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Case report

Torque control with set-up and auxiliary spring in an adult severe class II case treated by lingual straight-wire appliance, premolar extractions and orthognathic surgery

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Keywords
Class II
Mandible pathology
Retrognathia
High-angle
Orthognathic surgery
Lingual
Torque

Summary

This case report describes a complex full-step class II high angle case in an adult patient treated with lingual straight-wire appliance, premolar extractions and orthognathic surgery. With the twofold aim of obtaining ideal occlusal relationship and aesthetic improvement, surgical treatment with appropriate biomechanical strategies, including extraction choice and torque control during space closure, are needed to achieve the planned results. This case report demonstrates the possibility of solving successfully severe sagittal, transverse and vertical discrepancies in an adult patient with surgical treatment by means of an invisible technique. This report also underlines the need for precise biomechanical control, including set-up overcorrections and an auxiliary spring to manage teeth inclination, in lingual orthodontics extraction cases.

Introduction

Torque control is one of the most difficult aspects of orthodontic extraction treatment, in particular when lingual appliances are employed.
A research of Komaki et al. comparing maxillary incisors' inclinations between lingual and labial appliances by finite element method concluded that loads of the same magnitude produced translation of the maxillary incisors in labial orthodontics but lingual crown tipping of the same tooth in lingual orthodontics [1]. To provide better torque control of the incisor or prevent a vertical bowing effect for the lingual appliance, the incorporation of extra torque into brackets of incisors and the use of power arm were recommended.
Deguchi et al. remarked that "exaggerated uprighting of the maxillary and mandibular incisors following treatment of class II extraction cases with lingual appliances indicates the need for increased lingual root torque to regain control of incisor movement during retraction" [2].

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On the other side, a recent case series concluded that "control of anterior torque is a realistic goal of lingual orthodontic treatment, even in a complex extraction case, when overcorrections are included in the set-up prescription and space closure is managed with light forces, appropriate stainless steel archwires, and compensation bends and curves to limit bowing effects'' [3].
Through the combined use of the ribbon-wise customized lingual appliance, palatal bar, and orthodontic anchor screw, vertical control and an excellent treatment result were achieved by Inami et al., without the vertical and horizontal bowing effects peculiar to conventional lingual treatment [4].
Some researchers compared the torque control achieved by different combinations of wires and brackets (conventional vs. selfligating) concluding that full-size wires and conventional brackets produced the best results [5,6].
In most cases, torque is properly controlled with the exception of few elements that show evident differences: this can happen since anterior retraction may produce a reactive tipping force due to differences in the biomechanical force directions [7]. In rare cases, despite a symmetric mechanics, one single tooth can evidence a higher torque loss.
In order to solve this shortcoming, this article describes how the employment of an auxiliary spring, in addition to set-up overcorrections, is successful to normalize single tooth torque, since orthodontic appliances are less efficient in torque movements, due to limited moment [8].

Diagnosis and aetiology

A 20-year-old male presented with the request to have his teeth aligned by means of an aesthetic appliance. From a frontal perspective, the face was well proportioned, with a mild form of hypertelorism, a mandibular symphysis deviation toward the right side and divergent mandibular angle (*figure 1*). The patient exhibited a convex profile, a prominent nose, a 90° nasolabial angle, a marked labio-mental sulcus, and a severely retrusive lower jaw. In medical history, a significant snoring at night was reported.

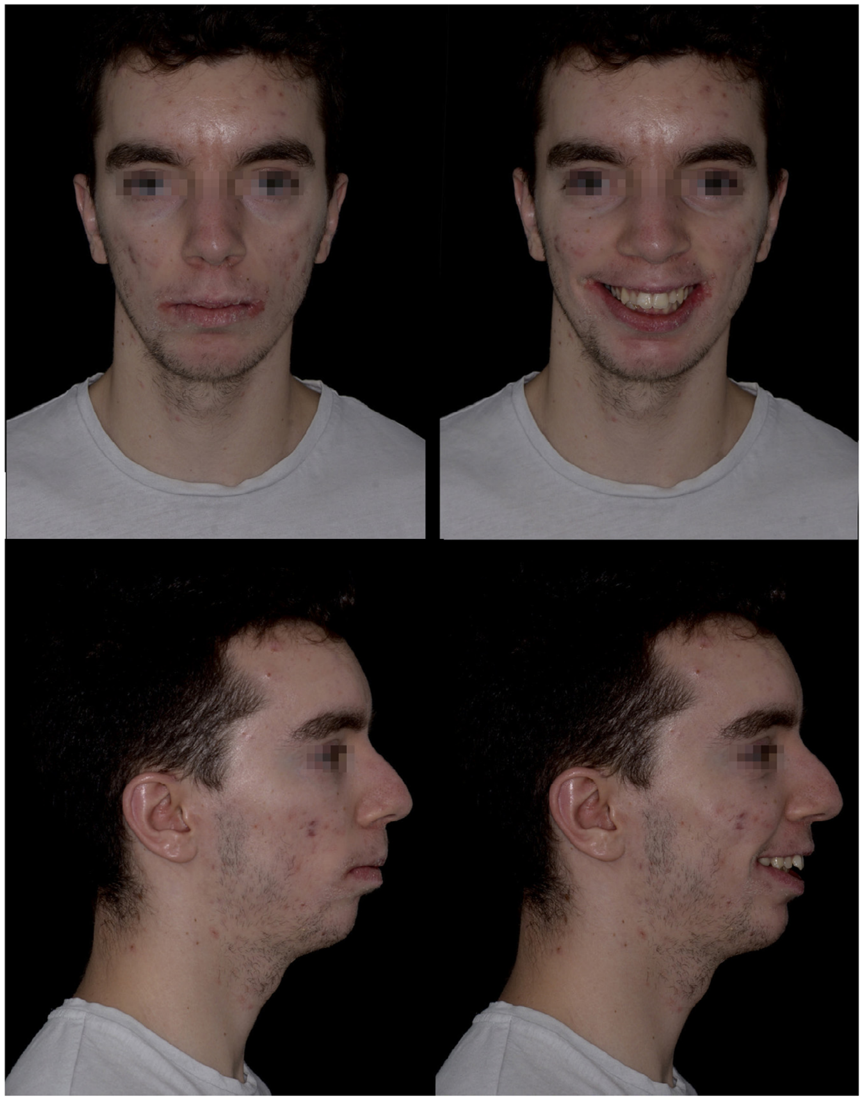


FIGURE 1
Initial frontal and lateral extraoral photographs

The midlines were not coincident, with the lower deviated toward the right side, while a crossbite involving the upper right first and second molars was present (*figures 2 and 3*); negative torque of the buccal and posterior segments was evident in both arches, along with an anterior deep bite and an accentuated lower curve of Spee. The patient had bilateral full-step class II canine and molar relationships, a constricted upper arch, and an asymmetrical lower arch. The upper lateral incisors and the lower right lateral incisor were lingually displaced.

The periodontal biotype was thick. The panoramic radiograph showed the presence of all teeth, including the third molars, with the lower left impacted (*figure 4*).

