The average anterior cranial base length, maxillary length and mandibular length among male and female adults in kerala population

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Abstract:
Background*: The cranial base plays a pivotal role in craniofacial growth and development. The cranial base has got anterior and posterior cranial base segments articulating with maxilla and mandible. The drastic variation in size and shape of this region would alter the jaw's sagittal skeletal relationship. Many studies have shown that there is a significant difference in cranial base features for different ethnic, racial and gender groups. Different groups should be treated according to their characteristics and it is important to develop individual standards for each population.*
Aim &objective*: The primary objective was to determine the average anterior cranial base length, maxillary length and mandibular length among male and female adults in Kerala population. The secondary objective of the study was to assess the anterior cranial base, maxillary and mandibular length in class I, II and III skeletal malocclusion. Comparison of the above quantitative variables between class I, II and III skeletal malocclusion was also one of the secondary objectives.*
Materials and Methods*: Lateral Cephalograms of 220 (110 males and 110 females) were analysed. The cephalometric measurement was done using Nemoceph software version 6. Anterior cranial base length was measured as line connecting sella and nasion, maxillary length as line connecting anterior nasal spine and posterior nasal spine, mandibular length as line connecting gonion and menton. The total sample of 220 were divided into class I, class II and class III skeletal classes with 73 samples in class I and class II and 74 samples in class III group. The division was done based on Beta angle and Steiner's ANB angle.*
Results*: The anterior cranial base length for adult male Kerala population was found to be 69.21+4.218 mm, female was 67.96+4.351 mm. The mean maxillary length for adult male Kerala population was found to be 52.99+4.031 mm, female was 51.85+4.160 mm. The mean mandibular length for adult male Kerala population was found to be 77.83+5.248 mm, female was 76.69 +4.731 mm. There is statistically significant difference existing in anterior cranial base length, maxillary length and mandibular length between skeletal class I, class II and class III groups.*
Conclusion: *The average anterior cranial base length, maxillary length and mandibular length among male and female adults in Kerala population was found to be statistically significant. The measurements was greater in male samples. Since the variation in the average anterior cranial base length, maxillary length and mandibular length, it is necessary to correct these linear measurements to the norms.*
Key Word: *Cephalometry; Anterior cranial base length; maxillary length; mandibular length*

I.   Introduction

Concepts of beauty has changed over the centuries and differs from one race to another but it has always been a subject of interest and importance to people of all culture . Cephalometric norms for different ethnic and racial groups have previously been established in many studies. Most investigators have concluded that there are significant difference between the diverse ethnic and racial groups and many cephalometric standards have been developed for different racial groups must be treated according to their own characteristics.

The cranial base plays a pivotal role in craniofacial growth and development. The cranial base has got anterior and posterior cranial base segments articulating with maxilla and mandible and thus any change in flexion due to variation in size and shape of this region would alter the jaw's sagittal skeletal relationship.Clinical evaluation itself has a lot of difference in opinion among observers. So, cephalometric evaluation of the patient is mandatory. In cephalometric analysis various anatomic landmarks have shown variations. Variation in the anterior cranial base depends on the position of Sella and Nasion points. Nasion point is more subjected to variation compared to Sella point. Correcting such variation in cranial base is arbitrary and error prone. This will invariably affect the cephalometric values based on cranial base. Moreover, many studies have shown that there is a significant difference in cranial base features for different ethnic, racial and gender groups. Different groups should be treated according to their characteristics and it is important to develop individual standards for each population.

In literature, a vast wealth of information is available concerning norms for Caucasians. Very little information is available for this ethnic group. Hence it is a necessity to determine cephalometric parameter for this ethnic group.

