Case Report

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Mini Implants Assisted Mandibular Teeth Distalisation on Class III Malocclusion: A Case Report

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KEYWORDS

Temporary anchorage devices, orthodontic camouflage, adult orthodontics, whole arch distalisation

ABSTRACT

A case report of 24 years old male with Class III malocclusion on a Class III skeletal base with missing upper lateral incisors is presented to describe the mechanics to distalise mandibular molars using mini implants in a borderline orthognathic surgery case. Mini implants were placed buccally between the lower second molars and lower first molars bilaterally. Mandibular molars were distalised and intruded using elastics power chains from the mini implant to the long hook placed distal to the lower canines on a 0.019x0.025-inch stainless steel archwire. Extrusion of the lower anterior segment was prevented with the use of the stiff archwire and lowered retraction by the long hook. Labial root torque was expressed on the lower incisor from the use of MBT brackets with -6 degrees torque. Treatment was completed within 21 months. In conclusion, accurate planning and understanding of biomechanical teeth movement may facilitate the correction of borderline Class III orthognathic surgery cases.

INTRODUCTION

A non-extraction orthodontic treatment in the correction of Class II and Class III molar relationships could be achieved by the molar distalisation [1, 2]. Class III malocclusion normally results from mandibular prognathism or maxillary hypoplasia and retrognathism, or a combination of the two [3]. Furthermore, there is possible anatomic heterogeneity of this type of malocclusion, since either jaw or both jaws can be affected in sagittal length or position relative to the other [3]. Familial aggregation studies also suggest that familial environmental factors or heredity can play a substantial role in the etiology of the Class III malocclusion [4]. Previous studies reported that the Class III relationship is due to polygenic multifactorial inheritance with the variable mode of transmissions although there have been suggestions that environmental factors such as enlarged tonsils and nasal blockages may contribute to the mandibular prognathism [5]. The Class III skeletal pattern is normally compensated by the proclination of upper incisors and retroclination of lower incisors. In orthodontics, there are several methods to correct the Class III malocclusion and it depends on the age and severity of the skeletal pattern.

Early treatment of the skeletal and dental Class III relationships could be addressed orthopedically by the use of facemask with rapid palatal expansion [6, 7], which has been shown to demonstrate long-term favorable improvement in the skeletal relationship [8]. In older patients with moderate to severe skeletal Class III pattern, cases usually do not camouflage well to conceal the skeletal problem and may need combined orthodontic-orthognathic approach.

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Early treatment of the skeletal and dental Class III relationships could be addressed orthopedically by the use of facemask with rapid palatal expansion [6, 7], which has been shown to demonstrate long-term favorable improvement in the skeletal relationship [8]. In older patients with moderate to severe skeletal Class III pattern, cases usually do not camouflage well to conceal the skeletal problem and may need combined orthodontic-orthognathic approach.

Extraction of mandibular teeth is usually indicated in adult patients to compensate for the Class III skeletal pattern and the teeth that are usually involved in extractions are lower premolars or lower incisors [12]. Extraction of a mandibular incisor is occasionally indicated for patients with an anterior crossbite or an edge-to-edge incisor relationship. Factors determining the decision include the severity of anterior crowding in the mandibular arch, the Bolton discrepancy, and the degrees of negative overjet and overbite [3].

The use of mini-implant currently is more able to predictably facilitate achievement of good results of more severe class III skeletal pattern [13]. This case report discussed the biomechanics of teeth movement using the mini-implants on the buccal shelf in the correction of Class III borderline orthognathic surgery case.

CASE PRESENTATION

A 24-year-old, male, complained of missing teeth and underbite of the front teeth. He also complained of recurrent pain related to the lower third molars teeth. He was in a good health and had no significant medical history.