FIGURE 2
Initial intraoral photographs

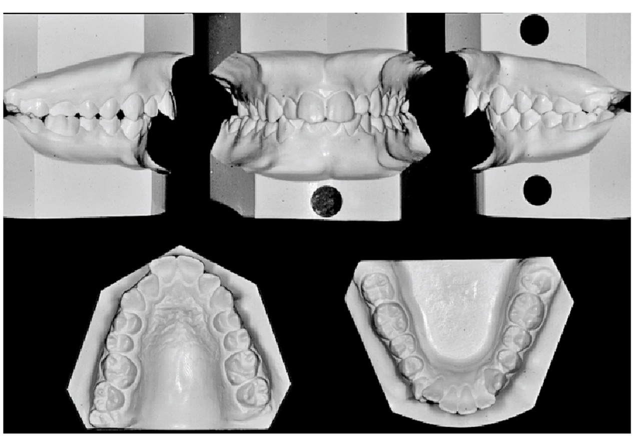
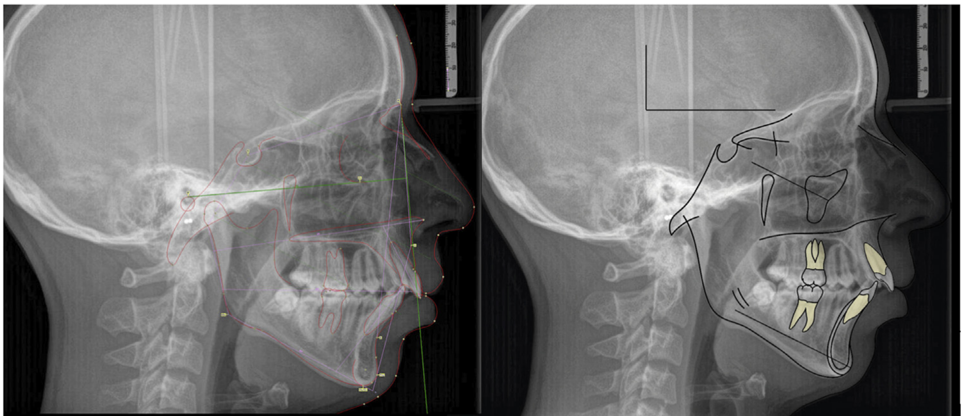


FIGURE 3
Initial models

FIGURE 4
Initial orthopantomography

Cephalometric values pointed out a skeletal class II relationship (ANB = 10°) with both the maxilla (SNA = 76°) and mandible (SNB = 66°) in retruded positions (*figure 5*). The skeletal pattern was hyperdivergent (SN/MP = 46°) with a counterclockwise-oriented occlusal plane. The upper incisors were normally inclined (U1/PP = 109°) while the lower incisors were proclined (L1/MP = 101°).



Mc Laughlin					
Variable	Description	Clinical Norm	Value	Difference	Deviation
SNA	SNA Angle	82,0±3,5°	76,0°	-2,5	
SNB	SNB Angle	80,0±3°	65,9°	-11,1	
ANB	ANB Angle	2,0±2,4°	10,1°	+5,7	
A / NP	Distance of A-point to Nasion Perpendicu	0,0±3,1mm	-0,7mm	0,0	
Po / NP	Distance of Pogonion to Nasion Perpend	-4,0±5,3mm	-20,8mm	-11,5	
WITS	Distance of A and B on Occl. Plane	0,0±1mm	14,7mm	+13,7	
SN / MP	Angle of S-N to Mand. Plane	32,0±5°	46,0°	+9,0	
FH / MP	Angle of FH to Mand. Plane	26,0±5°	32,7°	+1,7	
PP / MP	Angle between Palatal and Mand. Plane	28,0±6°	36,2°	+2,2	
PP / OP	Angle between Palatal and Occl. Plane	10,0±4°	9,2°	0,0	
MP / OP	Angle of Mand. to Occl. Plane	17,4±5°	27,0°	+4,6	
U1 / A Po	Distance of L1 to A-Po	6,0±2,2mm	9,8mm	+1,6	
L1 / A Po	Distance of L1 to A-Po	2,0±2,3mm	1,5mm	0,0	
U1 / PP	Angle of Axis of U1 to Palatal Plane	110,0±5°	109,0°	0,0	
L1 / MP	Angle of Axis of L1 to Mand. Plane	95,0±7°	100,8°	0,0	
U1 / OP	Angle of Axis of U1 to Occl. Plane	57,5±7°	61,8°	0,0	
L1 / OP	Angle of Axis of L1 to Occl. Plane	72,0±5°	52,1°	-14,9	

Roth - Jarabak					
Variable	Description	Clinical Norm	Value	Difference	Deviation
Dental Analysis					
MeGoOcP	Angle of Mand. to Occl. Plane	14°	28°	+14	
II	Interincisal Angle	135°	114°	-21	
Max1-SN	Angle of Axis of 1u to Max. Base	102±2°	99°	-1	
Mand1-MeGo	Angle of Axis of 1l to Mand. Base	90±3°	101°	+8	
1up-NPog	Distance of Incisal Edge of 1u to N-Pog	5±2mm	16mm	+9	
1lo-NPog	Distance of Incisal Edge of 1l to N-Pog	-2..2mm	9mm	+7	
Ls-NsPog'	Upper Lip to Esthetic Line	-4..1mm	1mm	0	
Li-NsPog'	Lower Lip to Esthetic Line	0..2mm	5mm	+3	
Skeletal Analysis					
NSar	Saddle Angle	123±5°	138°	+10	
SarGo	Articular Angle	143±6°	137°	0	
arGoMe	Gonial Angle	130±7°	131°	0	
Sum	Sum Angle	396±5°	406°	+5	
N-S	Anterior Cranial Base Length	71±3mm	72mm	0	
S-ar	Lateral Cranial Base Length	32±3mm	36mm	+1	
NGoar	Upper Gonial Angle	52..55°	53°	0	
NGoMe	Lower Gonial Angle	70..75°	78°	+3	
ar-Go	Ramus Length	44±5mm	41mm	0	
S-ar:ar-Go	Ratio of Lat. Cranial Base and Ramus Hei	60..75%	88%	+13	
Go-Me	Mandibular Length	71±5mm	68mm	0	
Go-Me:N-S	Ratio of Mand. and Cranial Base Length	100%	94%	-6	
SNA	SNA Angle	80..84°	76°	-4	
SNB	SNB Angle	78..82°	66°	-12	
ANB	ANB Angle	0..4°	10°	+6	
SNGoMe	Angle of Anterior Cranial Base to Mand. I	36°	46°	+10	
N-Go	Facial Depth		121mm		
S-Me	Facial Length on Y-Axis		120mm		
NSG	Y Axis to SN		80°		
S-Go	Posterior Facial Height		72mm		
N-Me	Anterior Facial Height		126mm		
S-Go:N-Me	Ratio of Posterior and Anterior Facial Hei	64±2°	57%	-5	
SNPog Angle	Facial Plane		67°		
NAPog	Facial Convexity	175°	161°	-14	

FIGURE 5
Cephalometric analysis, tracing and values

Treatment objectives

The primary objectives were profile improvement by orthognathic surgery, dental class II correction, crossbite resolution and vertical control. Additional goals were crowding correction, reduction of black buccal corridors during smile, ideal overjet and overbite achievement and aesthetic dental exposition improvement at smile.

