ORIGINAL ARTICLE

Evaluation of Skeletal Facial Types in Maharashtra Population: A Jarabak Cephalometric Analysis

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Abstract:

Background: Cephalometric analysis is a useful diagnostic tool to determine facial type and its growth pattern, so that the clinician can determine facial disharmonies in order to centralize therapeutic measures during treatment and to modify facial growth. *Aim and Objectives:* To establish cephalometric standards and different facial types in Maharashtra population. *Material and Methods:* The present study consisted of 200 subjects (100 males and 100 females) age between 18-25 years. Maxillary and Mandibular arches were well aligned in all participants. All participants included in study were residing in Maharashtra since their three to four generations. Bony landmarks used were Nasion (N), Sella (S), Menton (Me) and Gonion (Go). With the help of these landmarks linear measurements such as Anterior Facial Height and Posterior Facial Height were studied. Facial height ratio was studied to classify various facial types. *Results:* The present study was classified in various facial types according to Jarabak's ratio. Study showed 84% males and 65% females are hypodivergent. 16% males and 33% females are normodivergent. 2% females are hyperdivergent. *Conclusion:* Majority of population has hypodivergent facial types in males and females in Maharashtra population. Anterior Facial Height (AFH) is observed to be the best discriminating parameter for normodivergent male and female cephalograms.

Keywords: Facial types, Cephalograms, Normo-divergent, Hyperdivergent, Hypodivergent

Introduction:

Human facial profile provides the demographic information, such as ethnicity and gender. Ethnic group and gender also play an important role in face-related applications. The facial appearance of human is a highly rich stimulus that helps to provide various different information for adaptive social interaction with people. Human face can be processed in a various ways to classify it by its identity, along with a number of other demographic characteristics, including ethnicity (or race), gender, and age.

Over the past few decades, a lot of effort has been carried out in the biological, psychological, and cognitive sciences areas, to discover how the human brain perceives, represents, and remembers faces. The demographic features, such as race and gender, are involved to use human face identity for recognition. Humans are better at recognizing faces of their own ethnicity/race rather than faces of other races [1-2]. The identification of race and gender can help the face recognition system to concentrate more on the face related applications, and can lessen the number of entries to be searched and thus improving the search speed and efficiency of the retrieval systems. The race and gender are also useful for demographic statistics in many social applications.

Morphological characteristics in human beings are affected by ecological, biological, geographical, racial, gender, and age factors [3]. Most studies have accentuated the importance of anthropometric study on the basis of the above factors. This necessity is based on the fact that there will be greater validity, if an individual is compared to referent data matched for their specific ethnic, sex, and age group. The range of variations in the shape of their faces is a hallmark of the diversity and individuality of the people coming across in daily life. Studies on craniofacial relations and variations in human being will help in understanding the frequency of distribution of human morphologies. Facial morphology is defined as the study of structures of face, form and shape. Analysis of the human face has a long tradition, as shown earlier, the aetiology, diagnosis, treatment planning and clinical outcome assessment of different kinds of malocclusion, facial asymmetry and dysmorphology can be determined by different techniques used to assess facial morphology and growth of face and jaws.

The systematic collection and correlation of various measurements of the human body is known as Anthropometry. It is a technique of physical anthropology that is important for the fields like forensic, socio-cultural, industrial and bio-medical applications. Anthropometry is a method recommended for quantitative analysis of craniofacial morphology using direct clinical measurements including distances, angles, ratios and proportions [4]. Anthropometry remains a simple, inexpensive, efficient and non-invasive method for describing craniofacial morphology.

Jarabak is well known extensively for his cephalometric analysis of Brazilian Black patients in dentistry. The cephalometry practice helps for the diagnosis of dento-maxillofacial alterations. The craniometric landmarks found in the analysis are then used to measure the skeletal structure. Looking into history many successful doctors in orthodontic treatments have carried out studies to analyze facial growth patterns amongst different populations of the world. The aim of Jarabak's cephalometric study can assess and define the complex craniofacial dysplasia or disharmony that causes abnormalities. Cephalometrics defined by Jarabak as the scientific method that studies the dentofacial complex to assess the relationship among segments and how individual growth increments or their changes can affect the whole complex [5-6].

