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Case Report

Invisible treatment with lingual appliance for the correction of an adult class II subdivision with asymmetrical Wilson and Spee curves: A case report

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Summary

This article describes a class II subdivision malocclusion successfully treated by an invisible lingual appliance. The combination of en-masse distalization by interradicular palatal mini-screws and inner unilateral class II auxiliaries, first by intermaxillary elastic, later by a class II coil spring, resulted in a dento-alveolar correction, allowing one to maintain the appliance completely invisible. At the same time, the inclination of buccal sectors was normalized by a correct torque expression with set-up overcorrections, resulting in a significant improvement of the buccal corridors. This case report demonstrates the possibility of successfully solving class II division 2 subdivision malocclusion in adult patients without surgery by means of a completely invisible appliance. It also demonstrates that correct levelling and torque expression, for the correction of asymmetrical Spee and Wilson curves, are achievable with an accurate set-up planning. On the other hand, it underlines the necessity of mini-screws, auxiliaries and set-up overcorrections in order to obtain the best results.

Introduction

Class II subdivision malocclusions can be determined by different dental and skeletal combinations; their resolution is often challenging [1], in particular when the aetiology is mainly skeletal with an asymmetric mandible [2]. Orthognathic surgery represents the ideal solution in most cases [3] but not all patients are willing to undergo surgical treatment, since they often do not view their malocclusions or facial asymmetries as severe enough to undergo the associated risks and expense [3]. When the dento-alveolar component is predominant, an orthodontic camouflage can be successful [4]: the proposed treatment solutions include either non-extraction treatment with unilateral class II mechanics by means of distalization, elastics or functional appliance [5,6] or extraction treatment with the removal of one, three or four premolars [7].

When the patient requests a completely invisible appliance, the complexity is further increased. Few researches have been published on class II subdivision cases treated by lingual appliance [8–10], all including visible components.

The employment of skeletal anchorage can help the correction by reducing the necessity of patient cooperation [9]. En-masse distalization technique using interradicular mini-screws in

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combination with buccal appliance was proposed by Jeon et al. [11]; it has been also employed in lingual orthodontics, in combination with intermaxillary elastics, for the correction of bilateral full-step class II in adult patients [12–14].
The buccolingual inclination of buccal and posterior teeth has long been a debated topic for orthodontists. In order to obtain a suitable occlusion, maximum intercuspation and no balancing interferences, there should be no significant difference between the height of buccal and lingual cusps of maxillary and mandibular molars and premolars. The American Board of Orthodontics quantitatively evaluates proper buccolingual inclination of buccal and posterior teeth using a step gauge, in which the lingual cusps must be within 1 mm of the straight edge [15].
The curve of Spee, one of the factors specified in the six keys of occlusion defined by Andrews, ranges from flat to mild in subjects with proper occlusion [16]; in patients with a deep curve, its correction is essential in order to provide posterior teeth disclusion and anterior tooth guidance during forward movement of the mandible [17].
When significant asymmetries of Wilson and Spee curves exists, their normalization is of primary importance in order to obtain the best static and dynamic occlusion.
This article describes a class II subdivision case in an adult patient, in which sagittal correction and asymmetrical curve of Wilson and curve of Spee were normalized, by a completely invisible lingual appliance.

Case presentation

Diagnosis and aetiology

The patient presented at 27 years of age with a request to have his teeth aligned and black corridors improved, by means of a completely invisible appliance.

FIGURE 1
Initial extraoral photographs
a: frontal; b: lateral.

The face, from a frontal view, appeared well-proportioned in the three-thirds (*figure 1a*); a significant mandibular symphysis deviation towards the right side was highlighted, combined with a different height of the mandibular angles.
From a lateral view, the profile appeared regular, with an important nose, a correct nasolabial angle, a marked labiomental sulcus, a slightly retruded mandibular position and a prominent pogonion (*figure 1b*).
The skeletal pattern resulted normodivergent with a tendency to hypodivergence, with a well-represented mandibular symphysis and a counter-clockwise oriented occlusal plane. From the cephalometric values, a skeletal class II with the mandible in retruded position could be detected (*figure 2a,b*). Both upper (108°) and lower (97°) incisors turned out to be normally inclined. The orthopantomography revealed the presence of all teeth, with the exception of the third molars (*figure 2c*).

At frontal intraoral vision (*figure 3*), the midlines did not appear coincident (slight deviation of the upper towards left, significant deviation of the lower towards right); a negative torque of buccal sectors both in upper and lower arches was noticeable, even more accentuated on lower right quadrant; moreover, the significant extrusion of the left upper canine with buccal root torque also accompanied the mandibular deviation.
A downward canting of the mandibular anterior teeth to the right was noticeable, associated with differential torque on the lower canines and significant wear of the mandibular incisors. Mastication was unilateral on the right, where the vertical dimension was lowest, also stressing the buccinator and risorius, resulting in a deeper mandibular Spee curve on the right, with linguoversion of the lateral sectors. A cross bite of the upper right first molar was also visible (*figure 3*).
The lateral photographs showed an almost complete class II canine and molar, while on the left the relationship was class

