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THE IMPORTANCE OF THE FACIAL PROFILE IN ORTHODONTIC DIAGNOSIS AND TREATMENT PLANNING: A PATIENT REPORT

Orthodontic treatment to improve not only tooth alignment but also facial esthetics is a given in modern society. This paper illustrates this assumption with a report of a patient with a Class I, maxillary retrusion, concave profile, and retrusion of the upper and lower lips. Maxillary expansion was followed by face mask therapy and orthodontic treatment, which significantly improved the soft tissue profile by projecting the upper lip. World J Orthod 2009;10:361–370.

Key words: *esthetics, diagnosis, orthodontic profile, lips*

The concept of facial beauty and harmony has changed over the centuries. Facial beauty can be defined as harmony and balance among facial proportions, established by skeletal structures, teeth, and soft tissue.[1,2] The desire to improve one's dentofacial esthetics is one of the main reasons patients seek orthodontic treatment.[3] Changes in the soft tissue profile are closely related to dental and skeletal changes, caused by either orthodontic treatment or growth.[4]

In 1907, Angle emphasized the importance of soft tissues and facial esthetics in orthodontics. He believed that, to a great extent, facial harmony and balance depend on the shape and beauty of the mouth.[5] Therefore, the main goal of any orthodontic treatment had to be a perfect dental relationship.[6] In 1924, Carrea[7] conducted the first investigation on facial profile on radiographs; in 1944, Tweed emphasized that ideal positioning of the mandibular incisors is imperative for facial balance and harmony. Orthodontists such as as Downs[8] and Holdaway[9] included soft tissue profile measurements in their cephalometric analyses. Subsequently, numerous angular and linear measurements with respective norm values were presented.

With Ricketts' esthetic plane,[10] the position of the lower lip in relation to line E (soft tissue pogonion—nose tip) is evaluated. Ideally, the upper and lower lips should be positioned about 2.0 mm behind the E line. Steiner[11] suggested to use line S (a tangent from soft tissue chin to S = intersection of nasal columella and upper lip). If the lips touch the S line, the profile is straight. It is convex if the lips are positioned in front of this line and concave if positioned behind. In 1967, Burstone[12] suggested a line through subnasale and soft tissue pogonion to verify the ideal position of the upper and lower lips in thranteroposterior direction. On average, the upper lip should be 3.5 ± 1.4 mm in front of this line, whereas the lower lip should be 2.2 ± 1.6 mm behind it. In 1983, Holdaway[13] defined line H, which connects the upper lip and soft tissue pogonion (Ls-Pg). Line H and line NB determine the angle H, which according to Holdaway, should ideally range between 7.0 degrees and 15.0 degrees.

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Fig 1 Initial frontal and lateral facial views showing maxillary retrusion, a slightly concave profile, obtuse nasolabial angle, and some facial asymmetry.

Another important factor for facial analysis is the nasolabial angle, which is formed by Sn-Co (columella) and Sn-Ls (upper lip).[14,15] This angle was suggested by Scheideman et al[16] in 1980. According to McNamara,[17] it should be the main guide for defining the sagittal position of the maxilla. The ideal value of the nasolabial angle ranges from 90.0 degrees to 110.0 degrees, indicating maxillary retrusion if greater 110.0 degrees and protrusion if less than 90.0 degrees.

Since physical appearance became ever more important to society, analyses such as the ones of Arnett et al[18] and Bergman[19] became more and more complex comprising a big number of reference soft tissue points. Today, the analysis of the profile on lateral photographs and cephalograms is a substantial part of orthodontic diagnosis and treatment planning.[20–24] Still, according to Suguino,[25] it is a challenge to convert the results of any analysis into a well-defined, objective therapeutic goal. If orthodontic treatment aims at overcoming psychosocial difficulties related to facial and dental appearance, the evaluation of esthetics becomes increasingly more important.[26]

State-of-the-art orthodontic diagnosis and treatment planning aims at a balance and harmony among facial dimensions and proportions, primarily considering the soft tissue profile. Thus, the esthetic impact of dental correction on a patient's face should routinely be considered. In view of the importance of facial evaluation at the onset of orthodontic/orthopedic therapy, the following patient report will demonstrate that the profile improvement was predominant for orthodontic treatment planning.

PATIENT REPORT

A 14-year-old white female, presenting a Class I molar and canine relationship and an anterior crossbite of her maxillary left lateral incisor, requested orthodontic treatment with the chief complaint of buccally ectopic canines (Figs 1 and 2).