Jarabak's cephalometric analysis is clinically effective. It can be applied on evaluating anomalies and prognosis. Morphological characteristics, prediction of facial growth pattern, possible reactions to different orthodontic approaches and detection of possible tendencies to functional alterations should be considered. The several skeletal malocclusions are defined during growth. The orthodontist who is treating young patients will have to determine every specific growth pattern, and should know its directions and possibilities. Only after this orthodontic mechanics will be chosen for better results and can be applied easily [5-6].

Burstone [7] developed a very useful cephalometric analysis in 1978 which is still being in common use by orthodontists today for patients who require orthognathic surgery. The landmarks and measurements that can be changed through several common surgical procedures are used in this analysis. The Burstone analysis can also be known as Cephalometrics for Orthognathic Surgery (COGS) [7]. Cephalometric analysis is a useful diagnostic tool to determine facial type and its growth pattern, so that the clinician can determine facial disharmonies in order to centralize therapeutic measures during treatment and modify facial growth.

Material and Methods:

The study was conducted on a total sample of 200 subjects (males-100, females-100) from Vasantdada Patil Dental College and Hospital, Sangli. The sample size required for the study was calculated by using a population proportion with specified relative precision.

a) Anticipated population proportion (P)
b) Confidence level [100(1-α)%]
c) Relative precision (ε)
d) A rough estimate of anticipated population proportion (P) was usually sufficient to calculate the sample size. In this study it was not possible to estimate P, so a figure of 0.5 (i.e. 50%) was used, which was the "safest" choice for the population proportion since the sample size required was largest when P = 0.5.

A relative precision was assumed to be 10% with 95% confidence level.

Anticipated population proportion (P)	50%
Confidence level [100(1-α) %]	95%
Relative precision (ε) (from 45% to 55%)	10% (of 50%)

As per the table in the manual the anticipated population (P= 50%) with relative precision 10% at confidence level 95% the minimum sample size was 184. Hence, a sample size of 200 subjects selected for study. The subjects selected were living in Maharashtra from their 3-4 generations, their age ranged from 18 to 30 years with acceptable and pleasing facial profiles. Initially a clinical examination was made to determine the status of occlusion, and those subjects who had normal occlusion were selected. The study was conducted after obtaining clearance from the Institutional Ethics Committee and permission from the appropriate authority.

Inclusion Criteria:

1. Angle's Class I molar relationship
2. Overjet and overbite within normal limits as per Angle's classification.
3. All the permanent teeth present.
4. People who live in Maharashtra for their four generations.

Exclusion Criteria:

1. Congenital facial defects.
2. History of major orthodontic treatment
3. Facial asymmetry
4. History of trauma or major /plastic surgery in the facial region

All the subject's radiographs were taken in Natural Head Position (NHP) method (Fig. 1). Radiographs were taken with the patient head placed with left side towards image receptor. A lateral cephalogram of subjects was taken. All cephalograms were taken on same cephalostat with teeth in occlusion and the head oriented to Frankfort Horizontal plane. The radiographs were traced on acetate tracing paper with a 4H sharp pencil on a view box and important landmarks were marked (Fig. 2).

Fig. 1: Digital Lateral Cephalometric Image

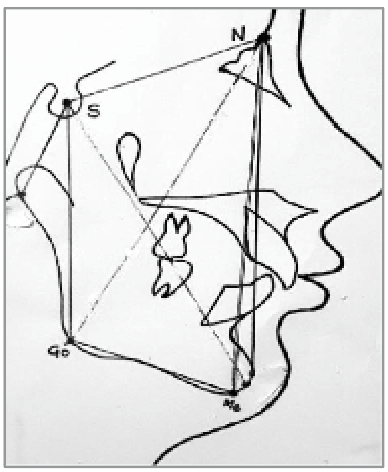

Fig. 2: Linear and Angular Measurements on Traced Lateral Cephalogram

The various craniofacial landmarks traced are as follows (Fig. 2):

- Nasion (N)- The anterior most point of the frontonasal suture in the median plane
- Sella (S)- A point located at the centre of the sella turcica
- Gonion (G)- The point of intersection of lines tangent to lower and posterior ramal borders of mandible
- Menton (Me)- Lowermost point on the outline of symphysis as seen in norma lateralis

The linear and angular measurements were measured to the nearest of 0.5 mm and 0.5 degree, respectively with the help of a digital vernier caliper, scale and protractor. The various parameters studied are as follows (Fig. 2):

Linear measurements: 1. Anterior Facial Height
2. Posterior Facial Height

Ratio: Facial Height Ratio (FHR)

Anterior Facial Height (AFH) - distance between N and Me

Posterior Facial Height (PFH) - distance between S and Go

Facial Height Ratio (FHR) - PFH/AFH x100

The sample was divided into normodivergent, hypodivergent, and hyperdivergent subgroups based on Jarabak's ratio for analysis.

