Study of Position of Mental Foramen on Panoramic Radiograph as an Index for Estimation of Mandibular Bone Resorption and Gender Estimation

Study Type: Original Study (MDS Dissertation)

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Abstract

Introduction: Mandible is a hard bone and exhibits a high degree of sexual dimorphism. Forensic investigations aid in identification of victims of mass disaster.

Aim: The aim of the present study was to determine gender using mandibular body height and width of mental foramen.

Materials and Methods: The study included 200 panoramic radiographs of 157 males and 43 females. Mandibular bone height at premolar region

was calculated from inferior border o mandible to alveolar crest at premolar region.

Results: The results of the study revealed that mandibular body height at premolar region was significantly more in males.

Conclusion: Mandibular bone height measurements in forensic dentistry could be useful in gender determination.

INTRODUCTION

Bones form a reliable source of information regarding growth and growth changes. Normally well-defined skeletal development in bones, cranial sutures and teeth take place at specific ages. However, these changes are significantly affected by genetics, general health and other environmental factors.[1]

Forensic Dentistry has been defined by Keiser Nielsen (1970), as that branch of odontology which in interest of justice – deals with proper handling and examination of the dental evidence and with

the proper evaluation and presentation of dental findings.[2]

Identification and determination of unknown human skeletal remains has been one of the most challenging tasks for forensic dentistry. The routine radiographic examination by orthopantomography of the mandible of the dental patients is necessary and justifiable for treatment. Radiographic examination not only allows observation of changes within alveolar ridge, which is expected to reduce with aging, may show consistent relationship with chronological age and it can also be used for gender determination.[3,4]

In this study, a sample of panoramic radiographs was surveyed to establish the frequency of radiological characteristics and the trend of ridge resorption which could be used in forensic dentistry for identification and gender determination.

AIM AND OBJECTIVES

1. To measure height of the mandibular body from inferior border of mandible to alveolar crest at premolar region
2. Gender determination using mandibular bone height
3. Gender determination using width of mental foramen using panoramic radiographs.

MATERIAL AND METHODS

Source of Data: Those attending the department of Oral Medicine and Radiology, Pacific Dental College & Hospital, Udaipur were included in the study after being briefed about the procedure and on giving their consent.

STUDY DESIGN: The study group comprised of 237 participants all above 40 years.

a) Inclusion Criteria:

1) Completely edentulous volunteers.
2) Good quality panoramic radiographs of the volunteers in which mental foramen are clear and distinct on both the sides.

b) Exclusion criteria:

1) Patients with developmental malformations of the jaws.
2) Patients with acute infections and clinical or radiographic evidence of pathologies.

MATERIALS USED:

1) Routine diagnostic instruments used with Kodak Lanex imaging screen ,T-MAT G/RA green sensitive dental Kodak Films of 15x30 cm in size, Xtropan 2000 panoramic machine, Radiographic view box, Magnifying lens, and Engineering T scale.

2) Method of Collection of Data

The study participants were briefed about the radiographic procedure. They were instructed to remove any dental appliances, earrings, necklaces, hairpins and any metallic objects from the head and neck region. The need to be still during the procedure was explained.

The subject was made to wear lead apron, and positioned carefully in the focal trough by using a special chin rest available for edentulous patients and the head was stabilized using side guides or head holders. Participant's chin was slightly tilted by asking to look down. The mid-sagittal plane was kept along the center line of the chin support and perpendicular to the Frankfurt horizontal plane. Frankfurt horizontal plane was made parallel to the floor. This was confirmed with the light indicators of the machine. The participants were instructed to swallow or suck on their tongue to be certain that the lips are sealed and the patient was asked to hold still. Exposure was accomplished at 65 kv and set exposure of approximately15 seconds. All the films were processed with visual method. The radiographs were dried, labeled and stored for further evaluation.

3) Method of Mandibular Bone Height Measurements Using Position of Mental Foramen on Panoramic Radiograph

Evaluation of radiographs was done in a quiet room with subdued lighting. Out of 237 panoramic radiographs, 37 radiographs in which mental foramen was not traced were discarded from study. Thus the study included 200 panoramic radiographs of 157 males and 43 females. The study population was divided into 5 age groups as 40-49, 50-59, 60-69, 70-79 and >79 years. The panoramic radiograph was properly oriented on the flat view box emitting even light. The mental foramen was located bilaterally with the help of a magnifying lens. A permanent marker was used to draw a

tangent connecting lower most points at the angle of mandible and the inferior border of the mandible close to mental foramen, with the help of engineering T scale (Figure 4). A perpendicular was drawn from the mandibular alveolar crest passing through the centre of mental foramen[5] (Figure 5). After drawing the tangent and the perpendicular on panoramic radiographs, following measurements were recorded on right and left side using measurement scale (Figure 6):

