

Soft-tissue cephalometric norms in a north Indian ethnic population

Avesh Sachan, Adit Srivastav¹ and T. P. Chaturvedi

ABSTRACT

Background: Soft tissues play the primary role of physical appearance and facial esthetics. This study aimed to establish soft-tissue cephalometric standards in North Indian adults, which can be used in diagnosis, treatment planning, and stability of orthodontic outcome and orthognathic patients.

Materials and Methods: A group of 60 individuals (30 males and 30 females) with normal occlusion and proportional facial profile were chosen. For the entire chosen sample, lateral cephalograms were obtained. Standard values of 11 soft-tissue measurements were determined.

Results: Soft-tissue measurements showed that men had greater soft-tissue facial angle (92.10°) than women (89.92°). Also, they had more nose prominence (18.10 mm) than women (16.44 mm). Skeletal profile convexity (A to N-pog) of men (0.40 mm) was less than women (1.76 mm). Basic upper lip thickness was higher in men (16.60 mm) compared to women (14.24 mm), while H-angle was higher in women (16.68°) as compared to men (14.30°). In the lower face area, inferior sulcus to the H line distance was more in men (7.30 mm) than women (4.80 mm). Men had greater soft-tissue chin thickness (14.10 mm) than women (12.84 mm).

Conclusion: The differences in soft-tissue cephalometric norms between men and women of North Indian faces were established, so the orthodontist or surgeon must individualize treatment planning, using local norms as the reference.

Key words: Cephalometry, soft tissue, standard values

INTRODUCTION

Beauty of face is an ill-defined concept that is obvious to observer and recognized cross-culturally. However, it is difficult to quantify and it may vary in its perception across different ethnic groups.^[1] Previously, various researchers have tried to relate the importance of soft-tissue esthetics with orthodontic diagnosis and treatment planning. In recent years, it has been suggested that certain cephalometric standards relating teeth to facial bones could ensure good facial form if adhered to the treatment goals. Most research demonstrates that soft tissues, which vary much considerably in thickness, are a major factor in determining patient's final facial profile.^[2-4] Analysis of dental and skeletal patterns alone might be inadequate or misleading because of marked variations in the soft tissues covering the dento-skeletal framework. Today facial appearance is an essential diagnostic criterion to be considered in comprehensive orthodontic treatment planning. Orthognathic

treatment is a comprehensive approach used to correct severe jaw discrepancy using a combination of fixed orthodontic appliances and jaw surgery. The objective of orthognathic treatment is to achieve a harmonious skeletal, dental, and soft-tissue relationship for the improvement of facial esthetics and function.^[3,4]

Cephalometric norms for various ethnic and racial groups have been established in many studies.^[3-6] Most investigators have emphasized about significant differences between ethnic and racial groups, and many cephalometric standards have been developed for various ethnic groups.^[5,6] These racial groups must be treated according to their own characteristics. Using the Holdaway soft-tissue analysis,^[7] Basciftci *et al.*^[8] reported that most Turkish adult measurements were similar to white norms. Mafi *et al.*^[9] studied the soft-tissue facial profiles of Iranian women and found some significant differences compared with

Department of Orthodontics and ¹Oral Medicine & Radiology, Faculty of Dental Sciences, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Address for correspondence: Dr. Avesh Sachan, Department of Orthodontics, Faculty of Dental Sciences, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India. E-mail: dr.aveshsachan@gmail.com

Access this article online

Quick Response Code:



Website:

www.jorthodsci.org

DOI:

10.4103/2278-0203.105877

white women. Because the norms for one ethnic group might not fit for others, in the present study, we aimed to develop soft-tissue cephalometric norms.

Numbers of North Indian patients seeking orthodontic treatment and orthognathic surgery have been increasing, and more North Indians are working or studying outside North India. Nevertheless, no published data have established cephalometric soft-tissue norms for North Indian adults. Normal values of the soft-tissue cephalometric analysis (STCA)^[10] for an ethnic North Indian population would be useful in providing racially specific values for orthodontic diagnosis and treatment planning.

Therefore, the aims of present study were to develop cephalometric soft-tissue norms that can assist in diagnosis and treatment planning for North Indian adults to provide a holistic approach to orthodontic diagnosis and treatment planning.