Treatment alternatives

Considering the patient's convex profile, the prominent nose and the bimaxillary retrusion, an orthodontic camouflage treatment with four premolar extractions would have adversely affected his facial balance.
Surgical orthodontic treatment including maxillo-mandibular advancement, posterior maxillary impaction, correction of asymmetry, transverse maxillary expansion and genioplasty was recommended as the only possible solution. The upper and lower second premolars would be extracted to prepare the patient for the surgical correction.
The maxillo-facial surgeon asked the lower third molars extraction. Surgical orthodontic treatment including maxillo-mandibular advancement, posterior maxillary impaction, correction of asymmetry, transverse maxillary expansion and genioplasty was recommended as the only possible solution. The upper and lower second premolars would be extracted to prepare the patient for the surgical correction.
Lower second premolars extractions were necessary in order to obtain a correct lower incisors inclination. Avoiding extractions in upper arch could have determined a molar class III relationship with an excessive number of upper teeth in comparison with the lower arch.
In lower arch, the possibility of decompensation by mandibular en-masse retraction, thus avoiding extractions, with either mini-screws or miniplates insertion and third molar extractions was considered [9,10]. However, the initial lower incisors proclination (requiring a significant correction, in order to allow the correct mandibular advancement) and the necessary increase in the duration of treatment lead to avoid this solution.

Treatment progress

Since the patient had asked for aesthetic treatment, a lingual appliance would be used. The lingual biomechanics would avoid lower incisor proclination during leveling, as a result of the intrusion force passing closer to the lower incisors' center of resistance [7].
Extraction tip and torque overcorrections were included in the manual set-up prescriptions for the preadjusted Ormco STb brackets (*figure 6*).
In consequence of the irregular incisal margins of upper right central incisor and the different height of lateral incisors, composite reconstructions on upper right central incisor and left lateral incisor were planned with the patient for treatment end.

FIGURE 6
Manual set-up

Indirect bonding was carried out with single jigs, according to the Komori KommonBase technique [11].
Lower arch was first performed with the insertion of a 0.013 Copper NiTi LSW small wire and an open-coil springs between the lower right lateral incisor and the lower right first premolar (*figure 7*a).
After a period of two months after the extraction of lower second premolars, the upper arch was bonded and the same size of Stb archwire was placed (*figure 7*b). Occlusal build-ups were added on the upper second molars to obtain a tripodic contact. A closed elastomeric chain was inserted between the upper left central and lateral incisor to facilitate their complete rotational correction. The open-coil springs between the lower right lateral incisor and first premolar was reactivated. Buccal tubes on lower first and second molars were bonded since lingual surface of lower second molars was too small for lingual brackets insertion. 0.019 × 0.025 NiTi buccal sectionals were then inserted for the application of bilateral criss-cross 3/16 6oz Ormco Impala elastics.
The crossbite elastics were prescribed to the patient in order to help the correction of upper molars torque: the main entity of expansion correction was planned with surgical treatment.
Six months after the start of treatment, the upper wire was changed to a medium 0.018 × 0.018 Copper NiTi for leveling

FIGURE 7

a: lower arch bonding. Insertion of 0.013 CuNiTi LSW Ormco Stb small. Insertion of open coil springs between the lower right lateral incisor and the lower right first premolar; b: upper arch bonding. Insertion of 0.013 CuNiTi LSW Ormco Stb small, build-ups on upper second molars and closed elastic chain between the upper left central and lateral incisors. Reactivation of open-coil springs between the lower right lateral incisor and first premolar. Bonding of buccal tubes on lower first and second molars. Insertion of 0.019 × 0.025 NiTi buccal sectionals

FIGURE 8

a: at the 6th month, insertion of a medium 0.018 × 0.018 Copper NiTi in upper arch; insertion of a small 0.018 × 0.018 Copper NiTi for leveling and torque management was inserted in the lower arch; b: at the 9th month, insertion of a 0.018 × 0.018 posted stainless steel upper archwire, with the addition of root-palatal torque from upper right to upper left lateral incisor; super-Spee and transverse antibowing compensation curves. Insertion of a 0.018 × 0.018 stainless steel lower archwire with the addition of antiSpee curve. Insertion of closed elastomeric chains from upper right to upper left second molar and from lower right to lower left first molar

and torque management; a small 0.018 × 0.018 Copper NiTi for leveling and torque management was inserted in the lower arch (*figure 8*a).

Following a period of three months, after the extractions of upper second premolars, a 0.018 × 0.018 posted stainless steel upper archwire was inserted with the addition of root-palatal torque from upper right to upper left lateral incisor; super-Spee and transverse antibowing compensation curves were added. A 0.018 × 0.018 stainless steel lower archwire was inserted with the addition of antiSpee curve. Closed elastomeric chains were inserted from upper right to upper left second molar and from lower right to lower left first molar in order to begin spaces closure (*figure 8*b).

From the extraoral photographs, the pre-surgery profile worsening can be evidenced (*figure 9*).

After 23 months of treatment (two weeks before surgery), buccal buttons, brackets and tubes were bonded to the remaining teeth as attachments for postsurgical intermaxillary elastics (*figure 10*). The presurgical panoramic radiograph confirmed that root parallelism had been achieved (*figure 11*).

Cephalometric values showed an increase in upper incisor torque from 109° to 118° despite the extraction space closure (*figure 12*).

The lower incisor torque change was ideal (from 101° to 94°) for the sagittal mandibular advancement.

FIGURE 9

Pre-surgery frontal and lateral extraoral photographs

Maxillo-mandibular advancement was planned to improve the profile (with the addition of a genioplasty), posterior maxillary expansion to correct the posterior crossbite, posterior maxillary impaction to improve the hyperdivergent pattern (*figure 13*). The correction of the maxillomandibular asymmetry was in addition planned.

The maxillofacial surgery was performed after 24 months of orthodontic treatment. Three weeks later, bilateral class II 3/16 6oz Ormco Impala elastics were prescribed full-time in order to improve the intercuspation.

One month after the operation (at month 25), upper and lower 0.0175×0.0175 TMA archwires were inserted in order to

FIGURE 10

Pre-surgery endobuccal views; upper and lower buccal buttons bonding

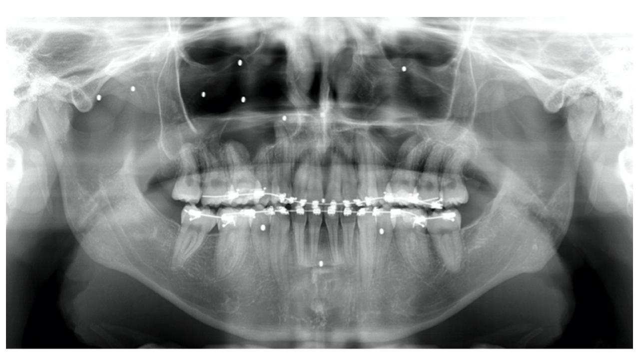
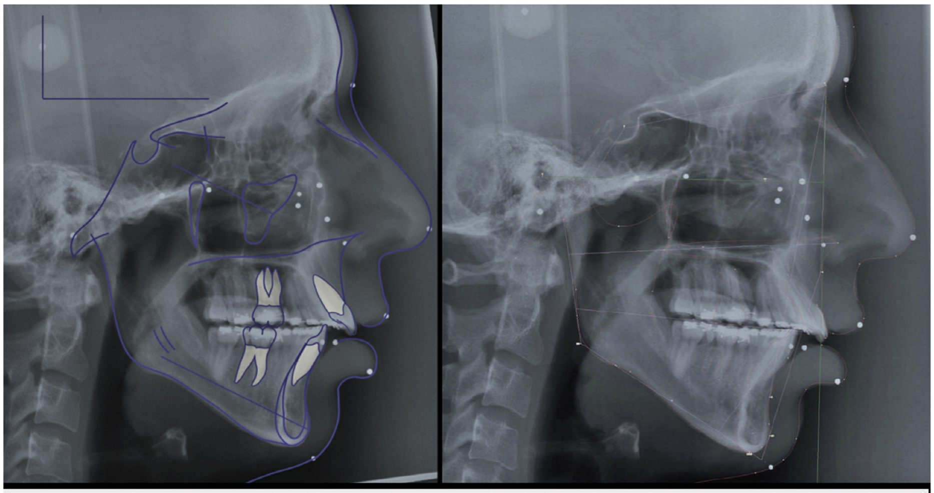


