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Diagnosis and Treatment Considerations of Orthodontic Miniscrews in Camouflage Treatment of Adult Class III Malocclusions by Distalization of the Mandibular Dentition- A Review of Literature

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KEYWORDS

Mandibular distalization, Class III camouflage, mini screws, skeletal anchorage.

ABSTRACT

Class III malocclusions pose a challenge to the orthodontist, and conventional treatment options to treat this condition in an adult patient include orthognathic surgery, or orthodontic camouflage. Up until a few years ago, orthodontic camouflage for correction of a Class III problem involved retroclination of the lower anterior teeth and proclination of the upper anterior teeth. The advent of skeletal anchorage systems has opened up new vistas in camouflaging Class III malocclusion due to mandibular prognathism. This article reviews the various treatment planning considerations, both clinical and radiographic, for camouflage of Class III malocclusion by miniscrew assisted distalization of the mandibular dentition, and also discusses treatment options, procedures, biomechanics and possible pitfalls.

INTRODUCTION

A skeletal Class III malocclusion can be caused by maxillary retrognathism, mandibular prognathism or a combination of both. In an adult patient, correction of skeletal malocclusions can be achieved by orthognathic surgery or by orthodontic camouflage [1]. Camouflage of mandibular prognathism is primarily achieved by distalizing the mandibular dentition using various appliances, thereby achieving a positive overjet, and a more pleasing lower lip appearance [1,2,3]. Many appliances have been designed to achieve this. These include Class III elastics, lip bumper, franzulum appliance, essix based distalizing appliances, modifications of the lingual arch etc. Although they do work, they are either dependant on patient compliance, or are cumbersome and not comfortable to the patient owing to their relatively bulky presence in the lingual/ buccal sulcus, or cause unwanted reciprocal movement of other teeth. To overcome this, skeletal anchorage systems were devised. These include different variations of miniscrews [4] and miniplates. This article deals with the use of miniscrews for camouflage treatment of Class III malocclusions. The various aspects such as treatment planning, site of insertion of the miniscrews, biomechanics are dealt with in detail in further sections of this article. Hence, the objective of this literature review is to provide the reader with contemporary information regarding treatment planning for orthodontic camouflage of class III cases, suitable sites for

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miniscrew placement in the mandible, biomechanics, and possible pitfalls associated with distalization of the mandibular dentition.

A) TREAMENT PLANNING CONSIDERATIONS IN MANDIBULAR MOLAR DISTALIZATION

1.1 ANATOMIC CONSIDERATIONS

In order to distalise the mandibular molars, and subsequently the entire mandibular dentition in a fully dentulous patient, accurate measurement of the space distal to the second molars is required. The third molars, when present are recommended to be extracted to allow for the distalization. Mandibular molar distalization (MMD) is limited by the proximity of the second molar's distal root to the inner border of the lingual cortical plate (Figure 1) and not by the distance between the crown of the second molar to the anterior border of the ramus [5].

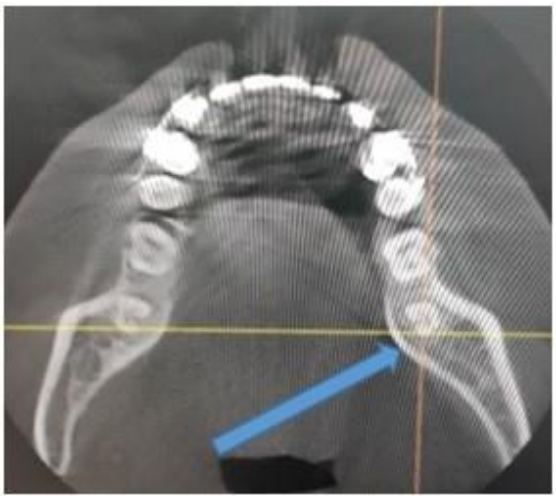

Figure 1. CBCT image of the mandible. For the mandibular molars to move distally, there needs to be sufficient space between the distolingual radicular surface of the second molar and the inner lingual cortical plate distal to the second molar (as marked by the blue arrow)

The anatomy of this region provides a unique challenge due to the shape of the lingual bone distal to the second molars. According to Kim et al. [5], the posterior anatomic limit for MMD is the lingual cortex. The shortest linear distance from the most lingual point of the distal root of the second molar to the inner border of the mandibular cortex describes the amount of space available for MMD [6] (Figure 2). A recent study by Choi et al has also shown that Class III patients with mandibular prognathism show more retromolar space compared to Class I patients [6].

