



# Non-surgical occlusal plane cant resolution with lingual straight-wire appliance and miniscrews in a class II asymmetric adult patient

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## Keywords

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Asymmetry

## Summary

This case report describes a complex class II case with important maxillo-mandibular asymmetry in an adult patient treated with lingual straight-wire appliance. With the twofold aim of obtaining dramatic aesthetic improvement, since the patient refused surgical option, and ideal occlusal relationship, accurate set-up planification and biomechanical strategies with TADS for occlusal plane cant correction are needed to achieve the planned results. This case report demonstrates the possibility of solving successfully class II malocclusion with significant asymmetry in adult patient without surgery by means of an aesthetic appliance; on the other hand, it underlines the necessity of miniscrews and auxiliaries in order to obtain the best results.

## Introduction

The correction of an asymmetric case with a significant occlusal plane cant in an adult patient is often challenging [1]. Surgical approach have always been considered the ideal treatment option: despite the complexity of the procedure, it can determine skeletal discrepancy resolution, reducing treatment time and avoiding adverse effects of conventional treatment biomechanics [2–6]. However, not all patients are willing to undergo surgical treatment [7,8].

Occlusal plane canting has been traditionally treated with complex mechanics like elastics, asymmetric bends in the archwire, bite blocks, high-pull headgears; however, the introduction of skeletal anchorage has increased the number of camouflage treatment possibilities for these cases [3,4,9–16].

Selective either intrusion or extrusion of each side or a combination of both are possible by miniscrews application in order to redirect the occlusal plane inclination.

The complexity of these cases is further increased when the patient requests a completely invisible appliance.

In this article, an adult class II case with a significant occlusal plane cant is treated with a lingual straight-wire appliance by a combination of interradicular miniscrews and intermaxillary elastics.

## Case report

### Diagnosis and aetiology

The patient presented at 22 years of age with the request of correcting the asymmetry of his anterior teeth by means of an aesthetic appliance. The previous orthodontic treatment, performed by a colleague by buccal technique and completed eight years earlier, had not been considered successful.

The face, from a frontal view, appeared well-proportioned in the three-thirds; a significant mandibular symphysis deviation towards the left side was evident, combined with a different height of the mandibular angles. An important occlusal plane cant was also noticeable, with reduced exposition of upper left buccal and posterior segments.

From a lateral view the profile appeared regular, with a prominent nose, a correct nasolabial angle, a marked labio-mental sulcus and a well-represented chin ([figure 1](#)).

The orthopantomography pointed out the presence of all the elements, third molars included.

From the cephalometric analysis a skeletal class I with both maxilla and mandible in correct position could be detected. The



FIGURE 1  
Initial frontal and lateral extraoral photographs

skeletal pattern resulted hypodivergent with a well-represented mandibular symphysis and a counterclockwise oriented occlusal plane. The upper and lower incisors appeared normally inclined ( $108.2^\circ$  and  $97.2^\circ$  respectively) (figure 2). At frontal intraoral vision the midlines did not appear coincident (slight deviation of the upper towards right and of the lower towards left), a negative torque of buccal and posterior segments of lower arch was noticeable; anterior deep bite and accentuated lower curves of Spee were also present. The lateral photographs showed slight canine and molar class II on the right side and head to head canine and molar class II on the left

side. The upper occlusal photographs highlighted a slight contraction from a transverse point of view and a dento-alveolar asymmetry; in the lower arch a slight crowding of the buccal segments and an accentuated lower curve of Wilson were noticeable. The periodontal biotype turned out to be thin (figure 3). An orthodontic wire syndrome was diagnosed, due to an active fixed lingual retainer in the lower arch, with right and left canines in lingual position and buccal-root torque on left lateral incisor [17-21]. The retainer was removed one month after our initial examination.

