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Soft Tissue Facial Profile of Normal Dental and Skeletal Subjects in Croatian Population Aged 12 to 15 Years

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A B S T R A C T

This study was carried out on 40 lateral cephalograms of Croatian subjects aged 12 to 15 years with dental and skeletal class I. The purpose of this investigation was to determine the means and standard deviations of the soft tissue parameters in the sample of Croatian population exhibiting dental and skeletal class I and to find the correlations between investigated parameters. The investigation included a total of 11 variables of which 4 were angular and 7 linear. Linear and angular measurements were made to the nearest 0.5 mm or 0.5° with dial calipers and a standard protractor with 0.5° increments. Data from this investigation could serve to determine the norms of 11 soft tissue variables for Croatian population with dental and skeletal class I, and to define craniofacial morphology of the soft tissue profile in patients with normal occlusion. Significant correlations were found between thickness of upper and lower lip, and between the distance of upper and lower lip to the Ricketts esthetic line, and Holdaway angle.

Key words: *soft tissue facial profile, dental class I, skeletal class I, upper lip, lower lip*

Introduction

It is very difficult to achieve harmony of the soft tissue facial profile because of the soft tissue thickness variability that covers teeth and bones. Those variations do not appear only because of the discrepancies in dental and skeletal structures but as a result of the individual variability in the thickness of the soft tissue drape[1–4].

»Ideal« soft tissue facial profile has been many times described by artist, anthropologists, plastic surgeons and orthodontist, but those profiles show significant variations in skeletal convexity, soft tissue thickness, protrusion of the lips and position of the lower incisors[5]. Therefore, a great variability between profiles considered as »good« or »ideal« could be found, depending on the population on which investigation were carried out[6].

The importance of the cephalometric norms relevant to certain age and ethnic groups is well known, but most of them were limited to hard tissue analysis with the exception of those using the Ricketts' esthetic line[7], and the Legan and Burstone soft tissue analysis for orthognathic surgery[8]. Detailed cephalometric soft tissue analyses have been reported by Epker et al.[9], and Holdaway[10], and these analyses have been extensively used for research and clinical purposes.

Different authors have determined the methods of the soft tissue profile analysis and suggested the standards for an esthetic profile[6,7,10–14]. The development of the soft tissue facial profile is a result of complex changes within the hard and soft tissue structures of the face. Altemus[15] found great variability in the soft tissue thickness of the individual faces. Subtelny[16] demonstrated that, although the skeletal profile tended to straighten with maturation, the soft tissue profile remained relatively convex. He concluded that soft tissue contours diverge from those of the undelying skeletal structures in certain areas, whereas area such as the lips show a strong tendency to follow the hard tissue changes. In-

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creased convexity of the soft tissue profile is consistent with earlier findings of Pelton and Elsasser[17], but contrasts with later findings of Mauchamp and Sassouni[18]. When evaluating esthetics it is important to consider ethnic differences. Most investigations dealing with esthetic parameters are based on data performed on Caucasians[19–22], they may not be applicable as a reference for the diagnosis and treatment for other ethnic groups[23–26].

Because the orthodontic treatment planning usually includes comparison of craniofacial structure of a patient to the norm it is important to create the norms performed on domestic ethnicity. The purpose of this investigation was to determine the mean and standard deviations of the previously defined soft tissue parameters in the sample of Croatian Caucasian population exhibiting dental and skeletal class I (no craniofacial deformities or history of orthodontic treatment, pleasant and balanced facial profile, competent lips), and to find the correlations between investigated parameters.

