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Extraoral Orthopedic Appliances – Headgear, Face Mask and Chin Cup –A Review Article

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Abstract
Dentofacial orthopedics aims to affect the unacceptable skeletal relations by modifying or redirecting the patient's growth potential. The force used in orthopedic appliances is intermittent with high magnitude. The need for use of these appliances is more important for correcting skeletal disbalance. The objective of dental orthopedics is the growth and development of craniofacial structures including dental irregularities malocclusions and associated dentofacial problems.Growth modification appliances still have a place in modern orthodontic practices. Orthopedic appliances mainly are used for achieving dentofacial harmony, and these appliances are using the neck or the cranium as anchorage. The aim is inhibition or redirection of the growth potential before and during the growth spurt. Growth modification is the most favorable option if possible.

Keywords: ***Dental orthopedics; Extraoral appliances; Headgear; Face mask; Chin cup***

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I. Introduction

The objective of dental orthopedics is the growth and development of craniofacial structures including dental irregularities malocclusions and associated dentofacial problems.Dentofacial orthopedics is part of the orthodontic specialty and includes diagnosis, prevention, interceptive orthodontics, and correction of the malocclusion, also the neuromuscular skeletal abnormalities of the orofacial structures during or with seized growth.(1)The need for use of these appliances is more important for correcting skeletal disbalance.

The difference between orthopedic and orthodontic therapeutic effects can be seen in the following :

- During the orthopedic treatment the aim is correcting skeletal discrepancies, while dental movement is undesirable. Contrary to this, the orthodontic treatment effect is dentoalveolar.

- During orthopedic treatment the applied force is more than 400g, while in orthodontic treatment the forces applied are in the range of 15g to 70g…and the effect is dental movement.(2)

The management of skeletal discrepancies can be divided into 3 categories. (2,3)

1. Growth modification,
2. Camouflage
3. Orthognathic surgery

Growth modification therapy aimsto affect the unacceptable skeletal relations by modifying or redirecting the patient's growth potential. The force used in orthopedic appliances is intermittent with high magnitude. Since the aim of these appliances is growth modification and bone remodeling, the effect is achieved by using the teeth during the process of transmitting the forces.(3)

Mainly the force magnitude is around 400 and 600 grams, and all that aims to maximizeskeletal and minimize dental effects. This kind of force can produce compression of the periodontal ligament on the site of force application, and the outcome is hyalinization that prevents tooth movement for a short amount of time but enoughfor expressing the skeletal effect. The treatment outcome depends on the age of the patient, the duration of the force application, and the amount of applied force. Force magnitude must be above 400 grams for absolute skeletal effect,and to avoiddental movements. An intermittent heavy force is less damaging to the teeth and periodontium than a continuous heavy force.(4)

Regarding the time duration of wearing the appliance, it must be around 12 to 14 hours daily, and also a very important moment is the force direction. [3,5]

Age is a key factor during treatment planning, and all that is due to the effectiveness of these appliances mainly in mixed dentition. This way we can use the effect of the growth spurt. This period for the females is around 9 years and for the boys 11-13 years of age. [6] The timing of force application is in correlation with the growth hormone release, which on the other hand is intense during night-time. This is very important for the appliances to be worn during night-time for effective treatment and optimal results. [7]Orthopedic appliances mainly are used for achieving dentofacial harmony. These appliances are using the neck or the cranium as anchorage. The aim is inhibition or redirection of the growth potential before and during the growth spurt. Growth modification is themost favorable option if possible.

Headgear

Headgear appliance was used since 1866 by Kingsley and Farrar in 1870 when it was described as head cup and was used for upper frontal teeth retraction. Angle in 1888 defined the extraoral part as a protractor for the maxillary front. [7]

Treatment with this appliance is indicated as a need for extraoralforce applicationwith posterior direction on the dentition and the skeletal structures and mainly is used in class 2 cases for maxillary arch distalization. This orthopedic appliance helps growth controlof the orofacial structures and is mainly used for seizing the maxillary forward and downward growth. This is important for modifying basal bone growth and harmonious and balanced appearance. This appliance's efficacy depends on a good knowledge of the mechanics. Of huge importance is how the force direction is controlled and produced by different types of headgear for the result to be achieved. Treatment shortcuts and optimal results are benefits of good treatment planning. [8] Headgear is a type of appliance that uses extraoral textile bands for cranial anchorage and transmits the forces througha face bow or hooks on the mobile orthodontic appliance or expander, and this contributes to the management of severe dental and skeletal problems. The mechanism of action of this appliance is mainly with bone remodeling in the sutures. [7,8] Class 2 correction is achieved by mandibular forward growth while maxillary growth is stopped.