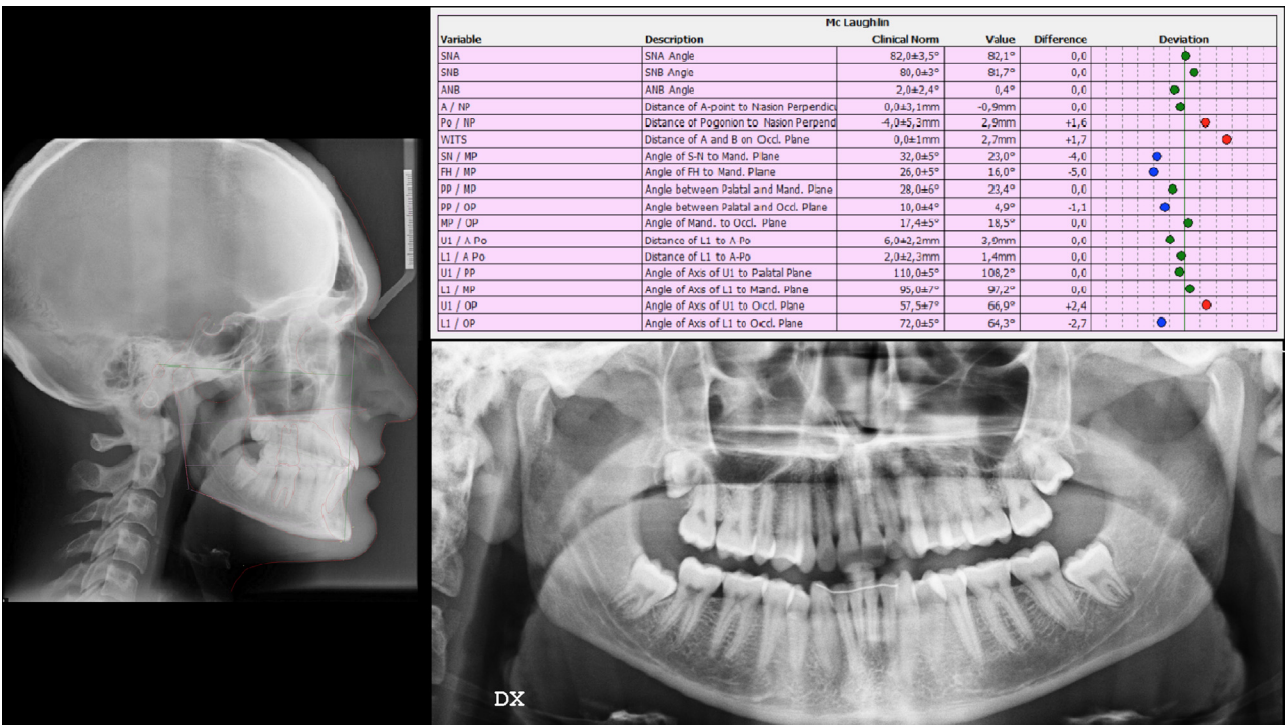


FIGURE 2  
Initial radiographs (Lateral and orthopantomography) and McLaughlin and Tweed cephalometric analysis



FIGURE 3  
Initial intraoral photographs

### Treatment objectives

The primary objectives were dental class II correction, dental occlusal cant resolution. Additional goals were to achieve an ideal overbite, flatten the curve of Spee, achieve midline coincidence, and correct buccal and posterior segment inclination.

### Treatment alternatives

The ideal orthodontic-surgical treatment which would have corrected the skeletal asymmetry was illustrated to the patient

without success. Considering the profile features of the patient (both maxillary and mandibular retrusion, nose prominence, correct nasolabial angle, well-represented chin) a non-extraction treatment was chosen. This choice was moreover driven by lip position with respect to Ricketts E-line and by Merryfield Z-angle that resulted increased ( $89^\circ$ ) [22,23].

The orthodontic treatment was performed by lingual technique: this choice was determined by the patient's request for an invisible appliance; furthermore, the appropriate biomechanics



made it possible to obtain less proclination of the lower incisors during levelling (as a result of the intrusion force passing closer to the centre of resistance of the lower incisors) [24].

### Treatment progress

The orthodontic treatment was performed by lingual "Straight-wire" technique [25] with Ormco Stb brackets, by means of a manual set-up (figure 4). Overcorrections for torque, in the anterior segment of lower arch, transverse expansion and overbite were included in the set-up prescriptions:

- extra anterior lingual crown torque to their mandibular incisors ( $-7^\circ$  beyond the desired outcome) to counteract excessive lower incisors proclination;
- 2 mm maxillary molars transverse expansion;
- 0.5 mm overbite (almost head-to-head relation).



FIGURE 4  
Manual set-up

The 33-43 fixed lingual retainer was removed and the brackets' bonding was carried out by "single jigs", following the "Komori system" technique, after the assembling of arches performed with "Kommen base" philosophy [26].

Lower arch bonding was first performed (figure 5a). A 0.013 CuNiTi LSW (Lingual Straight Wire) Ormco Stb Small was inserted for the initial alignment.

Two month later, the upper arch bonding was carried out (figure 5b); a 0.013 CuNiTi LSW Ormco Stb Medium was inserted for the initial alignment. Occlusal build-ups were bonded on upper second molars with the purpose of obtaining a tripodic contact during alignment and levelling phases.