MATERIALS AND METHODS

Our study was conducted in Faculty of Dental sciences, Institute of Medical sciences, Banaras Hindu University, India. In this study, lateral cephalometric radiographs were taken for 30 North Indian males and 30 North Indian females. All of them were aged between 16 and 25 years. The original inhabitants of India were Dravidians, but over the centuries, India has received waves of immigration leading to population dispersion. The invaders were gradually assimilated in North India, resulting in an Indo-Aryan population in North India and Dravidians in South India.^[3] Our volunteers included university students, hospital staff, and normal population.

Ethical approval was obtained from the ethical committee of Faculty of Dental sciences, Institute of Medical sciences, Banaras Hindu University. Informed signed consent was obtained from all the volunteers after explaining the nature and purpose of the radiograph.

Each of them fulfilled certain entry criteria as follows: North Indian (Indo-Aryans) with North Indian ancestry for at least three generations; Angle's class I occlusion with pleasant

and balanced facial profile; competent lip; normal over-jet and overbite; symmetrical face; no crowding; no previous orthodontic, orthognathic, or prosthodontic treatment; and no craniofacial deformities or trauma. Each volunteer underwent history taking and thorough clinical examination to exclude any abnormalities or malformation. The patients were categorized into males and females.

The cephalograms were obtained over a universal counter balancing type of cephalostat with the Frankfort horizontal plane parallel to the floor and the teeth in centric occlusion with relaxed lips. Kodak X-ray films (8" × 10") were exposed at 70 kVp, 40 mA for 1.8 s from a fixed distance of 60 inches. The lateral head cephalograms were traced on acetate tracing sheets of 0.003 inch in thickness using a sharp 4H pencil over a view box using transilluminated light in a dark room and any stray light radiations were eliminated. Cranial registration marks were traced on the acetate tracing sheets after marking them on the cephalogram. Only good qualities of lateral cephalograms were taken for the study. The following soft-tissue cephalometric measurements were taken for establishing soft-tissue norms of North Indian ethnic population using Holdaway^[7] analysis: Soft-tissue facial angle, nose prominence, superior sulcus depth, soft-tissue subnasale to H line, skeletal profile convexity (A to N-pog), basic upper lip thickness, upper lip strain measurement, H-angle, lower lip to H line, inferior sulcus to the H line, and soft-tissue chin thickness [Figure 1 and Table 1].

If the right and left structural outlines were lacking in superimposition on each other, then the average between the two was drawn by inspection and thereafter cephalometric points were located to the arbitrary line so obtained. The linear and angular measurements were made to the nearest 0.5 mm and 0.5°, respectively, with the help of scale and protractor.

Error due to fatigue was eliminated by tracing only 5-10 cephalograms on average in a day. The correction of magnification difference between successive cephalograms was not necessary because all radiographs were taken on the same cephalostat. To eliminate inter-investigator variability, all radiographs were analyzed by a single investigator. The

Table 1: Soft-tissue cephalometric measurements used in study

Soft-tissue facial angle	Downward and inner angle formed by the soft-tissue facial line intersecting with the Frankfort plane
Nose prominence	Distance from the tip of the nose to the line drawn through Ls perpendicular to the Frankfort plane
Superior sulcus depth	Distance from the deepest point of the upper lip sulcus to the same line as in 2 above
Soft-tissue subnasale to H line	Distance from subnasale (Sn) to H line
Skeletal profile convexity (A to N-pog)	Measurement between point A and the hard-tissue facial line (N-pog)
Basic upper lip thickness	Distance from a point 3 mm below point A to Sn
Upper lip strain measurement	Upper lip thickness: The distance between Ls and the labial surface of the maxillary incisor; upper lip strain: The difference between the basic upper lip thickness and upper lip thickness
H-angle	Angle formed between the soft-tissue facial line (N'-Pog') and the H line
Lower lip to H line	Measurement from Li to the H-line
Inferior sulcus to the H line	Distance from the point of greatest incurvation of the soft tissue of the chin (Si) to the H line
Soft-tissue chin thickness	Distance between the soft-tissue and hard-tissue planes at the level of suprapogonion

intra-investigator error was assessed by tracing 20 randomly selected cephalograms on two separate occasions. Methodological cephalometric tracing errors were assessed with Dahlberg's formula^[11] on 20 pairs of measurements randomly selected from all observations. The errors ranged from 0.35° to 0.44° for angular cephalometric measurements and from 0.15 to 0.48 mm for linear measurements, which were found to be insignificant.

