



## ORTHOPEDIC TREATMENT OF CLASS III MALOCCLUSION WITH MAXILLARY RETRUSION: *A REVIEW*

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### ABSTRACT

Class III malocclusion has been the subject of interest in many investigations, due to the treatment challenges. The standard care for correction of maxillary hypoplasia is to surgically advance the maxillary bone with a Le Fort I osteotomy after the adolescent growth completed. Orthodontic camouflage of class III malocclusion consists of extraction of teeth, proclination of maxillary incisors and retroclination of the mandibular incisors. However, orthopedic treatment of class III malocclusion can be done before puberty, although tooth – anchorage maxillary protraction using facemask is known as the regular orthopedic therapy there is other treatment modality that can be considered. The purpose of this paper is to update clinicians on the current orthopedic treatment options for class III malocclusion that is associated with maxillary retrusion.

**KEY WORDS:** Class III malocclusion, Maxillary hypoplasia, orthopaedic treatment, functional appliances, facemask, skeletal anchorage using miniplates, miniscrews.



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## INTRODUCTION

Class III malocclusion occurred when the lower molars is mesially positioned relative to the upper molar according to Angle classification<sup>1</sup>. On the other hand, British Orthodontic Society in 1992 introduced a classification for malocclusions based on the incisal relationship. Class III incisor relationship was defined as the lower incisor edges lies anterior to the cingulum plateau of the upper incisors in situations whereby the overjet is reduced. Skeletal class III malocclusion is one of the most challenging orthodontic problems to treat due to unfavorable nature of skeletal development<sup>2</sup>. The prevalence of class III malocclusion is 1.5% to 5.3% in white populations. However, in Asian populations, the prevalence of this malocclusion is as high as 14 %<sup>3</sup>. The standard treatment for correction of maxillary hypoplasia is to surgically advance the maxillary bone by a Le Fort I osteotomy, and the surgery is usually done after adolescent growth completed. Surgical intervention provides a rapid treatment option with limited need for patient cooperation<sup>4</sup>. However, this treatment approach has a number of disadvantages including the need to delay surgery until growth ceased making the patient suffers from bad appearance of this deformity until older age<sup>5</sup>. Orthodontic treatment of class III malocclusion consists of extraction of teeth, proclination of maxillary incisors and retroclination of the mandibular incisors, orthodontic treatment only camouflage the malocclusion and can result in deficient amount of supporting bone for the dentition so the overall result will be compromised<sup>6</sup>. Orthopedic treatment of class III malocclusion with maxillary retrusion can be done before puberty. Tooth – anchorage maxillary protraction

using facemask is the regular orthopedic therapy. In spite of high compliance required for its application, bulky appearance and the required long treatment time, the therapy itself has three main shortcomings that includes relatively strict age limit ,a great challenge in treatment of maxillary deficiency combined with long face type and its effectiveness is still doubtful<sup>7,8</sup>. There are some treatment protocols that can provide an effective treatment to class III malocclusion patients, but all of them have some limitations. For example, using rigid skeletal anchorage mostly by surgical miniplates to transfer the force directly to the circummaxillary suture, thus eliminate the undesirable dental effects and obtaining major skeletal effects<sup>2,9,10</sup>. Recently, a number of studies have proven that mini-screws provide rigid skeletal anchorage for orthodontic tooth movement. Mini-screws are easier to both insertion and removal and also, not expensive<sup>11</sup>. Distraction osteogenesis (DO) through the circummaxillary suture<sup>12</sup>, and alternating rapid maxillary expansion (RME) and constriction (RMC) that facilitated maxillary protraction<sup>13</sup> also can be consider as an alternative to conventional orthopedic treatment using face masks.

