ORIGINAL RESEARCH

Different Population- Different Analysis – A Cephalometric Study

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ABSTRACT

Introduction: Cephalometric norms derived for Caucasian population are routinely used for investigations. As these norms show great degree of variation when applied to different populations, it becomes necessary to establish the norms for every ethnic group. The present study was designed to derive norms for the Maratha ethnic population, which would be comparable in diagnosis and treatment planning, to the hard and soft tissue Cephalometrics for Orthognathic Surgery (COGS) analyses given by Burstone et al. (1978) and Legan and Burstone (1980) respectively.

Materials and Method: The study was conducted in the Department of Orthodontics, Dr. D. Y. Patil Dental College and Hospital, Pune. The sample consisted of 60 adult subjects (30 males and 30 females) of Maratha ethnic origin. The age ranged between 18 to 26 years. The cephalograms of the subjects were subjected to COGS analysis and were complemented by a few additional readings.

Result: The cephalometric norms for COGS analysis of the Maratha population differed significantly from the Caucasian population. Comparison of our sample with the other ethnic group reaffirmed the need to develop separate standards for different populations.

Conclusion: Therefore, it is legitimate and important for those undertaking surgical orthodontic treatment for patients of Maratha ethnicity to use cephalometric norms for Maratha ethnic population. A similar study can be done worldwide for establishing norms for different analysis for its local population.

Keywords: Cephalometrics, orthognathic surgery, ethnic group.

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INTRODUCTION

There is no doubt that successful outcome of treatment depends on the accurate diagnosis. Cephalometric analysis is an old aid in the diagnosis of skeletal and dental problems. Commonly used cephalometric analysis are primarily designed to harmonize the position of the teeth with the existing skeletal pattern.[1-3]

In patients requiring orthognathic surgeries, the maxillary bones are also misplaced in their relationship along with the teeth in three planes of space. Hence, to diagnose the extent of malposition of skeletal bones, Legan and Burstone designed a cephalometric analysis which could be used for planning orthognathic surgeries.[4,5] The Cephalometrics for Orthognathic Surgery (COGS) system describes the horizontal and vertical position of facial bones by use of a constant coordinate system (constructed horizontal and vertical planes); the sizes of the bones are represented by direct linear dimensions and their linear shapes, by angular measurements.

Planning to improve a patient's profile requires to evaluate the extent of corrections desired, which should also be coinciding with the extent of corrections desired by the patient and their family members, along the set of commonly agreed norms.[6] There is definitely a truth in the adage that 'beauty is altogether in the eyes of the beholder', as pointed out by Margaret Hungerford in l878, and our perception of attractiveness is both instinctive (inherited) and universal, i.e. cross-cultural. However, different norms are required for different populations as each racial group might have a different concept of facial esthetics, based on ethnic background and racial preferences. Numerous studies have shown that surgical and orthodontic cephalometric norms developed for Caucasian populations has been shown to be inadequate for other racial groups.[7-8]

Naidoo et al while evaluating cephalometric norms for black South African adults using hard and soft tissue COGS analyses found that they were at variance than those established in Caucasian population.[9] Variance was also found by Rafeal et al on comparing Japanese population with the Caucasian using similar analyses. The Japanese population had a shorter maxilla, a larger upper anterior facial height and a lower posterior facial height than the population compared.[10]

Well-established cephalometric norms are lacking for the different ethnic populations living in India. Since this study was done in the state of Maharashtra where the Marathas comprise of almost 50% of the dwelling population, they were considered to be compared to the Caucasian population using the hard and soft tissue COGS analyses. The purpose of this study was to evaluate mean measurements for Maratha ethnic adults which would be comparable in diagnosis and treatment planning, to the hard and soft tissue COGS analyses given by Burstone et al. (1978) and Legan and Burstone (1980) respectively. The established norms would be compared to those of the Caucasian population and between male and female sample subjects respectively.

MATERIALS AND METHOD

The study was conducted in the Department of Orthodontics and Dentofacial Orthopedics, Dr. D. Y. Patil Dental College & Hospital, Pimpri, Pune, Maharashtra, India. The sample consisted of 60 adult subjects (30 males and 30 females) of Maratha ethnic origin, selected from the dental students studying at various colleges of the same management in Pune. The age ranged between 18 to 26 years (Figures 1 & 2). An informed consent was taken from each subject for the study.