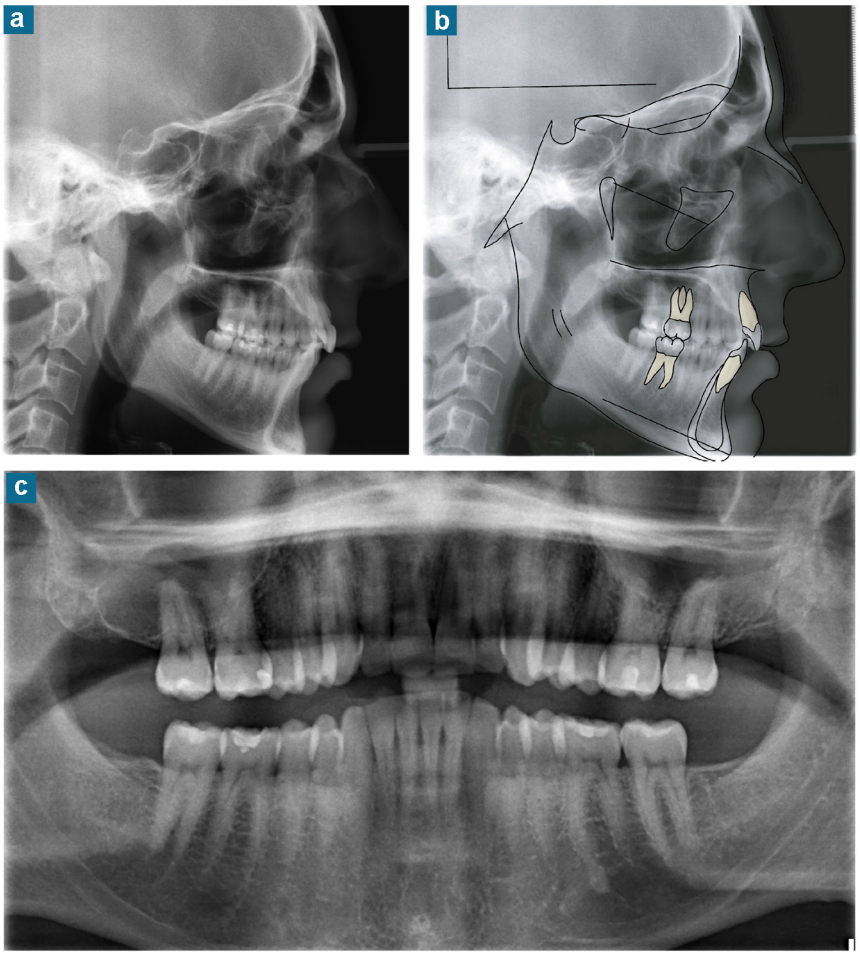

FIGURE 2

Initial radiographs

a: latero-lateral teleradiography; b: cephalometric analysis; c: orthopantomography.

FIGURE 3
Initial intraoral photographs

I. The occlusal photographs showed an asymmetrical, lyre-shaped maxillary arch with a slight mesiorotation and endoposition of the 16; the lower arch revealed a slight crowding in the left anterior area with lingual position of the lower left lateral incisor. The Wilson curve both in the upper and lower arches was accentuated in the buccal segments, with a significant linguoversion of the right mandibular hemi-arch, except for the 46. The periodontal biotype turned out to be thick (*figure 3*).

Treatment objectives and alternatives

The primary objectives were represented by the achievement of a bilateral class I relationship, upper right first molar crossbite correction, asymmetrical curve of Wilson and curve of Spee normalization.

Additional goals were upper alveolar asymmetry correction, lower crowding resolution, deep bite correction and midlines coincidence achievement.

The ideal orthodontic-surgical treatment, which would have also enabled the mandibular skeletal asymmetry correction, was illustrated to the patient without success. He was completely satisfied about his facial aesthetics and only asked for a dental correction.

Considering the profile features of the patient (important nose, well-positioned maxilla, mandibular retrusion, correct nasolabial angle), a non-extraction treatment was chosen.

No alternatives with extraction camouflage were considered.

FIGURE 4
Manual set-up

The orthodontic treatment was performed by lingual technique: that choice was driven by the patient's request for a completely invisible appliance and by the possibility of obtaining less lower incisor proclination for crowding resolution, curve of Spee flattening and class II correction due to the different biomechanics (intrusion force passing closer to the centre of resistance of the lower incisors) [18].

Although the patient's malocclusion could be treated by means of clear aligners, the entity of the lower curve of Spee and anterior deep bite [19], the full-step-class II on right side, combined with the patient's request for a completely invisible appliance, did not support this treatment option. In addition, the curve of Wilson correction by a combination of crown expansion and root-torque movement was not obtainable with clear aligners [20,21].

Orthodontic treatment was performed using the "Straightwire" lingual technique [18] and Ormco STb™ brackets (Ormco Corporation, Orange, CA), based on a manual set-up (*figure 4*).

Corrections for deep bite, narrowness, posterior crossbite and torque were included in the set-up prescriptions, as follows:

- extra anterior labial crown torque to their maxillary incisors (+5° beyond the desired outcome);
- extra anterior labial root torque to their mandibular incisors (+5° beyond the desired outcome);
- extra lingual root-torque on maxillary canines, maxillary premolars and mandibular premolars to correct black corridors and normalize curve of Wilson;
- slight mandibular reverse curve of Spee;
- vertical head to head relation (no overbite);
- 1 mm upper right first molar expansion, 1 mm lower right first molar contraction in order to correct posterior crossbite.

The brackets' bonding was carried out by "single jigs", following the "Komori system" technique, after the arches assembling performed with "Kommon base" philosophy [22].

Treatment progress

Lower arch bonding was carried out first of all. A 0.013-inch CuNiTi lingual small STb™ Straight-Wire (LSW) Ormco STb™ was inserted for the initial alignment. Two weeks later, the upper arch bonding was carried out. A 0.013-inch CuNiTi medium LSW was inserted for the initial alignment. Brackets were not bonded to upper first molars in order to allow conservative treatments. Occlusal build-ups were inserted on upper second molars with the purpose of avoiding occlusal precontacts, thus obtaining an ideal tripodic contact.

At month 1, after upper first molar bonding, a 0.018 0.018-inch CuNiTi medium LSW was inserted in the upper arch for obtaining torque establishment.

At month 2, a 0.0175 0.0175-inch TMA LSW was inserted in the upper arch to achieve posterior expansion. In the lower arch, a 0.016 0.016-inch CuNiTi LSW small was inserted for levelling and torque establishment. A button was bonded onto the buccal

FIGURE 5

Processing phase: at month 2, insertion of 0.0175 0.0175-inch TMA LSW in the upper arch and 0.016 0.016-inch CuNiTi LSW small in the lower arch

A button (46) was bonded for applying 3/16'' 6 oz Impala Ormco criss-cross elastic.

surface of lower right first molar for applying 3/16'' 6 oz Impala Ormco criss-cross elastic between upper and lower right first molars for night-time in order to achieve posterior crossbite correction (*figure 5*).

At month 3, interradicular mini-screws were inserted for en masse distalization [23] (*figure 6a*).

