

ORTHODONTICS

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Lec. 7

Functional appliances

Introduction:

In general functional appliances have no active components such as springs or elastics, but instead harness forces generated by the masticatory and facial musculature (they are often called myofunctional appliances). The uniqueness of these appliances lies in the fact that instead of applying active forces, they transmit, eliminate and guide the natural forces (e.g. muscle activity, growth, tooth eruption) to eliminate the morphological aberrations and try to create conditions for the harmonious development of the stomatognathic system.

Most of the functional appliances are intraoral devices, and nearly all of them are tooth borne or supported by teeth. With a few exceptions, these appliances are removable, consisting primarily of acrylic with wire components for retention and support. Most of the functional appliances are used to correct early Class II malocclusions and some cases of Class III malocclusion. Class II correction is achieved by constructing the appliance such that it holds the mandible in a postured position away from its position of rest, and, whilst there are many designs of functional appliance, they all engage both dental arches and cause mandibular posturing with displacement of the condyles within the glenoid fossae.

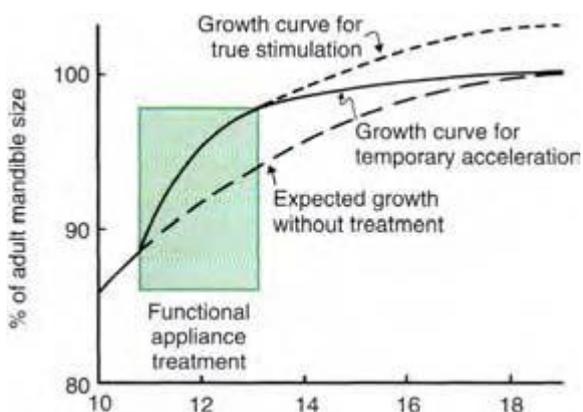
The purpose of functional appliances is to alter the anteroposterior occlusion between the two dental arches, and they cannot on their own treat irregularities of arch alignment such as crowding. A functional appliance can be used as the first part of a two-stage treatment, in which the overjet is reduced, followed by a second phase of treatment with fixed appliances to deal with crowding or other irregularities of dental alignment.

Mode of action:

The way that functional appliances work is not fully understood, but they are thought to achieve their effect by the posturing of the mandible

causing stretching of the facial musculature. This generates forces which are delivered primarily to the teeth, and there is no doubt that a posteriorly directed force acts upon the upper arch and an anteriorly directed force must therefore act upon the lower. The question is whether these forces could really stimulate mandibular growth or just to apply force toward the dentition (teeth)?

Growth stimulation can be defined in two ways: (1) as the attainment of a final size larger than would have occurred without treatment, or (2) as the occurrence of more growth during a given period than would have been expected without treatment. Figure 1 below is a hypothetical plot of the response to functional appliance treatment, illustrating the difference between (1) absolute stimulation (larger as an adult) and (2) temporal stimulation (acceleration of growth). As the figure suggests, an acceleration of growth often occurs when a functional appliance is used to treat mandibular deficiency, but the final size of the mandible is little if any larger than it would have been without the treatment. This is likely to be followed by a decrease in growth later, so that although the mandible grew faster than normal for a while, later growth was slower than would have been expected and the ultimate size of the mandible in treated and untreated patients is similar.



(Fig. 1) If growth occurs at a faster-than-expected rate while a functional appliance is being worn, and then continues at the expected rate thereafter so that the ultimate size of the jaw is larger, true stimulation has occurred. If faster growth occurs while the appliance is being worn, but slower growth thereafter ultimately brings the patient back to the line of expected growth, there has been an acceleration, not a true stimulation. The response to a functional appliance most often is similar to the solid line in this graph.

These appliances also can affect the maxilla and the teeth in both arches. When the mandible is held forward, the elastic stretch of soft tissues produces a reactive effect on the structures that hold it forward. If the appliance contacts the teeth, this reactive force produces an effect that move the lower teeth forward and the upper teeth back, and rotate the occlusal plane. In addition, even if contact with the teeth is minimized, soft tissue elasticity

can create a restraining force on forward growth of the maxilla, so that a "headgear effect" is observed, this change may not be permanent as there is evidence that 'catch-up' growth of the maxilla occurs after treatment. Any combination of these effects can be observed after functional appliance treatment.