Frontal and lateral facial analysis revealed a deficiency in zygomatic projection, indicating a maxillary retrusion. Further, a slightly concave profile and facial asymmetry were obvious.

In agreement with the subjective facial evaluation, the soft tissue analysis indicated a concave profile, maxillary retrusion, and retrusion of the upper and lower lips (Table 1).

Intraoral and dental cast analysis revealed a slight maxillary constriction with increased lingual inclination of the mandibular posterior teeth, a buccally ectopic maxillary left canine, a reverse overbite of the maxillary left lateral incisor, and a maxillary midline deviation to the left (Figs 2 and 3).

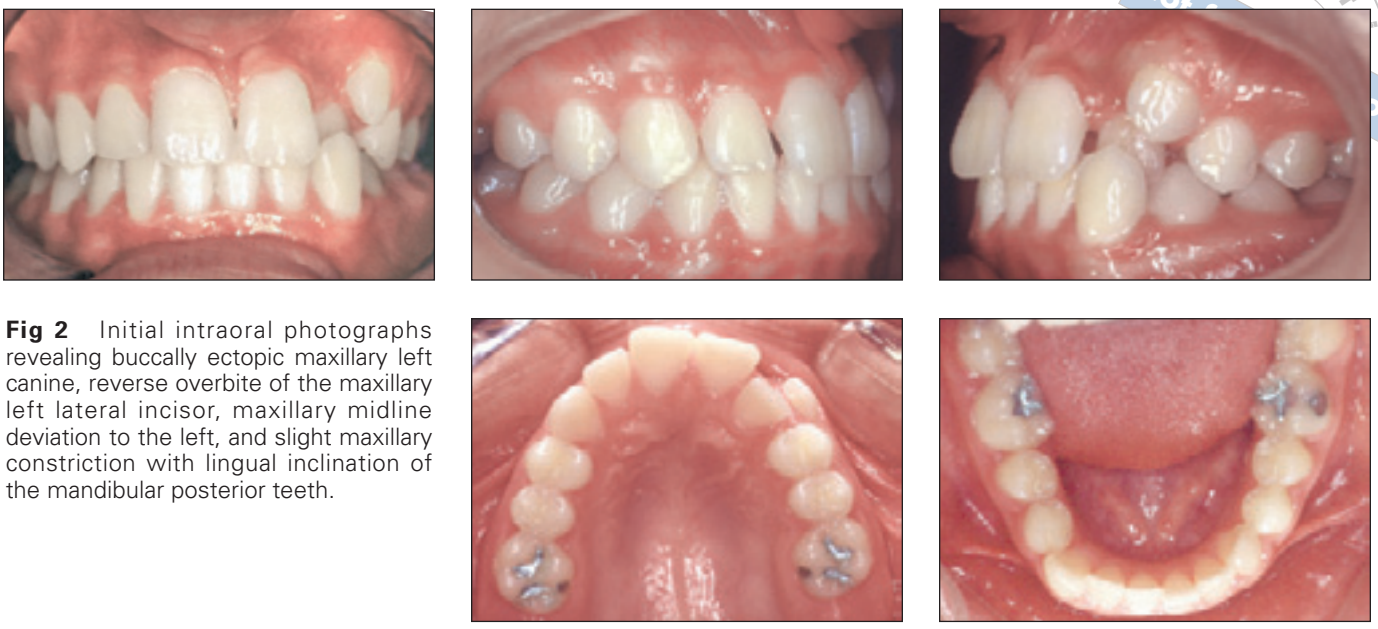


Fig 2 Initial intraoral photographs revealing buccally ectopic maxillary left canine, reverse overbite of the maxillary left lateral incisor, maxillary midline deviation to the left, and slight maxillary constriction with lingual inclination of the mandibular posterior teeth.

Table 1 Soft tissue profile analysis with initial values, ideal values, and interpretation

Parameter	Initial values	Ideal values	Interpretation
Ricketts' esthetic plane	LL 5.0 mm behind E-line	LL 2.0 mm behind E-line	Retrusion of lower lip
Steiner's S line	UL and LL behind S-line	UL and LL touch S-line	Concave profile
Burstone's line	UL 0 mm; LL 1.0 mm in front	UL 3.5 ± 1.4 mm in front, LL 2.2 ± 1.6 mm behind Burstone's line	UL retruded, LL protruded
Nasolabial angle	133 degrees	90 degrees to 110 degrees	Maxillary retrusion
H angle	8 degrees	7 degrees to 15 degrees	Normal

LL = lower lip; UL = upper lip.

