EVALUATION OF LATERAL CEPHALOMETRIC VARIABLES AND ITS EFFICACY IN IDENTIFICATION OF SEXUAL DIMORPHISM IN CHENNAI POPULATION USING DISCRIMINANT FUNCTION ANALYSIS

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CHENNAI

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation titled **"EVALUATION OF LATERAL CEPHALOMETRIC VARIABLES AND ITS EFFICACY IN IDENTIFICATION OF SEXUAL DIMORPHISM IN CHENNAI POPULATION USING DISCRIMINANT FUNCTION ANALYSIS"** is a bonafide and genuine research work carried out by me under the guidance of **Dr. KAILASAM, B.Sc., M.D.S.**, Professor and Head, Department of Oral Medicine & Radiology, Ragas Dental College and Hospital, Chennai.

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CERTIFICATE

This is to certify that this dissertation titled **"EVALUATION OF LATERAL CEPHALOMETRIC VARIABLES AND ITS EFFICACY IN IDENTIFICATION OF SEXUAL DIMORPHISM IN CHENNAI POPULATION USING DISCRIMINANT FUNCTION ANALYSIS"** is a bonafide record of work done by **Dr. KORLA SWETHA** under my guidance during her postgraduate study period 2013-2016.

This dissertation is submitted to the **THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY,** in partial fulfillment for the degree of **MASTER OF DENTAL SURGERY, BRANCH IX – ORAL MEDICINE AND RADIOLOGY.**

It has not been submitted (partial or full) for the award of any other degree or diploma.

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Truly

Korla. Swetha

LIST OF ABBREVIATIONS

S.NO	ABBREVIATION	EXPANSION
1.	Ba-ANS	Basion to anterior nasal spine
2.	N-ANS	Upper facial height
3.	Ba-N	Length of cranial base
4.	N-M	Total face height
5.	FsHt	Frontal sinus height
6.	Ma-SN	Perpendicular distance from mastoidale to SN plane
7.	Ma-FH	Perpendicular distance from mastoidale to FH plane
8.	MaHt: (Ma-B1B2)	Mastoid height from cranial base
9.	MaWd: (B1-B2)	Mastoid width at level of cranial base

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Introduction

INTRODUCTION

Forensic medicine is an interdisciplinary science applying reliable and scientifically proven knowledge to form accurate and precise statements.[34] Anthropometry constitutes a technique of expressing the form of the human body.[34] The use of anthropometry in the field of forensic science and medicine dates back to 1882 when **Alphonse Bertillon**, a French police expert invented a system of criminal identification based on anthropometric measurements.[33] Anthropometric characteristics have direct relationship with sex, shape and form of an individual and these factors are intimately linked with each other and plays a major role in manifestation of the internal structure and tissue components which in turn, are influenced by environmental and genetic factors.[34,27] Use of anthropometry may arise under several sets of circumstances i.e. Natural, intentional and accidental (war dead cases, air crash, road and train accidents, earth quake, flood, fire; deliberately mutilation, disfigurement, pounding, gouging etc. of the dead body).[35,36]

Earlier the role of the dentistry in forensic sciences was confined to the dental records where orthopanthomogram, intraoral periapical radiograph, history were compared to dental restorations, dental anomalies, missing, impacted, periodontal pathology of the unidentified body. Recently due to the improved techniques, the skull radiography with its variables were found to exhibit sexual dimorphism, thus increasing the scope of the dentistry in the field of forensic sciences.

The first step in forensic identification is determination of sex of an individual.[50] Human skeleton bone is used for sex determination as it has extraordinary resistance to putrefaction and effects of external agents.[60] The major contributors in determining the sex in skeletal components are pelvis followed by the skull.[5,47,58] As the pelvis is fragile, the skull plays a major role in determination of sex.[63] Craniofacial skeleton exhibits inherent complexity exhibiting large variability in size, shape and proportions which leads to individualization.[57] However reliability of skull in identification of sex questionable until adolescence.[7,46,14]

Several studies have been conducted in the past to identify the sex of the individual using anthropometric measurements of the skull which resulted in an accuracy ranging from 77 to 92% .[7,37,51,31,39,48,49,61] The studies conducted to determine sex from the skull radiograph resulted in an accuracy ranging from 80-100%. [6,7,15,25,32,35,36,46] In this regard skull radiographic studies are feasible, accurate, reproducible method of sex determination by using multiple linear and angular measurements.[17] Further these cephalometric variables provide multiple points for comparison.[32,46]

Veyre-Goulet[63] et al conducted a study using 18 cephalometric variables for sexual dimorphism in European population and claimed an accuracy of 95.6%. **Kanchan and Modi[32] et al** conducted a study using 10 cephalometric variables for sexual dimorphism in Central Indian population and claimed an accuracy of 99%. **Hsiao[25] et al** conducted a study using 18 cephalometric variables for sex discrimination and claimed an accuracy of 100%.

The craniofacial characteristic traits of sex determination exhibit population dependent differences, therefore there is a need for population specific assessment.[27] In this study, we are using lateral cephalographs of individuals of Chennai population within the range of 25-45years to evaluate the lateral cephalometric variables and to derive a discriminant function equation which could be of any value in future forensic investigations in Chennai population.

Aims & Objectives

AIMS AND OBJECTIVE

AIM OF THE STUDY:

The aim of the study is to evaluate the lateral cephalometric variables and its efficacy in identification of sexual dimorphism in Chennai population using discriminant function analysis.

OBJECTIVES OF THE STUDY:

- To assess the lateral cephalometric variables of Chennai population within the age group of 25-45 yrs using RADI ANT DIACOM software.
- To statistically derive a discriminant function equation.
- Applying the outcome in identification of sexual dimorphism statistically.

Review of Literature

REVIEW OF LITERATURE

Determination of sex is usually the first step in identification of an individual. The pelvis and skull are the two most used parts of the skeletal system in identification of sex. The pelvis being more fragile is usually found in more damaged conditions than the skull, making the latter used more often.[63] Features like larger and stronger skulls, prominent mastoids, pogonion and supraorbital ridges help to differentiate skulls of males from female individuals.[3] Sometimes these features may lead to misidentification like in the cases of females with larger skulls or men with small skull**. Vikan Sassouni[57]1963** et al has stated the importance of lateral cephalograms in sexual dimorphism.

In the recent years, new methods in sex determination using radiographs of skulls have been proposed. In this study we are using lateral cephalographs and evaluating the efficacy of lateral cephalometric variables in determining sex. A proper and detailed review of literature is of at most importance to obtain a meaningful study and results.

Ceballos and Rentschler[12] et al 1958 had conducted a study to determine the sex in 35 adult skull characteristics. Posteroanterior skull projection was used, from which they measured four diameters: total craniofacial height, mastoid height, bicondylar width, and mandibular width. They have concluded from extensive tests that "sex can be predicted in 88 per cent of the cases by utilization of these measurements."

Hanihara[23] et al 1959 had conducted a study in 35 Japanese skulls. The aim of the study was to use discriminant analysis in sex determination. He has used nine measurements: maximum length, breadth of the skull, height of the skull, facial breadth, upper facial height, mandibular breadth, symphysial height, condylar height, and ramal breadth. The discriminate functional equation derived in the study was able to differentiate the sex with 88.6% accuracy rate.

Krogman[35,36] et al 1962 has described certain traits distinguishing skulls of males and females in the following table.

TABLE 1:

TRAITS IN THE SKULL DIAGNOSTIC OF SEX

Trait	Male	Female
General Size	Large(Endocranial Volume 200 Cc Or More)	Small
Architecture	Rugged	Smooth
Supra-Orbital Ridges	Medium To Large	Small To Medium
Mastoid Processes	Medium To Large	Small To Medium
Occipital Area	Muscle Lines And Protuberances Marked	Muscle Lines And Protuberances Not Marked

Frontal Eminences	Small	Large
Parietal Eminence	Small	Large
Orbits	Squared, Lower, Relatively Smaller, With Rounded Margins.	Rounded, Higher, Relatively Larger, With Sharp Margins.
Forehead	Steeper, Less Rounded	Rounded, Full, Infantile
Cheeck Bones	Heavier, More Laterally Arched	Lighter And More Compressed
Mandible	Larger, Higher Symphysis, Broader Acetabular Ramus	Small With Less Corpal And Ramal Dimensions
Palate	Larger, Broader,, Tends More To U-Shape	Small Tends To Be Parabola
Occipital Condyles	Large	Small
Teeth	Large, Lower Molar More Often 5-Cusped	Small, Molars Most Often 4-Cusped

Inoue[28] et al 1990 studied lateral radiographic views of Japanese skulls of 100 male and 100 female for sex difference in forehead shape and quantified it with the Fourier analysis method. An automated sexing computer system based on the quantification was created and achieved 85% accuracy in sex determination.

Hong Wei Song[26] et al 1992 conducted a study in 60 chinese skulls consisting of 30 males and 30 females. Forty one variables on each skull were measured and one group of 14 and a second group of 5 variables were selected from all the variables by applying multiple stepwise regression on a computer. Discriminate function equation for the 14 and 5 variables for sex diagnosis have been obtained and then these variables are highly significant. The discriminate rate for the group of 5 variables resulted in accurate sex determination in 96.7% of cases. For the group of 14 variables there was 100% success rate.

Wen -Jeng Hwang[65] et al 1996 conducted a study in Caucasians and African American to establish age and sex specific normative data within a age group of 6-18 years by using conventional cephalometry.

- The cephalometric variables used in this study are 12 in number which includes linear measurements and angular measurements.
- Cephalometric variables are SNA, SNB, FNA, AFB, ANV, BNV, AOOB, APBP, AFBF, POOR.
- There was no significant difference between males and females in most of the angular and linear measurements.

- Exceptions to this were the linear measurements AP-BP, AF-BF, PO-OR and the angular measurements FNB, AFB.

Maryna Steyn[43] et al 1997 conducted a study to establish population specific standards for sex determination from the skull of South African whites. A total of 12 standard cranial and five mandibular measurements were taken from 44 male and 47 female skeletons of known sex and race. These were subjected to discriminant function analysis. Bizygomatic breadth was the most dimorphic dimension. Five functions were developed from the complete cranium, vault, face, mandible and bizygomatic breadth. Dimensions from the complete cranium provided the best accuracy. In the mandible, bigonial breadth was the most dimorphic of the measurements taken. Average accuracies ranged from 80% (bizygomatic breadth alone) to 86% (cranium).

Kanchan .R.Patil and Rajendra Modi[32] et al 2005 had conducted a study in Central India population in year 2004 to evaluate the cephalometric variables and its efficacy in determining sex by conventional cephalometry. The following 10 landmarks were traced.

FIGURE 1: LATERAL CEPHALOMETRIC VARIABLES

(Patil and Modi 2005)

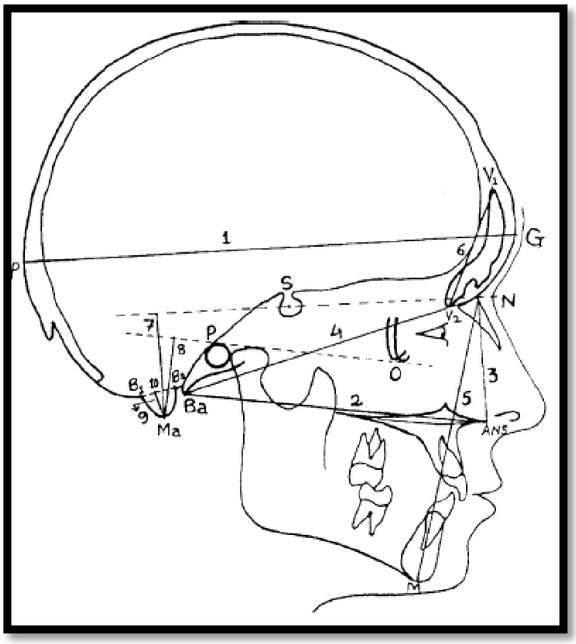


TABLE 2 : VARIOUS MEASUREMENTS ON LATERAL CEPHALOGRAM

(1) G–Op:	Maximum length of skull;
(2) Ba–ANS:	Basion to anterior nasal spine
(3) N–ANS:	Upper facial height;
(4) Ba–N:	Length of cranial base;
(5) N–M:	Total face height;
(6) FsHt: (V1–V2):	Frontal sinus height;
(7) Ma–SN:	Perpendicular distance from mastoidale to SN plane;

(8)Ma–FH:	Perpendicular distance from mastoidale to FH plane;
(9)Ma-B1B2	Mastoid from cranial base
(10)Ma-Wd(B1-B2)	Mastoid width at the level of cranial base

