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# Rationale For Early Treatment And Different Treatment Modalities Of Class I I I Malocclusion: A Review

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**Abstract**
Class III malocclusion is associated with a deviation in the sagittal relationship of the maxilla and the mandible, characterized by a deficiency and/or a backward position of the maxilla, or by prognathism and/or forward position of the mandible. 1 The incidence in Caucasians ranges between 1% and 4% depending on the method of classifying the malocclusion and the age group evaluated. 2,3 In the Asian populations, however, the incidence ranges from 9% to 19%, 4,5 and in Latin populations the incidence is approximately 5%. 6 The prevalence of Class III malocclusion in India was reported to be in the range of 0.5 % to 4%. 7

**Key Words**
Class III, gonial angle, maxillary protraction, sutures

## Introduction

Class III malocclusion is associated with a deviation in the sagittal relationship of the maxilla and the mandible, characterized by a deficiency and/or a backward position of the maxilla, or by prognathism and/or forward position of the mandible.[1] The incidence in Caucasians ranges between 1% and 4% depending on the method of classifying the malocclusion and the age group evaluated.[2],[3] In the Asian populations, however, the incidence ranges from 9% to 19%,[4],[5] and in Latin populations the incidence is approximately 5%.[6] The prevalence of Class III malocclusion in India was reported to be in the range of 0.5 % to 4%.[7]

The etiology of Class III malocclusion is multifactoral because of an interaction of both hereditary and environmental factors such as habits and mouth breathing may also play a role. Individuals with Class III malocclusion may have combinations of skeletal and dentoalveolar components. According to Guyer and coworkers, 57% of the patients with either a normal or prognathic mandible showed a deficiency in the maxilla.[10] The contributions of the cranial base, maxilla, mandible, and temporomandibular articulation have been described in detail in the literature.[8],[9],[10],[11],[12] Class III malocclusions associated with craniofacial disharmonies are much more difficult to treat and tend to relapse.[13]

Early treatment of Class III malocclusion has been advocated to reduce the need of treatment in the permanent dentition.[1] However, one of the reasons orthodontists are reluctant to render early orthopedic treatment in Class III patients is the inability to predict mandibular growth.[14] Also patients who have received early orthopedic treatment could still require surgical treatment at the end of the growth period. The ability to identify Class III patients with excessive mandibular growth at an early age could help orthodontists to plan for future orthodontic care. The use of a single cephalometric radiograph to predict mandibular growth has limitations. Discriminant analysis from long-term results of early treatment identified several cephalometric variables such as the position of the mandible, corpus length, gonial angle, and ramal height that have predictive values.[15],[16],[17] These predictive formulae are better in predicting successful outcomes than unsuccessful outcomes.

Different treatment modalities and outcomes are explained in this article regarding early orthopedic treatment in Class III malocclusion so as to reduce the need of treatment in the permanent dentition, when camouflage orthodontic treatment or surgery become the only options.

## Rationale for Early Timely Treatment of Class III Malocclusions

The objective of early orthodontic treatment is to create an environment in which a more favorable dentofacial development can occur.[18] The goals of early Class III treatment may include the following:

1. To prevent progressive irreversible soft tissue or bony changes. Class III malocclusion is often accompanied with an anterior crossbite. Uncorrected anterior crossbite may lead to abnormal wear of the lower incisors, dental compensation of mandibular incisors, leading to thinning of the labial alveolar plate and/or gingival recession.[19]
2. To improve skeletal discrepancies and provide a more favorable environment for future growth. Excessive mandibular growth is often accompanied by dental compensation of the mandibular incisors. Early orthopedic treatment using facemask or chin cup therapy improves the skeletal relationships, which in turn minimize excessive dental compensation such as overclosure of the mandible and retroclination of the mandibular incisors.
3. To improve occlusal function. Class III malocclusion with an anterior crossbite is often accompanied by a

functional shift. Early orthopedic treatment may help in eliminating centric occlusion/centric relation (CO/ CR) discrepancies and avoid adverse growth potential.