The present study is intended to find out the average anterior cranial base length, maxillary length and mandibular length among male and female adults in kerala population. Its variation among class I, class II and class III skeletal relations were evaluated. Thus this would help in standardization which would facilitate treatment planning

II. Material And Methods

After obtaining the ethical clearance from the Institutional Regulatory Board, the database for cephalometric evaluation was obtained from the preexisting records of the patients who had registered for orthodontic treatment between 2019 and 2021 at PSM dental college, Kerala. The inclusion criteria comprised healthy subjects of 18–30 years of age without any facial deformity or congenital abnormality and without any history of craniofacial trauma.

The sample included 110 females and 110 males. The total sample of 220 were divided into class I, class II and class III skeletal classes with 73 samples in class I and class II and 74 samples in class III group. The division was done based on Beta angle and Steiner's ANB angle.

Study Design: cross sectional study
Study Location: Kerala.
Study Duration: November 2019 to November 2021.
Sample size: 220 patients.
Sample size calculation:
The sample size was calculated to get a precision of 0.5 using the formula:

$$n = 4\frac{S.D2}{d2}$$

Where, n is sample size
SD = Standard deviation = 3.70 (As per the study by Kazutaka Kasai et al[1] 1995)
d = Precision value = 0.5

$$n=4\frac{(3.70)\,2}{(.5x.5)\,2} = 219$$

Thus 220 samples (110 males and 110 females) were considered for the study
Subjects & selection method: The sample included 110 females and 110 males. The total sample of 220 were divided into class I, class II and class III skeletal classes with 73 samples in class I and class II and 74 samples in class III group. The division was done based on Beta angle and Steiner's ANB angle.
Inclusion criteria:
1.   Natives of Kerala
2.   Individuals with age ranging from 18 to 30 years
3.   Skeletal classes I, II and III
Exclusion criteria:
1.   Genetic or craniofacial deformity
2.   Previous history of craniofacial trauma or surgery
3.   Individuals with history of orthodontic treatment

Procedure methodology

The cephalometric tracing for all the subjects were carried out by Nemoceph software (Version 6.0) at department of orthodontics and dentofacial orthopaedics, PSM dental college. Anterior cranial base length, maxillary length and mandibular length measured to find out the mean value.
The mean value was compared between 2 categories

1. Male and female
2. Skeletal class I, II and III.

The following landmarks were used for cephalometric analyses. The anterior cranial base length, maxillary Length and mandibular length were measured using Nemoceph version 6.

