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A Cross-Sectional Study To Establish Soft Tissue Cephalometric Norms For Orthognathic Surgery In Kerala Population

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ABSTRACT:
Aim: The aim of the investigation is to establish soft tissue cephalometric norms for orthognathic surgery in the population of Kerala and to compare the values obtained with Legan and Burstone soft tissue cephalometric analysis.
Materials and methods: Lateral cephalometric radiographs were taken for a total of 100 subjects (50 males and 50 females) of age group 18- 25 years, selected according to the inclusion criteria. All lateral cephalometric films were traced digitally and Legan and Burstone analysis was done using Nemoceph NX Orthodontic Cephalometric Software (version 6). The values obtained were statistically analyzed using the Statistical Package for Social Sciences (SPSS 16.0) and tabulated. The change in the values of different parameters were compared with the standard values of Legan and Burstone soft tissue analysis.
Results: The study revealed almost all the values as statistically significant hence necessitating the importance of this study. The norms are discussed under facial form and lip position.When the values derived for facial form from Kerala population was compared with original Caucasian norms all the values obtained were found to be significant except lower vertical height depth ratio with a highly significant difference for vertical height ratio and lower face- throat angle. When the lip position and form was compared with the Caucasian norms, all the values were significant except the vertical lip- chin ratio with highly significant values for the upper lip protrusion, lower lip protrusion, mentolabial sulcus, maxillary incisor exposure and inter labial gap. Thus a different set of soft tissue cephalometric norms was necessary for Kerala population which can aid the clinicians for diagnosis and treatment planning and the present study has formed a norm which could be used for future reference for patients undergoing orthognathic surgery.

Conclusion: COGS (Cephalometrics for Orthognathic surgery) can be used as the cephalometric norms for orthognathic surgery across the world in order to know the variation from normal and to bring these values to normal or near normal by orthognathic surgery.

Clinical significance: This present study has helped to form a new norm for this population for orthognathic surgery using COGS (Cephalometrics for Orthognathic surgery) which could be useful in future for knowing the variation from normal and to bring these values to normal or near normal by orthognathic surgery.

Keywords: COGS, Legan and Burstone soft tissue analysis, Cephalometric Norms.

1. INTRODUCTION

Though beauty lies in the eyes of the beholder, a thorough understanding of facial beauty is required including the evaluation of facial proportions, esthetics, and symmetry to alter dentofacial form clinically, whether through facial growth modification, orthodontics, or surgery[1]. In the past, the clinician's focus was on dental and skeletal relationships, on the assumption that if these were correct, soft tissue relationships would take care of themselves. Recently, it has been suggested that the major factor in determining a patient's final facial profile are the soft tissues[2,3]. Formulating a soft tissue treatment objective will enable the clinician to maximize the facial esthetic outcome by deciding on the treatment plan and mechanotherapy[4]. Orthodontic treatment targets to expand function, by creating optimal occlusion and stability and refining facial esthetics. However, in some instances,orthodontics alone may not be enough to correct the malocclusion resulting in a combination of orthodontics and orthognathic surgery. There are a number of methods existing for planning the orthognathic treatment and these have become more and more refined over the years and have concentrated on defining the skeletal pattern and the position of the dentition but a constant problem has been the prediction of soft tissue profile. One of the prediction method is cephalometric analysis. Orthodontists use cephalometric techniques to plan treatment, to monitor the patient during therapy, and to analyze growth and mechanotherapy after active patient care[7] and lateral cephalograms are being taken systematically in many countries prior to orthodontic treatment[8]. It has been shown that strict adherence to the hard tissue norms alone does not result in neither good facial balance nor long-term retention[9,10]. Various cephalometric analysis for Orthognathic surgery have been designed. Legan and Burstone soft tissue analysis[11]/Cephalometrics for Orthognathic Surgery (COGS), developed at University of Connecticut, was established in the year 1980 and was modified from previously established Burstone analysis in the year 1958[3] is one of the most common analysis systems used for orthognathic surgery.[5,12]COGS analysis has the features which make it particularly adaptable for the assessment of surgical orthognathic problems. The designated landmarks and measurements can be changed by several surgical procedures; rectilinear measurements can be readily transferred to a study case for mock surgery. Cephalometric norms can be valuable aids to the clinicians in determining patient abnormalities. Categorizing a patient and planning the extent of surgical manipulation is largely dependent on the normal values for that population. Therefore it becomes necessary to establish the norms for every ethnic group. Many studies have established cephalometric norms for various ethnic and racial groups[5, 12-15]. However little research has been done on Indian population. India is a subcontinent with plenty of racial subgroups and various religious and interracial mixtures. Nowadays, an increasing number of adult Keralites are looking for orthognathic and plastic surgery. It has become important to determine the cephalometric norms that could be useful in clinical applications for this ethnic group.The