4. To simplify phase II comprehensive treatment. In mild and moderate Class III patients, early orthodontic or orthopedic treatment may eliminate the necessity for orthognathic surgery treatment. Even if surgery is eventually needed, early correction of the transverse dimension and maximizing the growth potential of the maxilla may minimize the extent of the surgical procedures.
5. To provide more pleasing facial esthetics, thus improving the psychosocial development of a child.[20] Studies have shown that treatment with facemask and/or chin cap improves lip posture and facial appearance.[21],[22]

**Different Treatment Modalities for Early Treatment of Skeletal Class III Malocclusions**

**Chin Cup Therapy**

Skeletal malocclusion with a relatively normal maxilla and a moderately protrusive mandible may be treated with the use of a chin cup. This treatment modality is popular among the Asian population because of its favorable effects on the sagittal and vertical dimensions. The objective of early treatment with the use of a chin cup is to provide growth inhibition or redirection and posterior positioning of the mandible. The orthopedic effects of a chin cup on the mandible include redirection of mandibular growth vertically, backward repositioning (rotation) of the mandible, and remodeling of the mandible with closure of the gonial angle. To date, there is no agreement in the literature as to whether chin cup therapy may or may not inhibit the growth of the mandible.[23],[24],[25],[26] However, chin cup therapy has been shown to produce a change in the mandible associated with a downward and backward rotation and a decrease in the angle of the mandible.[24],[25],[26],[27] In addition, there is less incremental increase in mandibular length together with posterior movement of the mandible. Because of the backward mandibular rotation of the mandible, control of vertical growth is difficult to manage, especially in long-face patients.

Chin cups are divided into two types: the occipital-pull chin cup that is used for patients with mandibular protrusion and the vertical-pull chin cup that is used in patients presenting with a steep mandibular plane angle and excessive anterior facial height. Most of the reported studies recommended an orthopedic force of 300 to 500 g per side.[28],[29],[30] Patients are instructed to wear the appliance 14 hours per day. The orthopedic force is usually directed either through the condyle or below the condyle. Evidence suggests that treatment of mandibular protrusion is more successful when it is started in the primary or early mixed dentition.[26],[29],[31] The treatment time varies from 1 year to as long as 4 years, depending on the severity of the malocclusion. The stability of chin cup treatment remains unclear. Several investigators reported a tendency to return to the original growth pattern after the chin cup is discontinued.[31],[34] Sugawara and coworkers published a report on the long-term effects of the chin cup on three groups of Japanese girls who started treatment at 7, 9, and 11 years of age.[33] The authors found that patients who started at an early age had a catch-up mandibular displacement in a forward and downward direction before growth was completed. However, several investigators believe that early correction of anterior crossbite reinforces the horizontal growth of the maxilla and prevents deterioration of horizontal jaw relationships.[30],[31]

**Protraction Facemask Therapy**

The protraction facemask has been used in the treatment of patients with Class III malocclusions and a maxillary deficiency. The facemask has an adjustable anterior wire that can accommodate a downward and forward pull on the maxilla with elastics. To minimize the tipping of the palatal plane, the protraction elastics are attached near the maxillary canines with a downward and forward pull of 30° from the occlusal plane.[34] Maxillary protraction usually requires 300 to 600 gm of force per side, depending on the age of the patient. Patients are instructed to wear the appliance for 12 hours per day. In the mixed dentition, a banded or bonded expansion appliance can be fabricated as anchorage for maxillary protraction. The expansion appliance is activated twice daily (0.25 mm per turn) by the patient or parent for 7 to 10 days. In patients with a more constricted maxilla, activation of the appliance is performed for 2 weeks or more. Several facial sutures play an important role in the development of the nasomaxillary complex (frontomaxillary, nasomaxillary, zygomaticotemporal, zygomaticomaxillary, pterygopalatine, intermaxillary, ethmomaxillary, and the lacrimomaxillary sutures). Animal studies have shown that the maxillary complex can be displaced anteriorly with significant changes in these facial sutures.[33],[35],[36] Maxillary protraction, however, does not always result in forward movement of the maxilla. With the same line of force, different midfacial bones were displaced in different directions depending on the moments of force generated at the sutures.[36] The center of resistance of the maxilla was found to be located at the distal contacts of the maxillary first molars one half the distances from the functional occlusal plane to the inferior border of the orbit.[37] Protraction of the maxilla below the center of resistance produces counterclockwise rotation of the maxilla, which may not be favorable for patients with an open bite tendency.[38]

