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MANDIBULAR ARCH DISTALIZATION IN A CLASS III ADULT PATIENT WITHOUT THIRD MOLAR EXTRACTION USING CLEAR ALIGNERS: A CASE REPORT

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ABSTRACT

This case report of a 37-year-old male presented with Class III malocclusion, edge-to-edge bite, protrusive lower lip, moderately crowded lower arch, and extracted maxillary right first molar. The patient requested esthetic treatment and demanded that no additional teeth were to be extracted. The patient was treated using clear aligners by distalization of the mandibular arch without extraction of the mandibular third molars. The correction was also achieved by interproximal reduction in the mandibular arch and proclination of the maxillary incisors to achieve final results. The results showed bodily distalization of the mandibular molars. Treatment was accomplished in 33 months and the patient was satisfied with the esthetic results. Conclusion: Clear aligners were effective in distalizing the mandibular arch without the need for extraction of the mandibular third molars. This treatment may be considered an alternative treatment option for mild to moderate class III malocclusion patients requesting non-extraction treatment with clear aligners.

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INTRODUCTION

Class III malocclusion is a challenging problem faced by orthodontists. Different treatment strategies have been described in the scientific literature based on the age and the developmental stage of the patient, as well as the characteristics of the Class III malocclusion. (1) In mild skeletal Class III cases in adults, the goal of orthodontic therapy is usually to correct the molar and canine relationship, and to normalize the anterior overjet to camouflage the skeletal problem. Mandibular arch distalization is one of the main methods that can be employed to achieve such goals. (2)

In recent years, clear aligners have become increasingly popular for orthodontic treatment in adult patients. Molar distalization is one of the tooth movements facilitated by the use of clear aligners.(3-5) On the other hand, there is a lack of literature describing the treatment of Class III adult patients with mandibular distalization using clear aligners. Two studies previously analyzed mandibular molar distalization using clear aligners, but they both involved extraction of the mandibular third molars. (6, 7) Hence, the aim of this work is to present a report of Class III malocclusion in a non-growing patient treated with mandibular arch distalization using Invisalign clear aligner (Align Technology, San Jose, Calif) without extraction of the mandibular third molars.

DIAGNOSIS AND ETIOLOGY

A 37-year-old man presented with the chief complaint of crowded lower teeth and shallow bite. Extraoral examination showed a straight balanced profile with a slightly protruded lower lip (Figure 1, A-C).

Intraoral examination (Figure 1, D-H) showed that the patient had a previous extraction of the upper right first molar, and he had Class III molar and canine relationship on both sides. Analysis of the digital scans showed moderate mandibular crowding (5 mm) and crossbite of the canines. The patient had an edge-to-edge bite. The upper dental midline coincided with the facial midline while the lower dental midline was deviated by 1 mm to the right side. No signs or symptoms of temporomandibular joint dysfunction were reported by the patient. Functional analysis did not detect a centric relation/centric occlusion discrepancy; however, the patient had a tongue thrusting habit and a low tongue posture.

The panoramic radiograph (Figure 2, A) showed that all permanent teeth were present except for the maxillary right first molar. Analysis of the

lateral cephalometric radiograph (Figure 2, B and Table I) confirmed that the patient had a skeletal Class III relationship (ANB= -0.32°, Wits appraisal= -5.21 mm), primarily due to a prognathic mandible (SNB= 84.05°) and normal facial height (SNˆMand Plane = 28.18°). The maxillary incisors were upright while the mandibular incisors were slightly retroclined which was consistent with the patient's Class III pattern.

A diagnosis of skeletal and dental Class III malocclusion, with a normodivergent facial pattern, an edge-to-edge bite, moderate mandibular arch crowding, and mandibular midline deviation was inferred.

TREATMENT OBJECTIVES

The primary treatment objectives were to manage the patient's chief complaint of mandibular incisors crowding and to achieve an overbite. Other objectives were to establish a Class I molar and canine relationship on both sides, close the space of the extracted maxillary molar, and to center the lower dental midline with the upper midline. Additionally, treatment aimed to reduce the lower lip protrusion and to manage the tongue thrusting habit.