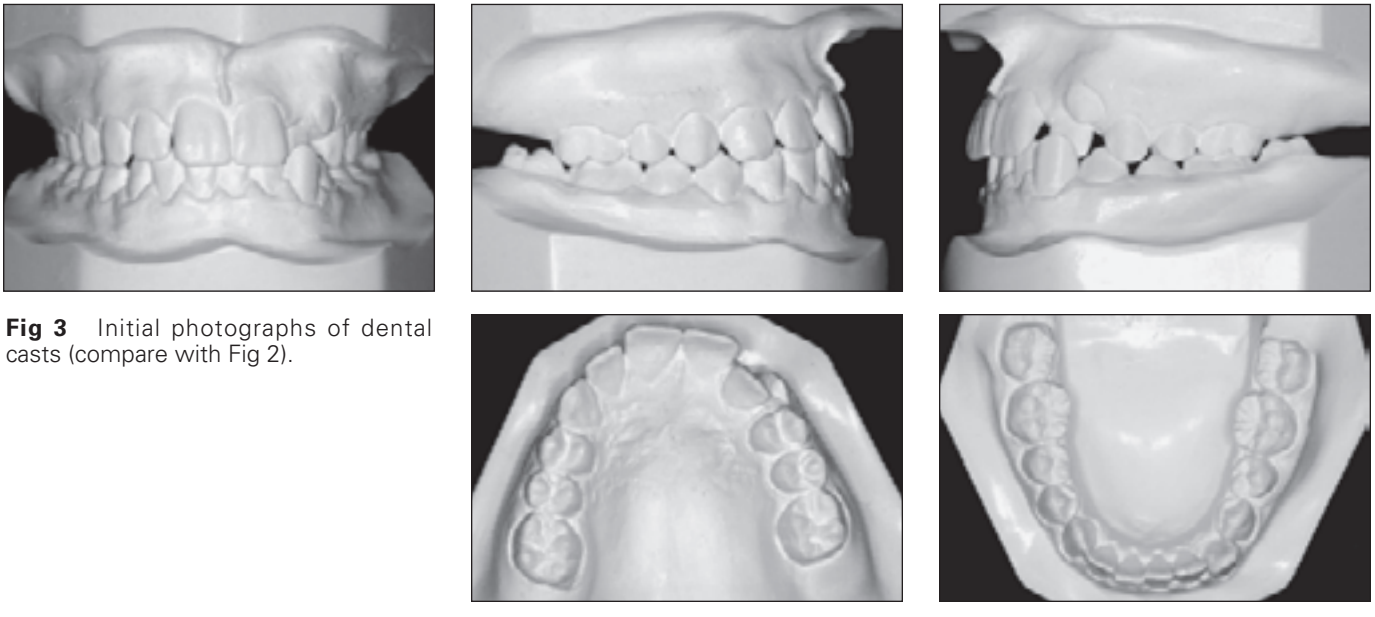


Fig 3 Initial photographs of dental casts (compare with Fig 2).

Table 2 Initial and final cephalometric measurements

Cephalometric measurements	Initial	Final
NAP (degrees)	−4.0	0.0
SNA (degrees)	81.5	85.0
SNB (degrees)	82.0	83.0
ANB (degrees)	−0.5	2.0
SN-Gn (degrees)	67.0	68.0
SN-Po (degrees)	11.0	11.0
IMPA (degrees)	85.0	86.0
FMA (degrees)	18.0	25.0
SN-GoMe (degrees)	32.0	30.0
UI-NA (degrees)	32.0	25.0
UI-NA (mm)	6.5	5.0
LI-NB (degrees)	16.0	22.0
LI-NB (mm)	1.8	5.0
H-NB (degrees)	7.0	8.0
H-nose (mm)	13.0	14.0

