Radiographic evaluation of sexual dimorphism utilizing mandibular ramus parameters: A digital orthopantomography study

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Abstract

Introduction: Identification of age as well as gender is an initial step to determine one's identity in any forensic investigation. In the human body, the mandible, after the pelvis, plays an important role in determining gender when the whole body is not present. Forensic dentists require knowledge about a lot of disciplines since the dental records obtained can identify an individual or get the clues needed by the authorities to establish neglect, fraud or abuse

Objective: To determine the gender of individual using mandibular ramal parameters, namely, gonial flexure and minimum ramal breadth in panoramic radiographs.

Materials and Methods: A retrospective study was conducted using orthopantomography of 50 males and 50 females between the age group of 18 – 50years. Mandibular ramus measurements, namely gonial flexure and minimal ramal breath were done on OPGs taken by New-Tom VGi Scanner (QR srl; Verona, Italy) in standard resolution mode (tube potential:50-85KV, tube current:12mA, and time:14sec. The mean values were calculated and compared between females and males using unpaired *t*-test and discriminant functional analysis.

Results: It was observed that gonial flexure is more obtuse in females when compared to males (R gonial angle, $t = 2.52$, $P = 0.0013$ L gonial angle $t = 2.23$, $P = 0.028$) and the minimum ramal breadth was wider in males compared to females (R ramus breadth, $t = -3.27$, $P = 0.002$, L ramus breadth, $t = -3.46$, $P = 0.001$) and the discriminant function analysis was also found to be significant at $P = 0.013$, Wilks' lambda = 0.877 (Goodness of fit).

Conclusion: Mandibular ramus parameters, namely, gonial flexure and minimum ramal breadth can be used efficiently to determine gender which has implication in forensic medicine

Keywords: forensic, mandible, Gonial flexure, minimum ramal breadth, orthopantogrpahs

Introduction

In this digital era , Dentofacial radiographs play an important role in participating in primary investigations in various dental and medical hospitals and therefore helps in performing routine procedures there.(1). Identification of human remains can occur by the available antemortem data because large segments of the population have these radiographs already taken at different intervals of life (1). Panoramic radiography is widely used to get an overview of the maxillofacial complex nowadays (2). In forensic investigations, the primary aspects are identification of the ethnic population and determination of the age and gender (3).Gender estimation is known as one of the four pillars of the anthropological protocol (4). In human remains, the best preserved part is the human skull along with the teeth. Gender can more exactly determine after puberty is reached and well marked differences are seen in both pelvis and skull. In human remains, both pelvis and mandible (next to pelvis) help us to identify age, sex and race (5). In medicolegal and anthropological work, mandible identification is important, which is the largest, strongest and moveable part of the skull (6). Mandible and its variations in age, sex and race will help anthropologists, physicians, surgeons, medico-legal authorities to give correct interpretation for the results of diagnostic procedures in living (6,7). Mandible is highly durable because in this bone, a dense layer of compact bone is present. It plays an important role in gender determination of an individual in situation where intact skull is not found (8). Dimorphism of the mandible is determined by the size and shape of bone itself. Male bones are generally more in volume and

robust as compared to female bones (9). The highest dimorphism in the mandible is present in the condyle and ramus according to studies carried out by Humphrey et al. marked dimorphism is noted regarding the mandibular ramus when compared with the mandibular body (10). Hence the main aim of this study was to determine gender in panoramic radiographs using mandibular ramus parameters namely gonial flexure and minimum ramal breadth and finally to obtain the potential use of these parameters in forensic analysis

MATERIALS AND METHODS:

A retrospective study was conducted of fifty males and fifty females, using orthopantomography which were taken using New- Tom VGi Scanner (QR srl; Verona, Italy) in standard resolution mode(tube potential :50- 85KV), tube current :12Ma, and time :14 sec.

Inclusion criteria:

1. Panoramic radiographs of both dentulous and edentulous patients of age groups 18-50 years
2. Panoramic radiographs where both gonial flexure and minimal ramus breadth were clearly visible
3. Only high quality radiographs with no visible errors

Exclusion criteria:

Patients with a history of extraction, trauma and any other severe developmental disturbances leading to variation in the size of mandible were excluded from the study

The following variables were measured using Newtom digital software (figure1 and 2)

figure1: Gonial flexure measurements of male patient on OPG using Newton digital software

