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Case report

Profile changes in extraction treatments of upper premolars: A case series

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Summary

This case series describes the soft tissue changes following extraction treatment in two patients with diverse lip thickness, but with similar baseline parameters including: labial competence, soft tissue profile, patient's age, extraction protocol, methods of anchorage, malocclusion, crowding, treatment appliance and mechanics. The same treatment plan involved upper first premolar extractions and lingual appliance combined with skeletal anchorage. The lip thickness played a crucial role in these cases, since a similar change of the incisor position leads to a different profile variation. This difference could be explained by the differing initial lip thicknesses as the patient with thin lips showed a more pronounced profilometric change. The choice of the ideal treatment plan must be tailored to the individual patient, taking into account not only initial skeletal and dental factors but also soft tissue factors, as well as the treatment goals.

Introduction

Improving facial aesthetics is one of the main motivations to start an orthodontic treatment. Soft tissues, responsible for aesthetics, show different responses in relation with underlying orthodontic tooth movement [1]; their behaviour is multifactorial and difficult to predict accurately [2–4].

In the literature, there is a lack of consensus on soft tissue movement, especially in extraction case [1].

Although it was thought that premolar extraction led to a worsening of profiles, current studies have demonstrated that the association between extraction and a retruded or dished-in profile is unfounded and unacceptable [5–7]. In fact, similar hard and soft tissue profiles could be reached with both extraction and non-extraction treatments [5,8].

The question is not which treatment is better to perform, but under what conditions is it better to choose one treatment rather than the other one [5].

Various predictors should be considered during the treatment planning in order to anticipate extraction and non-extraction treatment effects on soft tissue such as: skeletal characteristics, lip competence, pretreatment crowding, incisor position, anchorage, lip thickness and strain, and patient's age [1,2,5,6].

Lips seem to play a crucial role. Snow and Chung have underlined a strong correlation between thin lip and bone changes in extraction cases [9]. Holdaway reported that thin lips follow incisors in a 1:1 ratio [10].

On the other hand, thicker lips showed less soft tissue retraction in extraction cases [9].

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This case series describes the soft tissue changes following upper premolar extraction treatment of two patients with diverse lip thickness, but with similar baseline parameters for all cited factors including: labial competence, soft tissue profile, patient's age, extraction protocol, methods of anchorage, malocclusion, crowding, treatment appliance and mechanics [6].

Case 1

Diagnosis and treatment plan

A 21-year-old male presented with the request to have his teeth aligned and correctly inclined using an invisible appliance (*figure 1*a). From a frontal view, the face proportions and symmetries appeared well balanced with a slight labial incompetence. The posed smile revealed a non-consonant and inverse smile arc [11]. The patient showed a convex profile with a balanced nose, a correct nasolabial angle, a marked labiomental sulcus, and a retrusive lower jaw.

The patient presented bilateral full-cusp Class II canine and molar relationships with centred midlines and noticeable overjet.

There was no crowding, the upper arch was slight constricted, while the upper and lower curve of Spee were accentuated.

The panoramic radiograph indicated the presence of all teeth, including the third molars. Cephalometric analysis (*figure 1*b, *table I*) revealed a skeletal Class II relationship (ANB: 5.5°; Wits appraisal: 9 mm) and the skeletal pattern indicated a hyperdivergence (FMA: 33.1°). The upper incisors revealed an excessive proclination (U1/PP: 132.4°) while the lower incisors were bordering on the normal range (IMPA: 96.2°).

The treatment alternative of orthognathic surgery was not considered since the normalization of upper teeth inclination could also improve also the facial aesthetics.

Sagittal discrepancy and incisors proclination promoted a camouflage treatment with upper premolar extractions in order to obtain a canine Class I relationship and anterior light contact.

The presence of erupted upper third molars hinders the distalization of the contiguous teeth and therefore two extractions in the upper arch were mandatory for each treatment plan.

The upper incisors proclination and inverse smile arc would have obtained a better improvement with premolars extractions since the gained spaces were nearer to the anterior teeth.

The full-cusps molar Class II relationship required a space closure with maximum anchorage; therefore, the use of miniscrews could be helpful.

Since the patient had requested an invisible appliance, a lingual treatment was selected. The lingual biomechanics would promote the lower curve of Spee correction with a perfect control of the lower incisor proclination while the skeletal anchorage would lead to the upper anterior teeth retraction.

FIGURE 1

a: Case 1: initial extraoral and intraoral photographs; b: Case 1: panoramic radiograph, teleradiography and cephalometric tracing

