Holdaway’s soft tissue cephalometric norms for the population of Lucknow, India

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Abstract
Aim: To establish the Holdaway’s soft tissue Cephalometric norms for the population of Lucknow, India. Methods: This study was conducted on pre-treatment lateral Cephalograms of 55 Orthodontically untreated subjects (25 males and 30 females) having normal occlusion and pleasing facial profile, in the age group of 18-25 years with a mean age of 21.36 years. All Cephalograms were traced and analyzed for 12 soft tissue variables (two angular and ten linear) as described by Holdaway. Results: Basic upper lip thickness, lip thickness at vermilion border, inferior sulcus to H line distance and soft tissue chin thickness was found to be significantly higher amongst males (p<0.05) while lower lip to H line distance was found to be significantly higher amongst females (p<0.001). Upper lip strain, soft tissue subnasale to H-line, superior sulcus depth, skeletal profile convexity, basic upper lip thickness, the upper lip thickness at vermilion border and H-angle were found to be more among the study population whereas the nose prominence was found to be less in comparison to the Holdaway’s norms. Conclusions: There are differences in the soft tissue parameters of the Lucknow population as compared to the Holdaway’s Caucasian norms as well as between the genders.

Key words: Holdaway’s norms; Cephalometry; Soft tissue; Lucknow.

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Introduction

The study of cephalometric norms has been part of orthodontics for more than half a century. Steiner (1), Downs (2), Broadbent and associates (3, 4), Ricketts (5, 6), Sassouni (7) and a host of others have developed cephalometric analyses and corresponding norms. However, these norms were usually based on samples of Caucasian patients only. Sassouni (7), Ricketts (5, 6) and others have suggested that different ethnic and racial groups exhibit different sets of norms than their Caucasian counterparts. They have concluded that norms differ between Caucasians and other ethnic and racial groups (8), hence methods have been used to establish the cephalometric norms of different ethnic groups. Despite of the formulation of many hard tissue norms and the treatment according to them it was found that the soft tissues of the patient didn't respond as expected to give a pleasing profile instead they exhibited high variability in their response to treatment based on hard tissue goals. Hence it was understood that the hard tissue measurements can deviate considerably from the facial form the patient expresses with the soft tissues (9, 10).

Soft tissue variables such as lip thickness, soft tissue chin thickness etc., can give results contrary to the hard tissue readings as in the case of a soft tissue camouflage and one can find that the lips maybe more protrusive or retrusive than indicated by dentoskeletal measurements because of lips that are either excessively thick or thin (11).

These findings add importance to the need of a soft tissue cephalometric analysis as a good facial profile reflects harmony between many facial forms that are dependent on tooth position, bone position and soft tissue mass (11).

Hence, evaluation of the patient’s soft tissue profile is one of the most important components of Orthodontic Diagnosis & Treatment planning. As orthodontic patients nowadays range from juveniles to senior citizens and come from various ethnic groups, a wide range of representative norms would be ideal. Awareness of the normal dentofacial pattern of each ethnic group will undoubtedly ensure better success of treatment to establish optimal facial harmony. These conclusions prompted the present investigation as the Holdaway’s (9,10) Soft tissue Cephalometric analysis consists of the study of twelve important soft tissue parameters.

The analysis was given by Holdaway (9, 10) in July 1983 published in the American journal of Orthodontics and Dentofacial Orthopaedics. His article presents a soft-tissue analysis which demonstrates the inadequacy of using a hard-tissue analysis alone for treatment planning. The material and methods used to develop this technique came from years of observation and description of patients from the private practice of the author based on samples of Caucasian patients only.

Holdaway’s (9, 10) norms have also been established for the Turkish (12) and Korean (13) populations. At present, there are no published Holdaway (9, 10) soft tissue cephalometric norms for the population of Lucknow. The aim of this study is therefore to establish norms for population of Lucknow, India.

Material and methods

The present study was conducted on Pre-treatment lateral Cephalograms of 55 Orthodontically untreated subjects (25 Males and 30 Females) having normal occlusion and pleasing facial profile, in the age group of 18-25 years with a mean age of 21.36 years. They were selected after careful evaluation of facial photographs (frontal and profile) of 82 subjects (41 males and 41 females) studying in the various institutes in and around Lucknow. The sample were put into three groups Group A – 25 Males in the age group of 18-25 years with a mean age of 21.5 years Group B – 30 Females in the age group of 18-25 years with a mean age of 21.2 years
Holdaway's soft tissue Cephalometric norms

Group C – 55 Subjects (25 males and 30 females) in the age group of 18-25 years with a mean age of 21.36 years.