Material and Methods

The sample consisted of 40 lateral cephalograms of Croatian Caucasian subjects (15 male and 25 female) aged 12 to 15 years exhibiting dental and skeletal class I. All subjects signed the informed consent to participate in the study, and the research was approved by the Ethics Committee of the School of Dental Medicine University of Zagreb, Croatia. Dental class I was determined by clinical exemination, and skeletal by cephalometric analysis (ANB angle: 2.5° ± 2°). The criteria for selection included the abscence of craniofacial deformities or history of orthodontic treatment, pleasant and balanced soft tissue profile, competent lips, good facial proportions, no visible facial asymmetry, normal overjet and overbite, minimal spacing or crowding. All cephalograms were selected

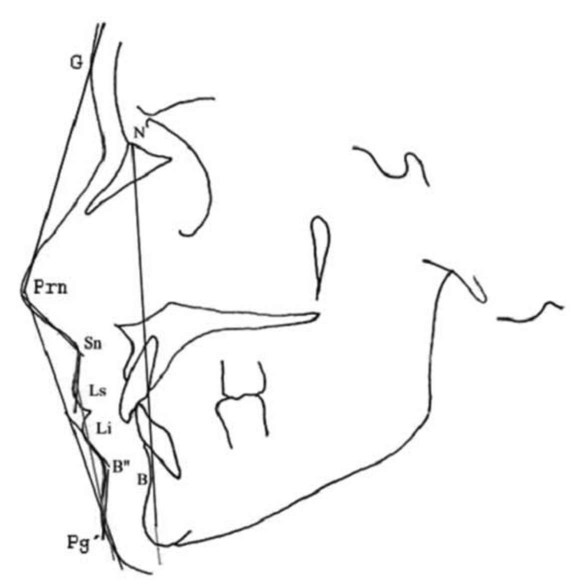

Fig. 1. Angular measurements.

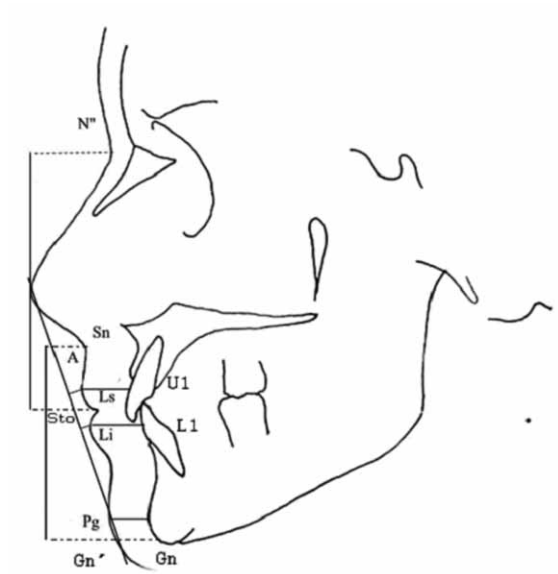

Fig. 2. Linear measurements.

from the records of the Department of Orthodontics, School of Dental Medicine, University of Zagreb. They were recorded by standard techniques with the subjects standing with their head positioned in the cephalostat and teeth in the maximal intercuspation. The distance from focus to the midsagital plane of the head, and from the plane to the film was identical for each subject, and the amount of magnification due to focus-subject and subject-film distances was calculated in all the measurements (8%). All relevant hard and soft tissue structures were copied onto tracing paper for further investigation. The radiographs were traced and measured by the same investigator. The investigation included a total of 11 variables of which 4 were angular (Figure 1) and 7 linear (Figure 2) to determine the average soft tissue facial profile.

Angular measurements:

- Nasolabial angle (Cm-Sn-Ls)
- Facial convexity angle (G-Prn-Pg')
- Mentolabial angle (Ll-B-Pg)
- Holdaway's soft tissue angle (N-B/Ls-Pg')

Linear measurements:

- Upper lip to E-line (Ls/Prn-Pg)
- Lower lip to E-line (Li/Prn-Pg)
- Upper lip thickness (Ls-U1)
- Lower lip thickness (Li-L1)
- Soft tissue chin thickness/(Pg'-Pg)
- Upper face height (N'-Sto)
- Lower face hight (Sn-Gn')

Linear and angular measurements were made to the nearest 0.5mm or 0.5° with dial calipers and a standard protractor with 0.5° increments.

Statistical analysis

The reproducibility of the measurements were analysed using Dahlberg's (1940) formula. The error was calculated from the equation: ME= vd^2/2n. where d is the difference between duplicated measurements and n is the number of replications. To determine the difference between two measurements made at least 10 days apart, 20 randomly selected cephalograms were reanalysed. Biological variation of every cephalometric measurement was assessed as a standard deviation, and it was always higher than method's error.

