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Original Research Article

Establishment of Cephalometric Norms in Tamilnadu Young Adults Using Mcnamara Analysis

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Abstract:

Background: Cephalometric analysis is fundamental to orthodontic diagnosis and treatment planning. McNamara's analysis, although widely adopted, is primarily based on Caucasian reference data. This study aims to establish cephalometric norms for young adults from Tamil Nadu and compare these with McNamara's established standards.

Methods: One hundred standardized lateral cephalograms (50 males and 50 females), aged 19–26 years, were selected from the archives of the Department of Orthodontics, Tamil Nadu Government Dental College and Hospital. All participants exhibited clinically acceptable Class I occlusion and no history of orthodontic treatment. The radiographs were digitized and analyzed using VistaDent OC software following McNamara's protocol. Descriptive and inferential statistics were employed to evaluate gender-based differences and deviations from McNamara's norms.

Results: Tamil Nadu males exhibited significantly greater midfacial and mandibular lengths than females ($P < 0.001$). Compared with McNamara's norms, the midfacial length in Tamil Nadu males was reduced, indicative of a retrusive maxilla. Females showed more upright maxillary and mandibular incisors and a more prominent chin. Intra-examiner reliability was established with a Cronbach's alpha > 0.6.

Conclusion: Distinct cephalometric patterns were observed among Tamil Nadu young adults, emphasizing the importance of population-specific reference values in orthodontic diagnosis and treatment planning.

Keywords: Vista Dent, McNamara, Lateral Cephalograms.

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Introduction

Facial balance and harmony have long been core concerns in orthodontics, extending beyond dental alignment to encompass aesthetic appeal. In contemporary society—where appearance influences confidence, communication, and social integration—there is an increasing demand for orthodontic treatments that not only correct malocclusion but also enhance facial aesthetics.

However, the concept of beauty is neither fixed nor universal. It evolves over time and varies significantly across different cultural and ethnic backgrounds. This variability presents a unique challenge for clinicians aiming to achieve aesthetically pleasing treatment outcomes. Cephalometric analysis has emerged as a critical tool in orthodontics for diagnosing skeletal and dental relationships. Introduced independently by Broadbent in the United States and Hofrath in Germany in 1931, cephalometry provides a standardized two-dimensional radiographic assessment of craniofacial structures. This methodology remains central to orthodontic diagnosis and treatment planning, offering objective, reproducible data that guide clinical decisions. Early cephalometric analyses often relied on universal standards developed from Caucasian samples, assuming homogeneity in craniofacial structures [1].

However, extensive research has since demonstrated that cephalometric norms differ widely among racial and ethnic groups. Populations such as Japanese, Chinese, African Americans, Nigerians, and Arabs show distinctive skeletal and dental characteristics that influence facial form and function [2,3,4,5]. Applying generalized norms to diverse populations can lead to diagnostic errors and suboptimal treatment outcomes. Thus, developing population-specific cephalometric standards is es-

sential for personalized and effective orthodontic care. Over the decades, several analytical frameworks have been introduced to interpret cephalometric radiographs. Among the earliest and most influential was Downs' Analysis (1948) [18], which assessed skeletal-dental harmony in ideal occlusion cases. Subsequent models, including Steiner (1953), Sassouni (1969), Ricketts (1981), and Wits (Jacobson, 1975), each introduced new landmarks and angles to refine diagnostic accuracy. Among them, McNamara's Analysis (1984) stands out for its integrated approach [12]. It combines previous concepts with novel linear measurements, most notably the use of the nasion perpendicular to evaluate the anteroposterior relationship of the maxilla and mandible. Derived from the well-documented Bolton Standards, McNamara's method provides a clinically reliable and adaptable tool for orthodontic assessment.

While McNamara's analysis has been widely adopted, its application across ethnically diverse populations necessitates the development of localized norms. Aesthetic preferences and craniofacial structures vary, and relying on reference values derived from a different demographic may compromise treatment goals. Therefore, establishing cephalometric norms established for a specific population, especially those with naturally harmonious facial profiles and good occlusion is vital for accurate diagnosis and culturally sensitive treatment planning [9].