For measuring anterior cranial base length:
Line connecting sella and nasion where,
S-Sella :The geometric centre of pituitary fossa
N-Nasion: The most anterior point on the fronto-nasal suture in the midsagittal plane
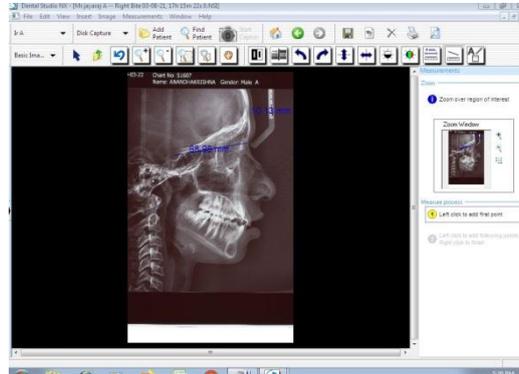
For measuring maxillary length:
Line connecting Anterior nasal spine and Posterior nasal spine where,
ANS- Anterior nasal spine: the anterior tip of the sharp bony process of the maxilla at the lower margin of the anterior nasal opening
PNS- Posterior nasal spine: the posterior spine of the palatine bone constituting the hard palate.
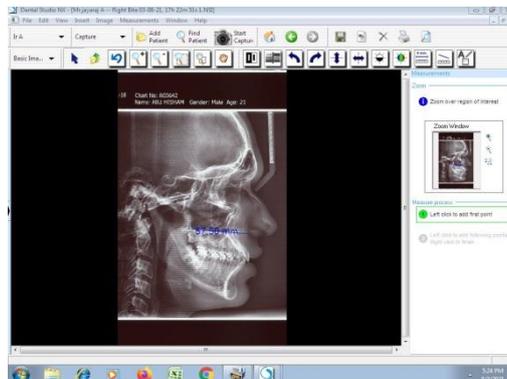
For measuring mandibular length:
Line connecting Gonion and Menton where,
Go-Gonion: a point on the curvature of the angle of the mandible located by bisecting the angle formed by lines tangent to the posterior ramus and the inferior order of the mandible.
Me-Menton: The lowest point on the symphyseal shadow of the mandible seen on a lateral cephalogram.
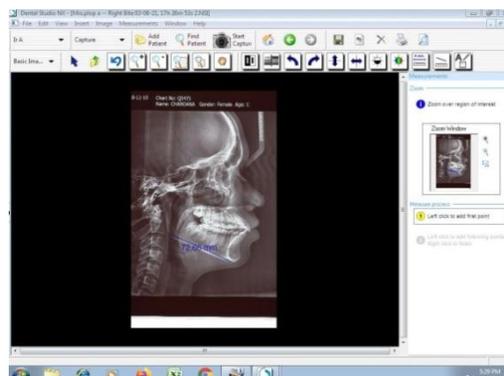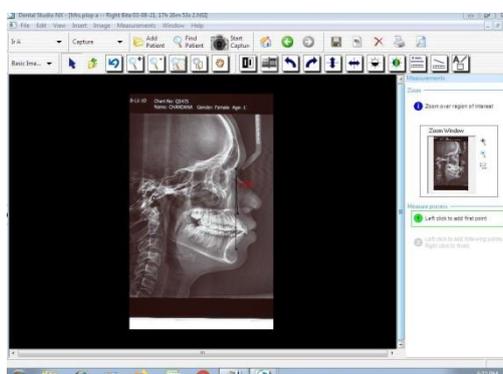
For measuring ANB angle:

Steiner's[2] ANB angle is used to classify the subjects. This uses point A, point B and Nasion.

Point A- subspinale. The most posterior midline point in the concavity of the ANS and the prosthion (the most inferior point on the alveolar bone overlying the maxillary incisors)

Point B- supramentale.The most posterior midline point in the concavity of the mandible between the most superior point on the alveolar bone overlying the mandibular incisors (infradentale) and Pog.

N-Nasion: The most anterior point on the fronto-nasal suture in the midsagittal plane

The angle formed by lines connecting nasion and point A &nasion and point B denotes ANB angle. It denotes the skeletal relationship of maxilla and mandible. The average value of ANB is taken as 2 degree for Class I, greater than 2 degree as Class II and less than 2 degree as Class III.


For measuring Beta angle:

The Beta angle[3] is used for assessing the skeletal discrepancy between the maxilla and the mandible in the sagittal plane. It uses 3 skeletal landmarks- point A, point B, and the apparent axis of the condyle (C- center of the condyle, found by tracing the head of the condyle and approximating its center) to measure an angle that indicates the severity and the type of skeletal dysplasia in the sagittal dimension. 3 lines are defined for the measurement of Beta angle which includes:

1. Line connecting the center of the condyle C with B point (C-B line).
2. Line connecting A and B points
3. Line from point A perpendicular to the C-B line

The angle between the perpendicular line and the A-B line denotes the Beta angle. The average value of Beta angle is between 27° and 34° for class I skeletal pattern,less than 27° indicates a Class II skeletal pattern and greater than 34° indicates a Class III skeletal pattern.
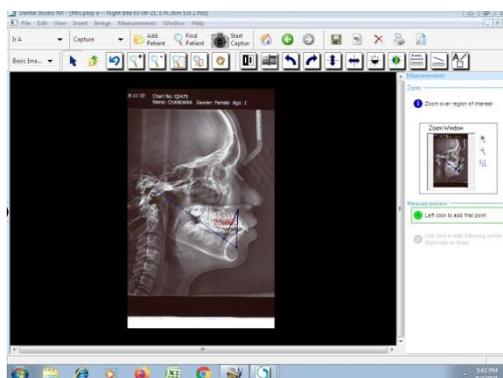
Statistical analysis

Quantitative variables of the study were summarized as mean and standard deviation . SPSS software was used to calculate the means and standard deviations of all measurements, and independent t-tests were used to determine significant differences between genders. Relationship between skeletal class I, II, and III was assessed using ANOVA.

