Original Article

Soft tissue cephalometric analysis applied to regional Indian population

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ABSTRACT

Introduction: Importance of soft tissue consideration in establishing treatment goals for orthodontics and orthognathic surgery has been recognized and various cephalometric analysis incorporating soft tissue parameters have evolved. The great variance in soft tissue drape of the human face and perception of esthetics exists and normative data based on one population group cannot be applied to all. The study was conducted to compare the standard soft tissue cephalometric analysis (STCA) norms with norms derived for population of western Uttar Pradesh region of India. **Materials and Methods:** The sample consisted of lateral cephalograms taken in natural head position of 33 normal subjects (16 males, 17 females). The cephalograms were analyzed with soft tissue cephalometric analysis for orthodontic diagnosis and treatment planning, and the Student's *t* test was used to compare the difference in means between study population and standard STCA norms. **Results:** Compared with established STCA norms, females in our study had steeper maxillary occlusal plane, more proclined mandibular incisors, and less protrusive lips. Both males and females showed an overall decrease in facial lengths, less prominent midface and mandibular structures and more convex profile compared with established norms for the White population. **Conclusions:** Statistically significant differences were found in certain key parameters of STCA for western Uttar Pradesh population when compared with established norms.

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Introduction

The esthetics of the face depends upon the soft and hard tissue contour. A pleasant face can be a great asset to one's personality while a facial deformity can greatly affect one's social acceptance and behavior.[1] Attaining excellence of facial form is one of the prime objectives of orthodontic treatment.

The role of skeletal structures influencing the facial form is a recognized and accepted fact. However, one must not lose sight of the fact that the soft tissue that covers the bony surface of the face plays an equally important part in the stability of the dental arches and aesthetic harmony. Much research demonstrates that soft tissues, which vary considerably in thickness, are a major factor in determining a patient's final facial profile.[2-6]

With advances in the field of orthognathic surgery, a need for a specialized cephalometric appraisal system was felt which would enable a comprehensive analysis of the skeletal, dental as well as the soft tissues. This led to the development of cephalometrics for orthognathic surgery (COGS) for hard tissue and soft tissue ana ly sis. [7] Epker and Fish also developed cephalometric analysis to aid in the successful diagnosis and treatment planning of an orthognathic surgical patient.[8]

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In 1999, a new cephalometric analysis was introduced by William Arnett called the soft tissue cephalometric analysis (STCA), which tried to amalgamate both the hard tissue and soft tissue analysis, and came up with a comprehensive analysis for patients needing orthognathic surgery.[9] Arnett studied both hard tissue and soft tissue parameters and suggested ideal values to which patient values could be compared. He was of the opinion that the soft tissue profile is a critical guide to tooth placement, occlusal correction, and optimal facial harmony. It can also be a valuable tool in identifying subjects requiring surgery and improve the likelihood of successful outcome.

Important advantage of STCA over other cephalometric analysis is the use of natural head position (NHP) as reference plane. There is a plethora of cephalometric analysis, which put emphasis on hard tissue during treatment planning and uses cranial base structures as reference planes. When cranial base is used as the reference line for measuring dentofacial parameters, false findings can be generated because the cranial base is as variable as the dental and facial structures that it measures.[10]

The concept of NHP was introduced to orthodontics in the 1950s.[11] NHP has been found to be highly reproducible.[12-14] Analysis based on NHP and the true horizontal as a reference plane should have greater clinical application than traditional methods.

The cephalometric norms of different ethnic and racial groups established in various studies. Most investigators have concluded that there are significant differences between ethnic and racial groups, and cephalometric standards have been developed for specific ethnic and racial groups.[15-20] It is important while considering a patient's treatment goals and needs to compare the cephalometric findings with the norms for his or her ethnic group for an accurate diagnostic evaluation.

The purpose of this study was to compare STCA norms derived for subjects belonging to western Uttar Pradesh region of India with standard STCA norms derived for Caucasians.

