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Abstract

This 13-year-old female had a severe Angle's Class III malocclusion with an excessive negative overjet 7 mm, anterior open bite 2 mm, a prognathic chin and a concave lateral profile. But this patient and her parents refused orthognathic surgery. Finally, she was treated with a non-surgical and non-extraction approach. The treatment plan consisted of total distalization of mandibular dentition with bilateral temporary anchorage device (TAD) and maxillary incisor extrusion with vertical elastics. The active treatment period was 34 months. Normal overbite, overjet, and acceptable profile were achieved.

Keywords

reverse bite; anterior open bite; temporary anchorage device (TAD); distalization

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NON-SURGICAL AND NON-EXTRACTION ORTHODONTIC TREATMENT OF AN EXCESS REVERSE BITE WITH ANTERIOR OPEN BITE

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This 13-year-old female had a severe Angle's Class III malocclusion with an excessive negative overjet 7 mm, anterior open bite 2 mm, a prognathic chin and a concave lateral profile. But this patient and her parents refused orthognathic surgery. Finally, she was treated with a non-surgical and non-extraction approach. The treatment plan consisted of total distalization of mandibular dentition with bilateral temporary anchorage device (TAD) and maxillary incisor extrusion with vertical elastics. The active treatment period was 34 months. Normal overbite, overjet, and acceptable profile were achieved. (*Taiwanese Journal of Orthodontics*. 32(2): 93-103, 2020)

Keywords: reverse bite; anterior open bite; temporary anchorage device (TAD); distalization

INTRODUCTION

Several studies reported that a Class III malocclusion is a common problem in orthodontic patients of Asian or Mongoloid descent.¹⁻³ Cases of the Class III malocclusion are the result of mandibular prognathism in common. However, some cases are the result of deficient maxilla, or combination of both.⁴ There are three main treatment options for skeletal Class III malocclusion cases, including growth modification, camouflage orthodontic therapy, and orthodontic treatment combined with orthognathic surgery.^{5,6} The choice of treatment methods are decided by the growth status and the severity of skeletal discrepancy of patients.

When a patient has a skeletal Class III jaw discrepancy that exceeds orthodontic range of correction with little or no growth potential, orthognathic surgery in conjunction with orthodontic treatment might be the best way to achieve both ideal occlusal and esthetic outcome. If patients consent to orthognathic surgery, subsequent orthodontic treatment will become simpler with superior functional and esthetic outcomes. However, orthognathic surgery requires more financial and biological costs that need a strong motivation of the patient. Thus, orthodontic camouflage treatment may be an alternative option when the jaw discrepancy was mild to moderate.⁷ The application of the temporary anchorage device (TAD) increases the treatment possibilities and range of tooth

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movement of orthodontic camouflage for patients with skeletal problem.^{7,8}

This case report presents the camouflage orthodontic treatment of Class III malocclusion with an excess reverse bite and anterior open bite by mini-screws and vertical elastics.

CASE REPORT

A 13-year-old female had chief complaint of a prognathic mandible and anterior crossbite. Her first visit to our department was at age of 12. Her menarche initiated at 6 months before then. She had a family history of Class III malocclusion. In the functional examination, she denied any TMJ symptoms or other parafunctional habits. The habits of mouth breathing and tongue thrusting were reported.

Extra-oral examination

The frontal view revealed a symmetric facial profile and lip competency. From smiling view, deficient display

of upper incisors and anterior open bite were noted. Her lateral profile was concave with acute nasolabial angle and prominent chin. Her mandible could not be guided to an edge-to-edge incisal position. She didn't have CO-CR discrepancy as well (Figure 1).

Intra-oral examination

Her dental manifestation presented Angle's Class III molar and canine relationships in both sides, with an excessive 7 mm negative overjet and 2 mm open bite. The upper dental midline was coincided with facial midline while lower dental midline deviated to her left by 2 mm. Lower dentition exhibited dental space of total 6.5 mm. Upper dentition was crowding and existed 5.5 mm space deficiency with bilateral partial posterior lingual crossbite at premolar area. Severe rotation of tooth 35, 45 was noted (Figure 1).