## MATERIALS AND METHODS

An electronic search was conducted, spanning the period from January 1995 to June 2015, to identify the available literature on the orthopedic treatment of class III malocclusion materials written in the English language. Additionally orthodontics textbooks as well as the reference lists were hand searched. (Table 1)

**Table 1**  
**Electronic database searched and combinations of key words**

Electronic database searched	<ul style="list-style-type: none"> <li>• NCBI databases PubMed</li> <li>• PubMed Central PubMed Health</li> <li>• Web of Science</li> <li>• SciSearch</li> <li>• Science Direct</li> <li>• Research gate</li> <li>• Google Scholar</li> </ul>
Key words for search	Class III malocclusion, Maxillary hypoplasia, orthopaedic treatment, functional appliances, facemask, skeletal anchorage using miniplates, miniscrews.

## DISCUSSION

### 1. Conventional orthopedic treatment

The concept of orthopedic treatment includes the application of protraction forces on the maxilla. The therapeutic regimes designed to influence facial morphology during growth period include functional intraoral appliances and extra oral traction to the maxillary dentition using facemasks.

#### 1.1. Functional intra-oral appliances

There are few alternatives in Class III treatment with intraoral appliances that can cause skeletal changes through neuromuscular modifications includes

#### 1.1.1. The Frankel III appliance

The Frankel III appliance has been developed by Frankel in 1970, it control the forces of the muscles on the maxilla by transmitting these force to the mandible. Through the lip pads that eliminate the restricting forces coming from the upper lip on the maxilla, and apply tension on the tissues and periosteum to stimulate the development of the retruded maxilla<sup>14</sup>. It encourage backward and down ward movement of the mandible with slight forward maxillary movement according to Baik et al.,(2004)<sup>15</sup> and Levin et al.,(2008)<sup>16</sup>.

#### 1.1.2. The double-plate appliance

The double-plate appliance (DPA) was designed by Planas in 1983 as intra-orally opposed angulated acrylic blocks. The aim of the blocks is to alter the vertical components of the masticatory forces to the

sagittal components. The system was supplied by Class III elastics that were accepted to be effective in Class III treatment. Generally, reduced mandibular protrusion and more favorable sagittal growth of the maxilla were reported with these appliances. But its skeletal effects in relation to extra-oral traction appliances using facemasks is limited<sup>18,20</sup>.

### 1.1.3. The Twin block appliance

The Twin block appliance developed by (Clark, 1995) consists of upper and lower removable inclined plate for treatment of class II malocclusion. The first clinical report for using the reverse twin block appliance is done by Kidner et al., in 2003<sup>19</sup> and he found that the reverse twin block appliance can decrease the SNB angle, increase the anterior vertical dimension and retroclination of mandibular incisor and proclination of maxillary incisor and this confined with the finding of Nashid Faren et al., (2015)<sup>35</sup>. According to Hong et al., (2005)<sup>14</sup> The treatment effect of reverse Twin-block is different from conventional Twin-block which includes:

- \* Reduced mandibular soft tissue protrusion.
- \* Correction of skeletal anterior cross bite.
- \* Increase in maxillary/mandibular plane angle.
- \* Reduced angle SNB
- \* Maxillary forward growth and mandibular retrusion.

### 1.1.4. Tandem appliance

Tandem appliance was introduced by Klempler in 2011<sup>20</sup> as an attempt to early treatment of class III open bite malocclusion without increasing the vertical dimension during treatment and so avoid one of the major limitations of using face masks for treatments of class III malocclusion that accompany with hyper divergent mandibular growth pattern. Tandem appliance have an upper fixed maxillary expander with soldered buccal arms for elastics attachments and

lower removable component with bite blocks to control the vertical dimension and facebow tubes in the first molar region. Dr. Klempler reported that tandem appliance can treat class III open bite in children without an unfavourable increase in the lower vertical dimension and with less compliance in wearing the tandem appliance than that is required with face mask treatment.