The inclusion criteria for the sample selection were as follows:

1. Subjects should be Maratha ethnic individuals, traced back to two generations.
2. Acceptable, pleasing and preferably straight profiles.
3. Class I molar relationship on both the sides, with normal overjet and overbite with no or minimal crowding or spacing.
4. Good quality Cephalometric records.

The exclusion criteria for the sample selection were as follows:

1. History of previous orthodontic treatment.
2. Presence of gross abnormality or severe crowding.
3. Missing teeth except III molars.
4. Presence of gross facial asymmetry or deformity.

The lateral cephalometric radiographs were taken on a Planmeca Proline XC Dimax3 x-ray machine in the Department of Oral Medicine Diagnosis and Radiology, Dr. D. Y. Patil Dental College & Hospital, Pune. Lateral cephalograms of all the sample subjects were taken from the same X-ray machine with the subject in the Natural Head Position (NHP), with teeth in maximum intercuspation and lips in repose. Natural Head Position was obtained by asking the subject to look straight ahead such that the visual axis was parallel to the floor. The radiographs were exposed at 80KV/ 8mA for 0.8 second. The film to source distance was 5ft 2", and the distance between the film and patient's mid-sagittal plane was 6". The tracings were done on 75µm lacquered polyester papers using a 0.03mm lead pencil. A single operator performed the tracings in a standardized manner to avoid errors due to intra-operator variations.

All the tracings were subjected to COGS (Cephalometrics for Orthognathic Surgery) analysis, both for hard and soft tissues as described by Burstone et al.[14,15] The COGS analysis was complemented by a few additional readings (N-ANS/ANS-Gn, S-Go/N-Me).

STATISTICAL ANALYSIS

The measurements were statistically analyzed by calculating their means and standard deviations. Then the means of Maratha ethnic population were compared with means of Caucasian population with the help of Student's unpaired 't' test. A comparison was also made between males and females within the present study.

RESULTS

Measurement †	Male [Caucasian (n=14)]		Male [Maratha (n=30)]		Signi.
	Mean	SD	Mean	SD	
Cranial Base					
Ar - PTM (ll HP)	37.1	2.8	37.6	2.9	NS
PTM - N (ll HP)	52.8	4.1	58.8	2.1	***
Horizontal (Skeletal)					
N - A - Pg (angle)¶	3.9°	6.4°	-1.7	7.5	*
N - A (ll HP)	0.0	3.7	0.0	4.6	NS
N - B (ll HP)	-5.3	6.7	-1.0	5.3	*
N - Pg (ll HP)	-4.3	8.5	1.8	6.3	*
Vertical (Skeletal, Dental)					
N - ANS (⊥ HP)	54.7	3.2	57.6	4.0	*
ANS - Gn (⊥ HP)	68.6	3.8	67.6	7.2	NS
PNS - N (⊥ HP)	53.9	1.7	58.8	2.7	***
MP - HP (angle)¶	23.0°	5.9°	16.1	4.9	***
U1 - NF (⊥ NF)	30.5	2.1	30.2	3.6	NS
L1 - MP (⊥ MP)	45.0	2.1	40.9	3.7	***
U6 - NF (⊥ NF)	26.2	2.0	26.2	2.2	NS
L6 - MP (⊥ MP)	35.8	2.6	33.9	2.8	*
N-ANS/ANS-Gn	0.80	0.04	0.86	0.11	*
S-Go/N-Me	0.63	0.04	0.72	0.04	***
Maxilla, Mandible					
PNS - ANS (ll HP)	57.7	2.5	61.5	3.4	***
Ar - Go (linear)	52.0	4.2	59.1	4.9	***
Go - Pg (linear)	83.7	4.6	86.3	5.3	NS
B - Pg (ll MP)	8.9	1.7	6.2	1.6	***
Ar - Go - Gn (angle)¶	119.1°	6.5°	120.4	5.3	NS
Dental					
OP - HP (angle)¶	6.2°	5.1°	2.3	3.7	*
A - B (ll OP)	-1.1	2.0	1.2	3.5	**
U1 - NF (angle)¶	111.0°	4.7°	119.3	7.0	***
L1 - MP (angle)¶	95.9°	5.2°	98.7	5.9	NS

¶ Angular measurements in degrees; † All other measurements are linear measurements in millimeters.

