Sex Determination by using Mandibular Ramus and Gonial Angle – a Preliminary Comparative Study

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ABSTRACT

Introduction: Identification of sex is an important issue in forensic dentistry and in medico-legal investigations. The skeletal components most often investigated for sex determination are the pelvis and skull with mandible. In human remains, next to pelvis, mandible is used to estimate age, sex, and race. Mandibular ramus and gonial angle can be used to determine sex. Study aimed to measure, compare, and evaluate various measurements of ramus, gonial angle and bigonial width as observed on panoramic radiographs.

Material and methods: Panoramic radiographs of 25 males and 25 females (age 11-19years) were taken randomly, measurements were made using two methods. In 1st method (ramus), measurements of height and breadth of ramus were taken and in 2nd method (gonial), measurements of gonial angle and bigonial width were made. The measurements were subjected to discriminant functional analysis.

Results: In ramus method, condylar, coronoid and projection height of ramus was higher in males ($p<0.001$) whereas in gonial method, gonial angle was higher in females ($p<0.007$). Ramus breadth and bigonial width were not different.

Conclusion: Both methods can be used for sex determination. Ramus method proved to be more accurate than gonial method

Keywords: Panoramic study, sexual dimorphism, ramus – gonial method

INTRODUCTION

Determination of sex in skeletal remains is an important part of archaeological and many medicolegal cases, particularly where the bodies are damaged beyond recognition as in mass disasters.[1] Next to pelvis, skull with mandible plays a vital role in the identification of age, sex and race.[2] By radiological examination, sex determination of skull is possible to an extent of 88%. Panoramic radiographs are reproducible, gives accurate linear and angular measurements on mandibles.[3]

With the above background this present study was being aimed to evaluate various measurements of ramus, gonial angle, bigonial width on panoramic radiographs and its role in sexual dimorphism and also to ascertain an accurate method for sex determination.

MATERIAL AND METHODS

A retrospective study was conducted at our department utilizing digital panoramic radiographs randomly collected from the database (SIRONA Orthophos XG5 Digital OPG Machine) of 50 subjects in the age group between 11 to 20 years. Panoramic radiographs showing pathologies, fractures, developmental disturbances of the mandible and edentulous mandible were excluded from the study. Clearance by Ethical committee of Rajarajeswari Dental College and Hospital was obtained.

Two methods were considered for sexual dimorphism using mandibular parameters and for the methods, the names were given as follows

1. Ramus method: in this method, measurements of ramus height and breadth were used.
2. Gonial method: in this method, measurements of gonial angle and bigonial width were used

Ramus method: (Figure 1)

The following parameters were measured using mouse-driven method

- Maximum ramus breadth (A): 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
- Minimum ramus breadth(B): Smallest anterior–posterior diameter of the ramus
- Condylar height/maximum ramus height(C): 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.
- Projective height of ramus (D): Projective height of ramus between the highest point of the mandibular condyle and lower border of mandible.
- Coronoid height (E): Projective distance between coronoid and lower border of the mandible.

Gonial method: (Figure 2)

Following parameters were measured

Gonial angle: The gonial angles were measured using a method described by Mattila et al.[4] A line was digitally traced on the panoramic radiographs tangential to the most inferior points at the gonial angle and the lower border of the mandibular body and another line tangential to the posterior borders of the ramus and the condyle. The intersection of these two lines formed the gonial angle, which was measured either on right or left side depending upon the accuracy of the image.

Bigonial width: The bigonial width is the distance between both Gonia (Go). Gonian is the most inferior, posterior and lateral point on the external angle of the mandible.[5] It was measured horizontally from the right to left gonia.

All the above measurements were performed using SIDEX software and the measurements were compensated to the

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magnification (19%) of the panoramic machine. All the measurements were made with the observers being blinded to the age and sex of the patient's radiographs.

STATISTICAL ANALYSIS

Statistical study design was an observational comparative study and the statistical method used was descriptive and inferential statistical analysis. The Statistical software used are SAS 9.2, SPSS 15.0, Stata 10.1, Med Calc 9.0.1, Systat 12.0 and R environment ver.2.11.1.

RESULTS

The mean age of subjects 14.26±2.53 (Table 1). Shows gender differences of ramus breadth, ramus height (Table 2). Shows gender differences in gonial angle, and bigonial width.

