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Evaluation of Mandibular Anatomical Formation for Gender Determination in Turkish Population

SUMMARY

Background/Aim: *Gender determination is one of the most challenging tasks in medico-legal research and forensic dentistry. Several skeletal components are investigated for this purpose and the mandible is one of them. The mandible has several specific anatomical features. The purpose of this study was to analyze the effects of measurements related to the mental foramen, gonial angle and antegonial angle on gender determination using digital panoramic radiographs.* ***Material and Methods:*** *A retrospective study was planned with 150 digital panoramic radiographs (75 males and 75 females, aged between 20 to 49 years). The radiographs were analyzed by dividing them into two equal gender groups (male and female). Several parameters were compared to determine the gender. The distances from the superior and inferior border of the mental foramen to the basis of the mandible on the right side were measured. Gonial and antegonial angles were evaluated bilaterally. The difference between the males and females were analyzed with independent samples t-test ($p<0.05$).* ***Results:*** *There was statistically significant difference between the males and females in terms of all the evaluated parameters ($p<0.05$). The distances related to mental foramen is higher in the males however gonial and antegonial angles are larger in the females.* ***Conclusions:*** *The mental foramen position, gonial and antegonial angles can be used to predict the gender in Turkish population.*

Key words: Forensic Dentistry, Sex Determination Analysis, Mental Foramen, Gonial Angle, Antegonial Angle, Panoramic Radiography

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Introduction

The determination of human skeletal components is important in criminal cases for advanced analysis[1,2]. Gender determination is the first step of the determination process[3]. If the whole adult bone structure is available, gender can be determined easily. However, when skeletal remnants do not present in good condition, morphological indicators of sexual dimorphism do not allow a correct diagnosis[4]. Gender determination in forensic dentistry and human anthropology is mainly based on anatomical variations and various skeletal morphological characteristics that can be used to distinguish males from females[5,6].

As evident from the previous studies, the skull is the most reliable portion of the human skeleton after the pelvis to distinguish the gender, providing precision up to 92%[1]. However, sometimes, intact skull cannot be found. In these cases, the mandible may play a vital role in sex determination, because it is the strongest and the most dimorphic bone of the skull, and has a dense layer of compact bone[7-9]. The structure of the mandibular ramus may vary according to the gender, because mandibular growth and development is different in both genders. Occlusal forces are also different in both genders. In addition, the anatomical changes of the mandible are affected by the occlusal status[10]. Among the craniofacial bones, the mandible is the most reliable one for discriminating the sex, therefore, the anatomical

structures of the mandible are commonly used in the gender determination[5,11].

In the field of forensic dentistry and anthropology, dentofacial radiographs are indispensable[11]. Panoramic radiography is a very popular technique and commonly used in routine dental practices to evaluate mandibular and maxillary vital structures[12,13]. Panoramic radiographs are suitable as a means of radiologic approach to view the integrity of whole dento-facial tissues[12]. Due to the possibility of imaging the entire body of the mandible, the position of the mental foramen is reasonably well depicted in panoramic radiographs both in horizontal and vertical dimensions. Panoramic radiographs are also the best choice for the determination of the gonial angle[11,14]. Gonial angle is generally used to evaluate the rotation of the mandible and diagnose growth patterns[15]. In recent years, numerous studies have assessed the reliability of panoramic radiographs for the determination of morphological dimensions of the mandible[12,16,17]. The gonial angle was evaluated in some studies with controversial results[14,18,19]. Skeletal characteristics differ in each population accentuating the need for population-specific bone metric standards for gender determination[1,20]. To our knowledge, there is no study evaluating the mental foramen for gender determination in the Turkish population.

Therefore, the aim of the present study was to determine the effect of the average distances of the superior and inferior borders of the mental foramen to the inferior border of the mandible on right side, and the average gonial and antegonial angles on both sides of the individuals on the gender determination. The null hypothesis was that there would be no effect of these parameters on gender determination.

Material and Methods

The study was performed at the Department of Maxillofacial Radiology, Selcuk University, Konya, Turkey. Panoramic radiographs of 150 patients (75 females and 75 males of Turkish population between the ages of 20 and 49 years) were selected from the archive of patients who were referred to the Maxillofacial Radiology Clinic for routine dental procedures. None of the images were obtained for the purpose of the present study. Suitable panoramic radiographs were selected randomly. All the radiographs were taken with the same panoramic machine (Kodak 8000 Panoramic system Carestream Health Inc, Rochester NY, USA) by the same technician (A.E.) and exposed under standard protocols (70 kV and 10 mA). Inclusion criteria comprised the lack of any pathologic bony lesion in the mandible, excellent visualization of the mental foramina and borders of the mandible, and high quality and correctly positioned radiographs without distortion and artifacts. Any developmental problems, deformation, fractures or edentulousness of the mandible were eliminated from the study. No ethics committee report was required for this study.

