

Review Article

Determination of Cephalometric Norms of Sassouni's Analysis in South Indian Ethnic Population: A Retrospective Study

Preethy Thulukanam¹, Umarevathi Gopalakrishnan^{2*}, Uvanesh B³, Rayshika¹, Baghya¹, Mohammed Rafi⁴

¹Post Graduate Student, Department of Orthodontics and Dentofacial Orthopaedics, Sri Venkateswara Dental College and Hospital, Chennai, India

²Professor, Department of Orthodontics and Dentofacial Orthopaedics, Sri Venkateswara Dental College and Hospital, Chennai, India

³Undergraduate Student, Sri Venkateswara Dental College and Hospital, Chennai, India

⁴Reader, Department of Orthodontics and Dentofacial Orthopaedics, Sri Venkateswara Dental College and Hospital, Chennai, India

*Correspondence author: Umarevathi Gopalakrishnan, PhD in Pediatric Dentistry. Professor. Faculty of Health Sciences. University Fernando Pessoa. FP I3ID, FCS. Porto, Portugal; E-mail: umarevathigopalakrishnan@gmail.com

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Abstract

Objective: Numerous cephalometric analyses have been proposed with the advent of cephalometric radiographs in orthodontics to ascertain the true skeletal and dental picture and correlate them with the clinical diagnosis. Sassouni's analysis differs from other analyses that it provides detailed interaction between sagittal and vertical discrepancies. As the literature enlightens the existence of variability in the craniofacial morphology among different ethnic groups, cephalometric norms derived from standardized groups like Bolton samples and Ann Arbor samples cannot be considered normal for other populations. The aim of this study was to enforce the importance of deriving the cephalometric norms from the local population.

Methods: The sample comprised the retrospectively collected pre-treatment lateral cephalograms of 60 adults (25 males, 35 females) belonging to South Indian origin and was categorized into four groups based on inclusion and exclusion criteria. These cephalograms were traced, analysed and interpreted as per Sassouni's analysis. The statistical evaluation was performed using Pearson's chi square and spearman's rho tests to assess the correlation between various morphological aspects of the craniofacial region including the palate, key ridge, mandible and their association with the sagittal and vertical dimensions.

Results: The Σ shaped key ridge, the facial type III B with post archial and concave profile were more prevalent.

Conclusion: This study emphasizes the existence of variability in the facial characteristics of the South Indian and Mediterranean populations and the need to devise cephalometric norms for specific racial, ethnic and geographic origins.

Keywords: Sassouni's Analysis; South Indian Population; Cephalometry; Cephalometric Norms; Orthodontics

Introduction

Regarding facial forms, literature enlightens the uniqueness of facial features that demark different races and ethnicity like the Australoid race having a dolichocephalic face with heavy jaws and marked alveolar prognathism, the Mediterranean race having a dolichocephalic skull with rounded occiput, oval face with shorter facial height [1,2]. Asians having flat or concave facial profiles, greater mandibular width with the retruded chin [3]. Even within the Asian population, South Asians possess smaller jawlines, Transcontinental Asians have wide-set jaws and East Asians have rounded jawlines. Narrowing down the lane, Indians possess round, leptoprosopic faces with prominent cheeks [4] and this variability in craniofacial structures is evident in gender as well with South Indian males having long faces to round faces and South Indian females having broad to long face types whereas North Indian males were found to have very long faces and females show very long to round faces [5]. With so much diversity among facial features even with similar races, we are so used to following cephalometric norms based on a single population like the Bolton sample, the Burlington sample, Ann Arbor sample depicting the Western population. Cephalometric

norms for different ethnic and racial groups have previously been studied by many authors to provide quality individualized treatment to the local population [6-8]. A few studies report that there is an existing difference in cephalometric norms for different races based on the analysis of the local population like the Cephalometric study of the dentofacial complex of North Indians by Nanda [9]. The Cephalometric norm for the Central, Cephalometric profile of North Indian by O. P. Kharbanda, etc [10,11]. Although many studies were carried out in India, very little information is available in the literature for the South Indian population.