most challenging task in any diagnostic system is the establishment of the range of normality. To determine the very existence of an abnormality, we should first establish a normal range from which to measure and evaluate the changes. It is a proven fact that the soft tissue profile of Kerala population is different from Caucasian population[13,15]. An established soft tissue cephalometric norm for orthognathic surgery in Kerala population was lacking and these norms are very useful before doing the surgery. Hence, the present study was aimed to establish soft tissue cephalometric norms for orthognathic surgery in Kerala population based on Legan and Burstone soft tissue analysis which was done on Caucasian population and also a gender wise difference were also calculated to see whether there was any significant change in facial profile with gender.

2. MATERIALS AND METHODS

This was across sectional study done in a tertiary care setting and samples were chosen using the simple random sampling. The sample size has been calculated to select the sample for the present study by using the formula:

$$E = Z_{\frac{\alpha}{2}} \cdot \frac{\sigma}{\sqrt{n}}$$

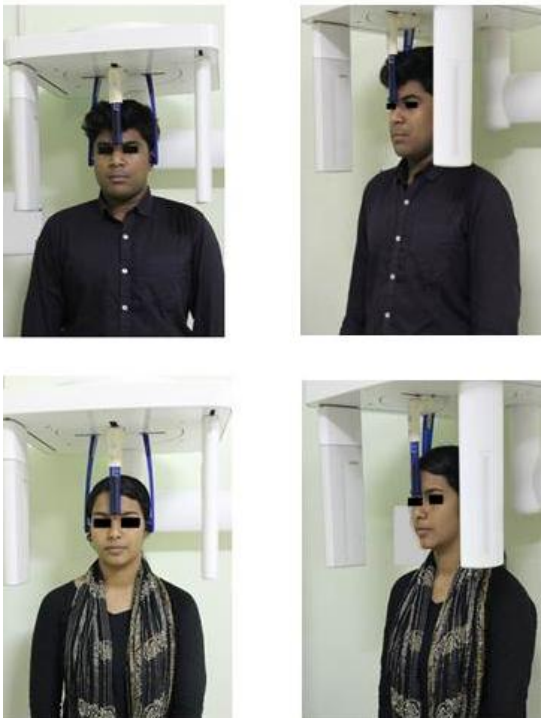
Where $Z_{\frac{\alpha}{2}}$ is the critical value, σ is the population standard deviation and 'n' is the sample size. E is the maximum difference between observed sample mean, $\bar{x}$ and true population mean, μ. With an error of 6 %, the samples size required for the present study was calculated as 96 and a total rounded off to 100 subjects for screening after considering inclusion and exclusion criteria. Lateral cephalometric radiographs were taken for a total of 100 subjects (50 males and 50 females) of age group 18- 25 years, selected according to the inclusion criteria with well- balanced facial profile and aesthetics, IOTN grade 1 or 2 and both parents and grandparents being Keralites without any interracial marriage. Subjects with history of previous orthodontic, prosthodontic or facial surgery treatment, systemic disease or with dento skeletal deformity were excluded from the study (Figure 1). The study period was one and half years. Written informed consent from the volunteers was obtained before taking their lateral cephalometric radiographs and after informing them about the radiation exposure. Subject confidentiality of personal information were strictly kept. The radiographs were taken in the cephalostat, Sirona Sidexis (XG model). The following recommendations were checked while taking the radiograph: 1. Teeth in centric occlusion.2. Head in natural head position.3. Lips passive[5, 13-15]The cassette was exposed while operating the cephalostat at a constant of 73 KVP, 15 mA and 14.9 s exposure time. The magnification factor of the cephalostat was 1:1.1. All lateral cephalometric films were traced digitally and Legan and Burstone analysis was done using Nemoceph NX Orthodontic Cephalometric Software (version 6). The landmarks taken for Legan and Burstone analysis is shown in Figure 2.The variables were analyzed digitally. The values obtained were statistically analyzed and tabulated. The change in the values of different parameters were compared with the standard values of Legan and Burstone soft tissue analysis. Error due to fatigue was eliminated by the investigator tracing 5 cephalograms on average in a day. The correction of magnification difference between successive cephalograms was deemed unnecessary because all radiographs were taken on the same cephalostat. To eliminate inter-investigator variability all radiographs were analyzed by a single investigator. The intra-investigator error was assessed by tracing 10 randomly selected cephalograms at a two weeks interval by the same investigator for evaluating the error of measurement using Karl Pearson's Correlation

