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Forensic Science

PANAROMIC IMAGING – A REALITY CHECK IN UNMASKING HUMAN IDENTITY

Mallipudi Bhavana	post graguate , Sri sai college of dental surgery
Syed Afroz Ahmed*	professor and head , Sri sai college of dental surgery *Corresponding Author
Charu Suri	Professor, Sri sai college of dental surgery
Shahela Tanveer	Reader, Sri sai college of dental surgery

ABSTRACT

Objective:- The objective of the study was to evaluate the best possible indicator of sex amongst the mandibular ramus measurements (MRM), gonial angle(GA) and position of mental foramen(MF).

Aim:- A retrospective study was conducted on orthopantomographs(OPG) of 60 male and 60 female patients, using Kodak 8000C Digital Panoramic and Cephalometric System (73 kVp, 12 mA, 13.9 s). MRM were carried out using Adobe photoshop CS6. The measurements of the MRM , MF index and GA were subjected to discriminant function analysis.

Results :- Multiple regression analysis was used to determine the equation for MRM, GA, MF to know the relationship between the independent variable(i.e.Group) among male and females and the dependent variables(Sub Parameters) for MRM. The cut off point for all the three determinants was 0.5, where greater than 0.5 was male and less and 0.5 was female. We found that all the three determinants are a significant predictors in classifying the given sample.

Conclusion:- This study on MRM, GA and MF using OPG showed strong evidence suggesting that all the three can be used for wasender determination for forensic analysis. Amongst the three determinants MRM was the most accurate predictor of gender. In MRM, among its dependent variables maximum ramus breadth was considered to be more significant.

KEYWORDS : Mandibular ramus measurements(MRM), Gonial angle (GA), Mental foramen (MF), Orthopantomograph (OPG)

INTRODUCTION:-

Forensic science refers to the area of endeavour that can be used in a judicial setting, accepted by the court and the general scientific community to separate truth from untruth.[1] The word *forensic* is derived from the latin word *forensis* which means the art or study of public.[2] Forensic investigations dealing with personal identification incorporate the application of fingerprints, anthropology, odontology and other techniques like Deoxyribose Nucleic Acid (DNA) profiling.[3] Personal identification forms an integral part of forensic science especially when one is dealing with any crime or with mutilated bodies that have undergone damage beyond recognition.[4] In case of major disasters where bodies are severly damaged and identification of the individual is not possible, sex determination is of utmost significance.[5]

On predicting the sex, the biological profile of the unidentified human remain is built, thereby excluding about half the population in search operations and thus enabling a more focused search of the missing person.[5] Among various skeletal parts, pelvis and skull are considered as traditional sex indicators.[6] However, when they are not available, teeth are considered as a useful adjunct in sex estimation. The major advantage of teeth in forensic science is that the dentition is often preserved and highly resistant to post-mortem insults better than any other skeletal structures.[6]

Chronological age assessment is an important part of medico-legal practice. The procedures for age determination are complex and involve the consideration of many factors. Changes related to chronological age are seen in both hard and soft tissue among dental hard tissues and bone are extremely resistant to fire and are usually the only remains after an extended period of burial.[7]

The relative development (size, strength, and angulation) of the muscles of mastication is known to influence the expression of mandibular dimorphism as masticatory forces exerted are different for males and females.[8] Humphrey *et al (1999)*. showed that the sites associated with the greatest morphological changes in size and remodeling during growth, mandibular condyle, and ramus in particular are generally the most sexually dimorphic. Measurements of the mandibular ramus tend to show higher sexual dimorphism, and differences between the sexes are generally more marked in the mandibular ramus than in the mandibular body.[9]

The term "Gonion" is derived from the Greek word "γωνία", i.e. angle.[10]

It is a point in the extreme posterior portion of the inferior most region of mandibular angle.[11] Gonial angle (GA) is the angle between an imaginary tangential line along the inferior border of mandible and another tangent along the posterior border of ramus of mandible.

Mattila et al (1977), proposed that GA can be easily measured in panoramic radiographs, with the same degree of accuracy as that of lateral cephalograms.[12] Further the major disadvantage of superimposition of both the sides of mandible in lateral cephalograms, made panoramic radiographs, more precise tool for measuring GA.

Radiographically, MF appears as either round,oblong, slit-like or very irregular radiolucent area which is partially or completely corticated. MF is located in the body of mandible midway between the inferior and alveolar margins. Panoramic radiographs (OPG) show bilateral location MF, mandibular foramen, ramus, angle, and body of the mandible. OPG allows more accurate location of the MF in both horizontal and vertical dimensions.[13]

Data available for gender determination based on location MF in relation to lower border of mandible (LBM) and height of mandible using radiographs are sparse. In this background, the present study was designed to evaluate the differences in measurements from superior border of MF (SMF) and inferior border of MF (IMF) to the LBM and the height of mandible using OPG.