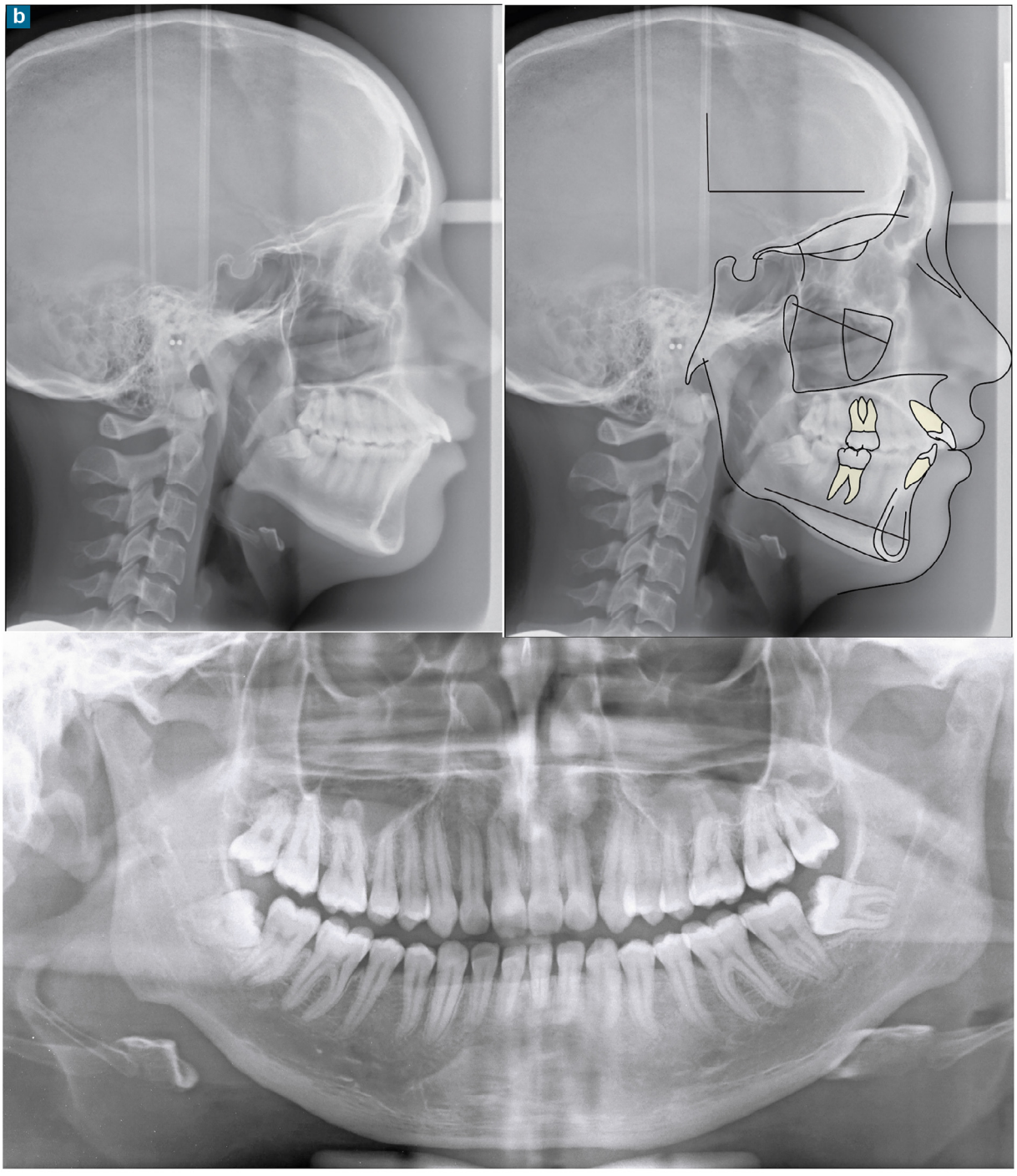

FIGURE 1
(*Continued*).

Table I

Comparison of cephalometric values before and after treatment of Case 1

	Norm	Pretreatment	Posttreatment
SNA (°)	82.0 ± 3.5	83.6	83.3
SNB (°)	80.0 ± 3.0	78.1	78.0
ANB (°)	2.0 ± 2.4	5.5	5.3
Wits appraisal (mm)	0.0 ± 1.0	9.0	5.9
FMA (MP-FH) (°)	26.6 ± 5.0	33.1	31.1
Gonial Angle (°)	124.31 ± 5.4	128.4	126.8
Mandibular plane angle (GoGn-SN) (°)	32 ± 4.0	36.0	34.4
U1 – palatal plane (°)	110 ± 5.0	132.4	108.6
L1 – mandibular plane (°)	46.4 ± 3.6	53.6	44.4
IMPA (°)	95.0 ± 7.0	96.2	88.5
Interincisal angle (°)	128 ± 5.3	107.5	133.7

Treatment progress

Torque overcorrections were excluded in the setup prescriptions of preadjusted Ormco ALIAS brackets (*figure 2*) in order to decrease the upper incisors proclination during space closure.

Indirect bonding was performed using single jigs following the Komori Kommon Base technique [12].

The arches were bonded with medium and small 0.013˝ Copper NiTi archwires for initial alignment (*figure 3*). The upper first premolars were not bonded and closed springs were placed in that archwire segments in order to increase the stiffness of a larger interbracket distance. The mesial slicing of the upper premolars was performed to avoid jiggling of the anterior teeth, to delay extraction and to start the space closure with a full thickness stainless steel archwire.

Occlusal build-ups were added to the upper molars to promote vertical control by molar intrusion.

One month later the archwires were replaced with a 0.016˝ × 0.016˝ Copper NiTi medium in the upper arch and small in the lower arch (*figure 4*).

Three months after the start of treatment a medium 0.018˝ × 0.018˝ Copper NiTi upper archwire and small 0.018˝ × 0.018˝ Copper NiTi lower archwire were placed for continued levelling and torque management (*figure 5*).

In the lower arch, a closed elastic chain was placed to maintain the spaces closed and avoid incisors proclination during the curve of Spee levelling.

After the complete expression of the full thickness CuNiTi archwires, the upper first premolars were extracted; a medium 0.018˝ × 0.018˝ stainless steel upper archwire with power arms and palatal interradicular miniscrews were inserted for retraction of the upper anterior teeth (*figure 6*).

Figure 2

Setup of Case 1

FIGURE 3
Bonding with 0.013″ CuNiTi Medium in the upper arch and Small in the lower arch (T0)

FIGURE 4
Archwires replaced with 0.016″ × 0.016″ CuNiTi Medium in the upper arch and small in the lower arch (1st month)

Figure 5

Archwires replaced with 0.018″ × 0.018″ CuNiTi Medium in the upper arch and Small in the lower arch with closed elastic chain (3rd month)

Figure 6

Upper first premolars extraction, upper archwire replacement with 0.018″ × 0.018″ SS Medium, power arms and palatal interradicular miniscrews (4th month)

FIGURE 7

Power arms moved between lateral incisors and canines; archwire replaced with 0.0175″ × 0.0175″ Small in the lower arch (8th month)

FIGURE 8

Archwire replaced with 0.0175″ × 0.0175″ TMA Medium in the upper arch (21st month)

FIGURE 9
Finishing and detailing bends (28th month)

Four months later, the power arms were moved between lateral incisors and canines, in order to increase the distance with miniscrews and to allow a better torque control during en-masse retraction (*figure 7*) [13]. At the same time, a small 0.0175˝ × 0.0175˝ TMA archwire was inserted in the lower arch to increase the wire stiffness and continue the curve of Spee levelling.