Coefficient which showed a total negative correlation with p values statistically insignificant (Table 1).

3. RESULTS

Soft tissue cephalometric norms in Kerala population and the Caucasian population were compared in the present study. All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS 16.0). Data obtained were expressed in mean and standard deviation. Student's t test was used for analyzing the data and comparing the norms obtained for Kerala population with Caucasian norms. Subjects of age group 18 – 25 were taken for the study. Legan and Burstone analysis has both facial form and lip position and form. When the values derived for facial form from Kerala population was compared with original Caucasian norms all the values obtained were found to be significant except the lower vertical height-depth ratio with a highly significant difference for vertical height ratio and lower face- throat angle (Table 2). Concerning the facial convexity angle, it was found to be greater in Kerala population (13.74) than in Caucasians (12). The other parameters, maxillary and mandibular prognathism, also showed statistically significant differences. The lower face–throat angle was more obtuse (109.78) when compared with Caucasians (100). When the lip position and form was compared with the Caucasian norms, all the values were significant with highly significant values for the upper lip protrusion, lower lip protrusion, mento labial sulcus, vertical lip- chin ratio, maxillary incisor exposure and inter labial gap. Those upper lip protrusion, maxillary incisor exposure and inter labial gap were slightly increased in Kerala population than the Caucasian people whereas the naso labial angle, lower lip protrusion, mentolabial sulcus and vertical lip chin ratio were found to be decreased. When gender wise comparison was done for facial form, a significant difference was found for lower vertical height-depth ratio where it was found to be more in males than females. The rest of the values were similar in both the genders (Table 3).Gender wise comparison of lip position and form showed that the maxillary incisor exposure was more for females when compared with males and was statistically significant. The rest of the values were similar in both the genders.After obtaining the norms for Kerala Population, to test the validity of these results, another sample of 10 subjects were chosen according to the inclusion criteria and the lateral cephalometric radiographs were taken in a standardized manner and traced using Nemoceph NX Orthodontic Cephalometric Software (version 6). The values obtained were insignificant with similar results showing that the norms obtained could be applied for the Kerala population (Table 4).

Figure 1: Subjects positioned for the lateral cephalogram



Parameters	r-value	t-value	p-value
Facial Convexity Angle	-0.4286	-1.3416	0.2172
Maxillary Prognathism	-0.2817	-0.8304	0.4315
Mandibular Prognathism	-0.4804	-1.5491	0.1603
Vertical Height Ratio	-0.4637	-1.4803	0.1778
Lower face-throat angle	0.2005	0.5789	0.5786
Lower vertical height-depth ratio	0.4642	1.4826	0.1764
Nasolabial Angle	-0.1363	-0.3893	0.7071
Upper Lip Protusion	-0.0759	-0.2154	0.8348
Lower Lip Protusion	0.2395	0.6978	0.5050
Mentolabial Sulcus	-0.0618	-0.1754	0.8651
Vertical Lip-Chin Ratio	0.0476	0.1348	0.8960
Maxillary Incisor Exposure	-0.25	-0.7302	0.4860
Interlabial Gap	0.1666	0.4780	0.6453