* P<0.05 - Significant; ** P<0.01 - Highly Significant; *** P<0.001 - Very Highly Significant. NS - Non significant

Table-1: Comparison of mean values of hard tissue COGS analysis for males

Measurement †	Female [Caucasian (n=16)]		Female [Maratha (n=30)]		Signi.
	Mean	SD	Mean	SD	
Cranial Base					
Ar - PTM (ll HP)	32.8	1.9	36.3	2.8	***
PTM - N (ll HP)	50.9	3.0	54.6	2.3	***
Horizontal (Skeletal)					
N - A - Pg (angle)¶	2.6°	5.1°	2.6	6.0	NS
N - A (ll HP)	-2.0	3.7	-1.6	4.6	NS
N - B (ll HP)	-6.9	4.3	-5.5	7.1	NS
N - Pg (ll HP)	-6.5	5.1	-4.9	7.1	NS
Vertical (Skeletal, Dental)					
N - ANS (⊥ HP)	50.0	2.4	55.5	3.6	***
ANS - Gn (⊥ HP)	61.3	3.3	62.4	4.3	NS
PNS - N (⊥ HP)	50.6	2.2	54.5	3.0	***
MP - HP (angle)¶	24.2°	5.0°	21.5	4.7	NS
U1 - NF (⊥ NF)	27.5	1.7	28.6	2.5	NS
L1 - MP (⊥ MP)	40.8	1.8	37.2	3.3	***
U6 - NF (⊥ NF)	23.0	1.3	24.0	1.6	*
L6 - MP (⊥ MP)	32.1	1.9	31.3	3.8	*
N-ANS/ANS-Gn	0.82	0.06	0.90	0.09	**
S-Go/N-Me	0.63	0.04	0.67	0.04	**
Maxilla, Mandible					
PNS - ANS (ll HP)	52.6	3.5	55.8	3.6	**
Ar - Go (linear)	46.8	2.5	49.7	3.7	**
Go - Pg (linear)	74.3	5.8	80.3	4.5	**
B - Pg (ll MP)	7.2	1.9	4.9	1.5	***
Ar - Go - Gn (angle)¶	122.0°	6.9°	122.8	4.8	NS
Dental					
OP - HP (angle)¶	7.1°	2.5°	7.7	3.9	NS
A - B (ll OP)	-0.4	2.5	1.4	2.4	*
U1 - NF (angle)¶	112.5°	5.3°	117.6	5.9	**
L1 - MP (angle)¶	95.9°	5.7°	101.0	6.5	**

¶ Angular measurements in degrees; † All other measurements are linear measurements in millimeters.

* P<0.05 - Significant; ** P<0.01 - Highly Significant; *** P<0.001 - Very Highly Significant. NS - Non significant

Table-2: Comparison of mean values of hard tissue COGS analysis for females

Measurement †	Caucasian (n=40)		Male [Maratha (n=30)]		Signi.
	Mean	SD	Mean	SD	
Facial Form					
G - Sn - Pg' ¶	12.0°	4.0°	13.50	6.90	NS
G - Sn (ll HP)	6.0	3.0	10.60	3.90	***
G - Pg' (ll HP)	0.0	4.0	6.02	6.32	***
G - Sn / Sn - Me'(⊥ HP)	1.0	0.0	0.85	0.12	***
Sn - Gn' - C ¶	100.0°	7.0°	116.80	9.80	***
Sn - Gn' / C - Gn'	1.2	0.0	1.20	0.24	NS
Lip Position and Form					
Cm - Sn - Ls ¶	102.0°	8.0°	99.98	10.80	NS
Ls to (Sn - Pg')	3.0	1.0	3.40	2.50	NS
Li to (Sn - Pg')	2.0	1.0	2.98	2.30	*
Si to (Li - Pg')	4.0	2.0	7.08	1.75	***
Sn - Stm_s / Stm_i - Me' (⊥ HP)	0.5	0.0	0.43	0.04	***
Stm_s - 1	2.0	2.0	2.32	1.78	NS
Stm_s - Stm_i (⊥ HP)	2.0	2.0	0.17	0.64	***

¶ Angular measurements in degrees; † All other measurements are linear measurements in millimeters.