He presented with a Class III malocclusion on a Class III skeletal base with an average lower facial height ratio. There was no obvious facial asymmetry. His lips were competent and showed 7mm of upper incisors on smiling with a normal upper lip length. The nasolabial angle was normal, and the labio-mental fold was shallow (Figure 1). Intraorally revealed full permanent dentition with missing upper lateral incisors and mild crowding in the lower arches (Figure 1). The maxilla and mandibular arch were U-shaped. On occlusion, the incisor relationship was in a Class III incisors relationship with a reverse overjet of 2 mm (Figure 2). The overbite was measured from the left central incisors was 5% and incomplete to the teeth. The curve of Spee was almost flat observed from the occlusal plane between the distal cusp of the lower second molar to the lower central incisal edge. The buccal segments were in ¼ unit Class III on both sides. The canine relationship on the right side was ¼ unit Class III and Class I on the left side. The upper centerline was 2 mm to the left from the facial midline and the lower centerline was coincident with the facial midline (Figure 1).

Figure 1 Pre-treatment Extra-Oral and Intra-Oral photographs

Figure 2 Pre-treatment study models

The pre-treatment panoramic radiograph (Figure 3) shows that the bone level was normal, with all teeth present except both upper lateral incisors. All third molars were present with horizontal impaction of lower third molars. There was radiopacities apical to the lower right canine roots, which is consistent with the impression of dens bony island. The lateral cephalometric radiograph (Figure 4) shows that the patient presented with a Class III skeletal base with an average maxilla mandibular planes angle, upper incisors were procline and lower incisors were normal for a given maxilla-mandibular angle. The lower lip appeared protrusive from the E-plane by 5.0mm.

Treatment Objectives

The objectives for this patient focused on the 7 objectives: (1) Secure the optimum oral hygiene before starting the orthodontic treatment; (2)

Eliminate the dental crowding, level and align the teeth; (3) Address the missing upper lateral incisors; (4) To achieve a Class I canines and molars relationship bilaterally; (5) Obtain correct overbite and overjet; (6) Achieve a mutually protective functional occlusion and (7) To plan an appropriate retention protocol.

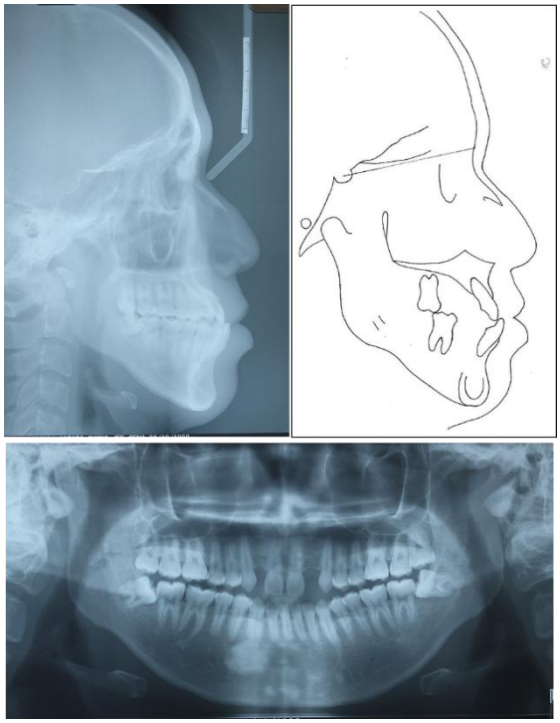


Figure 3 Pre-treatment panoramic radiograph, lateral cephalometric radiograph, and tracing

Figure 4 Middle treatment to open space for lateral incisors and distalisation of the lower arch on 0.019 x 0.025-in SS archwire with mini-implant anchorage reinforcement

Treatment alternatives

The main problem for this patient was a Class III skeletal pattern with a reverse overjet and minimal overbite. Based on these problems, 4 options were proposed to the patient:

1. The first option involved combination of orthodontic and orthognathic surgery. In the orthognathic joint clinic, the treatment proposed to extract lower third molars and close the space in the upper arch with camouflaging upper canines to be upper laterals. These were followed by decompensation of the teeth with fixed appliances before orthognathic surgery. In addition, the patient was informed about the risks and benefits during the combined orthodontic and orthognathic consultation. However, the patient refused to have orthognathic surgery after thinking about the risks of orthognathic surgery.
2. The second option involved orthodontic camouflage with the extraction of the lower premolars and space closure in the upper arch. The option of upper arch is the same as the first option. However, the patient refused to have extraction of the lower premolars.
3. The third option is the extraction of lower premolars and prosthesis to replace missing upper laterals. the retraction of the mandibular anterior teeth and mesial movement of the mandibular molars. However, this treatment would compromise the optimal inclination of the mandibular incisors.
4. The fourth option involved orthodontic camouflage with the extraction of lower third molars. Anchorage reinforcement with the mini-implant to distalise the lower dentition. Anterior cross-bite would be corrected by the labial flaring of maxillary incisors. In addition, the upper arch requires prostheses to replace missing upper laterals.

After discussing the treatment options with the patient, he agreed with option 4 since he had recurrent pain of the wisdom teeth. The written consent was signed by him and the tentative treatment plan included the following: (1) Upper fixed appliances; (2) To procline upper incisors; (3) Extraction of all third molars; (4) Placement lower fixed appliances (0.022x0.028-in slot, MBT prescriptions); (5) Placement of mini implant distobuccal of lower first molars as direct anchorage to distalise lower arch on 0.019x0.025-in SS archwire; (6) Finishing and detailing; (7) Upper and lower Hawley retainers with prosthesis on the upper lateral incisors.

Treatment progress

Orthodontic treatment started in July 2015 and finished in March 2017. It took 21 months to finish with a good occlusion. Treatment started with the placement of pre-adjusted edgewise brackets (0.022x0.028-in, MBT prescription) on the upper teeth with upper 0.012-in nickel-titanium archwires. The brackets on the upper canine teeth were placed slightly in a distally angulated position to facilitate distal root tip and the placement of the implant prostheses on the lateral incisors space. The treatment progressed until 0.019x0.025-in

stainless steel archwires and spaces for upper lateral incisors were created with opening coil spring. The lower third molars were referred for extraction to prepare the space for the distalisation of the lower arch while the upper third molars were also extracted since there would be no opposing teeth. Treatment continued with placement of fixed appliances on the lower arch in June 2016 with 0.012-in Nickel-titanium wire and progressed to 0.019x0.025-in stainless steel. In addition, the bracket on the lower canines was transposed in between left and right respectively. Upper and lower 0.019x0.025-in stainless steel archwires were maintained for one month for full prescription expression.

In October 2016, mini-implants (10.0 mm length and 1.6mm diameter, Brand, country) were placed on the distal buccal sites of teeth 36 and 46 respectively. The long crimpable hooks (7.0mm) were placed distal to lower canines. Distalisation of the lower arch initiated with the placement of elastic chains from the mini-implants to the long crimpable hooks.

In January 2017, space was created for upper laterals and replaced with acrylic denture teeth. The acrylic denture teeth were trimmed and attached with lateral brackets (Figures 4 and 5). Elastic chains were placed in the upper and lower arches to close all the remaining spaces.

Figure 5 Further distalisation of lower arch and the estimation of upper lateral incisor with acrylic teeth.

Finishing and detailing were done in 2 months and brackets were debonded in March 2016. The patient was instructed to wear the retainers for 24 hours for 6 months and to continue wearing the retainers at night indefinitely. The patient was referred to a prosthodontist for the prostheses construction. Routine supragingival professional mechanical plaque removal was performed accordingly throughout all treatment phases.

Treatment results

The patient's treatment was complete after 21 months. Anterior crossbite was successfully corrected and adequate overjet and overbite were achieved. Panoramic radiograph showed good parallelism among tooth roots and distally inclined lower second molars (Figure 6).