Following a three-months period a  $0.018 \times 0.018$  CuNiTi LSW Ormco Stb Medium and a  $0.018 \times 0.018$  CuNiTi LSW Ormco Stb Small were inserted respectively in upper and lower arches for levelling and torque establishment. From the frontal extraoral photograph the entity of the occlusal plane cant after arches alignment can be evidenced (figure 6).

One month later two interraderic miniscrews were inserted: palatally between upper right second premolar and first molar, buccally between lower left second premolar and first molar. 0.014 kobayashi were added on upper left canine and second premolar, lower right canine and first premolar in order to start buccal segments extrusion for occlusal plane cant correction: full-time 3/16" 6 oz Impala Ormco elastics were prescribed from upper right palatal miniscrew to lower right canine and first premolar and from lower left buccal miniscrew to upper left canine and second premolar. Closed elastomeric chains were inserted in upper arch between first molars, in lower arch between first premolars, in order to maintain the spaces closed (figure 7).

Ten months later, from the frontal extraoral photograph the improvement of the occlusal plane cant can be evidenced (figure 8).

Seventeen months after treatment start an interraderic upper miniscrew was inserted palatally between upper left second premolar and first molar. An upper  $0.018 \times 0.018$  SS Ormco Stb posted was applied with the addition of closed elastomeric chains between hooks and miniscrews in order to start upper arch en-masse distalization. An elastic thread was inserted between the upper miniscrew, the upper right first molar and the first premolar in order to help occlusal cant correction by upper right buccal and posterior segments intrusion. Upper right first and second molar tubes were bonded, with the insertion of a  $0.019 \times 0.025$  NiTi sectional for better controlling upper right molars torque. Full-time 3/16" 6 oz Impala Ormco elastics for occlusal plane correction were continued on left side between the kobayashi on upper left canine and second premolar and the



FIGURE 5

**Start of treatment. a: first, lower arch bonding. Insertion of 0.013 CuNiTi LSW Ormco Stb Small on lower arch. b: Two months later, upper arch bonding. Insertion of 0.013 CuNiTi LSW Ormco Stb Medium on upper arch. Insertion on build-ups on upper second molars**

buccal lower left miniscrew. Closed elastomeric chains were inserted in upper arch between second premolars, in order to maintain the spaces closed (*figure 9*).

Four months later, after lower left buccal miniscrew removal, aesthetic buttons were bonded to the buccal surfaces of upper left canine, upper left second premolar and lower left first molar in order to complete class II correction on left side in combination with a correction of the crown-lingual torque of upper left buccal segment by the employment of 3/16" 6 oz Impala Ormco class II elastics.

The elastic thread between upper right miniscrew-upper right first premolar-upper right first molar was reactivated to carry on medium and posterior segments intrusion; closed elastic chains were inserted in upper arch between first premolars, in lower arch between left second premolar and right canine in order to maintain the spaces closed.

Following a five-months period, after class II correction was completed, a 0.0175 × 0.0175 TMA was inserted in the lower arch. Some refinement bends were performed: 11 tip bend; 12, 21, 22, 32, 42, 45 rotation bends (*figure 10a*). Closed elastic chains were inserted in upper arch between first molars, in lower arch between left second premolar and right first

premolar, in order to maintain the spaces closed. Intermaxillary elastics were continued on left side with class II vector (upper left canine-lower first molar on lingual side, upper left canine-upper first premolar-lower first molar on buccal side).

One month later a 0.0175 × 0.0175 TMA was inserted in the upper arch with the addition of refinement bends: 11, 23 tip bends; 12, 21 rotation bends; 23 step-down. Upper left miniscrew was removed. Closed elastic chains were inserted in upper arch between first premolars, in lower arch between second premolars (*figure 10b*).

Two months later a buccal interradicular miniscrew was added between upper right first and second molars. A 0.019 × 0.025 NiTi was inserted between upper right first and second molar on buccal side, in order to intrude and slightly expand upper right posterior sector by means of a closed elastic chain (*figure 11a*). One month later a buccal interradicular miniscrew was added between upper right second premolar and first molar. An aesthetic button was bonded on upper right first premolar buccal surface in order to add a triangular closed elastic chain first premolar-first molar-miniscrew to intrude the buccal and posterior segment for completing the correction of the occlusal cant (*figure 11b*).



