DETERMINATION OF CEPHALOMETRIC SOFT TISSUE NORMS FOR LOCAL POPULATION WITH NORMAL OCCLUSION USING HOLDAWAY ANALYSIS

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ABSTRACT

Objective: To assess soft-tissue values in a group of local ethnic population with Class I occlusion by Holdaway's soft tissue cephalometric analysis, and to verify the pertinence of Holdaway's norms to local sample subjects.

Study Design: Cross sectional study.

Place and Duration of Study: Orthodontics department, Bolan Medical College, Civil Sandman Hospital, Quetta, from Jun 2018 to Dec 2018.

Methodology: Cephalometric radiographs of 69 Adults (33 males and 36 females) aged between 18-28 years, with normal occlusion and well aligned arches, were measured. Cephalometric landmarks were identified as stated by Holdaway analysis. On each radiograph two angular and nine linear measurements were evaluated.

Results: Local ethnic population showed more convex profiles with higher skeletal convexity (1.97 ± 1.85) and H angles (15.05 ± 3.31), greater nose prominence (18.25 ± 3.73), upper lip thickness (13.43 ± 1.64), and soft tissue chin thickness (12.64 ± 1.94) compared to Holdaway's values. All values showed sexual dimorphism, amongst these statistically significant values ($p<0.05$) were of soft tissue subnasale to H line, total upper lip thickness, nose prominence, soft tissue chin thickness and inferior sulcus to H line.

Conclusion: Racial variance was present in sampled population, compared to Caucasian norms. These differences must be kept in the mind when planning and executing orthodontic therapy.

Keywords: Cephalometric analysis, Holdaway analysis, Soft tissue norms.

INTRODUCTION

Decades ago, it was established that soft tissues dictate the extent of orthodontic therapy. Orthodontist should plan therapy from the viewpoint of optimal function, long-term stable occlusion, and pleasing esthetics and it must be within the limits of patient's soft tissue modification and contours[1]. Soft tissue paradigm places greater importance on clinical examination of soft tissue esthetics and function, unlike previous practice[2].

Holdaway[3] called his treatment method the "soft tissue approach to treatment planning" and he urged that the integumental covering of the hard tissues and soft tissue profile are the most important orthodontic considerations while planning treatment. Holdaway[4] stated that "Better treatment goals can be set if we quantitate the soft-tissue features which contribute to or detract from that 'physical attractiveness stereotype". He stressed that relying on hard tissue analysis alone is not enough for treatment planning.

Holdaway[3,4], derived his norms from Caucasian subjects. European-American norms are still used in

the orthodontic treatment of patients belonging to other racial groups despite the different ethnic backgrounds. Many authors have assessed the cephalometric soft tissue norms on their local populations including Turkish[5], Jordanian[6], North Indian[7], Polish[8], and Korean[9], they found that their samples had dissimilar values when they were compared to the Caucasian or European samples. Our study had a similar goal. The purpose of this study was to provide local reference values for facial soft tissues, rather than using the ones inferred from Caucasian norms. Such steps are an effort to ensure a better treatment outcome and one that would be more aligned with the patient's ethnic and racial identity.

METHODOLOGY

This was a cross-sectional study, carried out at the Orthodontic department, Dental section of Civil Sandeman Provincial Hospital Quetta. Convenience sampling was used. Sample size was calculated by using WHO sample size calculator, mean and standard deviation of H angle 15.47 and 4.21 respectively[10], taking margin of error at 1%, sample size of study was 69 (36 females and 33 males) aged between 18 and 28 years of age. Inclusion criteria comprised of subjects having normal overjet (upto 4mm) and overbite (40%), bilateral Class I canine and molar relationship, competent

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lips, no crowding or spacing, having no prior orthodontic treatment or Orthognathic surgeries. Patients with history of trauma and significant medical history were also excluded. Permission was granted by the ethics review committee of Sandeman provincial hospital, (ref: 7886) Quetta. All participants provided informed consent. All participants belong to Pakistani ethnicity and it was confirmed by their national identity cards.