Cephalogram is a bi-dimensional radiograph that allows us to visualize the sagittal and vertical dimensions of the face. Of the variously known analyses till date, Sassouni's analysis given by Viken Sassouni in 1955 describes the detailed interaction between the sagittal and vertical discrepancies [12].

Hence, this current study aims to determine cephalometric norms for Sassouni's analysis of the South Indian population and assess the sagittal and vertical dimensions, the morphology of various structures and their association with malocclusion.

Material and Methods

Sample Characteristics and Data Collection:

The study sample comprised of retrospective collection of lateral cephalograms of 60 adults (25 males, 35 females), aged between 17-25 years who had visited the Department of Orthodontics at Sri Venkateswara Dental College and Hospital, Thalambur between 2021- 2022 [10]. The cephalometric radiographs of young adults of South Indian origin with the age range of 17-25 years having the full complement of permanent dentition with proper intercuspation excluding the third molars were included in the study. The cephalometric radiographs of people with mixed or early permanent dentition under the age of 17 years, any missing teeth, any gross carious lesion, or any abnormalities such as a supernumerary tooth, root resorption, periodontal bone loss and any other periapical pathology, patients who had undergone orthodontic treatment or orthognathic surgery, history of trauma or fracture in the maxillofacial region were excluded in the study [9-11]. The radiographs that fulfilled the inclusion criteria were divided into four groups based on the ANB angle given by Steiner's analysis [14]. Out of 60 cephalograms, 6 could not be included in the study since the horizontal planes in those were grossly misoriented. The remaining 54 cephalograms were included in the study. The 14 lateral cephalograms with acceptable facial harmony and symmetry, class I molar relationship, normal overjet and overbite and ANB angle of 2 ± 2 degrees were included as group I (normal occlusion) [15]. Lateral cephalograms with class I molar relationship, presence of crowding, spacing, increased overjet and ANB angle of 2 ± 2 degrees were considered as group II (class I malocclusion) [15]. Lateral cephalograms having convex profile with class II molar relationship, increased overjet and overbite and ANB angle of ≥ 4 degrees were included as group III (class II malocclusion) [10]. Lateral cephalograms having concave profile with class III molar relationship, reverse overjet and ANB angle of ≤ 0 degrees were included as group IV (class III malocclusion). The lateral cephalograms were traced manually by a single operator to minimize the observer's error and all the landmarks, planes, arcs and angles were drawn as given in Fig. 1-3 according to the description and definition given by Viken Sassouni [12].

Statistical Analysis

Reliability was assessed by repeating the cephalometric measurements of 10 randomly selected cephalograms by the same investigator and Intra class correlation coefficient was used for assessing the intra- observer variability. Since the data followed non-normal distribution, a non-parametric test was performed for all statistical evaluation. Pearson's chi-square test was used to find the association between two groups and Spearman's rho test was used to find the association between three or more groups.