This study aims to establish cephalometric reference values for individuals with well-aligned dentition and aesthetically pleasing facial profiles using McNamara's analytical framework. By focusing on a defined ethnic group, the research intends to contribute normative data that can guide orthodontic practice within that population. The findings will not only enhance diagnostic precision but also promote individualized treatment planning in an increasingly multicultural clinical landscape. In essence, this research underscores the importance of integrating both scientific measurement and cultural context in orthodontics, reinforcing the idea that cephalometric norms must be as diverse and adaptable as the populations they serve.

Materials and Methods

Sample Selection: A total of 100 lateral cephalometric radiographs (50 males and 50 females) of subjects aged 19–26 years were retrieved from the archives of the Department of Orthodontics, Tamil Nadu Government Dental College and Hospital, Chennai. Individuals below 19 years of age were excluded to eliminate the influence of growth.

Inclusion Criteria:

- Balanced, aesthetically acceptable facial profile
- Class I molar relationship with a full set of permanent teeth (excluding third molars)
- Normal overjet and overbite
- No prior orthodontic treatment
- Acceptable minor crowding or rotations

Radiographic Protocol: All radiographs were captured in natural head position using a standardized cephalostat (Kodak 70 kVp, 30 mA, and exposure time 1.8 seconds, at a fixed distance of 60 inches), (Fig 1) Plumb line markers were used for magnification correction. Radiographs were digitized using an HP Scanjet G3110 (Fig 2)

Figure 1: CEPHALOSTAT

Figure 2: SCANNER HP SCANJET G3110

Cephalometric Analysis: Digitized cephalograms were analyzed using VistaDent OC software (Fig3) Landmarks and reference planes included the Sella-Nasion (S-N) line, Frankfort Horizontal plane, Nasion-Basion (N-Ba) line, and Nasion-Perpendicular plane. Angular and linear measurements were obtained as per McNamara's protocol (Fig 4).

All measurements and landmark identifications were performed by a single calibrated examiner.

Figure 3: VISTADENT SOFTWARE

Figure 4: MCNAMARA ANALYSIS

Statistical Analysis:

- Independent t-test was used to determine differences in cephalometric means between male and female groups.
- Pearson Correlation (2-tailed) was used to assess correlations between sample data and McNamara's norms.
- Mann–Whitney U test was used for parameters involving negative values or when normal distribution assumptions were violated.
- Chi-square test was used to compare range values for Co-Gn and ANS-Me.
- Reliability test was performed using Cronbach's Alpha to rule out intra-examiner error.

Descriptive statistics were calculated.

Inter-group comparisons (male vs female) and deviations from McNamara's norms were analyzed using Mann-Whitney U tests. Intra-examiner reliability was assessed by re-digitizing 10 randomly selected radiographs after a 3-week interval. A Cronbach's alpha > 0.6 was considered acceptable.

Results

Table 1: Midfacial length

Parameter	Male Mean	Female Mean	p-value	Significance
Co-A (Midfacial length)	92.22	90.18	<0.001	Significant
Co-Gn (Mandibular length)	121.06	117.70	<0.001	Significant
ANS-Me (Lower facial height)	67.62	67.18	>0.05	Not Significant
Na-Ba-Ptm-Gn (Facial axis)	85.94	87.92	<0.001	Significant
Pog-N⊥ (Chin projection)	-2.34	-3.98	<0.001	Significant
Upper incisor to A-vertical	6.62	4.92	<0.001	Significant
Lower incisor to A-Pog	4.16	3.40	<0.001	Significant

Table 2: Mandibular length

Sex	N	Mean	Std. Deviation	Std. Error Mean
co-a Male	50	92.22	2.690	.380
Female	50	90.18	2.833	.401

	Levene's Equality of Test for Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
co-a Equal variances assumed	2.245	0.137	3.692	98	0.000	2.040	0.553	0.944	3.136
Equal variances not assumed			3.692	97.737	0.000	2.040	0.553	0.943	3.137

Midfacial Length: Statistically greater in males than females (P < 0.001). Both groups showed reduced values compared to McNamara's norms.

Table 3: Independent T- TEST Male /Female Comparison for chin point

Sex	N	Mean	Std. Deviation	Std. Error Mean
c0-gn Male	50	121.06	2.931	.414
Female	50	117.70	3.157	.447

Mandibular Length: Significantly greater in males (P < 0.001).

