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# Determination of Holdaway soft tissue norms for the North Indian population based on panel perception of facial esthetics

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ABSTRACT

*Introduction:* The purpose of this study was to determine Holdaway soft tissue norms for the North Indian population based on panel perception of facial esthetics.
*Material and method:* 90 individuals (45 males and 45 females) from the North Indian population with normal anteroposterior and vertical skeletal relationships on analysis of lateral cephalometric radiographs were selected for the study. The landmarks were located according to the definitions of Holdaway. Ten linear and two angular measurements were analysed on each radiograph. For each variable, the arithmetic mean and standard deviation were calculated. For statistical evaluation, an independent-samples *t* test was performed.
*Results:* Except for the measurements of soft tissue chin thickness, H angle and nose prominence all soft tissue measurements were similar to Holdaway norms. For upper lip thickness, soft tissue chin thickness, skeletal profile convexity and basic upper lip thickness measurements, statistically significant sex differences were determined.
*Conclusions:* Based on this study, new soft tissue norms are established for orthodontic and surgical diagnosis and treatment planning.

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## 1. Introduction

One of the most important components of orthodontic diagnosis and treatment planning is the evaluation of the patient's soft tissue profile. Angle[1] emphasized the importance of soft tissue and facial esthetics in orthodontic treatment. He believed that the harmony and the balance of the face depend largely on form. Holdaway[2] stated that "better treatment goals can be set if we quantify the soft tissue features" which contribute to or detract from that 'physical attractiveness stereotype' which has been ingrained into our culture.

Though the perception of beauty has always been a subject of interest and importance to people of all culture, its quantification has changed over the centuries and differs from one population to another.[3] In orthodontic practices a diagnosis is determined, in part, by comparing a patient's cephalometric measurements to standard norms. These norms however may be specific to a particular ethnic group and cannot always be compared for orthodontic treatment planning of patients belonging to other ethnic types. There are differences in the dentofacial relationships of various ethnic and racial groups, so each of them exhibits different characteristic features.

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According to Hwang et al, [4] attempts have been made to investigate the differences in the faces of various ethnic groups including American blacks,[5] Africans,[6] Chinese,[7] Japanese,[8] Koreans,[9] Indians,[10] Saudi Arabians,[11] Mexican-Americans,[12] Brazilians,[13] and Puerto Ricans.[14]

In spite of possible ethnic differences most classical cephalometric standards are established, based on sample populations of people with European-American ancestries. Therefore it is important to develop cephalometric standards for different ethnic groups. Though the Holdaway's[2] norms are widely used, their applicability to populations may vary; hence this study proposes to compare Holdaway's soft tissue norms with that of norms for ethnic population of North India.

## 2. Aims and objectives of the study

The aim in this study is to:

1) Determine the Holdaway soft tissue norms for the North Indian population based on panel perception of facial esthetics.
2) Investigate the differences between the Holdaway soft tissue norms of males and females in the North Indian population.
3) Compare the soft tissue norms of the North Indian population with Holdaway's norms.

## 3. Material and method

Study was conducted on 90 adults, age group between 18 and 28 years of the North Indian population. Out of these 90 adults, 45 were males and 45 were females. The data was collected by using standardized technique of lateral cephalometry, facial photographs and study models. The lateral cephalometric radiograph of each subject was taken with a Rotograph plus cephalometer. All subjects were positioned in the cephalostat with the sagittal plane at a right angle to the path of the X-rays, the Frankfort plane parallel to the horizontal, the teeth in centric occlusion, and the lips in relaxed position.

The following criteria was used to choose the sample size:

1) Well aligned maxillary and mandibular dental arches.
2) Angle's Class I molar relationship with normal overjet and overbite.
3) Normal growth and development, Class I skeletal relation (ANB angle 2 ± 2), normal vertical relation (FMA angle 17–28) with straight profile (angle of convexity −8° to 10°).
4) No history of previous orthodontic or prosthodontic treatment or surgical treatment.
5) Esthetically pleasing appearance.

### 3.1. *Study design*

The photographs and study models were taken to validate the inclusion criteria. The slides of the photographs were projected in natural head position. A panel consisting of 12 judges, out of which 6 judges picked from general public and 6 were dental practitioner, belonging to different age and gender groups.

To obtain the sample of 60 individuals with esthetically pleasing appearance, a panel of 12 judges evaluated each of the 90 profile projected on the screen for duration of 10 s. Each profile was evaluated as very pleasant (5 points), pleasant (4 points), average (3 points), below average (2 points) and unpleasant (1 point). The score for each profile were recorded and summated. Only very pleasant and pleasant profiles were included in our study.