The facial photographs were evaluated by a 3 member panel of judges comprising of one plastic Surgeon, one beautician and one orthodontist each having a minimum of two years of work experience in their respective field of work. The panel members were given a Profile Rating Chart and were asked to rate the subjects on the basis of a five point scale with 1 = Poor, 2 = fair, 3 = good, 4 = very good and 5 = excellent. Each panel member made his evaluation separately without any knowledge of the subject’s identity and the scores allotted by the other panel members.

The scores obtained for each subject allotted by the team of judges were then added up separately for both males and females and the mean score calculated. All the subjects with a total score equal to or above the average score were selected for Cephalometric evaluation.

The Cephalograms had been taken by properly positioning the subjects on a Universal Counterbalancing type of Cephalostat with the Frankfort Horizontal plane parallel to the floor and the teeth in Centric Occlusion. All Cephalograms had been taken with the subjects in a standing position with lips lightly touching.

Agfa® X-Ray Films (8” X 10”) had been exposed at 70 Kvp : 30 mA for 1.8 seconds from a fixed distance of 60 inches by following the standard technique. Each Cephalogram met the following essential requirements

- Good definition of hard and soft tissue profiles
- Teeth in Centric Occlusion
- Lips lightly touching

After placing Registration points on the Cephalograms, the pretreatment radiographs were traced on Acetate tracing sheets of 0.5 micron thickness using a sharp 4H pencil on a view box using transilluminated light in a dark room. Any stray light rays were eliminated by covering the margins of the view box with a black paper leaving only that much part required for radiograph visibility. When there was a lack of superimposition of the right and left structural outline, the average between the two was drawn by inspection and the cephalometric points were located in reference to the arbitrary line so obtained.

The various soft tissue and hard tissue landmarks were used to construct the lines and planes (figure 1) as described by Holdaway (9, 10) for measuring the two angular and ten linear measurements.

Figure 1: Lines and planes used (1-H Line, 2-Soft tissue facial line, 3-Hard tissue facial plane, 4-Sella-nasion plane, 5-Frankfort horizontal plane, 6-Right angle to the Frankfort plane down tangent to the vermilion border of the upper lip)

Figure 2: Angular and Linear Measurements (1-Facial angle, 2-H angle, 3-Skeletal profile convexity, 4-Soft tissue Subnasale to H-Line, 5-Lower lip to H line, 6-Inferior sulcus to H line, 7-Soft tissue chin thickness)
Angular measurements included Soft tissue facial angle and H-Angle (figure 2) and the linear measurements used were Skeletal profile convexity, soft tissue subnasale to H line, lower lip to H line, inferior sulcus to H line, soft tissue chin thickness, superior sulcus depth, nose prominence, basic upper lip thickness and lip thickness at vermillion border (figure 3).

**Figure 3:** Linear measurements (1-Basic upper lip thickness, 2-Lip thickness at vermillion border, 3-Nose prominence, 4-Superior sulcus depth)

**Statistical analysis**

The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 15.0 statistical Analysis Software. The values were represented in Number (%) and Mean±SD.

The linear and angular measurements were made to the nearest 0.5mm and 0.5 degrees respectively with the help of millimeter ruler and protractor. The Mean and standard deviation (SD) was calculated for all the values. Student's t-test was done to evaluate statistical significance between the values obtained and norms established by Holdaway (9, 10) for Caucasians.

Error of measurement was tested by doing double determinations of ten Cephalograms randomly selected at fifteen days interval from the collected sample by the same operator. The comparison was drawn between first and second determinations by Student’s t-test. Statistically no significant differences were noted between first and second measurements.

**Results**

Table 1 shows the comparison of mean values for soft tissue variables between males (Group-A) and females (Group-B).

