Compensatory treatment for hyperdivergent skeletal Class II using temporary anchorage device

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Abstract

Introduction: The treatment of hyperdivergent skeletal Class II is one of the most challenging tasks facing orthodontists. With the advent of temporary anchorage devices, patients who were previously submitted to orthognathic surgery may be favored by a counter-clockwise rotation of the mandible, resulting from vertical control of the posterior teeth. Also, cases with increased incisor display at rest may benefit from these biomechanics in the anterior segment. Methodology and resources: This case report illustrates the successful treatment of a patient with hyperdivergent skeletal Class II malocclusion resulting in an unaesthetic smile with excessive gingival display when smiling and absence of passive lip seal. Results: The temporary anchorage device produced a suitably functional and aesthetic result, with the correction of the increased gingival exposure, passive lip sealing and improved angulation of the mandibular plane. In addition to the conventional cephalometric superimposition, three-dimensional superimposition was performed and evaluated to validate the treatment outcome. Discussion: Although it does not replace orthognathic surgery, this modality of treatment may benefit patients who are unwilling to undergo a more invasive procedure.

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Introduction

Treatment of hyperdivergent skeletal Class II is one of the most challenging tasks facing orthodontists. The use of appropriate orthodontic devices is very important to control the vertical dimensions during the orthodontic treatment of hyperdivergent patients.[1] This condition is often caused by clockwise rotation of the mandible or excessive vertical growth of the posterior segments,[2] particularly maxillary vertical alveolar growth.

Surgical-orthodontic treatment is often the best approach when the condition has a skeletal origin, such as vertical maxillary excess. However, patients are not always willing to undergo

surgery, which makes compensatory treatment an option.[2,3] To achieve success, the nonsurgical treatment needs to induce a counterclockwise rotation of the mandible.[2,4]

The advent of temporary anchorage devices (TADs, mini-implants, MI, or mini-screws), by which the direction and the amount of force are carefully controlled, enables the successful achievement of maxillary molar intrusion.[5,6] Skeletal anchorage has enabled the treatment of some problems that were previously treated only by orthognathic surgery.[7] Patients who are referred for orthognathic surgery may be favored with the intrusion of the posterior teeth through the use of TADs and resulting counterclockwise rotation of the mandible.[8]

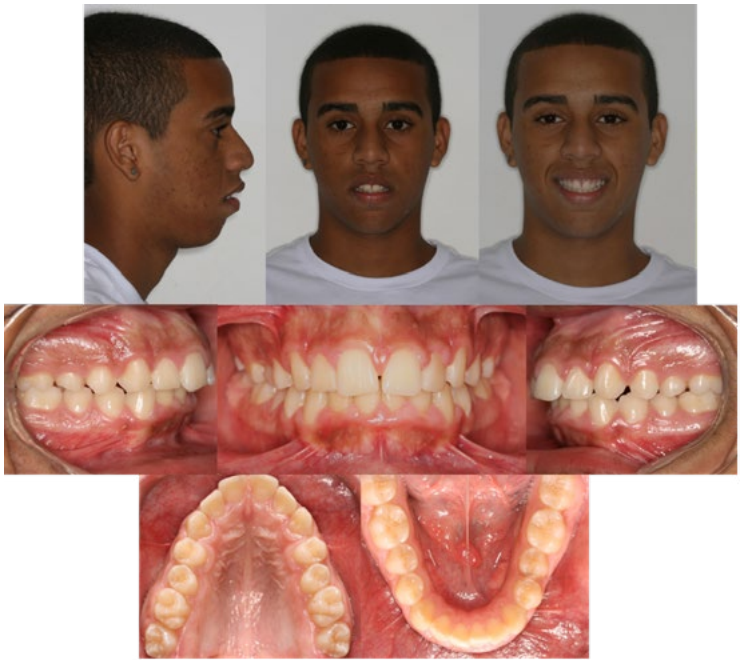
The widespread use of TADs is attributable to their relatively simple installation and to the fact that force can be applied immediately after installation. Therefore, the purpose of this report is to present a treatment option for a hyperdivergent skeletal Class II patient with increased gingival display and increased lower facial height.