Lateral cephalometric radiographs (Soredex Cranex Excel Finland) were taken in natural head position (NHP) using the mirror technique, where the subject looks into his/her own eyes and positions their head in its physiologically normal position. Dentition was positioned in centric occlusion, and lips in relaxed state. Lateral cephalometric radiographs were manually traced by a single operator on matte acetate paper with 0.5 black pointer using illuminator light box. Soft tissue cephalometric analysis was performed on each radiograph using landmarks and reference lines of Holdaway. Following are the two angular and nine linear parameters that were measured figure.
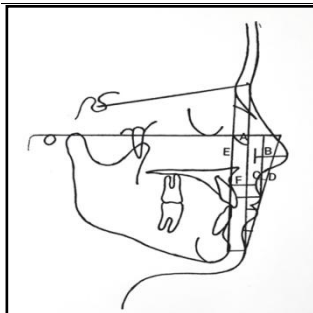

Figure-1: Cephalometric tracing demonstrating the angular and linear measurements. Soft tissue facial angle (A), nose prominence (B), upper lip sulcus depth (C), soft tissue subnasal to H line (D), skeletal profile convexity (E), total upper lip thickness (F).
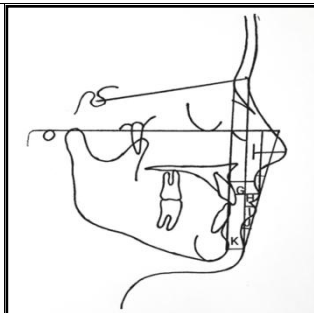
Figure-2: Upper lip thickness (G), H angle (H), lower lip to H line (I), inferior sulcus to the H line (J), soft tissue chin thickness (K).

Soft tissue facial angle: Inner and downward angle formed at the point where sella-nasion line crosses the soft tissue profile, and a line joining the suprapogonion with Frankfort horizontal plane. **Nose prominence:** Distance between the tip of the nose and a perpendicular line drawn to Frankfort plane from the upper lip vermilion. **Upper lip sulcus depth:** distance between the upper lip sulcus and a perpendicular line drawn from the upper lip vermilion to the Frankfort plane.

Soft tissue subnasale to H line: The distance from subnasale point to H line. **Skeletal profile convexity:** The measurement between point A and the skeletal facial plane. **Total Upper lip thickness:** The measurement from a point 3mm below point A to subnasale. **Upper lip thickness:** The distance between labrale superius and labial surface of maxillary incisor.

H-Angle: Angle formed between the soft tissue facial plane and the H-line (the tangent drawn from the tip of the chin to upper lip). **Lower lip to H line:** The distance between labrale inferius and H line. **Inferior sulcus to H line:** The distance at the point of greatest convexity between the vermilion border of the lower lip and soft tissue chin measure to H line. **Soft tissue chin thickness:** The distance between the soft tissue and hard tissue planes at the level of suprapogonion.

SPSS-21 was utilized to perform the statistical analyses. Descriptive statistics were determined for the whole sample, including means and standard deviations. To evaluate the errors in tracing and measure-

Table-I: Holdaway's measurements and descriptive statistics for Pakistani sample.

Norms	N	Min.	Max.	Mean ± SD
Soft Tissue Facial Angle (°)	69	81.50	98.00	89.47 ± 3.40
Nose- Prominence (mm)	69	9.00	27.00	18.25 ± 3.73
Upper Lip Sulcus Depth (mm)	69	1.00	5.50	3.09 ± 1.14
Soft Tissue Subnasal to H-Line(mm)	69	1.50	9.00	5.50 ± 1.97
Skeletal profile convexity (mm)	69	-2.50	5.00	1.97 ± 1.85
Basic Upper Lip Thickness (mm)	69	12.00	20.00	15.97 ± 1.96
Upper Lip Thickness (mm)	69	10.00	17.00	13.43 ± 1.64
H-angle (°)	69	5.00	23.00	15.05 ±3.31
Lower Lip to H-Line (mm)	69	-3.00	3.50	0.31 ± 1.75
Inferior sulcus to H line (mm)	69	1.50	10.50	5.57 ± 2.04
Soft Tissue Chin Thickness (mm)	69	8.00	17.00	12.64 ± 1.94

ment of radiographs, fifteen radiographs were randomly selected. The tracings were redrawn fifteen days apart. First and second measurements showed no significant difference on application of a paired t-test. To study the difference between females and males an

Table-II: Comparison of Holdaway's norms amongst Pakistani females and males (t-test).