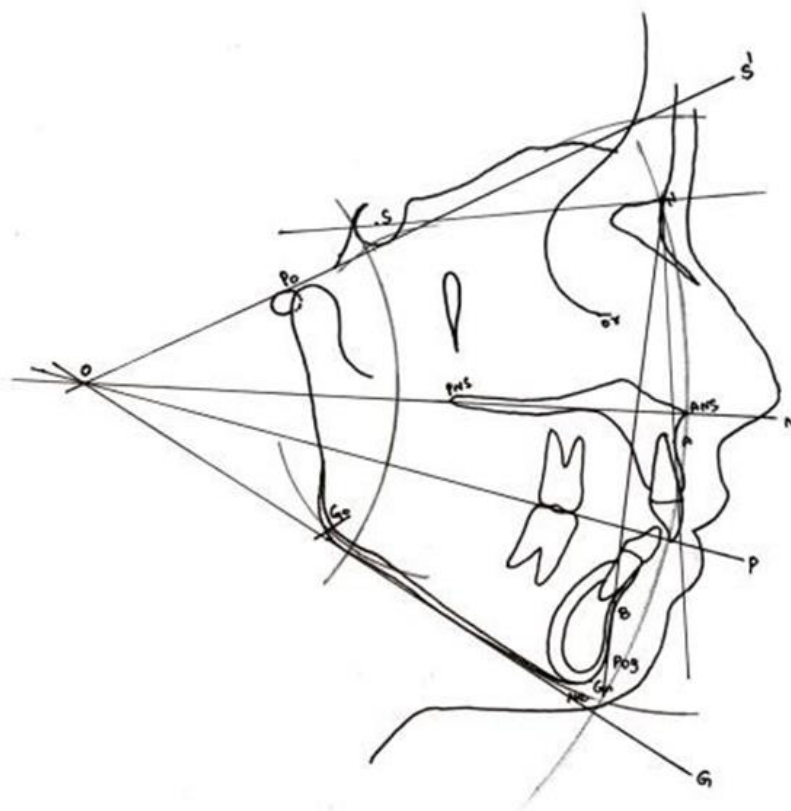


Figure 1: Landmarks, Planes and Arcs used in Sassouni's analysis.

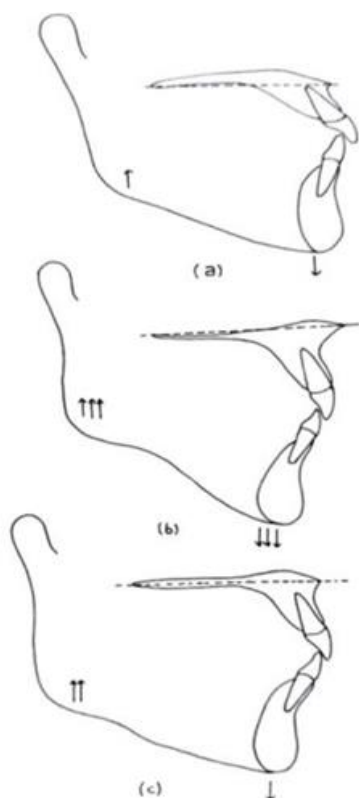


Figure 2: Different types of palate, mandible. (a)-Convex palate, Horizontal mandible (b)-Concave palate, Oblique mandible (c)-Horizontal palate, curved mandible.

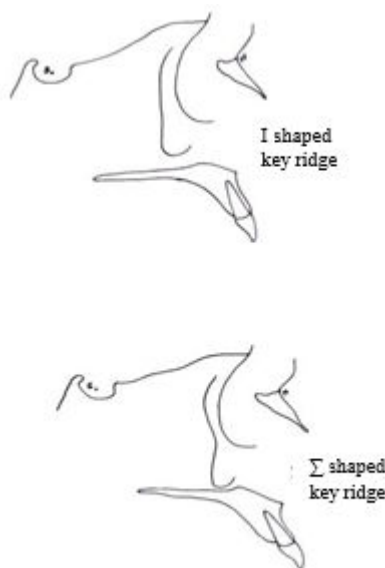


Figure 3: Types of key ridge: I-shaped key ridge; Σ -shaped key ridge.

Results

The results were given in Tables 1 to 4. With regard to palatal morphology, a total of 27 patients had horizontal type of palate. On the other hand, a sum of 27 patients of different malocclusions possessed either convex or concave type of palate (Table 1).

When considering key ridge morphology with sagittal occlusal relation, it was found that a total of 34 patients had Σ shaped key ridge whereas 20 patients had I-shaped key ridge irrespective of the sagittal class of occlusion (Table 1).

In particular to mandibular morphology, 24 individuals had curved mandible. Oblique mandible was evident in 15 individuals. The horizontal type of mandible was found in 15 individuals (Table 1). Concerning facial pattern and occlusion, only one individual (7.1%) with normal occlusion had a well-proportioned face. Type I A facial pattern where the cranial base plane passes above point O was evident in 4 patients. Type II A facial pattern where the palatal plane passes above point O was observed in 10 individuals. A total of 5 patients had Type II B facial pattern irrespective of malocclusion. Only 2 individuals presented with Type III A facial pattern where the occlusal plane passes above point O. Type III B facial pattern where the occlusal plane passes below point O was found in about 13 patients. About 8 individuals irrespective sagittal relationship presented with Type IV A where the mandibular plane passes above point O. Type IV B was evident in about 10 individuals irrespective to sagittal jaw (Table 2).