TREATMENT ALTERNATIVES

Given that the patient's profile was acceptable, and the skeletal problem was mild, orthognathic surgery was not considered a treatment option. Orthodontic camouflage involving extraction of the mandibular first premolars or a mandibular incisor was proposed. Another treatment option was to use temporary anchorage devices (TADs) as skeletal anchorage for distalization of the mandibular arch following extraction of the mandibular third molars. The patient accepted camouflage treatment but requested that no teeth were to be extracted and that no invasive procedures were to be performed. In addition, the patient asked for an aesthetic treatment. Hence, a non-extraction treatment plan that included the use of clear aligners was selected to achieve the treatment objectives.

TREATMENT PROGRESS

The initial ClinCheck (Align Technology, San Jose, Calif) is shown in figure 3, A. The clinician requested addition of attachments on lower left second premolar, lower left first molar, lower right first molar, and lower right second molar. The adjusted ClinCheck is shown in figure 3, B. The mechanics used aimed to distalize the mandibular molars sequentially and control the mandibular incisors torque with 3.5 mm of interproximal reduction (IPR) in the lower arch.

The first set of aligners included button cuts on the maxillary right second molar and left first molar, with precision cuts on the mandibular canines to aid in Class III elastics wear. The patient was instructed to wear 4.5 oz elastics from a button placed on the maxillary molars to the mandibular canines on both sides. The elastics were also prescribed to aid in closing the extraction space of upper right first molar. Optimized attachments on premolars were utilized to aid in bodily movement of the premolars following third, second and first molar distalization sequentially.

Forty-nine aligners were generated using ClinCheck software to distalize the mandibular molars sequentially, changing each pair of aligners every 10 days as recommended. At the end of the first set of aligners, the patient complained of loose aligners. The second set of aligners (25 stages) was fabricated as a refinement with optimized deep bite attachments added on the premolars to flatten the curve of Spee (Figure 3, C). One more refinement (17 stages) was needed to obtain overcorrection and control the incisors torque (Figure 3, D).

Myofunctional training to eliminate the tongue thrusting habit was performed throughout the orthodontic treatment period. Tongue training was done by the patient by placing the tongue behind the maxillary incisors and elevating the dorsum of the tongue to touch the palate during swallowing.

The total treatment time was 33 months. At the end of treatment, maxillary and mandibular fixed retainers (Remanium® Stangendraht, Dentaurum Gmbh & Co. KG, Ispringen, Germany) were bonded from canine to canine. In addition, vacuum formed Vivera™ retainers (Align Technology, San Jose, Calif) were delivered to the patient, recommending that they be worn 24 hours a day for the first two months after the end of the active treatment, and then progressively reducing the number of hours until they were to be worn only at night. Additionally, the patient was instructed to continue the tongue exercises during the retention period to improve the stability of the results.

TREATMENT RESULTS

The post-treatment records demonstrated that all the treatment objectives were achieved. Extraoral photographs (Figure 4, A-C) showed an improvement in facial aesthetics both in the frontal and lateral view, where the lip protrusion was reduced. Intraorally, Class I canine relationship was achieved on both sides. The crossbite was successfully corrected and a positive overjet and overbite were obtained (Figure 4, D-F). Moreover, the maxillary and mandibular arches were aligned (Figure 4, G and

4, H) The tongue posture and function were improved by the end of the treatment.

The final radiographs are shown in figure 5. The panoramic radiograph showed acceptable root parallelism. However, the periodontal status of the maxillary right second molar deteriorated, and an angular intra-osseous bone defect developed, thus the patient was referred for periodontal consultation. The cephalometric tracings and superimposition revealed that the inclination of the maxillary incisors increased, while the mandibular incisors became slightly retroclined (Figure 6 and Table 1). The cephalometric superimposition confirmed the distal movement of the mandibular molars with minimal distal tipping. As expected for a non-growing patient, there were no differences in the position of the maxilla or the mandible. At the end of the therapy, the patient was satisfied with his dental and facial appearance.