FIGURE 6

Five months later: Insertion of  $0.018 \times 0.018$  CuNiTi LSW Ormco S**tb** Medium and  $0.018 \times 0.018$  CuNiTi LSW Ormco S**tb** Small respectively in upper and lower arches



FIGURE 7

At the 6th month: Insertion of two interradicular miniscrews: palatally between upper right second premolar and first molar and buccally between lower left second premolar and first molar. Addition of 0.014 kobayashi on upper left canine and second premolar, lower right canine and first premolar in order to start buccal segments extrusion for occlusal plane cant correction with full-time 3/16" 6 oz Impala Ormco elastics. Insertion of closed elastomeric chains in upper arch between first molars, in lower arch between first premolars





FIGURE 8  
Progress frontal extraoral photographs

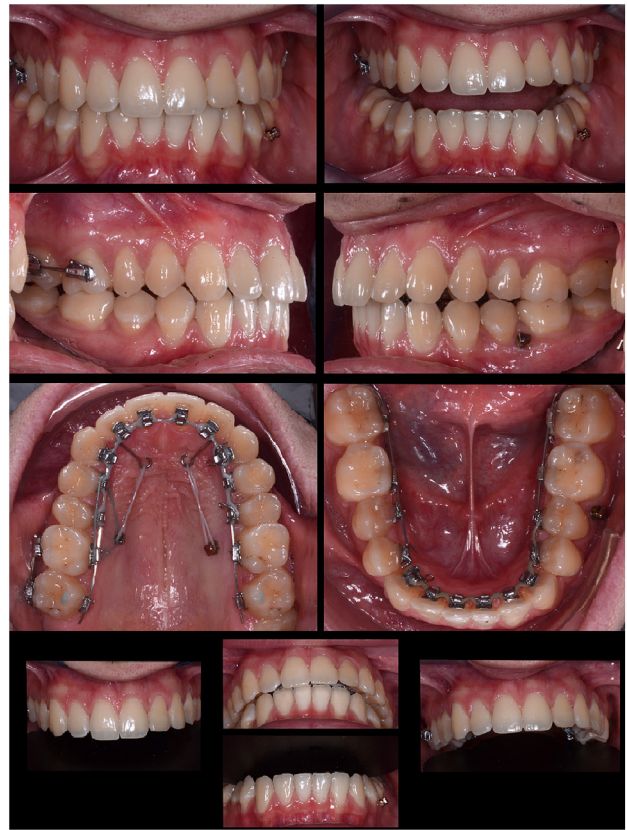


FIGURE 9  
At the 17<sup>th</sup> month: Insertion of an interradicular upper miniscrew palatally between upper left second premolar and first molar. Insertion of an upper 0.018 × 0.018 SS Ormco Stb posted with the addition of closed elastomeric chains between hooks and miniscrews. Insertion of an elastic thread between the upper miniscrew, the upper right first molar and the first premolar in order to help occlusal cant correction by upper right buccal and posterior segments intrusion. Bonding of upper right first and second molar tubes, with the insertion of a 0.019 × 0.025 NiTi sectional. Insertion of a closed elastomeric chains in upper arch between second premolars





FIGURE 10

**Insertion of  $0.0175 \times 0.0175$  TMA. a:** at the 22th month in lower arch. Addition of aesthetic buttons bonding to the buccal surfaces of upper left canine, upper left second premolar and lower left first molar in order to complete class II correction on left side with intermaxillary elastics (after remotion of lower left miniscrew). Reactivation of the elastic thread between upper right miniscrew-upper right first premolar and first molar. Insertion of closed elastic chains in upper arch between first molars, in lower arch between left second premolar and right canine. **b:** in the lower arch. Refinement bends: 11 tip bend; 12, 21, 22, 32, 42, 45 rotation bends. Insertion of closed elastic chains in upper arch between first molars, in lower arch between left second premolar and right first premolar



FIGURE 11

**Addition of miniscrews. a:** buccal interradicular between upper right first and second molars at the 24th month. Insertion of a  $0.019 \times 0.025$  NiTi between upper right first and second molar on buccal side, in order to intrude and slightly expand upper right posterior sector by means of a closed elastic chain. **b:** buccal interradicular miniscrew between upper right second premolar and first molar at the 25th month. Bonding of an aesthetic button on upper right first premolar buccal surface in order to add a triangular closed elastic chain upper right first premolar-upper right first molar-miniscrew



## Treatment results

After 36 months of treatment, upper and lower arch debonding was performed. Upper 12-22 and lower 33-43 fixed lingual retainer were directly bonded with upper and lower essix prescribed for night time. Final treatment radiographies were at this point performed.

A solid canine and molar class I was obtained on both sides, with lower curve of Spee flattening and torque normalization of

medium and posterior sectors of upper and lower arch. The overbite resulted at this point correct and the light contact ideal. The frontal extraoral photographs show the improvement of the occlusal cant in respect of treatment start in response to the combination of intrusion and extrusion forces by the employment of TADS (*figure 12*). A correct smile arch could be noticed together with a significant improvement of anterior teeth display and symmetry. The lateral extraoral photographs evidence the balanced profile (*figure 12*).