Twenty-one months after the start of treatment, a medium 0.0175˝ × 0.0175˝ TMA archwire was inserted in the upper arch in order to close the remaining small spaces and to apply the finishing bends; the lower left second molar was rebonded and a new TMA archwire was placed (*figure 8*).

In the following seven months, the finishing and detailing bends were added to refine alignment, posterior contact and anterior light contact (*figure 9*).

Treatment results

After 28 months of treatment, the fixed appliances were removed, meticulous composite removal [14] and oral hygiene appointments were performed, and upper and lower Essix retainers were delivered (*figure 10*).

Two weeks after debonding, upper and lower fixed retainers were added to insure the stability of the anterior teeth, and the recovery phase after the end of the treatment allowed better interarches posterior contact (*figure 11*a). Posttreatment records show a satisfactory result with optimal achievement of treatment goals due to the high accuracy of the lingual straight wire system [15].

As a result of treatment, a solid Class I canine and Class II molar relationships were obtained on both sides. The anterior torque values were normalized and the curves of Spee were levelled.

FIGURE 10

Lingual fixed appliance removed and Essix retainers delivered (28th month)

The final anterior light contact was ideal and the marginal ridges were aligned. Facial balance was maintained and the smile arc was optimized.

The labial incompetence was corrected, and the facial profile remained unchanged. With regard to the aesthetic aspect of the smile, the normalization of incisors torque and the smile arc correction improved the facial harmony.

The panoramic radiograph confirmed root parallelism and a good expression of the setup (*figure 11*b).

Cephalometric analysis (*table I*) indicated a correction of the upper and lower incisors inclination (U1/PP: 132.4–108.6°; IMPA: 96.2–88.5°).

Superimposition of pre- and posttreatment cephalometric tracings (*figure 12*) carried out according to the methodology developed by Pr. Arne Björk [16,17] highlights the incisors torque normalization, molars advancement and unchanged soft tissue profile (*figures 13–15*).

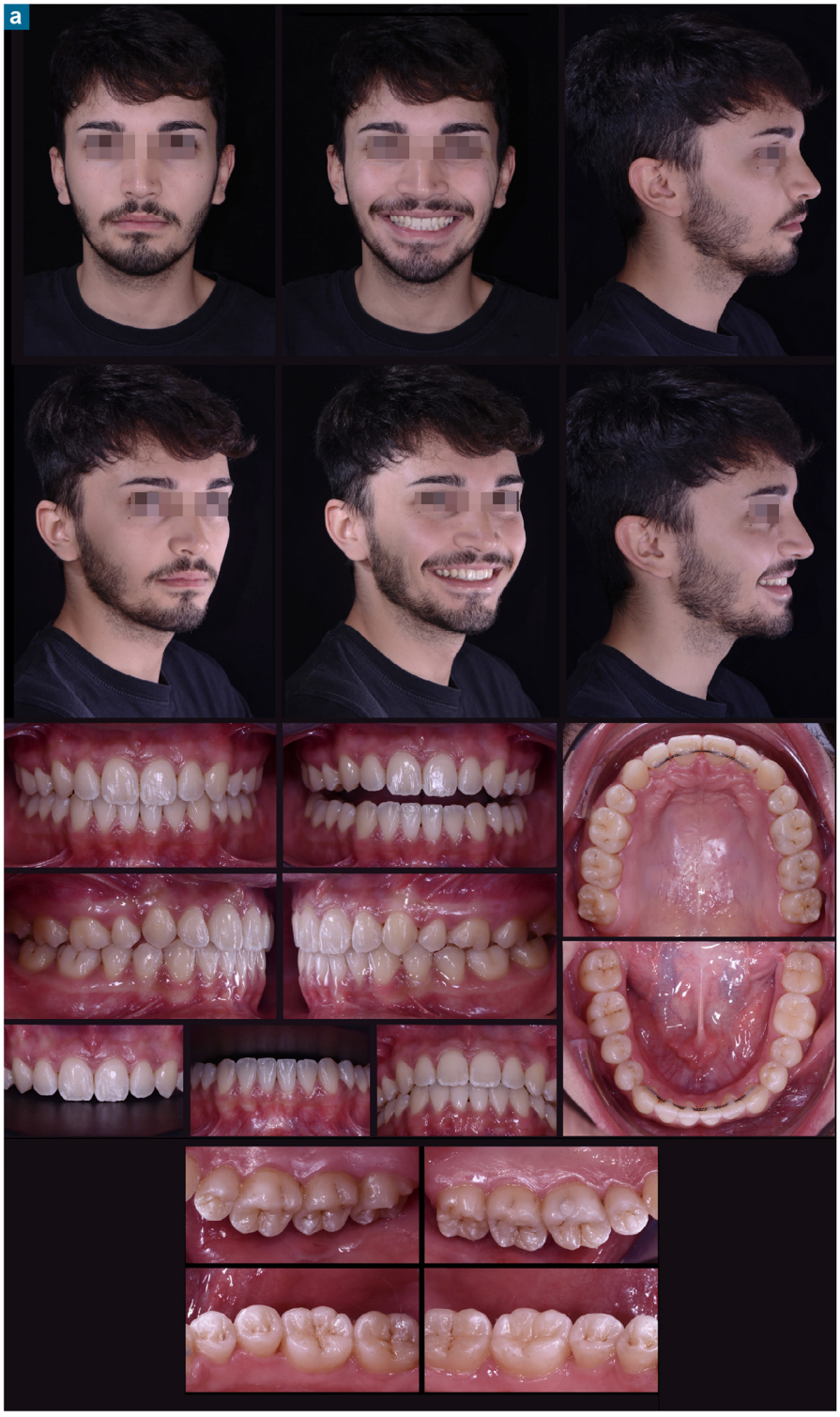

FIGURE 11

a: posttreatment extraoral and intraoral photographs with upper and lower fixed retainers bonded (29th month); b: posttreatment panoramic radiograph, teleradiography and cephalometric tracing