Figure 1. Pre-treatment photographs of the patient. **A, B, C,** Extra-oral photographs; **D, E, F, G, H,** Intraoral photographs.

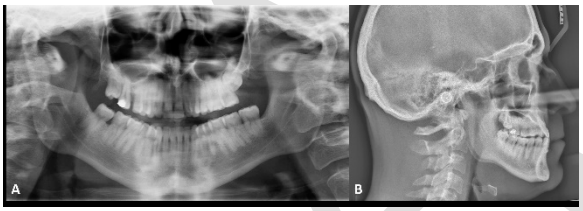

Figure 2. Pre-treatment radiographs of the patient. **A,** Panoramic radiograph; **B,** Lateral cephalometric radiograph.

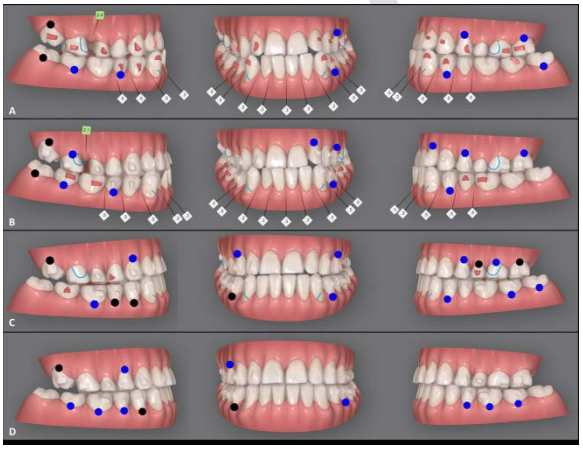

Figure 3. ClinCheck (Align Technology, San Jose, Calif) of the patient. **A,** Initial ClinCheck, **B,** Initial ClinCheck after requesting addition of attachments, **C,** First refinement, **D,** Second refinement.

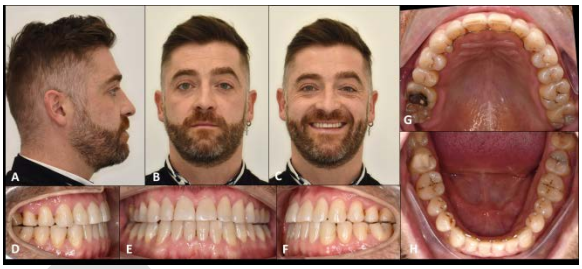

Figure 4. Post-treatment photographs of the patient. **A, B, C,** Extra-oral photographs; **D, E, F, G, H,** Intraoral photographs.

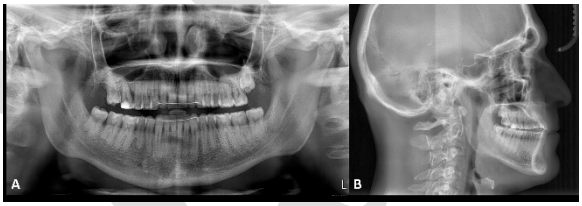

Figure 5. Post-treatment radiographs of the patient. **A,** Panoramic radiograph; **B,** Lateral cephalometric radiograph.

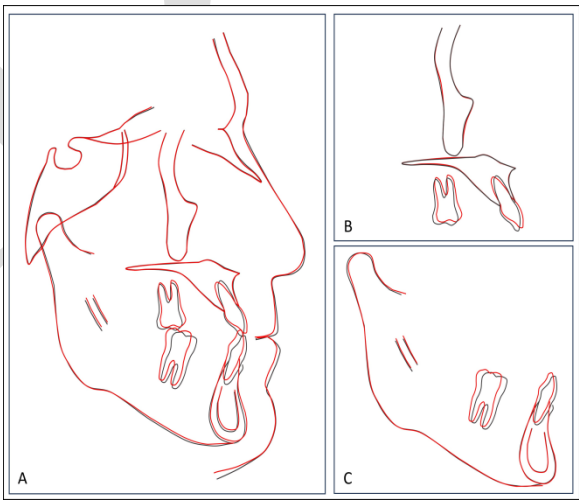

Figure 6. Cephalometric superimposition before treatment (black) and after treatment (red); **A,** Overall superimposition; **B,** Maxillary superimposition; **C,** Mandibular superimposition.

