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Soft tissue profile assessment by means of linear and angular parameters in Pakistani population

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Abstract

Introduction: The contemporary orthodontics gives more emphasis on the soft tissue paradigm especially the areas around the mouth. Various studies have established norms of different ethnicities and races. Norms of one ethnicity cannot be applied to another ethnicity and race. The objectives of the study was to determine the soft tissue norms of non-growing adults of Pakistani origin and to assess any gender dimorphism in the soft tissue profile analysis.

Material and Methods: A cross sectional study was conducted on the lateral cephalograms of esthetically pleasing profiles of undergraduate students (35 males and 35 females) of Dr. Ishrat ul Ebad Khan Institute of Oral health Sciences, Karachi, which were obtained in natural head position. Several soft tissue linear and angular measurements of upper and lower lips, nose, and chin were carried out on lateral cephalogram. An Independent Sample T test was used to compare all the soft tissue cephalometric variables between genders. Results were taken statistically significant at *p*-value of ≤ 0.05.

Results: Among the linear parameters, we found significant differences in the upper lip length (p <0.001), thickness (p <0.001), prominence (p = 0.03), strain (p <0.001), sulcus depth (p = 0.01) and S plane to upper lip (p = 0.02). The lower lip linear parameters showed significant differences in E (p = 0.02) and S planes (p = 0.01), and H line (p <0.001). Among the angular parameters, we found statistically significant differences in the Z (p <0.001), H line (p = 0.01), angle of facial convexity (p <0.001), nasofacial (p = 0.04), nasomental (p = 0.05) and nasolabial angles (p <0.001).

Conclusions: Males showed more prominent upper and lower lips, decreased prominence of nasal tip and increased soft tissue chin thickness as compared to females. Significant differences were found in various angular parameters among males and females.

Keywords: Soft tissue; standard values; cephalometry; Pakistani adults

Introduction

In practice of orthodontics, the importance of facial harmony and balance is globally recognized. Evaluation of both hard tissue and soft tissue is a significant factor for achieving facial harmony and esthetics.[1] Balance and harmony of faical apparatus do not necessarily mean an attractive appearance because perception of facial esthetic is always an area of subjectivity.[2] In reality, soft tissue adaptation over underlying hard tissue is of great importance towards the facial appearance. Soft tissue limitation is one of the deciding factors for the success of orthodontic treatment. Through most of facial structure is established by hard tissue. However, actual appearance is a consequence from soft tissue contribution.[3]

Historically, many authors have proved the importance of soft tissue facial esthetics in orthodontic diagnosis and planning. In current years it is advocated that many cephalometric standards involving dento-skeletal structures showed ideal facial esthetics, if stick to treatment goals.[4] The contemporary orthodontics now gives more emphasis on the soft tissue paradigm

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especially over the areas around the mouth.[3] Many studies established that soft tissue which fluctuate significantly in thickness, are of prime factor in governing facial profile.[5]

Alone investigation of skeletal and dental pattern may be ambiguous to orthodontic diagnosis due to obvious variation in soft tissue covering the skeletal framework.[5] In many previous studies, cephalometric norms were established for various races and racial groups.[6-9] Majority of investigators have proved that there are substantial differences among various racial and ethnic groups and various cephalometric values have established for different racial groups including Caucasians,[6] Korean,[7] Japanese,[8] Chinese,[9] Persians,[10] Yemeni[11] and Turkish.[12] An individual with certain ethnic background should be treated according to their ethnic norms and established values. Norms of one population might not be suitable for another population, therefore a dire need arises to establish the soft tissue norms for Pakistani population.[13]

The literature lacks in the establishment of soft tissue esthetic norms for Pakistani population. Very few studies have reported the soft tissue norms but either they are not listed separately for sexual differences,[14] lacking in the standardization of lateral cephalogram[15] and only hard tissue cephalometric norms have been evaluated.[16,17] This demands a survey, to assess only the soft tissue parameters pertaining to lip, nose and chin using a standardized lateral cephalogram and assessment of these soft tissue parameters for both men and women.