A 0.016 0.022-inch SS STb™ was inserted in the upper arch with a posterior overexpansion and with the addition of 0.019 0.025-

FIGURE 6

Processing phases

a: at month 3, insertion of interradicular mini-screws and 0.016 0.022-inch SS STb™ and 0.019 0.025-inch TMA power arms in the upper arch; b: at month 8, upper left mini-screw remotion. Insertion of kobayshi on upper canines, upper and lower left first premolars.

FIGURE 7

Processing phase

At month 14: insertion of 350 g 7 mm class II coil-spring on the lingual right side.

FIGURE 8

Processing phase

At month 19: upper right mini-screw removal. Insertion of 0.0175 0.0175-inch TMA LSW medium on upper arch. Finishing bends: 13, 23 step-out, 23 palatal-root torque. Kobayashi insertion on 13, 44.

inch TMA power arms. An open elastic chain was inserted between upper first premolars in order to avoid space opening. In the following months, en-masse distalization was continued and criss-cross elastics were prescribed until the complete posterior crossbite resolution.

At month 8, once an end-to-end class II on right side and a class I on left side were obtained, the upper left mini-screw was removed. 0.012-inch Kobayashi on the upper canines, upper left first premolar, lower left first premolar were inserted; 3/16'' 6 oz Impala Ormco class II elastics were prescribed full-time on the right side; 3/16'' 6 oz Impala Ormco intercuspation elastics were prescribed for night-time on the left side (*figure 6b*).

At month 14, after five months of intermaxillary elastics, although improvements were noted, the patient stopped wearing the full-time unilateral class II elastic; another device seems necessary to complete the treatment in the shortest possible time. One 350 g 7 mm Dynaflex (DynaFlex, St. Ann, MO) class II coil-spring, designed to be employed on the buccal side, was inserted on the lingual side for class II correction on right side (*figure 7*). An open elastic chain between upper first molars was inserted in order to keep all the spaces closed. 3/16'' 6 oz Impala Ormco intercuspation elastics were continued for night-time on the left side.

At month 19, after five months of class II coil-spring, a class I relationship was obtained on the right side. One month later, a 0.0175 0.0175-inch TMA LSW was inserted in the upper arch to insert some finishing bends (13 step-out, 23 step-out, 23 palatal-root torque). The upper right mini-screw was removed and 0.012-inch Kobayashi were inserted on upper right canine and lower right first premolar for 3/16'' 6 oz Impala Ormco intercuspation elastics for night-time (*figure 8*).

At month 23, a 0.0175 0.0175-inch TMA LSW was inserted in the lower arch with a slight reverse Spee curve and finishing bends were performed: 33 step-out, 32 step-in, 42 step-up, 12 step-down, 13 step-down, 23 step-in. An open elastic chain was inserted between upper first premolars to avoid space opening.

At month 24, lower arch debonding was performed and lower essix was delivered. Upper finishing bends were performed:

FIGURE 9

Debonding phase

At month 24: lower 33–43 fixed lingual retainer bonding.

11,12 step-down bends; 24,25 step-out bends. Two weeks later, upper debonding was performed and lower 33–43 fixed lingual retainer was directly bonded with fabrication of new upper and lower essix (*figure 9*).

Treatment was at this point completed and final treatment radiographies were prescribed.

Treatment results

A class I was achieved for canines and molars on both sides, despite a slight tendency towards class II on the right, with alignment, resolution of the posterior crossbite, coincidence of the midline, levelling of the lower Spee curve, correction of the Wilson curve and deep bite. Light contact proved ideal at this point. On the post-processed frontal photos, a correct smile arc can be seen (*figure 10*), with clearly improved black corridors. The post-treatment lateral photographs revealed a harmonious profile. Post-treatment orthopantomography showed a good root parallelism, with no evidence of bone and/or root resorption. The cephalometric values highlighted the improved skeletal class II and the correct orientation of the occlusal plane (*figure 11*, *table I*). The torque of the upper incisors was slightly increased (116°) and the inclination of the lower incisors showed a proclination (97° to 103°), a consequence of the levelling of the Spee curve, the correction of class II and the resolution of the crowding. The Merrifield Z-line [24] was harmonious and confirmed the correct decision of non-extraction. Superimposition of the cephalometric tracings before and after treatment, carried out according to the methodology of Prof. Arne Björk [25,26], showed that there was no skeletal movement and that the correction was obtained by dento-alveolar compensations (*figure 12*). The upper incisors were torqued, as planned in the set-up, to improve incisor exposure during the smile and to allow dento-alveolar advancement of the lower arch for class II correction. The lower incisors were proclined due

