Changes of the upper lip in orthodontic and orthopedic treatment of angle's class II malocclusion

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ABSTRACT

Aims: This study aimed to evaluate the changes in upper lips due to incisors retraction in Class II Division 1 patients treated with mandibular protraction, fixed appliances, and without extraction.
Materials and Methods: The sample consisted of 64 pre- and post-treatment lateral cephalometric X-rays of 32 patients with 9-12 years old (16 men and 16 women), who presented ANB > 4°, overjet ≥ 4 mm, treated with Balter's Bionator and fixed appliances. The average period between initial and final radiographies was 5 years (maximum of 5.5 years and minimum of 4.5 years).
Statistical Analysis Used: A Student's *t*-test ($P < 0.01$) evaluated the statistical significance of differences between the mean values obtained for pre- and post-treatment in each variable, for males and females. Linear regression analysis for hard-tissue variables in relation to soft-tissue variables were also made for correlation.
Results: The male group presented cervical point with $r = 0.40$ and incisal point with $r = 0.42$. Female subjects showed incisor cervical point with $r = 0.86$ and incisal point $r = 0.74$. The average Ls retraction was 0.55 mm in 2.43 mm of incisal point movement and 0.34 mm of cervical point. The nasolabial angle showed increase average of 2° for men and 3.9° for women.
Conclusion: There is a difference between genders regarding the lip-incisor relation at this age. Males presented thickening of soft tissue and week correlation between the movement of the incisor and soft tissue both cervical and incisal point. In females' subjects, a strong correlation between the retraction movement and soft tissue, both cervical and incisal point.

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The facial aesthetics concern followed the rise of civilizations, always using "ideal" faces as beauty's standards. In orthodontics, this concern was taken into account back in Angle's time (1899). During the sixties, orthodontists highlighted the subjective criteria in treatment.[1] Different methods for analyzing facial morphology were developed making a careful evaluation of any subclinical patient's asymmetry.[1]

We evaluated the proportion of change of the upper lip in relation to the level of retraction of the maxillary incisors, among males and females patients with Angle Class II, Division 1 malocclusion treated with mandibular protraction device (Balters' Bionator) without extraction.

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MATERIALS AND METHODS

Materials

The materials used in this study were obtained from the clinic of the Orthodontics and Facial Orthopedics Specialization Course, ministered by the Odontology Association together with the Dental Press Educational Center. The materials were comprised of 64 cephalometric radiographs in lateral norm, taken during pre- and post-treatment stages from 32 patients with Angle Class II, Division 1 malocclusion. Subjects ranged from 9 to 12 years of age, of which 16 were male and 16 female. All patients displayed ANB angle and overjet equal to or greater than 4, and were treated using Balters' Bionator along with a fixed appliance. The mean interval between radiographs (initial and final) was 5 years (maximum of 5.5 years and minimum of 4.5 years).

Methods

Cephalometric tracings were performed using transparent

0.003 acetate paper and 0.03 mm HB lead pencil. The drawings of anatomical structures were made as shown in Figure 1, with cephalometric points demarcated using fine-point pens (0.05 mm) in the colors blue (initial tracings) and red (final tracings).

The cephalometric points for both tracings of each patient were then digitized. Once digitized, the data were processed using a measuring software named Radiomemory (Belo Horizonte, MG, Brazil), which registered the horizontal and vertical differences between both tracings, for each point.

The radiographs were taken with the patients in maximum habitual intercuspation, with the Frankfurt horizontal plane parallel to the ground and lips at rest, thereby evidencing sealing quality. All radiographs were taken using the same machine, a Siemens Orthophos (Germany) model.

The following hard-tissue cephalometric points were used:

- N (nasion) – viewed laterally, it is the most anterior point on the fronto-nasal suture; S (sella) – midpoint of the sella; ENA (anterior nasal spine) – most anterior point on the anterior nasal spine; A – position of the deepest concavity on the anterior profile of the maxilla; Go (gonion) – most posterior inferior point on angle of mandible; Gn (gnátio) – most anterior and inferior point of the mandibular symphysis; A1s – apical of the most vestibularized central maxillary incisor; C1s – cervical of the central maxillary incisor; I1s – incisal of the central maxillary incisor; Ls (upper lip) – most anterior point of the convexity of the upper lip; Sn (subnasal) – point located in the junction of the upper lip and the nose columella; Cm (columella) – most anterior point of the nose columella; A' - deepest point of the of the anterior concavity of the upper lip; Es – lowest point of the upper lip.