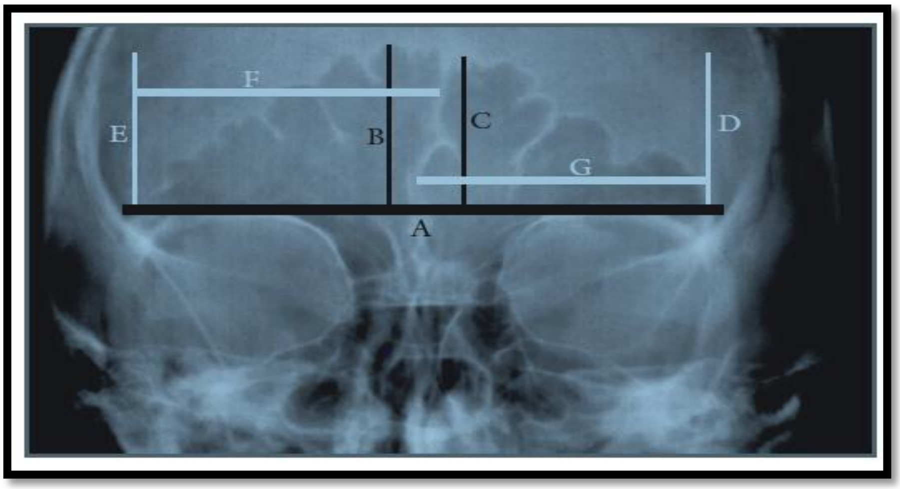
- Discriminant function was derived for variables and discriminant score were then calculated for individuals.
- A sectioning point was then determined which divided the score.
- Reliability of this discriminant function was 99%.
- It was observed that Ba–N, MaHt, N–M, MaWd, Ba–ANS, Ma–FH and G–Op were major variables in determination of sex and their respective discriminative powers were 25.88, 15.12, 13.31, 11.88, 7.78, 7.02 and 6.90%, where as FsHt, Ma– SN and N–ANS were the least reliable variables to determine the sex.
- Out of 10 variables studied the seven variables, i.e. Ba–N; MaHt; N–M; MaWd;Ba–ANS; MaFH and G–Op were found to be more reliable while remaining three, i.e. FsHt; Ma–SN and N–ANS were found to be least reliable in descending order in determining sex.

Marlon Alvaro Moldeza[42] **2006** et al quantified relevant cephalometric parameters for Filipinos according to age and sex.

- A total of 157 Filipino subjects (78 males, 79 females) were divided into comparison groups (GI, GII, GIII, and GIV) on the basis of chronological age and sex using digital lateral cephalometry.
- They were divided into GI = 7 years of age; GII = 9.5years of age; GIII = 14 years of age; and GIV = 22 years of age.
- All relevant angular and linear parameters and coordinates were measured with the aid of Windows-based cephalometric software WinCeph.
- N-S, **N-Me**, **N-ANS**, ANS-Me, A-Ptm, Gn-Cd, Pog_-Go, Cd-Go, Is-Is, Ii-Ii, Mo-Ms, Mo-Mi are the linear measurements measured.
- The angular measurements are facial Angle, Convexity, A-B plane, Y-axis, FH to SN, SNA, SNB, ANB, FP to SN, PP to SN, MP to SN,RP to SN, Gonial Angle, Is to SN, Ii to MP, Is to Ii, OP to SN, OP to FH.
- The male group had a longer anterior cranial base (S-N), **total facial height (N-Me)**, **longer lower anterior facial height (N-ANS**), longer ramus height (Cd-Go), longer lower posterior dentoalveolar height (Mo-Mi_), and total mandibular length (Gn-Cd) than the female group.
- All these linear measurements were statistically significantly different between males and females in GI, GIII, and GIV.
- No statistically significant differences were present in the angular measurements.

Camargo[8] et al 2007 conducted a study in radiographs of 100 individuals of which 50 females and 50 males of Brazilian population to determine the sex of individuals by using measurements of the frontal sinus by conventional Caldwell technique. The right and left areas and maximum height and width of the frontal sinus were determined in 100 radiographs taken by Caldwell technique of 50 women and 50 men between age ranges 20-30 years old. The study concluded that mean values of frontal sinus were greater in males and the left area was larger than the right area. With the use of one variable, this analysis provides a 79.7% precision in the determination of sex.

FIGURE 2: CALDWELL WITH DEMARCATION OF BORDERS OF FRONTAL SINUS AND IDENTIFICATION OF THE MEASUREMENTS COLLECTED WITH THE AID OF REFERECE BASELINE OF 10 cm. (Camargo 2007)



Sophie A. Veyre-Goulet[63] et al 2008 conducted a study in a sample comprised of 114 dry skulls (59 men and 55 women). Lateral teleradiography was conducted on each skull. The cephalometric traces were made by an orthodontic software. Nineteen cephalometric points were identified which enabled the identification of 18 cephalometric variables as described in Hsiao et al. There were eight angles, nine linear measurements (mm), and a proportional measurement (%).

Variables Description:

Angular:

1. GMSN Angle between the glabella to metopion line and the sella to nasion line (SN)
2. GMFH Angle between the glabella to metopion line and the porion to orbitale line (Frankfort horizontal plane, FH)
3. GMBaN Angle between the glabella to metopion line and the basion to nasion line (BaN)
4. GSgM Angle between the metopion to supraglabellare line and the supraglabellare to glabella line
5. IOpSN Angle between the inion to opisthocranion line and the SN line
6. IOpFH Angle between the inion to opisthocranion line and the FH line
7. IOpBaN Angle between the inion to opisthocranion line and the BaN line

8. OIOp Angle between the opisthocranion to inion line and the inion to opisthion line

Linear measurements (mm):

9. SgGM Distance between supraglabellare and the glabella to metopion line
10. GSgN Distance between glabella and the supraglabellare to nasion line
11. **FSHt Frontal sinus height, vertical parameters of the frontal sinus cavity**
12. **FSWd Frontal sinus width on bregma to nasion line**
13. IOpO Distance between inion and the opisthocranion to opisthion line
14. **MaSN Distance between mastoidale and the SN line**
15. **MaFH Distance between mastoidale and the FH line**
16. **MaHt Mastoid height from cranial base**
17. **MaWd Mastoid width at the level of cranial base Proportional, %:**
18. GPI Glabella projection index = (distance between glabella and the supraglabellare to nasion line)

The p value was significant in the **FS-HT, Ma-SN, Ma-FH, Ma-HT, Ma-WD**.

Sex was determined with **95.6%** accuracy using the 18 variables discriminant function.

- The stepwise discriminant analysis selected eight variables the distances GSgN, **MaHt, SgGM, FSHt, MaWd**, and FSWd, the angle GMSN, and the GPIA which could predict sex with the same accuracy.
- **All the linear variables were greater in males than in females.**
- In conclusion, it can be said that skull-sexing methods using lateral teleradiography seem always suitable but the most indicative variables could differ relative to the ethnic population concerned.

V.G Naikmasur[46] et al 2010 conducted a study in of South Indian state and immigrant Tibetans population within the age range of 25-54 years. Only the dentulous subjects were considered in the study. Conventional lateral and posterior anterior cephalometric radiographs of each selected subject were taken and Manual method of tracing was done.

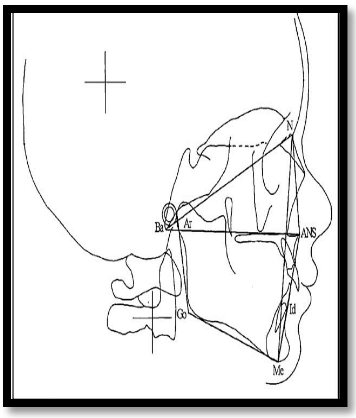
- The linear measurements on the lateral cephalogram are **Ba-ANS**(depth of the face), **N-ANS(**upper facial height**), Ba-N**(length of the base of the skull), **N-Me**(anterior facial height), Id-Me(symphysis height), Ar-Go(mandibular ramus height), Me-Go(mandibular body length).
- The linear measurements in the posterior anterior view are Zg-Zg(bizygomatic width), Go-Go(bigonion width), Co-Co((bicondylar width).
- The **classification accuracy for males** was about **77.8%** for South Indian population and **85.2%** for Tibetans.

- For **females** it was **85.2%** and **91.3%** for South Indian and Tibetian population.
- This study was done to assess the **overall discrimination accuracy** which was **81.5%** in the South Indian population, **88.2%** in Tibetans population using 11 cephalometric variables.
- Among the chosen variables bizygomatic width, ramus height and **depth of face** contributed sexual dimorphism in both the population.
- **Upper facial height** was a additional parameter for sexual dimorphism in immigrant Tibetan population.

The study concluded that cephalometric cranio- mandibular parameters contribute to sex. prediction across population.

FIGURE 3: TRACING OF LATERAL CEPHALOGRAM

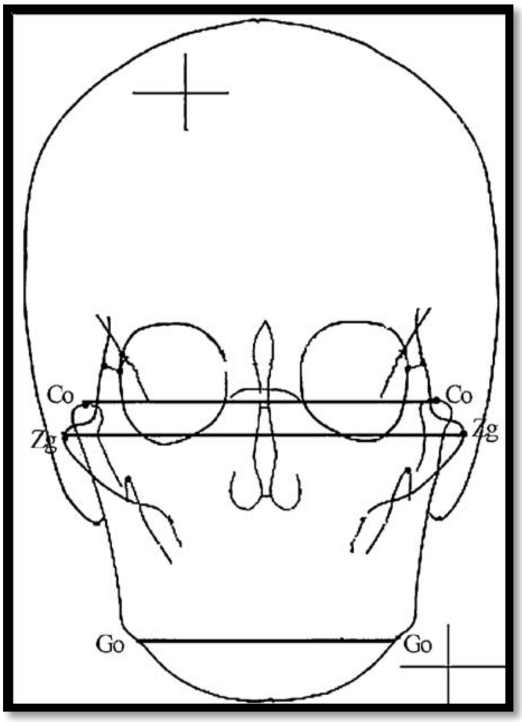
(Naikmasur 2010)



Ba-ANS(depth of the face), **N-ANS(**upper facial height**), Ba-N**(length of the base of the skull), **N-Me**(anterior facial height), Id-Me(symphysis height), Ar-Go(mandibular ramus height), Me-Go(mandibular body

FIGURE 3: cont. TRACING OF PA CEPHALOGRAM

(Naikmasur 2010)



Zg-Zg(bizygomatic width),

Go-Go(bigonion width),

Co-Co((bicondylar width).

Elena F kranioti[18] et al 2010 conducted a study to develop a sex determination technique using osteometric data from skeletal components of Cretan population. A total of 90 males and 88 females are measured according to standard osteometric techniques. A total of 16 dimensions taken from the craniofacial skeleton are used. Results stated that males are statistically significantly greater than females in all dimensions. Bizygomatic breadth is the most discriminatory single dimension and can provide an accuracy rate of 82% on average. Using a stepwise method involving five dimensions (bizygomatic breadth, cranial length,nasion–prosthion andmastoid height and nasal breadth), accuracy is raised to 88.2%.

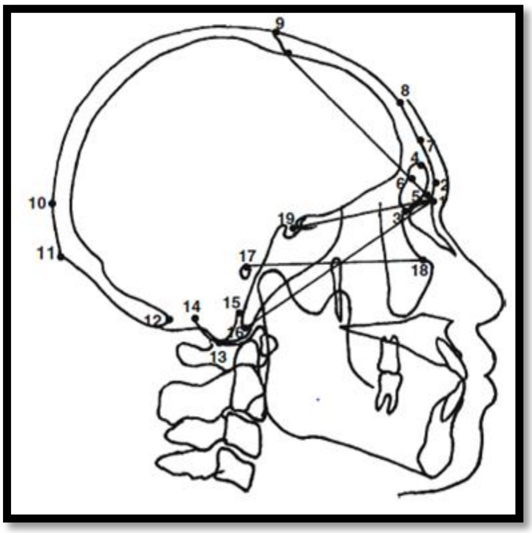
Tin Hsin Hsio[25] et al 2010 conducted a study in population of 50 male and 50 female cephalograms of Taiwanese children of age 15-16 yrs years of age to validate sex determination using digital lateral radiographic cephalometry and discriminative function analysis. Twenty two cephalometric variables were performed using computerized cephalometric system winiceph version 8.0.Statistical analysis.

- The angular measurements were glabella-metopion to basion- nasion, glabella-metopion to sella-nasion, glabella-metopion to porion-orbitale,inion-opisthocranion to basion-nasion, inion oipisthocranion to sella-nasion,inion-opisthocranion to porion-orbitale, glabella-suprabellare-metopion, opisthion-inion to inion-opisthocranion.
- Linear cephalometric variables are glabella to opisthocranion, basion to bregma, basion to opisthion, **frontal sinus height**, frontal sinus width, **mastoid width** at the level of the cranial base, **mastoid height** from the cranial base, **mastoidale to sella-nasion**, **mastoidale to porion-orbitale**, supraglabellare to glabella-metopion, inoin to opisthocranion-opisthion, supraglabellare to nasion, glaballe to supraglabellare-nasion.
- For stepwise discriminant functional analysis, this study used the SAS computer program to select a combination of measurements that best determine the sex.