The parameters used in this study were the distance between the inferior border of the mental foramen and the inferior border of the mandible (IBM), between the superior border of the mental foramen and the inferior border of the mandible (SBM) on the right side, and gonial and antegonial angles on both sides. The distances between the IBM and SBM on the right side, bilateral gonial and antegonial angles were measured on the images by a dento-maxillofacial radiologist (D.I.) with a Java Image Processing Software (ImageJ, a public domain program). This program can be downloaded from http://rsb.info.nih.gov/ij/. For measurements, a line was drawn tangent to the inferior border of the mandible and the mental foramen was marked with a circular line. The perpendicular distances from the superior and inferior borders of the mental foramen to the tangent line were measured (Figure 1). Gonial angle was obtained by measuring the angle between the line tangent to the lowest points of the anterior and posterior borders of the mandible and the line tangent to the two distal points of the ramus. The antegonial angle was measured by drawing two lines parallel to the antegonial region which intersected at the deepest point of the antegonial notch (Figure 2). For the study 10% of all the measurements were performed twice by the same observer (D. I.). The data were analyzed by independent samples t-tests using a statistical software (IBM SPSS 15.0 version IBM Corp).

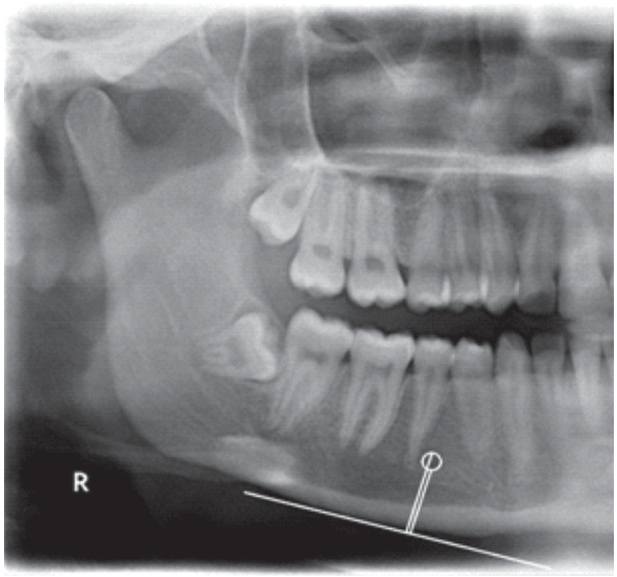

Figure 1. The measurements of IBM and SBM

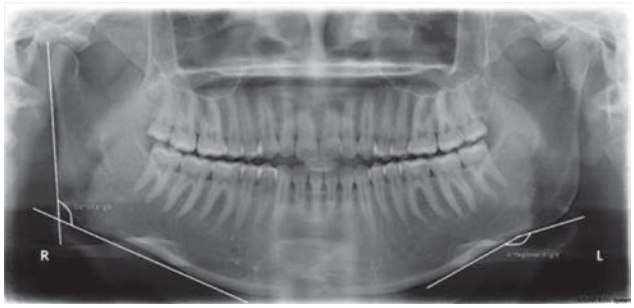

Figure 2. Measurement method of gonial and antegonial angles

Results

No statistically significant differences existed between the first and second measurements ($p>0.05$). The difference of measured parameters between the males and females were analyzed with independent samples t-tests and the present study showed that, for all measurements, a statistically significant difference was present between the males and females ($p<0.05$) (Table 1).

Table 1. Dimensions of IBM, SBM, gonial and antegonial angles of males and females

	Gender	N	Mean	Std. Dev.	P
IBM	male	75	1.448	0.11	**0.000***
	female	75	1.245	0.09	
SBM	male	75	1.752	0.11	**0.000***
	female	75	1.549	0.10	
Gonial angle (R)	male	75	109.96	5.19	**0.014***
	female	75	112.22	5.88	
Gonial angle (L)	male	75	111.52	6.42	**0.024***
	female	75	113.85	6.01	
Antegonial angle (R)	male	75	160.99	8.46	**0.001***
	female	75	165.65	7.69	
Antegonial angle (L)	male	75	159.56	9.09	0.000*
	female	75	166.66	7.27	

*refers to statistically significant difference ($p<0.05$).

