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Research Article

Lip Profile Angles in Persons with Different Dentoskeletal Pattern -A Cephalometric Study

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Abstract

Background/Purpose

The analysis of the lips position is one of the most important soft tissue analyses indicating the stability of the front teeth position and facial aesthetics. The aim of this study is to establish the values of the soft tissue lip angles of a facial profile in subjects with the dentoskeletal pattern of Class I taken as a control group in relation to Class II division 1, Class II division 2, and Class III.

Materials and Methods

This study included the examination and the analysis of cephalometric radiography derived lateral cephalogram evaluating the profile angles of 120 adult Caucasian orthodontic patients (60 females and 60 males) from the central Balkan area. Generally, the subjects with Class I had harmonic profiles due to the orthognatic jaw relationships; this group was taken as a control one and compared

to the other three groups: Class II division 1, Class II division 2 and Class III. The following angles were examined: the projection of the upper lip to face (Ls-N- Pg) the angle of the upper lip (Ls-Sn-Pg), the projection of the lower lip (Li-N-Pg) and the interlabial angle (Sn- Ls/Li-Sm).

Results

The angle of the upper lip projection and upper lip angle depend on the dentoskeletal pattern of Class II division 1 (P<0,001) and Class III (P<0,001), whereas the interlabial angle depends only on Class II division 1.

Conclusion

The significant differences for the upper lip angle in the dentoskeletal pattern of Class II division 1 and Class III, and for the interlabial angle in Class II division 1 have been established. There are no significant differences for the values of the soft tissue lip angles in the dentoskeletal pattern of Class II division 2.

Abbreviations

N - nasion, Sn - subnasale, Ls - labiale superior, Li - labiale inferior, Sm - supramentale, Pg - pogonion, ANB angle - skeletal relationship angle between the maxilla and mandible, Ls-N-Pg – projection of upper lip to face angle, Ls-Sn-Pg - upper lip angle, Li-N-Pg - projection of lower lip, Sn-Ls/Li-Sm - interlabial angle.

Introduction

The profile of facial soft tissue consists of five facial prominences: forehead, nose, lips, chin and submental-cervical prominence, where the nose, lips and chin are considered as the most dominant ones [1,2].

Their analysis is an integral part of the diagnostic procedure and therapy planning, since the interrelation of these components plays an important role in the perception of facial aesthetics (for example, the lip prominence can influence the perception of the chin prominence) [1]. On the other hand, the lip position can significantly change the choice of treatment, but, an orthodontic treatment itself can also change the lip position. The analysis of the lip position is one of the most important soft tissue analyses indicating the stability of the front teeth position and facial aesthetics [3]. Placing the front teeth according to the accepted cephalometric criteria may not necessarily enable the lips to overlap them in a harmonious manner, or guarantee that the soft tissue profile will directly follow the dentoskeletal profile during the therapy.

The lip soft tissue may vary, so the dentoskeletal pattern alone may be inadequate in evaluating facial disharmony. Some soft tissue structures are closely related to the hard tissue, while others are influenced by their own length, thickness and function [4]. Saxby and Freer [5] found that the position of the upper and lower incisors and the inclination of the upper incisors were very important determinants for the related lip soft tissue.

It was found that the sagittal jaw relationship was closely related to overlapping the soft tissue outline, but the soft tissue may camouflage or emphasize the jaw discrepancy [4,6-8]. This could happen when individuals showed great differences in thickness, length, and postural tone of soft tissue that overlapped teeth and bone, since cephalometric analyses were based on patients with the skeletal disorder not being shown [3,9,10]. In recent years, it has been suggested that the favored lip position has changed according to the variations in facial types. Czarnecki *et al.* [11] suggested that the lip position changed according to the variations in the size of the nose and chin and stated the importance of the balance between the parts composing the face.

Ioi *et al.* [12] reported that the lip position changed according to the variations in facial convexity. Several assessments of the favored antero-posterior lip positions for the various sagittal dentoskeletal patterns were published. Murakami *et al.* [10] reported that the perception of the favored antero- posterior lip positions may be changed in accordance with an increase or decrease in the facial disproportions inherent in individual patients. Some authors reported that the influence of full and protruding lips was such that even when there were evident occlusal deviations such as midline deviation, small lateral incisors, and crowding, they were effectively camouflaged by this type of lips [13,14].

The aim of this study is to establish the values of the soft tissue lip angles of a facial profile in subjects with the dentoskeletal pattern of Class I , taken as a control group in relation to Class II division 1, Class II division 2, and Class III, in order to, in this way, examine the influence of the sagittal dentoskeletal pattern (malocclusion) to the value of the angular lip parameters of a facial profile, as well as to examine the significance of the established variations for each angle individually.

