Establishment of Cephalometric Norms for the South Indian (Karnataka) Population Based on Burstone's Analysis

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Abstract

Primary aim Variability is characteristic of different faces and facial types, and normative data based on one population group does not represent all. Hence, this study was undertaken to establish skeletal cephalometric norms for the South Indian (Karnataka) population utilizing the norms laid by Burstone's analysis for Caucasians.

Methods The sample comprised of lateral cephalograms taken in natural head position of 100 participants (50 men, 50 women). The cephalograms were traced, analyzed and interpreted using the landmarks and values given by Burstone's analysis (Cephalometric analysis for Orthognathic surgery). The student's *t* test, standard deviation and mean deviation were calculated to compare between two groups.

Results Statistically significant skeletal differences were found between men and women of the South Indian origin in comparison to Caucasian origin. Men had decreased facial divergence, anterior maxillary dental height and proclined upper incisors. Women had marginally increased cranial base, increased midfacial height and proclined upper incisors.

Conclusion Statistically significant differences were found between South Indian men and women when compared with Caucasians in certain key parameters. These differences need to be considered when analyzing the cephalogram for orthognathic surgeries. The values derived from this study may be considered to make the deformity assessment and plan surgery to get optimal results for people of south Indian origin conclusive results can be derived after conducting a study with an eager sample size.

Keywords Cephalometric norms · Burstone's analysis · South Indian population · Karnataka · Ethnic norms · Racial groups · Dentofacial deformities

Introduction

The standard values of human facial measurements are derived from studies conducted. These standard measurements are utilized to measure the craniofacial dimensions, assessment of facial deformities and to monitor the post-operative results.

Various studies have stated that the standard measurement of one group should not be considered normal for other racial groups [1–4]. Different racial groups should be treated according to their own characteristics and it is therefore important to develop standards for various population groups [5–25]. Caucasian norms developed are in use for numerous cephalometric analysis, and are thus inadequate for application to other racial groups.

Burstone's cephalometric analysis [26, 27] is specially designed for patients who require orthognathic surgery and was developed by identifying various landmarks and measurements that can be altered by common surgical procedures. Because measurements are primarily linear,

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they may be readily applied to prediction overlays and study cast mountings and may serve as a basis for the evaluation of post-treatment stability.

Hence, a study was undertaken to develop cephalometric cranio-facial norms for Karnataka population using Burstone's cephalometric landmarks, dental and skeletal measurements (Figs. 1, 2, 3), so that those norms can be used for better understanding and management of dento-facial deformities in people belonging to Karnataka state.

Materials and Method

The study sample consisted of 50 male and 50 female subjects from different parts of Karnataka, studying in various colleges in Davangere city, aged between 18 and 25 years. A lateral cephalogram in occlusion and photographs were recorded.

Inclusion criteria

1. Clinically acceptable facial harmony and symmetry
2. Angle's class I molar relation, with minimum crowding/spacing/rotations
3. Normal overjet and overbite (<3 mm)
4. Full complement of teeth except 3rd molars with proper intercuspation
5. All the landmarks and planes used in the present study are according to the description and definition given by Burstone [26, 27].

Fig. 1 Burstone's cephalometric landmarks

Fig. 2 Burstone's Horizontal planes and angles

Fig. 3 Burstone's vertical, maxilla-mandible, dental planes and angles

PC, trophy radiologic orthopantomography machine with a filter wedge.

The films used were Kodak 8 × 10 in., KR4 cassettes were used with inbuilt intensifying screen of speed 400, distance between midsagittal plane of patient and film cassette was 6.25 in. The films were taken with teeth in centric occlusion.

For cephalometric application, the distance between the x-ray source and the midsagittal plane is 152.4 cm (60 inches). The central ray is directed towards the external auditory meatus and perpendicular to the plane of the film used and the midsagittal plane. The tracings were measured according to Burstone's planes and angles (Cephalometric analysis for Orthognathic surgery, COGS)

The films were then traced manually twice by operator to minimize observer's error. Two other observers also traced each cephalogram in order to assess any error. The midline of double contour bilateral structures was drawn to minimize error caused by head positioning and facial asymmetry. Angular and linear measurements were taken to the nearest 0.05° or 0.05 mm on lead acetate sheets with extra smooth finish HB pencil with a diameter of 0.3 mm.