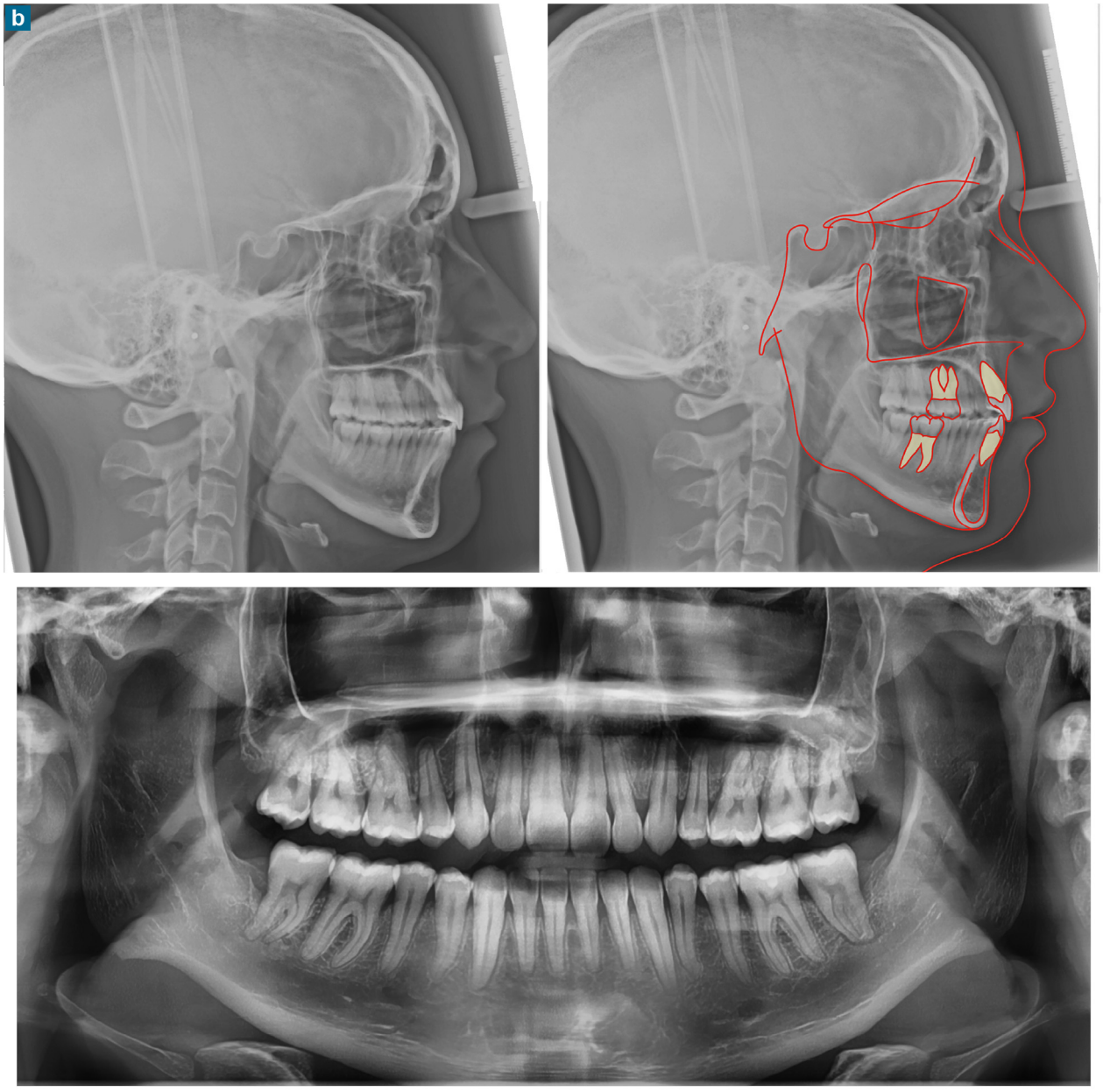

FIGURE 11
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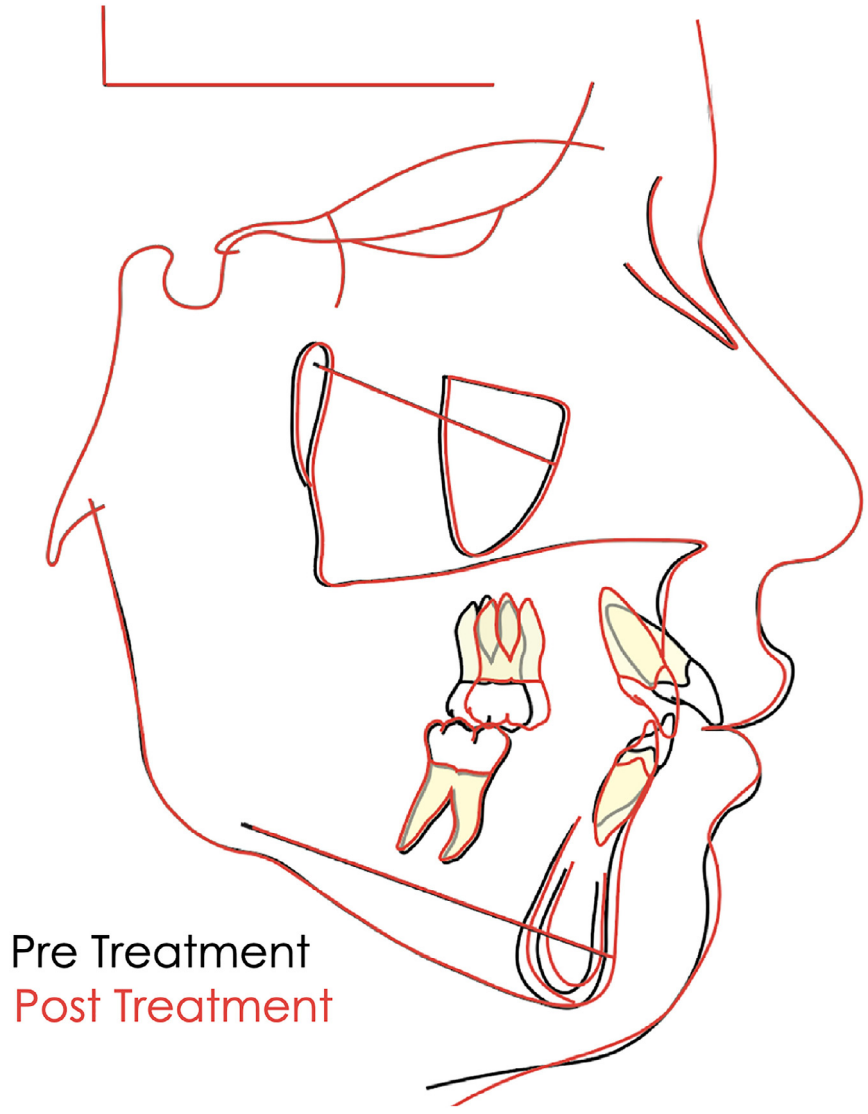

FIGURE 12

Superimposition of pre- and posttreatment cephalometric tracings according to the methodology developed by Pr. Arne Björk

FIGURE 13

Comparison of static extraoral photographs before and after treatment (face, 3/4 and profile)

FIGURE 14

Comparison of dynamic extraoral photographs before and after treatment (face, 3/4 and profile)

FIGURE 15

Comparison of intraoral photographs before and after treatment

Case 2

Diagnosis and treatment plan

A 22-year-old female presented with the request to have her "social six teeth" aligned using an invisible appliance (*figure 16*). From a frontal view, the face proportions and symmetries appeared well balanced with a slight labial incompetence and a slight mandibular symphysis deviation towards the right side. The posed smile revealed a non-consonant smile arc. The patient showed a regular profile with a correct nasolabial angle, a marked labiomental sulcus, and a retrusive lower jaw.

The patient presented bilateral full-cusp Class II canine and molar relationships, although more severe on the right side. Furthermore, a noticeable overjet could be observed.

The upper arch was crowded and slight constricted, while the lower curve of Spee was accentuated.

The panoramic x-ray indicated the presence of all teeth, excluding the lower third molars. Cephalometric analysis (*figure 16*, *table II*) revealed a skeletal Class II relationship (ANB: 7.4°; Wits appraisal: 7.7 mm) and the skeletal pattern indicated a normodivergence (FMA: 21.3°). The upper and lower incisors revealed an excessive proclination (U1/PP: 115.6°; IMPA: 99.3°).

FIGURE 16

a: Case 2: initial extraoral and intraoral photographs; b: Case 2: panoramic radiograph, teleradiography and cephalometric tracing