* P<0.05 - Significant; ** P<0.01 - Highly Significant; *** P<0.001 - Very Highly Significant. NS - Non significant

Table-3: Comparison of mean values of soft tissue COGS analysis for males

Measurement †	Caucasian (n=40)		Female [Maratha (n=30)]		Signi.
	Mean	SD	Mean	SD	
Facial Form					
G - Sn - Pg' ¶	12.0°	4.0°	14.77	5.30	*
G - Sn (ll HP)	6.0	3.0	7.95	4.60	*
G - Pg' (ll HP)	0.0	4.0	1.82	7.80	NS
G - Sn / Sn - Me'(⊥ HP)	1.0	0.0	0.90	0.10	***
Sn - Gn' - C ¶	100.0°	7.0°	113.35	4.70	***
Sn - Gn' / C - Gn'	1.2	0.0	1.00	0.19	***
Lip Position and Form					
Cm - Sn - Ls ¶	102.0°	8.0°	103.37	12.80	NS
Ls to (Sn - Pg')	3.0	1.0	3.95	2.28	*
Li to (Sn - Pg')	2.0	1.0	3.38	2.50	**
Si to (Li - Pg')	4.0	2.0	6.07	1.34	***
Sn - Stm_s / Stm_i - Me' (⊥ HP)	0.5	0.0	0.46	0.06	**
Stm_s - 1	2.0	2.0	2.37	1.50	NS
Stm_s - Stm_i (⊥ HP)	2.0	2.0	0.10	0.28	***

¶ Angular measurements in degrees; † All other measurements are linear measurements in millimeters.

* P<0.05 - Significant; ** P<0.01 - Highly Significant; *** P<0.001 - Very Highly Significant. NS - Non significant

Table-4: Comparison of mean values of soft tissue COGS analysis for females

Measurement †	Male [Maratha (n=30)]		Female [Maratha (n=30)]		Signi.
	Mean	SD	Mean	SD	
Cranial Base					
Ar - PTM (ll HP)	37.6	2.9	36.3	2.8	NS
PTM - N (ll HP)	58.8	2.1	54.6	2.3	***
Horizontal (Skeletal)					
N - A - Pg (angle)¶	-1.7	7.5	2.6	6.0	*
N - A (ll HP)	0.0	4.6	-1.6	4.6	NS
N - B (ll HP)	-1.0	5.3	-5.5	7.1	**
N - Pg (ll HP)	1.8	6.3	-4.9	7.1	***
Vertical (Skeletal, Dental)					
N - ANS (⊥ HP)	57.6	4.0	55.5	3.6	*
ANS - Gn (⊥ HP)	67.6	7.2	62.4	4.3	**
PNS - N (⊥ HP)	58.8	2.7	54.5	3.0	***
MP - HP (angle)¶	16.1	4.9	21.5	4.7	***
U1 - NF (⊥ NF)	30.2	3.6	28.6	2.5	NS
L1 - MP (⊥ MP)	40.9	3.7	37.2	3.3	***
U6 - NF (⊥ NF)	26.2	2.2	24.0	1.6	***
L6 - MP (⊥ MP)	33.9	2.8	31.3	3.8	*
N-ANS/ANS-Gn	0.86	0.11	0.90	0.09	NS
S-Go/N-Me	0.70	0.04	0.67	0.04	**
Maxilla, Mandible					
PNS - ANS (ll HP)	61.5	3.4	55.8	3.6	***
Ar - Go (linear)	59.1	4.9	49.7	3.7	***
Go - Pg (linear)	86.3	5.3	80.3	4.5	***
B - Pg (ll MP)	6.2	1.6	4.9	1.5	**
Ar - Go - Gn (angle)¶	120.4	5.3	122.8	4.8	NS
Dental					
OP - HP (angle)¶	2.3	3.7	7.7	3.9	***
A - B (ll OP)	1.2	3.5	1.4	2.4	NS
U1 - NF (angle)¶	119.3	7.0	117.6	5.9	NS
L1 - MP (angle)¶	98.7	5.9	101.0	6.5	NS

¶ Angular measurements in degrees; † All other measurements are linear measurements in millimeters.

* P<0.05 - Significant; ** P<0.01 - Highly Significant; *** P<0.001 - Very Highly Significant. NS - Non significant

Table-5: Comparison of mean values of hard tissue COGS analysis between males and females

Measurement †	Male (n=30)		Female (n=30)		Signi.
	Mean	SD	Mean	SD	
Facial Form					
G - Sn - Pg' ¶	13.50	6.90	14.77	5.30	NS
G - Sn (ll HP)	10.60	3.90	7.95	4.60	*
G - Pg' (ll HP)	6.02	6.32	1.82	7.80	*
G - Sn / Sn - Me' (⊥ HP)	0.85	0.12	0.90	0.10	NS
Sn - Gn' - C ¶	116.80	9.80	113.35	4.70	NS
Sn - Gn' / C - Gn'	1.20	0.24	1.00	0.19	***
Lip Position and Form					
Cm - Sn - Ls ¶	99.98	10.80	103.37	12.80	NS
Ls to (Sn - Pg')	3.40	2.50	3.95	2.28	NS
Li to (Sn - Pg')	2.98	2.30	3.38	2.50	NS
Si to (Li - Pg')	7.08	1.75	6.07	1.34	*
Sn - Stm_s / Stm_i - Me' (⊥ HP)	0.43	0.04	0.46	0.06	*
Stms - 1	2.32	1.78	2.37	1.50	NS
Stms - Stmi (⊥ HP)	0.17	0.64	0.10	0.28	NS

¶ Angular measurements in degrees; † All other measurements are linear measurements in millimeters.