When examining profile patterns in different sagittal relationships, it was found that archial and pre archial profile pattern was evident in less than 2 % individuals of the studied samples. Convex profile was found in 9 patients which included 6 patients with class II malocclusion and 3 patients with class I malocclusion.

On the other hand, 23 individuals (8 patients with normal occlusion, 6 patients with class I malocclusion, 9 patients with class III malocclusion) had concave profile and 20 patients (5 patients with normal occlusion, 5 patients with class I malocclusion, 9 patients with class II malocclusion, 1 patient with class III malocclusion) presented with post archial profile (Table 3).

A statistically significant correlation existed between palate and mandibular morphology. The horizontal palate was seen more commonly associated with a curved mandible irrespective of the existing malocclusion. The palatal morphology was equally distributed between the various classes of malocclusion. The Σ shaped key ridge, III B facial type, post archial and concave facial profile were more prevalent with no statistical significance (Table 4).

Occlusion		Palatal Morphology		Keyridge Morphology		Mandibular Morphology		
		Horizontal	Convex/ Concave	I shape	Σ shape	curved	Oblique	Horizontal
Normal occlusion	Count	8	6	7	7	6	5	3
	%within occlusion	57%	43%	50%	50%	43%	36%	25%
Class I	Count	6	9	5	10	6	3	6
	%within occlusion	40%	60%	33%	67%	40%	20%	40%
Class II	Count	8	7	5	10	9	3	3
	%within occlusion	53%	47%	33%	67%	60%	20%	20%
Class III	Count	5	5	3	7	3	4	3
	%within occlusion	50%	50%	30%	70%	30%	40%	30%
Total	Count	27	27	20	34	24	15	15
	%within occlusion	50%	50%	37%	63%	44%	27.8%	27.8%
Correlations				Palate	Occlusion	Key Ridge	Mandibular Morphology	
Spearman' srho	Palate	Correlation Coefficient		1.000	.017	.230	.581**	
		Sig (2- tailed)		.	.902	.094	.000	
		N		54	54	54	54	
	Occlusion	Correlation Coefficient		.017	1.000	.138	.004	
		Sig(2-tailed)		.902	.	.321	.975	
		N		54	54	54	54	
	Key Ridge	Correlation Coefficient		.230	.138	1.000	.222	
		Sig(2-tailed)		.094	.321	.	.107	
		N		54	54	54	54	
	Mandibular Morphology	Correlation Coefficient		.581**	.004	.222	1.000	
		Sig(2-tailed)		.000	.975	.107	.	
		N		54	54	54	54	

** . Correlation is significant at the 0.01 level (2-tailed).

Table 1: Correlation between occlusion, palatal morphology, key ridge and mandibular morphology.

Facial Pattern		Occlusion				Anterior Vertical Proportions			Posterior Vertical Proportions		
		Normal occlusion	Class I	Class II	Class III	LAFH #NAME?	LAFH > UAFH	LAFH < UAFH	LPFH #NAME?	LPFH > UPF H	LPFH < UPF H
Well-proportioned face	Count	1	0	0	0	0	1	0	0	1	0
	%	7.10%	0%	0%	0%	0%	100%	0%	0%	100%	0%
I A	Count	3	1	0	0	1	2	1	3	0	1
	%	21%	6.60 %	0%	0%	25%	50%	25%	75%	0%	25%
II A	Count	0	2	6	2	5	1	4	2	8	0

	%	0%	13.3 %	40%	13.3 %	50%	10%	40%	20%	80%	0%
II B	Count	2	1	2	0	4	1	0	2	0	3
	%	14.20%	6.60 %	13.3 %	0%	80%	20%	0%	40%	0%	60%
III A	Count	0	1	2	0	1	2	0	2	1	0
	%	0%	6.60 %	13.3 %	0%	33.3 %	66.60%	0%	66.6 %	33.3 %	0%
III B	Count	3	5	1	4	8	2	3	9	2	2
	%	21.40%	33.3 %	6.60%	40%	61.55	15.30%	23.10%	69.2 %	15.3 %	15.3 %
IV A	Count	1	1	3	3	3	4	1	3	1	4
	%	7.10%	6.60 %	20%	30%	37.5 %	50%	12.50%	37.5 %	12.5 %	50%
IV B	Count	4	4	1	1	5	2	3	3	5	2
	%	28.50%	26.6 %	6.60%	10%	50%	20%	30%	30%	50%	20%

