

Treatment protocol for skeletal Class III malocclusion in growing patients

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1. Introduction:

Skeletal class III malocclusion is characterized by mandibular prognathism, maxillary deficiency or some combination of these two features. The prevalence of Class III malocclusion varies among different ethnic groups, depending on the method of studying and age group of the patients. The prevalence in Caucasians ranges between 1% and 4%. A high prevalence has been reported in Asian population. Various studies have reported that 4% to 12% of Chinese and 9% to 19% of Koreans suffer from Class III malocclusion which is relatively higher than 0.6% to 1.2% reported for African Americans and 6% reported for Swedish people.¹

Approximately half of all skeletal class III malocclusions are reported to result from maxillary deficiency. More precisely, the incidence of Class III malocclusions suffering from maxillary deficiency was reported to be 65% to 67%.² If the mandible of patients is markedly affected then the most common treatment would be orthodontics in combination with orthognathic surgery. In this chapter, the main focus of attention will be on maxillary deficiency in growing patients.

In view of the high frequency of maxillary deficiency, maxillary advancement by orthopedic forces, is considered to be a viable treatment option in growing patients.^{3,4} A number of techniques have been described, including the use of a facemask,⁵⁻⁷ reverse chin cup,⁸ direct force application through implants placed in the zygomatic processes.⁹ It was also suggested that intentionally ankylosed teeth may be used as abutments for extra-oral traction in patients with a severe disturbance in maxillary growth.¹⁰ Miniscrew implants and miniplates have also been used to provide the necessary orthodontic anchorage in these cases.¹¹⁻¹⁴ The tongue plate and tongue appliance have also been used for the correction of maxillary deficiency in growing patients.¹⁵⁻¹⁷ The mechanism of action associated with these appliances relies upon forward pressure from the tongue, which is transmitted via the appliance to the maxillary dentition and maxilla.

Treatment of maxillary deficiency in growing patients:

Growing patients with skeletal Class III malocclusion characterized by maxillary deficiency can be treated by either extra oral or intra oral appliances. extra oral appliances include facemask, reverse chin cup, reverse headgear, and protraction head gear and intra oral appliances include tongue appliance, fixed tongue appliance, tongue Plate, Frankel III, miniplate in combination with Class III elastics, miniscrew in combination with Class III elastics.

1. Extra-oral Appliances:

1.1 Facemask

Face mask therapy has become a common technique used to correct the developing Class III malocclusion. A search in literature will reveal copious researches about face masks and their effects on nasomaxillary complex. In addition, the experimental studies constantly demonstrate pronounced forward movement of the maxilla due to heavy and continuous protraction forces of face masks.¹⁸

Face masks were first described more than a century ago.¹⁹ Delaire et al's¹⁹ facemask promotes midface orthopedic expansion with slight inferior and anterior movement of the maxilla. The protraction face mask provides a direct constant anterior force to the maxilla with downward and backward rotation of the mandible.²⁰ Nanda introduced a modified protraction headgear that aimed to control the point and direction of force application.²¹ (Figure 01)

Similar appliances to facemask have been proposed by various clinicians which vary slightly from each other but their mechanisms are almost the same. Some of these appliances are reverse headgear, front pull headgear, protraction headgear and so on.

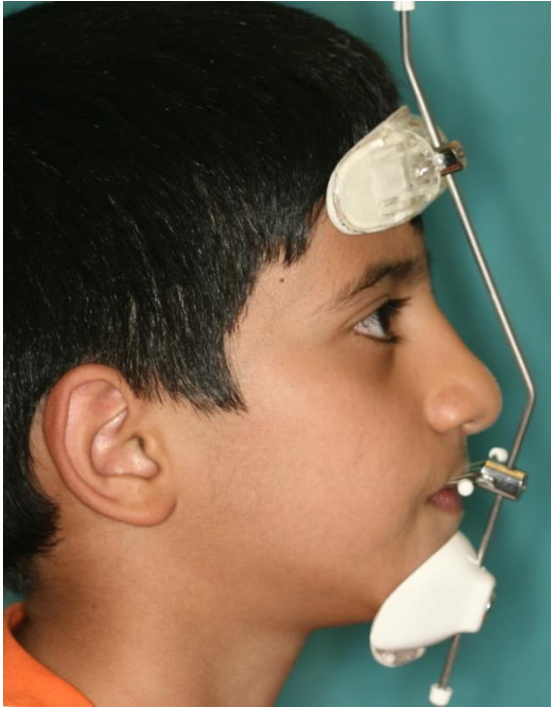


Figure 1: facemask in situ including: Forehead and chin pads, main bar, cross bar, and elastics connecting the cross bar to the maxilla.