- The program selected seven of these twenty two cephalometric variables for discriminant function analysis.
- Seven variables are GM-BaN˚, Iop-BaN˚, Fswd(mm), Ba-Br(mm), Bao(mm), **MaHt(mm),** GPI(mm).
- The model alone with the GM-BaN alone classifies 73% of the sexes correctly.
- The models **with two variables** GM-BaN and basi-bregmatic height and **three variables** (GM-BaN,Ba-Br and MaHt) classify the sexes with **84% and 90%** accuracy respectively.
- The models with **seven cephalometric variables** (GM-BaN, Ba-Br, MaHt, Ba-O, GPI, IOP-BaN and frontal sinus width classify the sexes with accuracy ranging from **92-95%.**

In conclusion, this study selects at least 4 cephalometric traits required to obtain the maximum discriminant effectiveness of sex determination in children and adolescents.

FIGURE 4: CEPHALOMETRIC TRAITS (Tin Hsin Hsio 2010)



1.Nasion, 2.Glabella,3.V_1- upper parameter of frontal sinus, 4. V_2-lower parameter of the frontal sinus, 5.H_1-anterior parameter of frontal sinus cavity to nasion line, 6.H_2- posterior parameter of frontal sinus on inner bregma to nasion line, 7.supraglabella, 8. Metapion, 9.metapion, 10.opisthocranion,11.inion 12.opisthion, 13.mastoidale, 14. Posterior parameter of mastoidale, 15.anterior parameter of mastoidale, 16.basion, 17. Porion, 18.orbitale, 19. sella .

Rajkumar[51] et al 2011 conducted a study to determine the sex using lateral cephalometry.

- The study population consisted of 100 adults (50 males, 50 females).
- 15 cephalometric variables were used for analysis.
- The cephalometric variables were Sg-GM(supraglabelllare to glabella-metapion), GSgN (glabella to supraglabellare-nasion), **Fsht(frontal sinus height)**, Fs-Wd(frontal sinus width), **Ma-Sn(mastoidale to**

sella-nasion), **Ma-Fh(mastoidale to Frankfort horizontal plane), Ma-WD(mastoidale width from cranial base),** CBL(Cranial base length), GMSN(Glabella-metapion to sella –nasion),GMFN (Glabella-metapion to porion –orbitale), GMBaN (Glabella-metapion to basion nasion), GSgM(metapion-supraglabebellare to supraglabellare galbella), SNAr-(Sella-nasion to articulare), GPI(glabella projective index).

- This study was done to assess the discrimination accuracy using these 15 variables which was found to be 84%.

Ji-Hwan Kim[30] et al 2011 conducted a study in the year 2010 to establish cephalometric norms of Mongolian adults and compare them with Korean adults. Lateral cephalometric radiographs of 74 Mongolian adults (35 men, 39 women) and 95 Korean adults (52 men, 43 women). Forty craniofacial variables were measured, and groups were compared by analysis of covariance which consisted of measurements from the cranial base, vertical and horizontal skeletal skeletal relationship, size of the mandible,,dentition and soft tissue.

VERTICAL SKELETAL RELATIONSHIP:

- **AFH (mm) Anterior facial height, distance N-Me**
- **FHR Facial height ratio, posterior to anterior facial height ratio, S-Go/N-Me**

- **LAFHR Lower anterior facial height ratio, ANS-Me/N-Me**

These were variables had a P-value which was significant.

Sexual dimorphism was found to be significant, especially for skeletal linear measurements and vertical skeletal relationships.

Guilherme Janon[22] et al 2011, had conducted a study on cephalometric variables for sex determination in Afro-Caucasian Brazilian subjects to compare the skeletal, dental and soft tissue characteristics of Caucasian and Afro-Caucasian Brazilian subjects and to evaluate sexual dimorphism within the groups.

- The sample comprised lateral cephalograms divided into 2 groups.
- Caucasian females and males did not have any statistically significant difference in the measurements.
- The Afro-Caucasian female subjects had less mandibular protrusion and smaller total posterior facial height and upper posterior facial height than males.

The study concluded that Brazilian Afro-Caucasian subjects have greater dentoalveolar and soft tissue protrusion than Brazilian Caucasian subjects, with slight sexual dimorphism in some variables.

Das Gupta[13] et al 2012 conducted a study in 70 adult skulls with known sex out of which 35 male and 35 female. Only skulls with no apparent deformity and intact mastoid process were included in the study.

- The mastoid measurements taken were mastoid length, medio-lateral diameter, anterior posterior diameter and size.
- The study stated that mastoid length is the best discrimination followed by anterior-posterior being second best indicator in the prediction of sex.

The study concluded that the **four variables** when put to together, correctly determined the sex **in 90%** of the samples. **Mastoid length** was found to be the best sex determinant with a discriminant power of **85.7%**.

Almas Binnal[2] et al 2012 conducted a study in 100 lateral cephalograms in 50 males and 50 females subjects aged between 25 and 54 years belonging to South Indian population to determine the accuracy of cephalometric variables to determine sex.

- The following nine cephalometric variables –**Basion to anterior nasal spine(Ba-ANS), length of the cranial base(Ba-N), total facial height(N-M), frontal sinus height(Fs-ht), mastoidale to porion-orbitale plane(Ma-Fh), mastoid height (Ma-Ht),mastoid width at the cranial base(Ma-Wd).**

- Among the nine cephalometric variables 7 cephalometric variables were reliable in identification of sex.
- The seven variables are Ma-Sn, Ba-ANS, N-M, Ma-Fh, N-ANS, Ba-N, Ma-Ht.
- The derived discriminate function equation accurately identified 88% of male study as males and 84% of females study subjects as females.

The study concluded the derived discriminant function can be useful in identification of sex in human remains pertaining to South Indian population.

Ayar Razzaq Ali[56] et al 2013 conducted a study in a population of 113 adults with age ranging from 22-43 of which 51 were males and 62 were females using digital lateral cephalograms. Total of 11 cephalometric variables were measured of which 8 were linear measurements and 3 were angular measurements.

- 8 linear cephalometric variables were **nasion-menton, basion-nasion,** glabella to opsithocranium, **Ba-ANS, N-ANS, Ma-SN, Frontal sinus height.** The angular measurements are Ba-N-M,M-N-ANS,S-N-M.
- The study concluded that the overall predictive accuracy of sex determination by discriminate analysis was 85.8%.
- The first ranked variable in the discriminate power was **nasion-menton** with 87.3% diagnostic accuracy.

- Next followed by length of the cranial base and finally the S-N-M angle gave the overall predictive accuracy of sex determination.

The study concluded that the lateral cephalometric measurements of craniofacial bones are useful to support sex determination of Iraqi population in forensic radiographic medicine.

Maria Elen[41] et al 2013 had conducted a study on sexual dimorphism by three dimensional geometric morphometrics of the palate and the cranial base in a sample of 176 crania of known sex -94 males, 82 females. Three dimensional geometric co-ordinates of 30 ecto-cranial landmarks were digitized using a microscribe 3DX contact digitizer. The results indicate that there are shape differences between sexes. In males, the palate is deepest and more elongated; the cranial base is shortened. The accuracy of improves when both shape and size are combined that is 90.4% for the cranial base and 74.8% for the palate.

Mahalakshmi[44] et al 2013 conducted a study in 156 subjects comprising of 76 males and 80 females with in a age range of 25-55yrs to determine sexual dimorphism and stature using lateral cephalogram. Digital lateral skull view of each subject was taken. Ten linear measurements were plotted using specially designed windows trophy diacom software on radiograph. Data was subjected to discriminant function analysis and regression analysis for sex and stature determination respectively. The 10 cephalometric linear variables plotted for analysis are

1. G-OP: glabella to opisthocranion
2. **Ba-ANS: nasion to anterior nasal spine**
3. **N-ANS: nasion to anterior nasal spine**
4. **Ba-N: basion to nasion**
5. **N-M: nasion to menton**
6. **Fs-HT: V_1-V_2- upper and lower parameter of the frontal sinus cavity**.
7. **Ma-SN: perpendicular distance from the mastoidale to S-N plane.**
8. **Ma-FH: perpendicular distance from mastoidale to the FH plane.**
9. **Ma-HT: Ma-B_1B_2- anterior and posterior parameter of the mastoid width at the level of the cranial base.**
10. **Ma-WD:B_1-B_2 mastoid width at the level of cranial base.**

This study concluded that MA-ht, V_1-V_2, G-OP, Facial depth (Ba-ANS) and total facial height (N-M) emerged to be the major contributors for sexual dimorphism whereas upper facial ht and cranial base were least reliable for sex determination. Based on these variables, sexual dimorphism can be determined with an accuracy of 73.1% and mastoid ht gave significant sexual differentiation of 71.8%.

FIGURE 5

CEPHALOGRAPH WITH LINEAR CEPHALOMETRIC LINEAR LANDMARKS (Mahalakshmi 2013)

Ruchi U. Mathur[54] et al 2014 conducted a study to determine sex using discriminant functional analysis in young adults of Nasik in conventional Lateral cephalograms

- The sample included an equal number (total-60) of males and females with age range of 20-25years.
- Each radiograph was traced and cephalometric landmarks were determined. Calculations of 11 cephalometric measurements were performed.
- The cephalometric data was treated using Minitab computer program.

- With discriminant function derived by using all the 11 variables simultaneously the sex was determined correctly in 93% of the cases.
- Out of 11 variables studied, 4 variables were more reliable in determining sex of the adolescent population of Nasik.
- Out of 11 variables studied, 4 variables, i.e. N-S, **N-ANS**, Co-Gn & Gonial angle were more reliable while the remaining 7 were found to be less reliable in determining sex of the young adults of Nasik.

Mahesh Kumar[45] et et al 2014 conducted a study in a population of 800 subjects- 400 males and 400 females, of age above 18 years.

- The purpose of the study was to determine the sex from the cephalometric parameters-
  1. **max head length,**
  2. maximum head breadth,
  3. maximum biparietal diameter,
  4. bigonial diameter,
  5. morphological facial length by discriminant function analysis.

This study concluded that the cephalometric variables **classified the sex with an accuracy of 77.5%.** The accuracy in **males was 76.3% and 78.8% in females.**[45]

Ruhi sidhu[55] et al 2014 conducted a study 50 subjects which included 25 males and 25 females to check the accuracy and reliability of maxillary sinus in sex determination.

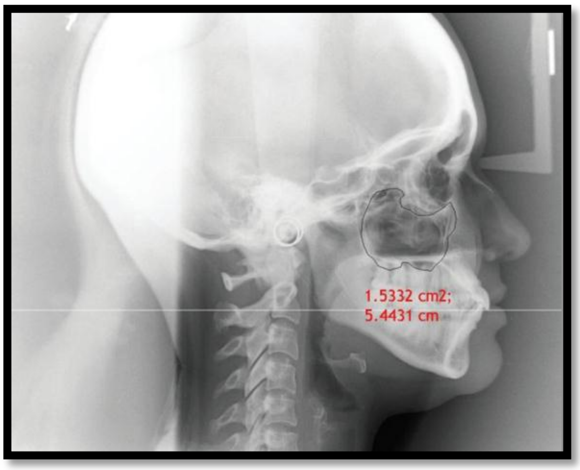
- Lateral cephalograms of 50 subjects were taken and morphometric parameters of maxillary sinus were analyzed using autocad 2010 software.the mean area.
- The overall sensitivity and specificity was found to be 80% and 72%.

The study concluded that males have larger maxillary sinus when compared to females and that the morphometric analysis (area and perimeter) of maxillary sinus using AUTOCAD 2010 software can assist in sex determination.