In ramus method (Table 1) the condylar, coronoid and projection height of ramus was higher in males with $p<0.001$. and maximum ramus breadth and minimum ramus breadth were not significant.

The sex could be determined from calculations using the equation

D = -0.074 (ramus breadth) + 0.257 (condylar height) - 0.229 (projection height of ramus) + 0.132 (coronoid height) - 8.430.

The sectioning point was found to be −0.659. Values greater than this sectioning point indicate male and values lesser than this point indicate female. The accuracy of classification was found to be 72%

In gonial method (Table 2) the gonial angle was larger in females with $p<0.007$ and bigonial width was not significantly different in males and females.

The sex could be assessed from calculations using the equation D=0.167(Gonial angle) - 0.023 (Bigonial width) -16.881. The sectioning point was found to be -0.417**.** Values greater than this sectioning point indicate female and values lesser than this point indicate male**.** The accuracy of classification was found to be 66%.

DISCUSSION

Sex determination in an unidentified skeletons may be extremely complicated in cases of explosions, warfare and other mass disasters because of skeletal fragmentation.[1] Identification of skeletal remains holds a prime importance in forensic medicine and anthropology especially in criminal investigations. Main attributes of biological identity include sex, age, stature, and ethnic background of individual which are called 'Big Four' in forensic context. The mandible and its variations in age, sex and race will help physicians, surgeons, medico-legal authorities and anthropologists to give correct interpretations for the results of diagnostic procedures in living.[2]

Skeletal components most often investigated for gender determination are pelvis and skull with mandible being a practical element to analyse sexual dimorphism in fragmented bones.[3] Mandible is the largest, strongest and movable part of skull and its identification is important in medico-legal cases and anthropological work.[6]

Panoramic radiographs have been advocated routinely as a one of the appropriate screening tool for diagnosis of oral diseases. The principal advantages of panoramic image is its broad coverage, low patient radiation dose, short time required for image acquisition and has been a very good source for retrospective studies.[3] Several studies have been reported that panoramic radiographs are reproducible and accurate for the linear and angular measurements on mandibles. Larheim and Svanaes have found that the gonial angle assessed from a

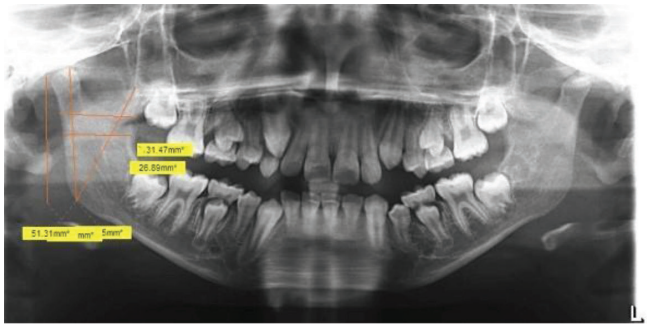

Figure-1: Measurements of mandibular ramus on panoramic radiograph

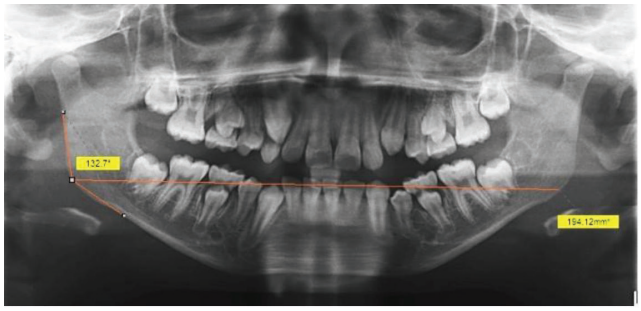

Figure-2. Measurements of mandibular gonial angle and bigonial width on panoramic radiograph

Variables	Male		Female		Wilk`s L	F	P value
	Mean	SD	Mean	SD			
ramus breadth (A)	37.65	3.66	35.75	2.57	0.919	4.219	0.045*
Condylar height (B)	70.30	7.90	61.84	5.79	0.720	18.654	<0.001**
Projection height of ramus (C)	65.13	7.33	57.61	6.29	0.760	15.134	<0.001**
Coronoid height (D)	65.69	6.96	58.13	5.63	0.729	17.860	<0.001**

Table-1: Discriminant Function analysis for sex determination using the ramus breadth, Condylar height, ramus height, Coronoid height