III. Result

Results show that the mean anterior cranial base length for adult male Kerala population was found to be 69.21+4.218 mm. The mean anterior cranial base length for adult female Kerala population was found to be 67.96+4.351 mm. (Table 1)

The mean maxillary length for adult male Kerala population was found to be 52.99+4.031 mm. The mean maxillary length length for adult female Kerala population was found to be 51.85+4.160 mm. (Table 1)

The mean mandibular length for adult male Kerala population was found to be 77.83+5.248 mm . The mean mandibular length for adult female Kerala population was found to be 76.69 +4.731mm. (Table 1)

The comparison of male and female samples using t- test shows that males have increased anterior cranial base length, maxillary length and mandibular length than females. (Table 1)

Anterior cranial base length, was found to be statistically significant (p value 0.001) in skeletal class II group (71.19 +3.768 mm), as compared to class I (68.72+4.218 mm) and class III (67.05+4.229 mm) groups. (Table 2). An increase was found in skeletal class II group.

Maxillary length, was found to be statistically significant (p value 0.001) in skeletal class II group (54.42+3.316 mm), as compared to class I (51.85+4.122 mm) and class III (50.97+4.130 mm) groups. (Table 2). An increase was found in skeletal class II group.

Mandibular length, was found to be statistically significant (p value 0.001) in skeletal class III group (80.36 +4.408 mm), as compared to class I (76.38+4.396 mm) and class II (75.04+4.686 mm) groups. An increase was found in skeletal class III group.

The comparison of male and female groups with different skeletal classes using ANOVA shows that there is statistically significant difference existing in anterior cranial base length, maxillary length and mandibular length between skeletal class I, class II and class III groups. (p value 0.001) (Table 3)

	Gender	N	Mean(mm)	Std. Deviation	P value(independent t test)
SN LENGTH	Male	110	69.21	4.247	0.033
	Female	110	67.96	4.351	
MAXILLARY LENGTH	Male	110	52.99	4.031	0.040
	Female	110	51.85	4.160	
MANDIBULAR LENGTH	Male	110	77.83	5.248	0.092
	Female	110	76.69	4.731	

Table 1: Mean anterior cranial base length, maxillary length and mandibular length among male and female adults in Kerala population using Independent t-test.

		N	Mean (mm)	Std. Deviation	P value(ANOVA)
SN LENGTH	Class I	73	68.04	4.218	0.0001
	Class II	73	70.66	3.768	
	Class III	74	67.05	4.229	
MAXILLARY LENGTH	Class I	73	51.85	4.122	0.0001
	Class II	73	54.42	3.316	
	Class III	74	50.97	4.130	
MANDIBULAR LENGTH	Class I	73	76.38	4.396	0.0001
	Class II	73	75.04	4.686	
	Class III	74	80.36	4.408	

Table 2: Comparison of anterior cranial base length, maxillary length and mandibular length with different Skeletal classes using ANOVA

GROUP			N	Mean (mm)	Std. Deviation	P value(ANOVA)
Male	SN LENGTH	Class I	36	68.72	3.976	0.001
		Class II	36	71.19	3.861	
		Class III	37	67.76	4.232	
	MAXILLARY LENGTH	Class I	36	52.58	4.059	0.001
		Class II	36	54.86	3.200	
		Class III	37	51.57	4.127	
	MANDIBULAR LENGTH	Class I	36	77.17	4.205	0.001
		Class II	36	75.14	5.298	
		Class III	37	81.11	4.408	
Female	SN LENGTH	Class I	37	67.38	4.393	0.0001
		Class II	37	70.14	3.653	
		Class III	37	66.33	4.161	
	MAXILLARY LENGTH	Class I	37	51.14	4.111	0.0001
		Class II	37	54.00	3.416	
		Class III	37	50.36	4.100	
	MANDIBULAR LENGTH	Class I	37	75.62	4.499	0.0001
		Class II	37	74.95	4.075	
		Class III	37	79.58	4.332	