Radiographic examination

The panoramic film demonstrated intact bilateral



Figure 1. Pre-treatment extra-oral and intra-oral photographs.

condyles and rami, and developing three wisdom teeth follicles (Figure 2). From lateral cephalometric analysis (SNA 89.0 °, SNB 89.0 °, ANB 0.0 °, and SN-MP 30.5 °), the patient was diagnosed as skeletal Class III with normal mandibular plane angle. Upper incisors were proclined (U1-SN: 121 °) with crowding, and lower incisors were proclined (L1-MP :116.5 °) with spacing. The Wits appraisal was -12 mm. Patient had a concave lateral profile with upper lip retrusive to E-line by 0.5 mm and lower lip protrusive to E-line by 2.5 mm (Table 1).

Diagnosis

The patient had skeletal Class III jaw relationship with normal mandibular plane angle and dental Angle’s

Class III malocclusion with anterior open bite and excessive cross-bite. In soft tissue aspect, she had a concave profile with protrusive lower lip.

Treatment objective

The treatment objectives included: (1) correct the anterior cross-bite and open bite to achieve normal overjet and overbite; (2) leveling and alignment, close all spaces and correct posterior cross-bite; (3) achieve bilateral Class I canine and molar relationship and coincide dental midline with facial midline; (4) establish a stable functional occlusion and prohibit oral habit of tongue thrusting; (5) improve smile arc and harmonize the facial profile to achieve better esthetic outcome.

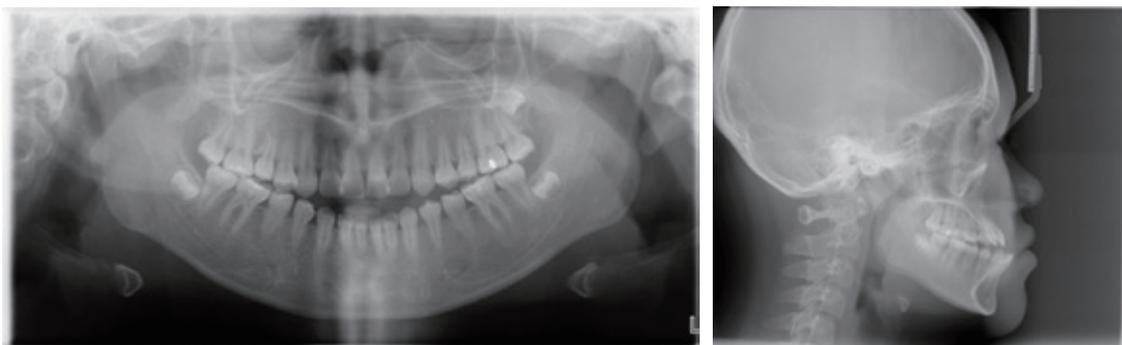


Figure 2. Pre-treatment radiographs.

Table 1. The data for cephalometric analysis before and after treatment.

		Pre-treatment	Post-treatment	Norm
Skeletal Analysis				
SNA°		89	89	83.3±2.6
SNB°		89	88.5	88.4±2.5
ANB°		0	0.5	2.8±1.8
SN-MP°		30.5	33	31.5±4.1
Dental Analysis				
Upper 1 to NA mm		6	4	3.9±2.3
Upper 1 to SN°		121	111	105.2±6.3
Lower 1 to NB mm		10.5	3.5	5.8±1.3
Lower 1 to MP°		116.5	84	94±5.7
Facial Analysis				
E-line	Upper	-0.5	-2	1.5±1.2
	Lower	2.5	-2	1.1±0.8

Treatment plan

Since this patient and her parents refused to consider orthognathic surgery, we proposed her the camouflage treatment plan with non-surgical approach. No further tooth extraction was planned for this patient. The excessive anterior cross-bite was corrected by the retraction of lower anterior teeth, distalization of posterior teeth with Class III elastics and aided by TADs at lower bilateral buccal shelf for anchorage. The correction of anterior open bite was achieved by the extrusion of upper and lower anterior teeth with wire leveling and vertical elastics. Upper arch crowding was relieved and posterior cross-bite was corrected by arch expansion and the extrusion of anterior teeth. The lateral profile was improved by the retraction of lower lip and the rotation of mandible in clockwise direction. We instructed this patient to perform tongue and lip training. She had quit the tongue thrusting habit through the entire orthodontic treatment period. Finally, the occlusion was finished with Class I canine and molar relationship.

Treatment progress

Patient was observed for the occlusion, serial cephalographs and body height in every 6 months before initiation of treatment. After one year follow up, no obvious dental and skeletal changes were found in model record and cephalometric analysis. Her body height was not increased during this year. Her growth potential went toward the end and occlusion was not changed significantly.