Variables	Male		Female		Wilk`s L	F	P value
	Mean	SD	Mean	SD			
Gonial Angle	125.48	5.67	129.55	4.44	0.858	7.976	0.007**
Bigonial Width	196.80	14.44	190.05	12.25	0.938	3.171	0.081+

Table-2: Discriminant Function analysis for sex determination using the bigonial width, and Gonial angle

panoramic radiograph was almost identical to that measured on the dried mandible.[7]

In the present study the condylar, coronoid and projection height of ramus was higher in males than the females, thus emphasizing that sex differences are more pronounced in mandibular ramus than in body. These findings are in accordance with the study conducted by Morant et al (1936), Martin (1936), Hrdlicka(1940) and Rajalakshmi Rai et al (2007).[9]

In our study the gonial angle was larger in females and bigonial width was not significantly different in males and females. These findings are in accordance with the studies conducted by Ingervall and Thilander (1974)[8] and Rajalakshmi Rai et al (2007)[9] but these findings are in contrast with the studies conducted by M.A.A. Kharoshah et al (2010)[11] and Ayoub et al (2009).[12] The varying results could be due to differences in the age group and population selected.

In the present study the accuracy of classification for sexual dimorphism was found to be 72% in ramus method and 66% in gonial method which indicates the ramus method proved to be more accurate than gonial method. A study conducted by Vineet Saini et al (2011)[10] showed significant sexual dimorphism with an accuracy of 80.2% using mandibular ramus. This varying result could be due to difference in the sample size selected.

Usually the sex can be accurately identified after puberty. The present study is conducted as a preliminary study on pre-pubertal age group and comparison has been made between the ramal and gonial dimensions to ascertain an accurate method for sexual dimorphism. In this study we found that Condylar, Coronoid and Projection height of the ramus was significant in males ($p<0.001$) and Gonial angle was significant in the females ($p<0.007$). The accuracy of classification for the ramus dimensions was 72% and for the gonial dimensions was 66%.

CONCLUSION

Mandibular ramus can differentiate between sexes, as the stages of mandibular development, growth rates, and duration are distinctly different in both sexes. From the present study it can be concluded that mandibular ramus and gonial angle can be used as aids for sex determination. Among them, ramus method was found to be more accurate than the other.

Further studies need to be done with a larger sample. Also, since growth spurt could affect the assessment of gender difference, further studies need to be done in adult age group to see the accuracy of the formula obtained in the present study.

REFERENCES

1. Fouadet al. Sex determination from mandibular canines: a new radiometric method Forensic Med. Clin. Toxicol. 2012;20:89-103.
2. Williams PL, Bannister LG, Berry MM.Gray's Anatomy.38th Ed, New York, Churchill Livingstone. 2000: 409-19.
3. Indira AP, Markande A, David MP. Mandibular ramus: An indicator for sex determination - A digital radiographic study. J Forensic Dent Sci. 2012;4:58–62.
4. Lux CJ, Conradt C, Burde D, Komposch G. Dental arch width and mandibular-maxillary base widths in Class II Malocclusions between early mixed and permanent dentitions. Angle Orthod. 2003;73:674-85.
5. Al-Shamut R, Ammoush M, Alrbata R, Al-Habahbah A. Age and gender differences in gonial angle and bigonial width in dentate subjects. Pak Oral Dental J. 2012;32:81-87.
6. Kumar MP, Lokanadham. S. Sex determination and morphometric parameters of human mandible. Int J Res Med Sci. 2013;1:93-96.
7. Larheim TA, Svanaes DB. Reproducibility of rotational panoramic radiography: Mandibular linear dimensions and angles. Am J Orthod Dentofac Orthop. 1986;90:45-51.
8. Ingervall B, Thilander B. Relation between facial morphology and activity of masticatory muscles. J Oral Rehabil. 1974;1:131-47.
9. Rai.R et al. A pilot study of the mandibular angle and ramus in Indian population. Int. J.Morphol Temuco. 2007;25:353-6.
10. Saini.V et al. Mandibular ramus: An Indicator for sex is fragmentary mandible. J Forensic Sci. 2011;56(S1):S13-S16.
11. M.A.A. Kharoshah et al. Sexual dimorphism of the mandible in a modern Egyptian population. J Forensic Leg Med. 2010;17:213–215.
12. Ayoub et al. Sexual dimorphism of mandibular angle in a Lebanese sample**.** J Forensic Leg Med. 2009;16:121-4.

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