Results

The male of Karnataka when compared to Caucasian male had: marginally increased cranial base relationship, decreased facial convexity, equally protruded maxillary anterior apical base and prognathic mandibular apical base in horizontal relationship, decreased facial divergence, decreased upper and lower incisor height. Essentially similar antero-posterior maxillary length, mandibular ramus length, similar chin prominence, decreased incisal plane and class I molar relationship, proclined upper incisors and normally inclined lower incisors (Table 1).

The South Indian Karnataka female compared to Caucasian female had; marginally increased cranial base length, increased anterior midfacial height, decreased facial divergence, upper and lower incisor and molar eruption,

Table 1 Values with significant differences (male)

	Burstone values		Observed values	
	Std.	Std.Dev	Std.	Std.Dev
N-A-Pg (angle)	3.9	6.4	1.8	6.0
N-B (11 HP)	−5.3	6.7	−1.4	6.9
MP-HP (angle)	23.0	5.9	19.1	4.0
1J-NF (⊥NF)	30.5	2.1	27.2	3.1
1J-MP (⊥MP)	45.0	2.1	41.5	4.1
OP-HP(angle)	6.2	5.1	3.4	1.9
1J-NF(angle)	111.0	4.7	121.2	7.3

Table 2 Values with significant differences (female)

	Burstone values		Observed values	
	Std.	Std.Dev	Std.	Std.Dev
Ar-PtM(11 HP)	32.8	1.9	37.1	2.8
N-ANS (⊥HP)	50.0	2.4	53.2	3.1
MP-HP (angle)	24.2	5.0	19.7	3.9
Ar-GO (linear)	46.8	2.5	49.4	5.0
Go-Pg (linear)	74.3	5.8	78.9	4.8
1J-NF(angle)	112.5	5.3	120.6	4.6

ramus and body length was increased, proclined upper incisor and adequately inclined lower anteriors (Table 2).

Discussion

In human beings, the lower face serves not only in the interest of digestion, speech and respiration, but it also influences to a large extent the social acceptance and psychological well-being of the individual. Appearance therefore is one of the primary functions of the face. Variations between and within different ethnic population was reported previously, which differs with factors such as age, sex and racial origin. Superimposed on these factors are those characteristics that are unique for each individual. Because of such inherent variations, standard developed for any population should be used only as a reference line and not as absolute values.

Cephalometric norms have been established using various analysis such as McNamaras, Steiners, Downs etc, for the Indian population like for Gujaratis [16], North Indians [17], Maharashtrians [18], Bunts [24], Gurkhas [20], Madras city population [21], Aryo-Dravidians [15] and Indo-Aryans [23].

Various other studies on different ethnic groups distributed in many geographic locations such as Japan [5–10], China [11–13], Iran [4, 14], Korea [15] and African ancestry negro [28, 29]. These studies have proved the difference in ethnic values and the importance to have norms developed for regional population for interpretation, deformity assessment and treatment planning.

Burstone's analysis used for orthognathic surgery provides a basis for the Caucasians norms, thus kindling the need to establish similar cephalometric norms for the Indian population [26, 27].

In our study, the total cranial base length (Ar-ptm-N) (Fig. 4) in Karnataka population was increased. The contributing factor for the overall length in males was due to increase in PtM-N, whereas in females it was due to increase in Ar-Ptm. In both cases the maxilla was positioned forward when measured against the skull base.