Orthodontic treatment was carried out by full mouth bonding with the pre-adjusted 0.022-inch slot brackets. The initial alignment and leveling was carried out with 0.014-inch Damon NiTi wire in upper arch and 0.014-inch NiTi wire in lower arch. After 6 months of initial alignment, the arch wire was gradually changed to .016" x.025" Damon NiTi wire in upper arch. At the same time, the wire of lower arch was changed into .016" x.022" SSW and bilateral TADs were inserted into the buccal shelves. The anterior retraction was performed with power chain attached to TADs and the lower dentition (Figure 3). The patient was instructed to wear bilateral Class



Figure 3. Extra-oral and intra-oral photography after 2 years of treatment.

III elastics (1/4" 4.5 oz.) for the correction of Class III molar relationship while .016"x .022" SSW was applied on upper arch. When positive overjet was achieved, she started to wear bilaterally anterior short vertical elastics (3/16", 6.0 oz.) from maxillary canine to mandibular canines and first premolars to correct the remaining anterior open bite. At the same time, upper arch was changed to 0.020-inch Australian wire for more extrusion of maxillary anterior teeth. The lower arch was changed to full-sized 0.018x .025-inch SSW to finalize the root angulation and torque.

After the total treatment time of 34 months, all fixed appliances were removed. The upper wraparound and lower 3-3 bonded fixed retainers were used for retention.

Treatment result

After treatment, Class I canine and molar relationships were achieved with 2 mm overjet and 2 mm overbite. The proclination of maxillary and mandibular

incisors were improved and all dental spaces were closed. The root parallelism of full mouth teeth was acceptable. A stable functional occlusion and good interdigitation was also achieved. The posterior lingual cross-bite was fully corrected. The patient's profile was improved to straight facial profile, symmetry and good facial proportion (Figure 4, 5). All data of cephalometric analysis after treatment were presented in Table 1.

From the overall superimposition, the mandible was rotated 2.5 degrees in clockwise direction. Upper lip was retracted 2 mm and lower lip was retracted 5.5 mm. From the maxillary superimposition, maxillary incisors were retracted 1 mm and extruded 3 mm, and maxillary first molar was extruded 2 mm. From the mandibular superimposition, mandibular incisors were retracted 9 mm and extruded 1mm, and lower first molar was distalized 3.5 mm and uprighted (Figure 6).



Figure 4. Post-treatment extra-oral and intra-oral photographs.

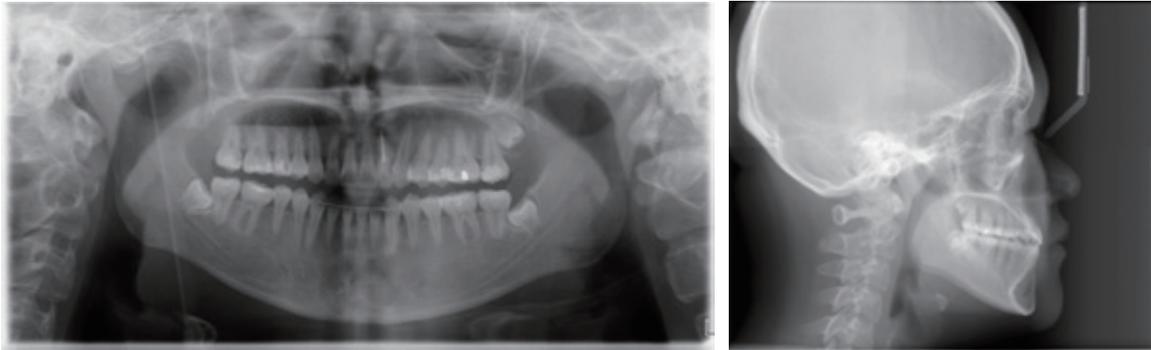


Figure 5. Post-treatment radiographs.