Descriptive statistics (means, standard deviations, standard error, and maximum and minimum values) were calculated for all variables in both groups. The Student's *t*-test was used for comparing the means of the two groups. *P* value of ≤ 0.05 was considered statistically significant.

RESULTS

Means, standard deviations, and significance values of the differences between the 30 men and 30 women are shown in Tables 2 and 3. Normal values were calculated as mean \pm SD for reference in the diagnosis and treatment procedure. Significance of the difference between the male and female samples was tested with the Student's *t*-test. Statistical analysis showed that the sexes were not similar in all measurements.

Soft-tissue measurements showed that men had greater soft-tissue facial angle (92.10°) than women (89.92°). Also, they had more nose prominence (18.10 mm) than women (16.44 mm). Skeletal profile convexity (A to N-pog) of men (0.40 mm) was lesser than women (1.76 mm). Basic upper lip thickness was higher in men (16.60 mm) compared to women (14.24 mm), while H-angle was higher in women (16.68°) as compared to men (14.30°). In the lower face area, inferior sulcus to the H line distance was more in men (7.30 mm) than women (4.80 mm). Men had greater soft-tissue chin thickness (14.10 mm) than women (12.84 mm) [Table 4]; these measurements were statistically significant [Figures 2 and 3].

DISCUSSION

The aim of the present study was to obtain cephalometric norms from North Indian population. Soft-tissue cephalometric measurements which are more essential and effective in diagnosis and treatment planning of orthodontic treatment and orthognathic surgery were selected. Previously, Legan and Burstone soft-tissue analysis was one of the most common soft-tissue analysis systems used for orthognathic surgery. It was modified from Burstone's previous soft-tissue analysis, reducing the analysis to its most relevant measurements and adding new measurements significant for surgical patient. Parameters used in this study are different from the parameters used by Legan and Burstone.^[12] The selection of samples with normal occlusion and esthetic profile, as well as ethical issues considering the risk of radiation associated with taking radiographs were the limiting factors for the sample size of this study.

Table 2: Soft-tissue cephalometric measurements for men

Soft-tissue value (units)	Men				
	Mean	SD	Std. error	Min.	Max.
Soft-tissue facial angle (°)	92.10	3.035	0.960	87	97
Nose prominence (mm)	18.10	1.969	0.623	15	22
Superior sulcus depth (mm)	5.00	1.563	0.494	3	8
Soft-tissue subnasale to H line (mm)	7.30	2.111	0.667	4	11
Skeletal profile convexity (A to N-pog) (mm)	0.40	1.897	0.600	-2	4
Basic upper lip thickness (mm)	16.60	2.011	0.636	14	19
Upper lip strain measurement (mm)	2.00	1.491	0.471	0	4
H-angle (°)	14.30	1.494	0.473	12	16
Lower lip to H line (mm)	1.10	1.197	0.379	-1	3
Inferior sulcus to the H line (mm)	7.30	1.947	0.616	5	10
Soft-tissue chin thickness (mm)	14.10	1.370	0.433	12	16

Table 3: Soft-tissue cephalometric measurements for women

Soft-tissue value (units)	Women				
	Mean	SD	Std. error	Min.	Max.
Soft-tissue facial angle (°)	89.92	2.216	0.443	85	95
Nose prominence (mm)	16.44	1.660	0.332	14	20
Superior sulcus depth (mm)	4.12	1.054	0.211	2	6
Soft-tissue subnasale to H line (mm)	7.56	1.474	0.295	6	12
Skeletal profile convexity (A to N-pog) (mm)	1.76	1.480	0.296	-1	5
Basic upper lip thickness (mm)	14.24	1.300	0.260	12	17
Upper lip strain measurement (mm)	2.04	1.241	0.248	0	5
H-angle (°)	16.68	2.657	0.531	11	20
Lower lip to H line (mm)	1.84	1.106	0.221	0	5
Inferior sulcus to the H line (mm)	4.80	1.384	0.277	2	7
Soft-tissue chin thickness (mm)	12.84	1.625	0.325	10	16