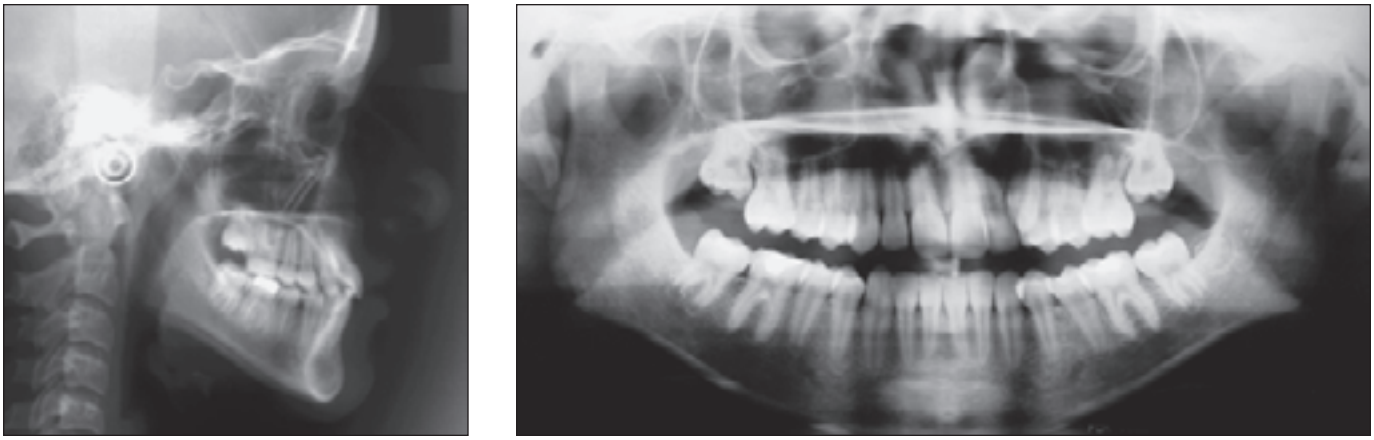


Fig 4 Initial lateral cephalogram and panoramic radiograph showing concave profile, slight maxillary retrusion, and reduced facial height. Protruded maxillary and retruded mandibular incisors compensate the Class III configuration.

Initial cephalometric measurements (Table 2) also confirmed a concave profile, slight maxillary retrusion, reduced facial height, and protruded maxillary and retruded mandibular incisors compensating the skeletal Class III. The analysis of the initial panoramic radiograph did not reveal any significant findings (Fig 4).

TREATMENT OPTIONS

Tooth extraction to gain space for the maxillary left canine and correct the midline had to be excluded because this treatment would have directly worsened the profile due to a retrusion of the upper lip.[15,18] Rapid maxillary expansion (RME) alone was not indicated either because it would not have improved the profile. However, it would have provided space for the maxillary left canine and allowed for the correction of the maxillary midline deviation. All in all, RME with a face mask followed by leveling and aligning all teeth seemed to be the most reasonable option.

TREATMENT SEQUENCE

After placement of elastic separators, bands were adapted on the maxillary first molars and first premolars and an

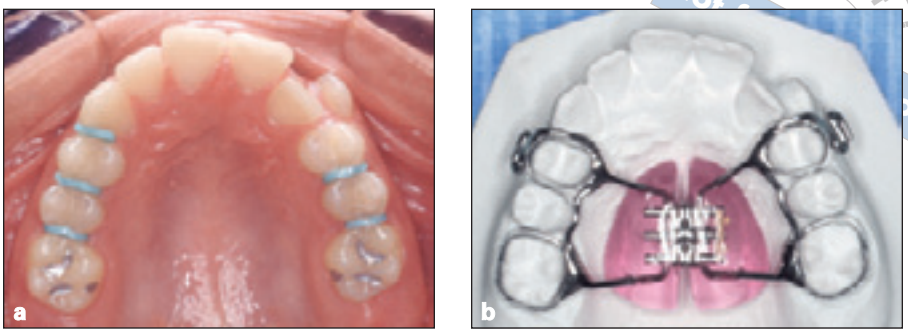


Fig 5 **(a)** Intraoral situation after placement of elastic separators; **(b)** fabricated Haas appliance on the patient's dental cast.