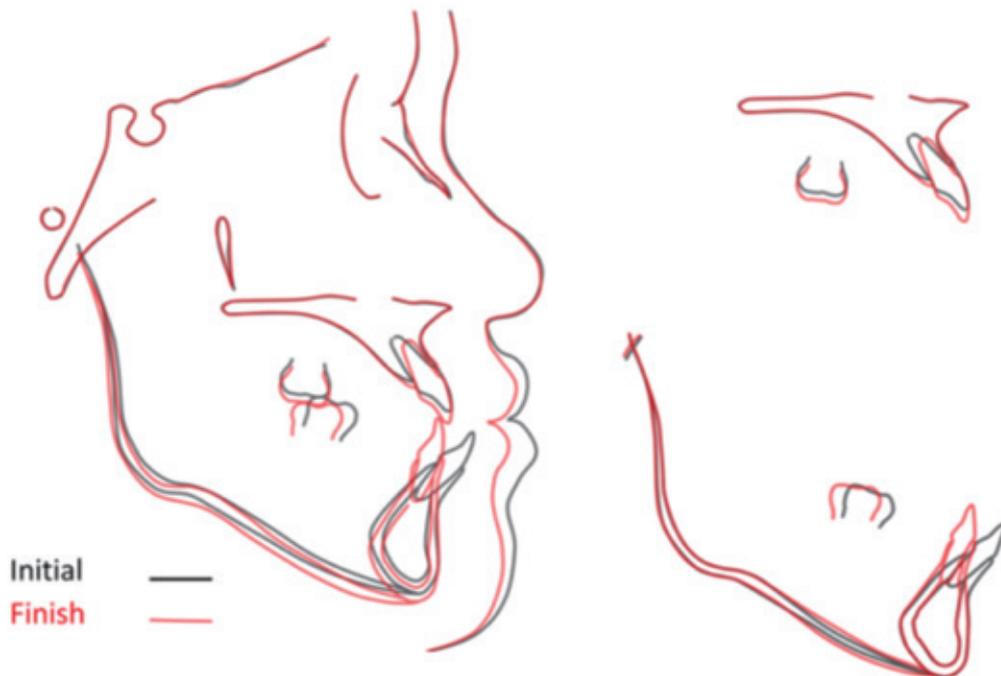


Figure 6. Cephalometric superimpositions. Overall superimposition registered on the cranial base and S point, maxillary superimposition on the palatal plane and mandibular superimposition on the anterior internal cortex of symphysis and mandibular lower border.

DISCUSSION

In patients with Class III jaw discrepancy, one question must be always addressed by orthodontists: is it possible to correct with camouflage treatment? It has been found in discriminant analysis that “Wits” appraisal is the most important factor to decide whether the orthodontic camouflage treatment or surgical options is favorable.⁹ A “Wits” appraisal of 0 to -5 mm may indicated that the Class III problem could be solved by orthodontic camouflage treatment or interceptive orthodontic (facemask or chin cup) therapy.¹⁰ Growth modification should be initiated before the pubertal growth spurt; after that, only orthodontic camouflage or orthognathic surgery is possible.^{11,15} The severity of Class III malocclusion in adult cases would define whether the patient is suitable for surgery or orthodontic treatment.¹² Both the Harvold and Wits analyses are aimed solely at describing the severity or degree of jaw disharmony. Wits analysis (mean, 0.1mm, S.D. 1.77) was commonly used to overcome the limitations of ANB as an alternative indicator for jaw discrepancy.¹³ In this case, the Wits appraisal was -12 mm, which indicated severe jaw disharmony.

Tseng et al. reported that for skeletal Class III malocclusion who requires surgical correction met any 4 out of these 6 measurement criteria, including overjet, ≤ -4.73 mm; Wits appraisal, ≤ -11.18 mm; L1-MP angle, $\leq 80.8^\circ$; Mx/Mn ratio, $\leq 65.9\%$; overbite, ≤ -0.18 mm; and gonial angle, $\geq 120.8^\circ$. The sensitivity was 88% and the specificity was 90% in determining the need for surgical treatment.¹⁴ According to the cephalometric analysis of this patient, the patient met 4 criteria (overjet, -7 mm ≤ -4.73 mm; Wits appraisal, -12 mm ≤ -11.18 mm; overbite, -2 mm ≤ -0.18 mm; gonial angle, $126^\circ \geq 120.8^\circ$). Therefore, an orthognathic surgery should be a proper treatment plan for her. However, this patient and her parents rejected this option and chose the camouflage treatment instead.

