Soft tissue facial profile in Himachal population: A photogrammetric analysis

Vikrant Bhandari, Anil Singla1, Vivek Mahajan1, Harupinder Singh Jaj1, Sukhraj Singh Saini1

ABSTRACT

Introduction: Craniofacial growth of the skeleton and soft tissue influences the final configuration of occlusion and overall facial esthetics.

Materials and Methods: Two hundred samples were taken from Himachali ethnic population with age ranging from 18 to 28 years. The records will then be scaled to life size and landmarks will be located on the digitized image to obtain all linear and angular measurements.

Results: The parameters were analyzed using SPSS Statistics Software version 11.5. Student’s t-test was conducted for comparison between male and female subjects. The reproducibility of the measurements was analyzed using Dahlberg’s (1940) formula. To determine the difference between two measurements, made at least 2 months apart, 25 randomly selected records were redigitized.

Conclusion: Himachali males and females show considerable sexual dimorphism with less prominent nose, less protrusive lower lip, and more chin height in males whereas females had more convex profile, less protrusive upper lip, and more tipped nose.

Key words: Esthetic, facial angle, photogrammetry

Orthodontic patients seek treatment primarily for esthetic reasons, and the resulting soft tissue profile is such a measure of esthetic success. Hence, the important components of orthodontic diagnosis and treatment planning are the evaluation of the patient’s soft tissue profile.[1,2] Considerations of facial esthetics always have been an inseparable part of the principles and practice of orthodontics. The soft tissue profile has been studied extensively in orthodontics, primarily from lateral cephalometric radiographs, under the assumption that the form of soft tissue outline largely determines the esthetics of the face.[3] Therefore, this is the ultimate compensating factor in facial contour morphology. Photographic evaluation of orthodontic patient has assumed considerable importance as an essential aid in treatment planning, since it depicts a very close representation of the appearance of the person. It pasteurizes how a face actually looks, and is therefore superior in this respect to cephalogram which gives only the facial outline. Therefore, it becomes necessary to supplement the cephalometric analysis with photographic evaluation.[4] It is an accepted fact that norms for different ethnic groups can differ widely. Therefore, it is not correct to apply the norms for the Western population blindly to the Indian population. Thus, there is a need to develop norms pertaining to Indian ethnic groups. Thus, this study was conducted to establish the angular and linear photographic norms from the soft tissue facial profile of Himachal population.

MATERIALS AND METHODS

The subjects of this study were taken from Himachali ethnic population with age ranging from 18 to 28 years.
The inclusion criteria were as follows:

- Facial symmetry
- Angle’s Class I occlusion with normal over jet-overbite relationships, well-aligned maxillary and mandibular arches with minor or no crowding
- No history of previous orthodontic or surgical treatment
- No significant medical history
- No history of trauma.

A photographic setup consisted of tripod supporting a Nikon D40 digital camera (Nikon India private limited) with a 108 mm macro lens. The height of tripod was adjusted so as to allow the optical axis of the lens to be maintained in a horizontal position. This was adapted to each subject’s body height. Each subject was asked to relax, with both arms hanging freely beside the trunk in a standing position. The subject was positioned on a line marked on the floor, and vertical measurement scale was placed behind the subject that was divided into millimeters, which allowed measurements at life size. A plumb line, suspending a 0.5 kg weight hung from the scale, held by a thick black thread was used to define the vertical plane (true vertical [TV]) on the photographs. A mirror was placed in front of the subject at a distance of 120 cm on the opposite wall. The subjects had to look into their eyes in the mirror with their lips relaxed so that the right-side profile records were taken in natural head position. Before every recording, the operator ensured that the subject’s forehead, neck, and ear were clearly visible. Photographs were then exported to Adobe Photoshop Software (Adobe systems incorporated limited), oriented and sized to equal sizes. A square with equal sizes was created to ensure that photographs were not squashed or too large. Each photograph was reduced to real size, overlaid over the calibrating gauge, and orientated so that the TV line on the photograph was parallel with the vertical line of the computer monitor. A black circular marker was created which was copied and placed on all landmark areas [Figure 1]. The Microsoft Visio Software (Microsoft corporation limited) was used and then marks were placed on appropriate landmarks. Landmarks were connected with lines. Linear and angular measurements were done [Figures 2-5] and rechecked for accuracy. There were 14 landmarks, 8 linear measurements, and 10 angular measurements. An Excel spreadsheet (Microsoft corporation limited) was created where all the data was captured.