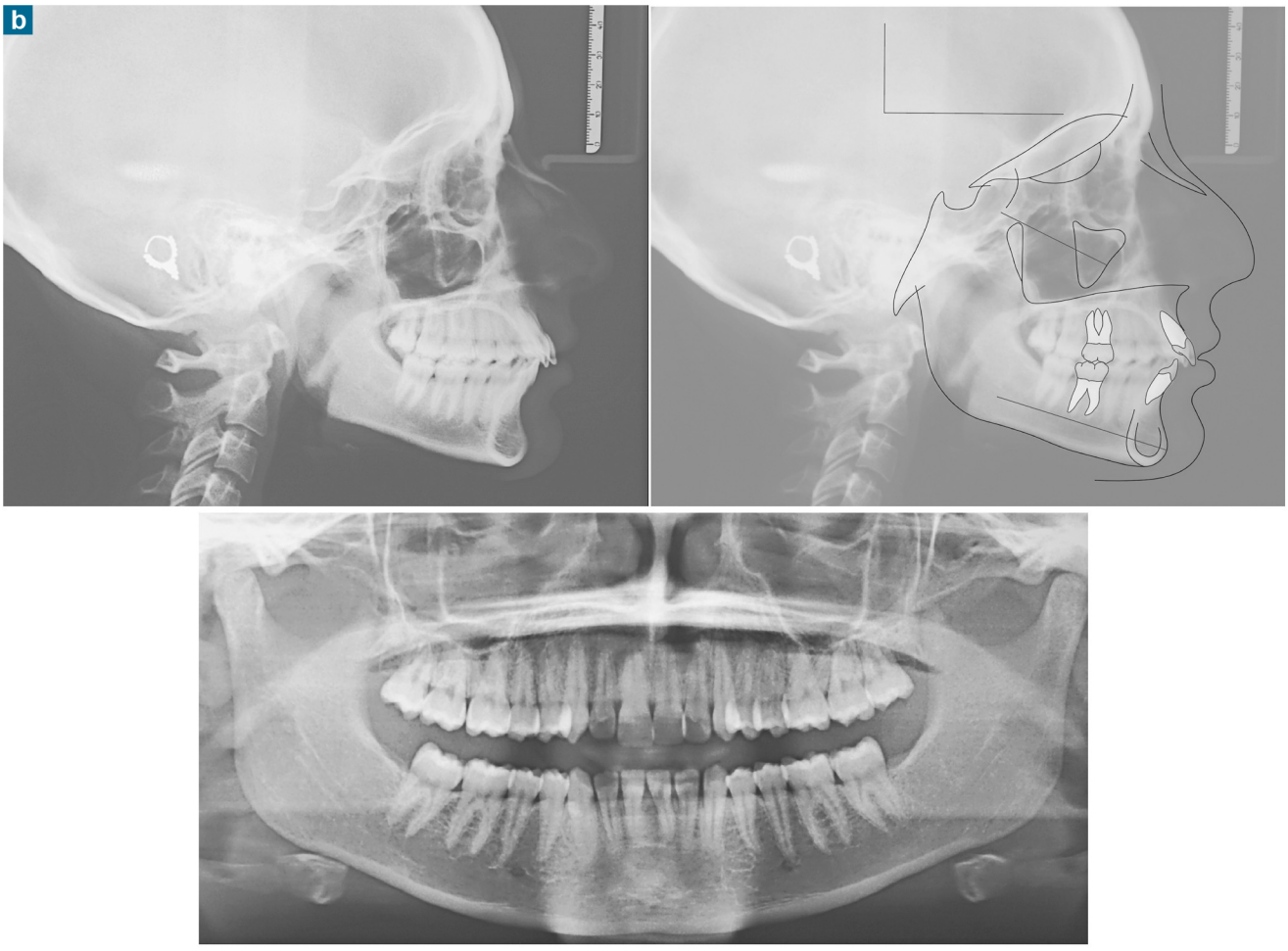

Figure 16
(*Continued*).

As in the previous case, the treatment alternative of orthognathic surgery was not considered since the normalization of upper teeth inclination and crowding could also improve the facial aesthetics.
Sagittal discrepancy, incisors proclination and crowding promoted a camouflage treatment with upper premolar extractions in order to obtain a canine Class I relationship and anterior light contact. First premolar extractions were preferred in order to correct anterior crowding and proclination of anterior segment. Nevertheless, the choice of second premolar extraction would have also been more advantageous, given the presence of a distinctive nose, thin lips and the different in buccal height between first and second premolars.
The presence of erupted upper third molars corroborated the extraction decision and the skeletal anchorage could be helpful during space closure.
Since the patient had requested the invisible appliance, a lingual treatment was selected. The lingual biomechanics would promote the lower curve of Spee correction with a perfect control of the lower incisor proclination, while the skeletal anchorage would lead to the upper anterior teeth retraction.

Table II
Comparison of cephalometric values before and after treatment of Case 2

	Norm	Pretreatment	Posttreatment
SNA (°)	82.0 ± 3.5	81.3	79.0
SNB (°)	80.0 ± 3.0	73.9	72.6
ANB (°)	2.0 ± 2.4	7.4	6.4
Wits appraisal (mm)	0.0 ± 1.0	7.7	1.2
FMA (MP-FH) (°)	26.6 ± 5.0	21.3	21.8
Gonial Angle (°)	124.31 ± 5.4	121.6	120.8
Mandibular plane angle (GoGn-SN) (°)	32 ± 4.0	34.1	35.0
U1 – palatal plane (°)	110 ± 5.0	115.6	105.1
L1 – mandibular plane (°)	46.4 ± 3.6	37.5	34.6
IMPA (°)	95.0 ± 7.0	99.3	95.0
Interincisal angle (°)	128 ± 5.3	118.1	131.5

Treatment progress

Torque overcorrections were excluded in the setup prescriptions of preadjusted Ormco STb brackets (*figure 17*) since the crowding resolution would have led to an excessive incisor proclination and a space closure similar to the previous case.
Indirect bonding was performed using single jigs, following the Komori KommonBase technique [12].

The arches were bonded with medium and small 0.013″ Copper NiTi archwires for initial alignment (*figure 18*). The upper first premolars were not bonded, the mesial slicing was performed to avoid excessive jiggling of the anterior teeth, to delay extraction, and to start the space closure with full thickness archwire. Occlusal build-ups were added to the upper molars to promote vertical control by molar intrusion.
One month later, the archwires were replaced with a 0.016″ × 0.016″ Copper NiTi medium in the upper arch and small in the lower arch (*figure 19*).
Two months after the start of treatment, the upper first premolars were extracted, a medium 0.018″ × 0.018″ Copper NiTi upper archwire and small 0.018″ × 0.018″ Copper NiTi lower archwire were placed for continued leveling and torque management (*figure 20*).
In the same month, a medium 0.018″ × 0.018″ stainless steel upper archwire with power arms and palatal interradicular miniscrews were inserted for retraction of the upper anterior teeth (*figure 21*).
Six months later, the space closure was almost completed and the anterior teeth required finishing bends (*figure 22*).
Eleven months after the start of treatment and complete space closure, a medium 0.0175″ × 0.0175″ TMA archwire was inserted with finishing bends in the upper arch (*figure 23*). In addition, two 0.012″ Kobayashi ligatures were placed on the upper canines to allow 3/16″, 6oz Class II elastics to be worn full day.
Six month later, a small 0.0175″ × 0.0175″ TMA archwire was inserted in the lower arch to refine few details (*figure 24*).