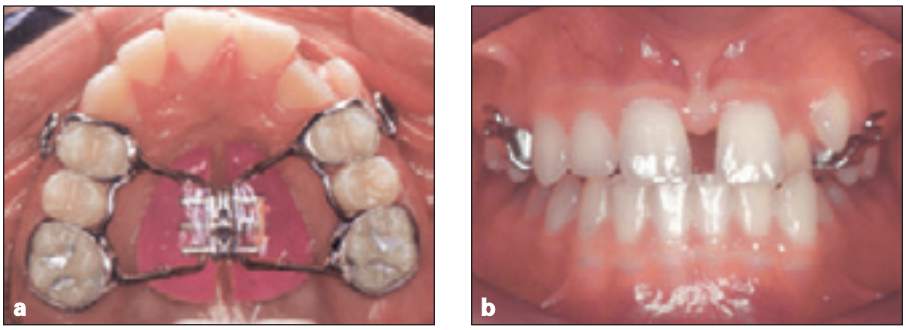


Fig 6 **(a)** Intraoral situation after Haas appliance insertion; **(b)** characteristic diastema after expansion.

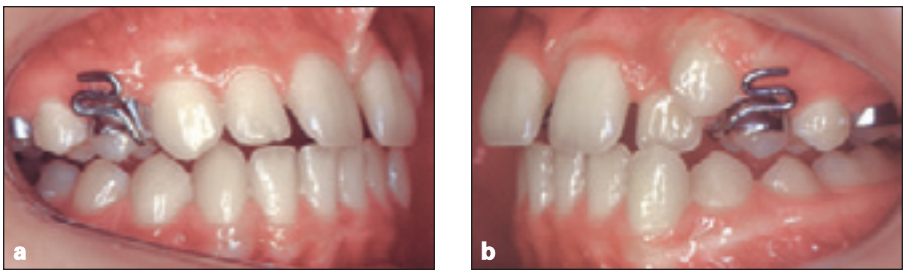
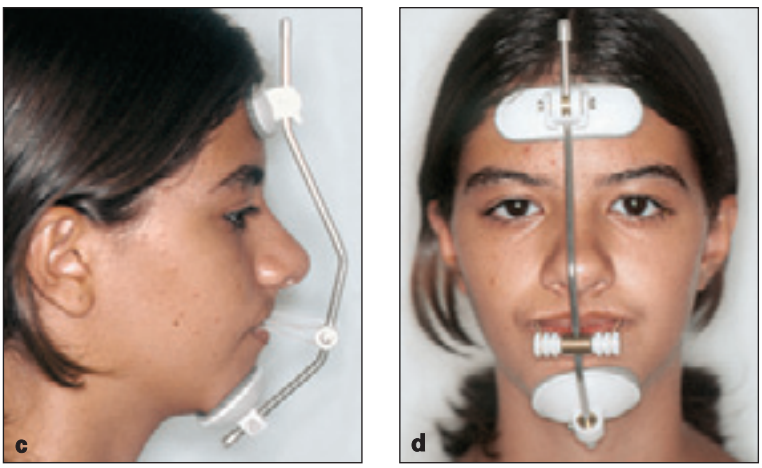


Fig 7 **(a and b)** Right and left lateral views showing hooks welded to the premolar bands **(c and d)** for application of face mask elastics.



impression was taken for the fabrication of a Haas appliance (Figs 5 and 6).

RME was performed by daily activations of the expander screw for 8 subsequent days.

After RME, a face mask for maxillary protraction (600 cN per side) was applied to hooks on the Haas expander (Fig 7).

The face mask was used for 5 months and then removed due to a lack of

Fig 8 Intraoral view after insertion of postexpansion retention plate.

Fig 9 Creating space with an open coil spring.

Fig 10 Bite plate with spring to move left lateral incisor mesially;at the same time, it is moved labially with a power chain.

Fig 11 Intraoral situation after insertion of superelastic Ni-Ti archwire.

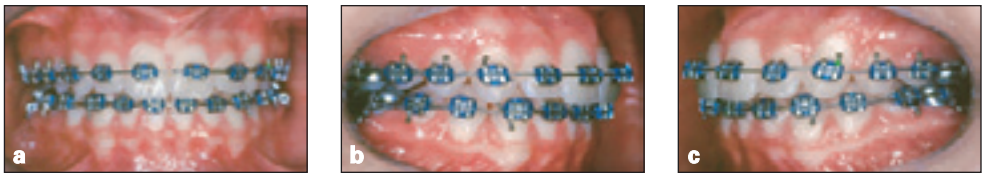


Fig 12 **(a)** Frontal and **(b and c)** lateral intraoral views after repositioning of the maxillary left canine bracket and placement of the fixed appliance in the mandible.

patient compliance. At this time, a retention plate was placed for 6 months (Fig 8). Also, a fixed appliance (Roth prescription) was inserted in the maxillary arch. All teeth were leveled and aligned with nickel-titanium archwires, followed by stainless steel wires.