Materials and Methods

The study was conducted at the Dental Clinic in Nis (Serbia). Before the commencement of the study, each volunteer gave an informed consent as to the purpose and nature of the study. All work was performed in accordance with the Declaration of Helsinki and was approved by the Faculty Ethics Committee, (General project title of Clinical and Experimental Examination of the Stomatognathic System and Modern Therapeutic Procedures, Project Number 11, March 8th, 2017, Nis, Republic of Serbia).

This study included the examination and the analyses of cephalometric radiography derived lateral cephalograms evaluating the profile angles of 120 adult Caucasian orthodontic subjects (60 females and 60 males) from the central Balkan area (Serbia), which were taken from the subjects archives. Cephalometric radiography derived lateral cephalograms were recorded during routine diagnostic procedures for subjects who were examined at the Department of Jaw Orthopedics at the Clinic of Dentistry in Nis, aged between 18-30 years, who underwent orthodontic therapy for the first time. The subjects with a history of trauma, craniofacial anomalies, cleft lip and palate, and previous orthodontic, prosthetic or orthognathic surgical treatment were excluded from the study. Cephalometric radiographs of the head using a cephalostat (head-holding device). All subjects included in the study underwent a detailed clinical assessment and analyses of their dental and skeletal profiles, as well as soft tissue profiles on cephalometric radiography. The equipment used for the imaging analyses was the Rotograf Plus(20090 Buccinasco MI Italy) (Number and series: 00036045), and the CEI-OPX/105X-ray tube (CEI, Bologna) in March 2000, which had a protective filter

(2.5mm a luminum - equivalent). Lateral cephalometric films were taken from a distance of 165 cm away from the tube, using a cephalostat to ensure a rigid head fixation. The subjects were placed in the cephalostat in such a way that the sagittal plane of the head was at a 90° angle to the path of the X-rays. The Frankfort horizontal plane (from the lower edge of foramen orbitale and upper rim of the external auditory canal) was parallel to the ground, the teeth were in the central occlusion position, and the lips were in relaxed position. No correction for magnification factors was required, since all the radiographs were taken with the same equipment and the same proportions. Each cephalogram was fixed on the viewing box with the profile to the right, and the acetate tracing paper was fixed by tape at the top. The soft tissue and skeletal features were traced manually in a darkened room, using a 0.5mm lead pencil. All the image tracing was done by the main investigator. Subjects were divided into four groups. The size of the ANB angle according to Steiner and the angle inclination of the upper incisors was the criteria used to categorize the subjects. The cephalometric ANB angle was the parameter that defined the sagittal relationship between the upper and lower jaw as orthognathic, distal, or mesial (Fig. 1). The points that determined the ANB angle included, point (N), the nasion, located on the suture between the frontal and nasal bones; point A, the deepest point on the line between the anterior nasal spine and the prosthion (alveolar point); and point B, the deepest point from the line between the infradentale and the pogonion (midline of the chin).

Figure 1: *The cephalometric ANB angle and the angle of inclination of upper incisors.*

The first group with an orthognathic jaw relationship (Class I) and the ANB angle between 2-4°. The second group with a distal jaw relationship, an ANB angle >4°, and the inclination angle of the upper incisor >22° (Class II, Division I, or Class II/1). The third group with a distal jaw relationship, an ANB angle >4° and the inclination angle of the upper incisors inclination <22° (Class II, Division 2, or Class II/2). The fourth group with a mesial jaw relationship and an ANB angle <1° (Class III). Each group consisted of 30 subjects (15 females, 15 males). Since subjects with Class I generally had a harmonic profile due to the orthognatic jaw relationship, this group was taken as a control one and compared to the other three groups.

Then, on the radiograph of each patient, the following anthropometric soft tissue points were determined (Table 1, Fig. 2).

Table 1: *Facial landmarks used for the determination of angular parameters*

Nasion (N)	the point in the middle line located at the nasal root
Subnasale (Sn)	the point where the upper lip joins the columella
Labiale superior (Ls)	the point that indicates the mucocutaneous border of the upper lip
Labiale inferior (Li)	the point that indicates the mucocutaneous border of the lower lip
Supramentale(Sm)	the deepest point of the inferior sublabial concavity
Pogonion (Pg)	the most anterior point of the chin

Figure 2: *The landmarks used in this investigation: nasion (N), subnasale (Sn), labiale superior (Ls), labiale inferior (Li), supramentale (Sm), pogonion (Pg).*

By pulling lines from these points, the following profile angles were formed:

1. Projection of upper lip to face (Ls-N-Pg) - angle between nasion (N) to pogonion (Pg) line and nasion to labiale superior (Ls) line (Fig. 3);

Figure 3: *Angular parameters:1. Projection of upper lip to face (Ls-N-Pg); 2. Upper lip angle (Ls- Sn-Pg).*

2. Upper lip angle (Ls-Sn-Pg) - angle between subnasale (Sn) to labiale superior (Ls) line and subnasale to pogonion (Pg) line (Fig. 3);

3. Projection of lower lip (Li-N-Pg) - Angle between nasion (N) to labiale inferior (Li) line and nasion to pogonion (Pg) line (Fig. 4);

Figure 4: *Angular parameters: 3. Projection of lower lip (Li-N-Pg); 4. Interlabial angle (Sn-Ls/Li- Sm).*

4. Interlabial angle (Sn-Ls/Li-Sm)- Angle between subnasale (Sn) to labiale superior (Ls) line and labiale inferior (Li) to supramentale line (Sm) (Fig. 4);

Since these were angular measures, all results were expressed in degrees (°).