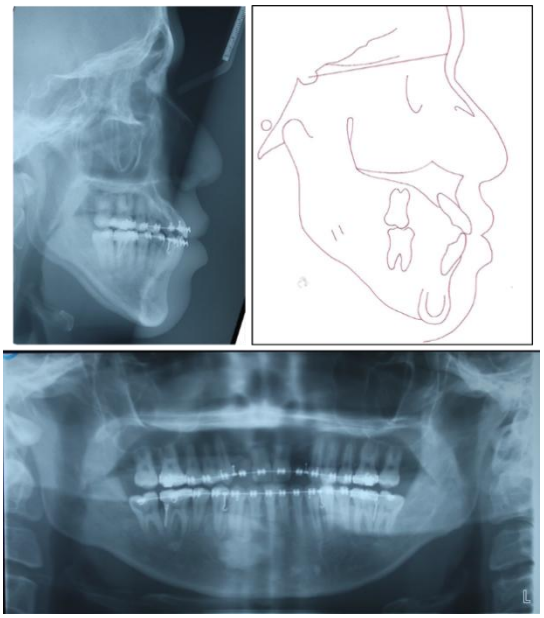


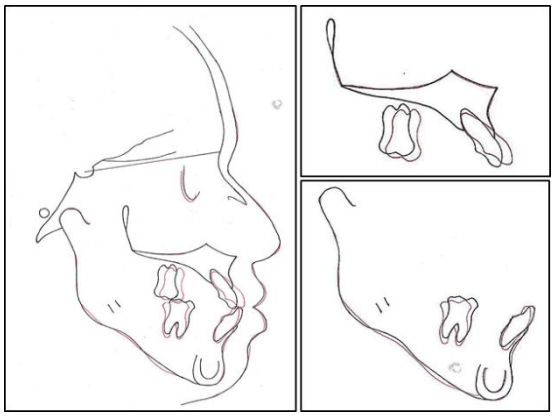
Figure 6 Near-end panoramic radiograph, lateral cephalometric radiograph, and tracing

The cephalometric analysis with superimpositions revealed the significant improvement of the facial profile from the general superimposition (Figure 7) due to dentoalveolar compensation with the proclination of upper incisors, retroclination of lower incisors with a consequent decrease in lower lip fullness. There was a slight clockwise rotation of the mandible due to the extrusion of the upper molars but nullified by the intrusion of lower molars. The facial profile was improved with an aesthetically satisfying smile (Figure 8). Intraoral examination and dental casts analysis revealed a Class I molar and canine relationship on both sides, with excellent intercuspation (Figures 8 and 9).

DISCUSSION

The present article reported a case of a 24-year-old man with a mild Class III skeletal pattern. The patient was treated by orthodontic camouflage treatment with mini-implant anchorage placed on the distobuccal side of the lower first molars. Generally, adult patients with mild Class III skeletal patterns were usually treated without orthognathic surgery [14]. The treatment options for Class III orthodontic camouflage cases included the use of

Class III elastics or tooth extraction. However, using elastics to correct class III malocclusion require great compliance and some patient refused to have extraction of teeth for orthodontic treatment. The malocclusion and existing dentoalveolar compensation to camouflage the underlying skeletal discrepancy suggested borderline orthodontic camouflage or orthognathic treatment approach.



Cephalometric Measurements			
	Pre-treatment	Post-treatment	Difference
Skeletal			
SNA (°)	81°	82°	+1°
SNB (°)	83°	82°	-1°
ANB (°)	-2°	0°	+2°
SN-Mx (°)	7°	7°	0°
FMA (°)	30°	31°	+1°
Dental			
U1 to NA	+5.0mm	+9.0mm	+4.0mm
U1 to Mx	116°	126°	+10°
L1 to NB	+10.0mm	+7.0mm	-3.0mm
L1 to MP	88°	82°	+6°
IIA	119°	112°	-7°
Facial			
E-line to UL	-2.0mm	0mm	+2.0mm
E-line to LL	+5.0mm	+3.0mm	-2.0mm
LFH ratio	55.5%	56.0%	+1.0%

U1, maxillary incisor; L1, mandibular incisor; UL, upper lip;
LL, lower lip; LFH, lower facial height; Mx, Maxillary Plane;
MP, Mandibular plane; IIA, Interincisal Angle

Figure 7 Cephalometric superimpositions and measurements

The extra-oral clinical examination was mild skeletal Class III pattern with an aesthetically acceptable facial profile and favourable for orthodontic camouflage treatment. Orthognathic treatment has the risks of increased morbidity associated with surgical treatments such as loss of sensation (temporary or permanent paresthesia or anesthesia) of the nerves where the surgical cut was made and risks associated with the general anesthesia in general. Another complication associated with the intraoperative phase is dental injuries, with maxillary segmentation being mainly associated with these complications [15].