Diagnosis and etiology

A 14-year-old male patient in good general health sought orthodontic treatment at the orthodontic clinic of the Federal University of Rio de Janeiro. He was unhappy with the position of his anterior teeth.

Extra-oral evaluation revealed a convex Class II profile. No evident facial asymmetry was found. The patient had a hyperdivergent facial pattern, increased lower facial height with (clockwise) mandibular rotation, retrognathic chin, incompetent lips at rest, short nasolabial angle and obtuse mentolabial angle. The pre-treatment intra-oral photographs (Figure 1) revealed a Class I molar relationship with mild dental crowding in the mandibular dentition, moderate overbite and a 5.0mm overjet. The lower midline was deviated by 1mm to the left. There was Bolton discrepancy of 3.7mm of excess in the lower arch, including 1.7mm in the anterior region.

Figure 1. Pretreatment facial and intraoral photographs.



Source: The authors (2023).

Evaluation and analysis of cephalometric radiography showed absence of facial asymmetries and revealed skeletal Class II (ANB = 9.7o) with protrusive maxilla (SNA = 89.2o) and high mandibular plane (SNGoGn = 41.4o). The upper incisors were upright in relation to the NA line. The lower incisors were protruding and projected in relation to the NB line, but relatively well-positioned in relation to the mandibular plane (IMPA). The results of the cephalometric analysis are presented in Table 1 and Figure 2.