	Mean ± SD	Sex	N	Mean ± SD	*p*-value
Soft Tissue Facial Angle (°)	89.47 ± 3.40	Female	36	90.01 ± 3.35	0.168
		Male	33	88.87 ± 3.40	
Nose- Prominence (mm)*	18.25 ± 3.73	Female	36	16.22 ± 3.60	0.000*
		Male	33	20.46 ± 2.39	
Upper Lip Sulcus Depth (mm)	3.09 ± 1.14	Female	36	3.34 ± 1.22	0.055
		Male	33	2.81 ± 0.99	
Soft Tissue Sub nasal to H-Line (mm)*	5.50 ± 1.97	Female	36	4.41 ± 1.46	0.000*
		Male	33	6.68 ± 1.79	
Skeletal profile convexity (mm)	1.97 ± 1.85	Female	36	1.83 ± 2.30	0.503
		Male	33	2.13 ± 1.20	
Total Upper Lip Thickness (mm)*	15.97 ± 1.96	Female	36	14.87 ± 1.41	0.000*
		Male	33	17.18 ± 1.77	
Upper Lip Thickness (mm)*	13.43 ± 1.64	Female	36	12.91 ± 1.64	0.005*
		Male	33	14.00 ± 1.47	
H-angle (°)	15.05 ± 3.31	Female	36	14.04 ± 3.96	0.007
		Male	33	16.5 ± 1.94	
Lower Lip to H-Line(mm)	0.31 ± 1.75	Female	36	0.38 ± 1.58	0.733
		Male	33	0.24 ± 1.95	
Inferior sulcus to H line (mm)*	5.57 ± 2.04	Female	36	4.44 ± 1.68	0.000*
		Male	33	6.81 ± 1.65	
Soft Tissue Chin Thickness (mm)*	12.64 ± 1.94	Female	36	11.43 ± 1.46	0.000*
		Male	33	13.96 ± 1.48	

*$p \leq 0.05$

independent student t-test was used. The level of significance was set at $p \leq 0.05$.

RESULTS

The descriptive statistical analysis of our sample is shown in table-I. It revealed that soft tissue facial angle was less than Holdaway's mean, basic upper lip thickness, skeletal profile convexity, and H angle were greater in local Pakistani sample. Table-II compares Holdaway's norms between males and females. There's a significant difference in nose prominence, soft tissue subnasale to H line, total upper lip thickness, inferior sulcus to H line, and soft tissue chin thickness. Table-III compares mean values and standard deviations with other studies done on individuals of Saudi and European-American (Holdaway's sample) ethnicities.

DISCUSSION

Richardson[11] studied racial differences in dimensional traits of human face and concluded that cephalofacial morphology is influenced by genetics, function and temperature. The areas of face closer to alveolar process and dental regions show greatest differences among ethnic and racial groups. Soft tissue envelope of the craniofacial hard tissues varies immensely in form and thickness[12]. An important step in orthodontic diagnosis and planning of treatment is the examination and evaluation of the patient's soft tissue configuration in

Table-III: Soft tissue norms compared in Pakistani, Saudis and Holdaway's Caucasian samples.

