft tissue–borne appliance that consists of a wire framework to which are attached acrylic pads and shields designed to displace

the soft tissues and muscles that restrict maxillary development. The vestibular shields in the FR3 appliance (Figure 1.12), as with the FR2, are positioned buccally, extending from the depth of the sulci to displace the force of the buccinators and the perioral muscles away from the dentition. The labial pads are situated in the upper labial vestibule above the teeth and extended to remove the force of the upper lip from the maxilla.



Figure 1.12: Frankel functional regulator 3

b- Reverse Twin Block appliance

The Twin Block appliance (Figure 1.13) was originally described by William Clark and has proved a very popular functional appliance for Class II correction, particularly in the United Kingdom. This popularity relates to its simple design and underlying concept. It also tends to be robust and well tolerated and can be worn in function without precluding speech or eating. It also has a very potent and efficient Class II effect, resulting in significant dento-alveolar results. Clark also described a version of the appliance for Class III correction, the basic premise of which is reversing the blocks so that the lower block occludes distal to the upper block.



Figure 1.13: Reverse Twin Block appliance

❖ **Construction and clinical management for functional appliances**

1- Impressions:

Good quality alginate impressions for upper and lower dental arches/ soft tissue where the functional appliance will extend, are sufficient for fabrication of any functional appliance.

2- Bite registration;

The bite registration is taken with the mandible in the most protruded or retruded position achievable without causing discomfort to construct a functional appliance for correction Class II or Class III, respectively.

3- Fitting the appliance

4- **Follow -up appointments:** It should be every 6-8 weeks.

ملاحظات مهمة:

- 1- **المادة العلمية المكتوبة باللون البرتقالي تم اضافتها كما وردت في منهاج طب اسنان جامعة بغداد لغرض الامتحان التقويمي للعام الدراسي 2023**
- 2- **المادة العلمية المكتوبة باللون الاخضر خاصة بمنهاج كليتنا تم شرحها هذا العام كما في الاعوام السابقة ولم يتم شرحها ضمن منهاج طب اسنان جامعة بغداد.**
- 3- **المادة العلمية المكتوبة باللون الاسود خاصة بمنهاج كليتنا تم شرحها هذا العام كما في الاعوام السابقة.**