The final effect is remodeling of the glenoid fossa more anteriorly which has been seen in animal experiments and there is some evidence that it may occur in humans. If this does happen, the temporomandibular joint and the mandible would become repositioned slightly further forward.

Indications for functional appliances:

All patients must meet the following general criteria for a functional appliance to be appropriate:

1. The patient must still be growing, preferably approaching a phase of rapid growth (the pubertal growth spurt).
2. The pattern and direction of facial growth should be reasonably favorable.
3. The patient must be well motivated. These appliances are bulky and must be worn for a substantial amount of time (at least 14-16 hours each day). This requires a considerable effort and commitment by the patient and the family, particularly in the early stages of treatment.

The timing of treatment:

Timing needs careful consideration. These appliances only work in patients who are growing, and their effect is greatest when growth is most rapid. The timing of dental development correlates poorly with that of skeletal growth and the pubertal growth spurt, and some children establish the permanent dentition at a relatively early age while others are still in the late mixed dentition at puberty. It is common practice to fit functional appliances in the mixed dentition stage, but some designs of functional appliance become difficult to manage when many primary teeth are mobile and exfoliating. The appliance should be worn until the end of the pubertal growth spurt, and if treatment is started early in a young child it is likely to be very lengthy. The patient's enthusiasm for treatment may well wane in these circumstances. However, in many cases the advantages of early treatment may be felt to

outweigh the disadvantages, such as where the overjet is very large and causing concern because of teasing or risk of trauma to the upper incisors.

In brief summary, the clearest indications for treatment of skeletal problems prior to adolescence are maxillary deficiency in any plane of space, and a progressive deformity (which almost always produces a worsening facial asymmetry). The clearest indication for delaying treatment until or even after adolescence is excessive mandibular growth, which is almost impossible to control and often continues into the late teens. Excessive maxillary growth and deficient mandibular growth, which combine to produce skeletal Class II problems, fall into a middle ground.

Treatment of skeletal class II division 1:

Functional appliances are most often used in Class II division 1 malocclusions. They are particularly appropriate where the arches are well aligned as they contain no mechanism for aligning irregular arches. Where a functional appliance is to be used, arch alignment is carried out either before or after the functional appliance phase of treatment.

The functional appliance may be fitted during the mixed dentition stage to achieve anteroposterior correction of the malocclusion, and the crowding treated later in a second phase of treatment after the first premolar teeth have erupted. This usually requires extractions and either removable or fixed appliances to align the arches. This sequence of treatment has the advantage of achieving early overjet reduction, but overall treatment time is often long. There is also a risk of some relapse of the overjet when the functional appliance has been stopped to make way for the appliances needed to align the arches. It may be necessary to reinsert a functional appliance as a retainer after the teeth have been aligned, but this must be done before the growth spurt is finished.

Where the premolars erupt before the pubertal growth spurt takes place, the sequence of treatment can be reversed. The crowding is relieved by extracting premolar teeth, and then the arches are aligned using fixed or removable appliances, or a combination of the two, but making no attempt to correct the incisor or molar relationships. The functional appliance is fitted when the arches have been aligned, and some designs can be made to fit over

a fixed appliance. It should be worn until the growth spurt is complete, and can serve as a retainer after the brackets have been removed.

The degree of **overbite** should be considered when selecting the design of functional appliance. Lower incisor capping acts as an anterior bite-plane to reduce an increased overbite, limiting lower incisor eruption and allowing molar eruption (**monoblock appliance**). Conversely, where the overbite is reduced, a design which incorporates molar capping, such as the **twin-block appliance**, will help to prevent an anterior open-bite from developing.

Treatment of skeletal class II division 2:

Treatment of a Class II division 2 malocclusion can be prolonged and difficult because correction of the incisor relationship requires reduction of the overbite and reduction of the inter-incisal angle to ensure stability of the result. This can be done with fixed appliances, but the treatment is extensive as it involves correcting the retroclination of the upper incisors by moving their apices palatally, thus reducing the inter-incisal angle.