### 1.2. Extra-oral traction using Facemask

Delaire's demonstration in 1970 stated that a facemask attached to maxillary splint could move the maxilla forward by inducing growth at the maxillary suture. That's why the face mask therapy is considered the most effective orthopedic treatment to class III malocclusion that is associated with retrusive maxilla<sup>21,8,122,23,224</sup>, however beside its big size and unfavorable appearance it have several short coming. Firstly, it has relatively strict age limit and its optimal age is younger than 10 years old preferable at the early mixed dentition or even in primary dentition period as the maxillary suture became more interdigitated and more difficult for separation during protraction procedure<sup>21</sup>, in addition to that face mask wear is usually limited to 14 hours per day at best<sup>22</sup>. Secondly, maxillary deficiency combined with long face type is a great challenge for it due to downward decent of the posterior part of the maxilla during protraction leading to clockwise rotation of the mandible and an increase in the lower vertical dimension of the face<sup>23</sup>. Thirdly so far, its effectiveness is still doubtful since the orthopedic effect is only about 2-3 mm on average and the success rate is only about 70%<sup>8</sup>. The shortcomings of tooth - anchorage may be relevant to its combinative effects, including skeletal and undesirable dentoalveolar changes such as extrusion and mesialization of the maxillary molars and proclination of the maxillary incisors<sup>24</sup>.

**Table 2**  
**Summary of conventional orthopedic treatment methods Included in the Review**

Author/s	Year	Method	Author's conclusion
Baik et al., Levin et al.,	2004 2008	Frankel III	encourage backward and down ward movement of the mandible with slight forward maxillary movement
Tuba et al., Tollaro et al.,	2004 1995	Double plate appliance	reduced mandibular protrusion and more favorable sagittal growth of the maxilla
Kidner et al., Osama Nashid et al.,	2003 2013 2015	Reverse twin block	decrease the SNB angle ,increase the anterior vertical dimension and retroclination of mandibular incisor and proclination of maxillary incisor.
Klempler	2011	Tandem appliance	can treat class III open bite in children without unfavourable increase in the lower vertical dimension
Kim et al., Hugo et al., Mandall et al., Vaughn et al., Kilicoglu, Kirlic	1999 2010 2010 2005 1998	Face mask	the most effective orthopedic treatment to class III malocclusion that is associated with retrusive maxilla

## 2. Non conventional orthopedic treatment

### 2.1. Skeletally rigid anchorage devices

#### 2.1.1. Miniplates (MP)

Skeletally anchorage devices (miniplates and dental implants) were developed in an attempt to overcome the shortcoming of tooth anchorage devices such as face masks that routinely used for maxillary protraction

aiming at reducing the dental compensation and maximizing skeletal effects. Several studies have examined the efficiency of miniplates and it was found that miniplates can provide a rigid skeletal anchorage together with a clinically significant maxillary protraction more than conventional face masks therapy. Lucia et al. (2010)<sup>27</sup>, conducted a study on 21 class III maxillary

retrusive cases treated by miniplates fixed in the infrazygomatic area in both sides in the upper arch and other miniplates fixed to the symphyseal area at both right and left sides, using class III elastics for applying a protraction force of 250gm /each side bilaterally for a period of about 1 year, and compared it with another group of 43 of class III retrusive maxilla treated using conventional face masks, and they found that the maxilla was moved forward in the miniplate group significantly more than face masks group by 2-3mm. Another study by Cagla et al., (2011)<sup>9</sup> examined this treatment approach on 45 subjects having class III maxillary retrusion, divided to 3 groups (15 patients treated using miniplates, 15 treated using face masks and 15 serve as control) and all the patients were in the prepubertal or in pubertal stage of skeletal maturity. It was observed that treatment of class III maxillary retrusion using miniplates fixed to the lateral wall of the maxilla bilaterally not only reduced the dental side effect but also maximized the skeletal response and reduced the treatment time. Hugo et al., (2010)<sup>22</sup> analyzed the treatment effects of bone anchorage maxillary protraction with miniplates fixed to infrazygomatic crest bilaterally in the upper arch and in the mandibular symphysis bilaterally in the lower arch connected with class III elastics. The treated samples were 21 patients (all in prepubertal stage, the mean age was 11.10 +/- 1.8 years). The authors compared those study samples with an untreated control group, and found that the maxilla was moved 4mm anteriorly more than the untreated control group and a favorable mandibular change was exceeded by 2mm. Bong and Peter in (2011)<sup>2</sup> compared between two groups of patients, one group treated with conventional face mask and the other one with skeletonized face mask, (each group have 25 class III patients with maxillary retrusion on the prepubertal stage of skeletal maturity), and they concluded that the group treated with skeletonized face mask has less dental mesial tipping of incisor teeth and less molar extrusion with more skeletal effects than the group treated using conventional facemask.