Table 4: Independent T- TEST

	Levene's Equality of Test for Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
naba-plane Equal variances assumed	0.597	0.441	-6.192	98	0.000	-1.980	0.320	-2.615	-1.345
Equal variances not assumed			-6.192	84.729	0.000	-1.980	0.320	-2.616	-1.344

Chin Prominence: Notably more prominent in females ($P < 0.01$)

Table 5: The Mann- Whitney test

	Levene's Equality of Test for Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Pog nper Equal variances assumed	25.553	0.00	4.338	98	0.000	1.640	0.378	0.890	2.390
Equal variances not assumed			4.338	79.709	0.000	1.640	0.378	0.888	2.392

Incisor Angulation: Males demonstrated bimaxillary protrusion, while females had more upright incisor inclination

Discussion

This study sought to evaluate cephalometric norms among young adults from Tamil Nadu using McNamara's analysis and to compare these findings with the original Caucasian norms proposed by McNamara. The observed craniofacial measurements demonstrated clear ethnic and gender-based differences, supporting the need for population-specific diagnostic standards.

Midfacial Length (Co-A): McNamara's norm for midfacial length (Co-A) is approximately 95 mm. In contrast, Tamil Nadu males exhibited a mean Co-A of 92.22 mm, and females 90.18 mm, both significantly shorter than McNamara's value ($p < 0.001$). This reduction suggests a relative retrusion of the maxilla in this South Indian population, particularly among females [6]. The finding aligns with other ethnic studies (e.g., Al-Barakati on Saudi subjects and Bhat on South Indian children) that have shown maxillary retrusion relative to Caucasian norms.

Mandibular Length (Co-Gn): McNamara described an ideal mandibular length (Co-Gn) of approximately 125–127 mm in adults. The Tamil Nadu cohort showed a mean of 121.06 mm in males and 117.70 mm in females, both significantly shorter than McNamara's standards ($p < 0.001$). This reduction indicates a less prominent mandible, though the male-female difference was statistically significant, confirming typical sexual dimorphism. Clinically, this suggests that treatment plans based on McNamara's mandibular norm may overestimate mandibular deficiency in this population [7].

Lower Anterior Facial Height (ANS-Me): McNamara's recommended lower anterior facial height is 66–70 mm. The Tamil Nadu sample revealed a mean of 67.62 mm in males and 67.18 mm in females, showing no significant gender difference ($p > 0.05$) and aligning closely with McNamara's range. This implies vertical facial proportions are relatively conserved between Caucasian and South Indian groups [13].

Facial Axis (Na-Ba-Ptm-Gn Angle): McNamara places high importance on the facial axis for skeletal balance, typically expecting angles around 90°–93°. In the present study, males showed a mean angle of 85.94°, and females had a mean of 87.92°—both significantly lower than McNamara's standard ($p < 0.001$). This implies a more backward mandibular growth direction or vertical growth

pattern, especially in males, which is characteristic of several South Asian phenotypes.

Chin Projection (Pog-N⊥): McNamara suggests a Pogonion-to-Nasion-perpendicular (Pog-N⊥) value of approximately 0 mm, indicating a well-aligned chin with the facial profile. The Tamil Nadu sample showed a negative chin projection, with males averaging −2.34 mm and females −3.98 mm ($p < 0.001$), suggesting a posteriorly positioned chin, more pronounced in females. This difference may contribute to a more convex profile and must be considered in profile improvement treatments [19,20].

Upper Incisor to A-Vertical: The normative value for upper incisor to A-Vertical in McNamara's analysis is 4–6 mm. Tamil Nadu males showed a higher mean of 6.62 mm, whereas females had 4.92 mm ($p < 0.001$). While females remained within McNamara's acceptable range, males exhibited a tendency toward maxillary incisor proclination, possibly contributing to bimaxillary protrusion.

Lower Incisor to A-Pog: McNamara advocates a lower incisor to A-Pog distance of 1–3 mm, reflecting ideal mandibular incisor position. Tamil Nadu males averaged 4.16 mm, and females 3.40 mm—both exceeding McNamara's standard ($p < 0.001$). These values support the finding of proclined lower incisors, especially among males, which may affect decisions regarding incisor retraction during orthodontic treatment.

The cephalometric profile of Tamil Nadu young adults, when compared with McNamara's Caucasian norms, reveals a consistent pattern of reduced skeletal dimensions, proclined incisors, and retruded chin structures, particularly among females.