As separation of the results between male and female does not show significant difference, the data were matched. Analysis of the obtained data was carried out by using statistical program SPSS 10.0 for Windows, included basic statistical parameters: the mean, standard deviation and minimum and maximum values. Kolmogorov-Smirnov test was used to test normality of the distribution of the data, and it confirmed that the data were normaly distributed. The Pearson correlation coefficients were used to test the correlations between investigated variables.

Results

Table 1 shows the descriptive statistics of 40 subjects with dental and skeletal class I with no gender differences. The greatest variability were found for the nasolabial and the mentolabial angle, which had the highest standard deviations (10.36 and 12.58 respectively) and those angles also showed the highest method error (1.4–2.4 degrees).

Pearson'correlation coefficients were used to test correlations between investigated linear and angular variables. Statistically significant correlations ($p<0.05$) were found between upper lip thickness and lower lip thickness (0,691), the distance between upper lip to E-line and the distance between lower lip to E-line (0,815), the distance between upper lip to E-line and Holdaway' s soft tissue angle (–0.674), the distance between lower lip to E--line and Holdaway' s soft tissue angle (–0.735, Table 2).

Discussion

The aim of this investigation was to evaluate the average angular and linear cephalometric variables that define the soft tissue facial profile of Croatian sample. The sample was selected from the records of the Department of Orthodontics, School of Dental Medicine, University of Zagreb. The clinic of the Department is located in the capital of Croatia, and provides treatment for patients from all parts of the country, so the records were representative for the entire Croatian population.

The phenomenon of lack of intergender difference, found in the sample of this investigation, is probably connectted to the earlier onset of growth spurt in girls.

Detailed soft tissue analyses has been widely used for clinical and research purposes in orthodontics and orthognathic surgery[27]. As far as some soft tissue parameters in a sample of Croatian students using photogrammetric method has been published previously[28], we found it necessary to develop soft tissue norms for Croatian population that should be used as reference for the diagnosis and treatment of this particular age group (12–15 years). It is important because the majority of patients seeking orthodontic treatment in Croatia belong to this age group.

The results obtained for the nasolabial and the mentolabial angle had large standard deviations (Table 1). The same finding was observed in a study conducted in Caucasian American males and Saudis[27] as well as in the study performed by Anic-Milosevic et al.[28] The large standard deviations reveal these measurements show a great degree of individual variability and indicate comparisons should be made with the range of normal values rather with the mean.

TABLE 1
DESCRIPTIVE STATISTICS OF 40 SUBJECTS WITH SKELETAL AND DENTAL CLASS I

Variable	No.	Min	Max	Mean	SD	Skewness
Cm-Sn-Ls	40	84	132	106.39	10.36	0.349
Gn-Prn-Pg	40	131.0	149	141.55	4.074	–0.522
Li-B-Pg	40	105	160	130.36	12.58	0.052
Ls/Prn-Pg	40	–1	–10	–4.22	2.18	0.148
Li/Prn.Pg	40	+2	–8	–2.09	2.39	0.106
Ls-U1	40	11	20	14.51	2.33	0.508
Li-L1	40	13.0	19.5	15.662	1.82	0.463
Pg'-Pg	40	6	15	12.15	1.81	–0.882
N-B/Ls-Pg	40	0	17	10.787	3.789	–0.464
N-Sto	40	70	84	78.81	3.28	–0.687
Sn-Gn'	40	53	69	61.26	4.67	0.059

No – number of subjects; Min – minimum value; Max – maximum value; SD – standard deviation

TABLE 2
STATISTICALLY SIGNIFICANT CORRELATIONS BETWEEN INVESTIGATED VARIABLES (N=40)