Clinically, anterior crossbite can be corrected with 3 to 4 months of maxillary expansion and protraction depending on the severity of the malocclusion. Improvement in overbite and molar relationship can be expected with an additional 4 to 6 months of treatment. In a prospective clinical trial, overjet correction was found to be the result of forward maxillary movement (31%), backward movement of the mandible (21%), labial movement of the maxillary incisors (28%), and lingual movement of the mandibular incisors (20%).[39] Overcorrection of the overjet and molar relationship was highly recommended in anticipation of unfavorable mandibular growth. Overbite was improved by eruption of the posterior teeth. The total facial height was increased by inferior movement of the maxilla and downward and backward rotation of the mandible. The question arises as to when is the best time to start protraction facemask treatment. The main objective of early facemask treatment is to enhance forward displacement of the maxilla by sutural growth. It has been shown by Melsen in her histological findings that the midpalatal suture was broad and smooth during the “infantile” stage (8 to 10 years of age) and the suture became more

squamous and overlapping in the "juvenile" stage (10 to 13 years).[40],[41] Clinically, studies have shown that maxillary protraction was effective in the primary, mixed as well as early permanent dentitions. Several studies suggested that a greater degree of anterior maxillary displacement can be found when treatment was initiated in the primary or early mixed dentition.[42],[43] The optimal time to intervene a Class III malocclusion is at the time of the initial eruption of the maxillary incisors. A positive overjet and overbite at the end of the facemask treatment appears to maintain the anterior occlusion. Biologically, the circummaxillary sutures are smooth and broad before age 8 and become more heavily interdigitated around puberty.[40] Another question is whether early treatment can sustain subsequent mandibular growth during pubertal growth spurt. In a prospective clinical trial, protraction facemask treatment starting in the mixed dentition was found to be stable 2 years after the removal of the appliances.[34] This is probably due to the overcorrection and the use of a functional appliance as retainer for 1 year. When these patients were followed for another 2 years 15 of the 20 patients maintained a positive overjet.[39] In patients who relapsed back to a negative overjet, the mandible outgrew the maxilla in the horizontal direction. When these patients were followed for another 4 years (8 years after treatment until about 17.5 years of age), 14 of 20 patients (67%) maintained a positive overjet.[44] For the patients who relapsed back into a reverse overjet, the mandible outgrew the maxilla by four times, compared with twice that in the stable group. These results suggest that in a random clinical trial when patients are followed until after completion of pubertal growth, two of three patients or 67% will have a favorable outcome. About one third of the patients might be candidates for orthognathic surgery later in life because of an unfavorable growth pattern. In an implant study, Bjork and Skieller examined the normal and abnormal growth of the mandible found that condylar growth does not follow a circular or logarithmic spiral course.[45] It is characterized by individual variations both in the rate and growth direction. In addition, the rotation of the maxilla also varied from child to adulthood.