Table I. Pre- and Post-treatment lateral cephalometric measurements

Variable	Pre-treatment	Post-treatment	Change
Sagittal skeletal relations			
Maxillary position- SNA (°)	83.73	83.75	0.02
Mandibular position- SNB (°)	84.05	83.80	-0.25
Maxillary mandibular relation- ANB (°)	-0.32	-0.05	0.27
Wits appraisal (mm)	-5.21	-4.19	1.02
Vertical skeletal relations			
Mandibular plane inclination- SNˆMand Plane (°)	28.18	28.55	0.37
Occlusal plane inclination- SNˆOcc Plane (°)	13.06	12.53	-0.53
Dental relations			
Interincisal angle- U1ˆL1 (°)	129.22	124.68	-4.54
Incisor mandibular plane angle- L1ˆMand plane (°)	91.84	92.00	0.16
Lower incisor inclination- L1ˆNB (°)	26.64	24.84	-1.80
Lower incisor position-L1/NB (mm)	3.92	2.52	-1.40
Upper incisor inclination-U1ˆNA (°)	24.46	30.22	5.76
Upper incisor position-U1/NA (mm)	3.45	4.55	1.10
Lower first molar inclination- L6ˆMand plane (°)	89.74	87.97	-1.77
Lower first molar position- L6/Pterygoid vertical (mm)	24.70	22.11	-2.59
Lower second molar inclination-L7ˆMand plane (°)	91.29	89.63	-1.66
Soft tissue relations			
Lower lip protrusion- Llip/S-line (mm)	-1.54	-2.84	-1.30
Upper lip protrusion- Ulip/S-line (mm)	-3.44	-4.34	-0.90
Z-angle (°)	82.15	85.72	3.57
Nasolabial angle (°)	91.00	92.53	1.53

DISCUSSION

Class III malocclusion is one of the challenging problems commonly encountered in the orthodontic office. Its prevalence ranges between 0.7 % and 19 % in the general population, with Caucasians having a mean prevalence of 5.92 %. (8, 9) Skeletal Class III malocclusion may result from underdevelopment of the maxilla, overdevelopment of the mandible, or a combination of both. (10-12) Dentally, Class III malocclusion may present in the form of Class III molar relationship and negative anterior overjet, or it may be compensated by proclined upper incisors and retroclined lower incisors. (13, 14)

For an adult patient with severe skeletal Class III malocclusion, the orthodontic treatment commonly involves orthognathic surgery to correct the skeletal discrepancy. (15) On the other hand, in less severe cases, the goal of orthodontic therapy is usually to correct the molar and canine relationship, and to normalize the anterior overjet to camouflage the skeletal problem. Mandibular arch distalization is one of the main methods that can be employed to achieve such goals. (2)

Mandibular molar distalization is considered a difficult movement to achieve owing to the high bone density and the morphology of the molar radicular region. (16) Some of the commonly used techniques to achieve such movement are the use of open coil springs on fixed appliances (17) or the use of lip bumpers. (18) However, anchorage loss in the anterior region, along with mandibular incisor proclination, are the main adverse effects of the abovementioned distalization techniques, which in turn hampers the correction of the overjet and may increase the lower lip protrusion. (19) Another option is to use temporary anchorage devices to evade the side effects on the mandibular incisors. (20) Nevertheless, such technique is invasive and may be associated with complications. (21)

Currently, the use of clear aligners has greatly facilitated distalization movements. The sequential distalization and staging of tooth movement allows better anchorage control. (22) Distalization of the maxillary molars has been profoundly studied in the orthodontic literature. The efficacy of clear aligners in distalizing maxillary molars between 1.5 -3 mm (3, 23, 24) has been previously shown. Contrarily, there is a lack of literature describing the treatment of Class III adult patients with mandibular arch distalization using clear aligners. Several case reports described the treatment of Class III patients using clear aligners,

nevertheless, all the patients had the mandibular third molars extracted to allow first and second molar distalization and the distalization in these studies ranged between 2.5 mm to 3 mm. (7, 22, 25, 26)