Jarabak Quotient:

Jarabak has categorized facial morphology on the basis of three distinct patterns defined by the FHR or Jarabak quotient. This is the ratio of PSH (S-Go) to AFH (N-Me). (Fig. 3)

FHR= S-Go/N-Me x100

- Hyperdivergent growth pattern-- FHR<59%. Here face rotates downwards and posteriorly with growth, anterior facial height increases more rapidly than posterior height and Y-axis and other angles tend to open (Fig. 4).
- Normodivergent growth pattern-- with FHR 59-63%. Here direction of growth is downwards and forward along Y-axis, with about the same increase in anterior facial height and posterior facial height and no progressive change in most angular relationships (Fig.5).
- Hypodivergent growth pattern: with FHR> 63%.

Here direction of growth is horizontal (Fig.6)

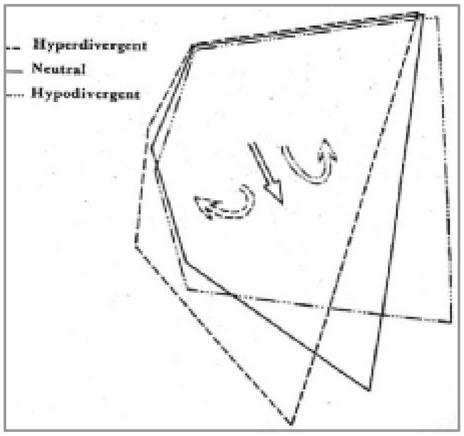

Fig. 3: Facial Growth Rotations Resulting from Differential Vertical Growth (Jarabak[5])

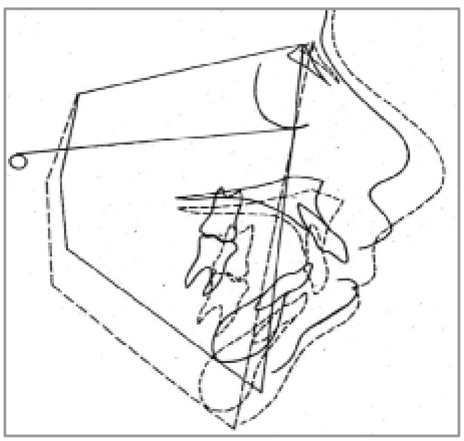

Fig. 4: Hyperdivergent- Facial Morphology with Posterior Growth Rotation

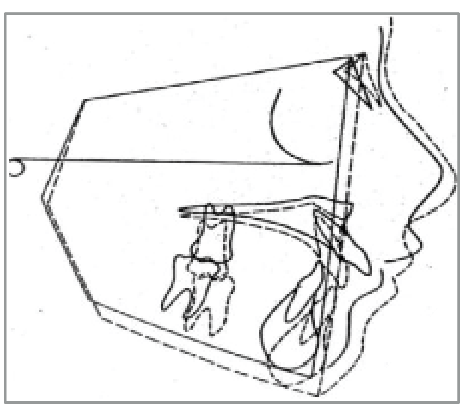

Fig. 5: Normodivergent- Facial Morphology with Horizontal Growth Rotation

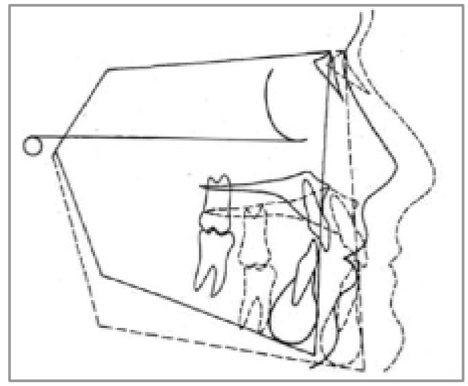

Fig. 6: Hypodivergent- Facial Morphology with Anterior Growth Rotation

Results:

To evaluate different craniofacial parameters, different measurements were taken on radiographs. Range, mean and standard deviation of these measurements were calculated. The identification point for each parameter was calculated from the range of each measurement. From this, percentage of identified radiographs was calculated. Maximum and minimum limits were calculated on the basis of standard deviation.