Limitations:

However, one of the problems with face masks is their bulky size and shape, which make it a discouraging choice for children. Especially patients who wear glasses will be more susceptible to discomfort. This discomfort along with the embarrassment caused by the large size for children, especially at school in front of other peers, might reduce patient compliance. In facemask, the forehead and the chin are used as areas of support. Nanda reported that in facemask therapy although maxilla would translate forward; downward and backward rotations of mandible are unavoidable.²¹ The backward and downward rotation of the mandible is unfavorable in vertical growth pattern patients. On the contrary, this effect would be favorable in patients with horizontal growth pattern. Facemask would also cause forward movement of the maxillary dentition and lingual movement of the mandibular incisors.⁸

1.2 Reverse chin cup

Reverse chin cup is an extra oral appliance first introduced by Showkatbaksh et al.^{8,22} Reverse chin cup is composed of an upper removable appliance and a custom made porous acrylic chin cup with two vertical arms. The upper removable appliance consist two Adams clasps on the permanent first molars, two C clasps on the primary canines and two C clasps on the permanent central incisors. If necessary, the number of C clasps and Adams clasps can be increased for anchorage reinforcement. The end of each arm of the chin cup is bent to form a hook. Two orthodontic latex elastics (recommended: 5/16, heavy) connect the hooks of the palatal canine area of the upper removable appliance to the hooks of reverse chin cup in order to deliver approximately 500 g of force on each side. A high pull head cup is used to hold the reverse chin cup. The patients are instructed to wear the appliance full-time except for eating, contact sports and tooth brushing. (Figure 2)



Figure 2: A 6 year old patient in the mixed dentition with Class III malocclusion and maxillary deficiency. Concave profile was obvious in her. She had a reverse overjet, and underbite. She was treated by reverse chin cup. After 18 months of treatment her profile was improved and a positive overjet was achieved.

Reverse chin cup is very similar to facemask and is able to produce forward movement of the maxilla in growing patients; however, chin cup may be more favorable for patients due to its smaller size.

Limitations:

Similar to facemasks reverse chin cup is also associated with lingual tipping of the lower incisors and labial tipping of the uppers. Another drawback of reverse chin cup is causing backward and downward rotation of the mandible.

2. Intra-oral Appliances:

2.1 Removable tongue appliance

The tongue appliance is a habit breaker which is constructed by Adams clasps in the first upper molars and C clasps in the anterior teeth in order to increase retention. Three to five tongue separate cribs are placed in the palatal area between canine to canine. These cribs are long enough to cage the tongue and are adjusted to avoid traumatizing the floor of the mouth. A screw is mounted in midpalatal area to correct bilateral posterior cross bite. The patients are instructed to tighten the screw once per week.¹⁵ (Figure 3)

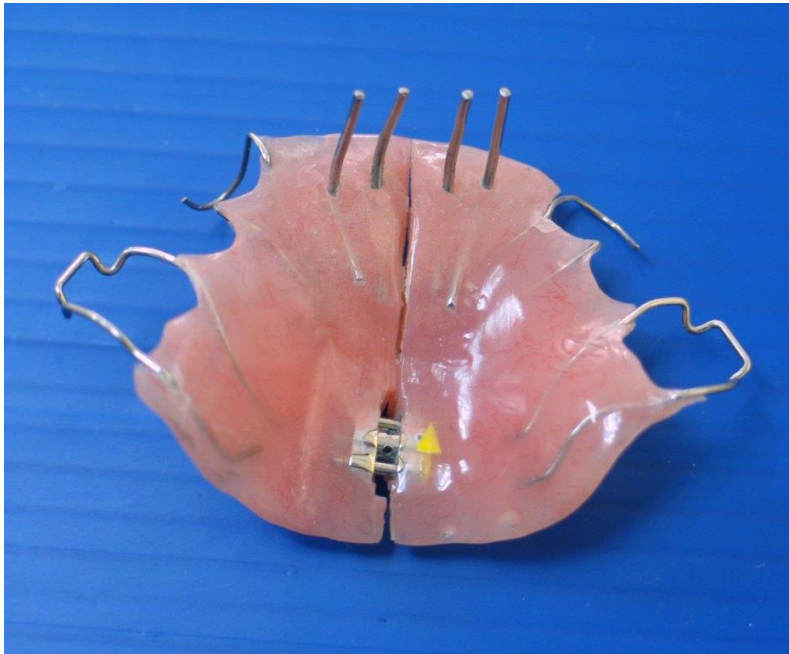


Figure 3: Tongue appliance

When the tongue appliance is in mouth, a considerable pressure is transmitted to the deficient maxilla. The mechanism of this force is provided by two following ways:

- 1- The pressure of the tongue during swallowing is estimated to be about 5 pounds in each swallowing. The frequency of swallowing is about 500 to 1200 times in 24 hours. This intermittent force is transferred through the tongue appliance to the deficient nasomaxillary complex.