Cartesian references were determined based on a line drawn 7° lower than SN (*x*-axis), with the *y*-axis starting from point S, perpendicular to the *x*-axis. For the superimposition, a drawing of the zygomatic process of the maxilla, as defined by Björk.[2]

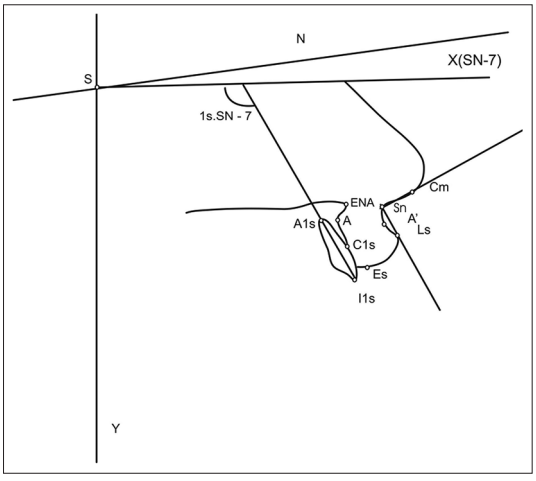

Figure 1: x and **y** reference lines, angles and cephalometric points evaluated in the maxillary superimpositions

The angle created by the long axis of the central maxillary incisor closest to the lip and the *x*-axis (inclination of the maxillary incisor) was also evaluated, as well as the nasolabial angel before and after treatment. Thus, the following angular measurements were applied:

- Cm. Sn. Ls – (nasolabial angle – ANL) – intersection of the lines that pass through the columella and subnasal points (Cm-Sn) and through the subnasal and most anterior point of the upper lip (Sn-Ls); 1.SN – 7 – angle formed between the maxillary incisor and the modified line of the base of the skull (SN – 7).

Two demarcations of the points were conducted for all radiographs, with an interval of 2 months. All tracings were repeated and digitized twice for error reduction. The average of all four measurements for each parameter was used.

For each demarcation of the points related to the maxillary and mandibular incisors (apical, cervical and incisal), in each sampled patient, a template was set over the initial tracing in order to maintain the relations between distances for the corresponding points in the second drawing. The average magnifying effect of 8%, produced by the radiographic equipment used, was corrected in all radiographs using the same software used in the digitalization of the data.

Statistical analysis

Student's *t*-test ($P < 0.01$) was used to evaluate the statistical significance of the differences between the mean values obtained for pre- and post-treatment in each studied variable, for males and females. Correlations were also made for some variables of the sample, employing linear regression analysis for hard-tissue variables in relation to soft-tissue variables.

RESULTS

As a reference to the horizontal movement of any point, the letter × was adopted, followed by the name of the point. For vertical movement, the letter y was added. The plus and minus signs denoted the behavior of the measurement. Horizontally, the negative sign represented movement toward the tongue, meaning retraction. The positive sign meant labial movement.

In the vertical plane, the negative sign represented a given point's movement upward. A positive sign consequently meant the downward movement of a given point.

The mean vertical and horizontal displacements of the studied parts are presented on Tables 1 and 2, respectively. Table 3 presents the Pearson correlation coefficients among the variables of interest.

Table 1: Comparison between the means and standard deviations of vertical changes in both genders, using Student's *t*-test

	Vertical changes groups				
	Males		Females		*P*
	X	SD	X	SD	
ENA-v	–0.28	0.76	0.44	0.38	0.05
A-v	0.29	0.25	–0.09	1.09	0.56
A`-v	–1.54	1.73	–1.31	1.97	0.83
A1s-v	–1.32	1.35	–0.58	1.58	0.36
I1s-v	–2.42	2.67	–1.63	0.84	0.18
C1s-v	–2.91	2.88	–2.27	1.14	0.30
Es-v	–1.13	1.08	–1.49	2.95	0.78
Cm-v	–0.88	1.12	–1.62	1.68	0.39
Sn-v	–1.38	1.60	–1.41	1.40	0.97
Ls-v	–2.30	2.54	–1.60	1.88	0.57

Table 2: Comparison between the means and standard deviations of horizontal changes in both genders, using Student's *t*-test