FIGURE 11

Pre-surgery orthopantomography



Mc Laughlin

Variable	Description	Clinical Norm	Value	Difference	Deviation
SNA	SNA Angle	82,0±3,5°	76,3°	-2,2	
SNB	SNB Angle	80,0±3°	67,7°	-9,3	
ANB	ANB Angle	2,0±2,4°	8,6°	+4,2	
A / NP	Distance of A-point to Nasion Perpendicu	0,0±3,1mm	-0,5mm	0,0	
Po / NP	Distance of Pogonion to Nasion Perpend	-4,0±5,3mm	-15,3mm	-6,0	
WITS	Distance of A and B on Occl. Plane	0,0±1mm	12,0mm	+11,0	
SN / MP	Angle of S-N to Mand. Plane	32,0±5°	44,7°	+7,7	
FH / MP	Angle of FH to Mand. Plane	26,0±5°	31,4°	+0,4	
PP / MP	Angle between Palatal and Mand. Plane	28,0±6°	35,2°	+1,2	
PP / OP	Angle between Palatal and Occl. Plane	10,0±4°	8,3°	0,0	
MP / OP	Angle of Mand. to Occl. Plane	17,4±5°	26,9°	+4,5	
U1 / A Po	Distance of L1 to A-Po	6,0±2,2mm	7,7mm	0,0	
L1 / A Po	Distance of L1 to A-Po	2,0±2,3mm	-2,1mm	-1,8	
U1 / PP	Angle of Axis of U1 to Palatal Plane	110,0±5°	118,4°	+3,4	
L1 / MP	Angle of Axis of L1 to Mand. Plane	95,0±7°	93,9°	0,0	
U1 / OP	Angle of Axis of U1 to Occl. Plane	57,5±7°	53,2°	0,0	
L1 / OP	Angle of Axis of L1 to Occl. Plane	72,0±5°	59,2°	-7,8	

Roth - Jarabak

Variable	Description	Clinical Norm	Value	Difference	Deviation
Dental Analysis					
MeGoOcP	Angle of Mand. to Occl. Plane	14°	26°	+12	
II	Interincisal Angle	135°	112°	-23	
Max1-SN	Angle of Axis of 1u to Max. Base	102±2°	109°	+5	
Mand1-MeGo	Angle of Axis of 1l to Mand. Base	90±3°	94°	+1	
1up-NPog	Distance of Incisal Edge of 1u to N-Pog	5±2mm	13mm	+6	
1lo-NPog	Distance of Incisal Edge of 1l to N-Pog	-2..2mm	3mm	+1	
Ls-NsPog'	Upper Lip to Esthetic Line	-4..1mm	0mm	0	
Li-NsPog'	Lower Lip to Esthetic Line	0..2mm	4mm	+2	
Skeletal Analysis					
NSar	Saddle Angle	123±5°	136°	+8	
SarGo	Articular Angle	143±6°	138°	0	
arGoMe	Gonial Angle	130±7°	131°	0	
Sum	Sum Angle	396±5°	405°	+4	
N-S	Anterior Cranial Base Length	71±3mm	65mm	-3	
S-ar	Lateral Cranial Base Length	32±3mm	34mm	0	
NGoar	Upper Gonial Angle	52..55°	52°	0	
NGoMe	Lower Gonial Angle	70..75°	79°	+4	
ar-Go	Ramus Length	44±5mm	39mm	0	
S-ar:ar-Go	Ratio of Lat. Cranial Base and Ramus Hei	60..75%	87%	+12	
Go-Me	Mandibular Length	71±5mm	63mm	-3	
Go-Me:N-S	Ratio of Mand. and Cranial Base Length	100%	97%	-3	
SNA	SNA Angle	80..84°	76°	-4	
SNB	SNB Angle	78..82°	68°	-10	
ANB	ANB Angle	0..4°	9°	+5	
SNGoMe	Angle of Anterior Cranial Base to Mand. P	36°	45°	+9	
N-Go	Facial Depth		112mm		
S-Me	Facial Length on Y-Axis		114mm		
NSG	Y Axis to SN		79°		
S-Go	Posterior Facial Height		69mm		
N-Me	Anterior Facial Height		117mm		
S-Go:N-Me	Ratio of Posterior and Anterior Facial Hei	64±2°	59%	-3	
SNPog Angle	Facial Plane		69°		
NAPog	Facial Convexity	175°	164°	-11	