Table 3: Comparison of male and female measurements of anterior cranial base length, maxillary length and mandibular length with different Skeletal classes using ANOVA
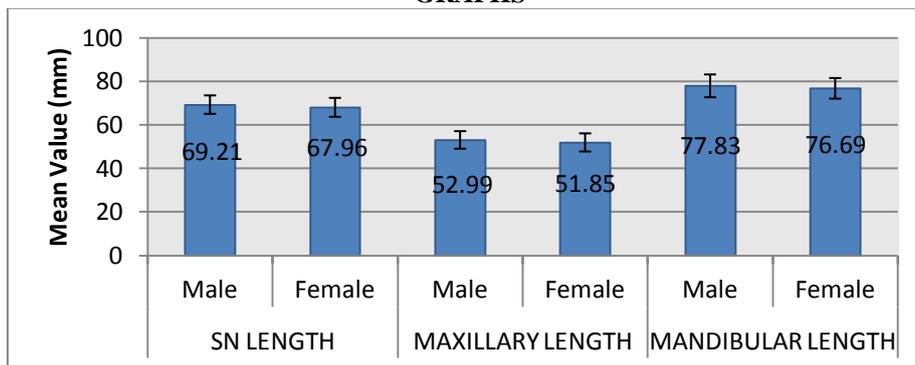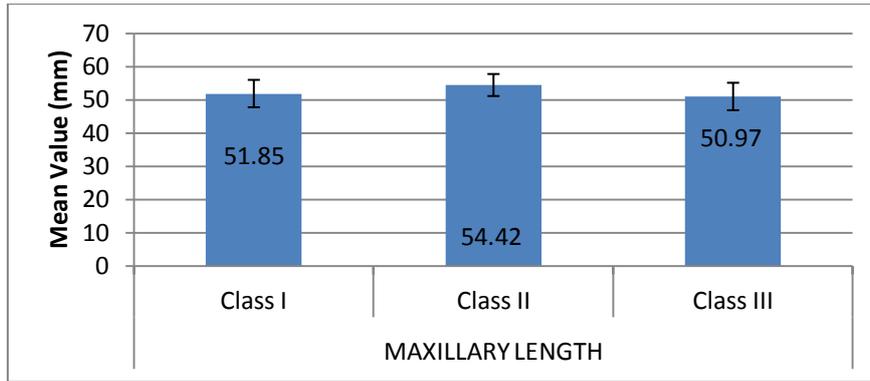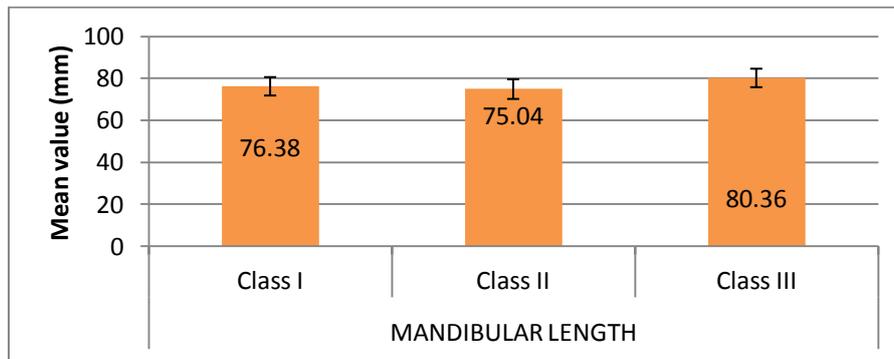

