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Treatment Protocol for Skeletal Class III Malocclusion in Growing Patients

Deepak M. Soni [1], Rajeev Sharma[2]

[1]*MDS Orthodontics, CHC Kuthera, Directorate Of Dental Health, Shimla, Health and Family Welfare Department, Himachal Pradesh, India*

E-mail: sonijamesdeepak@yahoo.com

[2]*MDS Orthodontics, PHC Sammerkot, Directorate Of Dental Health, Shimla, Health and Family Welfare Department, Himachal Pradesh, India* ,

E-mail: drraj105@gmail.com

Abstract

Maxillary retrusion in growing patients due to maxillary deficiency often leading to skeletal Class III malocclusion, is treated by various means which include either extraoral or intraoral appliances. Extraoral appliances embrace face mask, reverse chin cup, reverse headgear, and protraction headgear. Intraoral appliances are tongue appliance, fixed tongue appliance, tongue plate, Frankel III, miniplate in combination with Class III elastics, and miniscrew in combination with Class III elastics. Primary focus in this article will be concentrated on maxillary deficiency in growing patients (pseudo-Class III).

Keywords: **skeletal Class III malocclusion, maxillary deficiency, orthodontic treatment, growing patients.**

I. INTRODUCTION

Skeletal Class III malocclusion is characterized by mandibular protrusion/excess, maxillary deficiency/retrusion, or some combination of them. The existence of Class III malocclusion is different among different ethnic groups for instance 1% to 4% in Caucasians, a higher prevalence in Asians, 4–12% in Chinese and 9–19% in Koreans which is relatively higher than 0.6–1.2% reported for African Americans and 6% reported for the Swedish population[1]. Class III malocclusions from maxillary deficiency has been reported to be 65–67% [2].

Since growing patients have high frequency of maxillary deficiency, maxillary advancement by orthopedic force is considered to be a viable treatment option in them [3, 4]. Techniques commonly used include a face mask [5–7], reverse chin cup [8], and direct force application through implants placed in the zygomatic processes [9]. One technique also suggests the use of intentionally ankylosed teeth as abutments for extraoral traction in severe maxillary growth disurbance [10]. Recently use of Miniscrew implants and miniplates has gained vital importance in these cases for providing the essential orthodontic anchorage [11–14]. Other appliances include tongue plate and tongue appliance [15–17]. The mechanism of action of these appliances involves forward pressure from the tongue, transmitted through the appliance to the maxillary dentition and maxilla.

II. TREATMENT OF MAXILLARY DEFICIENCY IN GROWING PATIENTS

Generally applied orthodontic techniques for treating skeletal Class III malocclusiondue to maxillary deficiency in growing patients currently use either extraoral or intraoral appliances.

A. Extraoral Appliances

1) Face Mask: Face mask are commonly employed to correct the developing Class III malocclusion. These were first introduced for over a century before [19]. Delaire et al.'s [19] face mask stimulates little inferior and anterior movement of the maxilla assisted by midface orthopedic expansion. It provides a first hand continous anterior force to the maxilla and backward and downward rotation of the mandible [20]. The forehead and the chin support the face mask at the upper and lower ends respectively. Nanda introduced a modified protraction headgear that aimed to control the point and direction of force application [21] (Figure 1).Similar appliances are reverse headgear, front pull headgear, and protraction headgear among others with their mechanisms being almost the same.

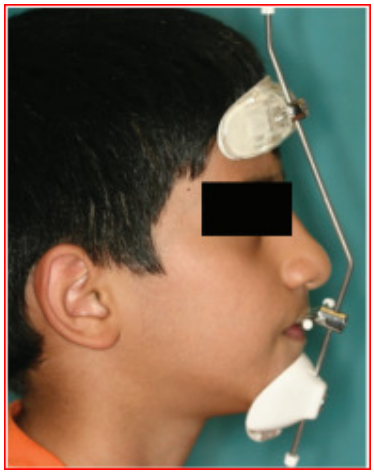

Figure 1. Face mask in situ; forehead and chin pads, main bar, crossbar, and elastics connecting the crossbar to the maxilla.