FIGURE 6:

MEASURING AREA AND PERIMETER OF MAXILLARY SINUS BY AUTOCAD

(Ruhi Sidhu 2014)

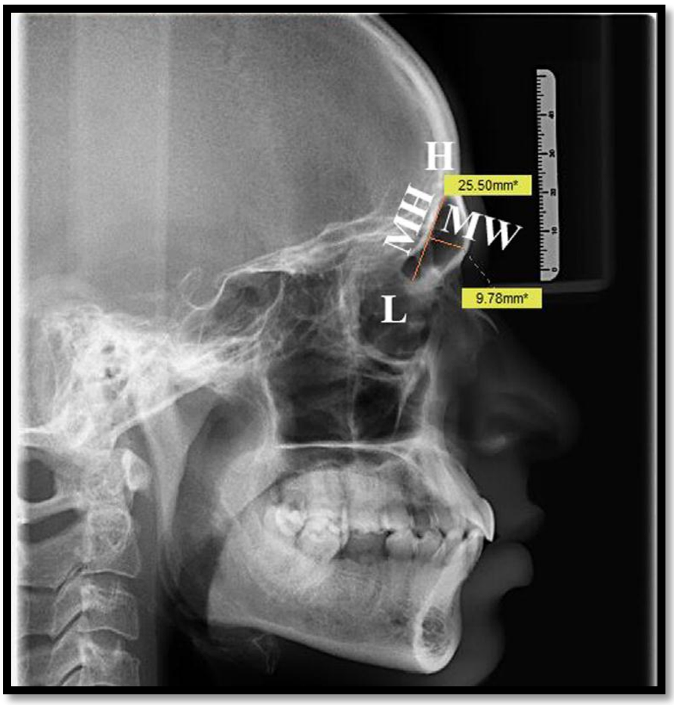


Chi. Sai Kiran[10] et al 2014 has conducted a study in a study group of 216 adult digital cephalometric radiographs using the length and angle measurement tools of SIDEXIS XG software. The study concluded that **mean height** and width **of frontal sinus** were significantly higher in males than females. The discriminant function equation derived in the study was able to differentiate the groups with 67.59% accuracy rate.

FIGURE 7:

FRONTAL SINUS MEASUREMENTS ON THE LATERAL CEPHALOGRAMS

(Chi. Sai Kiran 2014)



H – highest point on frontal sinus,

L – lowest point on frontal sinus,

MH – maximum height,

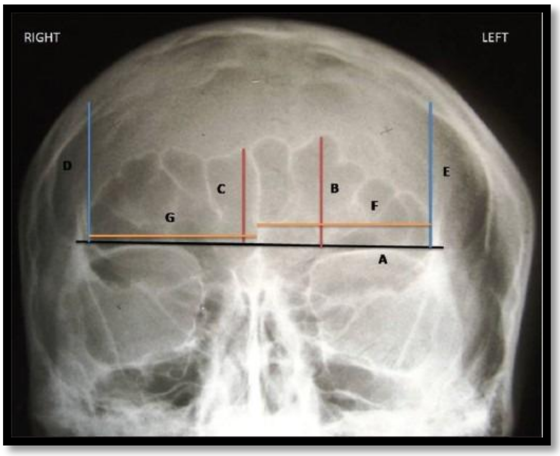
MW - maximum width of the frontal sinus

Sowmya verma[59] et al 2014 conducted a study to evaluate frontal sinus and its sexual dimorphism. The right and left areas, maximum height, width of frontal sinus were determined in 100 Caldwell views of 50 women and 50 men aged 20 years and above, with the help of Vernier callipers and a square grid with 1 square measuring 1mm in area.

- The mean values of variables were greater in men
- The study predicted the female sex as 55.2%, of right area as 60.9% and of left area as 55.2.

FIGURE 8:

DIAGRAM OF CALDWELL WITH THE DEMARCATION OF THE BORDERS OF THE FRONTAL SINUS AND IDENTIFICATION OF THE MEASUREMENTS (Soumya Verma 2014)



(a) Baseline, (b) Maximum left height, (c) Maximum right height, (d) lateral most point of the perimeter on right side,
(e) Lateral most point of the perimeter on left side, (f) Maximum left width

David marianayagam[60] et al 2010 conducted a study to establish cephalometric norms from digital posterior cephalogram for a Indian population. The study population consisted of 45 men and 55 women of age range 25-55 yrs old subjects had well balanced face and ideal occlusion. 12 cephalometric variables were used in the study. They are

1. Cranial width (eur-eur)
2. ZL-ZR
3. Facial width(ZA-AZ)
4. Nasal width(NC-CN)
5. Maxillary wdith(JL-JR)
6. Mandibular width(AG-GA)
7. Maxillary intermolar width
8. Mandibular intermolar width
9. A6-B6
10. 6A-6B
11. Upper midline deviation
12. Lower midline deviation.
13. The study concluded that there were statistical differences between male and female samples.

Comparison indicated that males have larger values than females.

Essam M. Mehlab[19] et al 2013 conducted a study to evaluate the age and sex dependent changes of craniofacial skeleton of the age period 7-17 years old. Two hundred children and adolescent consisting of 100 males and 100 females were categorized according to age into 5 equal groups and underwent posterior anterior cephalograms using high resolution after digitizing the PA landmarks. The land mark co-ordinates were used to calculate the cranial, bifrontotemporal, bizygomatic, mid facial, maxillary skeletal base, bigonial, biantegonial and nasal widths. Measurements of maxillary and mandibular intermolar widths were made directly on the plaster model with calliper. Both maxillary and mandibular intermolar widths show progressive significant difference, between males and females with age. The study concluded that there was a significant change in transverse craniofacial difference between males and was significantly evident in male measurements compared to females.

Li Luo[38] et al 2014 conducted a study in 127 males and 81 females skulls in the year 2013 for determining sex using automatic sex determination method by 3D digital skulls construction. Statistical shape model for skulls is constructed, which projects the high dimensional skull data into a low dimensional shape space and fisher discriminant analysis is used to classify skulls in shape space. The correct rate in classifying is 95.7% for females and 91.4% for male.

Materials and Methods

MATERIALS AND METHODS

TYPE OF STUDY: RETROSPECTIVE STUDY

STUDY PERIOD: June 2015-Oct 2015

PLACE CONDUCTED: Sri Venkateshwara Scan Center, Velachery, Chennai.

- **Sample size**: 100 lateral cephalograms

  Male-50

  Female -50

- Age group-25 to 45 yrs belonging to Chennai population.
- Nine cephalometric parameters (Ba-ANS, N-ANS, Ba-N, N-M,Fs-Ht,Ma-FH,Ma-Ht, Ma-Wd) were used to arrive a discriminant function equation for identification of sex.

INCLUSION CRITERIA:

- Study population included 50 male and 50 females in the age group of 25 to 45yrs within Chennai population.

EXCLUSION CRITERIA:

- Individuals with the history of orthodontic and orthognathic treatment, trauma and surgery of the skull,

- Clinical features suggestive of hereditary, developmental, nutritional disturbances and facial asymmetry were not included in the study.

CHEMICALS/ MATERIALS/REAGENTS USED :

FOR TAKING THE DIGITAL LATERAL CEPHALOGRAM:

- KODAK 8000C DIGITAL PANAROMIC AND CEPHALOMETRIC SYSTEM

FOR MEASUREMENTS:

- KODAK DENTAL IMAGING SOFTWARE 6.12-15.0.
- RADI ANT DICOM VIEWER 22.3- EVALUATION VERSION.

Facility to be obtained:

Sri Venketeshwara Scans, Velachery, Chennai.

Estimated budget:

Rs 30,000

Statistics to be used

- Student t-test.
- Discriminant functional analysis.
- Statistical analysis using the statistical package—SPSS, VERSION 20.0

METHODOLOGY:

- Lateral cephalograms of the study subjects would be obtained by using – KODAK having teeth in centric occlusion.
- The cephalograhs were obtained using a digital extraoral radiographic machine KODAK 8000C DIGITAL PANAROMIC AND CEPHALOMETRIC SYSTEM.
- The exposure parameters were 80 KVp, 10mA and 0.50seconds.[29]
- Digital cephalograms will be obtained.
- The following nine cephalometric variables were derived using a range of cephalometric bony landmarks –Ba-ANS, N-ANS, Ba-N, N-M, Fs-Ht, Ma-SN, Ma-FH, Ma-Ht, Ma-Wd.
- Linear cephalometric variables were measured using DIACOM software.
- Initially mean values, standard deviation, coefficient of variation were calculated for all the variables.
- Values derived were compared using student t test.
- A dicriminant function equation is derived statistically.
- Discriminant functional analysis is used to assess the efficacy of the selected cephalometric variables in the discrimination of the sexes.
- A sectiononing point is derived which divided the score into male and female group with minimum overlap.

- Cross validation was done to evaluate the efficacy of the discriminant function equation in determinantion of sex.

CEPHALOMETRIC LANDMARKS USED IN THE STUDY ARE

The landmarks were

- Basion—(Ba)—lowest point on the anterior rim of the foremen magnum in the median plane
- Anterior Nasal Spine—(ANS)—anterior tip of the sharp bony process of the maxilla
- Nasion—(N)—most anterior point on the frontonasal suture in the midsagittal plane
- Menton—(M)—lowest point on the symphysial outline of Chin
- Mastoidale—(Ma)—lowest point of the mastoid process
- Sella—(S)—mid-point of Sella-turcica
- V1 and V2—upper and lower parameter of the frontal sinus cavity respectively
- B1 and B2—anterior and posterior parameter of the mastoidal width at the level of cranial base respectively
- Frank-furt Horizontal plane—(FH plane)—line connecting the Porion {top of the earpost of the cephalostat} with the Orbitale {lowest point of bony orbit},
- Sella-Nasion plane—(SNplane)—line connecting Sella with Nasion.

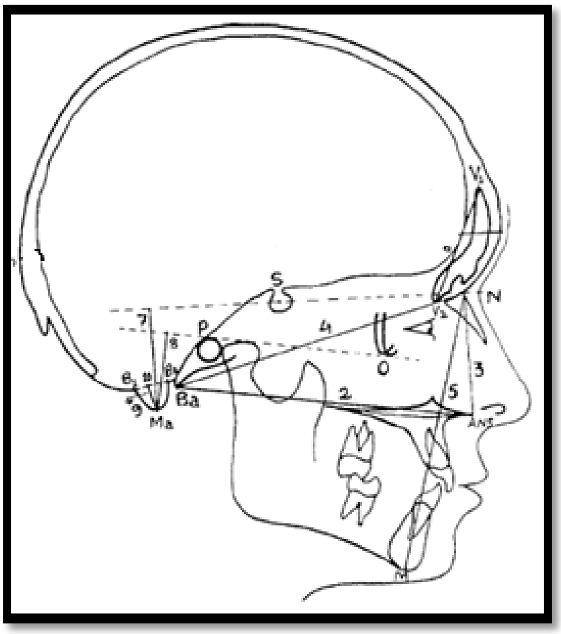
THE LINEAR MEASUREMENTS USED ARE

- Basion to anterior nasal spine (Ba-ANS)
- Upper facial height (N-ANS)
- Length of cranial base (Ba-N)
- Total face height (N-M)
- Frontal sinus height (Fs-Ht)
- Mastoidale to sella-nasion plane (Ma-SN)
- Mastoidale to porion-orbitale plane (Ma-FH)
- Mastoid height from cranial base (Ma-Ht)
- Mastoid width at the level of cranial base (Ma-Wd)

Figures

FIGURE 9:

CEPHALOMETRIC LANDMARKS USED IN PRESENT STDUY



(1)SCALE

(2) Ba–ANS

(3) N–ANS

(4) Ba–N

(5) N–M

(6) FsHt: (V1–V2)

(7) Ma–SN

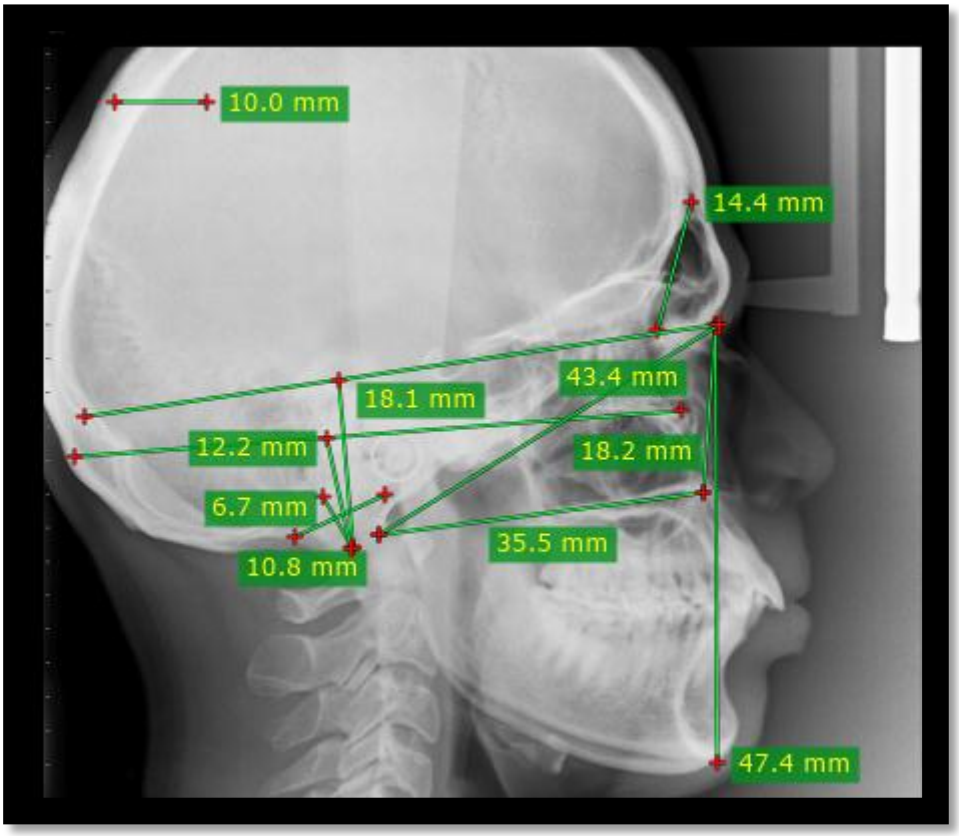
(8)Ma–FH

(9)Ma-B1B2

(10)Ma-Wd(B1-B2)

FIGURE 10

IMAGE ANALYSIS USING RADI ANT DIACOM SOFTWARE



Results

RESULTS

The present study is a retrospective study conducted in the Department of Oral Medicine and Radiology of Ragas Dental College and Hospital, Uthandi, Chennai. Aim of the study is “To evaluate the lateral cephalometric variables and its efficacy in identification of sexual dimorphism in Chennai population using discriminant function analysis.” Total of 100 cephalograms were collected which consisted of 50 males and 50 females. Nine cephalometric variables were considered in the study and their discrimination in determination in sex was assessed. Discriminant function equation was derived following which cross-validation was done within the study population.