Graph 1: Mean anterior cranial base length, maxillary length and mandibular length for male and female subjects
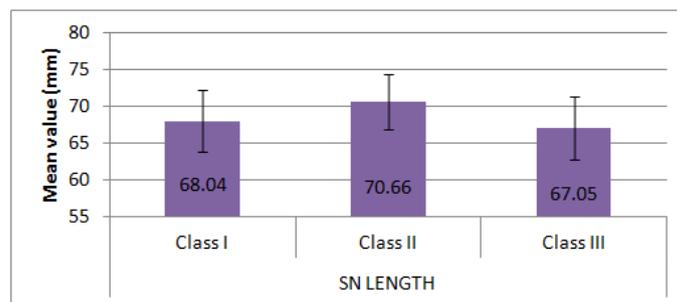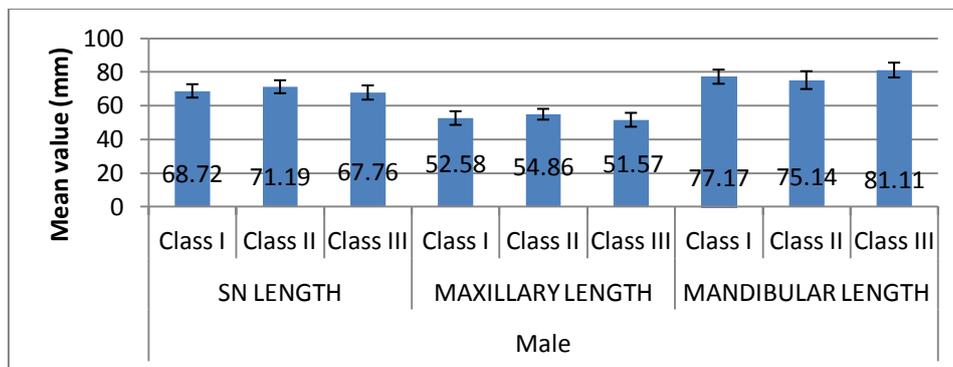

Graph 2: Mean anterior cranial base length in skeletal class I, class II and class III
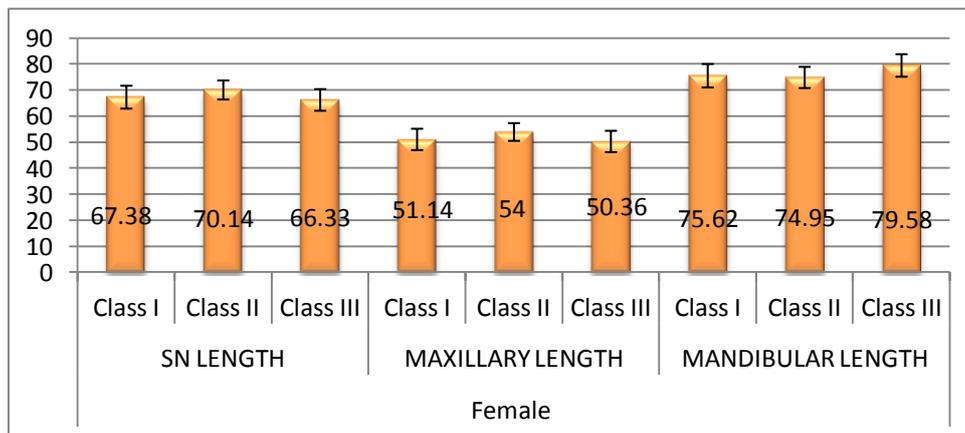
Graph 3: Mean maxillary length in skeletal class I, class II and class III

Graph 4: Mean mandibular length in skeletal class I, class II and class III

Graph 5: Male measurements of anterior cranial base length, maxillary length and mandibular length with skeletal class I, class II and class III

Graph 6: Female measurements of anterior cranial base length, maxillary length and mandibular length with skeletal class I, class II and class III

IV. Discussion

Roentogenographic cephalometry was first introduced to the orthodontic specialty by Broadbent[4] in 1931, mainly as a tool to study cranio-facial growth and development. Gradually it was used to study facial forms, development of norms, assessment of treatment prognosis and growth prediction for the individual patients.