FIGURE 12

After 36 months of treatment, debonding of the upper and lower arch. Upper 12-22 and lower 33-43 fixed lingual retainer bonding. Final frontal extraoral and intraoral photographs

TABLE I  
Comparison of cephalometric values pre- and post-treatment.

	Mean $\pm$ SD	Pre-treatment	Post-treatment
<b>Sagittal Skeletal Relations</b>			
Maxillary Position	$82^\circ \pm 3.5^\circ$	$82.1^\circ$	$82.9^\circ$
S-N-A $^\circ$			
Mandibular Position	$80^\circ \pm 3.5^\circ$	$81.7^\circ$	$81.6^\circ$
S-N-B $^\circ$			
Sagittal Jaw Relation	$2^\circ \pm 2.5^\circ$	$0.4^\circ$	$1.3^\circ$
A-N-B $^\circ$			
<b>Vertical Skeletal Relations</b>			
Maxillary Inclination	$8^\circ \pm 3.0^\circ$	$-0.4^\circ$	$-0.3^\circ$
S-N / ANS-PNS $^\circ$			
Mandibular Inclination	$33^\circ \pm 2.5^\circ$	$23.0^\circ$	$22.8^\circ$
S-N / Go-Gn $^\circ$			
Vertical Jaw Relation	$25^\circ \pm 6.0^\circ$	$23.4^\circ$	$23.1^\circ$
ANS-PNS / Go-Gn $^\circ$			
<b>Dento-Basal Relations</b>			
Maxillary Incisor Inclination	$110^\circ \pm 6.0^\circ$	$108.2^\circ$	$116.1^\circ$
1 - PP $^\circ$			
Mandibular Incisor Inclination	$94^\circ \pm 7.0^\circ$	$97.2^\circ$	$102.3^\circ$
1 - Go-Gn $^\circ$			
Mandibular Incisor Compensation	$2 \pm 2.0$	$1.4 \text{ mm}$	$0.1 \text{ mm}$
1 - A-Pg (mm)			
<b>Dental Relations</b>			
Overjet (mm)	$3.5 \pm 2.5$	$1.8 \text{ mm}$	$1.5 \text{ mm}$
Overbite (mm)	$2 \pm 2.5$	$3.4 \text{ mm}$	$1.4 \text{ mm}$
Interincisal Angle	$132^\circ \pm 6.0^\circ$	$131.2^\circ$	$118.6^\circ$
1 / 1 $^\circ$			