After expansion with an open coil spring, sufficient space for the labial movement of the maxillary left lateral incisor was created (Fig 9). A bite plate with coil springs was placed to move this tooth mesially. Simultaneously, a ligature between the bracket on the maxillary left lateral incisor and the archwire inclined it buccally (Fig 10).

This bite plate was used for 2 months; after the first month, the stainless steel wire was replaced by a Ni-Ti wire and the maxillary left lateral incisor and canine were included in the appliance, as demonstrated in Fig 11.

After the crossbite correction, the bracket on the maxillary left canine was rebonded to accomplish a better angulation. At the same time, the plate was removed and a fixed appliance was inserted in the mandibular arch (Fig 12).

RESULTS

After active treatment, a removable retainer was placed in the maxilla and a bonded 3-to-3 retainer in the mandible (Fig 13).

The facial profile was significantly improved by moving the upper lip forward, as seen in Figs 14 and 15 and confirmed by the final cephalometric analysis in Tables 2 and 3. The nasolabial angle was reduced, the NAP and SNA angle increased, and the ANB angle changed to a positive reading.

Fig 13 **(a and b)** Extraoral frontal and **(c to e)** intraoral photographs after completion of treatment.

Fig 14 **(a)** Initial and **(b)** final extraoral lateral photographs.

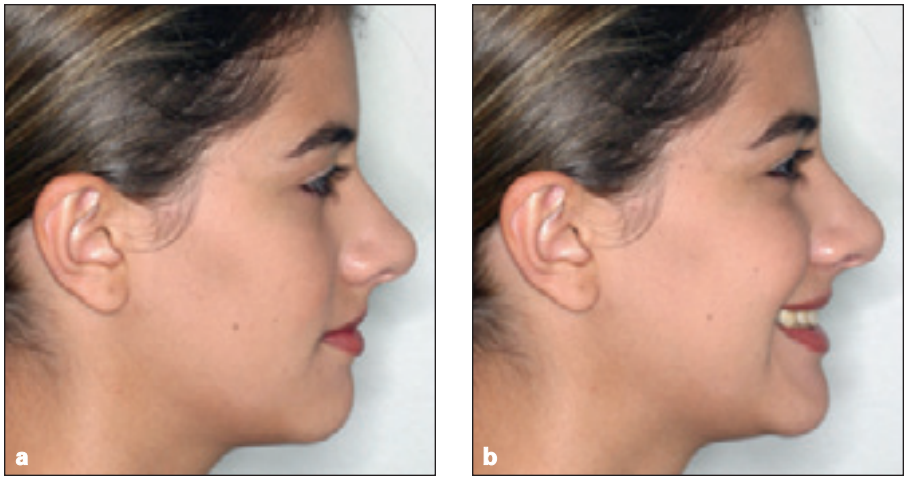


Fig 15 (below) Final lateral cephalogram and panoramic radiograph.

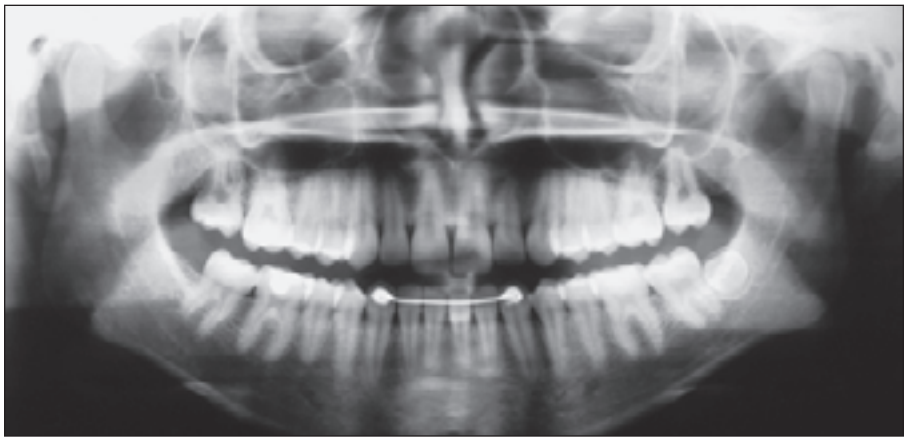


Table 3 Inital and final soft tissue profile analysis values

Parameter	Initial values	Final values
Ricketts' esthetic plane	LL 5 mm behind E-line	LL 5 mm behind E-line
Steiner's S line	Concave profile	Concave profile
Burstone's line	UL 0 mm	LL 1mm in front
	UL 0 mm	LL 1mm in front
Nasolabial angle	133 degrees	128 degrees
H angle	8 degrees	8 degrees

Figure 16 demonstrates satisfactory stability at the 4-year follow-up.