Correlations

			Occlusion	Facial pattern	Anterior vertical proportions	Posterior vertical proportions
Spearman srho	Occlusion	Correlation Coefficient	1.000	.010	.005	.020
		Sig(2- tailed)	.	.945	.971	.888
		N	54	54	54	54
	Facial pattern	Correlation Coefficient	.010	1.000	-.035	.075
		Sig(2- tailed)	.945	.	.799	.588
		N	54	54	54	54
	Anterior vertical proportion	Correlation Coefficient	.005	-.035	1.000	.250
		Sig (2- tailed)	0.971	0.799		0.068
		N	54	54	54	54

Table 2: Correlation between facial pattern, occlusion, anterior vertical proportions, posterior vertical proportions.

			Profile					Total
			Archial	Pre- archial	Post archial	Convex	Concave	
Occlusion	Normal occlusion	Count	0	1	5	0	8	14
		% within occlusion	0.0%	7.1%	35.7%	0.0%	57.1%	100 %
	Class I malocclusion	Count	1	0	5	3	6	15
		% within occlusion	6.7%	0.0%	33.3%	20.0%	40.0%	100%
	Class II	Count	0	0	9	6	0	15

	malocclusion	% within occlusion	0.0%	0.0%	60.0%	40.0%	0.0%	100%
	Class III malocclusion	Count	0	0	1	0	9	10
		% within occlusion	0.0%	0.0%	10.0%	0.0%	90.0%	100%
Total		Count	1	1	20	9	23	54
		% within occlusion	1.9%	1.9%	37.0%	16.7%	42.6%	100%
Correlation								
		Value		df		Asymp. Sig. (2-sided)		
Pearson Chi-Square		31.014 ^a		12		0.002		
Likelihood Ratio		38.924		12		0.000		
Linear-by-Linear Association		0.716		1		0.398		
N of Valid Cases		54						
a. 14 cells (70.0%) have expected count less than 5. The minimum expected count is .19.								

Table 3: Correlation between profile and occlusion.

			Gender		Total
			Male	Female	
Occlusion	normal occlusion	count	9	5	14
		% within occlusion	64.3%	35.7%	100.0%
	Class I malocclusion	count	4	11	15
		% within occlusion	26.7%	73.3%	100.0%
	Class II malocclusion	count	7	8	15
		% within occlusion	46.7%	53.3%	100.0%
	Class III malocclusion	count	4	6	10
		% within occlusion	40.0%	60.0%	100.0%
Total		count	24	30	54
		% within occlusion	44.4%	55.6%	100.0%
Correlations					
		Value	df		Asymp Sig
Pearson Chi-Square		4.262 ^a	3		0.235
Likelihood Ratio		4.357	3		0.225
Linear-by-Linear Association		0.726	1		0.394
N of Valid Cases		54			
a. 1 cells (12.5%) have expected count less than 5. The minimum expected count is 4.44.					
N of Valid Cases		54			
a. 5 cells (41.7%) have expected count less than 5. The minimum expected count is .19.					

Table 4: Correlation between occlusion and gender.

Discussion

Various morphological aspects of the craniofacial region have specific reasons for their existence like the key ridge serving as a buttress for the maxillary first molar which is subjected to maximum occlusal stresses [12]. Based on the muscular distribution and force, the morphology of the mandible is determined, like in cases where the masseteric pull is high and not counteracted equally by counterpart musculature, a deep Antegonial notch results. Since the development of the entire craniofacial system is so well synchronized, the aberration in the development of one structure affects the other [17,18]. In addition to determining the South Indian norms for Sassouni's analysis, the correlation between the various structural associations was also assessed in our study.