Limitations: Its bulky size and shape makes it a discouraging choice for children especially patients who wear glasses. This discomfort along with the embarrassment due to large size, for children at school, may reduce patient compliance. Nanda reported that in face mask therapy although the maxilla will translate forward and downward, backward rotations of mandible are unavoidable [21]. The downward and backward rotations of the mandible are not favorable in vertical growth pattern of the face whereas beneficial in horizontal growth pattern. Forward movement of the maxillary dentition and lingual movement of the mandibular incisors are additional effects of face mask [8].

2) Reverse Chin Cup: Showkatbakhsh et al. first introduced the chin cup as an extraoral appliance for skeletal class III malocclusion due to mandibular protrusion.[8, 22]. The reverse chin cup consists of a custom made porous acrylic chin cup with two vertical arms and an upper removable appliance. In the upper removable appliance there are two Adams clasps on the permanent first molars, two C clasps on the primary canines, and two C clasps on the permanent central incisors. The number of C clasps and Adams clasps can be increased for anchorage reinforcement. The end of each vertical arm is bent to form a hook. Orthodontic latex elastics (5/16, heavy elastics are suggested) connect the hooks of the palatal canine area of the upper removable appliance to the hooks of reverse chin cup and deliver approximately 500 g of force on each side. A high pull head cap is used to hold the reverse chin cup. The appliance is worn full time apart from eating, contact sports, and toothbrushing (Figure 2). Chin cup may be more favorable for patients than face mask due to its smaller size.

Figure 2. Reverse chin cup in a 6-year-old patient in the mixed dentition with Class III malocclusion and maxillary deficiency.

Limitations: Disadvantages are very similar to face mask and include lingual tipping of the lower incisors and labial tipping of the uppers. Backward and downward rotation of the mandible also occurs on the pattern matching face mask..

B. Intraoral Appliances

1) Removable Tongue Appliance *:* The tongue appliance is a habit breaker which is constructed via Adams clasps in the first upper molars and C clasps in the anterior teeth in order to increase retention. There are 3-5 tongue cribs in the palatal area from canine to canine, long enough to cage the tongue but adjusted to prevent trauma to the floor of the mouth. Bilateral posterior cross bite is corrected by a. screw mounted in the midpalatal area which is tightened once per week [15] (Figure 3). Sufficient pressure is transmitted to the deficient maxilla in two ways, namely: The pressure of the tongue during swallowing transfers an intermittent force through the tongue appliance to the deficient nasomaxillary complex, which is estimated to be about 5 pounds each swallow.

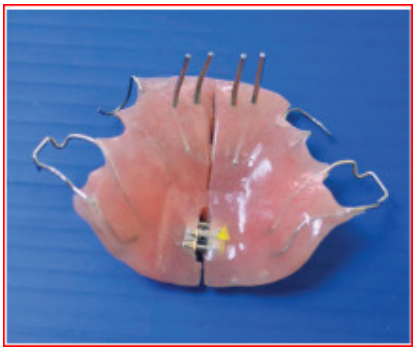

Figure 3. Tongue appliance.

Normal human swallow is about 500–1200 times in 24 h. Secondly there is considerable Pressure on the tongue appliance while the tongue is in the rest position. These forces are created by the physiological position and functional activity of tongue. These forces transmitted by the tongue through the palatal cribs to the nasomaxillary complex pushes the maxilla into a forward position. As the tongue is more forwardly positioned or the crib is more posteriorly placed, this continous force increases proportionately.

The removable tongue appliance, as expected, has no adverse effects on the mandible and doesn't cause its backward and downward rotation. It is also less conspicuous and less dependent on patient compliance.

Limitations: The removable tongue appliance will lingualize the lower incisors due to elimination of tongue pressure. In other words, after discontinuing the appliance, the IMPA and the overjet will be decreased [23]. Nonetheless patient cooperation is required and lack of compliance would compromise the results.