**Fränkel's Function Regulator Type III**

Among a great variety of appliances, Fränkel's function regulators (FR) have become a well-established adjunct for functional orthopedics. Their mode of action, however, is still a subject of controversy.[48],[49],[50] According to Fränkel, a Class III is the result of a maxillary growth deficit and concomitant excessive mandibular growth. Thus, the FR III aims to counteract the forces of the surrounding muscles which presumably restrict maxillary growth. Due to the appliance design, a reciprocal growth restricting force is believed to affect the mandible. It has been stated by Fränkel and McNamara that early treatment with FR III appliance offers some opportunities including normal displacement of teeth and facial bones and space gaining in dental arches.[51],[52],[53],[54] There are conflicting opinions regarding the treatment effects of the FR III appliance on maxillary growth. Some reports support the idea that FR III therapy produces a favourable growth effect on the maxilla and produced considerable improvements in maxillary size and position.[50],[52],[55],[56] Recently, Levin et al. showed that with the use of FR III appliance the SNA increased 1.3 degrees and effective midfacial length was 1.3 mm more than in the control group.[56] Also some studies failed to find significant improvements in the maxilla.[54],[57],[61] McNamara and Huge showed that FR-3 therapy directed mandibular growth in a vertical direction.[52] The vertical changes are in agreement with studies that found the FR III appliance to stimulate mandibular growth in a vertical direction.[54],[60],[61],[62],[63] Most of the studies on this subject evaluated the sagittal and vertical effects of the FR III appliance . According to those authors, correction of a Class III malocclusion is produced mainly by the downward and backward rotation of the mandible and/or alterations in upper and lower incisor inclinations.[54], [57], [59], [60], [61], [62], [63] Only a limited number of studies investigated the transversal dentoalveolar changes and demonstrated favourable maxillary dentoalveolar effects produced by FR III. The FR III appliance produced a significant dental and alveolar widening in maxilla, but it did not affect mandibular apical base.[54],[56],[57]

FR treatment never results in 'normalization' but only an approximation to normal parameters of the respective dental or skeletal structures. it is not an appliance to correct every Class III malocclusion. The Class III occlusion and overjet were improved by means of skeletal changes in conjunction with upper incisor proclination and lower incisor retroclination.[64] This is not a negative remark because the FR III will remain an indispensable treatment adjunct until replaced by a more effective one. The FR III will continue to be used until a more effective and comparably simple appliance for early treatment of patients with a developing Class III malocclusion.

**Class III Twin Blocks**

The Twin Block appliance is widely used for the treatment of Class II malocclusions. However, Clarke has also described a version of the twin block that may be used for Class III malocclusions. Clark states that reverse angulation of blocks harnesses occlusal forces to advance the maxilla and maxillary dentition while using the mandible as anchorage and restricting its development.[65] The appliance is effective at correcting reverse overjet during the mixed dentition as an alternative to the Frankel FR III appliance or an upper removable appliance alone. Changes are mainly dento-alveolar, due to proclination of the upper incisors and retroclination of the lower incisors.[65] Skeletal change is limited to slight downward and backward rotation of the mandible, with an associated increase in anterior, vertical dimension. Treatment during the deciduous or early mixed dentition has been shown to give more favourable skeletal changes during treatment with a functional appliance or rapid maxillary expansion and protraction headgear.[67],[68] The indications for treatment with the reverse Twin Block are those cases in the mixed dentition with a reverse overjet associated with a mild saggital skeletal discrepancy and an average or reduced anterior vertical dimension.

Class III Twin Block therapy is effective in the early treatment of a Class III malocclusion. However, long-term stability of the treatment effects will be influenced by favorable growth. The primary effects of the Class III Twin Block appliance are dental, as characterized by upper incisor proclination and lower incisor retroclination, with minimal skeletal effects. In contrast, significant maxillary

advancement and less pronounced dental changes occurred with Protraction Facemask therapy.[69]

**Tandem Traction Bow Appliance (TTBA)**

Orthopedic correction of the growing Class III patient is designed to improve the profile and occlusion by protracting the maxilla and repositioning the mandible. Although maxillary expander-facemask appliances and reverse headgears can achieve excellent orthopedic effects, they demand special patient compliance because they are worn extra - orally, and are not as esthetic or comfortable as intraoral appliances. Proffit believes the optimal age for maxillary protraction is about 6-7.[1] But because only a few permanent teeth have erupted at this young age, adequate anchorage for a maxillary protraction appliance can be problematic.