	Horizontal changes groups				
	Males		Females		*P*
	X	SD	X	SD	
ENA-h	1.35	1.39	–1.13	2.10	0.04*
A-h	–0.22	0.22	–1.07	1.42	0.26
A`-h	3.02	3.09	0.15	1.72	0.01*
A1s-h	0.64	0.63	1.45	1.06	0.13
I1s-h	–1.71	1.99	–2.43	1.82	0.60
C1s-h	–0.54	0.75	–0.34	1.35	0.84
Es-h	3.17	3.12	1,00	2.46	0.09
Cm-h	6.16	6.26	1.88	2.81	0.01*
Sn-h	3.53	3.44	0.33	2.89	0.03*
Ls-h	2.85	2.91	–0.55	2.01	0.02*

* Statistically significant difference (P < 0.01)

Table 3: Pearson correlation coefficients among the variables of interest to both genders

	I1s	C1s
LS males	0.42	0.40
LS females	0.74	0.86

DISCUSSION

Facial Type II is defined as individuals with maxillary protrusion and/or mandibular deficiency – the first of which is less frequently and almost rare, regardless of the molar relation featured in the dental arch.[3]

When the problem is located in the mandible, it is usually resolved through compensation – orthognatic surgery is almost usually a second choice for patients. When undertaking this compensating treatment, we can extract maxillary premolars or use functional appliances at the start of the second transitional treatment stage, which usually produces satisfactory changes for the correction of Class II malocclusion.[4] The orthopedic approach is able to procline mandibular incisors, retroincline maxillary incisors, and slightly alters mandibular and maxillary growth.[4-7]

The orthopedic effect restricts point A, stopping its protraction, and thus resulting in a slightly wider nasolabial angle. Another contributing factor to this widening is the retraction of the maxillary incisors, which results in a remodeling of the subnasal region, with apposition and resorption of the anterior portion of the alveolar process of the maxilla.[6]

The changes in the upper lip are directly related to this remodeling of the nasolabial region and the retraction of the maxillary incisors.[8,9] The upper and lower lips also change with age, both in width and thickness.[9-11]

These labial changes significantly alter the nasolabial angle,[3,12-14] making it wider in males in comparison to females Prahl-Andersen *et al*.[11]

Sample and differences between genders

In the age group used for this study, we sampled a limited number of patients who were treated for Class II malocclusion, without extraction, and subjected to mandibular protraction using Balters' Bionator. All patients in the sampling underwent functional orthopedics therapy for a period between 1 and 2 years. Following this period, they underwent corrective orthodontic treatment using a fixed appliance according to the straight wire technique. The total treatment duration and mean patient age did not differ between male and female groups.

It is known, however, that pubertal growth takes place on average two years earlier in females than in males. Therefore, soft-tissue changes were more noticeable in males, even though this study employed partial maxillary superimposition (which excludes changes in dentoskeletal tissue). This finding was consistent with Mamandras[10] and Bishara *et al*.[8] for the thickening in labial tissue in this younger stage for males. This was not a limiting factor in the work of Ramos *et al*.,[15] which employed a similar methodology, but in which all patients were over 12 years old.

Tables 1, 2 present the means and standard deviations for males and females, and a comparison applying Student's *t*-test.

Vertical changes

Table 1 presents the vertical changes to the studied points in both groups. As expected, there was no difference between the measurements of each group, as the methodology of partial maxillary superimposition excludes the differences between the groups in maxillary growth with reference to the base of the skull, as previously mentioned.

For males, it was detected that the maxillary incisors extruded 2.42 mm on average, while the Ls and Es points lowered 2.30 and 1.13 mm, respectively. Consequently, it can be concluded that the level of exposure of the maxillary incisors in relation to the upper lip remained stable, while the exposed vermilion area was reduced by about 1 mm.

For females, statistically similar behavior was observed, with maxillary incisors having extruded 1.63 mm, and Ls and Es lowering 1.49 and 1.60 mm, respectively – demonstrating proportionality between the incisor and upper lip, but negligible reduction in exposed vermilion area of the upper lip. The works of Ramos *et al*.[15] (extraction of two maxillary first premolars) and Delage[13] (extraction of four premolars), detected an average reduction of 1mm in exposed vermilion area.

Horizontal changes

As the main focus of the present study, the horizontal changes in the studied points did not differ between the genders in regards to dentoskeletal measurements. However, soft-tissue points presented different results for males and females, possibly due to differences in the biological ages of each group (chronological ages were similar). For the male group [Figure 2], the Ls point advanced on average 2.85 mm, in contrast to the retraction of the maxillary incisors (I1s = –1.71 mm). In the female group [Figure 3)], meanwhile, the Ls point retruded on average 0.55 mm, in the same direction (although with less intensity) as the retraction of the maxillary incisors (I1s = –2.43 mm).