Regarding the force direction, headgear can be classified as headgear with distal force direction and headgear with mesial force direction, while according to the anchorage localization, it can be cervical, parietal (also known as high pull headgear), and combined headgear.

In the**cervical-type** headgear (Fig.2) the anchorage is at the back of the neck. The action force produced is for achieving extrusion and distalization of the molars, and also distalization of the complete maxillary arch.

Indications for this type of headgear are:

- short face, class 2 division 1 case with low mandibular plane angle and hypo-divergent cases, deep bite cases,
- in cases where we need anchorage reinforcement for preventing mesialization of the molars,
- early class 2 treatment, for achieving complete distalization of the maxilla and class 1 molar correction.

Contraindications for cervical headgear application are:

- open bite cases
- large mandibular angle and hyperdivergent cases,
- increased lower facial high

High Pull headgear

The anchorage force is applied in the parietal region (Fig.1). This appliance produces a force that is mainlyinan upward direction, which is why it is used in cases where we should avoid an increase of the lower facial high or where decreasing of the lower facial high is required. The action is on the molar teeth where the low force of molar translation and high forces of intrusion are produced.

Combined headgear transmits the force from two regions, the parietal and cervicalregions. The applied force is with distal and upward direction on the dentition and maxillary complex.

(Figure.1) High pullheadgear with anchorage on the occipital or junction on the parietal and occipital bones, and the force produced is inan upward direction with a therapeutic effect mainly of intrusion.(Internet source)

(Figure .2) **Cervical headgear – low pull** withan anchorage at the back of the neck. (Internet source.)

Biomechanic aspects

The force this appliance generates is produced from the bands placed on the head or nuchal(cervical) part of the body and is transmitted to the teeth with face bow or J-hooks. Force transmission is performed by wires and orthodontic elastics. The point of force origin is the anchorage of the applianceand as already mentioned it can be the neck area or the occiput. For good treatment planning, localization of the center of resistance is important, which is a point where the resultant force passes through. This acts on the body by producing translatory movement of it. [(9)]

The high pull headgear produces translatory movement without tipping only if the force vector goes through the center of resistance. [(3)] This will enable upward and backward movement of the molars. It should be noted that the line of action is dependent on the extraoral arch length and position, which implies that a long extraoral arch upward inclined or short extraoral arch downward inclined may produce the same force. If the arch length and position produce force, and the force vector is directed above or below the center of resistance, the movement is going to be pure tipping. In case when high pull headgear is used in combination with the short intraoral element as part of a maxillary splint, the maxilla can be assumed as a whole and the line of force to pass through the center of resistance of the maxilla, and the outcome would be a rotation of the maxillary complex. [(3)]

When cervicalheadgear is used bodily movement is produced when the force vector goes through the center of resistance. The outcome is extrusion of the molar tooth and distalization. If the force vector does not pass throughthe center of resistance the outcome is distal tipping.

The therapeutic effect of headgear

It is used for maxillary sutures compression by stimulating the growth and remodeling of the sutures. Seizing the maxillary growth and growth modification is desirable. The aim is for the mandible to "catch up" with the maxilla and correct the anteroposterior skeletal discrepancy.[(4)] The effect of the extraoral force is not

limited to the maxilla only, some studies revealed that headgear stimulates mandibular growth in a forward direction during the treatment. [7] Correspondingly, SNA, and ANB angles were reduced. [10,11]

Facemask

An extraoral orthopedic appliance used for class III cases aims to limit mandibular growth and advance maxillary growth forward and downward. [8] Also known as reversed headgear, this appliance is used as early treatment for class III malocclusion with the hypoplastic maxilla. The force applied with this appliance is 900g.[13]Forces with this magnitude are placed in orthopedic forces. This appliance is best when used in primary or mixed dentition. [12]

Indications

- patients during growth with diagnosed mandibular prognathism combined with maxillary retrognathism,
- Class III malocclusion in primary or early mixed dentition,
- In patients with palatoschisis for palatal remodeling, [12]

Biomechanic aspects

The force magnitude applied during the use of these appliances is around 450g per site. [13] Required direction of the force is 30 degrees downward for producing pure forward translatory movement of the maxilla andto minimize the opening of the bite as the maxilla is repositioned.[4]Time duration would be dependenton the force magnitude, light forces of 250g per site would prolong the treatment and the same would take more than a year for obtaining the same effect, while forces around 1600-3000g would obtain a therapeutic effect for a period of 4-21 days. Recommended wearing time for this appliance is 12-14 hours a day. The action of this appliance is directed to the maxillary complex mainly the maxillary frontal part and premaxilla. The action to the mandible is by modification of the type of condylar cartilage growth and helps in achieving better occlusion and position of the mandible, balanced development of the jaws, and pleasant extraoral appearance. The dentoalveolar effect is visible by mezialization of the maxillary arch, distal positioning of the mandibular arch, and chin remodeling. [8,13] The effect of the appliance is visible on all anatomical structures, the maxilla, mandible, masticatory muscles, and the tongue. [11]