The radiographs were traced by the same investigator at two different occasions 3 weeks apart to calibrate for measurement errors. The landmarks were located according to the definitions of Holdaway. The following measurements were used (Figs. 1 and 2):

1. **H line:** Tangent drawn from the tip of the chin to the upper lip.
2. **Soft tissue facial angle**: A line drawn from soft-tissue nasion, where the sella-nasion line crosses the soft-tissue profile, to the soft-tissue chin at a point overlying the hard-tissue suprapogonion of Ricketts measured to the Frankfort horizontal plane.

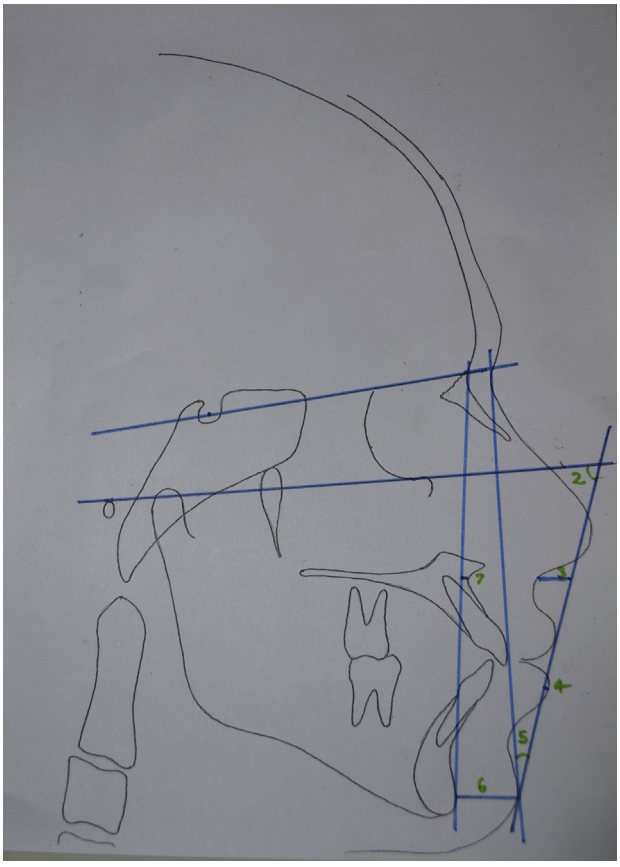



**Fig. 1 – Cephalometric measurements: 1, H line; 2, soft tissue facial angle; 3, soft tissue subnasale to H line; 4, lower lip to H line; 5, H angle; 6, soft tissue chin thickness; 7, skeletal profile convexity.**

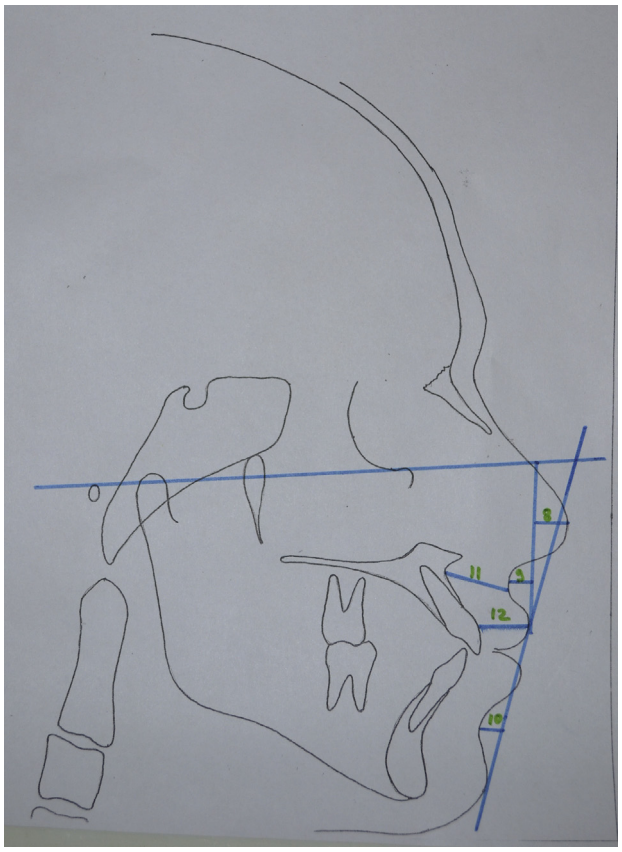



**Fig. 2 – Cephalometric measurements: 8, nose prominence; 9, upper lip sulcus depth; 10, inferior sulcus to H line (lower lip sulcus depth); 11, basic upper lip thickness; 12, upper lip thickness.**