		Cm-Sn-Ls	Gn-Prn-Pg	Li-B-Pg	Ls/Prn-Pg	Li/Prn.Pg	Ls-U1	Li-L1	Pg'-Pg	N-B/Ls-Pg	N-Sto	Sn-Gn'
Cm-Sn-Ls	Pearsonova	1.000	–0.202	0.139	0.405*	0.350	–0.156	–0.095	0.124	–0.237	0.073	–0.182
	p value	0.000	0.212	0.391	0.009*	0.027	0.335	0.560	0.445	0.141	0.656	0.262
Gn-Prn-Pg	Pearsonova	–0.202	1.000	–0.011	–0.029	0.112	–0.222	–0.305	0.149	–0.470*	–0.288	–0.119
	p value	0.212	0.000	0.944	0.857	0.491	0.169	0.055	0.360	0.002*	0.071	0.464
Li-B-Pg	Pearsonova	0.139	–0.011	1.000	0.018	–0.118	–0.276	–0.552*	–0.398	0.215	–0.120	–0.073
	p value	0.391	0.944	0.000	0.911	0.470	0.085	0.000	0.011	0.182	0.461	0.655
Ls/Prn-Pg	Pearsonova	0.405*	–0.029	0.018	1.000	0.815*	–0.308	–0.309	–0.161	–0.674*	0.103	–0.073
	p value	0.009*	0.857	0.911	0.000	0.000*	0.054	0.052	0.320	0.000*	0.528	0.653
Li/Prn.Pg	Pearsonova	0.350	0.112	–0.118	0.815*	1.000	–0.180	–0.251	0.124	–0.735*	0.115	–0.307
	p value	0.027	0.491	0.470	0.000*	0.000	0.267	0.118	0.444	0.000*	0.480	0.054
Ls-U1	Pearsonova	–0.156	–0.222	–0.276	–0.308	–0.180	1.000	0.691*	–0.051	0.373	0.054	0.151
	p value	0.335	0.169	0.085	0.054	0.267	0.000	0.000*	0.757	0.018	0.741	0.352
Li-L1	Pearsonova	–0.095	–0.305	–0.552*	–0.309	–0.251	0.691*	1.000	0.125	0.278	0.172	0.048
	p value	0.560	0.055	0.000*	0.052	0.118	0.000*	0.000	0.443	0.082	0.290	0.767
Pg'-Pg	Pearsonova	0.124	0.149	–0.398	–0.161	0.124	–0.051	0.125	1.000	–0.253	0.110	0.020
	p value	0.445	0.360	0.011	0.320	0.444	0.757	0.443	0.000	0.115	0.501	0.901
N-B/Ls-Pg	Pearsonova	–0.237	–0.470*	0.215	–0.674*	–0.735*	0.373	0.278	–0.253	1.000	–0.026	0.175
	p value	0.141	0.002*	0.182	0.000*	0.000*	0.018	0.082	0.115	0.000	0.874	0.280
N-Sto	Pearsonova	0.073	–0.288	–0.120	0.103	0.115	0.054	0.172	0.110	–0.026	1.000	0.223
	p value	0.656	0.071	0.461	0.528	0.480	0.741	0.290	0.501	0.874	0.000	0.167
Sn-Gn'	Pearsonova	–0.182	–0.119	–0.073	–0.073	–0.307	0.151	0.048	0.020	0.175	0.223	1.000
	p value	0.262	0.464	0.655	0.653	0.054	0.352	0.767	0.901	0.280	0.167	0.000

$p<0.01$; * – statistically significant differences

The mean value for the nasolabial angle of 106,39° in the present investigation was close to 102°± 8, the value defined as esthetically desirable, and this value should be the goal of orthodontic or orthognathic treatment as stated by Legan and Burstone[8]. They also found no gender difference for this angle. Angle stated that all procedures should place this angle in the cosmetically desirable range between 85 and 105°[30]. In the study of Anic–Milosevic et al[28] based on photogrammetry in the adult sample, the nasolabial angle value for males was 105.4±9.5 degrees and for females 109±7.8 degrees. The analysis was performed on subjects with dental class I and harmonious soft tissue profile on the same population as in this study.

Fitzgerald, Nanda and Currier on the sample of 104 adults with Class I found the value of 114.08°, without statistically significant difference between the genders[31]. Nanda[32] reported the value of 107.8° in 7-years old boys and 114.7° in girls, and 105.8° in 18-years old boys and 110.7° in girls. Zylinski et al.[27], who carried investigation on male subjects, satisfying the criteria of balanced profile reported the value of 111.5°, what was higher than the value found in our population, but the subjects with malocclusions were not excluded from their study.