Results of the present study documents the following data:

TABLE 3:

Mean age in the Male and Female group:

The mean age of the male and female group is 26.70 in the males and 26.42 in the females.

TABLE 4:

Mean values of cephalometric parameters in males and females with their respective coefficient of variance, t-value and p value:

T-test was done to test the variables which were significant to select the variables for discriminative analysis. It was found that all the variables were significant with P VALUE <0.001.

- The mean Ba-ANS value for the male group is 49.15 and in female group is 42.40.
- The mean N-ANS value for the male group is 23.88 and in female group is 20.42.
- The mean Ba-N value for the male group is 51.67 and in female group is 43.19.
- The mean N-M value for the male group is 55.52and in female group is 47.67.
- The mean Fs-HT value for the male group is 16.80 and in female group is 13.77.
- The mean Ma-SN value for the male group is 20.68 and in female group is 17.47.
- The mean Ma-FH value for the male group is 14.05 and in female group is 11.27.

- The mean Ma-ht value for the male group is 6.79 and in female group is 5.71.
- The mean Ma-wd value for the male group is 14.12 and in female group is12.00.

TABLE-5

Discrimiant analysis - Test of equality of group means:

- Discriminant analysis is used to determine which variable discriminate between two or more groups for which the test of equality.
- In this table the variable are tested for further significance using the teat of equality.
- All the variables were significant with a p-value of <0.001.

TABLE 6:

Wilk's Lambda:

- In this study the overall Wilk's lambda coefficient is 0.296 with a p value of <0.001which means the variables are contributory and **highly significant.**

TABLE 7:

Canonical correlation value:

- Canonical correlation displays the strength of correlation between the discriminant score and the set of independent variables with minimum acceptance level of 0.05.
- Therefore the canonical correlation of the entire sample resulted in .839 demonstrating a high correlation between the discriminant function and independent variable.

TABLE 8:

Standardized canonical discrimininant function coefficient:

- To assess the possibility to generate accurate gender models from the data collected for this study, discriminant functions were, calculated and tested using cross-validation.
- The standardized function coefficient with highest score is the one higher predictive power.
- In this study the one with higher predictive power is for Fs-ht, Ba-ANS, N-ANS, Ma-ht ,Ba-N.

TABLE 9:

Discriminant function coefficients for the nine variables and the derived discriminant function equation:

- This is the derived discriminant function equation from the population used under study.
- The discriminant function equation derived from the unstandardized coefficient functions.

TABLE 10:

FUNCTIONS AT GROUP CENTROIDS:

- From the step wise analysis group centroids was generated for both the genders.
- A group centroid is the mean value of mean discrinant score for each gender.
- A cut off point is the average of 2 group centroids, a smaller value than this is considered to be a female and larger value is considered to be male.
- The cut off point for this study is 0.527.
- Male group centroid value is 1.527.
- Female group centroid value is -1.527.

TABLE 11:

ACCURACY OF DISCRIMINANT FUNCTION IN SEX DETERMINATION

Classification Function Coefficients

- This second part of discriminant analysis where a classification function coefficients are derived.
- These are the classification function are used to determine to which group each case most likely belongs.

TABLE 12:

Classification Results – cross validation:

- After deriving a classification function coefficients this model is used on originally grouped cases to predict the accuracy of this model derived.
- Out of 50 males, 49 were predicted as males and one as female and shows a accuracy of 98%.
- Out of 50 females, 46 were predicted as females and 4 were predicted as males and shows a accuracy of 92%.
- 95% of originally grouped cases were correctly classified.

Tables & Graphs

TABLE 3: MEAN AGE IN THE MALE AND FEMALE GROUP:

	Sex	N	Mean	Std. Deviation	Std. Error Mean
Age in years	Male	50	26.70	1.705	.241
	Female	50	26.42	1.939	.274

TABLE 4: MEAN VALUES OF CEPHALOMETRIC PARAMETERS IN MALES AND FEMALES WITH THEIR RESPECTIVE COEFFICIENT OF VARIANCE, T-VALUE AND P VALUE

Parameter	Sex				t-value	P value
	Male		Female			
	Mean	SD	Mean	SD		
Ba-ANS	49.15	2.33	42.40	3.56	11.213	<0.001**
N-ans	23.88	1.74	20.42	1.72	10.006	<0.001**
Ba-n	51.67	3.34	43.19	4.25	11.088	<0.001**
n-m	55.52	5.51	47.67	4.61	7.720	<0.001**
FS-ht	16.80	1.57	13.77	1.73	9.170	<0.001**
Ma-sn	20.68	3.27	17.47	2.08	5.845	<0.001**
Ma-fh	14.05	2.47	11.27	1.66	6.588	<0.001**
MA-ht	6.79	.99	5.71	.79	6.049	<0.001**
MA-wd	14.12	2.08	12.00	1.77	5.492	<0.001**

TABLE 5: DISCRIMINANT ANALYSIS

Tests of Equality of Group Means

	Wilks' Lambda	F	P-VALUE	STANDARDIZED COEFFIENCT
Ba-ANS	0.438	125.721	<0.001**	0.443
N-ans	0.495	100.118	<0.001**	0.401
Ba-n	0.444	122.934	<0.001**	.230
n-m	0.622	59.598	<0.001**	-0.96
FS-ht	0.538	84.094	<0.001**	0.452
Ma-sn	0.742	34.161	<0.001**	-0.180
Ma-fh	0.693	43.400	<0.001**	-141
MA-ht	0.728	36.585	<0.001**	0.275
MA-wd	0.765	30.167	<0.001**	0.120

SUMMARY OF CONONIICAL DISCRIMINANT ANALYSIS

TABLE 6:

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Sig.
1	0.296	.000

TABLE 7:

Canonical correlation

Function	Eigenvalue	% of Variance	Cumulative %	**Canonical Correlation**
1	2.380(a)	100.0	100.0	**0.839**

TABLE 8:

Standardized Canonical Discriminant Function Coefficients

	Function
	1
Ba-ANS	0.443
N-ans	0.401
Ba-n	0.230
n-m	-0.096
FS-ht	0.452
Ma-sn	-0.180
Ma-fh	-0.141
MA-ht	0.275
MA-wd	0.120

TABLE 9:

DISCRIMINANT FUNCTION COEFFICIENTS FOR THE NINE VARIABLES AND THE DERIVED DISCRIMINANT FUNCTION EQUATION

Discriminant Function Coefficients

	Function
	1
Ba-ANS	0.147
N-ans	0.232
Ba-n	0.060
n-m	-0.019
FS-ht	0.274
Ma-sn	-0.066
Ma-fh	-0.067
MA-ht	0.308
MA-wd	0.062
(Constant)	-18.567

DERIVED DISCRIMINANT FUNCTION EQUATION

D= -18567 + 0.147(BA-ANS) + 0.232(N-ANS) + 0.060(BA-N) - 0.019(N-M) + 0.274(FS-HT) – 0.066(MA-SN) – 0.067(MA-FH) + .308(MA-HT) + .062(MA-WD)

TABLE 10:

FUNCTIONS AT GROUP CENTROIDS

Sex	Function 1
Male	1.527
Female	-1.527

TABLE 11:

ACCURACY OF DISCRIMINANT FUNCTION IN SEX DETERMINATION

Classification Function Coefficients

	Sex	
	Male	Female
Ba-ANS	4.385	3.936
N-ans	5.433	4.724
Ba-n	.008	-.176
n-m	.093	.151
FS-ht	4.567	3.731
Ma-sn	-.723	-.522
Ma-fh	-3.569	-3.364
MA-ht	6.947	6.007
MA-wd	1.438	1.248
(Constant)	-215.681	-158.974

Fisher's linear discriminant functions

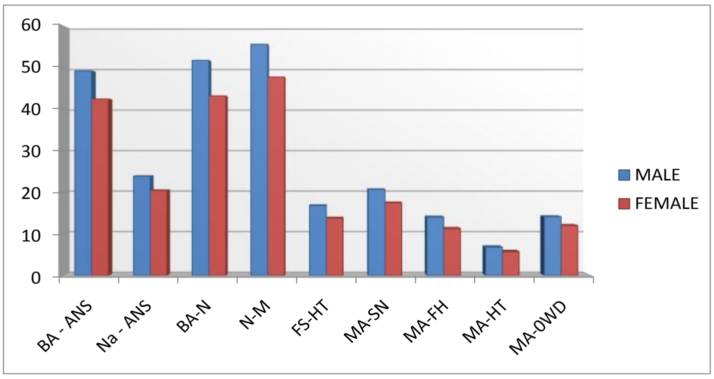
TABLE 12:

CLASSIFICATION RESULTS

		Sex	Predicted Group Membership		Total
			Male	Female	
Original	Count	Male	49	1	50
		Female	4	46	50
	%	Male	98.0	2.0	100.0
		Female	8.0	92.0	100.0

GRAPH 1:

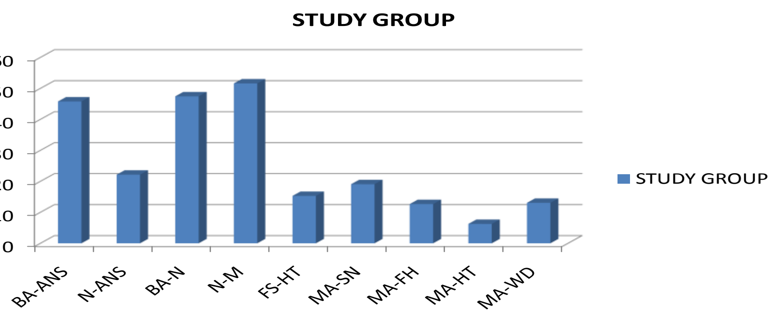
DIFFERENCES IN THE MEAN VALUES OF NINE CEPHALOMETRIC VARIABLES IN BOTH MALE AND FEMALE SUBJECTS:



- All mean values of the variables were greater in males and in females

GRAPH 2:

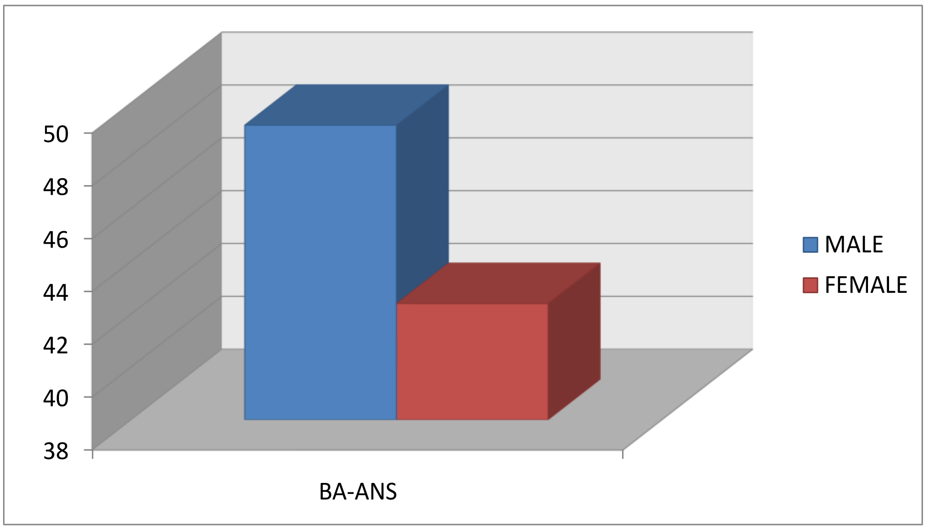
GROUP MEAN OF NINE CEPHALOMETRIC VARIABLES



- Group mean value of the variables are plotted
- It was found that the N-M had a greater value compared to others variables.