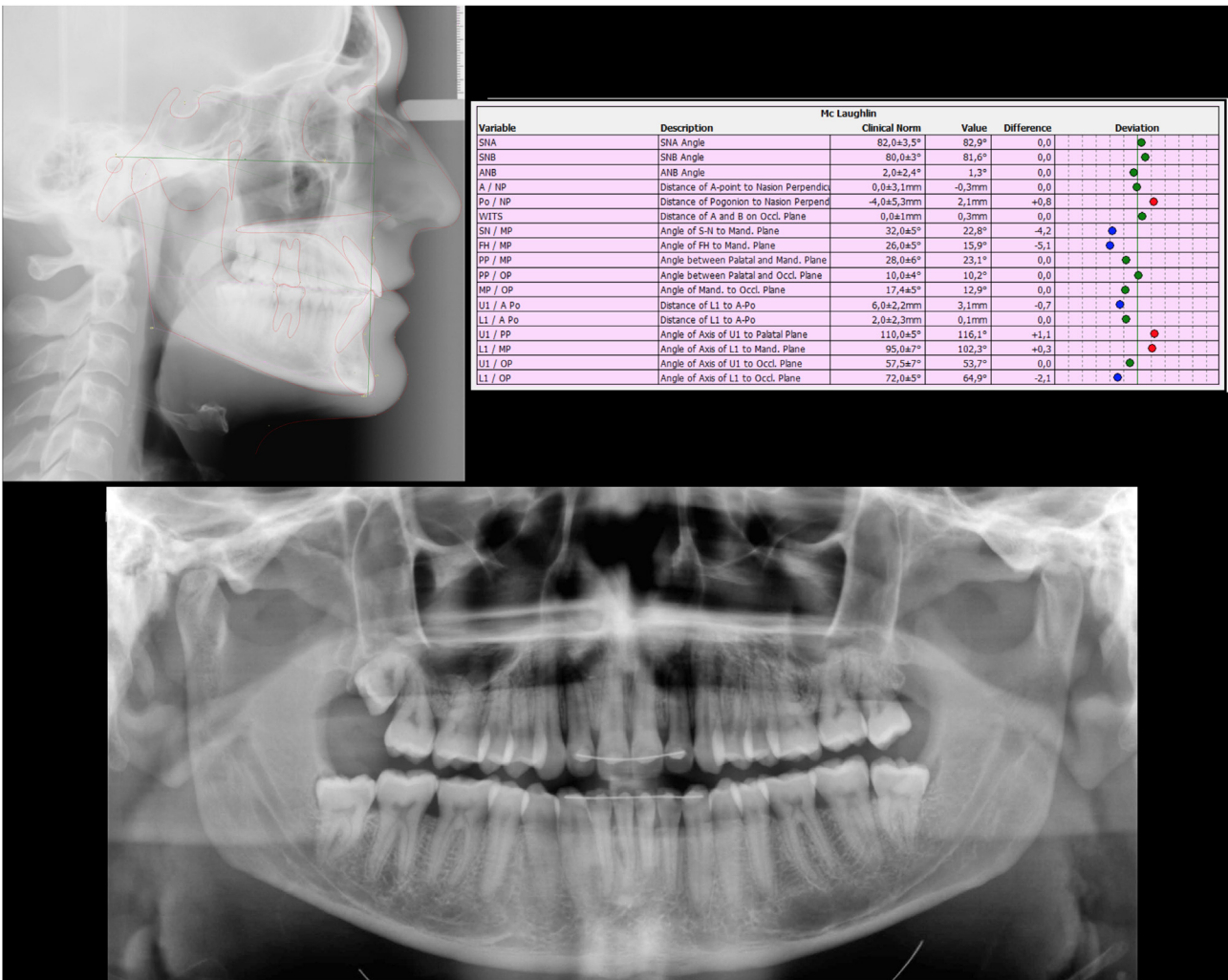


FIGURE 13  
Final radiographs (Lateral and orthopantomography) and McLaughlin and Tweed cephalometric analysis

The final orthopantomography showed the root parallelism between the elements with no signs of bone and/or root resorption. The cephalometric values evidenced the improvement of facial and dental relations. Upper incisor torque turned out to be slightly increased (from 108.2° to 116.1°) and lower incisors showed a proclination (97.2° to 102.3°). The Ricketts E line [22] was maintained unchanged and confirmed the correct non-extraction decision (figure 13, table I). Superimposition of pre- and post-treatment cephalometric tracings carried out according to the methodology described in the image captions, as developed by Professor Arne Björk [27,28] show that no growth occurred and the correction was obtained by dento-alveolar movements. Upper incisors were proclined, as planned in the set-up, in order to obtain incisor exposure

improvement during smile and permitting lower arch dento-alveolar advancement for class II correction. Lower incisors were proclined due to lower arch levelling and to the use of class II elastics. A good light contact had been achieved. Upper molars were slightly intruded in consequence of miniscrew employment, lower molars slightly extruded due to curve of Spee flattening. The clockwise rotation of the occlusal plane, which was reported in previous researches of distalization with miniscrews [29,30], was empowered by the use of class II intermaxillary elastics (figure 14). The control photographs performed one year (figure 15 and figure 16) show the aesthetic result obtained with occlusal cant correction stability.