Figure 8 Post-treatment Extra-oral and Intra-oral photographs

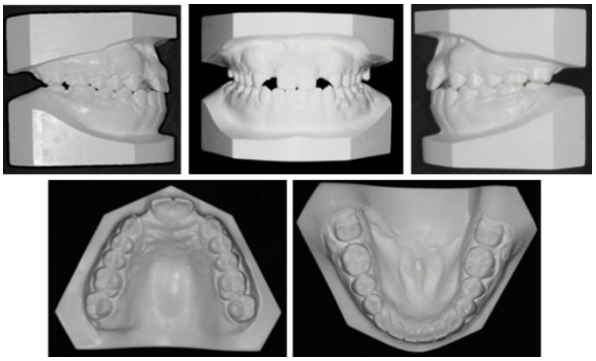


Figure 9 Post-treatment study models

In addition, orthognathic surgery may result in damage of periodontal tissue on perioperative area (segmental procedure) and the consequence may lead to tooth loss [16]. The stability of treatment was also dependent on the type of surgical movement involved. Stability to move the maxilla forward was found to be stable first-year post-surgery while the concurrent forward movement of the maxilla and backward movement of the mandible was found to be stable only with rigid fixation, and single jaw movement to bring the mandible back was found to be less stable [9]. The treatments options and risks were discussed with the patient, who then declined to undergo orthognathic surgery and opted for treatment to be done by orthodontics alone.

The patient decided to have camouflage treatment with the extraction of lower third molars considering his lower third molar area had difficulty in cleaning and he experienced recurrent pain. Extraction of lower second premolars in a mild crowding case and replacement of missing upper

laterals required careful consideration to achieve a good occlusion i.e. to occlude the mandibular first molars with maxillary premolars in finishing a good Class III molar relationship [17]: The mandibular first molars need to be positioned more lingually, no offset in a mandibular first molar, more offset in the maxillary premolars and molars, no toe-in in maxillary molars, lingual crown torque in mandibular molars, reduced palatal crown torque in maxillary premolars and molars [17]. In addition, the palatal cusps in the maxillary premolars and buccal cusps of the mandibular molars need to be trimmed for better intercuspation [17].

The prevalence of hypodontia for Chinese ethnic in Asian population is 13.7% and 20.5% among them had missing upper lateral incisors [18]. Evidence showed that the clinical management of missing lateral incisors can be successfully performed with either orthodontic space closure or space opening followed by prosthetic replacements [19]. In this case, the patient decided to replace the missing teeth with prostheses after discussion at the interdisciplinary treatment planning clinic. The modification for placement of the upper canine brackets was done to ensure adequate space for future implant placement[19]. The lower arch was not bonded at the initial stage to use them as reference for the degree of upper incisors proclination in order to improve the reverse overjet correction. This is not an uncommon approach for Class III cases [12] In addition, lower canine brackets were transposed to prevent the proclination of lower incisors during the alignment stage [20].

The correction of Class III incisor relationships requires proclination of the upper incisors and retroclination of the lower incisors. The retroclination of lower incisors requires space and the space can be gained from the extraction of lower premolars, and interproximal stripping of lower incisors. Use of extracted lower third molars space has only been advocated recently since the introduction of mini implants. In this case, the extraction of lower third molars in Class III malocclusion was appropriate to provide greater retromolar space for the retroclination of lower incisors and at the same time to correct the Class III incisor relationship [21, 22]. The retroclination of lower incisors and full distalisation of the lower arch to correct the molar relationships require high anchorage demand. The mini implants that act as anchorage were placed on the buccal shelf areas. The exact location was on the distobuccal sites of lower first molars. The attached gingiva on the mandibular first molar is wider and flat for the optimal site of the buccal shelf mini implant [23]. In addition, a previous study reported that the region between the mandibular first and second molars is the most reasonable and safest for placement of the mini implant for the distalisation of the entire mandibular dentition [24]. To perform 3-D control on the teeth, the 1.6mm diameter of the mini implant was placed because using the large diameter mini implant may be associated with increased surgical trauma to the bone [25].