2- Tongue transmits considerable pressure to the appliance while it is in the rest position. This continuous force of the tongue pushes the maxilla into a forward position.

Physiological position and functional activity of tongue generate these available forces. These forces are transmitted by tongue through the palatal cribs and finally to the nasomaxillary complex. The more anterior the tongue is, the greater the force will be. The more posterior the crib is, the greater the force will be. (Figure 4)

Unlike extra oral appliances such as facemasks and reverse chin cup, the removable tongue appliance has no adverse effects on the mandible and would not cause its backward and downward rotation. Another advantage of this appliance over the other extra oral appliances is that it's less conspicuous and needs less patient compliance.

Limitations:

Removable tongue appliance will lingualize the lower incisors due to elimination of tongue pressure on them. In other words, after discontinuing the appliance the IMPA will be increased and the over jet will be decreased.²³ Another disadvantage of removable tongue appliance is the need for patient cooperation and compliance lack of which would have negative effects on the final results.

2.2 Fixed tongue appliance

In order to remove the need for patient's compliance in removable tongue appliance, Showkatbakhsh et al designed a new appliance called "fixed tongue appliance".²⁴ Fixed tongue appliance consists of a hyrax® mounted on first maxillary molars and premolars a few curved cribs soldered to the anterior side of the hyrax®. (Figure 04) The patient are instructed to activate the screw of the hyrax® by making 1/4 turn at the beginning of each week. Fixed tongue appliance is a habit breaker used in conjunction with Hyrax for a different purpose other than its common application. 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 facilitates anterior displacement of the maxilla. When the fixed tongue appliance is in the mouth, a considerable pressure is transmitted to the deficient maxilla through the cribs of the appliance. The mechanism of this force is similar to removable tongue appliance. (Figures 05-06) Fixed tongue appliance is used for correction of skeletal problems and further treatment by fixed orthodontics would be required for dental problems. (Figure 07)



Figure 04: Fixed tongue appliance in situ.



Figure 05: A 12.1 year-old girl with maxillary deficiency in the late mixed dentition and class III molar and canine relationship. Skeletal problems of the patient were corrected by means of fixed tongue appliance.



Figure 06: Pre and post treatment lateral cephalograms of the same patient



Figure 07: The dentition of the same patient treated by fixed orthodontics

One of the advantages of fixed tongue appliance is that patient's cooperation is not needed. The vertical length of the cribs should be designed and adjusted in a way to avoid traumatizing the floor of the mouth. The main advantage of fixed tongue

appliance over facemask is that fixed tongue appliance does not cause backward rotation of the mandible; thus, it can be used in long face patients. While, the cup of facemask results in backward rotation of the mandible and can have unfavorable effects of long face patients.²⁵

Limitations:

Fixed tongue appliance has one disadvantage. It will lingualize the lower incisors due to elimination of tongue pressure on them. However, removal of the fixed tongue appliance will restore the pressure of the tongue on the lower incisors and will consequently result in increase of IMPA.

2.3 Tongue Plate

Tongue plate is a tightly fitting and well-retained upper removable appliance fabricated with Adams clasps on the upper first permanent molars and C clasps placed on the upper primary canines.¹⁷ Additional C clasps can be added if more retention is needed. An acrylic plate was mounted posterior to the upper incisors. The patients were instructed to wear the appliance full-time except for eating, contact sports and tooth brushing. (Figure 08)



Figure 08: Tongue plate in situ

Mechanism of action of the tongue plate is very similar to the fixed and removable tongue appliance. The force of tongue during swallowing and resting posture is transferred through the tongue plate to the deficient nasomaxillary complex. The considerable force of the tongue which is caged behind the acrylic plate moves the maxilla in a forward position. The rounded surface of the plate and its softened edges

make it undamaging for the tongue. In addition, it is designed and adjusted in a way to avoid traumatizing the floor of the mouth.

Limitations:

The disadvantages of tongue plate are similar to those of fixed and removable tongue appliances in that it also lingualizes the lower incisors.

2.4 Frankel III

Frankel III appliance is a removable appliance used to stimulate the growth of the upper jaw and move it forward. The appliance was first designed by Prof Frankel and is composed of wire and four acrylic parts: two vestibular shields and two upper labial pads.²⁶ The vestibular shields extend from the depth of the mandibular vestibule to the height of the maxillary vestibule. These shields act to remove the restrictive forces created by the buccinator and associated facial muscles against the lateral surfaces of the alveoli and the associated buccal dentition. The appliance 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. Vertical movement of maxillary molar will help in rotating the chin down, back, and improve facial appearance.