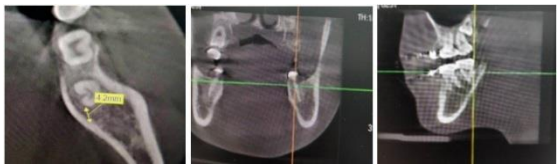

Figure 2. The distance from the lingual surface of the distal root of mandibular second molar to the inner border of the lingual cortex is measured parallel to the posterior line of occlusion. The posterior line of occlusion can be drawn parallel to the cusps of the posterior teeth [6]. In this patient being treated by the author, there is 4.2mm of space distal to the lingual root of the second molar. (Reference planes shown in the other sections of the CBCT image)

Another anatomic area of concern is the mandibular anterior teeth. In Class III patients, studies have shown that they have thinner anterior alveolar bone thickness compared to Class I patients [7,8]. Root apices of lower anterior teeth in such patients are shown to be closer to the labial cortex than the lingual cortex [7,8]. The author opines that a careful assessment of this region via CBCT is essential before embarking on distalization of the mandibular dentition.

1.1.1 MEASUREMENT OF RETROMOLAR SPACE IN A CBCT

Conventional 2D radiographs are incapable of displaying this area accurately, and hence Cone Beam Computed Tomography (CBCT) is recommended to assess the feasibility of MMD [6,7]. When measured on a CBCT, the anteroposterior distance between the distolingual radicular surface of the mandibular second molar and the lingual cortical plate would vary depending on the vertical reference plane used along the distal root of the mandibular molar [6]. In the sample assessed by Choi et al. [6], they found the mean retromolar space was 6.0 ± 3.3 mm at the furcation level and decreased to 2.7± 2.8 mm at 6mm apical to the furcation. This indicates that there is lesser space available for distalization of the root apex of the mandibular second molar compared to the more coronal parts of the root. However, the author recommends that it is wise to measure the retromolar distance along the entire vertical length of the root, at 2mm intervals apically from the Cementoenamel junction (CEJ), as individual variations in buccolingual width of second molars and/or anatomy of the lingual cortex adjacent to the second molars can vary from patient to patient.

An example is provided in Figure 3, where, in the CBCT viewing software (The author used EZ 3D plus software provided by Vatech. Appearance may vary depending on the CBCT viewing software used), the point of reference was placed at the apical third of the lingual surface of the distal root in the coronal and sagittal sections. This was done as this patient (treated by the author) had the least anteroposterior distance between the second molar distal root and the lingual cortical plate at the apical third.

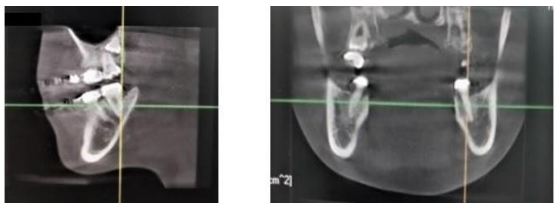

Figure 3. CBCT image showing the reference plane fixed in the vertical and transverse planes before measuring the anteroposterior distance.

Even though Class III patients have been shown to have more retromolar space [6], there exists a possibility of variability between individual patients. Figure 4 shows a patient being treated by the author, in whom the distal roots of the mandibular second molars are already in contact with the lingual cortex. Incorrect treatment planning at this stage, followed by an attempt at molar distalization will only lead to root resorption/ pushing the roots out of their alveolar housing.

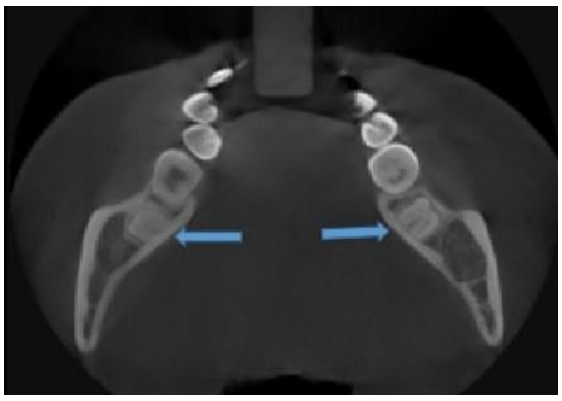

Figure 4. Pre-treatment CBCT showing contact of the distal roots to the lingual cortices (indicated by the blue arrows). This particular patient showed contact of the roots to the lingual cortex throughout the entire vertical height of the root, from the CEJ to the root apex.