Sutter and Turley[33] compared soft tissue values of Caucasian and Afro-American models. The nasolabial angle in Caucasian models was 108.3°, and 99.5° in Afro-American models. They concluded that the Afro-American profiles were more protruded because of the more protruded and prominent upper lip.

The facial profile is primary determined by the angle of total facial convexity. In his study Bishara[34] found the value of 139.8° in girls and 139.2° in boys, which was similar to the values found in the present study. According to Bergman[35], a Class I subject presented an angle range of 165–175 degrees. The measurement for the total facial angle in his study was excluding the nose and was determined by G-Sn-Pg. This angle decreased in Class II and increased in Class III. He concluded that this angle remains relatively constant in individuals who experience normal growth as subnasale and pogonion move forward with growth.

Mentolabial angle also showed great variability. In our sample the mentolabial angle was 130.36°±12.58°. Sutter and Turley[33] reported the value of 136.9° on the sample of American Caucasians, while in Caucasian models he found increased value (130.7°), which is identical to our finding. In Afro-American models he found the value of 133.7°. Zylinski et al.[27] also reported the value similar to those found in our population; 127.2±15.9°. The mean value according to Anic-Milosevic et al were 134.50±9.08 degrees in females and 129.26±9.55 degrees in males[28].

The distance between upper lip to Ricketts E-line was –4.22 mm, which was almost identical to the norm suggested by Ricketts[7]. Erbay et al[36] found –3.8 mm in male, and –5.2 mm in female defined as attractive profiles, and –5.8 mm in male and –5.2 mm in female unattractive profiles. All subjects had Angle class I occlusal relationships and normal anteroposterior and vertical skeletal relationships. The upper lip becomes more retruded in relation to the E- line between 5 and 25 years of age for 5.6 mm in boys and 5.0 mm in girls.

Zylinski et al.[27] found in preadolescent the value –0.1 mm, and in adolescent –7.1 mm, which confirmed the statement about increased distance between E-line and lips during growth. For evaluating the distance of the lower lip to E-line**,** Ricketts[7] suggested the norm of –2.0 mm, which was identical to our finding –2.09 mm but the subjects in this investigation was younger than those in the Rickett's study (12–15 years old). Bishara et al.[37] in 15 years old boys and girls found the same value; –1.5 mm. In adults he found increased value; –3.8 mm in male and –2.8 in female. The lower lip also showed the tendency to be more retruded with age.

Anic-Milosevic et al. found that upper lip in females was insignificantly closer to the E-line, while the lower lip was significantly closer to E-line comparing to males. She concluded that the male subjects in Croatian population had a slightly more retrusive lips in profile. Similar findings were reported by Nanda et al.[38] in their study using a video imaging system.

Upper and lower lip receded relative to the E-line from the younger to the older age group which could be attributed to the greater sagittal depth of the chin and nose than the lips in adult sample. This was also confirmed in the study of Zylinski et al.[27] who found 0 mm in preadolescents, and –5.2 mm in adults. In the Japanese normal subjects Alcalde et al.[39] found the value of –0.13 mm, which is more prominent than the value found in Caucasians (2.0 mm). This difference could be attributed to the ethnic characteristics of the Japanese, whose pogonion is in a more forward position and the nose is less prominent.

Upper lip thickness found in this study was 14.51 mm. However, Holdaway[10] indicated that in ideal profile the upper lip thickness value must be 15 mm. The value suggested by orthodontists as esthetically pleasing and harmonious is 14.63 mm for Afro-Americans, and 14.88 mm for Caucasians. On the sample of Japanese sample Alcalde et al. found the value of 15.11 mm[39]. Basciftci et al.[26] reported the upper lip thickness was 13.96 mm in Turkish adults with normal anteroposterior and vertical skeletal relationships.

Thickness of the lower lip in the investigated Croatian subjects with dental and skeletal class I was 15.7 mm. Girls at age of seven had thinner lips (12.3 mm) than boys (14.4 mm), while at age of 17 the value is 16.2 mm in girls, and 17.0 mm in boys[40].