Limitations:

Frankel III requires a long treatment time and excellent patient cooperation.

3. Skeletal Anchorage:

Recently dental implants, miniplates, and modified fixation screws have become popular as bone anchorage in orthodontic treatment. These temporary skeletal anchorage devices (TAD) are smaller than extra oral appliances and require short healing periods.²⁷ Various techniques have been developed to use miniplates and miniscrews as temporary anchorage devices. DeClerck et al treated a series of Class III cases with orthopedic traction on miniplates.¹²

3.1 Miniplate in combination with Class III elastics

Showkatbakhsh et al¹³ used Class III elastics connected from two mandibular miniplates to an upper removable appliance to treat an 11 year-old boy with maxillary deficiency. Plates for Orthodontic Anchorage were placed under local anaesthesia in the canine areas of the mandible by a maxillofacial surgeon. The ideal position for miniplates insertion was evaluated by using a panoramic radiograph in order to avoid damage to the roots of the adjacent teeth and mental foramen. A tightly fitting and

well-retained upper removable appliance was fabricated with two Adams clasps on the upper first permanent molars. Each of the Adams clasps had a loop which was used for retaining the elastics. A labial bow was also used on the anterior teeth for retention. A maxillary posterior bite plate was used to disocclude the upper and lower jaws. Orthodontic latex elastics (3/16" heavy size) were connected from the hooks of the miniplates to the Adams clasps of the removable appliance to generate approximately 500 g of anterior retraction. The patient was instructed to wear the appliance full-time except for eating, contact sports, and tooth brushing; he was also told to change the elastics every day. (Figure 09) After 10 months of active treatment a positive overjet and Class I buccal segments were achieved and the anterior cross bite of the patient was corrected. (Figures 10 and 11)



Figure 09: Miniplate in situ



Figure 10: Pretreatment photos of an 11 year old boy with maxillary deficiency



Figure 11: Post treatment photos of the same patient treated by miniplates and class III elastics

Limitations:

The need for minor surgery for inserting and removing the miniplates is their biggest disadvantage. Moreover, since the surgery involves flap elevation it must be done by a maxillofacial surgeon under local anesthesia. Difficult oral hygiene around the appliance is another disadvantage of miniplates.

3.2 Miniscrew in combination with Class III elastics

Ease of placement, often by orthodontists themselves has made miniscrews very popular. When used as orthodontic anchorage they also have the advantage of fewer adverse effects and lower operational costs than tooth implants.

Recently, Jamilian et al used titanium alloy miniscrews along with Class III elastics for forward positioning of the maxilla of a patient with maxillary deficiency. In order to do so, self-drilling titanium alloy Jeil™ miniscrews (Jeil Medical Corp., Seoul, Korea; 1.6 mm diameter, 8 mm length) were placed under local anesthesia into the buccal alveolar bone between the mandibular canine and first premolar roots on both sides. The ideal position for screw insertion was evaluated by using a panoramic radiograph in order to avoid damage to the roots of the adjacent teeth and mental foramen. A tightly fitting and well retained upper removable appliance was fabricated with Adams clasps on the upper first permanent molars and premolars. C clasps were placed on the upper permanent canines and central incisors. Orthodontic latex elastics (5/16" medium size) were connected from the miniscrews to the Adams clasps of the removable appliance to generate about 450 g of anterior retraction. The patient was instructed to wear the elastics all the time, except for eating and to change the elastics every day. In order to retain these elastics, the Adams clasps on the molars and premolars were bent to form four loops; however in order to achieve optimal traction the elastics were only connected to the loops adjacent to the molars (Figure 12). An expansion screw was placed in the midpalatal area of the upper removable appliance and the patient was instructed to turn the screw once a week in order to correct the posterior cross-bites. Two Z-springs were inserted in the upper removable appliance to correct the cross-bite on the lateral incisors. (Figure 13) After 8 months of active treatment a positive overjet and Class I buccal segments were achieved and the cross-bites were corrected. (Figures 14 and 15)



Figure 12: Miniscrews and Class III elastics



Figure 13: Expansion of the maxillary arch



Figure 14: Pretreatment photographs of a 12-year-old boy with maxillary deficiency



Figure 15: Post treatment photographs of the same patient

Limitations:

The limitations of miniscrews include a high risk of failure when placed in unattached gingiva, screw loosening, root injury when placed in keratinized mucosa, and limited amount and direction of tooth movement depending on the position of the miniscrews.

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