1.2 CASE SELECTION FOR CLASS III CAMOUFLAGE CASES

The extra oral changes that could be expected after distalization of the mandibular dentition are retraction of the lower lip and resultant improvement in profile. The extent to which this happens is highly variable and to a large extent unpredictable. Some articles have mentioned criteria by which a decision can be made regarding camouflage versus surgical treatment of Class III cases [19,20,21]. The case selection criteria for distalisation are varied in the literature probably due to the different treatment modalities used- skeletal anchorage, proclination of the upper anterior teeth, retroclination of the lower anterior teeth by class III elastics, or lower premolar extractions [17,18]. There is a lack of high level evidence that mentions clear case selection criteria for camouflage treatment of Class III cases using skeletal anchorage. This is probably owing to the relative infancy of this treatment modality. However, upon looking at the existing literature of Class III cases camouflaged using skeletal anchorage, some common extra-oral and intra-oral criteria can be noted [16-23]. These criteria are mentioned below:

i. Straight to slightly concave profile.
ii. Not having a very prominent chin.
iii. Lower anterior teeth are not significantly retroclined.
iv. Preferably a thick biotype of gingiva in the lower anterior teeth.

Following significant retraction of lower anterior teeth, if it is deemed that further retraction of the mandibular teeth is not feasible due to periodontal, functional or aesthetic reasons, falling back to a surgical plan at this stage would be very difficult. This makes the treatment planning very important. For example, if the clinician notices significant amount of gingival recession, alveolar bone loss, dehiscence or fenestrations mid treatment, modification of the treatment protocol at this stage would be very difficult. Occlusal interferences due to tooth movement during orthodontic treatment are commonly seen. In a well-planned case, these are transient and would resolve by the end of treatment upon achieving proper intercuspation. However, if such a situation is encountered in a mandibular distalisation case, and it is deemed mid treatment, that further distalisation is not possible, then the clinician risks leaving the patient with an erroneous occlusion in the anteroposterior plane. Hence, accurate treatment planning is very important in such patients.

B) TREATMENT CONSIDERATIONS

1.1 SITE OF MINISCREW PLACEMENT- FOR DIRECT AND INDIRECT ANCHORAGE SYSTEMS

This depends on whether direct or indirect anchorage is used to achieve the distalization. For the indirect method, the miniscrew is placed between the two premolar teeth, or between the second premolar and first molar [23] (These areas have been shown to be 'safe zones' for miniscrew placement in the mandible). The premolars are ligated to the miniscrew to prevent their mesial movement, and the distalizing force is achieved by placing an open coil spring between the molars and second premolar [9] (Figure 5).

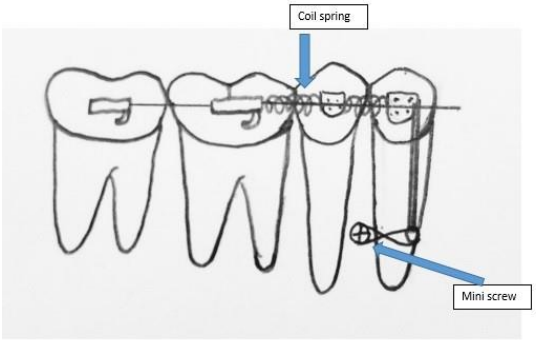

Figure 5. Illustration showing one of the possible setups for indirect anchorage. The distalisation force is being provided by the open coil spring by taking anchorage from the premolars. Unwanted mesial movement of the 1st premolar is prevented by tying it to a steel wire, which is in turn tied to the implant.

For direct anchorage, the common sites for miniscrew insertion are the retromolar bone immediately distal to the second molars, and the mandibular buccal shelf (MBS) [(12)]. Retromolar area provides a satisfactory site of implant placement in the sense that it is away from the teeth and has good thickness of cortical bone. The disadvantages of this site are that, for effective use as an anchor, the Temporary Anchorage Device (TAD) can be placed only after sufficient osseous healing of the third molar extraction site. Also, the thickness of soft tissue in this region has been shown to range from 3-6mm necessitating the use of longer miniscrews of 11-14mm length [9].

According to Nucera et al. [12], the recommended site for TAD placement in the MBS is around 4mm buccal to the CEJ of the distal root of the second molar (Figure 6). The advantage of this site is that its buccal extension allows clinicians to place miniscrews away from and parallel to the long axis of the molar teeth. The chances of screw to tooth contact upon placement and during tooth movement are also reduced. In cases where TADs are placed between the roots, an Intra Oral Periapical (IOPA) radiograph can be taken with a suitable guide wire to ensure safe insertion of the miniscrew away from the roots and vital structures [11]. However, in the MBS area, the TAD is placed vertically due to which the position cannot be verified by an IOPAR. As a CBCT would have been taken to measure the retromolar space for mandibular molar distalisation, the distance from the buccal surface of the second molar crown to the proposed site of TAD placement can be measured on the same CBCT image, and transfer it in the mouth. Taking another CBCT after miniscrew placement just to verify safe placement of the miniscrew does not conform to the As Low as Reasonably Practicable principle [13].