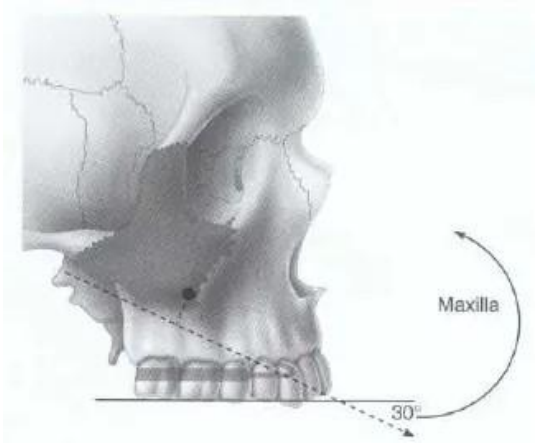

Figure.3 Maxillary protraction below the center of resistance produces anticlockwise rotation of the maxilla. Protraction elastics attached near the maxillary canine with a downward and forward pull of 30 degrees to the occlusal plane minimize bite opening. [4]

Parts of the face mask

This appliance is constructed of extraoral, intraoral, and elastics that connect both parts.

Variations of the appliance:

- Protraction headgear,
- Delaire Facemask,
- Tubingen facemask,
- Petit Facemask

Effects of the face mask therapy

Today some studies can prove the effectiveness of the treatment with the face mask. The study of Chong et al. [14] proved that early correction of class III with maxillary protraction demonstrated significant results. The main reason for negative overbite correction is the downward and forward movement of the maxilla. According to other authors[15],a face mask in combination with RPE (rapid palatal expansion) helps in the maxillary forward

movement. Other authors[16]claimed that rapid palatal expansion in combination with a face mask enabled insignificant orthopedic effect with mild dentoalveolar effect, and all that combined resulted inthe correction of class III malocclusion. The optimal time for face mask therapy based on some evidence is in the primary and early mixed dentition because in that period can be obtained a better skeletal and dental response. Better anchorage for maxillary protraction provides the erupted maxillary first molars. [4]

Chin Cup

A wide range of appliances is available for class III malocclusion treatment. Chin Cup takes a high place as a traditional appliance for the early interceptive treatment of class III malocclusion. It is among the oldest appliances for class III orthopedic treatment. A wide variety of these appliances are available on the market. [8]

In general, this appliance can be divided into 2 groups:

- Chin Cup with occipital pull is indicated for patients with mild to moderate mandibular prognathism. The highest rate of success is achieved in patients with primary to early mixed dentition and in patients that can position the teeth in edge-to-edge contact in centric relation. It is commonly used in patients with short lower thirds.
- Chin Cup with parietal pull is used in patients with high mandibular plane angleand increased lower facial high and open bite tendency.

The direction of the force and the magnitude used in this appliance is 300-500g per side. The instructions require 14 hours of wearing time. The force magnitude is 450g through the condyle or less below the condyle. Once it is accepted that rotation of the mandible is the main treatment effect, low force but able to produce better rotation is recommended. Force direction can pass through the condyle or below the condyle. Depending on this the result will be rotation downward and backward of the mandible. If the force direction is through the condyle, a restriction of the mandibular growth is obtained. An ideal patient for chin cup treatment is one with mild class III malocclusion that can bring the teeth into the edge-to-edge position, proclined lower incisors, and absent severe facial asymmetry. The most favorable age for chin cup treatment is prior to permanent canine and premolar teetheruption (CS2-CS3) and this presents the first intensive growth of the mandible, the second intensive growth is around the eruption of the third molars(CS4-CS6). [17]

Effects of the treatment with Chin Cup

Sakamoto [18] and Vendel[19] noticed seizing of the mandibular growth during the treatment. According to Graber [20], chin cup therapy possiblya significant change in craniofacial development that obtains noticeable correction of the malocclusion. The effect obtained with the chin cup is a direction change of the mandibular growth, chin rotation downward and backward which makes the chin less prominent[21], and remodeling of the mandible with the closure of the gonial angle.[4]

II. Conclusion

The need for orthopedic appliances is the result of the necessity of higher forces with an amplitude higher than that of the orthodontic appliances and the same ones will affect the cranial structures producing modification of the growth pattern. These treatment modalities should be performed always when applicable because they can exclude the future possibilities of extraction treatment or orthognathic surgical approach. This appliance might be used in combination with fixed appliances, or removable appliances, but always with maximum effectiveness if applied in the right age period, and very cautiously planned, which includes certain force magnitude, force direction, and patientosseal age.

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