3. **Soft tissue subnasale to H line:** Measurement from subnasale to the H line.
4. **Lower lip to H line:** Measurement of the lower lip to the H line.
5. **H angle:** The angle formed between the soft tissue facial plane line and the H line.
6. **Soft tissue chin thickness:** The distance between the hard and soft tissue facial planes at the level of suprapogonion.
7. **Skeletal profile convexity:** The dimension between point A and the facial line.
8. **Nose prominence:** The dimension between the tip of the nose and a perpendicular line drawn to the Frankfort plane from the vermilion.
9. **Upper lip sulcus depth:** The measurement between the upper lip sulcus and a perpendicular line drawn from the vermilion to the Frankfort plane.
10. **Inferior sulcus to the H line (lower lip sulcus depth):** The measurement at the point of greatest convexity between the vermilion border of the lower lip and the H line.
11. **Basic upper lip thickness:** The dimension measured approximately 3 mm below point A and the drape of the upper lip.
12. **Upper lip thickness:** The dimension between the vermilion point and the labial surface of the maxillary incisor.
13. **Upper lip strain measurement:** The difference between the basic upper lip thickness and the upper lip thickness.

### 3.2. *Statistical analysis*

All statistical analyses were performed with the SPSS software package (SPSS for Windows 98, version 10.0, SPSS, Chicago, Ill). For each variable, the arithmetic mean and SD were calculated. The measurements were compared with the Holdaway's norms. Thirty radiographs were selected at random from the observation group to determine the errors associated with radiographic measurements. The tracings and measurements were repeated 3 weeks after the first measurements. A paired *t* test was applied to the first and second measurements. The difference between the first and second measurements of the 30 radiographs was insignificant. Correlation analysis applied to the same measurements showed the highest *r* value, 0.98, for skeletal profile convexity and the lowest *r* value, 0.92, for basic upper lip thickness. For statistical evaluation, an independent-samples *t* test was performed.

## 4. Results

In Table 1, combined Holdaway norms, means, and SD for the North Indian population given. Most values for the North Indian population were similar to the Holdaway soft tissue norms. For soft tissue chin thickness, H angle and nose prominence some differences were found between Holdaway soft tissue norms and the values for the North Indian population. The following results were obtained through the independent-samples *t* test applied to compare the measurement differences of men and women.

Table 2 shows the descriptive statistics of the males and females and the comparisons of the sex differences. In the comparison of Holdaway soft tissue norms, 3 variables had significant differences. In soft tissue chin thickness ($P < 0.001$), upper lip thickness ($P < 0.001$) and basic upper lip thickness ($P < 0.05$) measurements, statistically significant sex differences were found between the North Indian males and

**Table 1 – Mean and SD of cephalometric measurements for 60 individuals of the North Indian population.**

| S. no | Variables | Holdaway norms | Mean ($n = 60$) | SD |
|---|---|---|---|---|
| 1. | Soft tissue facial angle | 91 ± 7° | 91.83 | 3.064 |
| 2. | H angle | 10(7–14)° | 16.07 | 3.095 |
| 3. | Nose prominance | 14–24 mm | 12.70 | 2.806 |
| 4. | Soft tissue subnasale to h line | 5 ± 2 | 6.83 | 1.967 |
| 5. | Inferior sulcus to h line | 3–7 mm | 6.37 | 1.564 |
| 6. | Lower lip to h line | 0–0.5 (–1 to 2) | –0.87 | 1.548 |
| 7. | Soft tissue chin thickness | 10–12 mm | 13.20 | 1.669 |
| 8. | Upper lip thickness | 13–14 mm | 10.67 | 5.874 |
| 9. | Basic upper lip thickness | 15 mm | 16.03 | 2.356 |
| 10. | Upper lip sulcus depth | 3 (1–4) | 3.90 | 1.322 |
| 11. | Skeletal profile convexity | 0 | 9.30 | 2.891 |
| 12. | Upper lip strain | No norms | 2.0 | 1.414 |