With this aim in mind, this study was conducted to evaluate the soft tissue profile of non-growing adults of Pakistani origin, to compare soft tissue linear and angular parameters with established norms of other population and to assess any gender dimorphism in the soft tissue profile analysis between Pakistani males and females.

Material and Methods

Data were collected from the lateral cephalograms of undergraduate students of Dr. Ishrat-ul-Ebad Institute of Oral Health Sciences. The sample size was calculated in OpenEpi Software using the findings of Kalha *et al*.[4] They reported 13.58 ± 2.72 mm means of upper lip thickness and 15.32 ± 1.79 mm means of nasal projection in their study. The alpha was set as 0.05 and power as 80%, giving us the sample size of 28 subjects in each group. We included maximum available individuals to increase the power of the study. The study comprises of 35 male and 35 females subjects.

Inclusion Criteria:

Subjects of Pakistani descents with ages between 19-24 years with well-balanced facial profiles and esthetics were included in the study. The entire sample had class I skeletal and dental relationships, with minimum or no crowding and normal overjet and overbite.

Exclusion Criteria:

Subjects with previous history of orthodontic or orthopedic treatment, presence of any craniofacial, dental anomaly, syndromes or history of trauma and surgery involving facial and vertebral structures were excluded from the study.

Assessment on Lateral Cephalogram:

The lateral cephalograms of subjects were obtained in natural head position with condyles seated in suitable location, teeth in centric relation and lips in their passive position. Head fixation with metallic rods in the ear at 165cm film to tube distance and parallel to the horizontal plane was done during exposure for the standardization of lateral cephalograms by trained technicians using Orthoralix 9200 (Gendex–KaVo, Milan, Italy).

The lateral cephalogram was traced on 8”x10” transparent cellulose acetate sheet. The landmarks were identified and reference planes were drawn. Tracing was first

performed by principal investigator (HTM) and later reevaluated by other clinician (SBB) to avoid inter observer variability. The landmarks are shown in Figure 1 and linear and angular parameters have been described in table I.

Statistical Analysis:

Data were analyzed in SPSS software for Windows (version 21.0, IBM, Armonk, NY). Descriptive statistics were calculated for each variable in both genders. The Independent Sample T test was used to compare all the soft tissue cephalometric variables between genders. Results were taken statistically significant at *p*-value of ≤ 0.05.

Reliability Evaluation:

The reliability of the measurements were assessed using Dahlberg's formula.[18] 25 randomly selected lateral cephalograms were reevaluated and linear and angular measurements were repeated at two weeks interval. The method error was found to be between 0.4 to 0.6 among various linear and angular soft tissue parameters.

Results

The study sample comprised of 35 males and 35 females. The mean age of participants in our study was 21.86 ± 0.73 for males and 21.77 ± 0.77 for females. Means, standard deviations and significance values of gender wise comparison for both linear and angular variables are shown in table II and III.

An independent sample T test was used to evaluate significance of the differences between male and female participants. The test showed significant differences in the majority of the soft tissue linear and angular variables.

Among the linear soft tissue parameters, we found statistically significant differences in the upper lip length (p <0.001), thickness (p <0.001), prominence (p = 0.03), strain (p <0.001), sulcus depth (p = 0.01) and S plane to upper lip (p = 0.02). These measurements showed that males have statistically greater upper lip length, thickness and prominence as compared to females (Table II).

The lower lip soft tissue linear parameters showed significant differences in E (p = 0.02), S plane (p = 0.01) and H line (p <0.001) to lower lip. All the parameters of the lower lip signifies that the males have greater lower lip prominence relatively as compared to females (Table II).

We found statistically non-significant differences in the nose and chin soft tissue parameters in both sexes. The females were found to have more prominent nose (7.7 mm) and less protruding chin (11.6 mm), on contrary males showed less prominent nose (6.3 mm) and more protruding soft tissue chin (13.2 mm) (Table II).