FIGURE 12

Pre-surgery cephalometric analysis, tracing and values

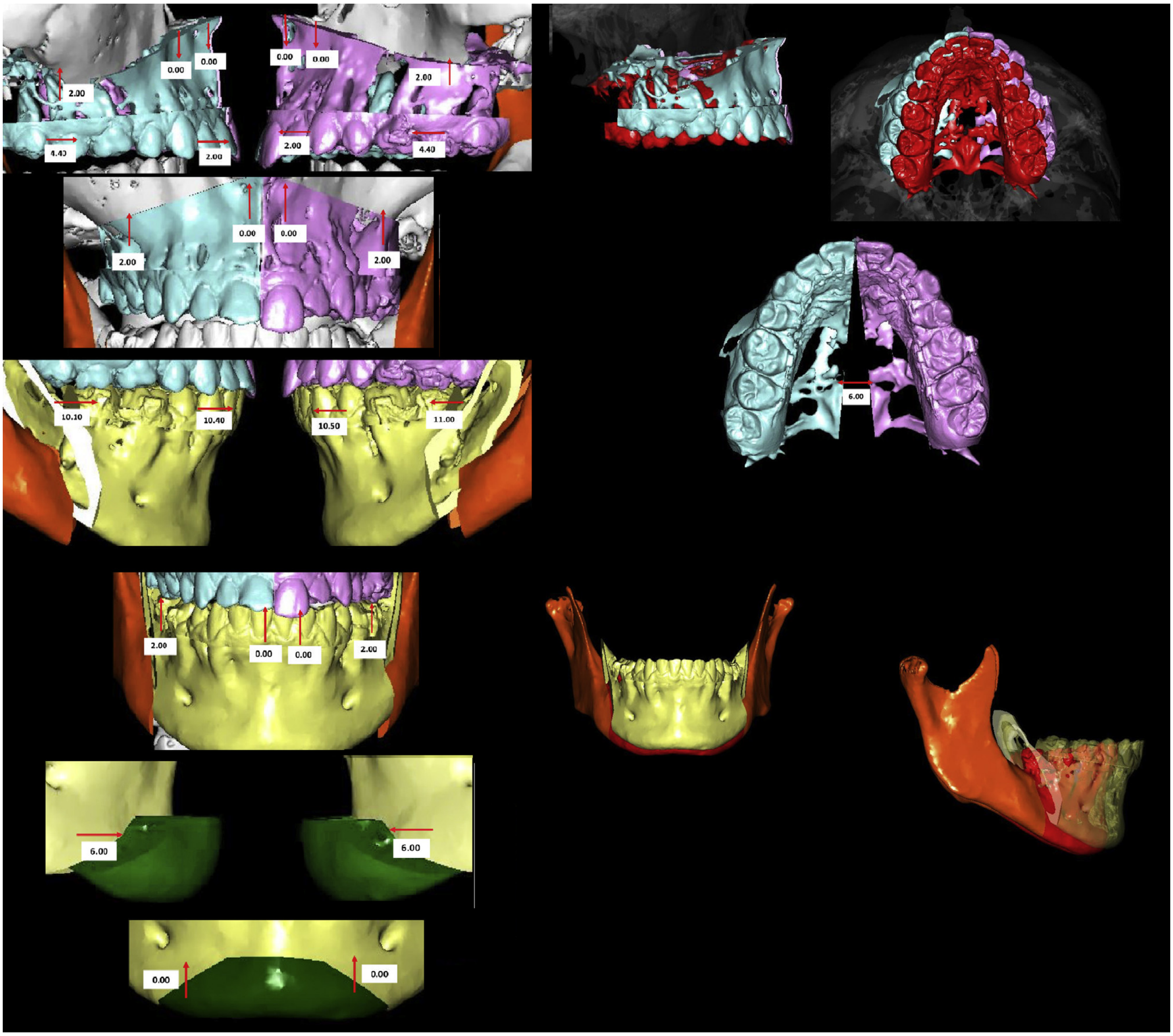


FIGURE 13

Surgery sagittal, transverse and vertical movements planning

perform some finishing bends both in upper and lower arches. Some buccal buttons were removed while others were left on the upper and lower posterior teeth for use of nighttime bilateral class II elastics and sectional wires insertion (*figure 14*). An auxiliary 0.016 SS spring was modeled and inserted for increasing upper left central palatal root-torque in order to correct the height discrepancy of the central incisors marginal height (*figure 15*).
During the following six months, the auxiliary springs improved the upper left central incisor torque and the following finishing bends were performed: 12 step-out, 13 rotation bend, 21 step-out, 22 step-in and step-down, 23 step-in and tip bend, 24 step-out, 32–41–42 rotation bends, 34–44 tip bends. Anterior vertical intermaxillary elastics were added for nighttime in order to obtain an ideal overbite.
After 32 months from treatment start, 0.016 SS auxiliary wire was removed and the last refinement bends were performed to finish the occlusion: 22–23 step-in, 23 step-down, 25 rotation bend, 43 step-up (*figure 16*).

Figure 14

One-month post-surgery (at month 25) endobuccal views; upper and lower 0.0175 × 0.0175 TMA archwires insertion. 0.016 SS auxiliary torque spring insertion. Closed elastic chain insertion between upper first molars. Bilateral class II elastics prescribed for nighttime