Statistical Analysis

Statistical analysis of obtained morphometric data was performed by IBM SPSS Statistics (version 25). Results of the Kolmogorov-Smirnov test showed that majority of the morphometric parameters were not normally distributed. Consequently, significance of detected differences was evaluated by non-parametric Mann-Whitney U test. In the statistical assessment, the following levels of significance were used: Non significant P>0,05; Significant 0,05≥P>0,01(*); Highly significant 0,01≥P>0.001(**); Very highly significant P ≤0.001(***); P= probability value.

Results

Descriptive statistics of the average measurements for different angular parameters in all four groups with different jaw relationships (Class I, Class II/1, Class II/2, Class III) are shown in Table 2. In Table 3, the statistical differences in the average values of the examined angles between the group with Class I and other three groups are shown.

Table 2: *Descriptive statistics for Class I, Class II division 1, Class II division 2 and Class III (mean value, standard deviation and min-max value).*

Classes	I	II/1	II/2	III
Ls-N-Pg	8.10±1.99	11.33±3.27	8,87±2,92	5.00±2,32
Min-max	5.0-12.0	7.0-21.0	2.0-13.0	0-10,0
Ls-Sn-Pg	13.93±5.01	19.13±8.72	14.33±8,17	9,27±5,64
Min-max	4.0-24.0	10.0-44.0	1.0-35.0	-2.0-23.0
Li-N-Pg	4.77±1,77	5.27±2.55	3,97±2,09	4.10±2,01
Min-max	2.0-9.0	1.0-11.0	0-7.0	1.0-10.0
Sn-Ls/Li-Sm	110.73±16.44	87.40±18.87	111.37±17,75	118.20±17,08
Min-max	80.0-150.0	53.0-138.0	72.0-153.0	74.0-148.0

Table 3: *Statistical differences between Class I and other groups (Z value; p=probability value)*

Classes		I-II/1	I-II/2	I-III
Ls-N-Pg	Z	-4.093	-1.535	-4.646
	P	<0,001***	0,125	<0,001***
Ls-Sn-Pg	Z	-2.097	-.015	-3.103
	P	0,036*	0,988	0,002**
Li-N-Pg	Z	-.557	- 1.280	-1.662
	P	0,578	0,201	0,096
Sn-Ls/Li-Sm	Z	-4.328	-.200	-1.953
	P	<0,001***	0,842	0,051

Discussion

The correlation between the facial profile harmony and the sagittal dentoskeletal and occlusal relationships was the subject of researches since the beginning of the last century, when Angle observed that the effect of sagittal malocclusion on facial contours produced different facial profile disharmonies. Angle also concluded that the quality of a balanced facial profile would be proportional to the proximity with normal occlusion [15]. It was established that Class I was more connected to a pleasant profile, and Class III with the least appreciated profile aesthetics indicating how the sagittal position of the lower jaw influences the quality of profile aesthetics [8,16]. However, it could happen that, in the absence of any form of occlusal disharmony, the facial profile, especially in the lip area, might be unacceptable. A typical example is a "bimaxillary protrusion", a feature prevalent among African-Americans, as well as some ethnic groups among the East Asian population [17]. This results in an unacceptable circumoral convexity of the facial profile, in an increase in the labial angles and a decrease in the interlabial angle, despite Class I and occlusion with a normal overjet, overbite and well-aligned upper and lower dental arches.

The value of the projection angle of the upper lip to the face (Ls-N-Pg) indirectly determines the position of the upper incisors and the thickness of the upper lip soft tissue that overlaps them. The upper lip angle was measured from nasion. Akter and Hossain [18] obtained, in eugnathic subjects, the average values of 9,15±2,307°. According to Anić Milosević *et al.* [19], in Croatian subjects with Class I this angle had an average value of 7,08 ± 2,00°. In our subjects with Class I, this angle has an average value of 8,10 ± 1,99°. However, in subjects with Class II malocclusions, the average value of this angle is higher: 11,33 ± 3,27° in subjects with Class II/1 (significant difference P<0,001) and 8,87 ± 2,92° (non-significant difference P=0,125) in subjects with Class II/2. In subjects with Class III, the average value is significantly less than 5,00 ± 2,32° (P<0,001)(Table 2, 3). This finding is expected bearing in mind the specific position of the incisors in subjects with Class II/1; the proclination of the upper incisors results in an increase of this angle. In subjects with Class II/2, there is a retroclination of the upper incisors, but the thickness of the upper lip exceeds the thickness of the upper lip in all other malocclusions [7,8], so it camouflages the retrusion of the upper incisors. The lowest average value of the upper lip angle in subjects with Class III malocclusion is caused by the anterior position of the Pogonion point, due to the overdeveloped lower jaw.