### 2.1.2. Miniscrews

Although miniplates had proved that it can provide a rigid skeletal anchorage, one of the main disadvantages is it's an invasive procedure because it requires two surgical interventions (one for application and one for removal). That's why the orthodontist could think for another alternative to obtain a rigid skeletal anchorage without the need for this invasive surgical procedure and this finally lead to the introduction of mini-screws as a valid substitute to miniplates for rigid skeletal anchorage. Miniscrews have provided an efficient skeletal anchorage for tooth movement and they are now commonly accepted as a simple and effective tool for daily orthodontic practice, the effectiveness of miniscrews as a rigid skeletal anchorage for applying a heavy orthopedic forces have been proven biomechanically. Except for few reported cases, the literature lacks a well-designed clinical investigation on this treatment approach<sup>28</sup>. On report by Bjorn et al., (2010)<sup>29</sup> have introduced a skeletally anchored facemask as treatment protocol for a 14 year old male having class III malocclusion. The device was

composed of two mini-screws placed in the anterior palate bilaterally joined by mid palatal expansion screw that joined to bands on the first permanent molar with buccal hooks for application of class III elastics that attached to the facemask. They found that these new devices have provided more skeletal protraction than conventional facemask. Also they have suggested its use in combination with miniplates placed in the anterior mandible to minimize the need of patient compliance needed with the use of facemask. Another report<sup>11</sup> examined the application of miniscrews for management a 12-year old boy with maxillary deficiency. The miniscrews were placed in the mandible bilaterally between the lower canine and first premolar and connected to upper removable appliance by class III elastics and the treatment lasted for 8 months and after which favorable correction of the malocclusion was observed. The SNA and SNB angle were increased by 3 degree and the IMPA was increased by 4 degree. The authors concluded that miniscrews can be a valid substitute to extra oral appliances and possibly surgery in mild class III cases. In a case report done by Ayhan et al., (2003)<sup>30</sup> they succeed to treat a young girl 10 years old having severe class III malocclusion and suffer from oligodontia with the aid of miniscrew inserted in the maxillary alveolus and connected to the present teeth with the force applied was 800gm. Stephen, (2011)<sup>4</sup> develop a treatment protocols for late maxillary protraction in CLP patients at Children's Hospital, Los Angeles, and they concluded that miniscrews can be successfully assist in the maxillary protraction by increasing the skeletal anchorage during protraction, limiting dental compensations, and reducing skeletal relapse.

### 2.2. Suture distraction osteogenesis (SDO)

Another modality used for maxillary advancement during adolescent period is distraction through the circummaxillary suture. Growth of the craniofacial complex is produced, by passive displacement, created by growth in the cranial base that pushes the maxilla forward and this will be ended at about 7 years old where the cranial base synchondroses closed, most of the growth after that time is due to active growth at the maxillary sutures and surfaces remodeling<sup>31</sup>. Mid-face distraction can be done through the circummaxillary suture<sup>32</sup>, the new bone growths in the distracted mid-facial suture. In a study conducted by Chumning et al., (2005)<sup>36</sup> on 8 CLP class III patients, 4 young (age from 8 to 12 year) and 4 older patients (age from 17 to 19). They treat the young group by suture distraction osteogenesis through circummaxillary suture and the older patients treated with osteotomy distraction osteogenesis by doing Le Fort III osteotomy cut and they said that in children we only install the bone-borne device and then protract the maxilla using face masks and extra-oral elastics like the conventional methods done in orthodontic treatment of class III malocclusion, the only difference is to get the anchorage from the bone near the center of resistance of the maxilla. The results in both young and older patients is almost the same (maxillary advancement was about 8 mm in both groups) so they concluded that the suture distraction osteogenesis is a valid treatment alternative to osteotomy distraction osteogenesis in younger patients

before growth cessation occur and will the suture is still patent.