Materials and Methods

Thirty three adults from western Uttar Pradesh, India who fulfilled the selection criteria and were judged to have well balanced facial profiles and esthetics participated in the study. Subjects were selected after two stage screening procedure .First the subjects were screened based on following inclusion and exclusion criteria. Incluison criteria were pleasing facial profile, competent lips, acceptable facial symmetry,class-I canine, and molar relationships. Subjects with past history of orthodontic treatment, prosthodontic treatment, or maxillofacial/plastic surgery treatment were excluded from the study. Subjects were given a questionnaire to confirm their past medical/dental history and also their ethnicity. Since the subjects were to undergo radiographic exposure, informed consent was obtained from everyone, who participated in the study. Second screening was done by a panel consisting of an orthodontist, a plastic surgeon, and a fashion designer who judged the extra-oral photographs of selected subjects on the basis of having reasonably balanced facial profile and pleasing facial appearance.

The subjects were first assessed clinically in NHP, with seated condyles and passive lips. Metallic markers were placed on various soft-tissue structures on the faces to study and relate them to the true vertical line (TVL) as described by Arnett *et al*.[9] The subjects were then asked to swallow and bite into centric occlusion. A lateral headfilm was obtained with the subject inNHP, with seated condyle and with passive lips. Standard 8 × 10 in Kodak T-mat lateral radiographic headfilms (Eastman Kodak, Rochester, NY, USA) were used for each subject on Rotograph plus (Villa system Medical, Italy) panoramic and cephalometric equipment. All exposed films were developed and fixed manually by the same technician using standard procedures. All lateral cephalometric films were traced on a transparent cellulose acetate sheet of 0.076 mm thickness by the same technician. Similar conditions of the light box and general illumination were maintained during viewing and tracing of all headfilms. All reference points were first identified, located, and marked. The landmarks and measurements were taken according to the STCA.[9] Mean and standard deviation were calculated for each parameter. The data were separated according to sex to obtain more specific and useful cephalometric normative values. Calculated values were compared between males and females within the study population and also between study population and standard STCA values. Significance of difference was evaluated using Student's *t* test and level of significance was kept at 5%.

Results

Cephalograms obtained for 33 subjects (16 males, 17 females) selected from western Uttar Pradesh (W.UP) population were traced and STCA was done. Data was separated for males and females. Mean and standard deviation was calculated for each parameter [Table 1].

The obtained data was compared with standard STCA[9] norms established for White population [Table 2].

Comparing Dento-skeletal factors, W.UP males and females had higher value for inclination of Maxillary. Occlusal plane to TVL [98.78° vs 95.00° (males) and 100.09° vs 95.60° (females)] than their White counterparts. Morover, W.UP females had lesser values than their white counterpart for the parameter of Mandibular incisor to occlusal plane (61.65° vs 64.30°). The value for overbite was less in W.UP males (2.63mm) compared with White males (3.20 mm)

Comparing soft tissue factors between two populations, W.UP females had thicker upper lips (1.08 mm) and thinner lower lips (1.01 mm) than their White counterparts. Upper lip angle was lower in W.UP females compared with their White counterparts (6.32° vs 12.10°).

Following facial length values were higher in White population: Maxillary incisor exposure [2.0 mm (males) and 1.9 mm (females)], maxillary height [4.1 mm (males) and 2.0 mm (females)], mandibular height [4.37 mm (males) and 2.3 mm (females)], interlabial gap [1.8 mm (males) and 3.3 mm (females)], length of lower third of face [7.8 mm (males) and 4.6 mm (females)].

Morover, White males had higher values for total facial height (5.04 mm), upper lip length (1.7 mm), lower lip length (3.7mm).

W.UP population had higher value (more negative to TVL) for the following parameters:

Orbital rims [2.13 mm (males) and 1.45 mm (females)], cheekbones [4.05 mm (males) and 4.31 mm (females)], A-point' [1.86 mm (males) and 1.78 mm (females)], upper lip anterior [2.31 mm (males) and 2.55 mm (females)], maxillary incisor [3.37 mm (males) and 3.56 mm (females)], mandibular incisor [3.04 mm (males) and 3.25 mm (females)], lower lip anterior[1.84 mm (males) and 0.29 mm (females)], B-point' [5.9 mm (males) and 5.38 mm (females)], and Pogonion' [6.53 mm (males) and 5.75 mm (females)].

Moreover, nasal projection was greater [1.34 mm (males) and 1.0 mm (females)] in White population than in W.UP population.