Because the patient could accept her facial profile

as the Holdaway angle is 13° , which is favorable for camouflaging a Class III malocclusion. Rabie et al. reported that 12° of the Holdaway angle could be a guideline in determining the treatment modalities for borderline Class III patients.¹⁵ They suggested that patients with a Holdaway angle greater than 12° can be successfully treated by orthodontics alone, while patients have Holdaway angles less than 12° would require surgical treatment. The preferences of operators and patients were also important. Benyahia et al. conducted similar study and found a threshold or borderline value of 7.2° , thus suggesting that patients with Holdaway angles above this value could be successfully treated by orthodontics without the need for orthognathic surgery.¹⁶ Abdolreza Jamilian et al. also reported that cases with a Holdaway angle greater than 10.3° and Wits appraisal greater than -5.8 mm could be treated successfully by camouflage, while those with Holdaway angle of less than 10.3° and Wits appraisal less than -5.8 mm could be treated surgically.¹⁷ Moreover, Kerr et al. suggested that surgery should be performed in patients with ANB and incisor mandibular plane angles smaller than -4° and 83° , respectively.¹⁸ In this case, her ANB was 0° and lower incisor to mandibular plane angle was 116.5° that were also beneficial to camouflage a Class III malocclusion. According to these analyses and patient's preference, we decided to challenge the camouflage orthodontic treatment instead of surgery for this patient.

Camouflage treatment is the displacement of teeth relative to their supporting bone to compensate for an underlying jaw discrepancy.¹⁹ An extraction treatment to camouflage a skeletal malocclusion was common and developed in the 1930s and 1940s.¹⁹ The strategy to camouflage a Class III malocclusion is usually proclination of the maxillary incisors and retroclination of the mandibular incisors to improve the dental occlusion. The extraction of mandibular first premolars were common for more lower anterior retraction.²⁰ Mandibular anterior teeth may be easily retracted to lingually tilting when lower first

premolars are extracted. To avoid lingual inclination lower incisors, non-extraction therapy with the reinforcement of lower TADs was suggested to patient. On the other hand, Kee-Joon Lee et al. found that the mandibular posterior anatomic limit for molar distalization was in the lingual cortex of the mandibular body.²¹ Furthermore, Nikia R. Burns et al. reported that the upper and lower limits for incisal movement to compensate for Class III skeletal changes were 120° to the sella-nasion line and 80° to the mandibular plane, respectively.²² Because she had protrusive lower lip and her mandibular incisors flared out with spacing. Bilateral mandibular third molars were still in follicles. Therefore, the mandibular incisors could be retracted by the closure of residual spaces in dentition and distalization of mandibular posterior teeth with the assistance of TADs. In this case, the correction of reverse overjet was achieved successfully by retraction and tipping of the mandibular incisors, distalization of mandibular posterior teeth and clockwise rotation of the mandible. Finally, her mandibular incisors were retracted 9 mm and extruded 1mm, mandibular incisors to mandibular plane angle was 84°, mandibular first molar was distalized 3.5 mm and uprighted.

Proclination of maxillary incisors is often indispensable in camouflage treatment of the anterior cross-bite. Labioversion of the maxillary incisors can easily ruin a pleasing smile, especially for a patient with Class III facial type.²³ To avoid excessive proclination of maxillary incisors, distal en masse movement of mandibular dentition should be achieved as much as possible in Class III camouflage treatment. The advent of skeletal anchorage increases the reliability and effectiveness since it does not require patient's compliance and the side effects are minimal. In this case, the distalization of mandibular dentition with TADs creates enough overjet to upright and extrude the labially inclined maxillary incisors therefore improves smile arch of the patient.

What is the mechanism for this patient to camouflage a Class III malocclusion? The most contributing factor

to correct her dental and skeletal discrepancies was the dentoalveolar compensation which was achieved by retraction of the mandibular dentition. The compensation of mandibular dentition occurred with a combination of clockwise rotation of the mandible and counterclockwise rotation of the occlusal plane (Figure 7).²⁴ One of the factors which contributed to the changes of mandibular plane and occlusal plane was wearing the Class III elastics to elongate the maxillary molars and mandibular incisors and caused further clockwise rotating of mandibular plane and counterclockwise rotation of the occlusal plane. Another factor was the direction of retraction force that applied to the TADs should be locate above the center of resistance in mandibular arch. In this way, the mandibular arch can be rotated counterclockwise when distalization, leading to a flattened occlusal plane. At the same time, molar distalization was beneficial for decreasing a negative overbite. With the combination of these factors, the anterior cross-bite could be corrected, and ideal overbite could be established (Figure 6, 8). Moreover, these mechanism was also helpful for the correction of anterior open bite for this patient due to controlled lingual and extrusive movement of the maxillary incisors and the retraction and extrusion of the mandibular anterior teeth (Figure 6).