Hence the present study was conducted to evaluate the possible influence of sex on MRM,GA and MF, with an objective of deriving an equation for sex determination.

AIM:-

To evaluate various measurements like MRM, MF, GF and their relationship to sex and role in sex determination.

MATERIALS AND METHOD:-

A retrospective study was conducted on OPG of 60 male and 60 female patients, using Kodak 8000C Digital Panoramic and Cephalometric System (73 kVp, 12 mA, 13.9 s). Mandibular ramus measurements were carried out using Adobe photoshop CS6. The measurements of the MRM, MF index and GA were subjected to discriminant function analysis.

The following parameters were measured using mousedriven method (by moving the mouse and drawing lines using chosen points on the digital panoramic radiograph for measuring the MRM variables.

1. *Maximum ramus breadth*: The distance between the most anterior point on the mandibular ramus and a line connecting the most posterior point on the condyle and the angle of jaw.[14]
2. *Minimum ramus breadth:* Smallest anterior–posterior diameter of the ramus.[14]
3. *Condylar height/maximum ramus height:* Height of the ramus of the mandible from the most superior point on the mandibular condyle to the tubercle, or most protruding portion of the inferior border of the ramus.[14]
4. *Projective height of ramus:* Projective height of ramus between the highest point of the mandibular condyle and lower margin of the bone.[14]
5. *Coronoid height*: Projective distance between coronion and lower wall of the bone.[14]

The following measurements were made:

GA: It was assessed by tracing one line tangent to the lower border of mandible and another line tangent to the posterior border of the ramus of mandible, which was proposed by *Mattila et al (1977)*[12] The intersection of these lines forms the gonial angle.

MF was classified according to Yosue and Brooks classification.[15]
Type I: Mental canal is continuous with the mandibular canal
Type II: Foramen is distinctly separated from the mandibular canal
Type III: Diffuse with a distinct border of the foramen
Type IV: Unidentified type, in which the MF cannot be identified on panoramic radiographs under ordinary exposure and viewing conditions.

Fig 1:- Measurements of MRM, GA, MF on OPG

STATISTICAL ANALYSIS
The data were analyzed using the regression procedure of the statistical package SPSS 13.0. Discriminant function analysis was used to determine variables that discriminate between male and female and is increasingly utilized for sex diagnosis from skeletal measurements.

RESULTS
MRM:-
Multiple regression analysis was used to determine the equation to know the relationship between the independent variable(i.e.Group) and the dependent variables(Sub Paramenters) and we arrived at the below Equation.

Equation derived :-
Y= -1.4996+0.031366(Max Ramus) 0.02228(MinRamus)+ 0.012059 (Condylar)- 0.0037(Project)+0.017744 (coronoid). Cut off being(0.5, <0.5=female, >0.5=male)

Table 1:- Table showing significance among the variables in MRM

Variables	Values
Intercept	-1.49964
Max ramus breadth	0.031366
Min ramus breadth	-0.02228
Condylar height	0.012059
Projection of condyle	-0.0037
Coronoid height	0.017744
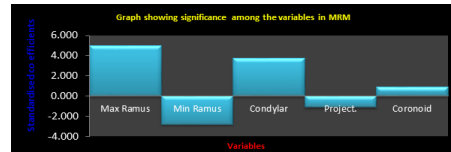
Graph 1:- Graph showing significance among the variables in MRM

GA:-
Multiple regression analysis was used to determine the equation to know the relationship between the independent variable(i.e.Group) and we arrived at the below Equation

Equation derived :-
• Y=-3.39203+0.033058 (Gonial Angle)
• We conducted discriminant analysis to arrive at the cutoff point in order to discriminate the groups(Male & Female) and found that the cut off point for male and female was **0.5.**

Table 2:- Table showing Mean, SD,P-Value, F-value of GA

S.No	Parameter	Mean	Standard Deviation	P- Value	F-Value
1	Gonial Angle	117.677	11.268	<0.001	112.995

Mental Foramen
Multiple regression analysis was used to determine the equation to know the relationship between the independent variable(i.e.Group) and arrived at the equation.