Figure 17 shows the superimpositions of the cephalometric tracings at the beginning, and at the end of treatment as seen at the 4-year follow-up. The superimpositions reveal the improvement of the incisor position and the soft tissue profile as the treatment stability.

DISCUSSION

Cephalometric analysis is routinely used for orthodontic diagnosis because it is an effective method to evaluate faciodental features. At the same time, it used to be thought that the achievement of established cephalometric standards would assure a satisfactory esthetic outcome with regard to the soft tissue profile.[6,23,25] However, this proved not to be true, because a good occlusal relationship does not necessarily imply facial harmony or vice versa. The increasing esthetic concern of modern societies and the advent of better therapeutic resources (advances in orthognathic surgery) led to an evolution of cephalometrics by establishing soft tissue measurements that might indicate facial beauty and harmony. Beside cephalometric analyses, standardized photographs provide even more reliable parameters for treatment planning.

The nasolabial angle is often employed for the evaluation of the facial profile even though it is influenced by nasal morphology.[14,15,17] That is why Fitzgerald et al[6] stated that the nasolabial angle may not reliably describe variations in the soft tissue profile. This highlights the importance of evaluating nasal morphology during orthodontic diagnosis. In the present report, the nasolabial angle at treatment onset was 133.0 degrees, which is far from the ideal of 90.0 degrees to 110.0 degrees. Subjective facial analysis was fundamental in confirming this deviation because the profile evaluation revealed a soft tissue deficiency of this region. The vermillion of the upper lip was reduced in thickness, even though the U1-NA (degrees and mm) values increased, thus favoring some projection of the upper lip.

Initial analysis in this patient revealed a facial convexity angle of −4.0 degrees, indicating a concave skeletal profile and thereby confirming the need for maxillary protraction to improve the profile. Because the nose grows forward and downward (more intensely during adolescence and slower throughout life)[4] and the chin grows forward, the lips are progressively retruded.[10] However, not to rely on growth, which is difficult to predict, seemed to be the best therapeutic option for this patient.

Even though the patient initially presented with a Class I molar relationship, a face mask was used after maxillary expansion to improve her facial esthetics. This is justified by the improvement of the nasolabial angle (133.0 degrees to 128.0 degrees) and the facial convexity angle (−4.0 degrees to 0 degrees). Notwithstanding the lack of her compliance, the face mask also helped to correct the patient's crossbite.

All treatment goals were fully achieved in this patient because her chief complaint (buccally ectopic canines) was eliminated. At the same time, a harmonious profile was established.

Fig 16 **(a and b)** Extraoral and **(c to g)** intraoral photographs at 4-year follow-up.

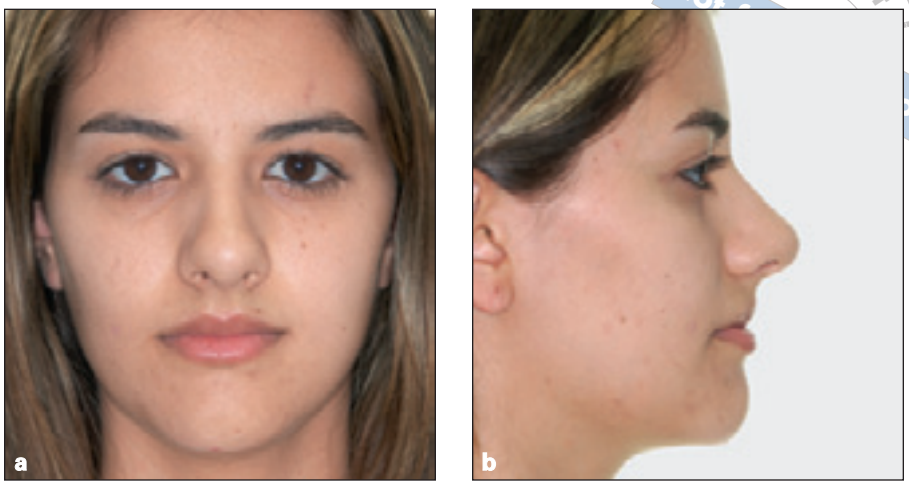
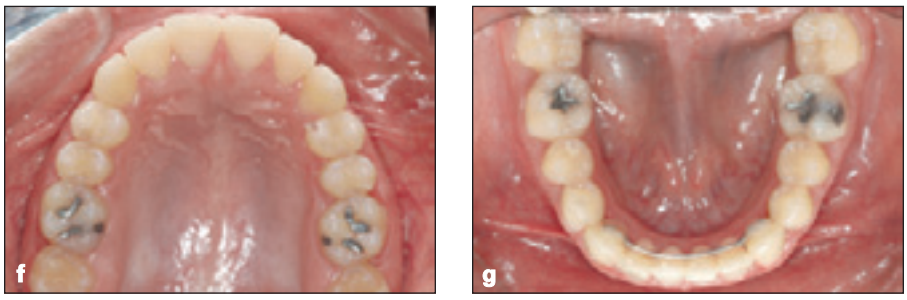