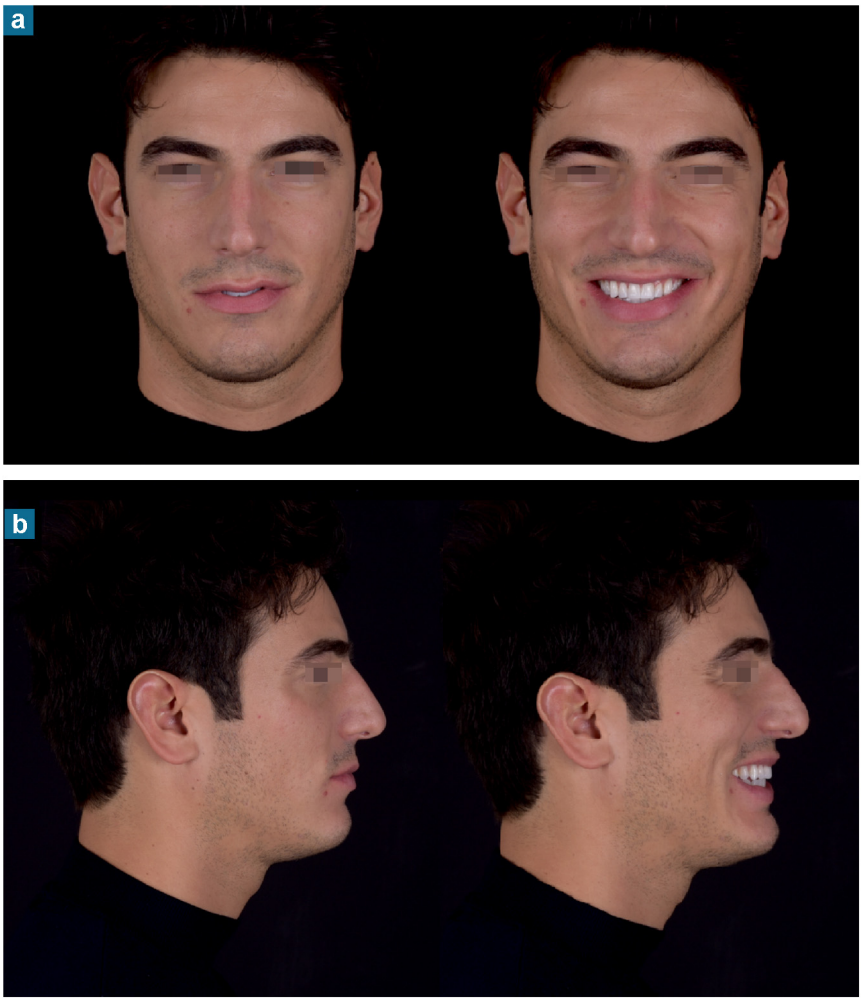

FIGURE 10

End of treatment photographs

a: frontal; b: lateral.

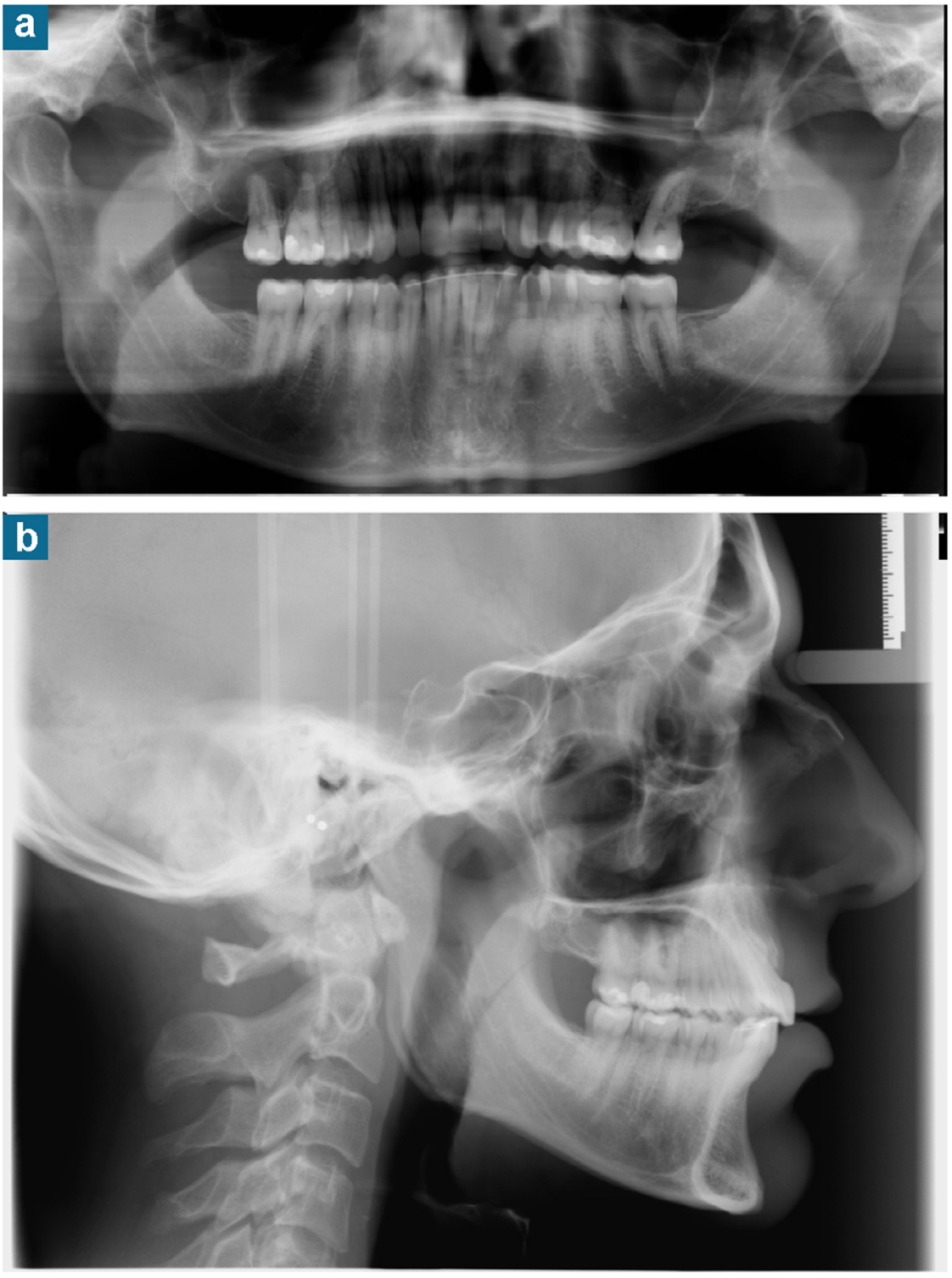

FIGURE 11

End of treatment radiographs

a: orthopantomography; b: latero-lateral teleradiography.

TABLE I
Initial and final cephalometric values

	Pre-treatment	Post-treatment	Mean SD
Sagittal skeletal relations			
Maxillary position S-N-A	83.1°	83.8°	82° ± 3.5°
Mandibular position S-N-B	79.9°	80.1°	80° ± 3.5°
Sagittal jaw relation A-N-B	3.2°	3.7°	2° ± 2.5°
Vertical skeletal relations			
Maxillary inclination S-N/ANS-PNS	1.0°	2.2°	8° ± 3.0°
Mandibular inclination S-N/Go-Gn	26.4°	27.9°	33° ± 2.5°
Vertical jaw relation ANS-PNS/Go-Gn	25.4°	25.7°	25° ± 6.0°
Dento-basal relations			
Maxillary incisor inclination 1 – PP	107.6°	116.8°	110° ± 6.0°
Mandibular incisor inclination 1 – Go-Gn	96.9°	102.8°	94° ± 7.0°
Mandibular incisor compensation 1 – A-Pg (mm)	0.2 mm	1.8 mm	2 ± 2.0
Dental relations			
Overjet (mm)	2.8 mm	1.4 mm	3.5 ± 2.5
Overbite (mm)	3.1 mm	1.3 mm	2 ± 2.5
Interincisal angle 1/1	130.2°	114.7°	132° ± 6.0°