Intramandibular harmony values for Mandibular incisor–Pogonion' harmony were higher [3.52 mm (males) and 2.27 mm (female)] in White populations while harmony values for lower-lip–pogonion' were higher [2.73 mm (males) and 1.47 mm (females)] are higher in W.UP population.

All three interjaw harmony values were higher in W.UP population: Subnasale–pogonion' harmony [5.59 mm (males) and 5.06 mm (females)]; A-point'–B-point' harmony [3.92 mm (males) and 3.6 mm (females)]; Upper lip anterior'–lower lip anterior' [1.54 mm (males) and 1.61 mm (females)].

Orbit to jaw harmony value for orbital rim'–pogonion' harmony was higher [4.46 mm (males) and 4.0 mm (females)] in White population.

Facial angle was higher [5.34 mm (males) and 4.1 mm (females)] in White population. Moreover, Glabella'–Pogonion' harmony values were higher [6.88 mm (males) and 7.81 mm (females)] in White population. Females of White population had higher values (4.4 mm) for Glabella'–A-point' harmony than for females of W.UP population.

Discussion

Our findings are discussed under the five headings of the STCA:[9]

1. Dentoskeletal factors
   - When compared with Whitehite population, following significant differences ($P < 0.05$) were found in our study population. Both males and females had higher value for *inclination of Maxillary Occlusal plane to TVL* than their white counterparts. This suggests a steeper occlusal plane in our study population compared with White population. Moreover, females had lesser value for *Mandibular incisor to occlusal plane* and *overjet* and males had lesser values for overbite compared with their White counterparts. These differences can be attributed to racial and ethnic differences between the two populations.
2. Soft tissue structures
   - When compared with White population, following significant differences were found in our study population. Females had *thicker upper lips and thinner lower lips* than their White counterparts. Moreover, *upper lip angle* was lower in females of our study sample. Males had *thinner lower lips* than their White counterparts. These findings suggest that females in our study had more retropositioned lips than their White counterparts.
3. Facial lengths
   - Significant difference was noted while analyzing facial lengths between our study population and White population. Maxillary incisor exposure, maxillary height, mandibular height, interlabial gap, and length of lower third of the face are greater in White population. Moreover, total facial height, upper lip length, lower lip length were higher in White males. Similar findings for Indian population have been reported in previous studies.[21-23]

Table 1: STCA values derived for subjects selected from western Uttar Pradesh population