- a= Mandibular bone height measured from inferior border of mandible to alveolar crest at premolar region
- b= Inferior margin of mental foramen to inferior border of mandible
- e=3b-a, where e is alveolar bone resorption, '3b' is considered the original height of the alveolar process before resorption and 'a' is mandibular height after resorption as measured on panoramic radiograph. [6]
- c= Superior margin of alveolar crest to superior margin of mental foramen
- d=Superior margin of alveolar crest to inferior margin of mental foramen
- d-c= width of mental foramen on panoramic radiograph
- Symmetry of mandible was also studied. Difference in magnification between right and left sides was noted and percentage of variance was calculated as follows. An edentulous mandible was stabilized and its position was standardized. Metal balls measuring 1cmx1cm, 1.8x1.8cm, 2.1x1.9cm, 1.9x1.5cm, 2.6x2.6cm were placed near the premolar region with reference to mental foramen with the help of wax sheet and panoramic radiographs were made.
- Measurements were made of the images of the metal balls and the percentage of variance for magnification on the right and left sides was calculated. It was found to be 2.6%.

A master chart was prepared including all the above measurements. Entire data of the study was recorded in numerical value using Microsoft excel sheet 2007, SPSS version 16 and the results were evaluated for their statistical significance using Post Hoc Test, ANOVA, T- test.

Fig 1: Materials used for interpretation of Panoramic Radiograph

Fig 2: Xtropan 2000 Panoramic Machine

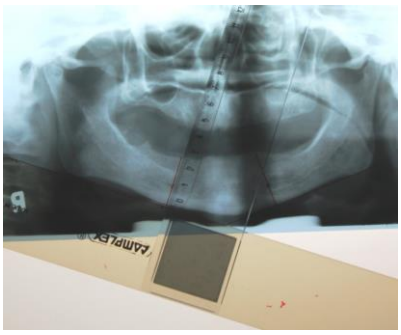


Fig 3: Demonstration of Measuremen of Mandibular Bone Height

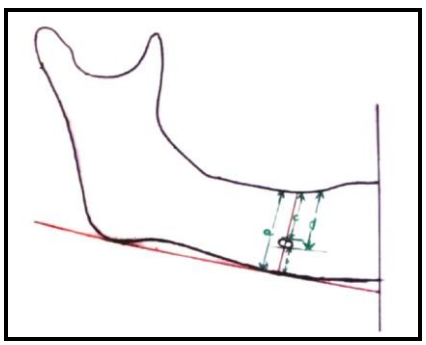


Fig 4: Schematic Diagram for Measurement of the Various Parameters

A total number of 237 patients were subjected to radiographic investigation after obtaining their consent. Panoramic radiographs where mental foramen could not be appreciated bilaterally, numbering 37 were not included. Thus the study included 200 panoramic radiographs of 157 males and 43 females. The study population was divided into 5 age groups. (Table I). Direct measurements were done on the panoramic radiographs using T Scale and permanent marker. The following measurements of 'a','b','e=3b-a','d-c'were tabulated and analyzed. The purpose of this study was gender determination using mandibular bone height at premolar region and width of mental foramen. Symmetry between right and left sides of mandible was also compared.

A master chart was prepared using 2007 Microsoft Excel sheet by assigning numerical values for all the parameters of the study. SPSS VERSION 16.0 software was used. The mean, standard deviation, ANOVA TEST, Post Hoc Test, and the T test were adopted for statistical analysis. Probability (p value) of calculated values occurring in case of ANOVA TEST, Post Hoc Test, and the 'T' test, was determined by referring to the respective tables and thus the results of the study were evaluated for statistical significance. The results obtained and the observations made are as follows.

Table 1: Study Group

Age Group	Number of Patients	Male	Female
40-49	24	17	7
50-59	61	42	19
60-69	71	57	14
70-79	37	34	3
>79	7	7	0
TOTAL	**200**	**157**	**43**

Table 2: Comparison of width of mental foramen'd-c' on right side between genders

Sex	N	Mean	Standard Deviation	T-test p Value
F	43	0.34	0.12	0.7315
M	157	0.33	0.18	
Total	**200**	**0.33**	**0.17**	

Table 3: Comparison of width of mental foramen'd-c' on left side between genders

Sex	N	Mean	Standard Deviation	T-test p Value
F	43	0.34	0.16	0.7628
M	157	0.35	0.20	
Total	**200**	**0.3515**	**0.19**	

- d=Superior margin of alveolar crest to inferior margin of mental foramen
- c= Superior margin of alveolar crest to superior margin of mental foramen

	Sex	N	Mean (cms)	SD	SEm		Sex	N	Mean (cms)	SD	SEm
Ra	Male	157	3.113	.5057	.0404	La	Male	157	3.117	.5013	.0400
	Female	43	2.826	.3799	.0579		Female	43	2.786	.4132	.0630
Re	Male	157	1.143	.6427	.0513	Le	Male	157	1.058	.6083	.0485
	Female	43	1.130	.5235	.0798		Female	43	1.002	.6209	.0947