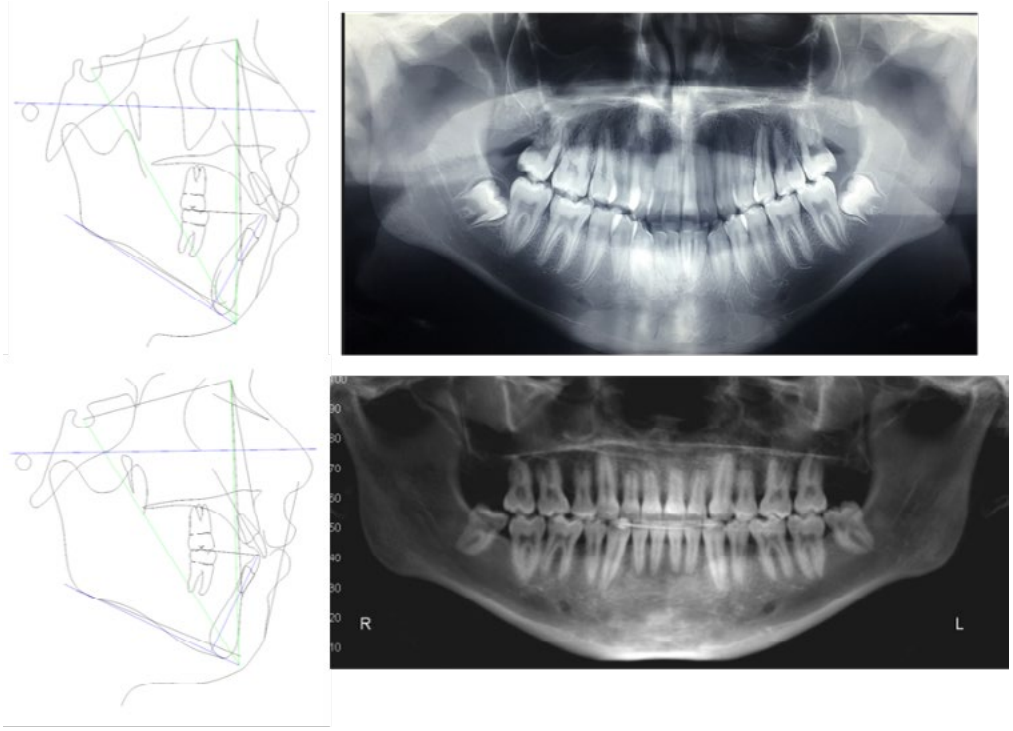
Table 1. Cephalometric measurements

Measurement	Pretreatment	Posttreatment
SNA	89.2	87.5
SNB	79.5	80.1
ANB	9.7	7.4
SND	75.6	75.7
NA.A.Pog	21.4	16.9
SN.GoGN	41.4	35,7
FMA	31.1	31,0
SGn-FH	58.9	58.4
U1-NA (mm)	2.8	0.9
U1-NA (°)	18	20.2
L1-NB (mm)	12.1	9.3
L1-NB (°)	30.9	29.2
IMPA	88.1	91.4
Pl.Ocl.SN	17.5	21.5
S.Ls	5	3.3
S.Li	10	4.4

Legend: SNA: SNA angle, indicates the position of the maxilla; SNB: SNB angle, indicates the position of the mandible; ANB: ANB angle indicates the maxilla-mandible relationship in the anteroposterior direction; SND: angle formed by line SN to point D; NA.A.Pog: convexity angle; SN.GoGN: angle formed by lines S-N and Go-Gn; FMA: angle formed by the mandibular plane and the Frankfurt plane; SGn-FH: U1-NA (mm): the distance between the tip of the upper incisor and a line from nasion to point A; U1-NA (°): angle that measures the inclination of the upper incisors; L1-NB (mm): distance from the most anterior part of the lower incisors to the NB line; L1-NB (°): angle that measures the inclination of the lower incisors; IMPA: angle between the mandibular plane and the long axis of the lower central incisor; Pl.Ocl.SN: angle formed between the SN line and the Occlusal Plane S.Ls: distance from the most prominent point of the upper lip to the S line; S.Li: distance from the most prominent point of the lower lip to the S line.

Source: The authors (2023).

Figure 2. Panoramic radiograph and lateral cephalometric tracing: A) Pretreatment; B) Posttreatment.



Source: The authors (2023).

Treatment objectives

Orthodontic treatment was introduced with the aim of: (1) alignment and leveling of the upper and lower teeth; (2) retraction of the maxillary and mandibular incisors, providing normal overjet and overbite; (3) vertical control using MI to allow for mandibular autorotation; and (4) functional correction to achieve competent lips and to reduce mentalis muscle strain.

Treatment alternatives

The first treatment option suggested was orthognathic surgery with the aim of obtaining skeletal correction and a pleasant facial profile. The procedure would combine jaw surgery with maxillary impaction, using counterclockwise mandibular rotation to reduce the long lower facial height and genioplasty to balance the facial profile. However, the patient and his family refused to accept the surgical proposal.

The second alternative was an orthodontic camouflage treatment, with the extraction of the 4 second premolars and introduction of directional force using TADs (mini-implants) to promote maxillary teeth intrusion or to restrain the maxillary vertical alveolar growth. TADs can provide absolute anchorage not only for anteroposterior movements, but also for intrusions of the maxillary anterior and posterior teeth. This treatment would facilitate a counterclockwise mandibular response, leading to a more prominent chin and a balanced facial profile.

Treatment progress

Standard edgewise orthodontic accessories were used. After extraction of the upper and lower second premolars, a pair of 0.018" stainless steel (SS) archwires were made for alignment and

leveling, followed by a 0.018"x0.025" SS archwire and the distalization of the first premolars. Canine retraction was subsequently performed, using a power chain with simultaneous loss of antero-posterior anchorage, particularly in the lower arch. Upper and lower 0.019"x0.025 SS archwires were made with tear drop loops on the distal side of the lateral incisors for incisor retraction with 1.0mm activation and incorporation of a gable effect in the upper archwire. The retraction started in the lower arch and was followed by upper arch retraction. A TAD (8mm x 1.5mm, Morelli, Brazil) was inserted in the upper midline (between the roots of upper central incisors) for intrusive biomechanics with a power chain supported directly from the TAD to the archwire with approximately 45g (0.45 Newtons) of initial force (Figure 3A). This force was gradually increased to 80g (0.8 Newtons). One TAD was also placed on each posterior side, between the maxillary first molars and maxillary first premolars for vertical control of the maxillary posterior teeth, linking the archwire to the TAD with a power chain (Figure 3B). After reaching adequate vertical control, a metallic tie was placed to link the TAD to the archwire and stabilize the anterior and posterior segments until the orthodontic appliance was removed.