This case report reflected a non-extraction approach even though the extraction of lower third molars is necessary. The alternative was to extract in the lower arch to create space to allow retraction of the lower incisors [12]. However, as previously mentioned, the patient requested to avoid having more loss of the dentition when he already has had hypodontia of the upper lateral incisors. The placement of mini implants on the buccal shelf does not interfere with lower arch distalisation but due to the position of the center of resistance of the mandibular dentition is between the second premolar and the first molar [26], it may result in the movement of the lower teeth in transverse, vertical, and sagittal directions. The retraction force from the mini-implants which is away from the center of resistance of the mandibular dentition may create the moment and simultaneously rotate the occlusal plane in a counterclockwise direction [27, 28].

In the sagittal and vertical directions (Figure 10), the retraction force was applied away from the center of resistance of the lower arch. The retraction force created an angle against the center of resistance and at the same time generated the moment. The lower teeth moved distally with side effects of the intrusion of the lower posterior teeth and extrusion of the lower anterior teeth. If unsupervised, extrusion of the anterior teeth along with the rotation of the occlusal plane could have caused thinning of the alveolar bone around the anterior teeth and damaged the periodontal support [29]. Therefore, to prevent this side effect, in this case the retraction force was applied nearer to the center resistance. This was done using long hooks (7mm) placed distally to the lower canines, followed by the retraction of the anterior teeth to mini-implants on a rigid 0.019” x 0.025 in-SS archwire. Hence, the biomechanics had minimised extrusion of the lower anterior teeth and intrusion of the lower posterior teeth.

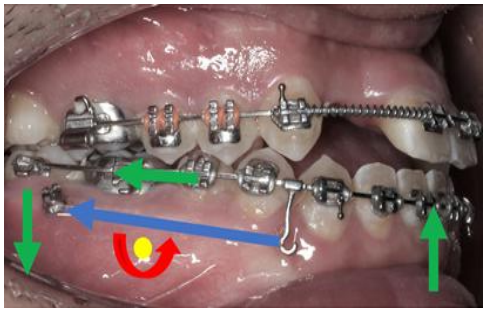


Figure 10 Sagittal and vertical directions;
Legend: Center of Resistance (Yellow); Moment (Red); Retraction force (Blue); Tooth Movement (Green)

In a transverse direction (Figure 11), the distolingual moment on the posterior teeth would occur during distalisation because of the buccolingual distance from the line of action of the force to the center of resistance. This may help to correct the posterior crossbite during the distalisation. However, with the small force angulation in the transverse direction, sometimes the distolingual movement of the posterior teeth was insignificant [30].

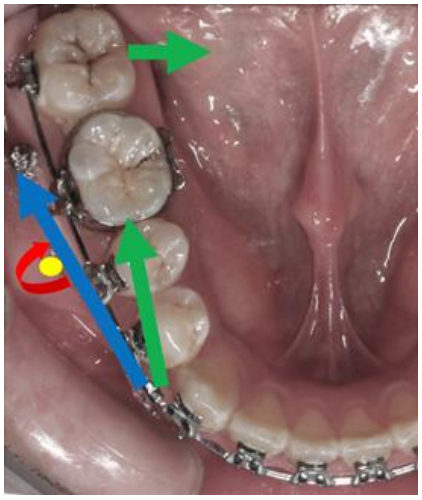


Figure 11 Transverse direction
Legend: Center of Resistance (Yellow); Moment (Red); Retraction force (Blue); Tooth Movement (Green)

When considering all three directions (sagittal, transverse and vertical), the side effects in the vertical direction is the most critical in the lower dentition during distalisation. Hence, the use of a rigid archwire is imperative to control the force angulation and elastic deflection during retraction and prevent extrusion of anterior teeth. In addition, biomechanical understanding on force angulation by appropriate placement of the mini implants may reduce the side effects and in the distalisation of the whole mandibular dentition [30].