Table 4: Comparison between genders for mandibular bone height 'a' at premolar region and mandibular alveolar bone resorption 'e' on right and left sides

	Mean Difference (cms)	Std. Error Difference	t	df	P		Mean Difference (cms)	Std. Error Difference	t	df	P value
Ra	.2872	.0829	3.463	198	.001	La	.3312	.0833	3.975	198	.000
Re	.0124	.1066	.117	198	.907	Le	.0556	.1052	.529	198	.597

Table 5: Width of the mental foramen 'Rd-Rc' on the right side

		Rd			Rc					
Age	N	Mean (cms)	SD	Std. Error	Mean (cms)	SD	Std. Error	Width of mental Foramen (Rd-Rc) (cms)	SD	Std. Error
40-49	24	1.929	.3495	.0713	1.58	.396	.081	0.349	0.1532	0.0313
50-59	61	1.608	.3870	.0495	1.28	.388	.050	0.328	0.1127	0.0144
60-69	71	1.534	.5297	.0629	1.24	.536	.064	0.294	0.0267	0.0245
70-79	37	1.743	.4438	.0730	1.35	.409	.067	0.393	0.1615	0.0265
>79	7	1.857	.1902	.0719	1.51	.227	.086	0.347	0.976	0.0369
Total	200	1.654	.4610	.0326	1.32	.457	.032	0.334	0.1666	0.0118

Table 6: Width of the mental foramen 'Ld-Lc' on the left side

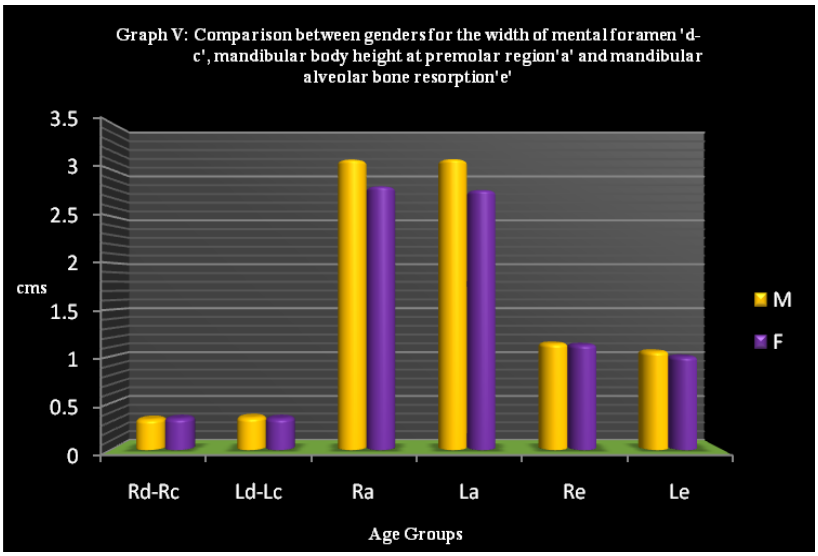
		Ld			Lc					
Age	N	Mean (cms)	SD	Std. Error	Mean (cms)	SD	Std. Error	Width of Mental Foramen (Ld-Lc) (cms)	SD	Std Error Mean
40-49	24	1.879	.3989	.0814	1.467	.4061	.0829	0.412	0.2542	0.0519
50-59	61	1.657	.3947	.0505	1.323	.3461	.0443	0.334	0.1914	0.0245
60-69	71	1.617	.5185	.0615	1.289	.5277	.0626	0.328	0.1830	0.0217
70-79	37	1.700	.4236	.0696	1.314	.4750	.0781	0.386	0.1417	0.0233

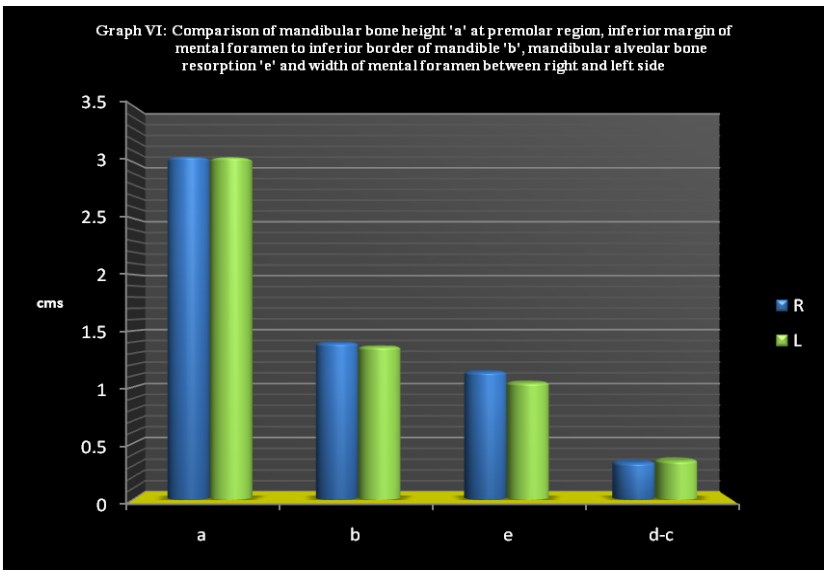
>79	7	1.786	.3078	.1164	1.443	.2573	.0972	0.343	0.01813	0.0685
Total	200	1.682	.4495	.0318	1.330	.4464	.0316	0.352	0.1894	0.0134