Figure 2 : Land marks - Legan and Burstone analysis

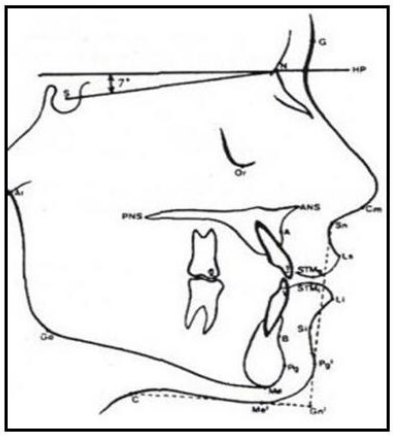


Table 1: Intra- observation calibration by Karl Pearson's correlation coefficient
*p<0.05

Table 2: Comparison of Kerala population and Caucasian population with respect to Facial Form and Lip Position and Form measurements by unpaired t test

Facial Form Measurements	South Indian population (n=100)		Caucasian population (n=40)		t-value	p-value
	Mean	SD	Mean	SD		
Facial Convexity Angle	13.74	3.31	12.00	4.00	2.4390	0.0073*
Maxillary Prognathism	4.24	4.71	6.00	3.00	2.4072	0.0089*
Mandibular Prognathism	1.71	5.88	0.00	4.00	1.9800	0.0238*
Vertical Height Ratio	1.06	0.11	1.00	0.001	3.4422	0.0008*
Lower face-throat angle	109.78	7.85	100.00	7.00	7.2099	0.0001*
Lower vertical height-depth ratio	1.25	0.23	1.20	0.001	1.3719	0.1723
Lip Position and Form Measurements	South Indian population (n=100)		Caucasian population (n=40)		t-value	p-value
	Mean	SD	Mean	SD		
Nasolabial Angle	98.41	10.96	102.00	8.00	2.0569	0.0211*
Upper Lip Protusion	4.48	2.13	3.00	1.00	4.6575	0.0001*
Lower Lip Protusion	3.51	1.84	2.00	1.00	4.9017	0.0001*
Mentolabial Sulcus	5.90	1.82	4.00	2.00	5.4234	0.0001*
Vertical Lip-Chin Ratio	0.57	0.72	0.50	0.00	0.6136	0.2706
Maxillary Incisor Exposure	3.63	1.85	2.00	2.00	4.4541	0.0001*
Interlabial Gap	3.06	1.48	2.00	2.00	3.0389	0.0011*

*p<0.05

Table 3: Comparison of male and females with respect to Facial Form and Lip Position and Form measurements by unpaired t test

Facial Form Measurements	Male		Female		t-value	p-value
	Mean	SD	Mean	SD		
Facial Convexity Angle	13.71	3.65	13.77	2.97	0.1007	0.4599
Maxillary Prognathism	3.72	5.80	4.76	3.26	1.1770	0.1210
Mandibular Prognathism	1.88	6.09	1.54	5.73	0.3286	0.3718
Vertical Height Ratio	1.04	0.11	1.07	0.11	1.5746	0.0592
Lower face-throat angle	110.86	9.22	108.71	6.08	1.4932	0.0692
Lower vertical height-depth ratio	1.31	0.24	1.20	0.20	2.7911	0.0031*

Lip Position & Form Measurements	Male		Female		t-value	p-value
	Mean	SD	Mean	SD		
Nasolabial Angle	96.38	9.48	100.45	12.02	1.8799	0.0315*
Upper Lip Protusion	4.53	1.69	4.44	2.51	0.2241	0.8232
Lower Lip Protusion	3.19	2.84	3.18	2.50	0.0187	0.4925
Mentolabial Sulcus	5.65	1.85	6.14	1.77	1.3533	0.0895
Vertical Lip-Chin Ratio	0.70	1.00	0.44	0.09	1.8311	0.0350*
Maxillary Incisor Exposure	3.02	1.51	4.24	1.96	3.4867	0.0003*
Interlabial Gap	2.83	1.25	3.29	1.66	1.5653	.06035

*p<0.05

Table 4: Comparison of present and standard study (validity)