The upper lip angle (Ls-Sn-Pg) can be determined from the subnasal point as well [20,21]. Then, the upper face is excluded, and this angle shows the relationships in the lower face only. Akter and Hossain [18] reported the average values of this angle of 19,23 ± 7,03°; according to Anić Milosević *et al.* [19] it is 12,33 ± 5,52°. In the current study, in subjects with Class I, the average value is 13,93 ± 5,01°, being close to the value established by Anić Milosević. In subjects with Class II/1 malocclusion, the value of this angle is significantly higher, 19,13 ± 8,72° (P = 0,036), as expected, since there is a large sagittal discrepancy between the subnasal area and the Pogonion point. There is a higher average value in subjects with Class II/2 of 14,33 ± 8,17°, but the difference does not have a statistical significance (P = 0,988). As expected, in subjects with Class III, a significantly lower average value of the upper lip angle of 9,27 ± 5,64° (P = 0,002) has been established (Table 2,3).

It is expected to have a highly dependent projection angle of the lower lip (Li-N-Pg) related to the presence of different dentoskeletal patterns. The lower lip overlaps the lower incisors where the inclination varies

with different types of sagittal dentoskeletal deviations. Moreover, it overlaps the cutting edges of the upper incisors (in case of competent lips), thus affecting their inclination but their inclination influences its projection respectively. On the other hand, some studies reported the variability in the thickness of the lower lip within various malocclusions. The thinnest lip is with Class III malocclusion, and the fullest lip is with Class II/1 [7,8], indicating the camouflaging property of the lower lip. The group of factors listed should significantly influence the value of this angle. However, the current research has not confirmed this hypothesis. There are no significant differences in the value of the lower lip angle for subjects with different malocclusions (Table 3). In subjects with Class I, the average value is 4,77 ± 1,77°. Anić Milosević *et al.* [19] established a lower average value of 3,49 ± 1,60°, while Akter and Hossain [18] established a higher one of 4,84 ±1,648°.

The interlabial angle is formed as the ultimate result of the sagittal jaw position, the inclination of the upper and lower incisors, the interincisal angle, and the position and thickness of the upper and lower lip. Due to many factors influencing the value of this angle, the differences in average values with a large range of variations are expected. The subjects from the current study with Class I, have an average value of this angle of 110,73 ± 16,44°. The subjects with Class II/1 have a significantly lower average value of this angle of 87,40 ± 18,87° (P<0,001). The reduction of this angle is a consequence of the lips position in malocclusion of this type: a protruded upper and lower lip overlapping an increased incisal step. In the end, even the interincisal angle in malocclusion of this type has been reduced. In subjects with Class II/2, there is an increased value of the interlabial angle of 111,37 ± 17,75°, due to the returusion of the incisors and the increased interincisal angle. This difference, however, is not statistically significant (P = 0,842). An increased average value of the interlabial angle has been established in subjects with Class III of 118.20 ± 17.08° (the difference is not significant, P = 0.051) (Table 2, 3).

Due to the specific position of the mandible, the lower lip with its position camouflages the negative overjet and thus contributes to the increase of the interlabial angle. Yassir *et al.* [22] examined differences in the value of the interlabial angle in subjects with Class I and III. Higher average values of the interlabial angle were obtained in subjects with Class III (103,114 ± 9,630°) compared to subjects with class I (99,447 ± 9,263°). Differences were not significant. This is close to the results of the current study. Diomande *et al.* [23] created this angle as Ls-Sn-Li and established an average value of 110.78 ± 7.42° and significant differences in the value of this angle between the subjects with narrow, middle and wide face. Reis *et al.* [16] and Fortres *et al.* (24) did not find a significant difference of the interlabial angle by comparing subjects with a pleasant and unpleasant profile. This implicitly indicates that the value of this angle did not affect the perception of attractiveness.

Conclusion

By comparing the average values of the soft tissue profile angles of the upper and lower lip and the interlabial angle, there are established significant differences for the upper lip angle in the dentoskeletal pattern of Class II division 1 and Class III, and for the interlabial angle in Class II division 1.

The lower lip angle is independent in relation to the dentoskeletal pattern. There are no significant differences for the values of the soft tissue lip angles in the dentoskeletal pattern of Class II division 2.

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