Throughout the orthodontic treatment, gingival tissue change i.e. gingival recession was observed following initial placement of fixed orthodontic appliances (Figure 4). In general, excessive incisor proclination should be avoided as it may cause the teeth shifting out of alveolar envelope, thus creating bone dehiscence and potential gingival recession [31]. Nonetheless, according to recent systematic review, there is no clear scientific evidence that incisor proclination caused by fixed orthodontic appliances has an impact on periodontal health [32].

CONCLUSION

Class III camouflage adult patient with missing upper laterals was successfully treated by total mandibular teeth distalisation. Correction of the overjet and overbite was mainly through dentoalveolar compensation with proclination of upper incisors and retroclination of lower incisors. Accurate planning of biomechanical teeth movements is essential to reduce the side effects of Class III camouflage orthodontic treatment.

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DECLARATION OF INTEREST

Authors declare no conflict of interest.

REFERENCES

1. Sfondrini MF, Cacciafesta V, Sfondrini G. Upper molar distalization: a critical analysis. Orthod Craniofac Res, 2002; 5(2):114-26.
2. Rey D, A David, Oberti G, Baccetti T. Treatment and posttreatment effects of mandibular cervical headgear followed by fixed appliances in Class III malocclusion. Am J Orthod Dentofacial Orthop, 2008; 133(3):371-8; quiz 476 e1.