Open bites can be classified as skeletal, dental or combination. The etiology of anterior open bite malocclusion includes genetic, anatomic, and environmental factors. Anatomic conditions such as tongue size and position, could affect the skeletal and dental components.²⁵ It has been reported that macroglossia had been suggested as a possible factor of open bite and mandibular prognathism.¹⁷ Another study indicated that characteristic tongue movements during deglutition in patients with anterior open bites were closely related to their maxillofacial morphological features.²⁶ The amount of incisor display was often insufficient for the patients in Class III malocclusion which affects aesthetic when smiling. According to the examination and photos, this patient had these characteristics such as tongue thrusting

habit, anterior open bite, flattened to reverse smile arch and flare out mandibular anterior teeth with spacing.

For these reasons, the correction of open bite is achieved by the extrusion of maxillary and mandibular anterior teeth in this patient. At the same time, tongue training was instructed to quit her tongue thrusting habit. The smile line was also improved by the extrusion of maxillary incisors and the correction of anterior cross-bite.

The patient had a tongue thrusting habit and entire mandibular arch was retracted significantly. Thus, the tongue had less space after camouflage treatment that may increase tongue pressure on mandibular incisors.

The pressure of the tongue may result in the relapse of the dental space in the mandibular teeth, anterior open bite and cross-bite again. She received myofunctional training throughout the treatment period and had a 3-3 bonded fixed retainer on the mandibular teeth to reduce the relapse and increase stability. This patient quit the tongue thrusting habit by myofunctional therapy to eliminate tongue interposition between teeth when swallowing and rest. The therapy included swallowing training, tongue lifting, and lip closing training to position the tip of the tongue at the incisive papilla during swallowing and position in the posterior region of the oral cavity at rest.²⁷

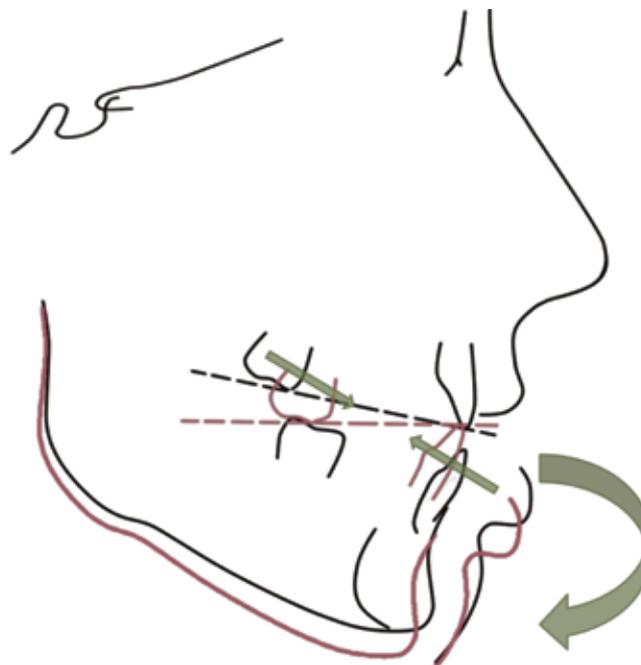


Figure 7. The Class III elastics elongate upper molar and lower incisors that causes the clockwise rotation of mandibular plane and counterclockwise rotation of occlusal plane.

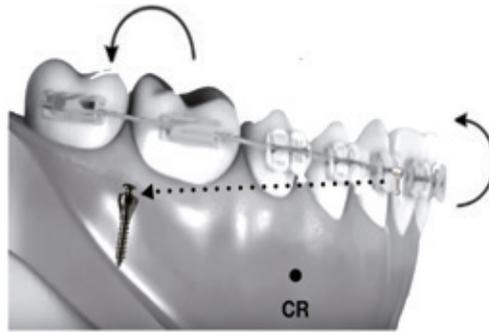


Figure 8. The dotted line presented the retraction force and the point indicated the center of resistance (CR) in the mandibular arch.

CONCLUSION

In this case report, TAD was proved to be reliable as an anchorage unit for distalization of mandibular dentition in adolescent skeletal Class III malocclusion.

Comprehension of the orthodontic biomechanics of TAD force system and inter-maxillary elastics ensure the effect of Class III camouflage treatment. The Class III malocclusion with excessive negative overjet and anterior open bite can be effectively and successfully treated by dentoalveolar correction.

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