An alternative approach is to correct the upper incisor angulation by moving their crowns labially, which is often straightforward using a removable appliance. The resulting increased overjet and the deep overbite can then be corrected using a functional appliance. This method is particularly appropriate where the lower arch is well aligned. The retroclined upper incisors are often crowded, but this resolves as they are tilted labially into a larger arc. The malocclusion has then been changed from Class II division 2 to a Class II division 1 with aligned arches, which is ideal for treatment with a functional appliance.

Treatment of skeletal class III (maxillary deficiency):

Both anteroposterior and vertical maxillary deficiency can contribute to Class III malocclusion. If the maxilla is small or positioned posteriorly, the effect is direct. If it does not grow vertically, the mandible rotates upward and forward, producing an appearance of mandibular prognathism that may be due more to the position of the mandible than its size (indirect effect).

For children with anteroposterior and vertical maxillary deficiency, the preferred treatment is to use a **reverse-pull headgear** (face mask) to move

the maxilla into a more anterior and inferior position, which also increases its size as bone is added at the posterior and superior sutures.

It is easier and more effective to move the maxilla forward at younger ages. Probably a variety of ages are acceptable after the permanent incisors have erupted, up to the age of 10.

Another possible treatment for correction of maxillary deficiency is a functional appliance made with the mandible positioned posteriorly and rotated open. One of the more popular designs is a variant of the Frankel appliance, the Frankel III (FR-III). This includes wires lying labial to the lower incisors and palatal to the upper incisor, together with the acrylic pads in the upper labial sulcus to stretch the upper lip forward.

In theory, the lip pads used in Frankel's FR-III appliance stretch the periosteum in a way that stimulates forward growth of the maxilla. The available data, however, indicate little true forward movement of the upper jaw. Instead, most of the improvement is from dental changes. The appliance, which allows the maxillary molars to erupt and move mesially while holding the lower molars in place vertically and anteroposteriorly, tips the maxillary anterior teeth facially and retracts the mandibular anterior teeth and this will rotate the chin down and back, the Class III relationship will improve, but again with no effect on the maxilla.

Treatment of skeletal class III (mandibular excess):

Children who have Class III malocclusion because of excessive growth of the mandible are extremely difficult to treat. The treatment of choice would appear to be a restraining device (e.g., chin cup/chin cap) to inhibit the growth of the mandible, at least preventing it from projecting forward as much as otherwise would have occurred.

In theory, extraoral force directed against the mandibular condyle would restrain growth at that location. What chin cup therapy does accomplish is a change in the direction of mandibular growth, rotating the chin down and back. In addition, lingual tipping of the lower incisors occurs as a result of the pressure of the appliance on the lower lip and dentition. This type of treatment is appropriate with normal or reduced lower anterior face height,

especially if the lower incisors are somewhat protrusive, but is contraindicated for a child who has excessive lower face height.

There is some evidence that a chin cup is more effective in young children under age 7 than the same treatment used later. The data seem to indicate a transitory treatment effect that is mitigated by subsequent growth. Unfortunately, despite efforts to modify excessive mandibular growth, many of these children ultimately need surgery, and the chin cup treatment is essentially transient camouflage. For that reason, it has limited application.

Another approach is the use of **Class III functional appliances**. They are designed to rotate the mandible down and back and to guide the eruption of the teeth so that the upper posterior teeth erupt down and forward while eruption of lower teeth is restrained. This rotates the occlusal plane in the direction that favors correction of a Class III molar relationship. These appliances also tip the mandibular incisors lingually and the maxillary incisors facially, introducing an element of dental camouflage for the skeletal discrepancy. The only difference from a functional appliance for a maxillary deficiency patient is the absence of lip pads.

Although the theory of the Class III functional appliance is quite different from that of the chin cup, the treatment effects are very similar, and the two approaches are approximately equally effective (or, in severe cases, equally ineffective).

The ideal patient for chin cup or functional appliance treatment of excessive mandibular growth has:

- A mild skeletal problem, with the ability to bring the incisors end-to-end or nearly so.
- Short vertical face height.
- Normally positioned or protrusive, but not retrusive, lower incisors.

Best wishes