Figure 3. MI in the midline, in order to intrude the anterior segment and MI posterior to upper space closure phase through sliding-jig distalization mechanics.

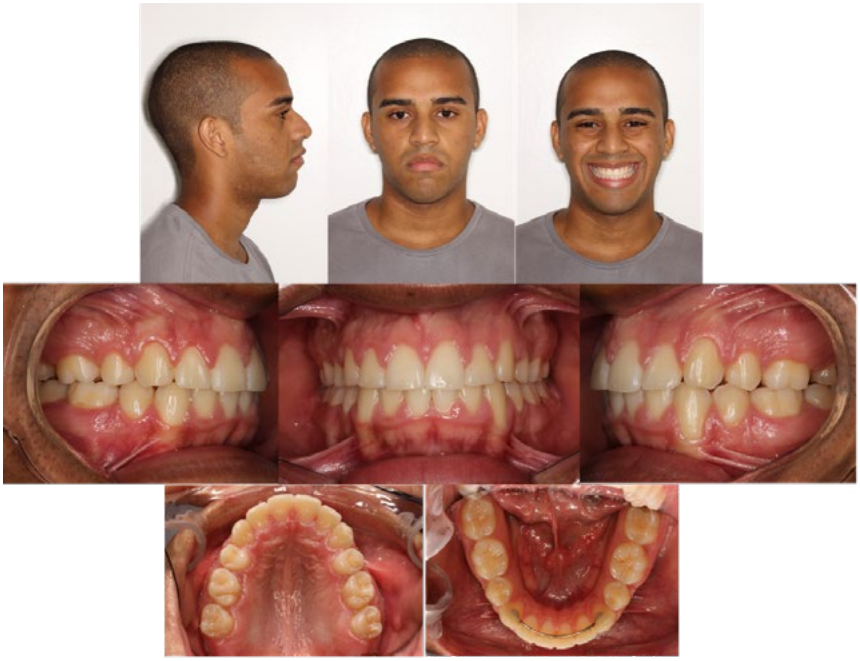
Source: The authors (2023).

Treatment results

Photographs were taken after debonding (Figure 4). Retention consisted of 3x3 lower bars bonded only at canines in the mandibular arch (lifetime) and a circumferential removable retainer in the maxillary arch (20 hours/day, first year; 12 hours/day, second year).

Evaluation of the treatment results showed a well-balanced and harmonious face resulting from less protrusive lips, improved lip seal, reduction of mentalis muscle strain, adequate display of incisors at rest, shorter lower anterior facial height and a more prominent chin.

Figure 4. Posttreatment facial and intraoral photographs.



Source: The authors (2023).