Figure 17
Setup of Case 2

Figure 18

Bonding with 0.013″ CuNiTi Medium in the upper arch and Small in the lower arch (T0)

Figure 19

Archwires replaced with 0.016″ × 0.016″ CuNiTi Medium in the upper arch and Small in the lower arch (T1)

FIGURE 20

Upper first premolars extraction, archwires replacement with 0.018″ × 0.018″ CuNiTi Medium in the upper arch and Small in the lower arch (T2)

FIGURE 21

Palatal interradicular miniscrews insertion and upper archwire replacement with 0.018″ × 0.018″ SS Medium with power arms ($T2_2$)

FIGURE 22

Space closure progress (T8)

FIGURE 23

Upper archwire replaced with 0.0175″ × 0.0175″ TMA Medium bended for the finishing phase (T11)

FIGURE 24

Lower archwire replaced with 0.0175″ × 0.0175″ TMA Small bended for the finishing phase (T17)

Treatment results

After 22 months of treatment, the fixed appliances were removed, meticulous composite removal [14] and oral hygiene appointments were performed and upper and lower Essix retainers were delivered (*figure 25*a).

As a result of treatment, solid Class I canine and Class II molar relationships were obtained on both sides. The intercuspation on the right side could be further improved; however, the initial Class II relationship was even more severe on this side. The anterior torque values were normalized and the curves of Spee were levelled. The final anterior light contact was ideal and the marginal ridges were aligned.

Facial balance was maintained and the smile arc was optimized. The labial incompetence was corrected to reduce perioral muscle contraction and restore spontaneous lip seal at rest.

The facial profile changes still maintained the facial harmony; the normalization of incisors torque and the smile arc correction increased the smile aesthetics. Nevertheless, second premolar extraction could have resulted in a more aesthetic alveolar process morphology and gingival contour, given the initial height difference between the crowns and the gingival margins of the first and second premolars.

The panoramic X-rays confirmed root parallelism and a good expression of the setup.

Cephalometric analysis (*figure 25*b, *table II*) indicated a correction of the upper and lower incisors inclination (U1/PP: 115.6–105.1°; IMPA: 99.3–95.0°).

Superimposition of pre- and posttreatment cephalometric tracings (*figure 26*) carried out according to the methodology developed by Pr. Arne Björk [16,17], highlights the incisors torque

FIGURE 25

Posttreatment records and Essix retainers delivered (T22)

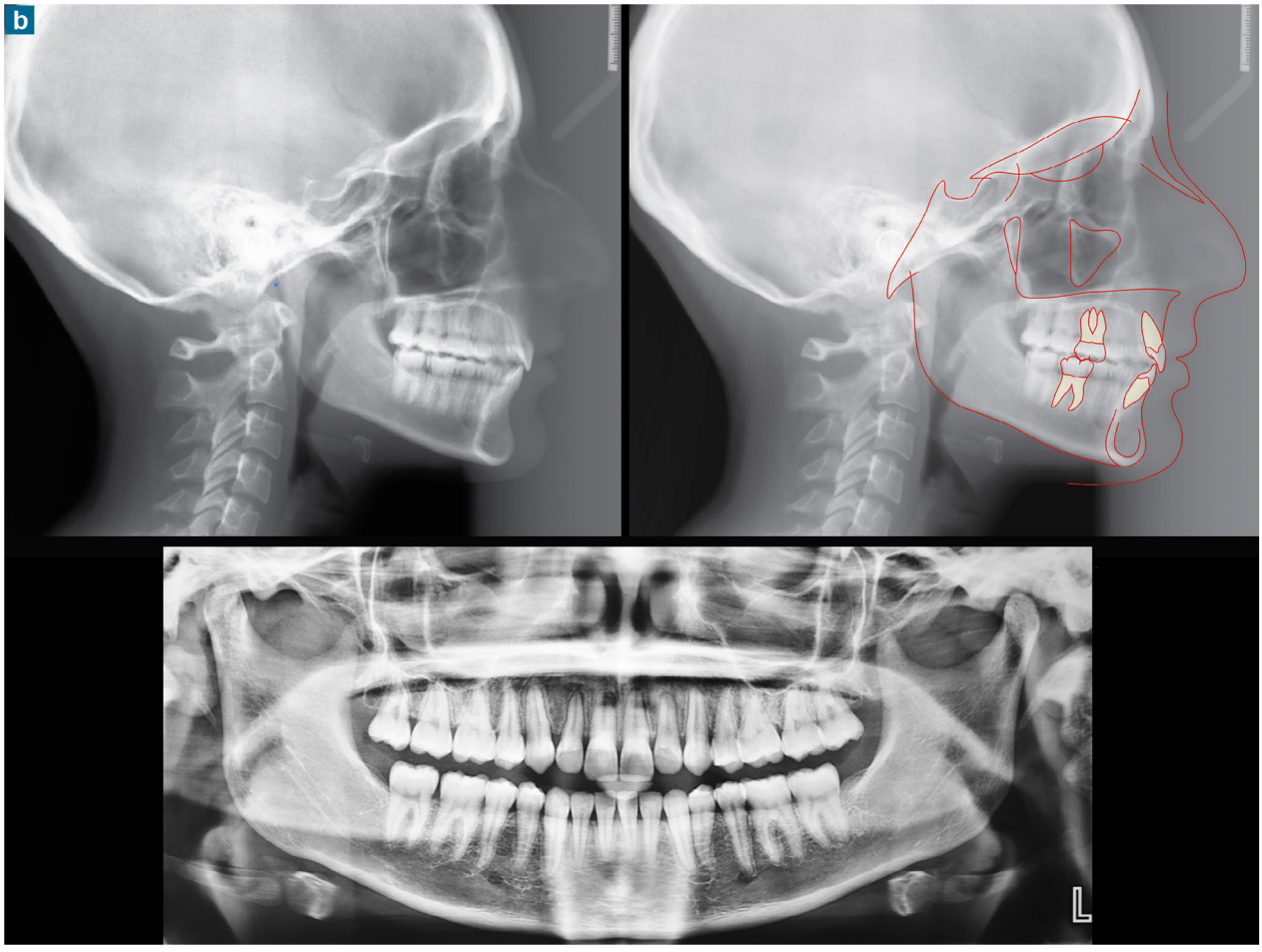

FIGURE 25
(*Continued*).