RESULTS

The results based on soft tissue parameters gave us variability between male and female Himachali population for their soft tissue facial parameters. The soft tissue parameters were analyzed using SPSS Statistics Software version 11.5 (Nikon India Pvt Ltd, Microsoft incorporated ltd). Student’s t-test was conducted for comparison between male and female subjects. The P value thus computed was treated as significant at 1% or $P < 0.01$ and not significant at $P \geq 0.01$. The average soft tissue profile measurement values for male and female subjects are shown in Table 1. Graph 1 represents the comparison of mean soft tissue parameters between
male and female Himachali subjects. The reproducibility of the measurements was analyzed using Dahlberg’s (1940) formula. The error was calculated from the equation: 
\[ ME = \sqrt{\frac{d^2}{2n}} \]
where ME is the method error, \( d \) is the difference between duplicated measurements, and \( n \) is the number of replications. To determine the difference between two measurements, made at least 2 months apart,

**Figure 4:** The angular parameters: projection of upper lip to chin (N-Pg/N-Ls), upper lip angle (Sn-Ls/Sn-Pg), projection of lower lip to chin (N-Pg/N-Li) used in this study

**Figure 5:** The linear parameters used in this study

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SD=Standard deviation, SE=Standard error, *** and **** shows the value of “P” i.e highly significant and significant

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DISCUSSION

Diagnosis and treatment planning play an important role in orthodontic considerations. One of the most important components of orthodontic diagnosis and treatment planning is the evaluation of the patient’s soft tissue profile. The soft tissue should be taken into consideration for the proper evaluation of underlying skeletal discrepancy because of differences in the soft tissue thickness. It has been shown that soft tissues vary in thickness over different parts of hard tissue facial skeletal.

Facial angle (G-Sn-Pg)

In the present study, the value of the facial angle for the male was $169.43° \pm 4.01°$, which is in accordance with the study conducted by Anic–Milosevic et al. (facial angle $= 168° \pm 5°$) and Arnett and Bergman (facial angle $= 169.4° \pm 3.2°$). The facial angle for Himachali female was $167.89° \pm 3.38°$ in the present study which showed lower mean value and standard deviation in accordance with the study conducted by Arnett and Bergman (169.3° ± 3.4°). Statistically significant gender difference was found ($P = 0.004$), with Himachali females having a lesser value of facial angle representing a more convex profile as compared to Himachali males. When Himachali females were compared with Caucasians, Himachali females are having a more convex profile.

Nasofrontal angle (G-N-Nd)

The measurement for nasofrontal angle (G-N-Nd) in the present study was $137.48° \pm 3.38°$ for males and it was $137.48° \pm 3.38°$ for Himachali females, which indicates Himachali males are having less prominent nose as compared to Himachali females. There was statistically significant gender difference ($P < 0.001$). Fernández-Riveiro et al. found higher values for males ($139.9° \pm 5.3°$) than for females ($139.2° \pm 4.4°$) because they measured from glabella, not from nasion; however, there were no significant gender differences. Yuen and Hirakata also found no gender dimorphism (males = 135° ± 4°; females 135° ± 3°). Anic-Milosevic et al. also found no significant gender difference (Croatian males = 130.5° ± 3.7° and Croatian females = 130.2° ± 3.5°). When Himachal population was compared with the Caucasians, Himachali population have less prominent nose, especially Himachali males showed highly statistical significant difference as compared to Caucasian males as shown in Table 3 and Graph 2 ($P < 0.0001$).