Fig 16 **(a and b)** Extraoral and **(c to g)** intraoral photographs at 4-year follow-up.



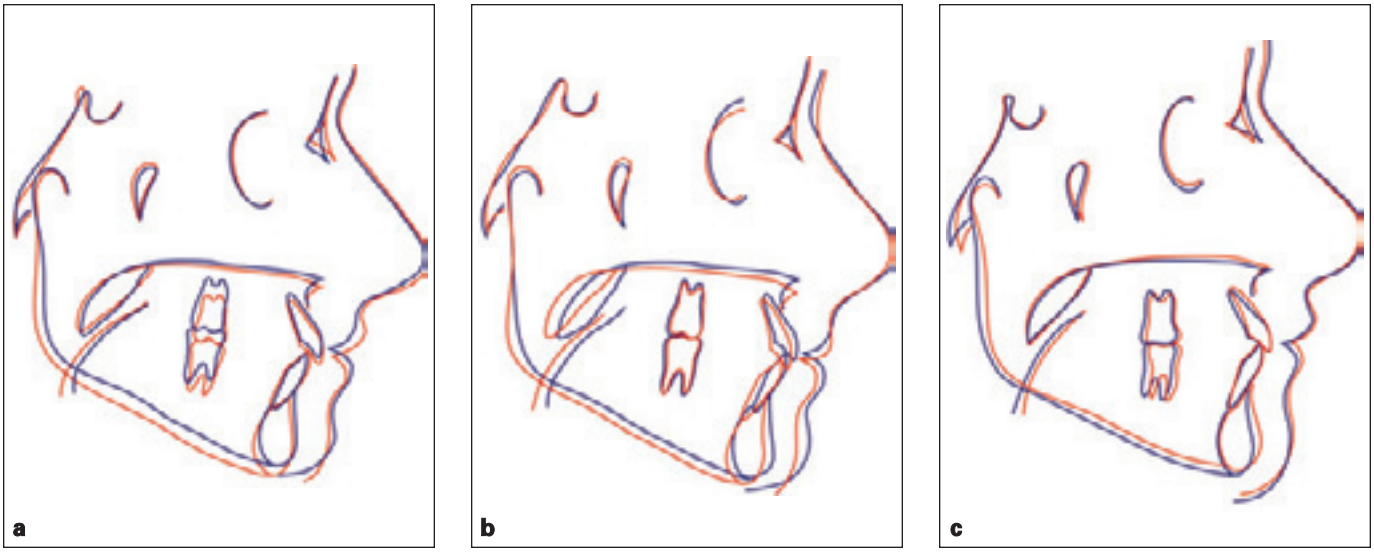


Fig 17 Superimpositions of cephalometric tracings on point S (S). **(a)** Superimposition of initial (blue) and final (red) tracing, **(b)** superimposition of initial (blue) and follow-up (red) tracing, and **(c)** superimposition of final (red) and follow-up (blue) tracing.

CONCLUSION

The search for balance and harmony of facial proportions for esthetics, especially in respect to the soft tissue profile, is fundamental for sound orthodontic treatment planning. RME with a face mask was effective for this patient who exhibited a maxillary deficiency in both anteroposterior and transverse dimension. Furthermore, this treatment was stable 4 years after therapy.

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