Facial harmony and esthetics are predominantly linked to racial preferences. The available norms derived from Caucasians Americans cannot be applied to other races unless they are modified. Alcade *et al.*^[13] developed soft-tissue norms for Japanese adults and found that analyses based on Caucasian norms cannot be applied as a reference for the diagnosis

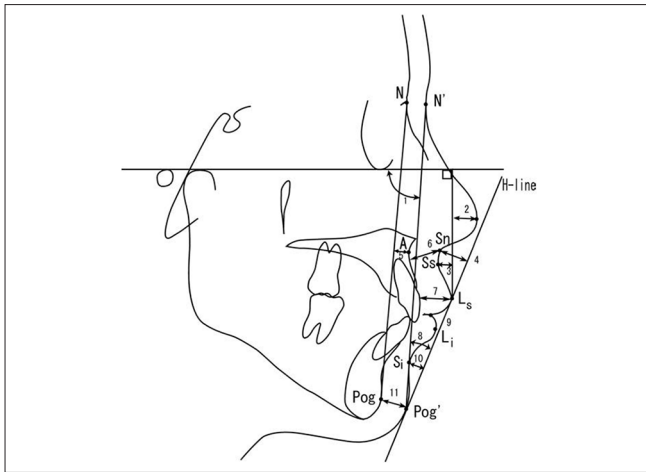


Figure 1: Soft-tissue cephalometric measurements used in the study

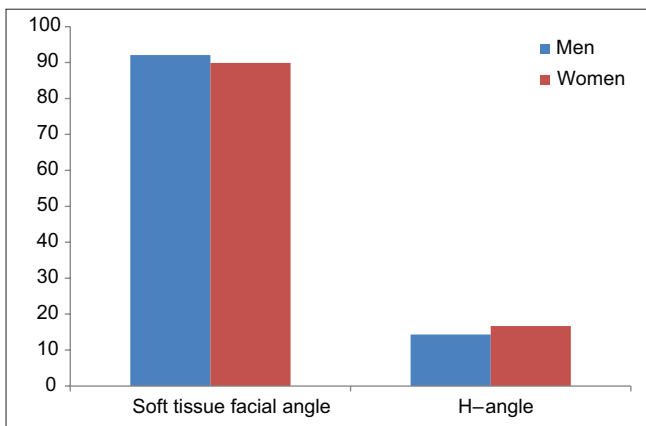


Figure 2: Comparison of soft-tissue cephalometric angular measurements between men and women of North Indian population

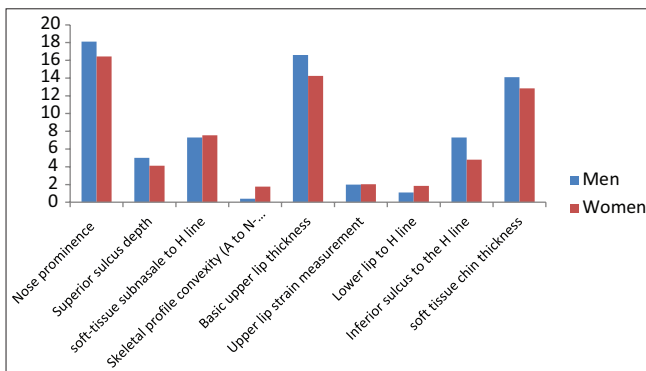


Figure 3: Comparison of soft-tissue cephalometric linear measurements between men and women of North Indian population

and treatment of the Japanese patients. Comparative studies have been done for other races in countries such as Saudi Arabia^[14] and Korea.^[15] This encouraged us to carry out the current study on North Indian ethnic population. Normative data of normal samples of different ethnic groups are a useful guide along with the clinical examination and patient records.^[13] The identification of the normal range of the cephalometric measurements for a particular population is necessary, and

Table 4: Comparison of soft-tissue cephalometric measurements between men and women