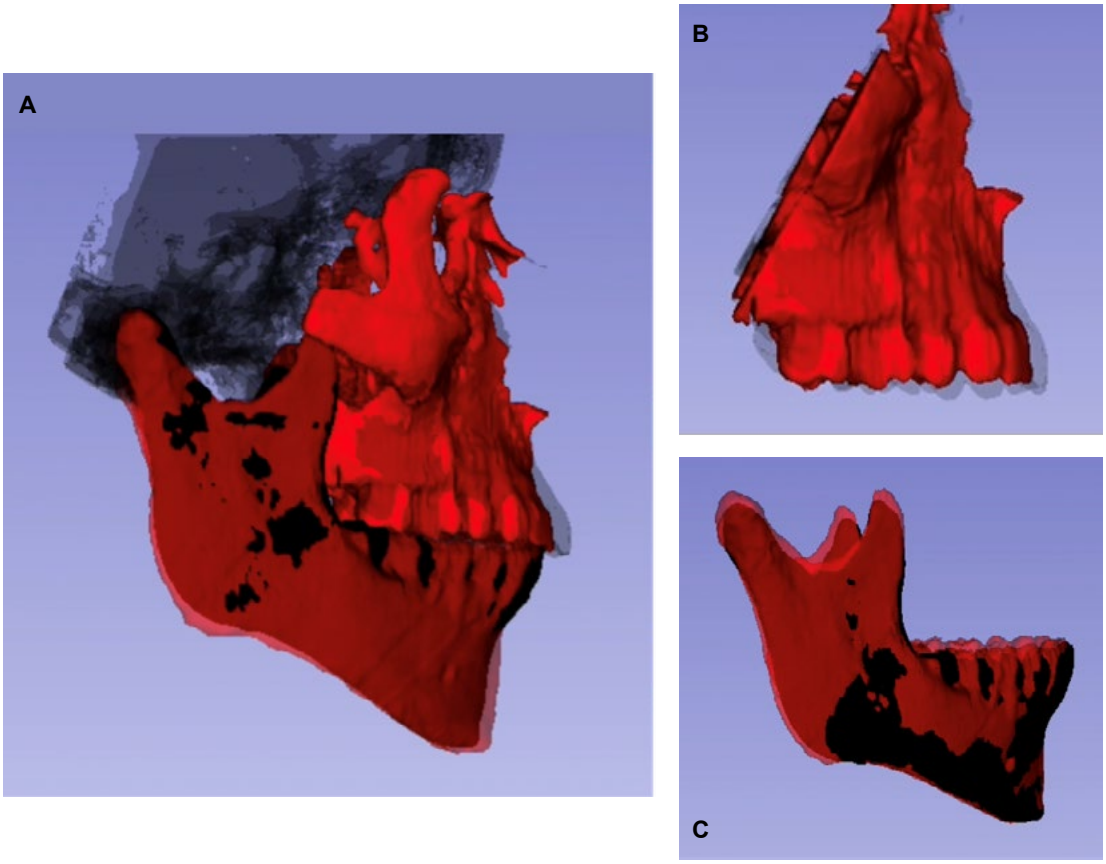
The excessively gummy smile was corrected by use of intrusive forces on the maxillary arch. An acceptable intercuspation of the teeth, good arch form, normal overjet and overbite relationship are shown in the intraoral photographs. A slight lower midline shift to the left occurred. Radiographic examination showed that good root parallelism was obtained and that the upper incisors presented mild apical root resorption (Figure 2B). The patient was referred for extraction of lower third molars.

Pretreatment and post-treatment 3D superimposition were performed (Figure 5), which demonstrated the achievement of a proper mandibular response (counterclockwise rotation) through correct directional forces (Figure 5A). The maxillary anterior teeth were retracted and intruded, while the maxillary posterior teeth were intruded (Figure 5B). The mandibular superimposition (Figure 5C) displays small condylar growth and slight incisor retraction. The results of the post-treatment cephalometric analysis are displayed in Table 1.

Discussion

The aim of this paper was to describe the orthodontic treatment with TADs of a patient with hyperdivergent skeletal Class II, retrognathic chin, excessive upper incisor display at rest, an unaesthetic gummy smile and absence of passive lip seal. Controlling the vertical dimension can be challenging, especially because high mandibular angles tend to increase during facial development.[1] Since the intrusion of posterior upper teeth is a difficult movement for patients with long faces, associated orthognathic surgery may be required. According to Wang et al,[2] or-

Figure 4. Three dimensional superimposition: A) cranial base superimposition; B) maxillary superimposition; C) mandibular superimposition.



Source: The authors (2023).

thodontic surgical treatment is often implemented in order to achieve a successful treatment for patients with skeletal involvement, clockwise mandibular rotation and gummy smile.