Total facial angle (N-Prn-Pg)

The measurement for total facial angle or facial convexity including the nose (N-Prn-Pg) in the present study was $124.26° \pm 3.06°$ for males and it was $128.48° \pm 2.24°$ for Himachali females, which indicates Himachali males are having less prominent nose as compared to Himachali females. There was statistically significant gender difference ($P < 0.001$).
Table 3: Correlation of the mean values of the Himachali and Caucasians subjects

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<tr>
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138.31° ± 3.22° for Himachali females with no statistical significant gender difference (P = 0.080). In the previous study by Anic-Milosevic et al.[10] in Croatian population showed gender dimorphism (P = 0.030); males = 136.38° ± 6.7°; females = 139.1° ± 6.35°, which indicates less prominence of nose in Himachali population as compared to Caucasians, but Epker[15] in a study on frontal and lateral facial views of Caucasians found no gender difference (130°).

Nasalabial angle (Cm-Sn-Ls)
The measurement for nasalabial angle (Cm-Sn-Ls) in the present study was 97.40° ± 3.20° for males and it was 97.73° ± 3.02° for Himachali females with statistical significant difference between the genders (P ≤ 0.001), indicating more protrusive upper lip in males as compared to females. When Himachal population was compared with the Caucasians, the mean value for males was 6.98° ± 2.29° and females was 7.17° ± 1.71°, with no significant gender difference indicating more protrusive upper lip in Himachal population.

Projection of upper lip to chin (N-Pg/N-Ls)
The measurement for projection of upper lip to chin (N-Pg/N-Ls) in the present study was 87.73° ± 4.04° for males and it was 84.36° ± 3.02° for Himachali females with statistical significant difference as compared to Caucasians and females as shown in Table 3 and Graph 2 (P < 0.001).

Mentolabial angle (Li-Sm-Pg)
The measurement for mentolabial angle (Li-Sm-Pg) in the present study was 129.46° ± 6.06° for males and it was 129.76° ± 4.33° for Himachali females with no significant gender difference (P = 0.688). The uprighting of the lower incisors tends to enlarge the angle. The mean value according to Burstone[17] is 122.0° ± 11.7°. In a study by Anic-Milosevic et al.[10] in Croatian sample, there was a significant gender difference for this angle. For the males, the value was 129.3° ± 9.5°, which is similar to the findings of Fernández-Riveiro et al.[13] and McNamara et al.[18] but greater than the values found by Zylinski et al.[19] In his research by Anic-Milosevic et al.[10] females had a measured value of 134.5° ± 7°, while Fernández-Riveiro et al.[13] using a similar photogrammetric technique, reported values that were 3° lower on average but with a higher standard deviation (131.4° ± 11°). When Himachali population was compared with the Caucasians, they indicate lesser deep mentolabial sulci.

Projection of lower lip to chin (N-Pg/N-Li)
The measurement for projection of lower lip to chin (N-Pg/N-Li) in the present study was 7.17° ± 1.71° for males and it was 7.26° ± 1.29° for Himachali females with statistical significant difference between the genders (P ≤ 0.001), indicating more protrusive lower lip in males as compared to females. When Himachal population was compared with the Caucasians, the mean value for males was 6.98° ± 2.29° and females was 7.17° ± 1.71°, with no significant gender difference indicating more protrusive lower lip in Himachal population.

Nasal tip angle (N-Prn-Cm)
The measurement for nasal tip angle (N-Prn-Cm) in the present study was 87.73° ± 4.04° for males and it was 84.36° ± 3.02° for Himachali females with statistical
significant gender difference (P ≤ 0.001). According to various studies by Línez et al.\textsuperscript{[20]} using silhouette profiles, McNamara et al.\textsuperscript{[18]} in Caucasian population with pleasing facial esthetics and a dental Class I occlusion and Anic-Milosevic et al.\textsuperscript{[10]} in Croatian population with good soft tissue profile, this angle showed gender dimorphism and also mentioned that it was most acceptable between 60° and 80°, which was lower than those of Himachali subjects, indicating less prominent nose in Himachali population as compared to Caucasians, but Himachali males showed highly statistical significant difference as compared to Caucasian males as shown in Table 3 and Graph 2 (P < 0.0001).