Figure 6. Miniscrew placed in the mandibular buccal shelf to distalise canine, premolars and molars. Two step retraction is being done in this patient treated by the author. After achieving a Class I canine and molar relationship, the spaces between the lateral incisors and canines were closed. Additional labial crown torque on the lower anterior teeth is recommended while performing this variation of distalization.

1.2 BIOMECHANICS

According to a finite element study done by Jo et al [14], the centre of resistance (CRes) of the entire mandibular dentition is around 13 mm apical to, and 25mm posterior to the incisal edge of the lower central incisors. (Figure 7)

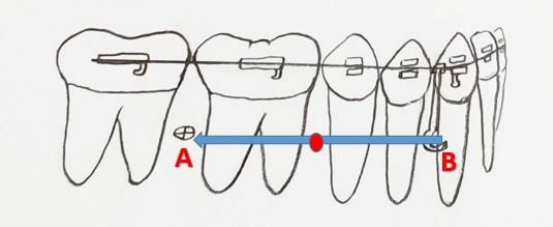

Figure 7. Clinical picture with illustrated centre of resistance of mandibular dentition (Blue circle represents the approximate centre of resistance of the entire mandibular dentition)

With this in mind, the resultant tooth movements can be easily predicted based on the position of the mini screw, and the point of force application onto the teeth. According to Park et al. [15], point of force application at the level of the bracket causes a tipping movement with more distal movement of the crown and less of the root apex, while applying force at the CEJ level reduces the amount of tipping seen. The use of hooks on the wire to ensure the point of force application is as close as possible to the centre of resistance would naturally provide more bodily tooth movement.

If the force for distalization is applied initially only on the molar, then it will tend to rotate as the distal force is being applied buccal to the centre of resistance. This can be minimized by placing a full sized arch wire and/or placing toe-out bends to compensate. It has been shown that the buccal movement is considerably reduced if the canine, premolars and molars are ligated as one unit, and distalization force is applied on the canine, or if the force is placed closer to the CEJ [15].

Figure 8. Illustration showing biomechanics of distalisation when force is applied from the miniscrew to the archwire hook through the centre of resistance. (A- miniscrew, Red circle- centre of resistance of mandibular dentition, B- archwire hook, blue arrow- force vector for distalization)

According to the alterations needed in the occlusal plane, the line of force can be altered. If the line of force passes through the centre of resistance, then there would be no changes in the occlusal plane. (Figure 8). In the lower arch, high positive torque brackets are preferred to allow for bodily retraction of the anterior teeth. If bracket inventory is a problem, then the lower anterior brackets can be inverted to get a positive torque, and additional torque, as required can be incorporated in to the archwire.

C) POSSIBLE PITFALLS OF DISTALIZATION OF MANDIBULAR DENTITION

I. One of the most common side effects of distal movement of the mandibular dentition, is varying degrees of periodontal complications around the lower anterior teeth ranging from simple recession of the interdental papilla to a more severe loss of bone support and dehiscence [16]. An easy predictor for this would be the pre-treatment labiolingual thickness of the mandibular anterior alveolar bone- the thinner the alveolar bone thickness, the greater the chance of periodontal damage if teeth are not properly torqued. However, the author failed to find studies that have accurately given a cut off measurement, so to speak, of the mandibular anterior alveolus thickness, below which the probability of periodontal damage increases in mandibular distalization cases specifically. Further studies are warranted in this regard.

II. Some case reports [25,26,27] have shown paraesthesia of the inferior alveolar nerve caused by close proximity of the second molar roots on the nerve. This could be a possible side effect caused by distalization. The exact pre-treatment proximity of the nerve to the second molar root, which could act as a risk factor, is currently unknown. Further high quality studies are warranted in this regard.

CONCLUSIONS

The level of evidence available with regard to the various aspects of distalization of mandibular dentition using mini screws is low. The author would like to emphasise that this article is only a review of literature and that the conclusions mentioned below be taken with reservations until further well controlled RCTs, systematic reviews and Meta analyses have been conducted on this topic.

a) Distalization of the mandibular dentition is a viable option to treat borderline Class III malocclusions by orthodontic camouflage.
b) Proper case selection and treatment planning is crucial. Some of the important pre-treatment factors in patient selection include a straight to mildly concave profile, thick gingival biotype, sufficient amount of alveolar bone around the mandibular anterior teeth, adequate bone in the retromolar region lingual to the second molars.
c) Surgical correction of Class III is still a viable option and one which should not be ignored. It is just that skeletal anchorage has increased the boundaries of orthodontic camouflage correction of Class III malocclusions.

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DECLARATION OF INTEREST

The author reports no conflicts of interest. The author alone is responsible with the content of this article.

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