Parameter	Sex	*N*	Mean	Std. deviation	*P* value
Dentoskeletal factors					
Maxillary central incisor to maxillary occlusal plane (°)	Male	16	58.719	4.3281	0.695
	Female	17	58.000	5.9214	
Mandibular central incisor to mandibular occlusal plane (°)	Male	16	62.406	4.9471	0.667
	Female	17	61.647	5.0952	
Overjet (mm)	Male	16	2.844	0.6511	0.847
	Female	17	2.882	0.4851	
Overbite (mm)	Male	16	2.625	0.6455	0.132
	Female	17	3.029	0.8380	
Maxillary occlusal plane (°)	Male	16	98.781	2.7566	0.242
	Female	17	100.088	3.4742	
Soft tissue structures					
Upper lip thickness (mm)	Male	16	14.938	1.1815	**0.001**
	Female	17	13.676	0.7276	
Lower lip thickness (mm)	Male	16	14.094	1.1287	**0.000**
	Female	17	12.588	0.8703	
Pogonion–pogonion' (mm)	Male	16	14.344	1.8140	**0.002**
	Female	17	12.294	1.5817	
Menton–menton' (mm)	Male	16	9.500	1.1547	**0.000**
	Female	17	7.912	0.7952	
Nasolabial angle (°)	Male	16	102.438	8.9589	0.942
	Female	17	102.676	9.7387	
Upper lip angle (°)	Male	16	5.594	4.2238	0.591
	Female	17	6.324	3.4728	
Facial lengths					
Nasion'–Menton' (mm)	Male	16	132.656	4.5267	**0.000**
	Female	17	122.265	4.2431	
Upper lip length (mm)	Male	16	22.750	1.6733	**0.032**
	Female	17	20.794	3.0724	
Interlabial gap (mm)	Male	16	0.063	0.2500	0.310
	Female	17	0.000	0.0000	
Lower lip length (mm)	Male	16	50.625	2.6426	**0.000**
	Female	17	45.794	2.8617	
Lower 1/3rd of face (mm)	Male	16	73.313	2.8040	**0.000**
	Female	17	66.500	4.7269	
Overbite (mm)	Male	16	2.625	0.6455	**0.034**
	Female	17	3.176	0.7694	
Maxillary central incisor Exposure (mm)	Male	16	1.906	0.9869	**0.014**
	Female	17	2.824	1.0299	
Maxillary height (mm)	Male	16	24.375	2.0453	0.504
	Female	17	23.765	3.0162	
Mandibular height (mm)	Male	16	51.625	2.0290	**0.000**
	Female	17	46.353	2.5906	
Projections to TVL					
Glabella (mm)	Male	16	-7.750	4.7293	0.516
	Female	17	-6.765	3.8735	
Orbital rims (mm)	Male	16	-24.531	3.5752	**0.000**
	Female	17	-20.147	2.4159	
Cheek bone (mm)	Male	16	-29.250	3.8557	**0.001**
	Female	17	-24.912	2.7400	
Subpupil (mm)	Male	16	-19.813	2.9826	**0.000**
	Female	17	-15.794	2.3787	
Alar base (mm)	Male	16	-14.469	2.2020	**0.001**
	Female	17	-11.882	1.8331	
Nasal projection (mm)	Male	16	16.063	1.8697	0.098
	Female	17	15.029	1.6054	
Subnasale (mm)	Male	16	0.000	0.0000	
	Female	17	0.000	0.0000	
A point'(mm)	Male	16	-2.156	0.9953	0.359
	Female	17	-1.882	0.6738	
Upper lip anterior (mm)	Male	16	0.906	1.8277	0.659
	Female	17	1.147	1.2345	
Maxillary central incisor (mm)	Male	16	-15.469	2.4253	**0.004**
	Female	17	-12.765	2.5194	
Mandibular central incisor (mm)	Male	16	-18.438	2.5941	**0.004**
	Female	17	-15.647	2.6325	
Lower lip anterior (mm)	Male	16	-2.844	2.8327	0.360
	Female	17	-2.088	1.7432	

Contd...

Table 1: (*Contd*...)

Parameter	Sex	*N*	Mean	Std. deviation	*P* value
B point' (mm)	Male	16	-13.000	2.6077	**0.011**
	Female	17	-10.676	2.2977	
Pgonion' (mm)	Male	16	-10.031	3.0955	0.117
	Female	17	-8.353	2.8819	
Facial harmony					
Intramandibular relations					
Mandibular central incisor–Pogonion' (mm)	Male	16	8.375	2.2840	0.403
	Female	17	7.529	3.3188	
Lower lip anterior–Pogonion' (mm)	Male	16	7.125	1.6882	0.106
	Female	17	5.971	2.2394	
Bpoint'–Pogonion' (mm)	Male	16	3.094	1.2678	0.204
	Female	17	2.529	1.2307	
Throat length (mm)	Male	16	58.000	5.0465	0.231
	Female	17	56.147	3.5784	
Inter jaw relations					
Subnasale'–Pogonion' (mm)	Male	16	9.594	2.9338	0.198
	Female	17	8.265	2.8729	
A-point'–B-point' (mm)	Male	16	10.719	1.8436	**0.011**
	Female	17	8.794	2.2084	
Upper lip anterior'–lower lip anterior' (mm)	Male	16	3.844	1.4688	0.341
	Female	17	3.412	1.0787	
Orbital rim'–A-point' (mm)	Male	16	22.250	3.6968	**0.001**
	Female	17	18.529	2.0423	
Orbital rim'–pogonion' (mm)	Male	16	14.438	3.5160	0.066
	Female	17	12.000	3.8079	
Full facial balance					
Facial angle (°)	Male	16	164.063	4.4903	0.405
	Female	17	165.265	3.6662	
Glabella'–A-point' (mm)	Male	16	5.688	5.0162	0.333
	Female	17	4.000	4.8380	
Glabella'–pogonion' (mm)	Male	16	-2.281	5.3259	0.839
	Female	17	-1.912	5.0443	

**P*-value shown in 'bold' suggest that the difference between calculated mean values is statistically significant for the given parameter