3. Ngan P, Moon W. Evolution of Class III treatment in orthodontics. Am J Orthod Dentofacial Orthop, 2015; 148(1):22-36.
4. Motford LA, Otero L, Hartsfied JK. Family history and genetics of mandibular prognathism. In: Ngan PW, Deguchi T, Roberts EW, editors. Orthodontic treatment of Class III malocclusion. Sharjah, United Arab Emirates: Bentham Science, 2014: p. 3-24.
5. Mossey PA. The heritability of malocclusion: part 2. The influence of genetics in malocclusion. Br J Orthod, 1999; 26(3):95-203.
6. Mandall N, Dibiase A, Littlewood S, Nute S, Stivaros N, Dyer F et al. Is early Class III protraction facemask treatment effective? A multicentre, randomized, controlled trial: 15-month follow-up. J Orthod, 2010; 37(3):149-61.
7. Baccetti T, Franchi L, and McNamara JA, Jr. Treatment and posttreatment craniofacial changes after rapid maxillary expansion and facemask therapy. Am J Orthod Dentofacial Orthop, 2000; 118(4):404-13.
8. Westwood PV, Mcnamara JA, Baccetti T, Franchi L, Sarver DM. Long-term effects of Class III treatment with rapid maxillary expansion and facemask therapy followed by fixed appliances. Am J Orthod Dentofacial Orthop, 2003; 123(3):306-20.
9. Proffit WR, Turvey TA, Phillips C. The hierarchy of stability and predictability in orthognathic surgery with rigid fixation: an update and extension. Head Face Med, 2007; 3:21.
10. Proffit WR, Fields HW, Sarver DM. Contemporary Orthodontics. 2007.
11. Kerr WJ, Miller S, Dawber JE. Class III malocclusion: surgery or orthodontics? Br J Orthod, 1992; 19(1):21-4.
12. Kumaresan J, Kumar TS, Kumar S. Skeletal class III camouflage by mandibular incisor extraction: A case report. APOS Trends in Orthodontics.
13. Ngan P, Sung JH. Treatment strategies for developing and non- developing Class III malocclusions. In: Nanda R, editor. Esthetics and biomechanics in orthodontics. 2nd ed. 2015: p. 246-92.
14. Sugawara Y, Kuroda S, Tamamura N, Yamamoto TT. Adult patient with mandibular protrusion and unstable occlusion treated with titanium screw anchorage. Am J Orthod Dentofacial Orthop, 2008; 133(1):102-11.
15. Ho MW, Boyle MA, Cooper JC, Dodd MD, Richardson D. Surgical complications of segmental Le Fort I osteotomy. Br J Oral Maxillofac Surg. 2011; 7(49).
16. Olate S, Sigua E, Asprino L, Moraes MD. Complications in Orthognathic Surgery. J Craniofac Surg, 2018; 29(2): e158-e161.
17. Farret MM, Farret MM,Farret AM. Strategies to finish orthodontic treatment with a Class III molar relationship: three patient reports. World J Orthod, 2009; 10(4): 323-33.
18. Qian L. Chew MT, Yow M, Wong HC, Weng K, Foong KWC. Anomalies of permanent tooth number in three Asian ethnicities. Aust Orthod J, 2017. 33: p. 212-219.
19. Alqahtani ND. Successful treatment modalities for missing lateral incisors- A systematic review. Saudi Dent J, 2021; 33(6):308-315.
20. Thickett E, Taylor NG,Hodge T. Choosing a pre-adjusted orthodontic appliance prescription for anterior teeth. J Orthod, 2007; 34(2):95-100.
21. Choi YT, Kim YJ, Yang KS, Lee DY. Bone availability for mandibular molar distalization in adults with mandibular prognathism. Angle Orthod, 2018; 88(1): 52-57.
22. Zhao Z, Wang Q, Yi P, Huang F, Zhou X, Gao Q, et al. Quantitative evaluation of retromolar space in adults with different vertical facial types. Angle Orthod, 2020; 90(6): 857-865.
23. Chen PJ, Juan SH, Lin JJ, Wond YK. Bone thickness of the buccal shelf for orthodontic implant placement. Poster, Annual Meeting of Taiwan Association of Orthodontists, 2009.
24. Liu H, Wu X, Tan J, Li X. Safe regions of miniscrew implantation for distalization of mandibular dentition with CBCT. Prog Orthod, 2019; 20(1): 45.
25. Lu YJ, Chang SH, Ye JT, Ye YS, Yu YS. Finite Element Analysis of Bone Stress around Micro-Implants of Different Diameters and Lengths with Application of a Single or Composite Torque Force. PLoS One, 2015; 10(12): e0144744.
26. Jo AR, Mo SS, Lee KJ, Sung SJ, Chun YS . Finite-element analysis of the center of resistance of the mandibular dentition. Korean J Orthod, 2017; 47(1):21-30.
27. Oh YH, Park HS, Kwon TG. Treatment effects of microimplant-aided sliding mechanics on distal retraction of posterior teeth. American Journal of Orthodontics and Dentofacial Orthopedics, 2011; 139(4):470-481.
28. Park JH, Heo S, Tai K, Kojima Y, Kook YA, Chae JM, et al. Biomechanical considerations for total distalization of the mandibular dentition in the treatment of Class III malocclusion. Semin Orthod, 2020; 26: 148-156.
29. Kim GS, Lim SH, Cho YH, Jeong SR, Park HS, Park JH, et al. Long-term changes of anterior alveolar bone after treatment with mandibular molar distalization, evaluated with cone-beam computed tomography. Am J Orthod Dentofacial Orthop Clin Companion 2021; 1: 73-85.

30. Chae JM, Park JH, Kojima Y, Tai K, Kook YA, Kyung HM. Biomechanical analysis for total distalization of the mandibular dentition: A finite element study. Am J Orthod Dentofacial Orthop, 2019; 155(3):388-397.
31. Vassalli J, Grebenstein C, Topouzelis N, Sculean A, Katsaros C. Orthodontic therapy and gingival recession: a systematic review. Orthod Craniofac Res, 2010; 13(3):127-41.
32. Tepedino M, Franchi L, Fabbro O, Chimenti C. Post-orthodontic lower incisor inclination and gingival recession-a systematic review. Prog Orthod, 2018; 19(1):17.

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