In cephalometric analysis, measurements are done with respect to different horizontal and vertical planes. The most commonly used horizontal planes are cranial base length, maxillary length and mandibular length. The study was conducted to find out the average anterior cranial base length, maxillary length and mandibular length among male and female adults in Kerala population.

According to Rolf Bjehin[5], a comparison between the Frankfort horizontal and the Sella turcica - Nasion as reference planes, Sella – nasion is the more reliable of the two reference lines. On a radiograph, nasion and the centre of the sella turcica are easier to determine than the porion and the orbitale.

The cranial base also exerts great influence on facial growth and plays an important role in coordinating craniofacial growth. During its growth, it carries the upper-middle face forward, inferiorly and laterally. A deficiency in anterior cranial base growth is often accompanied by midfacial deficiency.[6]

Attempts have been made to investigate the differences of the human face among various ethnic groups, including White/Caucasian, Mongoloid/Asian, Negroid/Black, and Australoid.

However, dental and skeletal structures exhibit different pattern for different races. It has become relevant to define norms for various ethnic groups of population for successful diagnosis and treatment planning. India is a land of diversified race of people; hence many research workers in India have initiated to undertake racial studies. Dr Sidhu[7], Dr John[8], Dr Anil Kudchadkar, Dr V P Jayade[9], Dr Shivratna[10], Dr Sushner [11] and many other eminent personals have enlightened us about esthetic profile by their studies on various racial groups in the subcontinent.

Athanasiou[12] indicated that all existing cephalometric data are of value for the diagnosis of various types of craniofacial anomalies and for monitoring groups according to age and race.

Having recognized, the fact that, the norms prescribed for one ethnic group need not be suitable for others, an attempt was made in this study to assess the average anterior cranial base length, maxillary length and mandibular length among male and female adults in Kerala population. It was thought that the norms established will be helpful in treatment planning to attain better results. Kerala population was selected for the present study, as it is a significant ethnic group in the country. The present study size was 220 members from Kerala population.

To overcome the errors of conventional radiography, digital cephalometry, which allowed the operator to manipulate data on the computer thereby facilitating the complex analysis and organization became popular. Nemoceph software version 6 was used for analysis in the present study. Nemoceph software version 6 permits the best localization of the cephalometric points, due to the huge quantity of tools for basic and advanced image processing. In the tracing process, a software wizard will guide step by step. The image processing tools allows to clearly visualize and identify bone and dental structures.

In a study of cranial base development by Bjork in 1955 found cranial development ceases at approximately 12 years of age, sutural growth in the cranial base would remain somewhat active to compensate for both upper and lower facial growth until the age of 18-20years in females and 20-24years in males. The average anterior cranial base length and mandibular length for Caucasian population was observed in this study.[13]Decreased anterior cranial base length and increased mandibular length was noted for Kerala population in the present study.

Burstone CJ in 1978 designed Cephalometrics for Orthognathic Surgery (COGS) especially for the patient undergoing maxillofacial surgery. The standards were based on a sample which included the sample of 16 females and 14 males30 for the ethinic population, Caucasians. This paved way for the construction of new cephalometric norms for every individual ethnic group. The average maxillary length for Caucasian population was observed in this study.[14] Decreased maxillary length was noted for Kerala population in the present study.