4. Projections to TVL
   - Significance difference is noted while analyzing 'projections to TVL' between our study population and standard STCA values. Orbital rims, cheek bone, nasal projection, A-point', upper and lower lips, maxillary and mandibular incisors, B-point', and pogonion' are more prominent in White population. The difference can be attributed to ethnic difference between the two populations.
5. Facial harmony
   - Comparison of intramandibular harmony reveals statistically significant higher values for Mandibular incisor-pogonion' harmony in White population suggestive of more prominent chin in White population compared to our study population. Moreover, lesser value for lower lip anterior to Pogonion' harmony in White population suggest more prominent chin in White population.
   - Comparison of mean interjaw relationships of facial harmony showed that all values were higher in our sample compared with STCA norms. This was indicative of more convex profiles in our study population compared with White population. Moreover, mean facial angle of facial harmony values of this study were lower than those of STCA further confirming more convex profile in our sample. Comparison of orbit to jaw harmony values reveal that while orbital rim–A-point' harmony is comparable between two population, the values for orbital rim'–pogonion' are significantly higher in W.UP population. This suggests convex profile in our study sample is due to more retropositioned mandible and chin compared with White population. This point is further validated by higher values for Glabella'-pogonion' harmony in White population. Similar findings were reported by Grewal *et al.*[22] for north Indian population and Kalha *et al.*[21] for south Indian population when compared with standard STCA.

Conclusions

From the cephalometric study which was conducted on the 33 subjects (16 males and 17 females) selected from W.UP region of India, according to Arnett's STCA, following conclusions were drawn: (1) Compared with White population, females in our study sample had steeper maxillary occlusal plane, more proclined mandibular incisors and less protrusive lips. (2) Subjects had overall decrease in facial lengths, less prominent midface and mandibular structures and more convex profile compared

Table 2: Comparison of STCA values for Western Uttar Pradesh Population with Standard STCA norms