**Table 2 – Comparison of mean and SD differences of cephalometric measurement changes between males and females.**

| S. no | Variables | Holdaway norms | Men (mean value) | Women (mean value) | t | P |
|---|---|---|---|---|---|---|
| 1. | Soft tissue facial angle | 91 ± 7° | 91.93 | 91.73 | 0.176 | 0.862 |
| 2. | H angle | 10(7–14)° | 15.20 | 16.93 | −1.57 | 0.127 |
| 3. | Nose prominance | 14–24 mm | 12.40 | 13 | −0.579 | 0.567 |
| 4. | Soft tissue subnasale to h line | 5 ± 2 | 7 | 6.67 | 0.458 | 0.651 |
| 5. | Inferior sulcus to h line | 3–7 mm | 6.53 | 6.20 | 0.577 | 0.569 |
| 6. | Lower lip to h line | 0–0.5 (−1 to 2) | −0.93 | −0.80 | −0.232 | 0.818 |
| 7. | Soft tissue chin thickness | 10–12 mm | 14.13 | 12.27 | 3.659 | 0.001 |
| 8. | Upper lip thickness | 13–14 mm | 15.13 | 6.20 | 6.456 | 0.000 |
| 9. | Basic upper lip thickness | 15 mm | 17.20 | 14.87 | 3.085 | 0.005 |
| 10. | Upper lip sulcus depth | 3 (1–4) | 4.27 | 3.53 | 1.556 | 0.131 |
| 11. | Skeletal profile convexity | 0 | 10.87 | 7.73 | 3.496 | 3.133 |
| 12. | Upper lip strain | No norms | 2.07 | 1.93 | 0.254 | 0.801 |

Significant ($P < 0.05$), Not Significant ($P > 0.05$), Highly Significant ($P < 0.01$).

females. Upper lip thickness, soft tissue chin thickness, and basic upper lip thickness measurements of the males were larger than those of the females. Soft tissue facial angle, Nose prominence, H angle, soft tissue subnasale to H line, lower lip to H line, inferior sulcus to H line, and upper lip strain did not vary by sex.

## 5. Discussion

In our orthodontic practice, various analyses are used to evaluate cephalometric radiographs. However, the applicability of the norms described in these analyses in the North Indian population is controversial. When assessing the success of orthodontic treatment, soft tissues values are often as important as hard tissue values. Therefore, soft tissue values must accurately reflect ideal norms for a particular ethnic group to which the patient belongs. It was thought that a study to determine the soft tissue norms for the North Indian population would be beneficial for orthodontic diagnosis and treatment planning.

The purpose of this project was to define current soft tissue norms for the North Indian population. An aim of this study was to determine the Holdaway norms for the North Indian individuals with esthetically pleasing appearance and ideal skeletal relationships in anteroposterior and vertical directions. The cephalometric films of those who lacked the ideal criteria were excluded. It was found that Holdaway's soft tissue norms and the North Indian population values were generally similar, except in H angle, nose prominence and soft tissue chin thickness measurements.

The H angle is formed by a line tangent to the chin and upper lip with the NB line. Holdaway said the ideal face has an H angle of 7°–15°, which is dictated by the patient's skeletal convexity. In the same article, Holdaway suggested that, with a normal ANB angle of 1°–3°, his soft tissue angle should be 7°–9°. The larger the ANB angle, the larger Holdaway's soft tissue angle, unless there is soft tissue compensation. The North Indian population values in this study for H angle were lesser to those given by Holdaway. According to Holdaway, upper lip sulcus depth (measured to a line perpendicular to Frankfort plane and tangent to the upper lip) has an acceptable range of 1–4 mm, with mean of 3 mm being ideal. The measurement of soft tissue subnasale to H line has an acceptable range of 3–7 mm, with mean value 5 mm being ideal. The distance between the lower lip and the H line has an acceptable range between 1 and 2 mm, with the ideal between 0 and 0.5 mm. Holdaway also specified that "the contour in the inferior sulcus area should fall into harmonious lines with the superior sulcus form," so a range of 3–7 mm will also be accepted as normal for inferior sulcus to the H line. According to all given values as stated above, the North Indian individuals have ideal values for soft tissue angle, upper lip sulcus depth, soft tissue subnasale to H line, lower lip to H line, basic upper lip thickness and inferior sulcus to H line measurements. It was found that approximately half of Holdaway's soft tissue measurements in males and females were similar to those of this study's sample. However, in soft tissue chin thickness, upper lip thickness, and basic upper lip thickness measurements, statistically significant sex differences were determined.

## 6. Conclusion

In this study, Holdaway soft tissue norms for the North Indian population were determined. These variables have received extensive clinical and research usage in the field of both orthodontics and orthognathic surgery. Generally, most measurements were similar to the Holdaway norms. Some differences for soft tissue chin thickness, H angle and nose prominence were noticed. These differences should be considered when formulating an orthodontic and surgical diagnosis and treatment plan for patients of the North Indian population. When comparisons were made between the sexes, some significant differences between males and females were noticed. On an average, males have relatively prominent upper lip thickness, soft tissue chin thickness, and basic upper lip thickness than do the females. According to these results, new soft tissue norms are established for orthodontic diagnosis and treatment planning for the patient of the North Indian population. The results of this study should be an aid in designing treatment plans that are consistent with the perception of beauty, attractiveness, and facial balance for our native North Indian population.

## Conflicts of interest

All authors have none to declare.

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