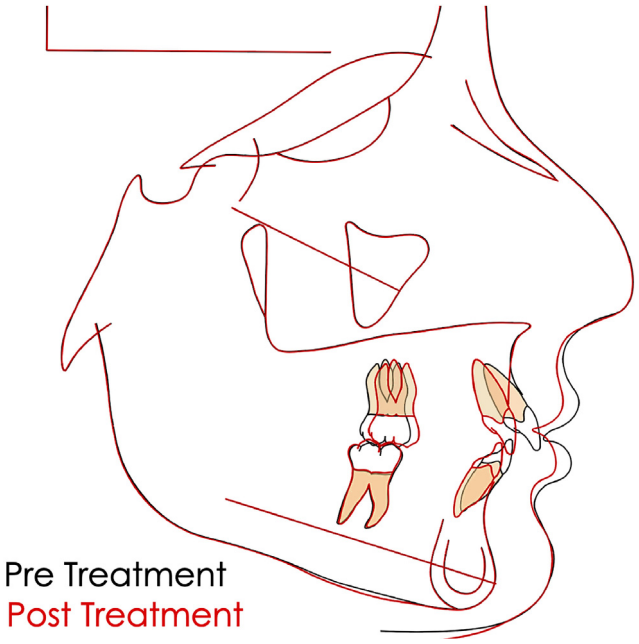

FIGURE 26

Superimposition of pre- and posttreatment cephalometric tracings according to the methodology developed by Pr. Arne Björk

FIGURE 27

Comparison of static extraoral photographs before and after treatment (face, 3/4 and profile)

FIGURE 28

Comparison of dynamic extraoral photographs before and after treatment (face, 3/4 and profile)

FIGURE 29
Comparison of endobuccal views before and after

normalization, molars advancement and unchanged soft tissue profile, (*figures 27-29*).

Discussion

Both cases presented similar initial malocclusion, crowding, protruding maxillary incisors and initial labial incompetence. The patients were treated with the same treatment plan and appliance, i.e. upper first premolar extractions, use of skeletal anchorage and lingual appliance.

The final treatment results were comparable in terms of occlusion and labial competence, and both patients showed a harmonious profile and improved facial aesthetics at the end of treatment.

Several studies have attempted to predict soft tissue behaviour after extraction treatment, but it remains difficult to predict as it is influenced by several factors such as patient age, gender, ethnicity, skeletal, dental and soft tissue characteristics [3,6].

According to a systematic review, soft tissue changes after premolar extraction are more pronounced with the four premolar extraction protocol than with the two premolar protocol [6]. More specifically, the position of the upper lip is not significantly affected by the extraction of two premolars, whereas the

extraction of four premolars may cause more retraction of the upper lip than no extraction [6]. This effect of 4 premolar extractions on the profile and lip position of an adult patient can be observed in a case series treated with a similar appliance [18]. However, this extraction pattern allowed the authors to achieve treatment objectives, such as an improvement of the facial balance, reduced muscular strain and lip protrusion [18]. Although the extractions of 2 upper premolars result only in a slight variation in profile, some factors such as lip thickness greatly affect profile changes, as demonstrated by this case series.

Indeed, as previously reported in the literature, the idea that extractions may result in a more retrusive or dished profile is nowadays considered unacceptable [5]. The same authors clarified that a careful evaluation of factors related to anchorage, crowding, soft tissue thickness and lip strain is always necessary when attempting to predict the effects of extraction and non-extraction treatments [4]. In addition, other factors such as lip competency should also be considered; indeed, as recently reported, in patients with incompetent lips, an extraction treatment may result in an increased lip retraction compared to patients with lip competency [1].

For both clinical cases, treatment goals included elimination of labial incompetence to reduce perioral muscle contraction and restore spontaneous lip seal at rest; therefore, some labial retraction following extraction treatment was desirable and useful for this purpose. However, in Case 2, this also resulted in a slight opening of the nasolabial angle, which is known to be one of the factors to consider in the extraction decision, in addition to crowding, lip thickness, vertical dimension and nasal shape [19–22].

Superimposition of the cephalometric tracings before and after the treatment was carried out according to the methodology developed by Pr. Arne Björk; the structural method has traditionally been recognised as the gold standard for superimposition [16,17,23].

As shown by general superimposition, the profilometric change was more pronounced in Case 2. This difference could be explained by the differing initial lip thicknesses, since the other baseline parameters were similar.

In fact, the patient in Case 1 had thick and full lips, whereas the lips in Case 2 were thin.

Holdaway has always referred to the importance of soft tissue analysis in treatment planning, emphasising the inadequacy of hard tissue analysis alone [10]. In addition, the author reported that in adult patients with thin lips, there was a tendency for the upper lip to follow the retraction of the incisors [10].

Indeed, in Case 2 the lips followed the extent of retraction of the upper incisors more than in Case 1.

Later, Oliver hypothesised that inter-individual variability in soft tissue response to skeletal and dental changes following orthodontic treatment may be due to intrinsic characteristics of the upper lip, such as thickness and postural tone [24]. The author showed that in patients with thicker lips and a low lip strain, the lips followed hard tissue changes and tooth retraction to a lesser extent than in patients with thin lips and a high lip strain [24]. In accordance with this assumption, the profile in Case 1 was perfectly maintained.

Conclusions

Assuming that an extraction treatment does not necessarily imply a profilometric change and that the premolar extraction is only one of many parameters to obtain facial change in orthodontic treatment. The choice of the ideal treatment plan must be tailored to the individual patient, taking into account not only initial skeletal and dental factors but also soft tissue ones, as well as the treatment goals.

The lip thickness plays a crucial role in any orthodontic treatment, since a change in the position of the incisors leads to a profile variation. Therefore, if the diagnosis has taken all these factors into account, the effects of extraction orthodontic treatment can only be favourable.

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