GRAPH 3:

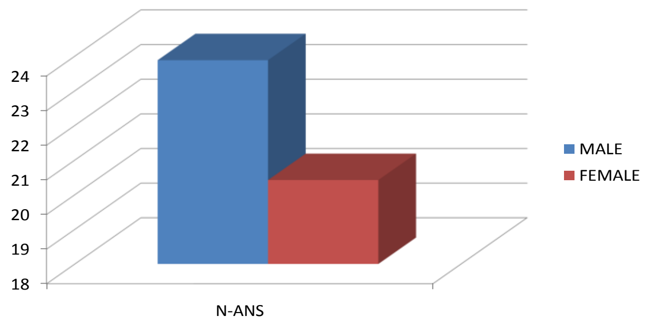
MEAN OF Ba-ANS IN MALE AND FEMALE SUBJECTS



- Mean value of Ba-ANS is greater in males compared to females

GRAPH 4:

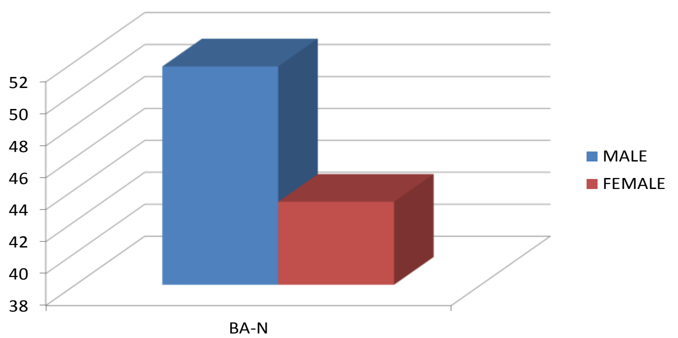
N-M MEAN VALUES OF MALE AND FEMALE:



- Mean N-M value is greater in males than females

GRAPH 5:

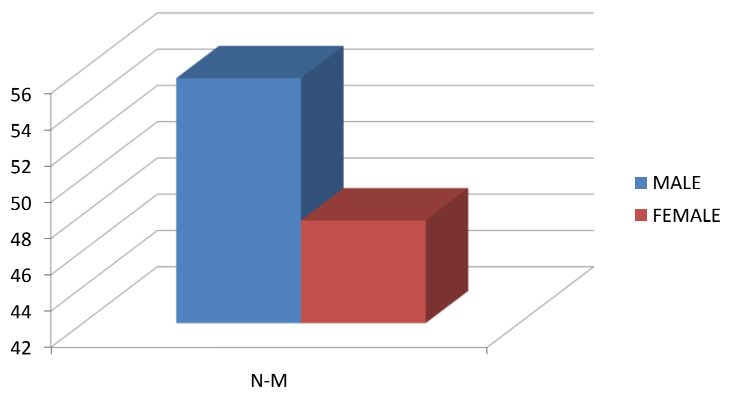
MEAN VALUES OF Ba-N IN MALE AND FEMALE SUBJECTS



- Mean Ba-N is greater in males than in females

GRAPH 6:

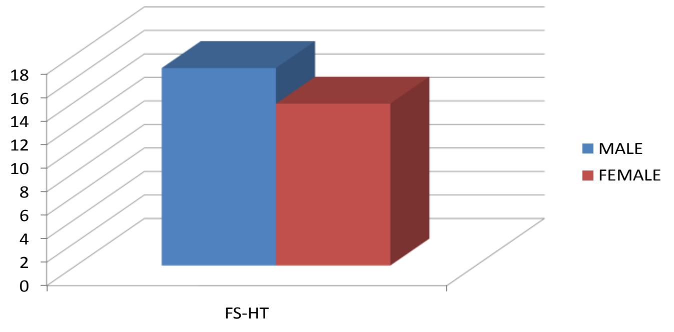
MEAN VALUES OF N-M IN MALE AND FEMALE SUBJECTS



- Mean N-M is greater in males compared to females.

GRAPH 7:

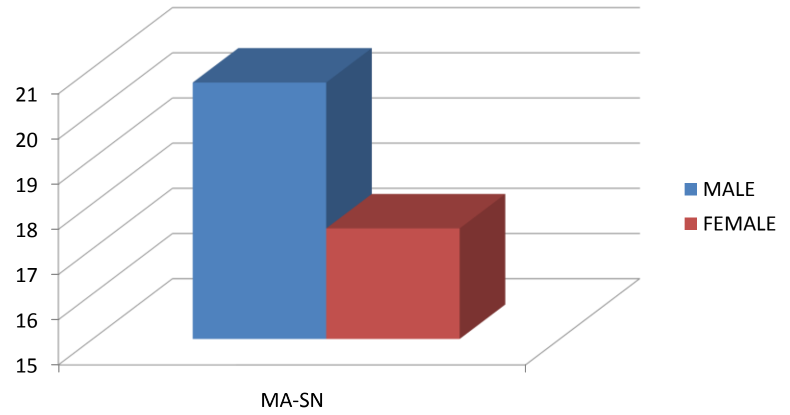
MEAN VALUES OF FS-HT IN MALE AND FEMALE SUBJECTS



- Mean Fs-HT is greater in males compared to females.

GRAPH 8:

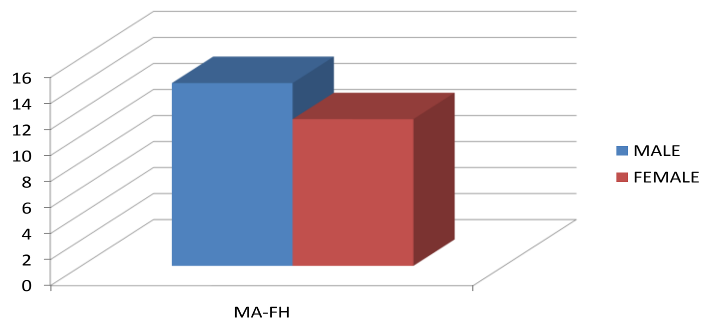
MEAN VALUES OF MA-SN IN MALE AND FEMALE SUBJECTS



Mean value of Ma-SN value was greater in males compared to females

GRAPH 9:

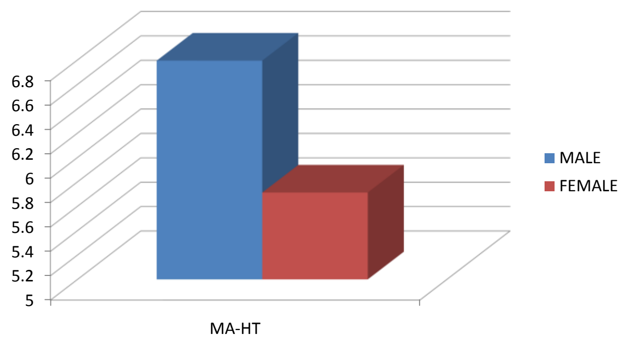
MEAN VALUES OF MA-FH IN MALE AND FEMALE SUBJECTS



- Mean MA-FH is greater in males than in females.

GRAPH 10:

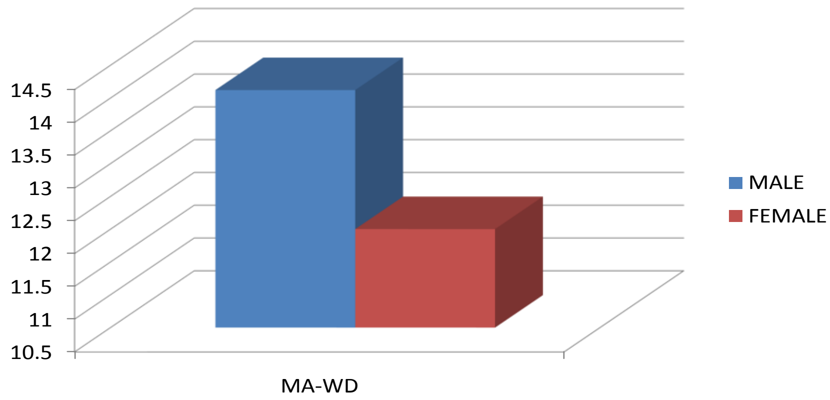
MEAN VALUES OF MA-Ht IN MALE AND FEMALE SUBJECTS



- Mean Ma-Ht is greater in males than in females.

GRAPH 11:

MEAN VALUES OF MA-Wd IN MALE AND FEMALE



Mean MA-Wd in males is greater than in females.

Discussion

DISCUSSION

In forensic sciences, the key analysis in construction of biological profile of human skeletal is to determine sex.[66] Human skeletal bone is used for sex determination as it has extraordinary resistance to putrefaction and effects of external agents.[60] Craniofacial skeleton exhibits inherent complexity expressed by a large variability in size, shape, and proportions, which leads to individualization.[57] Many studies were conducted to determine the sex from anthropometric skull measurements and from skull radiographs.[21] Pelvis is considered the gold standard for gender analysis in forensics.[35,36,7] Cephalographs are considered the second gold standard as they are more objective, standardized and reproducible.[29,63]

Expression of secondary sexual characters plays a vital role in determination of sexual dimorphism.[7] Lateral cephalometric variables exhibit sexual dimorphism between genders of the same species. Expression of sexual dimorphism, is highly accurate by the age of 25, since the growth of the craniofacial region is completed and expression of cephalometric parameters are more pronounced at this age but however the parameters are affected by changes occurring due to senility.[35,36,52] Because of this, in this study the subjects selected in Chennai population were within the age range of 25-45.

In this study a total of 100 lateral cephalographs were collected retrospectively, which consisted of 50 of each gender. The cephalometric variables selected in this study are Ba-ANS, N-ANS, Ba-N, N-M, Fs-Ht, Ma-

SN, Ma-FH, Ma-Ht, Ma-Wd and these were measured by Radiant Diacom viewer 2.2.3. The following were subjected to statistical analysis by SPSS version 20.00. The study had two parts where the part I consisted of evaluating the variables and to test their significance followed by discriminant function analysis where a discriminant function equation and classification functions were derived from the study population. The part II of the study was to statistically cross validate the study population with the derived equation and classification functions and to check the accuracy of the model. By using the student t-test, all the 9 predictor variables were found to be highly significant (p<.0.001). All the predictor variables were subjected to step wise discriminant function analysis. Further significance was assessed using Wilk's lambda (Test of Equality). Canonical correlation was done to assess the relationship between the variables, which was found to be significant. A discriminate function[53] equation was derived statistically from the population used in the study, following which a cross validation has been done to evaluate the efficacy of this model which had an overall accuracy 95%. This model had accuracy in predicting males by 98% and females by 92%.

In the present study, the cephalometric variables used were considered according to evidences from the previous studies in which have reported of high significance in sex determination **(Hsiao TH[25] et al 1996, De Paiva[14] et al 2003, Patil and Modi[32] et al 2005, Williams[66] et al 2006).** In the present study FS-ht, Ba-ANS, N-ANS, Ma-ht, Ba-N, Ma-wd were considered to be the major variables for sex determination compared to Ma-FH, Ma-SN,N-M which were considered to be least reliable. It was observed that all the cephalometric variables were greater in males compared to females.

Fs-ht was considered to be major variable which was consistent with the findings of **Camargo[8] et al 2007, Veyre gouley[63] et al (2008) Mahalaxmi[44] et al(2013), Sowmya Verma[59] et al (2014), Sai Kiran[10] et al 2014** and was not consistent with findings of **Almas Binnal[2] 2013**.

Ba-ANS (depth of the face) was considered to be major variable which was consistent with the findings of **Kanchan and Modi[32] et al 2005, V.G Naikmasur[46] et al 2010, Mahalaxmi[44] et al 2013, Almas Binnal[2] 2012. Naikmasur 2010** has done a study in immigrant Tibetian and in in South Indians where the depth of the face was very significant sex discriminator.[46]

Ma-ht, Ma-wd were considered to be the other major variables which were consistent with the study done by **Paiva et al (2003)** [14], **Kemkes et al 2006**[4]**, Das Gupta et al 2012**[13]**,Veyre Goulet et al 2008**[63]**, Mahalaxmi et al 2013** [44]**. Paiva et al 2003** [14]**and Kemes et al 2006**[4] concluded that mastoid process is the most protected and resistant structure to damage, even in cases of burns, due to its anatomical position at the base of the skull and its compact nature.[62] Thus, this anatomical region is favorable for sex determination especially when multiple measurements are carried out. (**Paiva[14] et al (2003)**, **Kemes[4] et al 2006). Das Gupta[13] 2012 et al** conducted a study using anthropometric skull measurements for the mastoid process, the mastoid height was the best sex determinant with an accuracy of 85.7% and the overall accuracy using mastoid measurements was 90%.[13]

N-ans which was the other major variable in this study is consistent with **Ruchi Mathur 2015**[54] and was inconsistent with **Almas Binnal et al 2013.**[2]

According to **Chang**[9] **et al 1993 and Rogers**[52] **et al 2005** there is a variation in growth of the different parts of the skull, with sexual differences being best defined in the late growing structures of the skull, such as lower facial height, facial depth and mastoid process, while the cranial base and upper face are the middle growing regions in which some sexual differences may be evident.[9,52] In the present study the results were consistent as the Ma-ht, Ma-wd (mastoid process), Ba-ANS(depth of the face) emerged as major contributors of sexual dimorphism excluding lower facial height. This disparity could be explained by geographical diversity. **Almas Binnal**[2] **et al 2013** conducted a study in 100 subjects belonging to south Indian population where the major variables were found to be lower facial height, depth of the face and mastoid process which were consistent with the proportions of **Chang**[9] **et al and Rogers**[52] **et al**.