Fig. 4 Cranial Base length

Fig. 5 a Horizontal skeletal (male). b Horizontal skeletal (female)

Fig. 6 a Vertical skeletal and dental (male). b Vertical skeletal and dental (female)

Fig. 7 a Maxilla and mandibular relation (male). b Maxilla and mandibular relation (female)

Fig. 8 a Dental relation (male).
b Dental relation (female) **Table 3** Burstones norms derived for Karnataka population (male)

	Burstone values		Observed values	
	Std.	Std. Dev	Std.	Std. Dev
Cranial base				
Ar-PtM(11 HP)	37.1	2.8	38.1	2.3
PTM-N (11 HP)	52.8	4.1	55.4	3.3
Horizontal (Skeletal)				
N-A-Pg(angle)	3.9	6.4	1.8	6.0
N-A(11 HP)	0.0	3.7	-0.9	4.7
N-B (11 HP)	-5.3	6.7	-1.4	6.9
N-Pg(11 HP)	-4.3	8.5	-2.5	6.2
Vertical (Skeletal, Dental)				
N-ANS ($\perp$ HP)	54.7	3.2	52.4	2.9
ANS-Gn($\perp$ HP)	68.6	3.8	67.2	4.4
PNS-N ($\perp$ HP)	53.9	1.7	56.4	3.9
MP-HP (angle)	23.0	5.9	19.1	4.0
I] - NF($\perp$ NF)	30.5	2.1	27.2	3.1
I]-MP($\perp$ MP)	45.0	2.1	41.5	4.1
6]-NF ($\perp$ NF)	26.2	2.0	23.9	1.6
6]-MP ($\perp$ MP)	35.8	2.6	35.7	4.8
Maxilla, mandible				
PNS-ANS (11 HP)	57.7	2.5	58.3	4.0
Ar-Go (linear)	52.0	4.2	54.4	6.3
Go-Pg (linear)	83.7	4.6	84.3	5.3
B-Pg (11 MP)	8.9	1.7	7.1	1.5
Ar-Go-Gn (angle)	119.1	6.5	118.5	5.2
Dental				
OP upper-HP (angle)	6.2	5.1	3.4	1.9
OP lower-HP (angle)	-			
A-B (11 Op)	-1.1	2.0	2.0	3.7
I]-NF (angle)	111.0		121.2	7.3
I]-MP (angle)	95.9		92.8	10.2

et al. [22] study on Aryo-Dravidians, a major ethnic group occupying Punjab and Kashmiri's facial norms were not different from Chinese and Iranians. Down's cephalometric norms showed comparatively retrognathic facial skeletal pattern among Indian ethnic groups and similarity to Gujarathis and Maharashtrians.

Maxilla, mandible relationship (Fig. 7a, b) did not differ much from Caucasians, but the ramus length was increased by 3 mm. The mandibular body length in female group was found to be 4.6 mm longer.

The dental relationship (Fig. 8a, b) showed a decrease in OP-HP angle in male with 3.20 as compared to 6.2° for the

Caucasians. A class I molar relation with relatively proclined upper incisors in both sexes and a decrease in occlusal plane for the male study group was recorded in our study.

Interpretations for male study group compared to Caucasian male are: marginally increased cranial base relationship, decreased facial convexity, equally protruded maxillary anterior apical base and prognathic mandibular apical base in horizontal relationship, but the apical base were found to be retrusive when compared to Chinese and Negros [24, 28, 29]. Equal midfacial height and lower facial height, posterior facial height, decreased facial divergence, decreased upper and lower incisor height with normal molar to mandibular lower border height. Essentially similar antero-posterior maxillary length, mandibular ramus length, similar chin prominence, decreased incisal plane and class I molar relationship, proclined upper incisors and normally inclined lower incisors (Table 1).

Interpretation for female study group compared to Caucasian female are: marginally increased cranial base length, similar profile, equally protruded anterior maxilla, increased anterior midfacial height, similar lower facial height and postero-anterior facial height, decreased facial divergence, upper and lower incisor, molar eruption, antero-posterior maxillary length remained same but ramus and body length was increased, occlusal plane values maintained with class I molar relationship, proclined upper incisor and adequately inclined lower anteriors (Table 2).