From the results of our study, it was evident that though the horizontal type of palate was found to be more frequent in normal occlusion than the concave or convex type similar to the original study, there was an insignificant correlation found between the morphology of palate and sagittal class of malocclusion.

About 65% of the samples irrespective of type of malocclusion possessed I-shaped key ridge and horizontal palate, which was statistically insignificant and contradicted the original study which had a significant correlation between palate and key ridge and a curved mandible was evident in about 87.5 % of individuals examined in our study [13]. This could be attributed to the fact that with balanced musculature, both the morphology of the palate and mandible followed the average norm in accordance with the results obtained.

In contrast to the original study [13], only 7.1 % of individuals with normal occlusion had a well- proportioned face. In all such cases wherein all the horizontal planes met at single point O, there was an equal proportion between lower and upper anterior facial heights. This was in contrast to the original study [13] wherein about 26 % of individuals (16 individuals out of 50 samples) with normal occlusion presented with a well-proportioned face. The most common facial pattern associated with normal occlusion individuals was type IV B (28.5%), where only the mandibular plane was not in synchrony with the rest of the horizontal planes and it passed below the meeting point of the other planes which again contradicted the original study in which well-proportioned face (26%) was more common in normal occlusion individuals. We can presume this effect due to the mandible being the last plane to adapt as per the cephalocaudal gradient.

In class I malocclusion cases, type III B was more common (33.3%) since in class I cases it's mostly the functional occlusal plane at fault with the jaws being orthognathic whereas Type II B was more prevalent in class I malocclusion samples in the original study.

Type II A was the most common pattern in class II cases indicating that most convex profile cases have an aberration with palatal plane inclination in addition to the sagittal issues. This inference will add to the significance of examining the palatal plane inclination (the J angle) in all class II cases which will influence the planning of treatment by addressing the inclination correction [15]. This inference contrasted the original study in which Type I A facial pattern was more common in class II cases.

Type III A was the common pattern associated with class III cases. This is in accordance with Tanaka and Sato wherein the occlusal plane was associated with a downward and backward tilt in the posterior region in class III cases which was not in accordance to the original where Type IV A was the common pattern noted in class III cases [16]. Although the results of our study differed from the original study, there was no statistical significance in the correlations.

About 90% (9 patients) of individuals with class III malocclusion and 57 % (8 patients) of normal occlusion had concave profile where in such cases, ANS and the upper incisors were situated posterior to the anterior arc passing by Na and pogonion. Similarly, 40 % of Class II cases predominantly possessed convex profile Where ANS and the upper incisors were situated anterior to the anterior arc passing by Na and pogonion. In addition, about 9 individuals with class II malocclusion also possessed post-archial profile (60%) where ANS, upper incisor and pogonion were situated posterior to the anterior arc passing by Nasion which was in accordance with the parent article [13]. Sexual dimorphism was evident in the study where the sample had 24 males and 30 females. Within the samples available, normal occlusion was found to be more common in males whereas class I malocclusion was more predominant in the female population. The class II and III malocclusions were apparently equally divided between the sexes. The major limitation of the present study was a smaller sample size and collection of cephalograms was limited to specific adolescent group of 17-25 years. Hence, future studies with large sample sizes and of different age categories should be performed.

Conclusion

Of the 54 samples evaluated, 7.1% of individuals with normal occlusion had a well-proportioned face. In about 87.5% of individuals, the horizontal palate was associated with a curved mandible. About 24% of individuals irrespective of sagittal occlusion presented with Type III B facial pattern and it can be concluded that Type III B was more prevalent in South Indian population. About 42.6% of individuals presented with concave profile and 37% of individuals had post archial profile indicating

that concave and the post archial profiles were more prevalent in South Indian population. These findings conclude that there exists a vast difference in the facial characteristics of the South Indian population and the Mediterranean populations and our study confirms that racial differences do exist with regard to facial pattern, profile and morphology of craniofacial structures re-emphasizing the need to devise orthodontic/orthognathic treatment goals based on cephalometric norms derived for individual's own racial and ethnic background.

Conflict of Interests

The authors have no conflict of interest to declare.

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