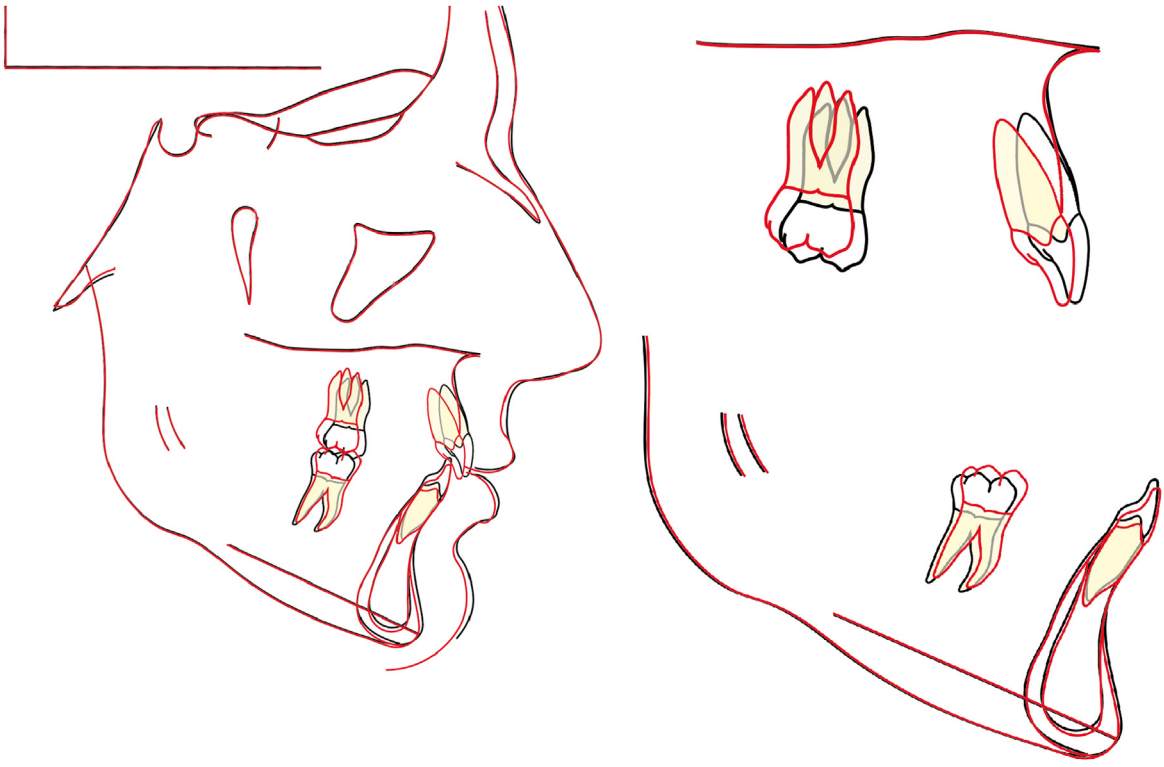

FIGURE 12
General and local structural superimpositions

FIGURE 13

Nine-month follow-up intraoral photographs

FIGURE 14
Nine-month follow-up extraoral photographs
a: frontal; b: lateral.

to the levelling of the lower arch and the use of class II elastics. A good light contact was obtained. The upper molars were slightly intrusive and distalized by the mini-screws; the lower molars were slightly extruded due to the levelling of the Spee curve. The clockwise rotation of the occlusal plane, reported in previous research on distalization with minivis [27], was also accentuated by the use of class II intermaxillary elastics.
The follow-up photographs, nine months post-treatment, provided evidence of the stability of the treatment (*figures 13 and 14*).

Discussion

The treatment of class II subdivision is often challenging, in particular when a completely invisible appliance is requested. According to Sanders et al., the aetiology of class II subdivision malocclusions is primarily due to an asymmetric mandible that is shorter and positioned posteriorly on the class II side; a mesially positioned maxillary molar and a distally positioned mandibular molar on the class II side are also minor contributing factors [2].

On the other hand, according to the study by Janson et al., the components that would lead to the asymmetric anteroposterior relationship in class II subdivision malocclusion would be mainly dentoalveolar; the main factor being the distal position of the mandibular first molars on the class II side in mandibles without unusual skeletal or positional asymmetries. The mesioposition of the maxillary first molars on the class II side would play a secondary role [4].

In addition, Minich et al. reported an asymmetric position of the maxilla in relation to the cranial base with consequent mesial position of upper canine and molar on class II side [28].

Despite the fact that in the present case a significant mandibular asymmetry was present, a dento-alveolar asymmetry represented the main component in the upper arch, with an asymmetric position of upper canines and molars. Since the patient refused the ideal orthodontic-surgical treatment, as he was completely satisfied with his facial appearance, the best camouflage was researched.

The resolution of class II subdivision with different systems of fixed lingual or buccal aesthetic appliances, more or less segmented or combined with auxiliaries depending on patient compliance, has already been described [8–10]. In this case, the patient required a completely invisible appliance, with no visible buccal auxiliaries. For this reason, en-masse distalization was performed using palatal mini-screws [28], reinforced by asymmetric class II inner mechanics.

En-mass distalization technique using interradicular mini-screws in combination with buccal fixed appliances was proposed in 2006 by Jeon et al. [11]. Its use has also been described in lingual orthodontics, in combination with intermaxillary elastics, for the correction of bilateral full-step class II in adult patients [12–14].

Bechtold et al. found that a pair of interradicular mini-screws provided sufficient anchorage for effective mass maxillary distalization to correct an end-to-end class II malocclusion using a labial technique [23]. While removal and reinsertion of the mini-screws during treatment was necessary for the correction of a full class II malocclusion [29]. Positioning the interradicular mini-screws on the palatal side, in combination with the lingual appliance, allows more space for tooth movement and thus corrects a full class II with less risk of root surface contact with the mini-screws. Unlike the buccal side, it is not necessary to remove and reinsert the mini-screws during treatment to avoid contact and consequent damage to the root surface [12–14].