**Nasomental angle (N-Prn/N-Pg)**
The measurement for nasomental angle (N-Prn/N-Pg) in the present study was 33.22° ± 1.73° for males and it was 30.74° ± 1.58° for Himachali females with statistical significant gender difference (P ≤ 0.001). According to Línez et al.\textsuperscript{[20]} the nasomental angle (N-Prn/N-Pg) showed esthetically most acceptable within a range of 20°–30°. Statistically significant gender differences showed that a less prominent nose in relation to the chin is preferable for females and the opposite in case of males.\textsuperscript{[20]} Anic-Milosevic et al.\textsuperscript{[10]} stated no gender differences were found with P = 0.077 (males = 29.5° ± 2.5°; females = 30.4° ± 2.4°), indicating more prominent nose in Himachali population as compared to Caucasians, while Himachali males showed highly statistical significant difference as compared to Caucasian males as shown in Table 3 and Graph 2 (P < 0.0001).

**Upper lip angle (Sn-Ls/Sn-Pg)**
The measurement for upper lip angle (Sn-Ls/Sn-Pg) in the present study was 12.73° ± 2.10° for males and it was 12.94° ± 2.79° for Himachali females with no statistical significant gender difference (P = 0.552). This study is in accordance with the study conducted by Arnett et al.\textsuperscript{[14]} on Caucasians population, who also found this angle to be greater in the females (12.1 ± 5.1) as compared to the males (8.3 ± 5.4). Anic-Milosevic et al.\textsuperscript{[10]} also found the upper lip angle more in females (12.90 ± 1.82) as compared to males (11.70 ± 6.20). When Himachali population was compared with Caucasians, they indicate more protractive upper lip in Himachali population.

**Superior, middle, and inferior facial third**
The measurement for superior facial third (Tri-G) in the present study was 55.41 ± 5.8 mm for males and it was 50.72 ± 4.50 mm for females with statistical significant gender difference (P < 0.001). This is in accordance with the study conducted by Farkas et al.\textsuperscript{[21]} who also found sexual differences (males 58 ± 6 mm and females 51 ± 6 mm) in which the heights were also larger in males.

The measurement for middle facial third, (G-Sn) in the present study was 65.43 ± 4.23 mm for males and it was 63.13 ± 3.08 mm for Himachali females with no statistical significant gender difference (P = 0.574).

The measurement for inferior facial third, (Sn-Me) in the present study was 66.21 ± 4.98 mm for males and it was 63.12 ± 3.87 mm for Himachali females with statistical significant gender difference (P < 0.001). This study is in accordance with the study conducted by Fernández-Riveiro et al.\textsuperscript{[22]} who also found similarity between the inferior facial third (Sn-Me: males 71.4 ± 5.7 mm and females 65.4 ± 4.3 mm) and the middle facial third (G-Sn: males 72.1 ± 5 mm and females 68.7 ± 4.5 mm). When Himachali population was compared with the Caucasians, Himachal population was having lesser values, indicating smaller facial height as compared to Caucasians and also showed highly statistical significant difference as shown in Table 3 and Graph 2 (P < 0.0001).

**Nasal length (N-Sn)**
The measurement for nasal length, (N-Sn) in the present study was 50.39 ± 3.32 mm for males and it was 49.55 ± 3.75 mm for Himachali females with no statistical significant gender difference (P = 0.742). When Himachali population was compared with the Caucasians, it was observed that males had a greater length (N-Sn: males 52.5 ± 4 mm and females 49.8 ± 4 mm), indicating lesser tipped nose as compared to Caucasians.