In this study the thickness of the soft tissue at Pg was 12.15 mm. In the sample of Japanese subjects with normal occlusion Alcalde et al[39] found increased value (13.58 mm), and in Caucasians11.00 mm what was significantly different than the value found in Japanese sample. Current analysis noticed anteriorly placed pogonion of the modern Japanese resulting in a straighter profile than previous generation[41]. Genecov[40] found increase in soft tissue from 7 to 17 years of age, from 11.1 to 13.5 mm. Basciftci[26] on the sample of Turkish adults with normal maxilomandibular relationship found the value of 12.96 mm. Holdaway found that subjects with normal maxillo-mandibular relationship, should have soft-tissue Holdaway angle of 7–8 degrees[10].

Holdaway soft tissue angle (line tangent to the chin and upper lip with the nb line) in investigated Croatian subjects was 10.8 °. In the present study no gender differences were found for this angle, Basciftci et al.[26] also found no gender dimorphism in H angle measurements. Erbay et al.[36] determined 10.1° in male and 10.0° in female with normal anteroposterior and vertical skeletal maxillo-mandibular relationships in Turkish population. Bishara[37] in 15 years old boys and girls found 13.2°, and 10.5° respectively, what is similar to our finding. In the sample of Japanese subjects with normal occlusion Alcalde et al.[39] determined 15.51°, and 10.00° in Caucasians, and concluded that there is significant difference between those two ethnic groups[39], probably because of a more retruded chin in Caucasians.

Upper face hight formed by a perpendicular from N' to Sto is originally determined for this investigation and therefore is uncomparable with other investigations.

Variable that determined the lower face height is very important as a diagnostic tool before any orthodontic-surgical procedures and treatment planning. In dental and skeletal class I subjects the value was 61.3 mm. Farkas reported the value 70.4 mm in male, and 63.0 mm in female subjects[42].

All variables in dental and skeletal class I subjects were normaly distributed, so Pearsons correlations analysis determined the correlation between angular and linear variables.

Significant correlations (positive linear but moderate in character) were found between thickness of upper and lower lip, and between the distance of upper and lower lip to the Ricketts esthetic line (strong positive linear), and both lips to ricketts line and Holdaway's angle (both negative linear but moderate in character).

From this investigation it is evident that the soft tissue analysis differs according to population and it became obvious that using the soft tissue norms developed for one population would be unsuitable in diagnosis and treatment planning for another.

Conclusions

Data from this investigation could serve to determine the norms of 11 linear and angular soft tissue variables for Croatian population with dental and skeletal class I, and to define craniofacial morphology of the soft tissue profile in patients with normal occlusion- aged 12 to 15 years. The values can be used for comparison of subjects with malocclusions, indicating areas of profile disharmony. The relatively large variability for the mentolabial and nasolabial angle is important because the results of this measurements should be viewed with caution.

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PROFIL MEKIH TKIVA LICA HRVATA S NORMALNIM DENTALNIM I SKELETALNIM FACIJALNIM ODNOSIMA U DOBI OD 12 DO 15 GODINA

SAŽETAK

Ovo istraživanje je provedeno na lateralnim kefalogramima 40 ispitanika hrvatske populacije u dobi od 12 do 15 godina koji su imali dentalnu i skeletanu klasu I. Svrha istraživanja je bila odrediti normalne vrijednosti i standardnu devijaciju parametara koji opisuju meka tkiva ispitanika te naći povezanost među ispitivanim parametrima. Istraživanje je uključilo 11 varijabli (4 angularne i 7 linearnih). Točnost mjeranja je iznosila 0,5 mm za linearne vrijednosti izmjerene digitalnom mjerkom i 0.5° za angularne vrijednosti izmjerene standardnim kutomjerom. Dobivene vrijednosti mogu poslužiti u svrhu određivanja normi za 11 varijabli mekih tkiva hrvatske populacije kao i definirati kraniofacijelnu morfologiju profila mekih tkiva pacijenata s normalnom okluzijom. Značajna povezanost je pronađena između debljine gornje i donje usne te između udaljenosti između gornje i donje usne prema Rickettsovoj estetskoj liniji i Holdawayevog kuta.