Summary and Conclusion

Since the introduction of cephalometric radiography by Broadbent [30] and Hofrath [13] in 1931, this technique has been used extensively to establish normal and abnormal relationship of dental and skeletal pattern. As variations exist between and within different population groups due to factors of age, sex and racial groups, the need arises for establishment of the norms for individual groups. This study was conducted to fulfill the need for establishing Burstone's cephalometric norms, for the population of south Indian state of Karnataka. Cephalometric tracings revealed that some significant differences in values do exist in both male and female groups of the population chosen in our study. Hence, it is essential to explore the individual norms on the different ethnic groups in Indian population before accepting the standard Burstone's values and applying them in treatment planning and postoperative follow-up for relapse tendencies after orthognathic surgical procedures. Though cephalometry forms an important aid in diagnosing the skeletal and dental discrepancies, the role of clinical examination and other diagnostic aids in orthognathic surgery should not be ignored.

This study is an attempt to provide better knowledge of facial morphology in this area of Karnataka population and

Table 4 Burstones norms derived for Karnataka population (female)

	Burstone values		Observed values	
	Std.	Std. Dev	Std.	Std. Dev
Cranial base				
Ar-PtM(11 HP)	32.8	1.9	37.1	2.8
PTM-N (11 HP)	50.9	3.0	50.5	3.9
Horizontal (Skeletal)				
N-A Pg (angle)	2.6	5.1	1.2	4.6
N-A (11 HP)	−2.0	3.7	−2.4	2.0
N-B(11 HP)	−6.9	4.3	−6.5	3.3
N-Pg (11 HP)	−6.5	5.1	−5.1	3.6
Vertical (Skeletal, Dental)				
N-ANS (⊥HP)	50.0	2.4	53.2	3.1
ANS-Gn (⊥HP)	61.3	3.3	62.1	5.2
PNS-N (⊥ HP)	50.6	2.2	51.6	2.6
MP-HP (angle)	24.2	5.0	19.7	3.9
1]-NF(⊥NF)	27.5	1.7	25.7	3.8
1]-MP (⊥ MP)	40.8	1.8	39.1	2.7
6]-NF (⊥ NF)	23.0	1.3	23.0	2.9
6]-MP (⊥ MP)	32.1	1.9	32.5	2.8
Maxilla, mandible				
PNS-ANS (11 HP)	52.6	3.5	53.7	3.5
Ar-Go (linear)	46.8	2.5	49.4	5.0
Go-Pg (linear)	74.3	5.8	78.9	4.8
B-Pg (11 MP)	+7.2	1.9	5.8	1.9
Ai-Go-Gn (angle)	122.0	6.9	119.6	4.1
Dental				
OP uppcr-HP (angle)	7.1	2.5	7.2	3.5
OP lower-HP(angle)	–			
A-B (11 OP)	−0.4	2.5	1.3	3.8
1]-NF (angle)	112.5	5.3	120.6	4.6
1]-MP (angle)	95.9	5.7	94.7	10.3

presents the norms specific for the people in this region (Tables 3 and 4). Hence a comprehensive treatment planning can be done based on the norms derived for the patients requiring orthognathic surgery for the correction of skeletal discrepancies.

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References

- Bishara SE, Abdalla EM, Hoppens BJ (1990) Cephalometric comparisons of dentofacial parameters between Egyptians and North American adolescents. *Am J Orthod Dentofacial Orthop* 97(5):413–421