**Table 1:** Comparison of mean values of soft tissue variables between Group A and Group B

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group A (n=25)</th>
<th>Group B (n=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean±SD</td>
<td>Mean±SD</td>
</tr>
<tr>
<td>Soft tissue facial angle*</td>
<td>92.54±3.25</td>
<td>91.93±3.62</td>
</tr>
<tr>
<td>Superior sulcus depth**</td>
<td>3.96±1.48</td>
<td>3.37±1.20</td>
</tr>
<tr>
<td>Skeletal profile convexity**</td>
<td>1.92±2.34</td>
<td>1.72±2.41</td>
</tr>
<tr>
<td>H angle**</td>
<td>15.72±5.00</td>
<td>15.17±3.45</td>
</tr>
<tr>
<td>Nose prominence**</td>
<td>13.98±3.13</td>
<td>12.88±2.96</td>
</tr>
<tr>
<td>Soft tissue subnasale to H Line**</td>
<td>7.42±2.58</td>
<td>6.42±2.36</td>
</tr>
<tr>
<td>Basic upper lip thickness*</td>
<td>16.08±1.70</td>
<td>13.92±1.08</td>
</tr>
<tr>
<td>Lip thickness at vermillion border*</td>
<td>15.12±2.12</td>
<td>12.10±1.57</td>
</tr>
<tr>
<td>Upper lip strain</td>
<td>1.12±1.23</td>
<td>1.82±1.37</td>
</tr>
<tr>
<td>Lower lip to H Line</td>
<td>0.52±1.98</td>
<td>1.50±1.45</td>
</tr>
<tr>
<td>Inferior sulcus to H line*</td>
<td>7.18±2.11</td>
<td>4.92±1.38</td>
</tr>
<tr>
<td>Soft tissue chin thickness*</td>
<td>14.48±2.40</td>
<td>12.38±1.86</td>
</tr>
</tbody>
</table>

*Student’s t test, p<0.001

**Table 2:** Comparison of soft tissue variables between study population and Holdaway’s norms

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean Value by Holdaway</th>
<th>Study population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft tissue facial angle*</td>
<td>91</td>
<td>92.21±3.44</td>
</tr>
<tr>
<td>Superior sulcus depth**</td>
<td>3</td>
<td>3.64±1.36</td>
</tr>
<tr>
<td>Skeletal profile convexity**</td>
<td>0</td>
<td>1.81±2.36</td>
</tr>
<tr>
<td>H Angle**</td>
<td>10</td>
<td>15.42±4.19</td>
</tr>
<tr>
<td>Nose prominence**</td>
<td>16</td>
<td>13.38±3.06</td>
</tr>
<tr>
<td>Soft tissue subnasale to H line**</td>
<td>5</td>
<td>6.87±2.49</td>
</tr>
<tr>
<td>Basic upper lip thickness**</td>
<td>15</td>
<td>14.90±1.76</td>
</tr>
<tr>
<td>Lip thickness at vermillion border*</td>
<td>14</td>
<td>13.47±2.37</td>
</tr>
<tr>
<td>Upper lip strain**</td>
<td>1</td>
<td>1.50±1.34</td>
</tr>
<tr>
<td>Lower lip to H line**</td>
<td>0</td>
<td>1.05±1.77</td>
</tr>
<tr>
<td>Inferior sulcus to H line**</td>
<td>5</td>
<td>5.95±2.07</td>
</tr>
<tr>
<td>Soft tissue chin thickness**</td>
<td>11</td>
<td>13.34±2.36</td>
</tr>
</tbody>
</table>

Student’s t test. *p<0.05, **p<0.001
Basic upper lip thickness, Lip thickness at vermillion border, Inferior sulcus to H line distance and Soft tissue chin thickness was found to be significantly higher amongst males (p<0.05) while Lower lip to H line distance was found to be significantly higher amongst females (p<0.001).

Table 2 shows the comparison of soft tissue variables between the study population (Group C) and Holdaway’s mean values. Upper lip strain, soft tissue subnasale to H-line, superior sulcus depth, skeletal profile convexity, basic upper lip thickness, the upper lip thickness at vermilion border and H-angle were found to be more for Group – C whereas the nose prominence was found to be less when compared to Holdaway’s norms.

Discussion

Orthodontic treatment is best when the facial and cephalometric characteristics of the ethnic background of patients are considered. Lateral Cephalometric norms maybe specific to an ethnic group and cannot be applied to other ethnic types. Holdaway (9, 10), Subtelny (14), Altemus (15), Hashim and Albarakati (16), Burstone (17), Arnett (18), Legan and Burstone (11) and many others have developed cephalometric analyses and corresponding norms. However, these norms were usually based on samples of Caucasian patients only. They have concluded that norms differ between Caucasians and other ethnic and racial groups. Ethnic differences in facial traits do exist & knowledge of the normal dentofacial patterns of various ethnic groups is important for clinical and research purposes.

Hence for the appropriate application of any cephalometric analysis, it must be used with norms derived from populations similar to the orthodontic patients with regard to ethnic group, gender, and age. At present, there is no published Holdaway’s (9,10), soft tissue Cephalometric norms for the population of Lucknow. The aim of this study was therefore to establish norms for Lucknow population.