* P<0.05 - Significant; ** P<0.01 - Highly Significant; *** P<0.001 - Very Highly Significant. NS - Non significant

Table-6: Comparison of mean values of soft tissue COGS analysis between males and females

A personal correspondence with Dr. Charles Burstone revealed that while deriving norms for the Caucasian population, the correction of magnification error was not done, which was about 5%. The magnification of 13% was found in the linear measurements of the COGS analysis in the sample study. Hence the norms derived for the Maratha ethnic population should be corrected by 13% for all linear measurements if they have to be used for comparison with other ethnic populations, only if the other lateral cephalograms represent the “true size”. Most X-ray machines may have a magnification error of 10-15% because of the distance between the subject and the film/ sensor.

DISCUSSION

Proportionality is an important consideration while being judgmental about esthetics of a human face. Knowledge of the hard and soft tissue traits and their normal range in population helps in designing treatment plan to normalize the facial traits for a given individual. As of today, when well established norms for specific ethnic groups are lacking, one has to rely on Caucasian norms for the assessment of orthognathic surgical patient. This seems to be logically inappropriate because the two populations may have several dissimilarities, as is evident from the present study.

While comparing the various parameters of the hard & soft tissue of the COGS analysis, although not all but many of the variables showed statistically significant differences in their values. The differences in the measurements were seen in the anterior cranial base length, the posterior maxillary height, the antero-posterior maxillary length, the ramal length, posterior facial height to anterior facial height ratio & the inclination of maxillary incisor, which were all significantly more in the Maratha group than the Caucasian group. The chin prominence, the vertical eruption of lower incisor, the middle third to lower third height ratio, the lower vertical height to depth ratio, the upper lip length to lower lip length ratio and the inter-labial gap were significantly less in the Maratha group than the Caucasian group. The lower lip prominence and the depth of the mento-labial sulcus were significantly more in the Maratha group than the Caucasian group. Samples of Maratha group showed a slightly more convex profile than those in the Caucasian group.

This study furnishes norms that are more specific to a particular population, and as a corollary, will provide a better appraisal of their beauty. While correcting the magnification error for established norms of Maratha ethnic population, high significant differences were observed in the linear measurements of the craniofacial bones. The corrected value for the linear measurements in the soft tissue analysis did not differ significantly except for the depth of mento-labial sulcus [Si to (Li - Pg')] which is mildly less than the observed cephalometric value.

The established norms can be used as a reference guideline to know the extent of discrepancy in a particular case of Maratha ethnic population. It will depend on the cephalogram obtained for that case is with a magnification error or is of 'True size'. The values proposed by us should prove to be more relevant for the Maratha ethnic population. However, it must be emphasized that the cephalometric evaluation should be correlated with clinical observations to arrive at proper conclusions.

SCOPE FOR FUTURE STUDIES

A similar study can be carried out on different ethnic population and using a larger sample size. Establishing norms for different analysis for different ethnic populations would help us gather data and help treat each individual as per the set norms. A similar study of different analysis could be done worldwide for its given local populations. Advent of Cone-Beam Computed tomography allows for the 3D reconstruction of the dentofacial structures. Hence norms for ethnic population could be derived in the 3 dimensional plane of space. Cephalometric norms for other ethnic populations should also be derived and compared as the Indian population comprises of diverse ethnics and races.

CONCLUSIONS

In conclusion, we can say that the cephalometric norms for COGS of Maratha population differ from Caucasian population. Comparison of our sample with the other ethnic group reaffirmed the need to develop separate standards for different populations. Therefore, it is legitimate and important for those undertaking surgical orthodontic treatment of Maratha ethnicity to use cephalometric norms for Maratha ethnic population and thereof, a different set of standard values are required for different ethnic population. Also to this fact we would like to quote McNamara and Ellis observation that "infinite combinations of dento-skeletal and soft tissue relationships are possible to arrive at a face that is well balanced." Hence, cephalometric observations must be complemented with the clinical acumen for the particular case.

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