Among the soft tissue angular parameters, we found statistically significant differences in the Z (p <0.001), H line (p = 0.01), angle of facial convexity (p <0.001), nasofacial(p = 0.04), nasomental (p = 0.05) and nasolabial angles (p <0.001) (Table III).

Figure 1. Soft tissue cephalometric landmarks used in the study

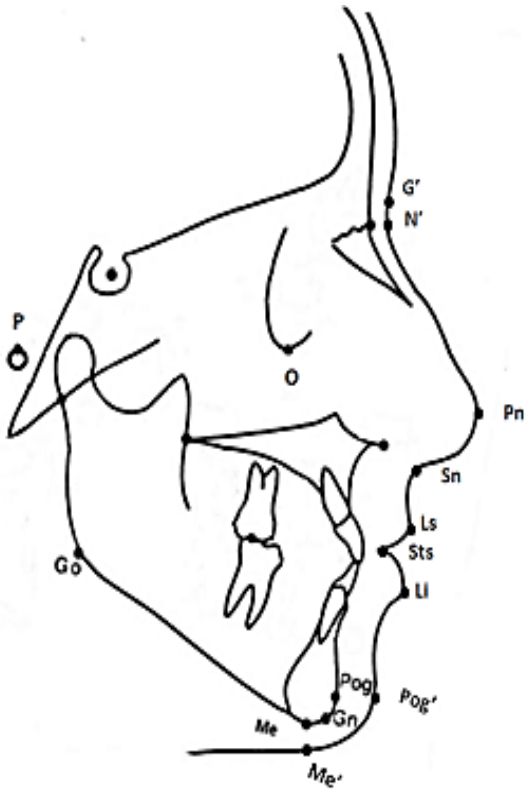

Table I. Soft tissue linear and angular parameters used in the study

Linear Parameters	
Upper lip length	Distance between Sn to Sts
Upper lip thickness	Point A to outer border of upper lip
Upper lip prominence	Distance of most prominent point on lip to Sn-Pog′
E plane upper lip	Distance between upper and lower lip
S plane upper lip	S-plane to most prominent point on upper lip
Upper lip strain	Vermilion border of upper lip to labial surface of the maxillary central incisor
Upper sulcus depth	H-line to deepest point on upper lip
Lower lip prominence	Distance of most prominent point on lip to Sn-Pog′
E plane lower lip	E-plane to most prominent point on lower lip
S plane lower lip	S-plane to most prominent point on lower lip
Lower sulcus depth	H-line to deepest point on lower lip
Lower lip to H line	Most prominent point on lower lip to H-line
Interlabial gap	Distance between upper and lower lip
Nose tip to H line	Distance between H- line and most prominent point on nose
Soft tissue chin thickness	Distance between hard tissue Pog to soft tissue Pog
Angular Parameters	
Merrifield Z angle	Angle between tangent to Pog′ & most anterior part of prominent lip and FH plane
Facial angle	Angle between FH plane and N′ to Pog′
H line angle	Angle form by the intersection of N′ & Pog′ line and labrum superioris & Pog′ line
Angle of facial convexity	Angle formed by the intersection of G-Sn & Sn-Pog′
Nasofacial angle	Angle formed by intersection of a line G to Pog′ and line drawn along axis of radix
Nasomental angle	Angle between axis of radix and Pn to Pog′
Nasolabial angle	Angle between columella tangent and upper lip tangent