The discriminant functional equation derived in this study is 95% accurate in differentiating male and female subjects. **Hsiao**[25] **et al (1996)** studied 100 cephalograms of Taiwanese origin and claimed 100% accuracy in sex determination using 18 cephalometric variables,[25] the variables common with our study were Frontal sinus height, mastoid width, mastoid height, mastoid to SN, mastoid to FH. **Franklin[20] et al 2005** reported an accuracy of 77-80% in sexual discrimination using 8 cephalometric variables[20], the variables common with our study was the mastoid length. **Almas Binnal[2] et al 2012** claimed accuracy of 86% gender determination using the same 9 variables,[2] all the variables were consistent with our study. **Naikumasur[46] et al 2010** reported a accuracy of 81.5% and 88.2% respectively by comparing the reliability of craniomandibular parameters in South Indian and Indian immigrant of Tibetans population using 12 variables on lateral and posterior-anterior cephalograms,[46] the variables common with our study are Ba-ANS, N-ANS, Ba-N, N-Me. A study done by **Patil and Modi[32] et** al **2005** in Central India population showed a accuracy of 99% considering 10 cephalometric variables,[32] the variables common with study were Ba-ANS,N-ANS, Ba-N, N-M, Fs-HT, Ma-ht Ma-SN,Ma-FH,Ma-Wd. **Verey-Goulet[63] et al 2008** conducted a study using 18 cephalometric variable based on **Hasio[25] et al** for sex determination and claimed a accuracy of 95.6%, where the variables common with our study are Fs-ht, Ma-SN, Ma-FH, Ma-ht,Ma-Wd. **Ayar Razzaq Ali[56] et al 2013** conducted a study conducted a study using 13 cephalometric variables and claimed an accuracy of 85.8%, the variables common with our study were N-M, Ba-N, Ba-ANS, N-ANS, Ma-SN,Fs-ht.

Mahalakshmi[44] et al 2013 conducted a study using 10 cephalometric variables for sex determination and claimed a accuracy of 73.1%, where the variables common with our study were Ba-ANS, N-ANS,Ba-N, N-M, Fs-ht, Ma-SN, Ma-FH, Ma-ht, Ma-wd. The disparity in the findings may be explained by the number of predictor variables, age of the study group, varying predictor variables, heterogenous population groups,[64] population specificity, magnification factors.

Summary & Conclusion

SUMMARY AND CONCLUSION

In this study a total of 100 lateral cephalographs were collected retrospectively, which consisted of 50 males and 50 females. Nine cephalometric variables were measured by Radiant Diacom viewer 2.2.3, the nine cephalometric parameters are Ba-ANS, N-ANS, Ba-N, N-M, Fs-Ht, Ma-SN, Ma-FH, Ma-Ht, Ma-Wd. It was found that statistically all the predictor variables were significant. All the predictor variables were greater in males than compared to the females. In the present study FS-ht, Ba-ANS, N-ANS, Ma-ht, Ba-N, Ma-wd were considered to be the major variables for sex determination and Ma-fh, Ma-SN,N-M were considered to be least reliable. A discriminate function equation was derived statistically from the population used in the study, following which a cross validation has been done to evaluate the efficacy of this model which had an overall accuracy 95% This model had accuracy in predicting males by 98% and females by 92%.

Sex determination based on cephalometric traits exhibit population specificity, hence a need for a population specific assessment.[27] The lateral cephalometric traits are influenced by a number of factors which produces differences in skeletal proportions between different geographical areas thus we in this study have derived discriminant function which can be a valuable tool in identification of sex in population pertaining to Chennai. Further studies should be conducted and specific standards of assessment are to be drawn among different populations of the world.

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Annexures

ANNEXURE -I

name	age	sex	Ba-ANS	N-ans	Ba-n	n-m	FS-ht	Ma-sn	Ma-fh	MA-ht	MA-wd
anirudh	26	m	48mm	22.8mm	48.6mm	53.6mm	16.5 mm	17.5mm	14.8mm	6.5mm	13.8,mm
avinash	27	m	49.3mm	22.3mm	50.4mm	5o.7mm	16.4mm	18.2mm	13.7mm	7.3mm	12mm
ramakrishnan	30	m	48.7mm	21.3mm	47.5mm	50.8mm	16.3mm	18.9mm	13mm	6.5mm	12.3mm
valliappan	26	m	49.7mm	21.4mm	46.8mm	52.1mm	16.7mm	18.5mm	10.6mm	5mm	12.7mm
veera raghavan	25	m	50.4mm	22.4mm	48.3mm	51.5mm	16.9mm	15.1mm	8.5mm	4.9mm	11.3mm
tivakar	27	m	51.2mm	24.5mm	47.8mm	50.8mm	14.5mm	15.4mm	8.2mm	4.4m	12.6mm
tarun	28	m	48.5mm	22.1mm	49.5mm	45.2mm	13.1mm	15.2mm	8mm	4.8mm	13.1mm
bhangaravya	27	m	53.9mm	24.5mm	55.2mm	63.2mm	17.8mm	26.7mm	14.2mm	6.7mm	19.2mm
bavitra kunarnay	25	m	46.9mm	24.3mm	53.1mm	55.9mm	16.1mm	19mm	12.3mm	8.4mm	11mm
chandran	27	m	43.4mm	19.4mm	47.3mm	51.9mm	14.6mm	19.5mm	13.2mm	7.1mm	13.3mm
ann mathew	28	m	51.3mm	26.5mm	57.1mm	64.6mm	16.6mm	23.4mm	14.8mm	5.2mm	13.4mm
sairam	27	m	51mm	21.3mm	53.4mm	50.3mm	15.2mm	16.3mm	11.2mm	5.1mm	12.3mm
rajaram	25	m	45mm	21.2mm	49.6mm	58.4mm	15.6mm	18.4mm	11.6mm	6.9mm	12.1mm
karthik	26	m	46.1mm	25.2mm	52.9mm	67.1mm	18.5mm	17.8mm	13.5mm	5.7mm	12.7mm
mohan babu	27	m	48.1mm	26.5mm	56.9mm	61.5mm	17.1mm	19.6mm	12.6mm	6.3mm	13.4mm
ramaih	28	m	51.9mm	24.5mm	53.9mm	57.8mm	17.2mm	24.6mm	15.6mm	7.5mm	12.5mm
krishna srinivasan	26	m	46.2mm	23.4mm	51.2mm	53.5mm	15.6mm	18.3mm	15.2mm	5.7mm	12.1mm
kathirisen	25	m	47.8mm	24.3mm	52.3mm	58.6mm	15.4mm	24.9m,	14.8mm	7.5mm	12.3mm
karthkeyan	28	m	51.4mm	22.3mm	55.6mm	51.4mm	16.2mm	23.4mm	13.2mm	6.1mm	12.8mm
karthik	26	m	50.2mm	26.8mm	55.9mm	69.3mm	21.1mm	27.5mm	18.9mm	6.5mm	11.8mm
jagadeesh	27	m	47.8mm	24.6mm	47.4mm	56.7mm	16.5mm	23.5mm	15.7mm	7.1mm	14.2mm
kalia selvan	26	m	51.7mm	23.2mm	50mm	50.5mm	17.2mm	20.1mm	12.1mm	8.3mm	17mm
jagan	27	m	47.4mm	23.6mm	47.8mm	54.6mm	15.5mm	22.2mm	15.8mm	7.9mm	16.9mm
guru	26	m	49.4mm	21.2mm	48.4mm	52.1mm	16.2mm	18.3mm	13.1mm	8.7mm	18.6mm
dilip.s	28	m	47.6mm	23.5mm	47.8mm	52.8mm	16.5mm	17.3mm	12.3mm	7.4mm	17.4mm
ganesh	27	m	47.8mm	24.3mm	55.4mm	59.5mm	20.2mm	20.2mm	15.1mm	6.7mm	19.9mm
harshan	26	m	51.5mm	24.7mm	56.6mm	53.6mm	16.2mm	17.6mm	12.2mm	6.1mm	15.4mm
susheel kumar	27	m	46.3mm	21.4mm	47.3mm	48.5mm	16.1mm	18.6mm	12.7mm	6.3mm	13.5mm
srivatsan	25	m	44.3mm	22.3mm	46.6mm	49.5mm	15.7mm	17.8mm	11.9mm	6.5mm	14.5mm
manohar	25	m	48.4mm	25.8mm	54.8mm	60.1mm	17.8mm	20.1mm	13.4mm	6.9mm	14.3mm
sai tej	26	m	51.7mm	21.7mm	54.6mm	51.1mm	15.8mm	16.8mm	12.5mm	6.1mm	13.1mm
raghuram	25	m	46.7m	22.8mm	50.2mm	58.4mm	15.8mm	18.4mm	11.6mm	6.9mm	13.4mm
arjun	29	m	46.5mm	25.mm	53.9mm	66.7mm	18.5mm	17.5mm	13.5mm	5.8mm	12.9mm
selvaraj	27	m	48.1mm	27.6mm	57.6mm	61.3mm	17.1mm	19.6mm	12.6mm	6.8mm	13.4mm
sriram	26	m	52.3mm	25.4mm	54.9mm	58.7mm	17.2mm	24.6mm	15.6mm	7.5mm	13.1mm
sreekrishna	25	m	47.2mm	24.3mm	52.1mm	53.5mm	15.6mm	18.3mm	15.2mm	6.2mm	13.7mm
kamalesh	25	m	47.8mm	24.3mm	52.3mm	58.6mm	15.4mm	24.9mm	14.8mm	7.5mm	13.3mm
koutilya	26	m	51.9mm	23.2mm	55.6mm	51.4mm	16.2mm	23.4mm	14.2mm	7.1mm	12.8mm