Although it has been shown that damage to the root surface caused by titanium mini-screws when the tooth is moved is reversible [30], it is nevertheless recommended that the insertion pathway be angled apically and the mini-screw placed closer to the distal side of the tooth to avoid contact with the root. As more distalization was required on the right side than on the left to resolve the initial maxillary dentoalveolar asymmetry, the left upper mini-screw was used for four months and then removed. The left-sided correction was stabilised with intercuspation elastics.

Class II elastics reinforced the effect of unilateral distalization and, at the same time, allowed mesialization of the lower right teeth and improved coincidence of the midline. Although class II elastics are often used in the lingual technique on buccal aesthetic buttons, they can be positioned on the lingual side with the help of a Kobayashi ligature, for the sake of discretion. As the patient found it increasingly difficult to wear a unilateral class II appliance full time during treatment, the mechanics of the distalizing mini-screw were subsequently reinforced by the insertion of a 350 g 7 mm class II coil spring, in order to correct the sagittal component of the malocclusion more rapidly. The use of a 350 g 7 mm coil spring has been described for class II correction in combination with oral appliances in non-cooperative patients [31]. The spring was also set up inside the arches in combination with lingual appliances, making it possible to combine effectiveness with high aesthetic expectations. The flexibility of this appliance makes it easy to open the mouth. After the first few days, the appliance was very well tolerated and was able to deliver a continuous force, facilitating the rapid correction of the total class II on the right side.

Despite the class II correction, intercuspation on the right side was not perfect, probably due to mandibular skeletal asymmetry. For the same reason, it was difficult to correct completely the mandibular occlusal plane cant in the incisor area. However, this slight class II did not worsen at the nine-month follow-up.

A retrospective study of the therapeutic results of Angle's class II subdivision showed that despite clinical excellence and various treatment strategies, up to 30% of finished cases did not achieve complete correction, and midline correction can be quite difficult and often incomplete [32].

During the en-masse distalization, combined with the unilateral class II elastic mechanics, a full size 0.016 0.022-inch rectangular stainless steel archwire was inserted, which allowed the torque to be controlled despite the asymmetric mechanics. The torque of the upper incisor increased symmetrically and correction of the buccal sector inclination was achieved, as planned in the set-up. This last aspect was very important because the initial Wilson curve was severely accentuated, particularly in the lower right quadrant. Insufficiently torqued posterior teeth would have a constrictive effect on the maxillary arch, as they do not allow appropriate cuspid-fossa relationships between the maxillary and mandibular teeth [33].

Establishing a correct Wilson curve has several implications: it avoids occlusal interference on the balancing side [34], it creates an effective position for maximum resistance to masticatory forces due to the buccolingual inclination of the posterior teeth parallel to the direction of the applied load and the orientation of the medial pterygoid muscle [35], and it allows better access to food during the masticatory process [36]. Furthermore, in this

case, the correction of Wilson's curve was successful in eliminating the buccal corridors, as requested by the patient.

McNamara et al. [37] suggested that flattening of the occlusal surface and the curve of Wilson should be included as a treatment goal in orthodontic treatment planning. On the other hand, other authors [36,38] believe that when the Wilson curve is excessively flattened, masticatory function is impaired, affecting the mastication of food on the occlusal table. Nanda et al. [38] stated that a small curve of Wilson between the buccal segments allowed for proper occlusal function, but that "an accentuated curve would result in balancing interferences, especially in the second molar area''.

In untreated children and adults, the curve of Wilson is present naturally [39]. For this reason, many clinicians believe that it makes sense to maintain a certain degree of Wilson's curve after orthodontic treatment to be consistent with the physiological needs of masticatory function and to encourage treatment stability [15,37,39]. In the presence of a deep Wilson curve, the negative torque must be increased to obtain the desired inclination of the maxillary and mandibular posterior teeth.

Although the Wilson curve is moderately to highly heritable (60.8% on average between siblings) [40], it is not unchangeable and orthodontic correction can be stable. Fixed appliances have been shown to have good predictability in correcting the Wilson curve [41].

On the other hand, it has been shown that removable aligners tend to flatten too much the mandibular Wilson curve (in 74% of subjects, with an average difference of 0.76 mm) compared to the planned set-up [20]. This is the consequence of the absence of buccal root torque in the mandibular first molars during expansion. The same effect has been reported for the upper arch: the global mean maxillary curve of Wilson is not predictably controlled with aligners [21]. According to Lim et al., Invisalign® treatment tends to over-express the coronal information in any prescribed direction, especially on posterior teeth (from 0.10 mm to 0.29 mm from the first premolars to the second molars), with under-expressed arch expansion at all levels (between 0.28 mm and 0.60 mm) of the arch, except for the second molars which are buccally inclined by almost four times (with an average of 0.42 mm) [21].

The increase in buccolingual tooth inclinations, when only coronal movement is performed, may induce the reduction of the WALA-FA distance [42] with potential periodontal problems after orthodontic treatment.

In this case, the aim was to reduce the negative inclination, leaving a slight Wilson curve at the end of treatment, using a controlled tipping movement, including a slight expansion component.

Some uncontrolled buccal tipping occurred in the early stages of alignment with round wires, which could also have been observed with removable aligners [43]. The improvement in residual inclination was achieved by a true root torque movement with the combination of a force on the crown and a counter-clockwise moment (palatal root torque). The centre of rotation was shifted towards the incisal edge, without opening any space, because the crown moved only minimally in the buccal direction.

The mandibular first premolar in class II malocclusions has a greater lingual inclination than in class I [44]. Here, the lower first premolars require significant correction of the inclination. The normalization of the Wilson curve was achieved here by overcorrections with the placement of almost full size square wires; an overcorrection was planned for the upper left canine and the lower right canines and premolars.

Clinical research into lingual orthodontics showed that it was possible to achieve the final result predicted by the set-up with a high degree of accuracy [45,46], including torque control.