Discussion

In this study, a statistically significant difference was found between the males and females in terms of measurements related to the mental foramen, gonial and antegonial angles. Therefore the null hypothesis 'there would be no effect of these parameters on the gender determination' was rejected. To our knowledge, no study has evaluated the mental foramen for gender determination in the Turkish population.

In this study gonial angle was significantly larger in females than males on both sides of the jaws. The current results are in agreement with the results reported by Abu Taleb et al[7]. The average gonial angle values reported in the study by Abu Taleb et al. (122.16 in males; 125.09 in females) [7] were higher than those of this study (110.74 in males; 113.03 in females). Average gonial angle varies according to different human population groups. The small differences between groups may be explained with homogeneity between these groups but relatively high differences should be considered for racial identification[7]. The results of the present study is also in agreement with the study by Gungor et al.[21]. However, according the studies by Rupa et al.[5] and Chole et al.[14], a statistically significant difference did not exist between genders in terms of gonial angle measurements. This discrepancy may be explained by the difference in populations. The reason for the larger gonial angle in females compared to males can be that high masticatory force results in small gonial angles and males usually have a greater masticatory force than females[16]. Also it was found that females had downward and backward rotation in mandible while males had forward rotation. So, the gonial angles in females are larger than males[7]. Some studies performed in Indian and Norwegian populations noted that gonial angle was statistically non-significant between genders or larger in males than females and this was explained with the effect of insertion of the masticatory muscles into the gonion[5,22,23].

Sexual dimorphism is related to anatomical regions and their functions[24]. According to many researchers, gender determination can be performed using the skull and hipbone with more than 95% accuracy. Despite these findings, gender differences are not a dominant and static phenomenon and there are overlaps in each gender's characteristics[7]. The literature revealed that ultimate shape of a fully grown mandible can be used to differentiate the gender. The morphological features of the mandible are most commonly used by anthropologists and forensic dentists in sex determination[9]. Radiographic X ray technology is a prominent tool for forensic dentistry and a simple and cheap method for human identification as well[7]. The reliability of measurements on radiographs depends on the quality of radiographs and panoramic radiographs can provide information about the localization and dimension of the anatomic structures[13]. In most of populations, the mandibles of the males are usually larger, have prominent muscular attachment sites and are slightly more robust than female mandibles. The prominent male features of the mandible include broad ramus, high symphysis, small mental eminence and gonial flaring. Based on these features mandibular

parameters can be considered as reliable markers for sex determination[5].

The mental foramen is a well observed anatomical landmark in panoramic radiographs and it is possible to evaluate both horizontal and vertical dimensions related to the mental foramen[25]. In the present study, SLM and ILM dimensions were significantly higher in the males than females and the results were compatible with those reported by Thakur et al.[11] and Naroor et al[25]. In this study SLM and ILM were evaluated only on the right side of the radiographs because some previous studies showed that the values on both sides were almost the same and there was no statistically significant difference between the right and left sides[25].

Bone deposition occurs on the inferior border of the mandible with the exception of the antegonial region where bone resorption takes place and increases antegonial angle and antegonial depth. In the present study, the males had a smaller antegonial angle than the females and our results correlated with those of Bhardwaj et al. and they explained this with the hormonal difference of testosterone in males and estrogen in females affecting the bone metabolism and possibly resulting in visible differences between genders[16]. This study has a limitation as the patients were not classified according to their age.

Conclusions

Within the limitations of this study, following conclusions can be drawn: Panoramic radiography is an effective radiographic method to evaluate the mandible and to determine the gender. The difference of gonial angle, antegonial angle and measurements related to the mental foramen between the males and females were statistically significant for the study population and these parameters may be used in sex determination in Turkish population.