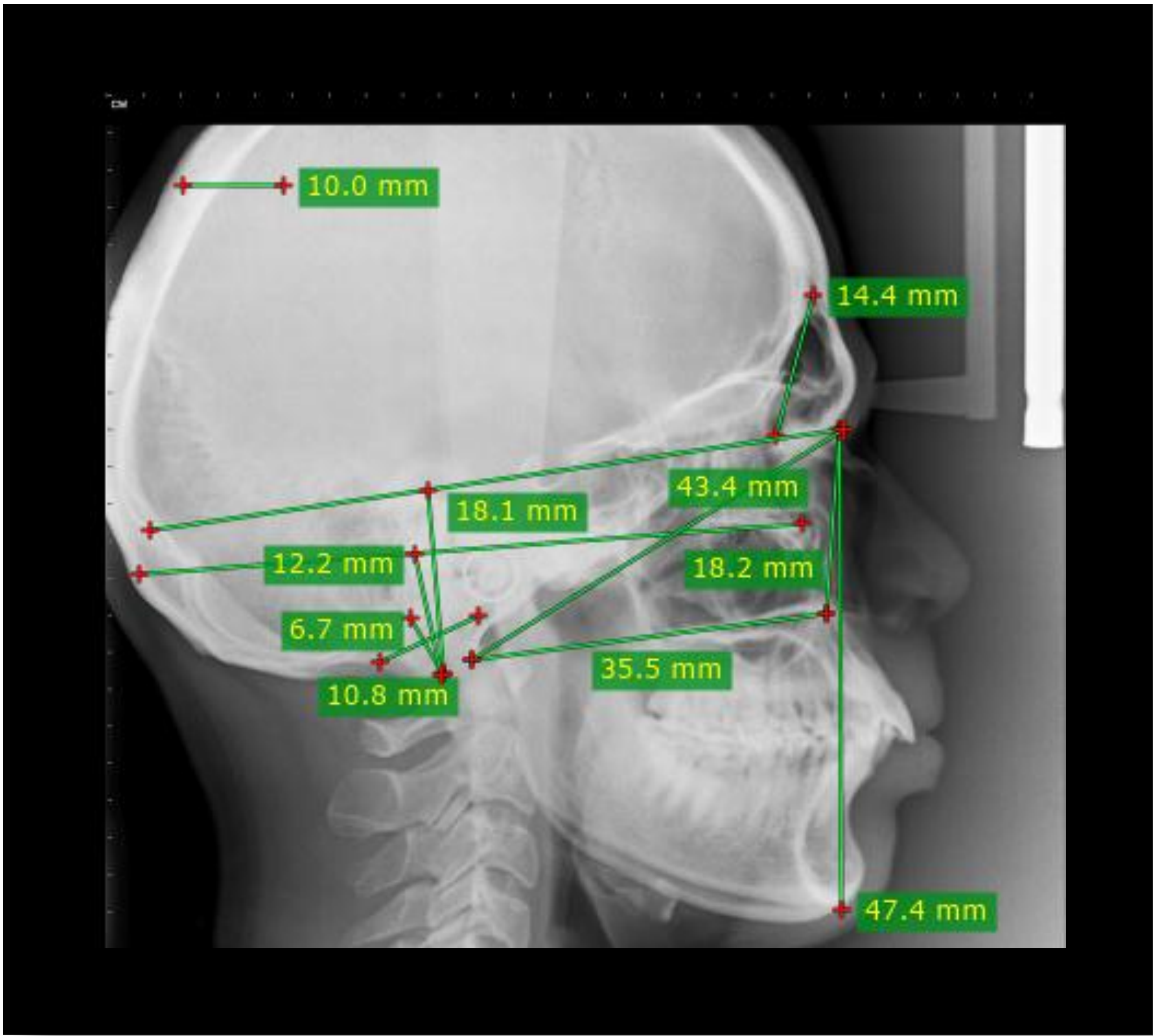
karthikeyan	27	m	51.2mm	26.8mm	55.9mm	69.3mm	22.1mm	27.5mm	18.9mm	7.3mm	12.8mm
jagan	26	m	49.1mm	24.6mm	47.4mm	56.7mm	17.1mm	23.5mm	15.7mm	7.2mm	14.2mm
kalia selvan	27	m	51.7mm	24.6mm	50.5mm	50.5mm	17.2mm	21.3mm	17.4mm	8.3mm	17mm
shyam	32	m	47.4mm	23.6mm	47.8mm	54.6mm	15.5mm	22.2mm	15.8mm	7.9mm	16.9mm
harshit	33	m	50.3mm	24.3mm	54.2mm	50.3mm	17.5mm	20.3mm	16.1mm	6.9mm	14.7mm
ganpath	25	m	48.8mm	24.8mm	48.5mm	52.5mm	16.3mm	23.3mm	16.3mm	6.9mm	15.3mm
nischal	27	m	49.6mm	25.3mm	49.8mm	55.8mm	17.7mm	24.7mm	15.9mm	7.4mm	15.2mm
ravitej	25	m	50.7mm	25.3mm	55.2mm	52.2mm	18.2mm	21.7mm	16.9mm	7.8mm	15.8mm
giri	29	m	52.4mm	24.6mm	51.6mm	54.4mm	18.3mm	23.4mm	16.8mm	7.4mm	15.4mm
tarrun	25	m	49.9mm	25.3mm	49.8mm	55.5mm	18.4mm	21.4mm	17.5mm	7.4mm	15.3mm
mahesh	25	m	51.3mm	24.5mm	52.3mm	50.5mm	17.8mm	22.4mm	17.3mm	7.8mm	16.9mm
sreeram	27	m	51.9mm	24.5mm	53.9mm	57.8mm	17.2mm	24.7mm	15.6mm	7.5mm	12.5mm

ANNEXURE -II

name	age	sex	Ba-ANS	N-Ans	BA-N	N--M	Fs-HT	Ma-SN	Ma-FH	Ma-HT	Ma-WD
ABHINAYA	25	F	46.1MM	23MM	48MM	54MM	18.6 MM	18.8	11mm	11.5	11.9
aishwarya	26	f	37.3mm	20.9mm	35.7mm	47mm	16.5mm	17.5mm	8.6mm	5.8mm	13.5mm
anitha	35	f	44.4mm	18.1mm	48.1mm	47.3mm	16.7mm	19mm	11.7	6.8mm	15mm
anusha	27	f	39.7mm	23.8mm	42.9mm	54.6mm	14.6mm	20.2mm	11.9	6.2mm	13.9mm
ashwini	25	f	44.9mm	21mm	45.4mm	46.5mm	15.8	17.1mm	11.6mm	5.9mm	9.1mm
bharani	26	f	40.6mm	19.2mm	42.9mm	47.6mm	14.8mm	20mm	13mm	6.8mm	12mm
chandana	27	f	45.5mm	18.5mm	47.8mm	47.9mm	15.7mm	17.6mm	9.8mm	5.6mm	7.9mm
esther ponnamal	26	f	38.9mm	20.5mm	43.2mm	47.7mm	13.7mm	15.2mm	9.4mm	5mm	10.5mm
gajalaxmi	26	f	38.6mm	18.2mm	38.4mm	43.3mm	16.2mm	17.4mm	8.9mm	4.7mm	10.2mm
keerthana	25	f	37.6mm	19mm	32.9mm	48.3mm	13.6mm	16.8mm	10.4mm	6.2mm	10.4mm
krishnaveni	27	f	40.4mm	19.5mm	42.5mm	40.6mm	13.9mm	15.3mm	9.8mm	4.6mm	10.5mm
munjushree	26	f	38.7mm	18mm	37.8mm	42.1mm	12.9mm	18.8mm	9.8mm	5.7mm	10mm
priyadarshini	25	f	43.7mm	18.7mm	44.8mm	45mm	13.7mm	19.8mm	9.7mm	6.2mm	9.8mm
ramya	25	f	39.3mm	20.4mm	41.4mm	43.8mm	14.2mm	19.4mm	11.2mm	6.6mm	12.1mm
rekha	26	f	40.6mm	19.8mm	42.6mm	47.4mm	13.9mm	15.1mm	9.9mm	4.6mm	10.8mm
sandhya	27	f	44.2mm	18.2mm	44.4mm	44.2mm	13.7mm	14.9mm	8.7mm	4.9mm	10.9mm
sanjana	30	f	38mm	21.6mm	38mm	47.4mm	13.8mm	13.8mm	11.2mm	5.3mm	13.7mm
vidhya	29	f	37.8mm	17.6mm	37.6mm	38mm	11.9mm	15.2mm	10.8mm	5mm	12.3mm
vandana	18	f	39.7mm	18.6mm	37.8mm	41.2mm	13.5mm	14.1mm	11.7mm	5mm	10.7mm
bowya	28	f	45.7mm	19.9mm	46.5mm	47.3mm	13.2mm	20.3mm	12.4mm	5.3mm	11.3mm
catherine	25	f	44.6mm	21mm	44.9mm	49.5mm	11.6mm	20.1mm	13.5mm	6.6mm	9.6mm
deepika	24	f	47.3mm	24.4mm	39.5mm	56.2mm	9.6mm	17.6mm	11.8mm	4.5mm	12.9mm
varshini	25	f	41.3mm	21mm	43.1mm	50.6mm	12.4mm	19.4mm	11.6mm	5.1mm	14mm
sumitharan	25	f	47.8mm	22.1mm	50.6mm	56.2mm	12.8mm	20.6mm	13.2mm	6.8mm	11.5mm
subhapradha	26	f	44.1mm	22.1mm	42.2mm	47.5mm	13.8mm	20.1mm	12.9mm	6.9mm	13.8mm
shilpa	25	f	43.3mm	21.4mm	46.2mm	52.2m	13.8mm	18.9mm	13.8mm	5.1mm	11.8mm
renuka	25	f	41.8mm	20.9mm	43.3mm	47.5mm	12.3mm	17.4mm	11.9mm	4.9mm	10mm
sandya.g	27	f	42.6mm	21.5mm	46.1mm	51.2mm	13.9mm	20.1mm	13.6m	6mm	13.5mm
ramya.y	26	f	42.2mm	20.1mm	44.9mm	52.4mm	12.8mm	18.8mm	12.8mm	5.4mm	14.1mm
shiny eben	25	f	46.4mm	21.6mm	47.1mm	51.4mm	14.7mm	17.5mm	11.4mm	5.1mm	13.9mm
shalini.d	25	f	47.2mm	21.1mm	48.1mm	52.1mm	14.8mm	15.6mm	12.1mm	6.2mm	13.3mm
mary gerald	31	f	43.9mm	21.9mm	45.3mm	48.7mm	12.8mm	16.6mm	13.1mm	6.1mm	11.6mm
madhumitha	26	f	46.5mm	23.1mm	48.7mm	51.9mm	12.6mm	17.`1mm	12.9mm	6.3mm	14.1mm
madhubala	27	f	48.1mm	20.7mm	49.1mm	6mm	14.6mm	17.8mm	13.2mm	6.1mm	13.9mm
lakshmi	25	f	41.7mm	19.3mm	41.7mm	48.2mm	16.1mm	18.6mm	10.6mm	5.6mm	15.6mm
kamalika	27	f	45.8mm	22.6mm	48.1mm	48.3mm	18.3mm	19.5mm	14.3mm	5.2mm	14.2mm
kalishwari.m	25	f	45.4mm	22.3mm	43.4mm	50.6mm	11.2mm	18.9mm	14.9mm	6.8mm	13.1mm
deepa raj	25	f	48.5mm	23.5mm	48.5mm	55.6mm	10.5mm	16.4mm	11.4mm	4.9mm	14.4mm

dinisha	25	f	43.1mm	20.8mm	44.4mm	49.4mm	13.5mm	15.6mm	11.7mm	6.7mm	14.3mm
samyuktha	26	f	42.1mm	18.6mm	40.1mm	39.8mm	11.6mm	14.8mm	8.7mm	5.7mm	10.1mm
raj shree	27	f	38.9mm	18.9mm	403mm	42.6mm	12.6mm	14.9mm	7.8mm	5.4mm	11.4mm
veena	28	f	38.6mm	19.3mm	33.5mm	48.3mm	13.7mm	16.8mm	10.4mm	6.2mm	10.8mm
sreeja	27	f	41.3mm	20.4mm	42.5mm	40.6mm	13.8mm	15.3mm	9.9mm	4.8mm	10.6mm
mithili	25	f	47.8mm	22.1mm	50.6mm	56.2mm	12.8mm	20.6mm	13.2mm	6.8mm	11.5mm
manjula	30	f	43.7mm	18.7mm	44.8mm	45mm	13.7mm	19.8mm	9.7mm	6.2mm	9.8mm
ramsri	25	f	39.3mm	20.4mm	41.4mm	43.8mm	14.2mm	19.4mm	11.2mm	6.6mm	12.1mm
rekha laya	27	f	40.6mm	19.8mm	42.6mm	47.4mm	13.9mm	15.1mm	9.9mm	4.6mm	10.8mm
soundarya	26	f	44.2mm	18.2mm	44.4mm	44.2mm	13.7mm	14.9mm	8.7mm	4.9mm	10.9mm
sanjani	25	f	38mm	21.6mm	38mm	47.4mm	13.8mm	13.8mm	11.2mm	5.3mm	13.7mm
vidhyya bhoomi	27	f	32.4mm	17.6mm	37.6mm	38mm	11.9mm	15.2mm	10.8mm	5mm	12.3mm

EVALUATION OF LATERAL CEPHALOMETRIC VARIABLES USING RADI ANT DIACOM 2.2.3 EVALUATION VERSION



ANNEXURE -III

RAGAS DENTAL COLLEGE & HOSPITAL
(Unit of Ragas Educational Society)
Recognized by the Dental Council of India, New Delhi
Affiliated to The Tamilnadu Dr. M.G.R. Medical University, Chennai
2/102, East Coast Road, Uthandi, Chennai - 600 119. INDIA.
Tele : (044) 24530002, 24530003-06. Principal (Dir) 24530001 Fax : (044) 24530009

TO WHOM SO EVER IT MAY CONCERN

Date: 28-12-2015
Place: Chennai

From
The Institutional Review Board,
Ragas Dental College & Hospital,
Uthandi,
Chennai – 600119.

The thesis topic **"EVALUATION OF LATERAL CEPHALOMETRIC VARIABLE AND IT'S EFFICACY IN IDENTIFICATION OF SEXUAL DIMORPHISM IN CHENNAI POPULATION USING DISCRIMINANT FUNCTIONAL ANALYSIS"** submitted by **Dr. Korla Swetha** has been approved by the institutional review board of Ragas Dental College & Hospital on 15th June, 2015.

(Dr. S. RAMACHANDRAN M.D.S.)
Secretary, Institutional Review Board,
Head of the Institution,
Ragas Dental College & Hospital,
Uthandi,
Chennai - 600119

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