Equation derived :-
• Y=-1.79655+0.1458(Mental foramen)
• Discriminant analysis was conducted to arrive at the cutoff point in order to discriminate the groups(Male & Female) and we found that the cut off point for male and female was **0.5.**

Table 3:- Table showing Mean, SD,P-Value, F-value of MF

S.No	Parameter	Mean	Standard Deviation	P- Value	F-Value
1	Mental Foramen	15.843	2.691	<0.001	122.902

Predective accuracies:-
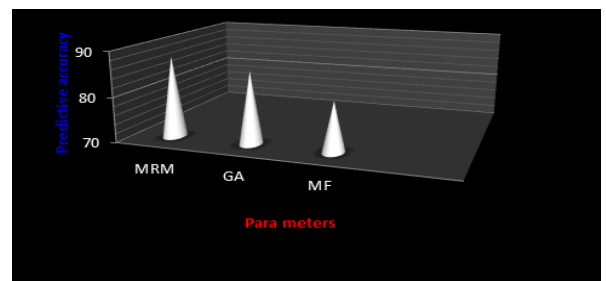
GRAPH 2:- Graph showing predictive accuracies of MRM,GA,MF

DISCUSSION:-
In the present study, **MRM** were subjected to discriminant function analysis. Each of the five variables measured on mandibular ramus using **OPG** showed **statistically significant** sex differences between sexes, indicating that ramus expresses strong sexual dimorphism. The mandibular ramus demonstrated **greatest** univariate **sexual dimorphism** in terms of **maximum ramus breadth,** condylar height, followed by coronoid height. Overall prediction rate using all five variables was **88%** .(GRAPH 1 &TABLE 1) *Giles (1964)* measured mandibles of known sex using anthropometric measurements and reported mandibular ramus height, maximum ramus breadth, and minimum ramus breadth as

highly significant, with an accuracy of 85% in American Whites and Negroes which is in accordance with the present study. [16]

Steyn and Iscan (1998) achieved an accuracy of 81.5% with five mandibular parameters (i.e. bigonial breadth, total mandibular length, bicondylar breadth, minimum ramus breadth, and gonion–gnathion) in South African Whites, which is comparable with the present study results.[17]

Dayal et al. (2008) found **mandibular ramus height** to be the **best parameter** in their study which is in accordance with the present study, with 75.8% accuracy.[14]

Jensen et al (1954). found a **significant difference** in the **gonial angle** between males and females.[18]

Casey et al (2009). proposed that, usually **males** have **3-5° greater** gonial angles than female.[10]

The present study showed **significant difference** in the mean gonial angles between males and females with the cut off point being **0.5(,0.5=female, >0.5= male)** and is in accordance with the above given study.(TABLE 2)

Keen et al(1945). proposed that after tooth extraction, there will be chronic and progressive resorption of residual alveolar ridge, which finally results in widened gonial angle .[19]

Chandra et al 2013 in their study on north Indian population concluded by saying that the **S-L in males** comes within the range of **16.921-18.160 mm**, and in **females** it fall within the range of **15.041-17.032 mm.** [20]

Suragimath et al in 2016 conducted a study to evaluate gender differences in distances from **superior border of MF (SMF)** and **inferior border of MF (IMF)** to the lower border of mandible (LBM) and height of mandible in the Maharashtra population and concluded that, the average distance from **SMF** to **LBM** in males was **17.3 mm** and in females was **15.4 mm**. The comparison between the genders showed statistically very high significant differences.[21]

The present study is in accordance with the above two studies where the S-L in **males** is in the range of **17.0- 19.3** and **females** where in the range of up till **16.0. (TABLE 3)**

In **1974,** *Wical and Swoope* described that despite the alveolar bone resorption above the mental foramen, the distance from the **foramen** to the **inferior border of the mandible** remains relatively **constant** throughout **life.[22]**

CONCLUSION:-

Mandibular ramus can be considered as a valuable tool in gender determination since it possesses resistance to damage and disintegration processes. We found that mandibular ramus measurements using **OPG** were **reliable** for **sex determination.**

The present study confirmed significant sexual dimorphism in the values of **Gonial index**. **Males** were observed to have **higher** GI when compared to **females.**

Based on the study results, it is possible to **conclude** that the distances from the **mental foramen** to the lower border of the mandible exhibit **sexual dimorphism.**

Even though **many** methods are available for **sex determination**, most of them are used only as an **adjunct,** because the **probability** of sex determination varies from method to method. Hence there is a **need** for **evaluating** all the possible methods and establishing a **comprehensive** and **contemporary database** of these methods, for increasing the prospect of identifying the correct sex.

Panoramic radiography is **efficient** for making the proposed measurements and can be considered as an additional radiographic method to determine gender from the skeletal remains. The technique is particularly important in **mass disaster** events, in which the **jaws** are available in **fragments.**

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