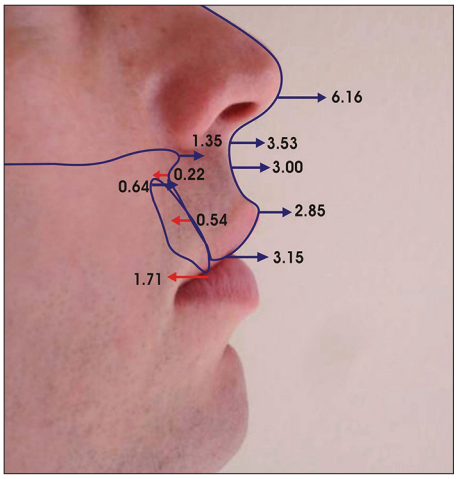

Figure 2: Schematic representation of the mean horizontal displacements of studied points, for males

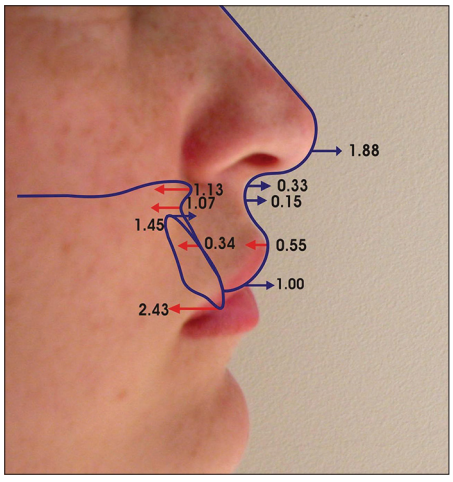

Figure 3: Schematic representation of the mean horizontal displacements of studied points, for females

One of the hypotheses tested in the present study is that the cervical point is more closely correlated with the movement of the Ls point, than the incisal point (I1s), although both are correlated [Table 3]. For males, perhaps due to their earlier development stage (in which thickening of lip tissue takes place), this hypothesis was rejected. Correlation coefficients were low for both the cervical and incisal points ($r = 0.40$ and $r = 0.42$, respectively), which results in a poor determination index of approximately 16%.

For the female group, the results were very close to those obtained by Ramos *et al*.[15] and Delage.[13] Although the methods were different, the incisors were retruded for correction of Class II. In the present study, an $r = 0.74$ was obtained for the incisal point of the maxillary incisors in relation to point Ls, whereas for the cervical point that value was $r = 0.86$. The determination indices stand near 53% when the incisal variable is used and 70%, when incisor's cervical variable is employed.

The more evident upper lip change observed in females could also have been influenced by the greater variation in the nasolabial angle, as well as by greater palatal inclination of the maxillary incisors. However, a comparison using the *t*-test did not show any statistically significant differences for these measurements. It is possible that the wider range of the standard deviations may have masked possible differences.

At any rate, on average there was a slight increase in the nasolabial angle for both groups (about 2º for males and 3.9º for females). These changes were smaller when compared to those found in the studies by Ramos *et al*.[15] and Delage,[13] who analyzed groups with greater upper lip alterations, as a result of greater retraction of maxillary incisors from treatments involving extraction.

Therefore, even if changes are smaller when compared to groups subjected to extraction, the correction of Class II malocclusion through mandibular protraction also affects the nasolabial angle, which is correlated to the side effect in the maxillary arch (incisor compensation). It should be noted that this angle remains stable in a non-treated sample.[16]

Based on the results obtained and the methodology employed, the study can conclude that there was a difference between genders regarding the lip-incisor relation, in this age group. Males presented thickening of soft tissue, masking the effect of retraction; for males, there was a weak correlation between the movement of the incisors and soft tissue (Ls), both for the cervical point ($r = 0.40$) and the incisal point ($r = 0.42$); for females, there was a strong correlation between the retraction movement and soft tissues, both for the cervical point ($r = 0.86$) and incisal point ($r = 0.74$), with an average

0.55 mm of retraction for point Ls, for an incisor movement of 2.43 mm considering the incisal point, and 0.55 for 0.34 mm, considering the cervical point and the nasolabial angle presented a slight increase for both groups (2º for males and 3.9º for females), but without statistically significant differences between them.

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