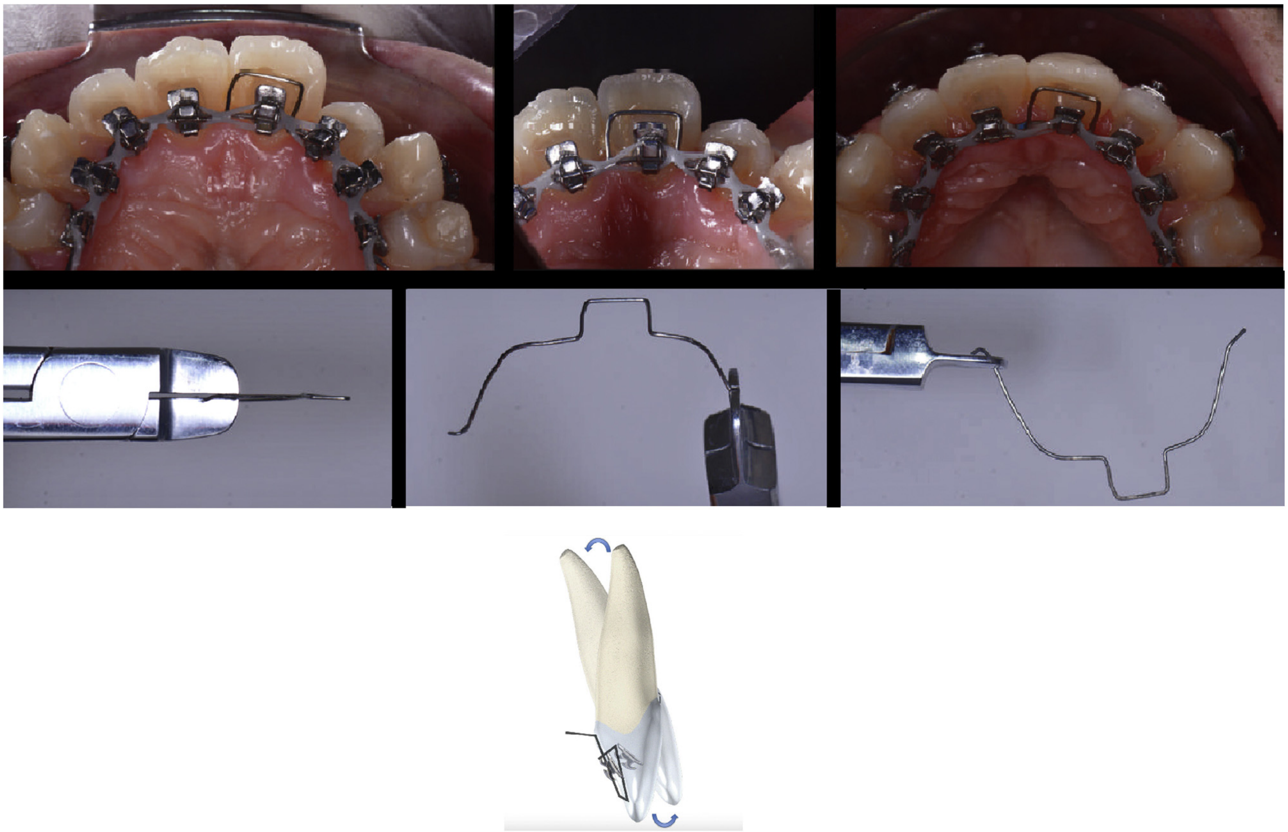


FIGURE 15

0.016 SS auxiliary torque spring activation

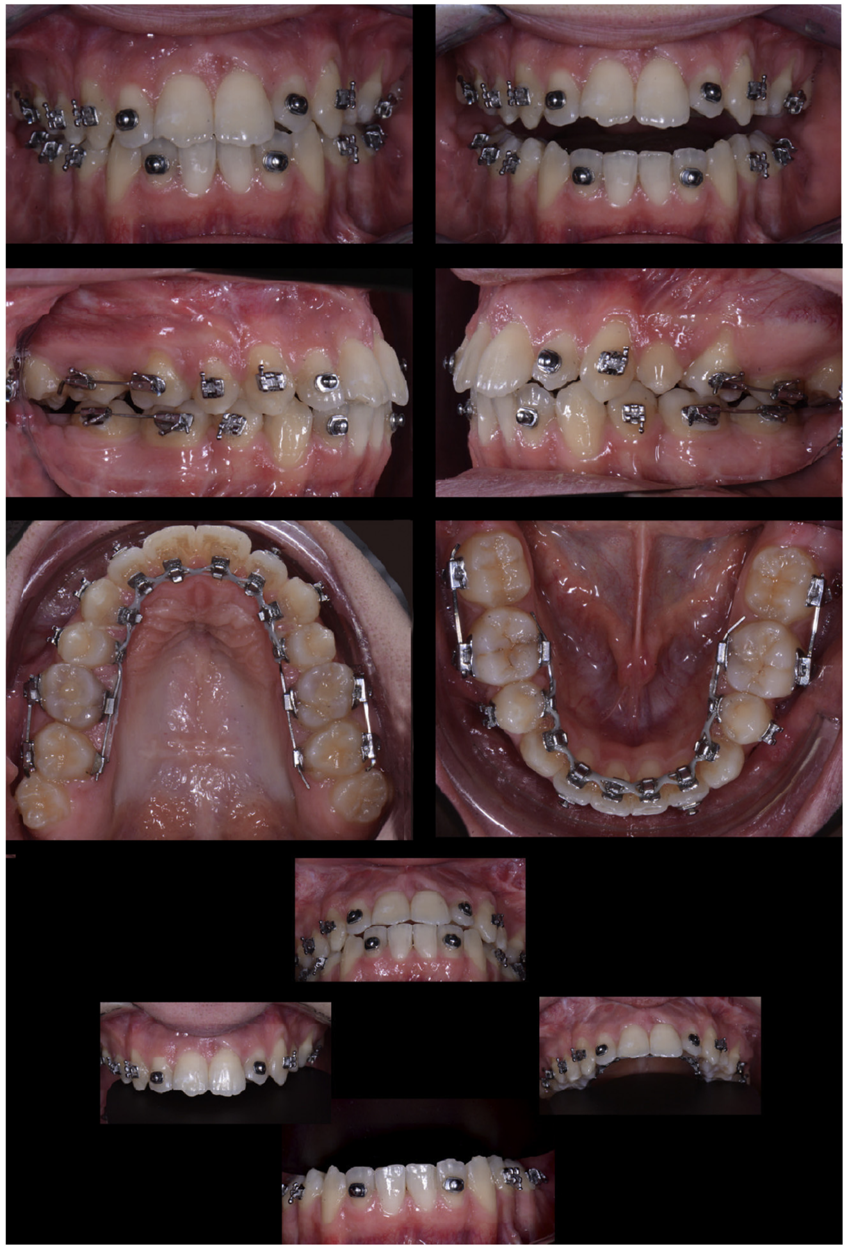


FIGURE 16

After removal of the auxiliary and 6 months of refinement bends: 13 mesial step-in, 21 step-in, 23 step-in, 24 step-out. Insertion of closed elastic chains between upper first molars and lower first molars

Treatments results

Fixed appliances were removed 33 months after the start of treatment (*figures 17 and 18*) and upper and lower essix retainers were delivered.

A solid class I canine and molar relationship was obtained on both sides, while the deep bite was resolved, the lower curve of Spee was flattened, and ideally minimal upper and lower curves of Wilson were attained. The resulting light contact was ideal. Despite the insertion of a sectional wire on buccal side (in addition to lingual appliance) and the use of posterior criss-cross elastics, the torque on upper left first molar remained slightly negative. The patient was referred to a periodontist in order to examine the gingival recession after treatment.

Facial balance was achieved by means of the improved maxillo-mandibular projection and ideal anterior tooth exposure. A pleasant smile arc and harmonious profile were evident and the asymmetry was corrected (*figure 19*).

The final orthopantomography showed the root parallelism between the elements with no signs of bone and/or root resorption (*figure 20*).

FIGURE 17

End of treatment (33rd month) intraoral photographs

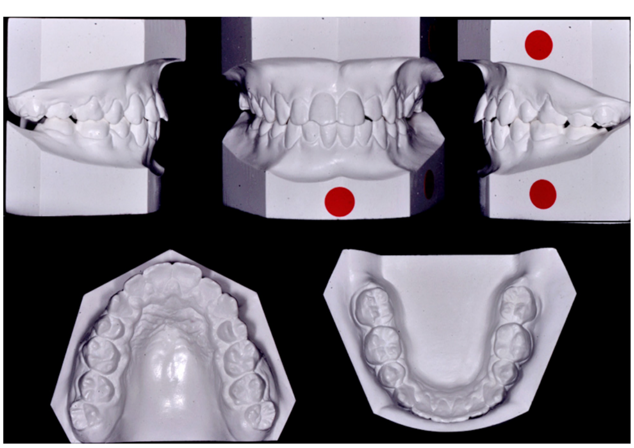


FIGURE 18

End of treatment (33rd month) models

Figure 19

End of treatment (33rd month) extraoral photographs

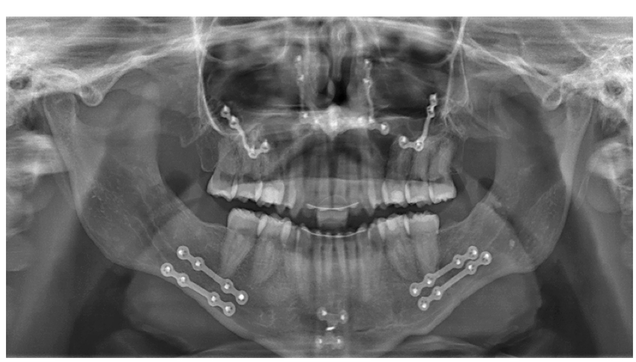
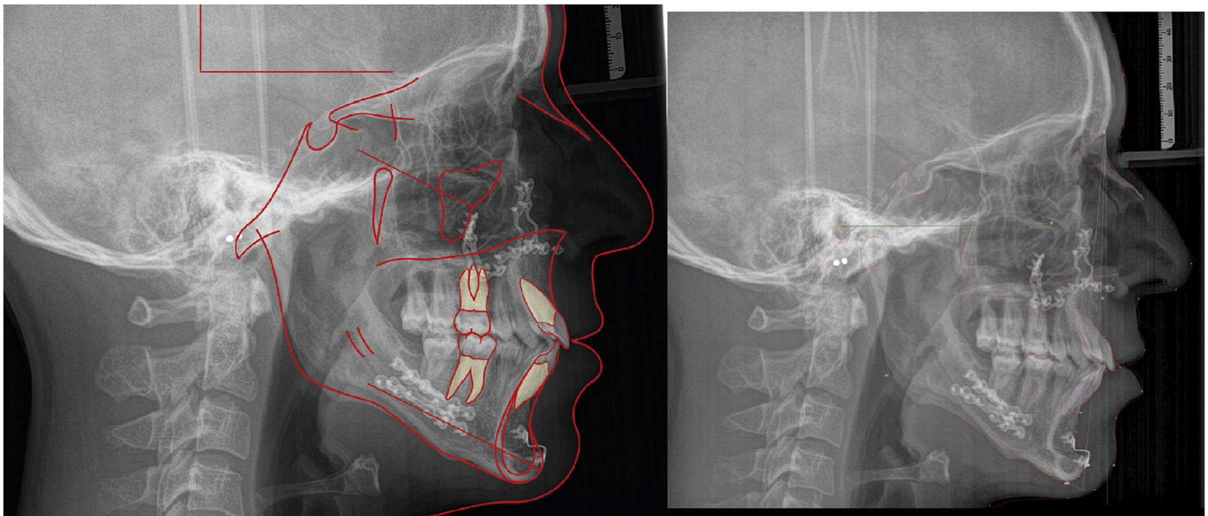