Para-meters	Sub variables	Study to check validity		Present study		t-value	p-values
		Mean	SD	Mean	SD		
Facial Form	Facial Convexity Angle	13.74	1.51	13.74	3.31	0.0000	1.0000
	Maxillary Prognathism	4.68	0.88	4.24	4.71	0.2904	0.7748
	Mandibular Prognathism	1.45	3.64	1.71	5.88	0.1369	0.4474
	Vertical Height Ratio	1.08	0.14	1.06	0.11	0.3555	0.7263
	Lower face-throat angle	109.63	3.75	109.78	7.85	0.0596	0.4768
	Lower vertical height-depth ratio	1.21	0.17	1.25	0.23	0.5346	0.3031
Lip Position and Form	Nasolabial Angle	99.29	9.65	98.41	10.96	0.1906	0.8509
	Upper Lip Protusion	4.43	1.65	4.48	2.13	0.0720	0.4720
	Lower Lip Protusion	3.44	1.84	3.51	1.84	0.0506	0.9602
	Mentolabial Sulcus	5.89	1.79	5.90	1.82	0.0743	0.9415
	Vertical Lip-Chin Ratio	0.50	0.08	0.57	0.72	0.3055	0.7634
	Maxillary Incisor Exposure	3.79	1.51	3.63	1.85	0.2117	0.8352
	Interlabial Gap	3.08	0.43	3.06	1.48	0.0410	0.9677

*p<0.05

4. DISCUSSION

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 cephalometric values play a key role when assessing the success of treatment. Lateral cephalometric norms, however, may be specific to an ethnic group and cannot always be applied to other ethnic types. Therefore soft tissue values must precisely reproduce ideal norms of that specific ethnic group throughout

treatment.Currently, the cephalometric norms used for assessment of the deformity and the treatment planning of Keralites are those for the Caucasian population.In the present study, surgically useful rectilinear cephalometric norms using COGS for the diagnosis and treatment planning of orthognathic surgery in Kerala population were developed for its practical implementation in the treatment of the facial deformities. All the lateral cephalograms were traced digitally using Nemoceph NX Orthodontic Cephalometric Software (version 6). According to Roden-Johnson D et al[46] there was no significant difference in tracing cephalogram manually or digitally. Since most patients pursuing orthognathic surgery treatment are adults, this sample was limited to young adults within the age group of 18 – 25 years. The norms are discussed under facial form and lip position. When the values derived for facial form from Kerala population was compared with original Caucasian norms all the values obtained were found to be significant except lower vertical height depth ratio with a highly significant difference for vertical height ratio and lower face- throat angle. Concerning the facial convexity angle, which decides the overall soft tissue profile of the patient, it was found to be greater, which implies a more convex profile in Kerala population than in Caucasians. The other parameters, maxillary and mandibular prognathism, also showed statistically significant differences. High variability was found in the value of maxillary prognathism, which might be due to the variable anterior and posterior position of the glabella. This measurement and other related anteroposterior measurements are important in planning treatment for anterior maxillary advancement or reduction and for LeFort I maxillary horizontal advancement or reduction. The measurement of mandibular prognathism gives an indication of prognathism or retrognathism. This value can be evaluated along with other measurements to distinguish between microgenia, micrognathia, or retrognathia. The lower face–throat angle was more obtuse (109.78) compared with Caucasians (100). An understanding of this angle is crucial in treatment planning to correct anteroposterior dysplasias. With an obtuse angle all the procedures that reduce prominence of the chin should be avoided. The lower vertical height – depth ratio was found to be insignificant between the Keralites and Caucasians similar to study by P. Jain et al[5] in North Indians. When the lip position and form was compared with the Caucasian norms, the upper lip protrusion, maxillary incisor exposure and inter labial gap was found to be more in Kerala population than the Caucasian people whereas the naso labial angle, lower lip protrusion, mentolabial sulcus, vertical lip chin ratio, was found to be decreased and all these values were significant. The naso labial angle which can be used to assess anteroposterior maxillary dysplasias and position of upper lip was more acute and could be due to more protrusive upper lips than in Caucasians. The interlabial gap and the maxillary incisor exposure was significantly larger when compared with Caucasians which could be due to vertical maxillary excess. The present study is compared with the study by P. Jain et al[5] because they have formed norms for North Indians based on COGS and can be easily compared to show that there is variation among different ethnic groups. Our study differed from the study done in north Indian population by P. Jain et al[5] in that they had statistically insignificant values when compared with the Caucasian population for maxillary prognathism, mandibular prognathism, vertical height ratio, lower vertical height- depth ratio and maxillary incisor exposure whereas all these values where statistically significant in the present study with the highly significant values for vertical height ratio, lower face throat angle, upper and lower lip protrusion, mentolabial sulcus, vertical lip – chin ratio, maxillary incisor exposure and inter labial gap. Adults of both sexes were included in the study to segregate soft tissue norms according to gender. In the present study it was found that when gender wise comparison was done for facial form, a significant difference was found for lower vertical height-depth ratio where it was found to be more in males than in females similar to the study by Anmol Kalha[14] on South Indians &P. Jain et al[5] on North Indians. When lip position and form were compared, it showed that the