Soft-tissue value (units)	Men		Women		Significance	
	Mean	SD	Mean	SD	F value	P value
Soft-tissue facial angle (°)	92.10	3.035	89.92	2.216	5.580	0.024
Nose prominence (mm)	18.10	1.969	16.44	1.660	6.427	0.016
Superior sulcus depth (mm)	5.00	1.563	4.12	1.054	3.753	0.061
Soft-tissue subnasale to H line (mm)	7.30	2.111	7.56	1.474	0.173	0.680
Skeletal profile convexity (A to N-pog) (mm)	0.40	1.897	1.76	1.480	5.132	0.030
Basic upper lip thickness (mm)	16.60	2.011	14.24	1.300	17.059	0.000
Upper lip strain measurement (mm)	2.00	1.491	2.04	1.241	0.007	0.936
H-angle (°)	14.30	1.494	16.68	2.657	7.044	0.012
Lower lip to H line (mm)	1.10	1.197	1.84	1.106	3.054	0.090
Inferior sulcus to the H line (mm)	7.30	1.947	4.80	1.384	18.392	0.000
Soft-tissue chin thickness (mm)	14.10	1.370	12.84	1.625	4.663	0.038

P<0.05 and *P*<0.01, Significant; *P*<0.001, Highly significant; *P*>0.05, Not significant

hence the diagnosis of abnormalities can be made possible.^[16] Our findings of soft-tissue measurements showed significant differences between the sexes; the mean soft-tissue facial angle of men was higher than that of women, suggesting that women have more convex profiles. However, Legan and Burstone^[12] and others^[17-19] reported nearly identical values. Scheideman *et al.*^[20] also showed nearly similar values between the sexes.

Nose prominence of men (18.10±1.969 mm) was higher than that of women (16.44±1.660 mm). Stark and Epker defined the nasal profile parameters of American men and women on traced cephalograms to establish normal value of nasal parameters.^[21] Skeletal profile convexity is a measurement from point A to the hard-tissue facial line or N-pog line. This is not really a soft-tissue measurement, but convexity is directly interrelated to harmonious lip positions. Our study showed women have more convex profile than men.

In our study, men had more protrusive lips and chin than women. This was mainly because of the thicker soft-tissue structures in the men. In comparison with the standard values of the STCA,^[10] the means and standard deviations of upper lip thickness and soft-tissue chin thickness for men and women in this study were found to be higher. It suggests that our subjects have thicker soft-tissue structures.

Ideally, as the skeletal convexity increases, the H-angle must also increase if a harmonious drape of soft tissue is present. Soft-tissue facial angle must also increase if a harmonious

drape of soft tissues is to be realized in varying degrees of profile convexity. The mean H-angle values of facial harmony for men were lower than for women, suggesting that among our subjects women had more convex profiles than men.

Inferior sulcus to the H line is measured from the point of greatest incurvation between the vermilion border of the lower lip and the soft-tissue chin to the H line. It is an indicator of how well we manage axial inclinations of the lower anterior teeth. In our study, inferior sulcus to the H line for men was more than for women.

The differences in soft-tissue parameters in the various races show the importance of defining what is normal or optimal for a particular group. Also, these differences highlight the importance of separate sets of values for men and women. This study highlights the differences in facial structures of various ethnic groups, which have been reported by many authors.^[21-23] Our study supports this conclusion. Many authors have also suggested that separate norms for distinctive populations are necessary and that all patients cannot be treated based on a single set of norms.^[24,25] What is normal for one ethnic group might not be for another.^[26,27] Also, in various populations, differences can be seen between the sexes, and attempts both in the past and in this study were made to establish separate norms for men and women.

These findings show that group-specific norms are an essential prerequisite for accurate evaluation of orthodontic patients. The main advantage of this study is giving standard lateral soft-tissue cephalometry measurements for North Indian people in both genders, helping in diagnosis and treatment plan for orthodontic and surgical decisions and improving post-treatment outcomes.

Further studies including more assessors of facial profile attractiveness and more North Indian subjects in general are needed. Conventional cephalometry is proved to be a good tool for soft-tissue analysis. Further study is needed to compare such results with those from the digital tracing and analysis to see how we could correlate both techniques.

CONCLUSION

The present study has produced normative soft-tissue cephalometric data for a North Indian population, which will aid in diagnosis and treatment planning. From the results of the present study, the following conclusions can be drawn:

- Women have more convex facial soft-tissue profile than men
- Men have more prominent nose than women
- Men have thicker soft-tissue structure than women.

The orthodontist or surgeon must individualize treatment planning using local norms according to sex as the reference rather than using the established norms for white people.

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How to cite this article: Sachan A, Srivastav A, Chaturvedi TP. Soft-tissue cephalometric norms in a north Indian ethnic population. *J Orthodont Sci* 2012;1:92-7.

Source of Support: Nil, **Conflict of Interest:** None declared.

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