Bibby RE conducted a cephalometric study of sexual dimorphism in the Scottish population. It was concluded that female cranial dimensions are smaller than the corresponding dimensions in the male. In general male skulls were 8.5 percent larger than female skulls. Hence, the data were separated according to gender to obtain a more specific and useful cephalometric normative values and because the sexual dimorphism was found to be significant, especially for linear measurements. The study revealed an increased anterior cranial base length in males compared to females in Scottish population.[15] In the present study on Kerala population also an increased anterior cranial base length was noted in males compared to females.

Flynn et al conducted a study to determine cephalometric norms for orthognathic surgery in Black American Adults in addition they compared the values obtained with White American adults. When compared with black subjects, there was greater maxillary skeletal prognathism in white subjects.[16] Maxillary length is found to be decreased in the kerala population, when compared to Black and White American Adults.

Kamak H et al conducted a study to examine the differences between cranial base measurements and different skeletal malocclusion patterns in patients with Turkish cephalometric norms. Increased anterior cranial base length for Turkish population when compared to Caucasian norms.[17] Decreased anterior cranial base length was found in the Kerala population when compared to Turkish population.

Satinder Pal et al conducted a study to establish the cephalometric hard tissue norms for North Indian subjects. The maxillary length was significantly more among North Indian females than male. The maxillary length is decreased in North indian male and increased in North indian female population compared to Caucasian population.[18] The maxillary length is increased in Kerala male population compared to North indian male population and the maxillary length is decreased in Kerala female population compared to North indian female population.

Yadav A O et al studied normal dentofacial patterns of adult population belonging to Central India. The study revealed that maxillary length in the Central Indian population is increased than those of the Caucasian population, The length of the maxilla was found to be greater in males than in females.[19] Maxillary length for Kerala population was decreased when compared with the Central Indian population.

Trivedi K et al conducted a study to compare the craniofacial pattern of Rajasthani population with Caucasian norms and to evaluate the skeletal variation between Rajasthani males and females. When comparing Rajasthani population with Caucasian population, the study revealed statistically significant increase in maxillary length for Rajasthani population.[20] Maxillary length for Kerala population was decreased when compared with the Rajasthani population.

K. V. Arunkumar et al conducted a study to establish skeletal cephalometric norms for the South Indian (Karnataka) population utilizing the norms laid by Burstones's analysis for Caucasians. The study revealed that maxillary length in the Karnataka population is increased than those of the Caucasian population.[21] Maxillary length for Kerala population was decreased when compared with the Karnataka population.

This study showed that males of Kerala population had increased anterior cranial base length, maxillary length and mandibular length than females. Decreased anterior cranial base length, maxillary length and increased mandibular length was noted when compared to the Caucasians.

Increased anterior cranial base length was observed for skeletal class II group, when compared to class I and class III groups. Increased maxillary length for skeletal class II group, when compared to class I and class III groups. Increased mandibular length for skeletal class III group, when compared to class I and class II groups.

It was inferred from the present study that a separate norms for normal ethnic kerala adults contemplating orthodontic treatment was needed.

V. Conclusion

The mean anterior cranial base length for adult male in Kerala population was found to be 69.21+4.218 mm. In comparison to males the adult female Kerala population showed an average value of 67.96+4.351 mm.

The adult male in Kerala population showed an average value of 52.99+4.031 mm for maxillary length where as for females it was found to be 51.85+4.160 mm.

The mean mandibular length for adult male Kerala population was found to be 77.83+5.248 mm and for females it was 76.69 +4.731 mm.

Sexual dimorphism was statistically significant as the males have increased anterior cranial base length, maxillary length and mandibular length than females.

Anterior cranial base length and maxillary length was found to be increased in skeletal class II group which was statistically significant. A similar trend was noted for Mandibular length in skeletal class III group.

The comparison of male and female groups with different skeletal classes shows that there is statistically significant difference existing in anterior cranial base length, maxillary length and mandibular length between skeletal class I, class II and class III groups.

Since the variation in the average anterior cranial base length, maxillary length and mandibular length, it is necessary to correct these linear measurements to the norms.

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