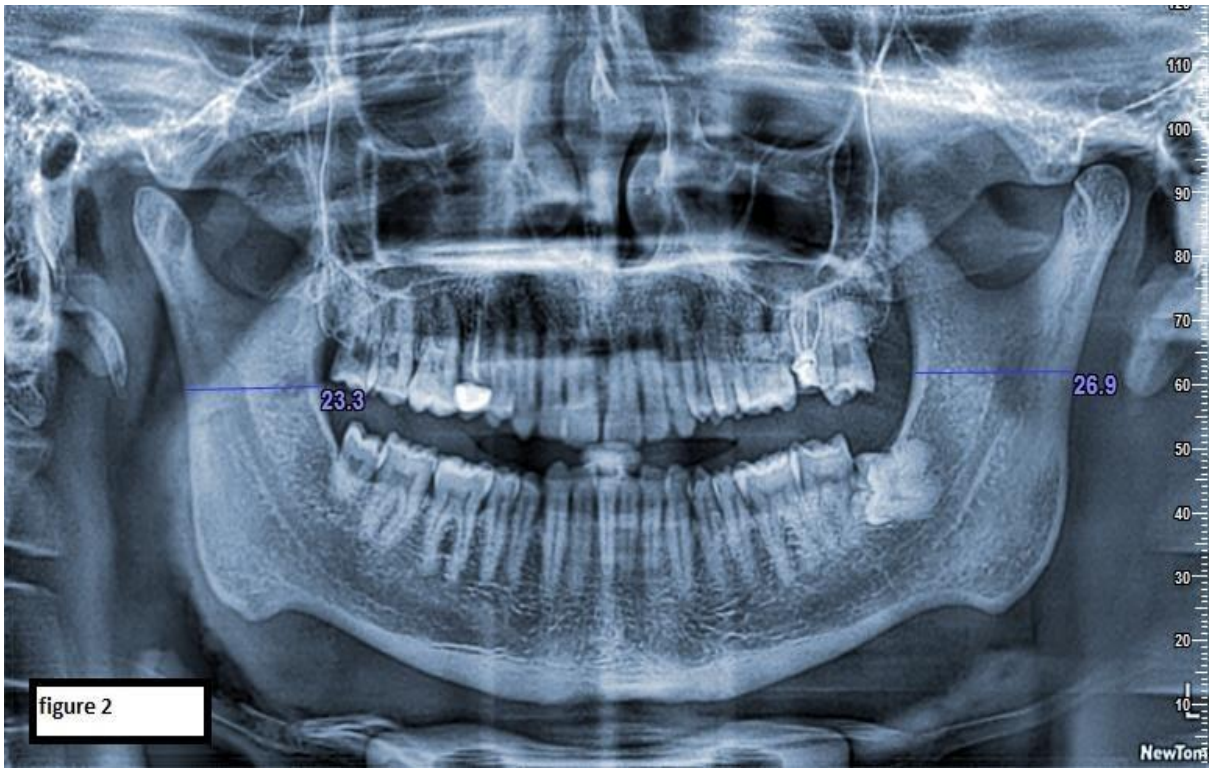


figure2: Minimum ramal breadth measurements of the same patient on OPG using Newtom digital software

Gonial flexure- a line traced tangential to the most inferior points at gonium and the lower border of the mandibular body (ML) and another line tangential to the posterior border of the ramus and the condyle (RL). The intersection of these lines forms the gonial flexure (11)

Minimum ramal breadth: It is the smallest anterior posterior dimension of the ramus (12)

STATISTICAL ANALYSIS

The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS version 20.0(SPSS inc; Chicago Illinois, USA)

Continuous variables were expressed as mean +- SD and categorical variables were summarized as frequencies and percentages. Graphically the data was presented by bar diagrams. Student's independent t – test was employed to determine the differences in measurements of right and left sides of the mandible and discriminant function analysis was carried out to find whether the variables can be used for gender determination. A P-value of less than .05 was considered statistically significant. All p- values were two tailed