Figure 20

End of treatment (33rd month) orthopantomography



Mc Laughlin

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A / NP	Distance of A-point to Nasion Perpendic	0,0±3,1mm	-1,9mm	0,0	
Po / NP	Distance of Pogonion to Nasion Perpend	-4,0±5,3mm	-8,0mm	0,0	
WITS	Distance of A and B on Occl. Plane	0,0±1mm	1,4mm	+0,4	
SN / MP	Angle of S-N to Mand. Plane	32,0±5°	45,0°	+8,0	
FH / MP	Angle of FH to Mand. Plane	26,0±5°	31,0°	+0,0	
PP / MP	Angle between Palatal and Mand. Plane	28,0±6°	37,4°	+3,4	
PP / OP	Angle between Palatal and Occl. Plane	10,0±4°	15,7°	+1,7	
MP / OP	Angle of Mand. to Occl. Plane	17,4±5°	21,7°	0,0	
U1 / A Po	Distance of L1 to A-Po	6,0±2,2mm	7,2mm	0,0	
L1 / A Po	Distance of L1 to A-Po	2,0±2,3mm	3,6mm	0,0	
U1 / PP	Angle of Axis of U1 to Palatal Plane	110,0±5°	115,2°	+0,2	
L1 / MP	Angle of Axis of L1 to Mand. Plane	95,0±7°	97,3°	0,0	
U1 / OP	Angle of Axis of U1 to Occl. Plane	57,5±7°	49,1°	-1,4	
L1 / OP	Angle of Axis of L1 to Occl. Plane	72,0±5°	61,0°	-6,0	

Roth - Jarabak

Variable	Description	Clinical Norm	Value	Difference	Deviation
Dental Analysis					
MeGoOcP	Angle of Mand. to Occl. Plane	14°	22°	+8	
II	Interincisal Angle	135°	110°	-25	
Max1-SN	Angle of Axis of 1u to Max. Base	102±2°	108°	+4	
Mand1-MeGo	Angle of Axis of 1l to Mand. Base	90±3°	97°	+4	
1up-NPog	Distance of Incisal Edge of 1u to N-Pog	5±2mm	8mm	+1	
1lo-NPog	Distance of Incisal Edge of 1l to N-Pog	-2..2mm	5mm	+3	
Ls-NsPog'	Upper Lip to Esthetic Line	-4..1mm	-4mm	0	
Li-NsPog'	Lower Lip to Esthetic Line	0..2mm	0mm	0	
Skeletal Analysis					
NSar	Saddle Angle	123±5°	135°	+7	
SarGo	Articular Angle	143±6°	136°	-1	
arGoMe	Gonial Angle	130±7°	134°	0	
Sum	Sum Angle	396±5°	405°	+4	
N-S	Anterior Cranial Base Length	71±3mm	70mm	0	
S-ar	Lateral Cranial Base Length	32±3mm	37mm	+2	
NGoar	Upper Gonial Angle	52..55°	55°	0	
NGoMe	Lower Gonial Angle	70..75°	79°	+4	
ar-Go	Ramus Length	44±5mm	39mm	0	
S-ar:ar-Go	Ratio of Lat. Cranial Base and Ramus Hei	60..75%	96%	+21	
Go-Me	Mandibular Length	71±5mm	75mm	0	
Go-Me:N-S	Ratio of Mand. and Cranial Base Length	100%	107%	+7	
SNA	SNA Angle	80..84°	74°	-6	
SNB	SNB Angle	78..82°	70°	-8	
ANB	ANB Angle	0..4°	4°	0	
SNGoMe	Angle of Anterior Cranial Base to Mand.	35°	45°	+9	
N-Go	Facial Depth		118mm		
S-Me	Facial Length on Y-Axis		127mm		
NSG	Y Axis to SN		76°		
S-Go	Posterior Facial Height		71mm		
N-Me	Anterior Facial Height		127mm		
S-Go:N-Me	Ratio of Posterior and Anterior Facial Hei	64±2°	56%	-6	
SNPog Angle	Facial Plane		72°		
NAPog	Facial Convexity	175°	176°	+1	