### 2.3. Alternate rapid maxillary expansion and constriction (Alt-RME-RMC)

The idea of influencing the mobile maxilla during and after rapid maxillary expansion RME is well mentioned in a study conducted by (Pawan et al., 2007)<sup>33</sup>. They found that RME not only facilitate expansion of the maxilla but also displace the maxilla downward and forward and thus can contribute to the correction of the class III malocclusion, they also reported that high stresses along the deep structures and the various suture of the nasomaxillary complex signify the role of the circummaxillary suture system in downward and forward displacement of the maxilla after RME. There are some studies found that the repetitive. Alternate rapid maxillary expansion and constriction (Alte. RME – RMC) can cause more forward and downward displacement of the maxilla and also more response to protraction forces. In a study done by Eric et al., (2004)<sup>13</sup> on treatment of class III malocclusion in cleft lip and palate patient, they conduct their study in 16

patients in mixed dentition stage treated with RME and face mask and compared with other 10 patients treated by Alte. RME - RMC combined with protraction spring, and they concluded that the repetitive weekly protocol of Alte. RME - RMC displace maxilla anteriorly two times better and facilitated maxillary protraction three times than a single course of RME. Following the protocol done by Eric et al., (2004)<sup>13</sup>, Stephen , (2011)<sup>4</sup> made a modification to this previous protocol by replacing the hinge screws used by Eric et al,(2004) by normal jack screws and by replacing the intraoral spring by face mask and intraoral class III elastics and use the technique with older subject age around 13 years old , and they obtain the same results .In addition to that a recent study done by Devrim et al., (2010)<sup>34</sup> they modify also the original protocol done by Dr. Eric by do repetitive RME and RMC for two weeks only before starting the protraction of the maxilla using face masks and they obtain the same result like that obtained by Eric et al, (2004) regarding the enhancement of maxillary protrusion than using the conventional protocol using the RME with the face masks.

**Table 3**  
**Summary of non conventional orthopedic treatment methods Included in the Review**

Author/s	Year	Methods	Author's conclusion
Lucia et al., Cagla et al., Hugo et al.,	2010 2011 2010	Skeletal rigid anchorage devices using miniplate	less dental mesial tipping of incisor teeth and less molar extrusion with more skeletal effects and reduced treatment time than the group treated using conventional facemask.
Bjorn et al., Stephen Abdolreza,Rahman	2010 2011 2010	Skeletal rigid anchorage devices using miniscrews	less dental mesial tipping of incisor teeth and less molar extrusion with more skeletal effects and reduced treatment time than the group treated using conventional facemask.
Ward et al.,	1988	Suture distraction osteogenesis using maxillary implant	8 mm of maxillary anterior displacement had occurred.
Chunming et al.,	2005	Using palatal bone device	
Eric et al., Stephen Devrim et al.,	2005 2011 2010	Alternate rapid maxillary expansion and constriction	Alte. RME - RMC displace maxilla anteriorly two times better and facilitated maxillary protraction three times than a single course of RME.

## CONCLUSION

On the basis of this review, the following can be concluded.

- (1) There are many options for orthopedic treatment of class III malocclusion associated with maxillary retrusion but all of which have some limitations.
- (2) Although skeletonized face masks was proven to be clinically more effective than conventional face mask for treatment of class III malocclusion especially in

adolescent patients , the invasiveness and high expenses which was required for its application prevent the expansion of their usage .

- (3) Miniscrews was attempt to replace the miniplate in providing a rigid skeletal anchorage that is required for maxillary protraction but still its usage in the primary stage ,and a further clinical studies will be needed to clarify the effectiveness of the miniscrews to obtain an orthopedic anchorage.

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