**Height of nasal tip (Sn-Prn)**
The measurement for the height of the nasal tip, (Sn-Prn) in the present study was 11.94 ± 1.62 mm for males and it was 13.39 ± 2.04 mm for Himachali females with statistical significant gender difference (P ≤ 0.001). When Himachali population was compared with the Caucasians, it was observed that the height of the nasal tip in males was 11.6 ± 2.2 mm and females was 11.1 ± 1.7 mm, indicating Himachali females were having tipped nose as compared to Caucasians, showing Himachali females having statistical significant difference as compared to Caucasian females as shown in Table 3 and Graph 2 (P < 0.001).

**Length of upper lip (Sn-Sts) and lower lip (Sti-Sm)**
The measurement for length of upper lip, (Sn-Sts) in the present study was 21.90 ± 2.68 mm for males and it was 19.08 ± 2.12 mm for Himachali females with statistical significant gender difference (P < 0.001), indicating larger upper lip length in males as compared to females, while Himachali females showed highly statistical significant difference as compared to Caucasian females as shown in Table 3 and Graph 2 (P < 0.001).

The measurement for the length of lower lip, (Sti-Sm) in the present study was 17.36 ± 0.85 mm for males and it was 16.79 ± 1.42 mm for Himachali females with statistical significant gender difference (P = 0.001), indicating larger lower lip length in males as compared to females. This study is in accordance with the study conducted by
Fernández-Riveiro et al.,[22] who also found larger lip length in males as compared to females (Sm-Sts: males 23 ± 2.6 mm and females 21.4 ± 2 mm; Sti-Sm: males 19 ± 2.5 mm and females 17.5 ± 2 mm). When Himachal population was compared with Caucasians, Himachal population was having smaller upper and lower lip length, especially Himachali males showed statistical significant difference as compared to Caucasian males as shown in Table 3 and Graph 2.

Height of chin (Sm-Me)
The measurement for the height of chin, (Sm-Me) in the present study was 27.97 ± 1.91 mm for males and it was 24.95 ± 1.85 mm for Himachali females with statistical significant gender difference (P ≤ 0.001), indicating greater height of chin in males as compared to females. This study is in accordance with the study conducted by Fernández-Riveiro et al.,[22] who also found greater chin height in males 29 ± 3 mm as compared to females 26 ± 2.5 mm. When Himachal population was compared with Caucasians, Himachal population had lesser chin height.

CONCLUSION
Following conclusions were drawn from this study and are enumerated as follows:

- Himachali males and females show considerable sexual dimorphism with less prominent nose as compared to Caucasian population
- Himachali males and females show considerable less protrusive lower lip as compared to Caucasian population
- Himachali males have larger superior, middle, and inferior facial third as compared to Himachali females but found lesser as compared to Caucasians
- Himachali males have larger upper and lower lip length as compared to Himachali females but found lesser as compared to Caucasians
- Himachali males have more chin height as compared to Himachali females but found lesser as compared to Caucasians
- Himachali females have more convex profile, less protrusive upper lip, and more tipped nose
- The comparison between Himachali population and Caucasian population suggested that Himachali population had more prominent nose, more protrusive upper and lower lip and more convex profile, lesser height of superior, middle and inferior facial third, smaller upper and lower lip length and smaller chin height.

Clinical significance of the study
Relying on dentoskeletal analysis for treatment planning can sometimes lead to esthetic problems, especially when orthodontists tries to predict soft tissue outcome using only hard tissue normal values.

This study points out certain facial characteristics of Himachal population. This is important because orthodontists always use dental and facial keys to diagnose and treat their patients referring to the soft tissue norms to obtain a pleasing esthetic profile.

So, the single norm for profile esthetic does not apply to all ethnic groups. Therefore, a clinician must use local norms for reference rather than established norms for the white people during diagnosis and treatment planning.

Declaration of patient consent
The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
There are no conflicts of interest.

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