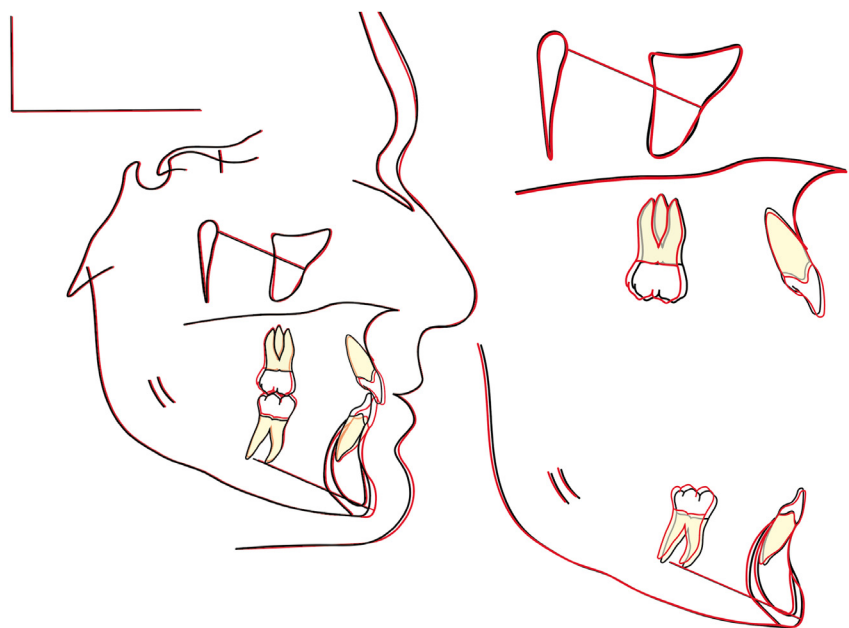
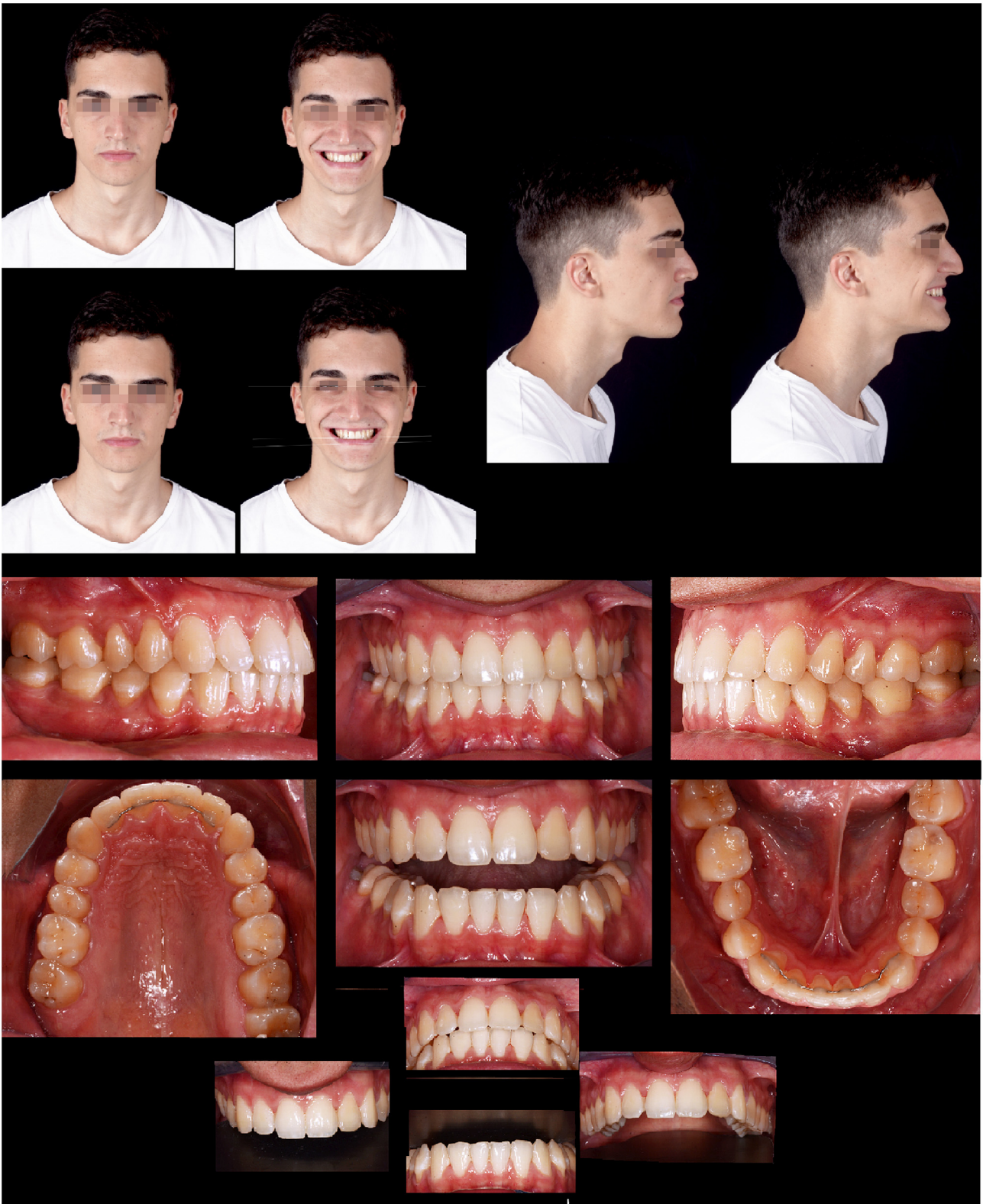


FIGURE 14  
General, maxillary and mandibular superimpositions



**FIGURE 15**  
**One year follow-up frontal, lateral extraoral and intraoral photographs**





FIGURE 16

**Comparison of the smiles in front view before and after treatment showing a perfect correction of the occlusal cant in the frontal plane which was a reflection of facial asymmetry**

## Discussion

In the present case-report an asymmetric class II malocclusion in an adult patient with a significant occlusal plane cant was corrected by a combination of extrusion and intrusion forces with lingual straight-wire appliance, interraderic miniscrews and auxiliaries.