These differences have major implications in orthodontic diagnosis, anchorage planning, and treatment objectives [9].

Conclusion

In this study established normative cephalometric values for young adults from Tamil Nadu using McNamara's analysis, revealing distinct gender-related and ethnic differences in craniofacial structure. Males demonstrated significantly greater midfacial and mandibular lengths and more protrusive incisors, while females exhibited relatively enhanced chin prominence. Compared to McNamara's Caucasian-based norms, both genders showed reduced midfacial and mandibular lengths, highlighting the importance of ethnic variability in craniofacial assessment.

The digitization process proved efficient and reliable, supporting its clinical utility. These results emphasize the need for population-specific cephalometric standards to improve diagnostic precision and ensure more individualized, culturally appropriate orthodontic treatment planning.

References

1. Abraham KK, Tandon S, Paul U. Selected cephalometric norms in South Kanara children. J Indian Soc and pedod Prev Dent. 2000 Sep; 18(3):111-118.
2. Hassan AH. Cephalometric norms for Saudi children living in the Western region. Head Face Med. 2005; 1:5.
3. Hassan AH. Cephalometric norms for Saudi adults living in the Western region of Saudi Arabia. Angle Orthod. 2006;76(1):109-113.
4. Altemus LA. A comparison of craniofacial relationships. Angle Orthod. 1960; 21:223-240.
5. Al-Jame B, Årtun J, Al-Azemi R, Al-Behbehani F, BuHamra S. Lateral cephalometric norms for adolescent Kuwaitis: Hard tissue measurements. Med Princ Pract. 2006; 15: 91-97.
6. Kalha AS, Latif A, Govardhan SN. Soft-tissue cephalometric norms in a South Indian ethnic population. Am J Orthod Dentofacial Orthopedics. 2008;133(6):876-889.
7. Bhat M, Sudha P, Tandon S. Cephalometric norms for Bunt and Brahmin children of Dakshina Kannada based on McNamara analysis. J Indian Soc Pediatric Prev Dent. 2001;19(2):41-51.
8. Baumrind S, Miller DM. Computer aided head film analysis: The University of San Francisco method. Am J Orthod Dentofacial Orthopedics. 1980; 78:41-51.
9. Thilander B, Persson M, Adolfsson U. Roentgen-cephalometric standards for a Swedish population: A longitudinal study between the ages of 5 and 31 years. Eur J Orthod. 2005; 27:370-389.
10. Björk A. The face in profile: An anthropological X-ray investigation on Swedish children and conscripts. Sven Tandlak Tidskr Suppl. 1947; 40:1-180.
11. Bishara SE, Abdalla EM, Hoppens BJ. Cephalometric comparisons of dentofacial parameters between Egyptian and North American adolescents. Am J Orthod Dentofacial Orthop. 1990; 97:413-421.
12. Chaconas SJ, et al. The Digigraph workstation. Part I: Basic concepts. J Clin Orthod. 1990; 24(6): 360-367.
13. Chaconas SJ, et al. The Digigraph workstation. Part III: Accuracy of cephalometric analysis. J Clin Orthod. 1990;24(8):467-471.
14. Cohen AM, Ip HH, Linney AD. A preliminary study of computer recognition and identification of skeletal landmarks as a new method of

cephalometric analysis. Br J Orthod. 1984; 11:143-154.
15. Chebib FS, et al. Online computer system for the analysis of cephalometric radiographs. Angle Orthod. 1976;46(4):247-258.
16. Rodrigues CD, et al. Evaluation of indirect methods of digitization of cephalometric radiographs in comparison with the direct digital method. Dental Press J Orthod. 2010;15(4):24-32.
17. Conner AM, Moshiri F. Orthognathic surgery norms for American Black patients. Am J Orthod. 1985; 87:119-134.
18. Cotton WN, Takano WS, Wong WW. The Downs analysis applied to other ethnic groups. Angle Orthod. 1951; 21:213-220.
19. Downs WB. Variations in facial relationships: Their significance in treatment and prognosis. Am J Orthod. 1948; 34:812-840.
20. Celik E. Comparison of cephalometric measurements with digital vs conventional cephalometric analysis. Eur J Orthod. 2009; 31:415-420.