In a retrospective study of 20 patients treated consecutively [45], Pauls et al. demonstrated very small differences in torque between the final result and what was predicted in the set-up (2.96° in the anterior segment) with a slightly greater difference in the buccal segment (5.18°).

In a clinical study of 40 patients [46], Albertini et al. compared the differences between the final result and what was planned, taking into account the initial position of the teeth. The authors found very small differences (85% and 92% for incisors, canines and premolars), while accuracy for molars ranged from 52% (maxillary second molars) to 81% (mandibular first molars) due to their end position. Curve of Spee levelling occurred predictably as planned in the set-up, as reported in previous researches [47]. Only a slight reverse curve of Spee was added in the last month of treatment with the insertion of a 0.0175 0.0175-inch TMA wire.

Obtaining a symmetrical Spee curve was crucial to achieve an ideal occlusion and to ensure disclusion of the posterior teeth and guidance of the anterior teeth during the forward movement of the mandible [19]. A coronoplasty was recommended to the patient to achieve dynamic lateral guidance due to abrasion of the upper and lower canines.

The posterior crossbite was resolved by the use of criss-cross elastics, taking advantage of the patient's cooperation during the early stages of treatment. Barrera et al. [48] compared the inclination of maxillary first molars using CBCT in adults with correct posterior occlusion and bilateral crossbite. Of the ten adults in normocclusion, the mean buccal inclination was 4.058° per side; whereas those with bilateral posterior crossbite had a mean buccal inclination of only 0.28°.

In this case, at the start of treatment, the lower right first molar was buccally tipped, while the upper right first molar was palatally tipped. Correcting their inclination allowed the crossbite to be corrected.

A better result in terms of maxillary expansion could have been achieved if the patient had accepted orthodontic-surgical treatment with skeletal maxillary expansion; the same applied to the

resolution of the buccal corridors. However, the patient was satisfied with the result.

Summary and conclusions

A combination of en-masse distalization by mini-screws and unilateral class II mechanics with lingual straight-wire appliance resulted in the correction of an adult class II subdivision malocclusion. All the auxiliaries employed were positioned on the inner side, allowing one to maintain the appliance completely invisible, together with an efficient correction of the malocclusion.

The asymmetrical curve of Spee was corrected by a minimal curve of Spee overcorrection on the set-up and by the insertion of a slight reverse Spee curve on the final archwire.

The asymmetrical curve of Wilson normalization was obtained by a controlled tipping movement, including a bodily root torque planned with the set-up overcorrection, which avoided an excessive expansion of buccal and posterior teeth. At the same time, the coronal expansion component made it possible to reduce the buccal corridors, as requested by the patient.

Contribution: Dr. Enrico Albertini treated the case. Dr. Paolo Albertini, Dr. Anna Colonna and Prof. Luca Lombardo contributed in the manuscript preparation.

Disclosure of interest: The authors declare that they have no competing interest.

References

[1] Turpin DL. Correcting the class II subdivision malocclusion. Am J Orthod Dentofacial Orthop 2005;128:555–6.

[2] Sanders DA, Rigali PH, Neace WP, Uribe F, Nanda R. Skeletal and dental asymmetries in class II subdivision malocclusions using cone-beam computed tomography. Am J Orthod Dentofacial Orthop 2010;138:542e1–542e20.

[3] Janson M, Janson G, Sant'Ana E, Simao TM, De Freitas MR. An orthodontic-surgical approach to class II subdivision malocclusion treatment. J Appl Oral Sci 2009;17:26–73.

[4] Janson GRP, Metaxas A, Woodside DG, De Freitas MR, Pinzan A. Three-dimensional evaluation of skeletal and dental asymmetries in class II subdivision malocclusions. Am J Orthod Dentofacial Orthop 2001;119:406–18.

[5] Melsen B, Bjerregaard J, Bundgaard M. The effect of treatment with functional appliance on a pathologic growth pattern of the condyle. Am J Orthod Dentofacial Orthop 1986;90:503–12.

[6] Paulsen HU, Karle A. Computer tomographic and radiographic changes in the temporomandibular joints of two young adults with occlusal asymmetry, treated with the Herbst appliance. Eur J Orthod 2000;22:649–56.

[7] Janson G, Carvalho PEG, Cancado RH, De Freitas MR, Henriques JFC. Cephalometric evaluation of symmetric and asymmetric extraction treatment for patients with class II subdivision malocclusions. Am J Orthod Dentofacial Orthop 2007;132:28–35.

[8] Lecocq G. European College of Orthodontics: commission of affiliation and titularisation. Int Orthod 2015;13:123–38.

[9] Cazenave C. Class II subdivision in adults: use of mini-screws anchorage in mixed technique. Orthod Fr 2014;85(4):341–54.

[10] O'Keeffe C, O'Keeffe ME. Class II therapy with a combination of customized lingual appliances and the Forsus device. J Clin Orthod 2013;47:464–540.

[11] Jeon JM, Yu HS, Baik HS, Lee JS. En-masse distalization with mini-screw anchorage in class II nonextraction treatment. J Clin Orthod 2006;40:472–6.

[12] Albertini E, Albertini P, Lombardo L, Siciliani G. Treatment of adult class II deep-bite patients with preadjusted lingual appliances and intermaxillary lingual elastics. J Clin Orthod 2021;55:751–61.

[13] Beyling F, Klang E, Niehoff E, Schwestka-Polly R, Helms HJ, Wiechmann D. Class II correction by maxillary en masse distalization using a completely customized lingual appliance and a novel mini-screw anchorage concept – preliminary results. Head Face Med 2021;17:23.

[14] Albertini E, Albertini P, Colonna A, Lombardo L. En-masse distalisation and torque correction in an adult full-step class II case treated with a lingual straight-wire appliance. Kieferorthopädie: die Zeitschrift für die Praxis 2023;37:151–67.

[15] Casko JS, Vaden JL, Kokich VG, et al. Objective grading system for dental casts and panoramic radiographs. Am J Orthod Dentofacial Orthop 1998;114:589–99.

[16] Andrews LF. The six keys to normal occlusion. Am J Orthod 1972;62:296–309.

[17] No authors listed. The gliding path of the mandible along the skull. Ferdinand Graf Spee (1855–1937), prosector at the Anatomy Institute of Kiel. J Am Dent Assoc 1980;100:670–5.