Demarking points were worked out from calculated range. The percentages of cephalograms identified by each demarking point in patients were estimated. The demarking points identify cephalograms with 100% accuracy. The difference observed between means of males and females and different facial types to know whether it is statistically significant, that is value of 'P' is calculated by applying 'Z' test.

Table 1 shows distribution among subjects according to facial height ratio. The maximum numbers of subjects were in the 78.5% of hypodivergent group followed by 21.5% of normodivergent. In the female group hypodivergent, normodivergent and hyperdivergent were 65%, 33% and 2% respectively. Among males hypodivergent, normodivergent were 92% and 8% respectively with no male subject with the hyperdivergent group.

Table 2 shows mean AFH, PFH and FHR with statistical difference among normodivergent males and females (P<0.001). When demarking points are applied, a cephalogram having AFH more than 114.34 is definitely male normodivergent and less than 96.6 is definitely female normodivergent cephalogram. By this point, percentage of identified male cephalograms is 43.8% and of female cephalogram is 3%. Similarly, when demarking points are applied, a cephalogram having PFH more than 76.47 is definitely male cephalogram and less than 59.47 is definitely female cephalogram. By this point, percentage of identified male cephalograms is 6.3%. AFH is observed to be the best discriminating parameter for normodivergent male and female cephalograms.

Table 1: Distribution according to Facial Height Ratio (FHR) or Jarabak Quotient

FHR	Male	Female	Total
Hyperdivergent (<59%)	00	02	02
Normodivergent (59-63%)	16	33	49
Hypodivergent (>63%)	84	65	149
Total	100	100	200

Table 2: Comparison of Angular, Linear and Ratio Measurements among Normodivergent Males (M) and Females (F)

P	G	No	Mean ±SD	Std E	Range		p	IP	% of IP	Calculated Range		D.P	% beyond D.P.	Z
AFH	M	16	113.01 ±5.29	0.59	100.2	119.8	0.0001**	>111.8	56.2	97.18	128.92	>114.33	43.8	14.33
	F	33	103.95 ±3.46	0.60	96.5	111.8		<100.2	18.2	93.58	114.33	<97.18	3	
PFH	M	16	70.81 ±3.78	0.41	62.3	77.4	0.0001**	>72.4	18.7	59.47	82.15	>76.47	6.3	10.19
	F	33	65.43 ±3.68	0.64	61.15	72.4		<62.3	18.2	54.39	76.47	<59.47	0	
FHR	M	16	61.9 ±0.77	0.08	60.8	62.9	0.035	>62.9	0	59.59	64.21	>64.74	0	0.92
	F	33	62.01 ±0.91	0.15	58.9	62.9		<60.8	3	58.28	64.74	<59.59	3	

Table 3: Comparison of Angular, Linear and Ratio Measurements among Hypodivergent Males (M) and Females (F)

P	G	No	Mean ±SD	Std E	Range		p	IP	% of IP	Calculated Range		D.P	% beyond D.P.	Z
AFH	M	84	123.31 ±13.12	1.44	70.6	147.5	0.03*	>138.2	6	83.9	162.67	>172.57	0	2.18
	F	65	117.43 ±18.38	1.57	79.2	138.2		<70.6	0	62.29	172.57	<83.9	1.5	
PFH	M	84	93.67 ±12.47	1.36	71.4	119.2	0.021*	>109	11.9	56.26	131.08	>122.07	0	2.33
	F	65	87.03 ±11.68	1.45	62.8	109		<71.4	15.4	51.99	122.07	<56.26	0	
FHR	M	84	76.37 ±5.53	0.59	64.8	88.54	0.011*	>85.5	4.8	60.11	92.63	>88.66	0	2.55
	F	65	74.20 ±4.82	0.60	65.2	85.5		<64.8	0	59.74	88.66	<60.11	0	
	F	65	386.93 ±12.88	1.59	369	479		<368	0	348.29	425.57	<362.73	0	

Discussion:

In Jharkhand, a study by Lall *et al*. [8] among the 58 subjects, hyperdivergent pattern group was found to be smallest (10.3%) with the normodivergent and hypodivergent patterns were 17.2% and 72.4% which is similar with present study that dominant facial type is hypodivergent. Orish *et al*. [9] studied 100 Nigerian skulls, he found that dominant face type in females was, hyperleptoprosopic (hyperdivergent, 45.5%) and in males it was mesoprosopic (normodivergent, 29.49%) while in our study we found dominant type of face in females and males was hypodivergent. Our findings have some similarity from Shetti *et al*. [10] who studied prosopic (facial) index of Indian and Malaysian students. Both belonged to normodivergent facial type.

They found that dominant type of facial type in Malaysian males was hypodivergent whereas females showed normodivergent with 34% each respectively. Least common type was hyperdivergent (4%) in males and females (8%). Among Indian males dominant type of face shape was normodivergent with 32% and females had dominant type of normodivergent and hypodivergent with 32% each respectively.

The present findings differ from study of Prasanna *et al*. [11] who reported that southern Indian males are hyperdivergent whereas females are normodivergent while North Indian males and females are hyperdivergent. Similar observations were found by Pandey [12]. In his study on Indians of Andaman and Nicobar Island indicated that almost

60% males and 77% females were hypodivergent. Jarabak and Siriwat [6] studied 500 lateral cephalogram and they categorized the sample on the basis of three distinct patterns by Facial Height Ratio (FHR) or Jarabak Quotient. He found hyperdivergent group smallest and normodivergent to be dominant type. Similar findings were found by Ghosh *et al*. [13] who studied on West Bengal population (India) and reported that Indians from this area were euriprosopic (broad face or hypodivergent) to hypereuriprosopic (very broad face or hypodivergent) in both genders differs. Jahanshahi's *et al*. [3] study on Fars and Turkmans of Iran revealed that they had normodivergent to hypodivergent face those are similar with our findings (Table 4).

In the study by Lall *et al*. [9] comparison of measurements among males and females like PFH (80.2 vs 71.25) and AFH (121.05 vs 112.88) showed statistical difference. Comparing this with present study PFH in males and females is higher and AFH is similar in males and females in present study. Prasanna *et al*. [12] studied facial indices of North and South Indian adults. He found facial

Table 4: Facial Morphology

Investigators	Region	Sex	Hyperdivergent	Hypodivergent	Normodivergent
Lall *et al*.[8]	Jharkhand	G	10.3%	72.4%	17.2%
Orish [9]	Nigeria	M	-	10.26%	29.49%
		F	45.5%	-	18.18%
Shetti *et al*. [10]	Indian	M	-	--	32%
		F	-	32%	32%
	Malaysian	M	4%	34%	-
		F	8%	34%	-
Pandey [12]	Andman Nicobar	M	-	60%	-
		F	-	77%	-
Jarabak JR [5]	Brazil	G	13.1%	38.6%	48.3%
		M	14.7%	40.2%	45.1%
		F	11.9%	42.5%	50.8%
Present study	Maharashtra	G	1%	78.5 %	20.5%
		F	2%	65%	33%
		M	-	84%	16%

Table 5: Linear Measurements among Males and Females

Investigators	Region	G	AFH	PFH
Lall *et al*. [8]	South Indian	M	121.05	80.2
		F	112.88	71.25
Prasanna *et al*. [11]	North Indian	M	123	-
		F	127	-
	South Indian	M	119	-
		F	107	-
Present study	Maharashtra	M	121.85	90.30
		F	112.73	79.20

AFH - Anterior facial height, PFH - Posterior facial height

height between North Indian males (123 ± 4.0) and females (117.0 ± 7.4) and South Indian males (119.7 ± 5.9) and females (101.0 ± 6.2). The facial height was greater in North Indian males and females than in Maharashtra population (males-121.85 ± 12.84, females-112.73 ± 16.13). South Indian males have similar facial height but females have smaller facial height than Maharashtra population (Table 5).

Conclusions:

The present study showed that majority of population have hypodivergent facial types in males and females in Maharashtra population. The present study established surgically useful cephalometric measurements for the diagnosis and treatment planning of dentofacial surgery in adult Maharashtra population for its practical implementation in the treatment of the facial abnormality.

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