Table II. Mean cephalometric measurements

Linear Parameters		**Males (n = 35) (Mean ± SD) mm**	**Females (n = 35) (Mean ± SD) mm**	**Significance *p* value**
Upper Lip	**Upper lip length**	21.29 ± 3.73	18.43 ± 1.89	<0.001**
	Upper lip thickness	16.40 ± 2.41	13.26 ± 2.39	<0.001**
	Upper lip prominence	4.37 ± 1.75	3.54 ± 1.35	0.03*
	E plane upper lip	-4.20 ± 2.97	-5.17 ± 1.87	0.10
	S plane upper lip	0.29 ± 2.30	-0.77 ± 1.39	0.02*
	Upper lip strain	13.57 ± 2.03	10.89 ± 2.70	<0.001**
	Upper sulcus depth	6.49 ± 1.94	5.43 ± 1.42	0.01*
Lower Lip	**Lower lip prominence**	4.06 ± 2.27	3.31 ± 2.33	0.18
	E plane lower lip	-0.89 ± 3.23	-2.46 ± 2.31	0.02*
	S plane lower lip	2.86 ± 6.16	0.17 ± 2.14	0.01*
	Lower sulcus depth	5.89 ± 2.25	5.26 ± 1.55	0.18
	Lower lip to H line	1.94 ± 1.47	0.86 ± 1.81	<0.001**
	Interlabial gap	0.11 ± 0.40	0.09 ± 0.28	0.73
Nose	**Nose tip to H line**	6.37 ± 4.75	7.77 ± 2.90	0.14
Chin	**Soft tissue chin thickness**	13.23 ± 2.84	11.66 ± 2.10	0.10

N= 70; SD – Standard Deviation; Independent Sample T test

*$p \leq 0.05$; **$p < 0.001$

Table III: Mean cephalometric angular measurements

Angular Parameters	**Males (n = 35) (Mean ± SD) mm**	**Females (n = 35) (Mean ± SD) mm**	**Significance *p* value**
Merrifield Z angle	69.77 ± 8.22	75.20 ± 7.14	<0.001**
Facial angle	91.29 ± 3.77	91.71 ± 3.50	0.62
H line angle	16.69 ± 4.34	14.31 ± 3.77	0.01*
Angle of facial convexity	18.17 ± 5.90	12.89 ± 5.13	<0.001**
Nasofacial angle	38.86 ± 4.45	36.63 ± 4.73	0.04*
Nasomental angle	115.34 ± 26.51	124.29 ± 6.37	0.05*

Nasolabial angle	101.80 ± 8.66	94.51 ± 12.33	<0.001**

N= 70; SD – Standard Deviation; Independent Sample T test
*$p \leq 0.05$; **$p < 0.001$

Discussion

For efficient treatment planning and execution of treatment goals, the realization of soft tissue norms of a specific population is imperative. The soft tissue paradigm contradicts the traditional Angle paradigm in which occlusion was the chief means of gaining facial esthetics and ideal profile. With the advent of soft tissue paradigm, more concerns are given to the soft tissues rather than the occlusion and teeth.[2]

It is always a good practice to consider the soft tissue norms of a certain population in the treatment planning. The soft tissue norms for Caucasians and Chinese population cannot be applied to Pakistani population. According to pertinent literature survey, very few studies[19,20] have reported soft tissue norms for Pakistani population, but none of the studies have reported such an exhausted soft tissue norms pertaining to separate for upper and lower lips, nose tip and chin projection.

In this regard, we conducted this study to evaluate the soft tissue norms of Pakistani population. To achieve this, only the specific areas in the profile: upper and lower lip, nose and chin linear and angular parameters were assessed. To avoid gender differences, we included equal number of males and females participants with esthetically pleasing profiles which were judged by consultant orthodontists, residents and general dentists.

We found statistically significant differences in the majority of soft tissue linear and angular parameters between male and female subjects. The males showed more prominent upper and lower lips as compared to females. Female showed increased prominence of nasal tip as compared to males. Furthermore, males showed increased soft tissue chin thickness as compared to females.

With regard to upper lip linear measurement, the male participants in our study sample showed significantly greater length, thickness, prominence, strain and sulcus depth as compared to female participants. We found upper lip length 21.2 mm, thickness 16.4 mm and strain 13.7 mm in the male subjects, whereas in the female subjects, the upper lip length was found to be 18.4 mm, thickness 13.2 mm and strain 10.8 mm. This is in contrast to the findings of Sheikh and Ijaz[19] who conducted their study in Pakistani population and recruited patients with skeletal class I pattern. They have reported upper lip length 21.2 mm, thickness 15.3 mm and strain 11.2 mm. The differences in the result can be attributed to the fact that they have not stratified their sample according to gender. We found upper lip values with respect to E plane for males -4.2 mm and for females -5.1 mm. On contrary, Alam and Qamruddin[21] have reported E plane to upper lip value of 1.6 mm for males and 1.1 mm for females.