maxillary incisor exposure was more for females when compared to males and was statistically significant and concurrent with Anmol Kalha[14] s study whereas this value was similar in both genders in the study by P. Jain et al[5]. The rest of the values were similar in both the genders and in agreement with P.Jain's. Significant differences were also found when other ethnic groups were compared with Caucasians using Legan and Burstone analysis. Lew et al[47] showed that Chinese subjects had less convex faces, retrognathic chin, less obtuse nasolabial angle and more protrusive lips in comparison with Caucasians. In a similar study by Alcaldeet al[35] Japanese subjects had a retrognathic maxilla, retruded chin with less deep inferior sulcus, obtuse nasolabial angle, and more protrusive lips compared with Caucasians. A similar study by Ahmet ArifCelebiet al[13] on Turkish subjects showed an increased facial convexity associated with retruded mandible, more obtuse lower face-throat angle, increased nasolabial angle and upper lip protrusion, deeper mentolabial sulcus, and smaller interlabial gap when compared with the Caucasians. In a study by Al-Gunaidet al[39] on Yemini population, soft tissue analyses showed a more convex facial form, a more retruded mandible, obtuse lower face–throat angle, deep mentolabial sulcus, shorter interlabial gap and increased incisor exposure compared with Caucasians. Study by Anmol. S. Kalha[14] in south Indian population using the soft-tissue cephalometric analysis (STCA) derived a statistically significant differences between South Indian men and women in certain key parameters. Men have thicker soft-tissue structures and a more acute nasolabial angle than women. Men have longer faces, and women have greater interlabial gap and maxillary incisor exposure.All the above studies show that there is variation among ethnic groups. Hence a separate set of cephalometric norms is necessary for the Kerala population. The present study has been validated by applying the norms derived from this study to a sample of 10 subjects selected according to the same inclusion criteria and statistically insignificant values were obtained showing that these norms can be applied for the Kerala population. Several studies have established cephalometric norms for various ethnic and racial groupsas these norms differs with these factors in different population. Hence, the present study was aimed to establish soft tissue cephalometric norms for orthognathic surgery in the Kerala population based on Legan and Burstone soft tissue analysis which was done on Caucasian population as an established soft tissue cephalometric norm for orthognathic surgery in Kerala population was lacking and these norms are very useful before doing the surgery. A gender wise difference was also calculated as there are minor variations between both genders and some values were found significant between both in the present study.In the present study, there was a significant difference in the norms obtained for Kerala population when compared with the Caucasian norms between almost all the values. Prior ethical clearance was obtained from the Institutional Ethics Committee (PMS/IEC/2013(b)/14).

5. CONCLUSION

COGS (Cephalometrics for Orthognathic surgery) can be used as the cephalometric norms for orthognathic surgery across the world in order to know the variation from normal and to bring these values to normal or near normal by orthognathic surgery.

Clinical Significance

The present study has helped to form a new norm for this population for orthognathic surgery using COGS (Cephalometrics for Orthognathic surgery) which could be useful in future for knowing the variation from normal and to bring these values to normal or near normal by orthognathic surgery.

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