The present study was conducted on Pre-treatment lateral Cephalograms of 55 Orthodontically untreated subjects (25 Males and 30 Females) having normal occlusion & pleasing facial profile, in the age group of 18-25 years with a mean age of 21.36 years. The age range was taken as above 18 years so as to ensure that complete growth of soft tissues had taken place as was noted by Genecov et al (19) and Subtelny (14).

The study population was divided on the basis of gender as many differences have been noted between male and female growth patterns and timings as shown by Genecov et al (19).

Most commonly the lateral Cephalograms are taken in the habitual relaxed lip position by various authors, but in this study habitual lip position was not taken, firstly because emotional and neuromuscular input into lip posture make it difficult to capture a relaxed lip posture repeatedly. This is essentially true when the subject is fixed in a cephalographic head positioner with ear rods in place. Oliver (20) concluded that the instruction to “bring the lips lightly closed” would allow the subject a tactile neuromuscular input to facilitate positioning the lips in a repeatable manner. Secondly most of the time people appear in public with their lips in slight contact (21).

Two angular and ten linear measurements were taken as described by Holdaway (9, 10). In the present study, the calculated mean value of soft tissue facial angle for Group – C was found to be higher than the Holdaway’s (9, 10) Caucasian norms, in contrast to results of Hashim and Albarakati (16) wherein values of soft tissue facial angle were higher in females (Group – B) than in males (Group – A); the difference between the norms for males and females was not statistically significant in this study.

For the H-Angle the values for Group – C were lower than the Holdaway’s (9, 10) Caucasian norms because of an increased value for skeletal profile convexity and upper lip thickness found in the present study. The
Holdaway’s soft tissue Cephalometric norms

difference between males and females for H-angle was not statistically significant similar to results of Hwang et al (22).

The values for superior sulcus depth was lower in Group –C as compared to the Holdaway’s (9, 10) Caucasian norms. The values for males was higher than females as also concluded by Genecov et al (19) and could be attributed to greater lip thickness at Vermillion border in males. The values of skeletal profile convexity at point A were higher in Group-C with no statistically significant difference seen between males and females, as also concluded by Basciftci et al (12).

In this study, the nasal prominence in Group- C was lesser compared to Holdaway’s (9,10) Caucasian norms. The difference between males and females was not statistically significant in contrast to results obtained by Basciftci et al (12).

For the linear distance between soft tissue subnasale to H Line, the values for Group - C were higher than the Holdaway’s (9,10) Caucasian norms. The norms for males and females did not show significant difference as also found by Basciftci et al (12).

Basic upper lip thickness and lip thickness at vermilion border was higher in Group –C. even Males showed statistically significant higher values as compared to females, as also found by Basciftci et al (12). Arnett (18) also concluded that lip thickness was higher in males.

The values for upper lip strain in Group – C were higher than Holdaway’s (9,10) Caucasian norms, which could be attributed to increased Skeletal Profile Convexity in this study. The difference between males and females was not statistically significant, similar to results of Basciftci et al (12).

Values for lower Lip to H-line showed higher values for Group – C compared to Holdaway’s (9, 10) Caucasian norms. Among both the genders, females showed higher values. This could be attributed to forward position of lower lip in Indians as found by Kharbanda (23). These results are in contrast to Basciftci (12) who did not find statistically significant differences between the genders and Hwang et al (22) who found that Korean males had more protrusive lower lip as compared to females. Similar results were obtained for inferior sulcus to H-line.

Soft tissue chin thickness showed higher values in Group – C as compared to Caucasian norms. Increased chin thickness was noted for males as also found by Basciftci et al (12). Even Nanda (24) and Arnett (18) concluded soft tissue chin thickness to be greater in case of males.

Based on the above findings it is clear that the soft tissues vary considerably among different populations and between males and females. A shift towards a Face First Paradigm in Orthodontics further increases the importance of using a soft tissue analysis such as the Holdaway’s (9, 10) analysis for orthodontic diagnosis and treatment planning.

Conclusions

Lower lip was found to be more prominent in the population of Lucknow compared to the Holdaway’s mean values. Upper lip strain, soft tissue subnasale to H-line, superior sulcus depth, skeletal profile convexity, H-angle, basic upper lip thickness and the upper lip thickness at vermilion border were found to be more in the population of Lucknow as compared to the Holdaway’s mean values while the decreased nose prominence was found in the population of Lucknow as compared to the Holdaway’s Caucasian norms.

Sexual dimorphism was observed, the lower lip was found to be more prominent in the females as compared to the males while the basic upper lip thickness, upper lip thickness at vermilion border and inferior sulcus depth were found to be higher in males as compared to females.
References