[18] Scuzzo G, Takemoto KA. A new approach using STb light lingual system & lingual straight wire. 1st ed. Surrey, UK: Quintessence Pub Co. New Malden; 2010, 256 p.

[19] Goh S, Dreyer C, Weir T. The predictability of the mandibular curve of Spee leveling with the Invisalign appliance. Am J Orthod Dentofacial Orthop 2022;162:193–200. doi: 10.1016/j.ajodo.2021.04.034 [Epub 2022 Jun 23. PMID: 35753894].

[20] Goh S, Dreyer C, Weir T. The predictability of the mandibular curve of Wilson, buccolingual crown inclination, and transverse expansion expression with Invisalign treatment. Am J Orthod Dentofacial Orthop 2023;163(1):109–16.

[21] Lim ZW, Weir T, Meade MJ. The predictability of maxillary curve of Wilson leveling with the Invisalign appliance. J World Fed Orthod 2023;12(5):207–12.

[22] Komori A, Takemoto K, Shimoda T, Miyashita W, Scuzzo G. Precise direct lingual bonding with the Kommonbase. J Clin Orthod 2013;47:42–9.

[23] Bechtold TE, Kim JW, Choi TH, Park YC, Lee KJ. Distalization pattern of the maxillary arch depending on the number of orthodontic mini-screws. Angle Orthod 2013;83:266–73.

[24] Merrifield LL. The profile line as an aid in critically evaluating facial esthetics. Am J Orthod 1966;52:804–22.

[25] Björk A, Skieller V. Growth of the maxilla in three dimensions as revealed radiographically by the implant method. Br J Orthod 1977;4:53–64.

[26] Björk A. Prediction of mandibular growth rotation. Am J Orthod 1969;55:585–99.

[27] Yamada K, Kuroda S, Deguchi T, Takano-Yamamoto T, Yamashiro T. Distal movement of maxillary molars using mini-screw anchorage in the buccal interradicular region. Angle Orthod 2009;79:78–84.

[28] Minich CM, Araujo EA, Behrents RG, Buschang PH, Tanaka OM, Kim KB. Evaluation of skeletal and dental asymmetries in Angle class II subdivision malocclusions with cone-beam computed tomography. Am J Orthod Dentofacial Orthop 2013;144:57–66.

[29] Choi YJ, Lee JS, Cha JY, Park YC. Total distalization of the maxillary arch in a patient with skeletal class II malocclusion. Am J Orthod 2011;139:823–33.

[30] Asscherickx K, Vannet BV, Wehrbein H, Sabzevar MM. Root repair after injury from mini-screw. Clin Oral Implants Res 2005;16:575–8.
[31] Lombardo L, Carlucci A, Cervinara F, Siciliani G. A new, no-compliance class II correction strategy using nickel-titanium coil-springs. J World Fed Orthod 2015;4:40–9.
[32] Cassidy SE, Jackson SR, Turpin DL, Ramsay DS, Spiekerman C, Huang GJ. Classification and treatment of class II subdivision malocclusions. Am J Orthod Dentofacial Orthop 2014;145:443–51.
[33] Gioka C, Eliades T. Materials-induced variation in the torque expression of preadjusted appliances. Am J Orthod Dentofacial Orthop 2004;125:323–8.
[34] Lewis D. The deviated midlines. Am J Orthod 1976;70:601–16.
[35] Wilson GH. A manual of dental prosthetics. Philadelphia, Pa, USA: Lea & Febiger; 1911.
[36] Dawson PE. Functional occlusion: from TMJ to smile design. Amsterdam, The Netherlands: Elsevier Health Sciences Division; 2006 (E-book, 648 p).
[37] McNamara JA, Brudon WL, Kokich VG. Orthodontics and dentofacial orthopedics. Norfolk, MA, USA: Needham Press; 2001 (554 p).
[38] Nanda R. Biomechanics and esthetic strategies in clinical orthodontics. St Louis, Missouri, USA: Elsevier Saunders; 2005.
[39] Yang B, Chung CH. Buccolingual inclination of molars in untreated children and adults: a cone beam computed tomography study. Angle Orthod 2019;89:87–92.
[40] Harris EF. Source of bias in heritability studies. Am J Orthod Dentofacial Orthop 1997;112:17A–21A.
[41] Lucchese A, Manuelli M, Albertini P, Ghislanzoni LH. Transverse and torque dental changes after passive self-ligating fixed therapy: a two-year follow-up study. Am J Orthod Dentofacial Orthop 2019;156(1):94–103.
[42] Dindaro□lu F, Duran GS, Tekeli A, Görgülü S, Do□an S. Evaluation of the relationship between curve of Spee, WALA-FA distance and curve of Wilson in normal occlusion. Turk J Orthod 2016;29:91–7.
[43] Alouini O, Knösel M, Blanck-Lubarsch M, Helms HJ, Wiechmann D. Controlling incisor torque with completely customized lingual appliances. J Orofac Orthop 2020;81:328–39.
[44] Shu R, Han X, Wang Y, Xu H, Ai D, Wang L, et al. Comparison of arch width, alveolar width and buccolingual inclination of teeth between class II division 1 malocclusion and class I occlusion. Angle Orthod 2012;83:246–52.
[45] Pauls A, Nienkemper M, Schwestka-Polly R, Wiechmann D. Therapeutic accuracy of the completely customized lingual appliance WIN: a retrospective cohort study. J Orofac Orthop 2017;78:52–61.
[46] Albertini P, Albertini E, Pellitteri F, Ghislanzoni LH, Lombardo L. Accuracy of planned tooth movement with lingual straight wire technique. Angle Orthod 2022;92:714–21.
[47] Barthelemi S, Hyppolite MP, Palot C, Wiechmann D. Components of overbite correction in lingual orthodontics: molar extrusion or incisor intrusion? Int Orthod 2014;12:395–412.
[48] Barrera JM, Llamas JM, Espinar E, Saenz Ramırez C, Paredes V, Perez-Varela JC. Wilson maxillary curve analyzed by CBCT. A study on normocclusion and malocclusion individuals. Med Oral Patol Oral Cir Bucal 2013;18:547–52.