Despite the fact that the case would have benefited from orthognathic surgery for skeletal discrepancy resolution, the patient refused this option and the best camouflage treatment was researched.

The final result lead to the resolution of the malocclusion and the occlusal plane cant. The duration of the treatment was 36 months; the patient was warned before treatment start that the correction without surgical treatment would have requested a long treatment time and was very satisfied of the result.

The prevalence of asymmetry in the general population is estimated to be as high as 85% [31,32]. Minor asymmetries are common in the general population and are even found in the most pleasing and apparently symmetrical faces [33]; however, they have no aesthetic or functional significance [34]. Dentoalveolar structures and facial soft tissues show compensatory changes to minimize the underlying asymmetry [35].

While the soft tissues can mask skeletal deviations of as much as 4 mm, asymmetrical deviations of the lower face are more frequent and severe than those of the middle or upper face [36]. About 45% of asymmetry cases present with a soft-tissue cant in relation to the corners of the mouth, while a cant in the occlusal plane is observed in 48% of patients with mandibular asymmetry [37,38].

The threshold for recognition of an occlusal plane by 90% of observers is 4°[39]; at treatment start occlusal plane cant was significantly higher in respect of this value.

The occlusal plane cant can be corrected either by intrusion on one side, extrusion on the other side or a combination of both [11].

Usually, the upper arch serves as the reference to the diagnosis through the exposure of the crowns and the gingiva: intrusion is indicated on the maxillary arch when gingival exposure is accentuated, extrusion when gingival exposure is reduced.

The series of photographs performed at treatment start was essential to address the diagnosis. The analysis of smiles was facilitated by the use of reference lines. Most patients that show a cant of the occlusal plane also have an asymmetry in the labial architecture when smiling: for this reason, the bipupillary line was employed as the most reliable horizontal reference [11,40,41].

In the present case the slight lack of incisal exposure at treatment start required an occlusal plane correction obtained initially for extrusion of the upper left and lower right buccal segments. For this reason, interraderic miniscrews were inserted in upper arch on palatal right side, in lower arch on buccal left side, in order to prescribe the patient full-time intermaxillary elastics from the miniscrews to opposing buccal segments.

For class II correction, en-masse maxillary distalization [42,43] was carried out for sagittal discrepancy correction, with the addition of the interraderic upper left miniscrew. At the same time occlusal plane correction was continued intruding upper right buccal and posterior segments: first, after seventeen months of treatment, the intrusive force was applied on palatal side by the interraderic miniscrew (with an elastic thread from the miniscrew to first premolar and first molar); then, after thirty-two months of treatment, two miniscrews were progressively added on buccal side between upper first and second molars and between upper second premolar and first molar, in order to help buccal segment intrusion together with a slight transverse posterior expansion.

On left side lower buccal miniscrew was removed after twenty-one months from treatment start, since intermaxillary elastics were necessary in order to help dental class II correction on left side. The application on buccal aesthetic buttons was determined by the need to correct the slight palatal root-torque of the upper left buccal segment.

An active lingual retainer, positioned at the end of the previous treatment, caused an orthodontic wire syndrome [17-21] resulting in an iatrogenic position of the lower canines (lingually displaced) and the lower left lateral incisor (with buccal-root torque). Their positions were corrected. Passive upper and lower fixed lingual retainers were bonded at the end of treatment.

The position of the lower right first premolar, with a thin band of gingiva and an absence of keratinised gingiva, needed to be monitored: for this reason, a periodontal assessment was requested after orthodontic treatment.

## Conclusions

In this case the employment of a lingual straight-wire treatment combined with miniscrews allowed the correction of a class II malocclusion with an occlusal planed cant deviation in an adult patient in 36 months of treatment. The lingual appliance with all the auxiliaries on the inner side allowed one to have a completely invisible appliance, as requested by the patient; only one buccal interradicular miniscrew and some aesthetic buttons for class II correction and root-palatal torque resolution were employed during treatment; furthermore, the set-up planning allowed one to obtain ideal overjet and overbite and to increase the incisal exposition during smile. Torque of anterior, buccal and posterior segments of upper and lower arch were normalized with set-up overcorrections.

In conclusion the successful resolution of this case shows the efficacy of a combined protocol involving lingual straight-wire treatment and miniscrews. The duration of the treatment recommends orthognathic surgery in order to obtain results in a shorter time of treatment.

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

## Disclosure of interest

The authors declare that they have no competing interest.

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