For the lower lip, we have found higher values for the male subjects as compared to females. The males showed more prominent lower lip as compared to females. In the male sample, the lower lip with respect to E plane was found to be -0.8 mm, while for females -2.46 mm. Our findings are in consistent with Alam and Qamruddin[21] who have reported lower lip to E plane value -0.7 mm for Pakistani males.

The projection of nose was found to be increased in females (7.7 mm) as compared to males (6.3 mm), however the results were not statistically significant. Erbay and Caniklioğlu[22] conducted a study in Turkish population and they also have reported an increased nasal projection of 9.1 mm in females and 6.6 mm in males.

Soft tissue chin projection was found to be increased in males (13.2 mm) as compared to females (11.6 mm) in our study group. This

finding is consistent with a study conducted by Kalha *et al*[4] in South Indian population. They have reported increased soft tissue chin projection of 13.4 mm in males as compared to 11.3 mm in females.

According to the angular parameters, females (75.2) in our sample have found to be Z angle values within the norms as described by Merrifield.[23] Similarly, the values for facial angle in both genders were found be 91°, indicating no significant gender differences. The values for both males and females are also found to be within the range and close to norms as described by Down's.[24] Furthermore, H line angle value for females is found to be within the norms as described by Holdaway in his studied population.[25]

The angle of facial convexity and nasomental angles showed sexual differences ($p < 0.05$). With regard to the nose tip to H line and soft tissue chin thickness measurement of females, nasomental angle in females (124.2°) also showed increased values as compared to males (115.3°). This signifies that a less protruding nose with reference to the chin is more favored in females.[26] This is in contrast to the male sample value of nasomental angle. Our findings are similar to the study conducted by Anicÿ-Miloševicÿ *et al*.[27]

The nasofrontal angle in our study sample also showed gender dimorphism ($p = 0.04$, males = 38.8° and females = 36.6°). These findings are in consistent to the studies conducted by Anicÿ-Miloševicÿ *et al*[27] and Epker *et al*[28] in Caucasian population.

The nasolabial angle depends on the anteroposterior position of the upper anterior teeth and is an important angle in decision making of extraction of premolars in cases of upper lip procumbence. We found gender dimorphism in our study population in nasolabial angle ($p < 0.001$) with females having more acute values (94.5°) as compared to males (101.8°). These findings are in contrast to Legan and Burstone[29] who found no gender differences in this angle and values within the range of 102 8 for both genders in their studied population. Gender dimorphism is also reported in a study conducted by Anicÿ-Miloševicÿ *et al*[27] and Burstone[30] in Caucasian population.

The clinical implications of our study was that the utilization of these soft tissue linear and angular measurements before formulating a comprehensive treatment plan for any patient undergoing orthodontic treatment. It should be emphasized that these measurements should be considered for soft tissue cephalometric evaluation rather than considering norms of races other than Paksitani population. This would help us in achieving results which are more esthetically pleasing as well as functionally stable.

A single center study design and utilization of two dimensional lateral cephalogram was the limitation of the study. Therefore, we recommend a multicenter study with involving different ethnicities of populations living in Pakistan and their volumetric assessment in the three dimensional scans should be carried out.

Conclusions

The study was conducted to evaluate the soft tissue norms of upper and lower lips, nose, and chin of males and females of Pakistani population. The values obtained from this survey can be used to compare normal or ideal profile patients with facial disharmony.

- The males showed more prominent upper and lower lips, decreased prominence of nasal tip and increased soft tissue chin thickness as compared to females.
- Female showed less prominent upper and lower lips, increased prominence of nasal tip and decreased soft tissue chin thickness as compared to males.
- Significant differences were found in various angular parameters among males and females

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