2) Fixed Tongue Appliance

Showkatbakhsh et al. with the objective of eliminating the biggest disadvantage of the need for patient compliance in the removable tongue appliances designed the "fixed tongue appliance" [24]. Fixed tongue appliances consist of a Hyrax® mounted on the first maxillary molars and premolars; a few curved cribs are soldered to the anterior side of the Hyrax® (Figure 4). The patient is instructed to activate the screw of the Hyrax® by making 1/4 of a turn at the beginning of each week. Fixed tongue appliance is a habit breaker used in conjunction with the Hyrax® for a different purpose other than its common application. The Hyrax® screw is for the purpose of loosening the maxillary sutures and extending the width of the maxillary arch and thus creating a better intermaxillary relationship. This expansion expediates the forward displacement of the maxilla. The mechanism of action of fixed appliance similar to the removable tongue appliance. The fixed tongue appliance is employed for treating skeletal problems and fixed orthodontics is needed for dental problems.

Advantages of fixed tongue appliance are the elimination of need for patient cooperation and lack of backward rotation of the mandible which is significant in extraoral appliances and results in increase in the vertical dimension of the face. Therefore it is preferred in long-face patients [25].

Limitations: The fixed tongue appliance like other similar

appliances, lingualizes the lower incisors due to elimination of pressure of the tongue on them. However, removal of the fixed tongue appliance restores the pressure of the tongue on the lower incisors and eventually results in the increase of the IMPA.

Figure 4. Fixed tongue appliance in situ.

3) *Tongue Plate*

The tongue plate is a tightly fitting upper removable appliance and has good retention because of the Adams clasps on the upper first permanent molars and C clasps on the upper primary canines [17]. There is a provision for Additional C clasps if more retention is needed. An acrylic plate with a big block is mounted posterior to the upper incisors, through which pressures from the tongue are transmitted to the dentition and upper jaw during swallowing and rest.. The patients are instructed to wear the appliance full time except while engaging in eating, contact sports, and toothbrushing activities (Figure 5).

Figure 5. Tongue plate in situ.

The rounded surface of the plate and its softened edges are effective in avoiding trauma to the tongue and the floor of the mouth. The tongue plate similar to other fixed and removable tongue appliances also lingualizes the lower incisors which is its major drawback.

4) Frankel III appliance

It is a removable functional appliance stimulates the growth of the upper jaw and displaces it forward. First designed by Professor Frankel, it is consists of a wire and four acrylic parts: two upper labial pads and two vestibular shields [26]. These vestibular shields fill up the space from the depth of the mandibular vestibule to the height of the maxillary vestibule. There function is to remove the restrictive forces which are created by the buccinator and associated facial muscles against the lateral surfaces of the alveoli and the buccal dentition. With the aid of this appliance, the maxillary molarsare allowed to erupt and move mesially while the lower molars are held in place vertically and anteroposteriorly; Maxillary anterior teeth are tipped facially and mandibular anterior teeth are pulled back lingually. Vertical ruption of the maxillary molars cuases the downward and backward rotation of the chin which improves facial appearance in horizontally growing patients.

Limitations: lengthy treatment time and need for excellent patient cooperation are its limitations which must be taken into account prior to initiating the treatment..

C. *Skeletal Anchorage*

Dental implants, miniplates, and modified fixation screws are the latest tools in the armamentarium of an orthodontist for bone anchorage in orthodontics. These temporary skeletal anchorage devices (TAD) being smaller than extraoral appliances, necessitate short healing periods [27]. De Clerck et al. treated a series of Class III cases with orthopedic traction on miniplates [12]. Various techniques have been evoluted for their use.