The effectiveness of using temporary anchorage devices during orthodontic treatment has been highlighted in previous studies,[6,9,10] since different types of orthodontic tooth movement can be achieved through their use. Furthermore, the use of TADs offers better anchorage control, in addition to eliminating the dependence on patients' compliance with the wearing of rubber bands and extra-oral appliances.[8]

In this case, the prediction of growth potential revealed that the patient had already passed the peak of the growth spurt, but some facial growth could still be expected. The biomechanics with TADs were intended to restrain the remaining vertical alveolar growth and effectively achieve intrusion of the upper teeth. These biomechanics corroborate those used by other authors,[2,6,11] who performed compensatory orthodontic treatment of skeletal Class II patients with severe high mandibular angle. TADs were used for vertical control, intrusion of both the anterior and posterior segments, and consequent favorable counterclockwise rotation of the mandible, thereby achieving successful results. According to a recent systematic review and meta-analysis,[10] mini-implants seem to be more effective than conventional anchorage for vertical control of class II treatments in adolescents after pubertal growth peak when extraction is prescribed.

Intrusion of the maxillary molars is difficult to accomplish through traditional methods of anchorage.[1,6,8] One of the limitations is related to the proximity of the upper molar roots to the sinus floor. According to Abdulghani et al,[12] intrusion of the upper molars of hyperdivergent patients is subject to a higher risk of root resorption due to the possible risk of cortical bone encroachment. We recommend a careful evaluation of the CBCT image before planning the intrusive treatment.

In 1967, Creekmore[1] mentioned that many orthodontic problems could be solved if the vertical growth of the face could be controlled. Orthodontists have tried to successfully control the vertical dimension of their patients and obtain mandibular counterclockwise autorotation using different approaches and this subject has been discussed in the literature. Wang et al[13] reported a satisfactory correlation between the amount of upper maxillary repositioning (after surgical maxillary impaction) and mandibular autorotation. Another successful method was reported by Kassem[7], who achieved mandibular autorotation with the intrusion of maxillary posterior teeth anchored in TADs (mini-plates), and confirmed by Kim et al,[14] who used mini-implants. Our treatment results for the described case report are similar to those described by Kassem[7] and Kim et al,[14] who obtained intrusion of the posterior segment with consequent mandibular autorotation and a more prominent chin. The findings of previous authors[15] show that adolescent patients tend to display more favorable effects from mandibular counterclockwise autorotation than adult patients.

Hart et al,[15] when performing open bite treatment in patients with and without growth, reported that the intrusion of upper posterior teeth using TADs is an effective non-surgical treatment modality, confirming the results found in the present case report. The camouflage treatment required extractions and differential displacement of teeth to compensate for jaw discrepancy (upper incisors displayed larger retraction than lower incisors, as shown in Figure 4), which can be an option to avoid the expenses and risks associated with orthognathic surgery.

The stability of this type of treatment may be questioned. The literature reports that the stability of molar intrusion using TADs can be considered relatively similar to that associated with surgical approaches, since 10 to 30% of relapse occurs.[16] Dental intrusion and associated orthopedic corrections, resulting from the use of TADs, remained stable post-treatment for growing patients.[17] The application of an appropriate retention method after debonding effectively enhances the long-term stability of total arch intrusion treatment.[18] The recovery of proper muscular function (passive lip seal, nasal breathing, normal swallowing and speech) is very important and usually requires an interdisciplinary approach for the treatment of hyperdivergent cases with incompetent lips and mouth breathing.

In the reported case, part of the mentalis muscle strain still persists, due to the reduction in upper lip length, but the smile is esthetically pleasant at the end of the orthodontic treatment. The lower midline shift could have been better managed during the space closure phase. TADs could also have been used in the posterior lower dentition to restrain mandibular alveolar growth and to obtain an even shorter lower third of the face. A genioplasty could improve the facial esthetics but, as mentioned above, the patient has refused to undergo surgery. The case has been followed-up for 5 years and has remained stable overall.

Conclusions

A patient with skeletal class II malocclusion with high mandibular plane was successfully treated using TADs for maxillary vertical control. The results of the orthodontic treatment were achieved: a Class I molar and canine relationship; successful esthetics and function, as evidenced by adequate gingival display when smiling; adequate incisor display at rest; more prominent chin; and harmonious facial profile. This modality of treatment may benefit patients who are unwilling to undergo a more invasive procedure.

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