References

1. Saini V, Srivastava R, Rai RK, Shamal SN, Singh TB, Tripathi SK. Mandibular ramus: an indicator for sex in fragmentary mandible. J Forensic Sci, 2011;56:13-16.
2. Suragimath G, Ashwinirani SR, Christopher V, Bijjargi S, Pawar R, Nayak A. Gender determination by radiographic analysis of mental foramen in the Maharashtra population of India. J Forensic Dent Sci, 2016;8:176-80.
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. Scheuer L. Application of osteology to forensic medicine. Clin Anat, 2002;15:297-312.
5. Rupa KR, Chatra L, Shenai P, Veena KM, Rao PK, Prabhu RV et al. Gonial angle and ramus height as sex determinants: A radiographic pilot study. J Cranio Max Dis, 2015;4:111-116.
6. Ghodousi A, Sheikhi M, Zamani E, Gale-Bakhtiari S, Jahangirmoghaddam M. The value of panoramic radiography in gender specification of edentulous Iranian population. J Dent Mater Tech, 2013;2:45-49.
7. Abu-Taleb NS, El Beshlawy DM. Mandibular ramus and gonial angle measurements as predictors of sex and age in an Egyptian population sample: a digital panoramic radiographic study. J Forensic Res, 2015;6:1-7.
8. Duric M, Rakocevic Z, Donic D. The reliability of sex determination of skeletons from forensic context in the Balkans. Forensic Sci Int, 2005;147:159-164.
9. Hu KS, Koh KS, Han SH, Shin KJ, Kim HJ. Sex determination using nonmetric characteristics of the mandible in Koreans. J Forensic Sci, 2006;51:1376-1382.
10. Huumonen S, Sipilä K, Haikola B, Tapio M, Söderholm AL, Remes-Lyly T et al. Influence of edentulousness on gonial angle, ramus and condylar height. J Oral Rehabil, 2010;37:34-38.
11. Thakur M, Reddy VK, Sivaranjani Y, Khaja S. Gender determination by mental foramen and height of the body of the mandible in dentulous patients a radiographic study. J Indian Acad Forensic Med, 2014;36:13-18.
12. Leversha J, McKeough G, Myrteza A, Skjellrup-Wakefiled H, Welsh J, Sholapurkar A. Age and gender correlation of gonail angle, ramus height and bigonial width in dentate subjects in a dental school in Far North Queensland. J Clin Exp Dent, 2015;8:49-54.
13. Schulze R, Krummenauer F, Schalldach F, d'Hoedt B. Precision and accuracy of measurements in digital panoramic radiography. Dentomaxillofac Radiol, 2000;29:52-56.
14. Chole RH, Patil RN, Balsaraf Chole S, Gondivkar S, Gadbail AR, Yuwanati MB. Association of mandible anatomy with age, gender, and dental status: a radiographic study. ISRN Radiology, 2013;18:453763.
15. Kitai N, Mukai Y, Murabayashi M, Kawabata A, Washino K, Matsuoka M et al. Measurement accuracy with a new dental panoramic radiographic technique based on tomosynthesis. Angle Orthod, 2013;83:117-126.
16. Bhardwaj D, Kumar JS, Mohan V. Radiographic evaluation of mandible to predict the gender and age. J Clin Diagn Res, 2014;8:66-69.
17. Ghosh S, Vengal M, Pai KM. Remodeling of the human mandible in the gonial angle region: a panoramic, radiographic, cross-sectional study. Oral Radiol, 2009;25:2-5.
18. Raustia AM, Salonen MA. Gonial angles and condylar and ramus height of the mandible in complete denture wearers- a panoramic radiograph study. J Oral Rehabil, 1997;24:512-516.
19. Xie QF, Ainamo A. Correlation of gonial angle size with cortical thickness, height of the mandibular residual body, and duration of edentulism. J Prosthet Dent, 2004;91:477-482.
20. Kharoshah MA, Almadani O, Ghaleb SS, Zaki MK, Fattah YA. Sexual dimorphism of the mandible in a modern Egyptian population. J Forensic Leg Med, 2010;17:213-215.

21. Gungor K, Sagir M, Ozer I. Evaluation of the gonial angle in the Anatolian populations: from past to present. Coll Antropol, 2007;31:375-378.
22. Upadhyay RB, Upadhyay J, Agrawal P, Rao NN. Analysis of gonial angle in relation to age, gender and dentition status by radiological and anthropometric methods. J Forensic Dent Sci, 2012;4:29-33.
23. Ohm E, Silness J. Size of the mandibular jaw angle related to age, tooth retention and gender. J Oral Rehabil, 1999;26:883-891.
24. Mahapatra GK, Nar OP, Joshi SN. Evaluation of radiographic predictors to assess the rate of mandibular residual ridge resorption. Indian J Dent Res, 2004;15:24-27.
25. Naroor N, Shenai P, Chatra L, Veena KM, Rao PK, Shetty P. Gender determination using the mental foramen. J Cranio Max Dis, 2015;4:144-147.

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