Chun and coworkers introduced the tandem traction bow appliance (TTBA) for the treatment of growing Class III patients. They defined the TTBA as a more aesthetic and comfortable device compared with conventional appliances because it is removable, easy to maintain oral hygiene, and worn intraorally. It allows early treatment of any Class III malocclusion, due to optimal retention in the deciduous, mixed, or early permanent dentition. TTBA distributes the force of protraction to all maxillary teeth and permits free mandibular movement, with its polished occlusal surface, so that a functional shift is easily corrected. It also maintains arch length, unlike extraoral maxillary protraction appliances that tend to produce anterior crowding. In two published case reports, it has been suggested that TTBA and modified applications have a similar treatment effect to that of an expander–facemask combination.[70],[71]

The TTBA comprises an upper splint, a lower splint, and a traction bow . Its design allows the patient to open the mouth freely .The upper splint, which can serve the same function as a rapid maxillary expander, covers the palatal and occlusal surfaces of the maxillary teeth . A portion of the buccal surfaces are also covered, providing adequate retention to overcome the maxillary protraction force of as much as 400-500g per side. During active treatment, the labial bow is embedded in the acrylic; it is uncovered and used to retain the incisors when the TTBA is reassembled as a monoblock retainer. The lower splint covers the buccal and lingual surfaces of the mandibular teeth to reinforce retention . The traction bow is a modification of a conventional headgear outer facebow . In the deciduous and mixed dentition, the applied force should be 300-500g for orthopedic effect; in the early permanent dentition, it should be 150-300g for orthodontic effect, avoiding undue stress on the TMJ. The patient is asked to wear the TTBA 12-14 hours per day for orthopedic effect, and more than 14 hours a day for orthodontic effect. After the crossbite is overcorrected, the two splints are fused into a monoblock and used as a retainer.[70]

In a study conducted to evaluate the dentofacial effects of a modified TTBA in skeletal Class III subjects and the effect of age on treatment response, satisfactory correction was obtained of the Skeletal and Dental Class III malocclusion. It was concluded that the indications for treatment with a modified TTBA include subjects with a skeletal Class III and an optimum SN/GoGn angle. As the extraoral view of the appliance is more aesthetic compared with a facemask, it could be a good alternative for non-compliant patients. In the study upper incisor protrusion and labioversion, lower incisors retrusion and tipping lingually, mesial movement of the upper molars and uprighting of the lower molar led to dental and skeletal changes due to which a positive overjet was obtained . As a result of the forward movement of the maxilla and the slight backward movement of the mandible, a significant increase was observed in ANB after TTBA treatment.[72]

Kim and other investigators in their study on Maxillary protraction effects of TTBA therapy in Korean Class III children found that the maxilla and maxillary dentition moved forward. The mandible moved backward, although not significantly, while the mandibular dentition moved forward. The net dental changes combined with the apical base change resulted in a favorable total molar relationship correction. The net dental movement was 26% and the apical base change 74% (MAX, 30%; MAND, 44%) of the total molar relationship correction, and the skeletal contribution to correction of this Class III malocclusion was higher than in other studies. These results suggest that TTBA has a maxillary protraction effect that is useful in the treatment of a growing skeletal Class III malocclusion with maxillary deficiency.[73]

**Conclusions**

Treating Class III malocclusion is one of the most complex problems arising in orthodontic practice because the growth patterns in such patients are unpredictable and unfavorable. The traditional orthopedic treatment for skeletal Class III malocclusion in children who have not yet reached the period of pubertal growth spurt involved correcting skeletal deficiencies. With the introduction of the new orthopedics based on bone-anchored systems has made it necessary to revise all of these previous concepts. In modern orthodontic practice, it appears possible to apply pure bone-borne orthopedic forces between the maxilla and the mandible for 24 hours per day, avoiding dentoalveolar compensations.[74]

This review compiles and analyzes the various possibilities of orthopedic treatment and conventional orthopedic appliances for Class III malocclusion in the scientific literature. The lack of long-term studies, however, means that further research, using well-designed studies and better clinical evidence, is necessary to assess the stability of orthopedic therapy in skeletal Class III malocclusions.

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