2. Cotton WN, Takano WS, Wong WMW (1951) The Downs analysis applied to three other ethnic groups. *Angle Orthod* 21(4): 213–220
3. Hajighamidi M, Dougherty H, Garanki F (1981) Cephalometric evaluation of Iranian children and its comparison with tweeds and steiner's standards. *Am J Orthod* 79(2):192–197
4. Kudhadkar A, Jayade VP (1997) Craniofacial morphology of an ethnic Tibetan population—a cephalometric evaluation. *J Ind Orthod Soc* 30:23–29
5. Engel G, Spolter BM (1981) Cephalometric and visual norms for a Japanese population. *Am J Orthod* 80(1):48–60
6. Iizuka T, Ishikawa F (1957) Normal standards for various cephalometric analysis in Japanese adults. *J Jpn Orthod Soc* 16:4–12
7. Kayukava H (1954) Roentgenographic cephalometric craniofacial morphology of Japanese—part I; application of Down's analysis. *J Jpn Orthod Soc* 13:6–17
8. Miura F, Inove N, Suzuki K (1963) The standard of steiners analysis for Japanese. *Bull Tokyo Med Dent Univ* 10:387–395 (Cited By Ueseto)
9. Alcalde RE, Jinno T, Pogrel MA, Matsumura T (1998) Cephalometric norms in Japanese adults. *J Oral Maxillofac Surg* 56(2): 129–134
10. Shishikura K (1969) The study on measurements of hard and soft tissues by cephalogram, particularly on normal and class I occlusion among Japanese adults. *J Jpn Orthod Soc* 28(2): 263–273
11. Chan GK (1972) Cephalometric appraisal of the Chinese. *Am J Orthod* 61(3):279–285
12. Cooke MS, Wei SH (1987) A Comparative study of Southern Chinese and British Caucasian cephalometric standards. *Angle Orthod* 59(2):131–138
13. Wu J, Hagg U, Rabie AB (2007) Chinese norms of Mcnamara's cephalometric analysis. *Angle Orthod* 77(1):12–20
14. Jahanshahi M, Golalipour MJ, Heidari K (2008) The effect of ethnicity on facial anthropometry in northern Iran. *Singapore Med J* 49(11):940–943
15. Park IC, Bowman D, Klapper L (1989) A cephalometric study of Korean adults. *Am J Orthod Dentofacial Orthop* 96(1):54–59
16. Kotak VB (1964) Cephalometric evaluation of Indian girls with neutral occlusion. *J Indian Dent Assoc* 183–197
17. Nanda R, Nanda RS (1969) Cephalometric study of the dentofacial complex of North Indians. *J Indian Dent Assoc* 39(1): 22–28
18. Jalili VP, Shalkh HS (1984) Vertical dimensions of face and dentition—a cephalometric study. *J Indian Dent Assoc* 56(7): 249–259
19. Valiathan A (1974) Down's cephalometric analysis on adults from India. *J Indian Dent Assoc* 437–441
20. Joshi MR (1975) Dentofacial characteristics of a group of Gurkhas. *J Indian Orthod Soc* 7(4):3–12
21. Kannappan JG, Balasubramaniam MR (1976) Cephalometric norms for Madras city population. *J Indian Dent Assoc* 48: 359–362
22. Kharbada OP, Sidhu SS, Sundram KR (1989) Cephalometric profile of Aryo-Dravidians II. *J Indian Orthod Soc* 20(6):89–94
23. Grewal H, Sidhu SS, Kharbada OP (1995) Cephalometric appraisal of the craniofacial pattern in Indo-Aryans. *J Indian Orthod Soc* 26:43–48
24. Bhat M, Sudha P, Tandon S (2001) Cephalometric norms for bunt and brahmin children of dakshina kannada based on Mcnamara's Analysis. *J Indian Soc Pedod Prev Dent* 19(2):41–51
25. Tippu SR, Subramaniam M, Rahman F, Akkera U (2007) Soft tissue cephalometric norms for orthognathic surgery in Indian adults. *Int J Oral Maxillofac Surg* 36(11):10–20
26. Burstone CJ, James RB, Legan H, Murphy GA, Norton LA (1978) Cephalometric for orthognathic surgery. *J Oral Surg* 36(4):269–277
27. Burstones CJ (1958) The integumental profile. *Am J Orthod* 44:1–25
28. Beugre JB, Sonan NK, Beugre-Kouassi AM, Djaha F (2007) Comparative cephalometric study of three different ethnic groups of black Africa with normal occlusion. *Odontostomatol Trop* 30(117):34–44
29. Jacobson A (1978) The craniofacial skeletal pattern of the south African Negro. *Am J Orthod* 73(6):681–691
30. Broadbent BH (1931) A new X-ray technique and its application to orthodontia. *Angle Orthod* 1:45–60
31. Kalhaa AS, Latif AB, Govardhan SN (2008) Soft tissue cephalometric norms in a South Indian ethnic population. *Am J Orthod Dentofac Orthoped* 133(6):876–881