FIGURE 21

End of treatment (33rd month) cephalometric analysis, tracing and values

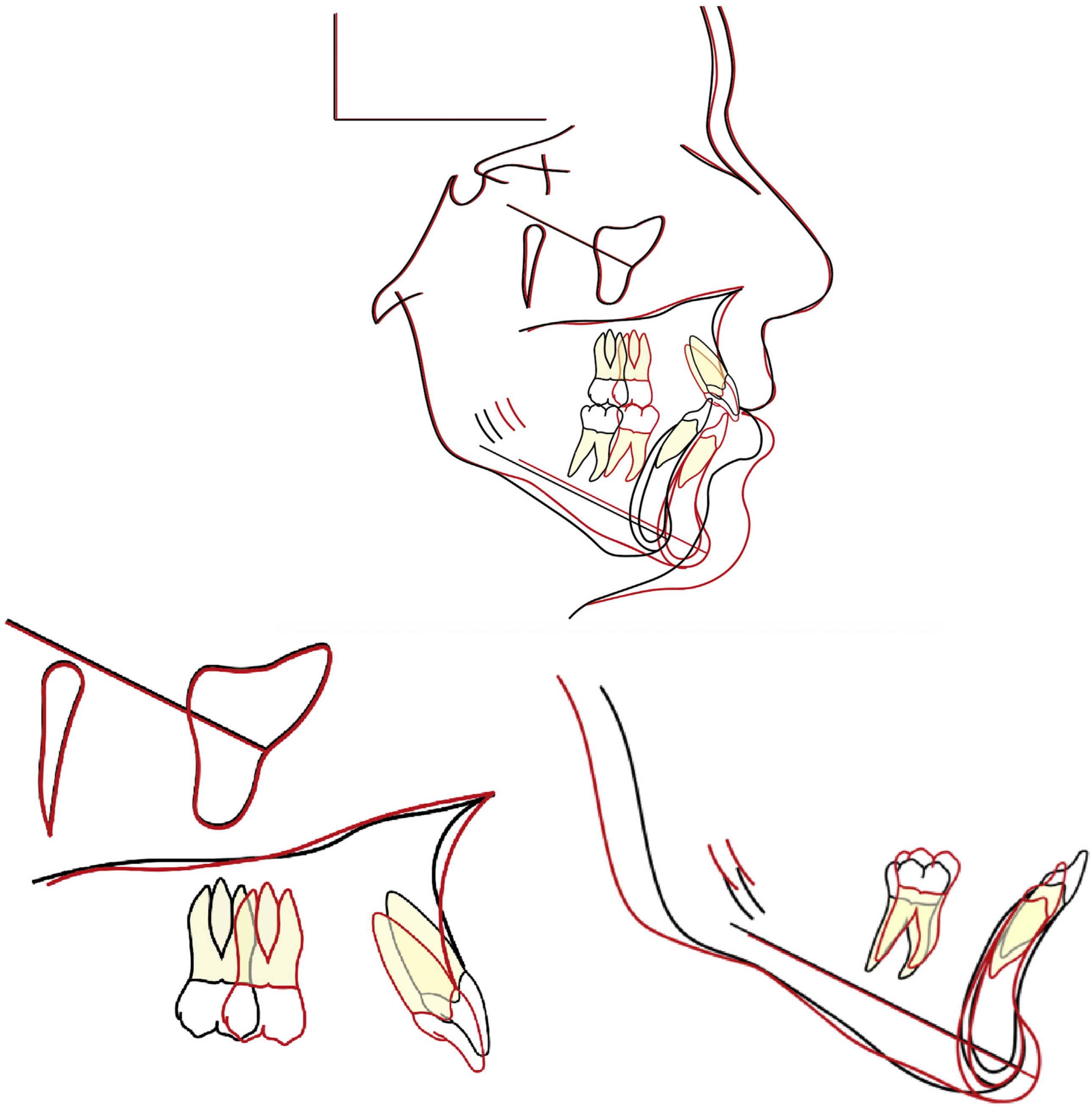

FIGURE 22

General and local maxillary and mandibular superimpositions

Cephalometric analysis showed that the upper incisor torque had increased to 115° and the lower incisor inclination was normal (97°) (*figure 21*). The Ricketts E-line and Merrifield Z-line were congruent, substantiating the surgical treatment decision. 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 [12,13] shows that the correction was obtained by surgical movements, in particular by mandibular advancement. Upper incisors were slightly proclined, as planned in the set-up, despite the premolar extractions. Lower incisors were retroclined. This would allow us to achieve the correct torque for the mandibular advancement. A good light contact had been achieved. Upper molars were slightly intruded, lower molars slightly extruded due to curve of

FIGURE 23
Follow-up (one year) extraoral photographs

FIGURE 24
Follow-up intraoral (one year) photographs

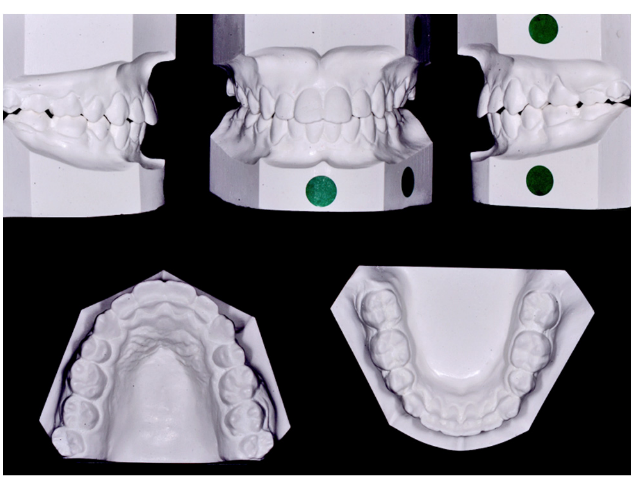

FIGURE 25
Follow-up models (one year)

Spee flattening. No significant posterior maxillary impaction was evidenced (*figure 22*).

The patient reported a significant improvement in breathing and snoring at night.

Two month later, reconstructions on upper right central incisor and upper left lateral incisor were performed; upper and lower lingual retainers were bonded and new upper and lower essix were delivered.

Despite the extraction of upper third molars had been requested to the patient, it was necessary to monitor their position since the patient decided to delay it. The upper essix included the third molars in order to avoid their extrusion, waiting for the patient to have them extracted.

Treatment results remained stable at the one-year follow-up appointment (*figures 23–25*).

Discussion

A lingual straightwire system was introduced in 2001, with the aim of simplifying treatment mechanics, expediting arch coordination, and eliminating the complicated wire bends of the mushroom archwires [14].

Management of extraction cases became more straightforward with the ability to use sliding mechanics. Other advantages were reduced chairtime and increased patient comfort from the elimination of severe canine-premolar bends [15].

In this case, anterior torque was managed using overcorrections in the set-up and manual torque bends in the archwires.
Despite the upper central incisors had the same torque prescriptions and the space closure mechanics were symmetrical, they evidenced at the end of space closure a significantly different inclination. When a different torque expression in adjacent teeth occurs in lingual orthodontics, the incisal margins height discrepancy is more pronounced in respect of buccal orthodontics due to the longer distance of the tooth surface to the orthodontic wire [16].
Since the correction with a bend into the main wire was difficult, in consequence of the unfavorable moment ratio [8], with a short distance for the couple of force application [17], an auxiliary 0.016 spring was modeled and activated by ligating the wire as an auxiliary one in addition to the main 0.0175 × 0.0175 TMA.
The employment of an auxiliary spring with an auxiliary arch was necessary in order to obtain complete correction in place of torque insertion on the main wire, in consequence of the entity of torque correction and the interbracket distance.
A correct control of upper and lower incisor torque was crucial in this case in order to prepare the patient for maxillofacial surgery. The upper incisors which were normally-inclined (109°) at the start of treatment, needed to be maintained, despite the premolar extractions. This would allow us to achieve the correct torque for the mandibular advancement.
Upper incisors inclination obtained before surgery was 118° with a significant increase in respect of treatment start. In accordance with the surgeon, the torque difference between the upper central incisors was correct immediately after the surgical treatment, without interfering with the planned movements. The upper incisors finished with slightly higher inclination (115°) compared with the start of treatment.
The lower incisors, which were proclined (101°) at the start of treatment, needed a reduction in torque to obtain the proper inclination for the surgical movements. Before the surgery, their inclination turned out to be 94°, permitting the mandible to be advanced. At treatment end, the lower incisors were normalized to 97°.
At the end of treatment, the facial balance was improved, with better maxillary and mandibular projection and ideal anterior tooth inclination.

Conclusions

A dramatic facial change was obtained by lingual straight-wire treatment and orthognathic surgery in a full-step class II hyperdivergent case.
Torque control, necessary to achieve the mandibular advancement, was obtained by overcorrections in the set-up, space closure with light forces, stainless steel archwires, and compensation bends and curves. Despite the extractions, upper incisors torque turned out to be even increased, while lower incisors torque was normalized, permitting the mandibular advancement.
The torque loss on upper left central incisor, that occurred despite the symmetrical bilateral space closure mechanics employed, was corrected with an auxiliary SS spring in a 0.016 SS wire, thus permitting also the leveling of the anterior incisal margins.
In consequence of the limited interbracket distance in lingual orthodontics, the employment of an auxiliary spring with an auxiliary arch is necessary in order to obtain complete correction in place of torque insertion on the main wire.

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