Extraction of the mandibular third molar may facilitate the distalization movement by creating more space in the retromolar area. However, such an invasive procedure may be associated with increased morbidity and complications, especially when the third molar lies in close proximity to vital structures. (27)

In addition to facilitating distalization, clear aligners have grown in popularity over the past years owing to their better esthetics and simplicity, and due to the advances in auxiliaries, attachments, and aligner materials (28, 29). Accordingly, after discussing the various treatment alternatives with the patient, the use of clear aligners for distalization of the mandibular arch was selected. In addition, a non-extraction treatment approach was selected based on the patient's preference.

The patient's main concern of dental crowding was successfully addressed at the end of treatment. Mandibular arch distalization in addition to IPR allowed the alignment of the lower incisors without increasing their inclination. On the contrary, the inclination of the maxillary incisors increased following treatment, possibly because of the prolonged use of Class III elastics.(30, 31) Previous research investigating the distalization of the mandibular arch has reported significant retroclination of the mandibular incisors amounting to -4.78°. (6) Adding a refinement stage in the current case allowed good mandibular incisors torque control. The change in the maxillary and mandibular incisors inclination was accompanied by a decrease in the patient's lip protrusion.

Attachments were placed on the mandibular canines, the mandibular premolars and on the first and second mandibular molars to enable distalization of the teeth. Contrarily, Rota et al (6) did not place attachments on the posterior teeth during their distalization, instead, rectangular attachments were placed after distalization of each tooth was complete to support the movement of the following tooth. Significant distal tipping of the first and second molars was reported in the study by Rota et al (-5.03° and -4.47°, respectively). The use of attachments during distalization was deemed necessary for the patient described in the current case report because of the presence of the third molars. In addition, the attachments allowed better control over the molar tipping. Previous research on maxillary molars distalization showed that placing attachments on the molars to be distalized resulted in higher accuracy of bodily movement. (32) The post-treatment records of the patient showed that mandibular arch distalization took place despite retaining the third molars and not placing attachments on them. Moreover, the amount of distal molar tipping measured on the lateral cephalometric tracing in the current study was minimal. However, it is crucial to note that 2.59 mm of mandibular first molar distalization was achieved in the current case although an amount of 2.8 mm was initially planned on the ClinCheck. This is in accordance with previous research that showed that prediction is overestimated. (33)

A part of the patient's chief complaint was the shallow overbite, which was successfully corrected at the end of treatment. The use of clear aligners to address the patient's concerns possibly facilitated deepening of the bite by allowing vertical control and counteracting the extrusive effect of the Class III elastics. Good vertical control was evident in the current case by the minimal change in the mandibular plane angle. A similar result was previously obtained using clear aligners to distalize the mandibular arch following third molars extraction.(6) The occlusal coverage by the aligner material has been previously shown to result in intrusion of the posterior teeth through a bite-block effect.(34) Moreover, coverage of the incisors may have facilitated the tongue exercises, hence, aiding in correction of the tongue thrusting habit and allowing closure of the bite. (35) Long-term follow-up of the patient is required to assess the stability of the achieved results. Despite the promising results obtained in the current case report, future research should be conducted to obtain evidence-based results regarding the efficiency of clear aligners for mandibular arch distalization with and without the presence of the mandibular third molars.

SUMMARY AND CONCLUSIONS

The case report describes the use of clear aligners for the non-extraction orthodontic treatment of an adult patient with mild skeletal Class III malocclusion. Clear aligners were effective in distalizing the mandibular arch without the need for extraction of the mandibular third molars. The correction of the Class III discrepancy was also achieved by IPR in the mandibular arch and proclination of the maxillary incisors. Therefore, such treatment may be considered an alternative treatment option for mild to moderate Class III malocclusion patients requesting non-extraction treatment.

Statement of informed consent

Informed consent was provided by the patient.

DECLARATIONS

Authors declare that they have no conflict of interest.

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