STCA values for W.UP population				Standard STCA norms				
Parameter	**Sex**	**Mean**	**Std. Deviation**	**Parameter**	**Sex**	**Mean**	**Std. Deviation**	***P* Value**
Dentoskeletal factors								
Maxillary central incisor to maxillary occlusal plane (°)	Male	58.72	4.33	Maxillary central incisor to maxillary occlusal plane (°)	Male	57.80	3.00	0.4575
	Female	58.00	5.92		Female	56.80	2.50	0.3629
Mandibular central incisor to mandibular occlusal plane (°)	Male	62.41	4.95	Mandibular central incisor to mandibular occlusal plane (°)	Male	64.00	4.00	0.2923
	Female	61.65	5.10		Female	64.30	3.20	**0.0421**
Overjet (mm)	Memale	2.84	0.65	Overjet (mm)	Male	3.20	0.60	0.0938
	Female	2.88	0.49		Female	3.20	0.40	**0.0239**
Overbite (mm)	Male	2.63	0.65	Overbite (mm)	Male	3.20	0.70	**0.0172**
	Female	3.03	0.84		Female	3.20	0.70	0.4760
Maxillary occlusal plane (°)	Male	98.78	2.76	Maxillary occlusal plane (°)	Male	95.00	1.40	**0.0001**
	Female	100.09	3.47		Female	95.60	1.80	**0.0001**
Soft-tissue structures								
Upper lip thickness (mm)	Male	14.94	1.18	Upper lip thickness (mm)	Male	14.80	1.40	0.7515
	Female	13.68	0.73		Female	12.60	1.80	**0.024**
Lower lip thickness (mm)	Male	14.09	1.13	Lower lip thickness (mm)	Male	15.10	1.20	**0.0146**
	Female	12.59	0.87		Female	13.60	1.40	**0.0113**
Pogonion–pogonion' (mm)	Male	14.34	1.81	Pogonion–pogonion' (mm)	Male	13.50	2.30	0.2409
	Female	12.29	1.58		Female	11.80	1.50	0.3111
Menton–menton' (mm)	Male	9.50	1.15	Menton–menton' (mm)	Male	8.80	1.30	0.1005
	Female	7.91	0.80		Female	7.40	1.60	0.2313
Nasolabial angle (°)	Male	102.44	8.96	Nasolabial angle (°)	Male	106.40	7.70	0.163
	Female	102.68	9.74		Female	103.50	6.80	0.7464
Upper lip angle (°)	Male	5.59	4.22	Upper lip angle (°)	Male	8.30	5.40	0.1094
	Female	6.32	3.47		Female	12.10	5.10	**0.0002**
Facial lengths								
Nasion'–Menton' (mm)	Male	132.66	4.53	Nasion'–Menton' (mm)	Male	137.70	6.50	**0.0128**
	Female	122.26	4.24		Female	124.60	4.70	0.105
Upper lip length (mm)	Male	22.75	1.67	Upper lip length (mm)	Male	24.40	2.50	**0.0301**
	Female	20.79	3.07		Female	21.00	1.90	0.7827
Interlabial gap (mm)	Male	0.06	0.25	Interlabial gap (mm)	Male	2.40	1.10	**0.0001**
	Female	0.00	0.00		Female	3.30	1.30	**0.0001**
Lower lip length (mm)	Male	50.63	2.64	Lower lip length (mm)	Male	54.30	2.40	**0.0001**
	Female	45.79	2.86		Female	46.90	2.30	0.1676
Lower 1/3rd of face (mm)	Male	73.31	2.80	Lower 1/3rd of face (mm)	Male	81.10	4.70	**0.0001**
	Female	66.50	4.73		Female	71.10	3.50	**0.0007**
Overbite (mm)	Male	2.63	0.65	Overbite (mm)	Male	3.20	0.70	**0.0172**
	Female	3.18	0.77		Female	3.20	0.70	0.9303
Maxillary central incisor exposure (mm)	Male	1.91	0.99	Maxillary central incisor exposure (mm)	Male	3.90	1.20	**0.0001**
	Female	2.82	1.03		Female	4.70	1.60	**0.0001**
Maxillary height (mm)	Male	24.38	2.05	Maxillary height (mm)	Male	28.40	3.20	**0.0001**
	Female	23.76	3.02		Female	25.70	2.10	**0.017**
Mandibular height (mm)	Male	51.63	2.03	Mandibular height (mm)	Male	56.00	3.00	**0.0001**
	Female	46.35	2.59		Female	48.60	2.40	**0.0058**
Projections to TVL								
Glabella (mm)	Male	-7.75	4.73	Glabella (mm)	Male	-8.00	2.50	0.8396
	Female	-6.76	3.87		Female	-8.50	2.40	0.0755
Orbital rims (mm)	Male	-24.53	3.58	Orbital rims (mm)	Male	-22.40	2.70	**0.0496**
	Female	-20.15	2.42		Female	-18.70	2.00	**0.0385**
Cheek bone (mm)	Male	-29.25	3.86	Cheek bone (mm)	Male	-25.20	4.00	**0.0042**
	Female	-24.91	2.74		Female	-20.60	2.40	**0.0001**
Subpupil (mm)	Male	-19.81	2.98	Subpupil (mm)	Male	-18.40	1.90	0.0935
	Female	-15.79	2.38		Female	-14.80	2.10	0.1592
Alar base (mm)	Male	-14.47	2.20	Alar base (mm)	Male	-15.00	1.70	0.4202
	Female	-11.88	1.83		Female	-12.90	1.10	**0.0274**
Nasal projection (mm)	Male	16.06	1.87	Nasal projection (mm)	Male	17.40	1.70	**0.0312**
	Female	15.03	1.61		Female	16.00	1.40	**0.0425**
Subnasale (mm)	Male	0.00	0.00	Subnasale (mm)	Male	0.00	0.00	NP
	Female	0.00	0.00		Female	0.00	0.00	NA
A-point' (mm)	Male	-2.16	1.00	A-point' (mm)	Male	-0.30	1.00	**0.0001**
	Female	-1.88	0.67		Female	-0.10	1.00	**0.0001**
Upper lip anterior (mm)	Male	0.91	1.83	Upper lip anterior (mm)	Male	3.30	1.70	**0.0003**
	Female	1.15	1.23		Female	3.70	1.20	**0.0001**
Maxillary central incisor(mm)	Male	-15.47	2.43	Maxillary central incisor(mm)	Male	-12.10	1.80	**0.0001**
	Female	-12.76	2.52		Female	-9.20	2.20	**0.0001**
Mandibular central incisor (mm)	Male	-18.44	2.59	Mandibular central incisor (mm)	Male	-15.40	1.90	**0.0003**
	Female	-15.65	2.63		Female	-12.40	2.20	**0.0001**

Contd....