1) Miniplate in Combination with Class III Elastics

An 11-year-old boy with maxillary deficiency was treated by Showkatbakhsh et al. [13] using Class III elastics connected from two mandibular miniplates to an upper removable appliance. Minor surgery is required to place under local anesthesia in the canine areas of the mandible by a maxillofacial surgeon. A panoramic radiograph was taken to confirm the ideal position for miniplate insertion to avoid damage to the roots of the adjacent teeth and mental foramen. Two Adams clasps with a loop for engaging the elastics were constructed on the upper first permanent molars for fabricating a tightly fitting and well-retained upper removable appliance. A labial bow was also constructed with respect to the anterior teeth which aided in retention. The upper and lower jaws were disoccluded by a maxillary posterior bite plate. 3/16″ heavy orthodontic latex elastics were connected from the hooks of the miniplates to the Adams clasps of the removable appliance and approximately 500 g of anterior traction was produced. The appliance was meant to be worn full time except for eating, contact sports, and toothbrushing; and elastics were changed every day (Figure 6)., a positive overjet, Class I buccal segments and resolution of the anterior cross bite of the patient were achieved after 10 months of active treatment (Figures 7 and 8). Remarkable work is done by other clinicians in this field [28,29,30]

Limitations: The need for for Insertion and removal of the miniplates needs minor surgery which involves flap elevation, and has to be done by a maxillofacial surgeon under local anesthesia. Secondly maintaining oral hygiene around the appliance is also a difficult task.

Figure 6. Miniplate in place.

Figure 7. 11-year-old boy with pseudoprognathism (maxillary deficiency)

Figure 8. Posttreatment photos of the same patient treated by miniplates and Class III elastics.

2) *Miniscrews in Combination with Class III Elastics*

Unike miniplates, miniscrews can be easily placed by orthodontists themselves and also have the advantage of fewer adverse effects and lower operational costs than tooth implants. Jamilian et al.[11,14] used titanium alloy miniscrews along with Class III elastics for forward positioning of the maxilla. They employed self-drilling titanium alloy JeilTM miniscrews (Jeil Medical Corp., Seoul, Korea; 1.6 mm diameter, 8 mm length) were placed into the buccal alveolar bone between the mandibular canine and first premolar roots on both sides under local anesthesia. A panoramic radiograph was used to determine the ideal position for screw insertion. Adams clasps with loops to engage elastics on the upper first permanent molars and premolars and C clasps on the upper permanent canines and central incisors were placed to construct a tightly fitting and well-retained upper removable appliance. 5/16″ medium size orthodontic elastics were connected from the miniscrews to the Adams clasps of the removable appliance to produce about 450 g of force for anterior traction. The elastics were worn full time and changed daily. in order to achieve optimal traction, the elastics were connected only to the loops adjacent to the molars (Figure 9).

Figure 9. Miniscrews and Class III elastics.

An expansion screw was placed in the midpalatal area and the patient instructed to turn the screw once in a week with the aim of correcting the posterior cross bites. cross bites on the lateral incisors were improved upon by the use of two Z-springs inserted in the upper removable appliance (Figure 10).

A positive overjet and Class I buccal segments were achieved and the cross bites were corrected after 8 months of active treatment.

Limitation: The limitations of miniscrews include There is a high risk of failure of miniscrew when placed in unattached gingiva, screw loosening can occur. Tooth root injury is a potential complications when placed in keratinized mucosa. Another major limitation is restricted range and direction of tooth movement depending on the position of the miniscrews.

Various other authors have developed different combinations of miniscrews with other modalities like a hybrid expander[31], a sliding Jig [32], or an inverted Forsus appliance[33] or employing computer aided designing and manufacturing of minicrew implant systems[34].

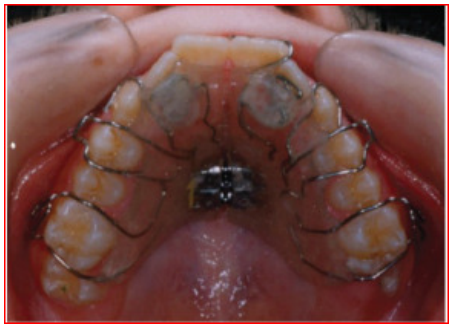

Figure 10. Expansion of the maxillary arch

III. CONCLUSION

Maxillary advancement by orthopedic forces is considered to be a viable treatment plan in growing patients with maxillary deficiency. A number of appliances both intraoral and extraoral and various techniques have been illustrated in the

literature, as well as direct force application through implants placed in the zygomatic processes and other sites have been demonstrated with the desired results to avoid the stigma of Class III malocclusion and prevent the need for orthognathic surgery in the adult stage.

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