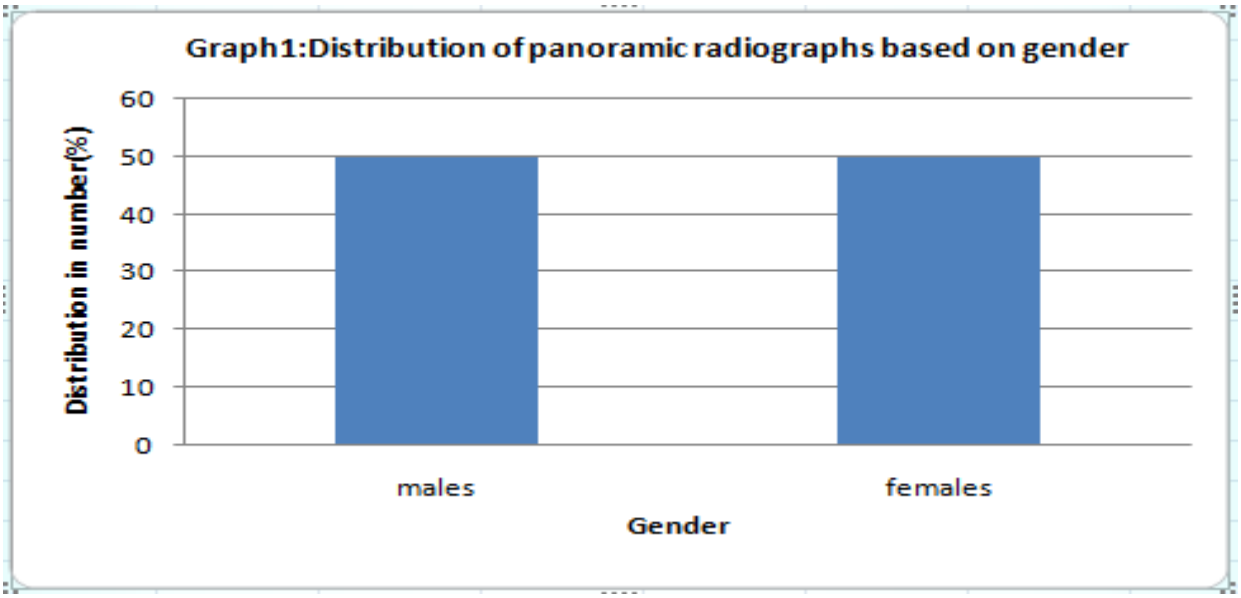
RESULTS

A retrospective study was conducted to determine the gender of individuals using mandibular ramus parameters on 100 panoramic radiographs

In the present study, out of 100 panoramic radiographs 50 were of males and 50 belong to females [Graph 1]

Table 1 shows the mean difference of gonial flexures and ramal breadth between males and females. R gonial flexure (4.13), L gonial Flexure (3.66), R ramal breadth (-2.06), L ramal breadth (-2.13). The results were significant at P<.05

Table 2 shows the Goodness fit for the variables to determine gender using radiographs. The results were significant at P <.05



Graph 1: distribution of panoramic radiographs based on gender

Table: 1: Gender determination using mandibular ramal parameters

Mandibular ramal parameters	Mean difference	SE	t-value	p-value
Right gonial flexure	4.13	1.640	2.52	.013*
Left gonial flexure	3.66	1.641	2.23	.028*
Right ramal breadth	-2.06	0.629	-3.27	.002*
Left ramal breadth	-2.13	0.617	-3.46	0.001*

***Statistically significant difference(P value<0.05); SE :Standard Error**

Table :2: goodness of fit using discriminant function analysis

Mandibular ramal parameters	females		males	
	mean	SD	mean	SD
Right gonial flexure	126.70	7.76	122.56	8.62
Left gonial flexure	126.15	7.40	122.49	8.94
Right ramal breadth	27.05	3.40	29.11	2.87
Left ramal breadth	27.14	3.29	29.28	2.87

Wilks lambda = 0.87; chi square =12.603; p value = 0.013*

***Statistically significant difference(p value< 0.05) ;SD: Standard Deviation**

DISCUSSION

Gender identification in a mass disaster can be estimated up to 100% accurately from the available adult skeleton. However in circumstances where intact bone is not available but only fragments are left, the mandible is the most commonly encountered bone found in these situations as it is most durable and well preserved because of the presence of a dense layer of compact bone (13, 14)

Male mandibles are larger and more robust than female mandibles with more prominent muscle attachments. With features such as gonial flaring, broad ascending ramus, and high symphysis metric analysis of mandible can be considered for gender determination(15,16) The studies conducted using the manual method of metric analysis on the dry bone are time consuming and the technique is prone to error. As panoramic radiography is a part of routine radiographic examination for a large segment of population, and digitization has the advantages of image accuracy, image storing and sharing and user friendly software that makes metric analysis easy and less time consuming and the analysis can be repeated to eliminate errors (17) Hence, the use of personal computer-assisted analysis of panoramic radiographs can be considered reliable in the present study

Various studies have been done by various authors where panoramic radiography is used to determine gonial flexure and the results vary between age, gender, and race. This study, however, showed that gonial flexure is more obtuse in females than in males and the respective values were statistically significant.

Various other studies conducted on Indian and other ethnic populations have shown that gonial flexure is higher in females than in males as noted in studies conducted by Xie and Ainamo , Ghosh *et al,* .[18,19]. In one more study conducted by Mathew et al showed that gonial flexure is more obtuse in females than in males [20]

Although many studies follow the general trend of gonial flexure being greater in males than in females, our study was in contrast with these showing similarity to the studies conducted by Xie and Ainamo ,Ghosh *et al* and Mathew et al

As mentioned in the studies conducted by Jensen and Palling, Ohm and Silness and Upadhyay *et al.*[21-23] contributing to the effect of masticatory muscles that is masseter and medial pterygoid whose insertion is into the gonion affects the size of the gonion and there by the gonial flexure.[3,24 25]

Minimum ramal breadth parameters were stated to exhibit the best dimorphism. In the present study, it was found to be wider in males when compared to females, which is consistent with the osteometric studies conducted by Vodanović and Dumančić , Mathew et al and Giles[1 20 26] These differences in the musculoskeletal development and to the differences related to different growth trajectories in males and females[10]

Socioeconomic factors such as food, climate, nutrition and pathologies influence the development and therefore affect the growth and appearance of the bone [8]

Various studies have shown that skeletal characteristics are different in different population and hence emphasized the need for population specific osteometric standards for gender determination [1 8 26]

Conclusion

The mandibular ramus can be considered another valuable tool in gender determination in forensics with the help of OPG. However, further studies on more diverse population are needed to be taken up in future for better results

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