Table 2: (*Contd*...)

STCA values for W.UP population				Standard STCA norms				
Parameter	**Sex**	**Mean**	**Std. Deviation**	**Parameter**	**Sex**	**Mean**	**Std. Deviation**	***P* Value**
Lower lip anterior (mm)	Male	-2.84	2.83	Lower lip anterior (mm)	Male	1.00	2.20	**0.0001**
	Female	-2.09	1.74		Female	1.90	1.40	**0.0001**
B point' (mm)	Male	-13.00	2.61	B point' (mm)	Male	-7.10	1.60	**0.0001**
	Female	-10.68	2.30		Female	-5.30	1.50	**0.0001**
Pogonion' (mm)	Male	-10.03	3.10	Pogonion' (mm)	Male	-3.50	1.80	**0.0001**
	Female	-8.35	2.88		Female	-2.60	1.90	**0.0001**
Facial harmony								
Intramandibular harmony								
Mandibular central	Male	8.38	2.28	Mandibular central incisor–	Male	11.90	2.80	**0.0003**
incisor–Pogonion' (mm)	Female	7.53	3.32	Pogonion' (mm)	Female	9.80	2.60	**0.0162**
Lower lip anterior–	Male	7.13	1.69	Lower lip anterior–Pogonion'	Male	4.40	2.50	**0.0007**
Pogonion' (mm)	Female	5.97	2.24	(mm)	Female	4.50	2.10	**0.0346**
B-point'–pognion' (mm)	Male	3.09	1.27	B-point'–pognion' (mm)	Male	3.60	1.30	0.2456
	Female	2.53	1.23		Female	2.70	1.10	0.6388
Throat length (mm)	Male	58.00	5.05	Throat length (mm)	Male	61.40	7.40	0.1264
	Female	56.15	3.58		Female	58.20	5.90	0.2066
Inter-jaw relations								
Subnasale'–Pogonion'	Male	9.59	2.93	Subnasale'–Pogonion' (mm)	Male	4.00	1.70	**0.0001**
(mm)	Female	8.26	2.87		Female	3.20	1.90	**0.0001**
A-point '–B-point'(mm)	Male	10.72	1.84	A-point '–B-point'(mm)	Male	6.80	1.50	**0.0001**
	Female	8.79	2.21		Female	5.20	1.60	**0.0001**
	Female	3.41	1.08		Female	1.80	1.00	**0.0001**
Orbit to jaws								
Orbital rim'–A-point' (mm)	Male	22.25	3.70	Orbital rim'–A-point' (mm)	Male	22.10	3.00	0.8939
	Female	18.53	2.04		Female	18.50	2.30	0.9654
Orbital rim'–pogonion'	Male	14.44	3.52	Orbital rim'–pogonion' (mm)	Male	18.90	2.80	**0.0002**
(mm)	Female	12.00	3.81		Female	16.00	2.60	**0.0002**
Full facial balance								
Facial angle ([o])	Male	164.06	4.49	Facial angle ([o])	Male	169.40	3.20	**0.0002**
	Female	165.26	3.67		Female	169.30	3.40	**0.0006**
Glabella'–A-point' (mm)	Male	5.69	5.02	Glabella'–A-point' (mm)	Male	7.80	2.80	0.1193
	Female	4.00	4.84		Female	8.40	2.70	**0.0004**
Glabella'–pogonion' (mm)	Male	-2.28	5.33	Glabella'–pogonion (mm)'	Male	4.60	2.20	**0.0001**
	Female	-1.91	5.04		Female	5.90	2.30	**0.0001**

**P*-value shown in 'bold' suggest that the difference between calculated mean values is statistically significant for the given parameter

with White population. The findings of this study re-emphasize the need to devise orthodontic/orthognathic treatment goals based on 'normative values' derived for individual's own racial and ethnic background, as the concept of beauty and esthetic vary between different ethnic groups and different geographic regions.

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