	Pakistani Norms Mean ± SD	Saudi Norms Mean ± SD	Holdaway Norms Mean (range)
Soft Tissue Facial Angle (°)	89.47 ± 3.40	89.66 ± 3.54	91* ± 7
Nose- Prominence (mm)	18.25 ± 3.73	13.46 ± 3.22	14-24
Upper Lip Sulcus Depth (mm)	3.09 ± 1.14	2.92 ± 1.37	3 (1-4)
Soft Tissue Sub nasal to H Line (mm)	5.50 ± 1.97	5.03 ± 2.09	5 (2)
Skeletal profile convexity (mm)	1.97 ± 1.85	1.75 ± 2.30	0**
Basic Upper Lip Thickness (mm)	15.97 ± 1.96	15.69 ± 2.09	15**
Upper Lip Thickness (mm)	13.43 ± 1.64	12.36 ± 2.17	13-14
H-angle	15.05 ± 3.31	15.16 ± 3.22	10** (7-14)
Lower Lip to H-Line (mm)	0.31 ± 1.75	0.86 ± 1.55	0-0.5 (-1-2)
Inferior sulcus to H line (mm)	5.57 ± 2.04	4.22 ± 1.55	-
Soft Tissue Chin Thickness (mm)	12.64 ± 1.94	11.33 ± 2.24	10-12

frontal and profile views. Several techniques and procedures have been adopted by the researchers that investigate and interpret diagnostic data available on lateral cephalograms[13,14].

In the field of orthodontics a diagnosis is obtained, in part, by tallying individual's cephalometric calculations with standard norms. These Cephalometric standard values were derived by measurements done on individuals belonging to European-American ancestries, in most cases. Cephalometric norms are specific to an ethnic group and cannot be applied to other ethnicities[15,16].

This study was done to provide more relevant reference norms as standard for individuals belonging to Pakistani ancestry. Most of the values of this study are similar to Holdaway's original norms[3]. Considering, the values for soft tissue facial angle (89.47˚), skeletal profile convexity (1.97˚) and H angle (15.05˚) indicates that Pakistani profiles are more convex compared to Caucasian standards. According to Holdaway[3] in harmonious soft tissues drape of the face, H angle must increase correspondingly as the skeletal convexity increases. Similar trends are seen in individuals of Saudi descent[17]. A comparison of Chinese and Malay subjects (males compared to females) showed that females had more prominent lips which present as being fuller and protrusive due to reduced prominence of nose in these ethnic groups[18]. Sexual dimorphism was also observed in our study. All variables were higher in males, but nose prominence, soft tissue subnasale to H line, total and upper lip thickness, inferior sulcus depth, soft tissue chin thickness were statistically significant. These findings were similar in Turkish sample[5,19]. Pakistani males had slightly more prominent noses (20.46mm) than Turkish males (19.83 mm) but overall means were quite similar. Sexual dimorphism points to the fact male and female soft tissue patterns differ even within the same ethnic group and this difference must be appreciated while treating these individuals[20]. Imani[21], "evaluated soft tissue characterization of Kurds" and imparted that Kurds had smaller noses, more convex profiles and prominent lips compared to Holdaway's sample.

Nasal projection is deemed to be an important and identifiable facial characteristic. Circumoral soft tissues like chin and lips influence the extent of apparent nose projection, therefore, affecting directly the treatment planning. Holdaway indicated that if nasal prominence is less than 14mm it suggests a small nose. Some researchers[22,23], have used the Holdaway analysis to assess the nasal prominence in individuals. These measurements could be used as guidelines in orthodontic and orthognathic surgeries. Although it is an easy method, there are limitations to it. Firstly, cephalometric analysis of nose does not provide much detail. Secondly, nose prominence is influenced by soft tissue point labrale superioris, which is greatly influenced by the labiopalatal tooth inclinations. Therefore, other Cephalometric measurements for nose prominence values should be incorporated that are not influenced by dental inclinations.

Our study had some limitations, larger samples should be used to assess the norms and advanced measurement techniques using three dimensional measurements should be applied using advanced.

CONCLUSION

According to the Holdaway's analysis, this study showed that Pakistani sample, on the whole, had larger H angles, smaller soft tissue facial angles, and greater skeletal profile convexities, signifying an overall more convex profiles compared to Caucasian norms. Sexual dimorphism, with females having thinner lips and decreased chin soft tissue thickness. These norms should be considered when orthodontically treating patients belonging to Pakistani ethnicity.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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