- Ld=Superior margin of alveolar crest to inferior margin of mental foramen on left side
- Lc= Superior margin of alveolar crest to superior margin of mental foramen on left side

Table 7: Comparison of width of the mental foramen'd-c' between right and left sides

Age	N	Mean difference (cms)	Standard error difference	t	df	p value
40-49	24	-.0583	.0606	-.963	46	.341
50-59	61	-.0066	.0284	-.231	120	.818
60-69	71	-.0296	.0328	-.903	140	.368
70-79	37	.0081	.0353	.230	72	.819
>79	7	.0000	.0778	.000	12	1.000
Total	**200**	**-.0180**	**.0178**	**-1.009**	**391.640**	**.314**





DISCUSSION

Forensic dentistry, simply defined, is the application of dental knowledge to the legal system.[7] This branch has wide applications in examination and evaluation of injuries to jaws, teeth and oral soft tissues, identification of individuals in criminal investigations and/or mass disasters, identification, examination and evaluation of bite marks which occur with some frequency in sexual assaults, child abuse and personal defense situations, and age estimation.

Forensic odontologists also play a vital role in identification of victims of mass disasters. [8] The mental foramen is defined as the entire funnel-like opening in the lateral surface of the mandible at the terminus of the mental canal. This foramen is contained entirely within the buccal cortical plate of bone.[9] The location of mental foramen could change during development of jaws, [10] therefore panoramic radiographs taken from patients who had completed their development were evaluated in the present study.

The purpose of this study was to determine gender using mandibular body height and width of mental foramen. The present study was undertaken in completely edentulous patients reporting to the Department of Oral Medicine & Radiology, Pacific Dental College & Hospital, Udaipur. The study included 200 panoramic radiographs of 157 males and 43 females. The study population was divided into 5 age groups (Table 1).

Gender Determination using width of mental foramen on panoramic radiograph

There was no significant difference in width of mental foramen between genders (Graph V). But in a study of Gintaras Jyodzbalys et al. width of mental foramen of 22 Caucasian skulls was related to gender.[11] This variation when compared with present study could be due to racial characteristics and method of study.

Gender Determination using mandibular bone height at premolar region on panoramic radiograph

Mandibular bone height 'a' at premolar region (Fig 6) was calculated from inferior border of mandible to alveolar crest at premolar region.[12] There was significant difference in mandibular bone height between males and females on right and left sides (Table VII) and males had greater mandibular body height. In the adult phase, the rate and speed of growth are bigger in men, with the result that the craniofacial dimensions in this gender are more than 5 to 9% bigger when compared with those of women.

Muscular tension is considered an inductive factor in bone formation, and in the mandible the contraction of the elevating muscles during masticatory movements exerts tension throughout the mandibular ramus. In general, men have stronger masticatory muscles than women. These two factors can explain the difference found between genders in mandibular height. [13] Similar results were reported in the studies by Cagri Ural et al., Laith Mahmoud Abdulhadi, who found that height of mandible was significantly greater in men than in women.[5, 14] Study of Bulem Yuzugullu et al. found mandibular bone height similar in men and women,[15] in contrast to the findings of present study. Maisaa Q et al. found that gender was not statistically associated with mandibular bone height in missing teeth areas.[16]

Gender determination using mandibular alveolar bone resorption'e'

No significant difference was found between male and female groups when mandibular alveolar bone resorption was considered on right and left side (Table VII) (Graph V).

Symmetry of Mandible

Error of magnification was calculated. The percentage of variance for magnification was 2.6%. Larheim and Svanaes investigated the precision of measurements of mandibular linear dimensions in panoramic radiographs and found that the variability of vertical measurements made from repeated panoramic radiographs is small when patients are properly positioned in the panoramic machine. According to Xie et al., if reference lines and measuring points are located in the same vertical plane, variations in vertical measurements in the mandible and the posterior regions of the

maxilla fall within a small range. The error for assessment of vertical distances in the mandible fell mostly within 3% of total variance. Every distance value in the radiographic films was significantly longer than in the direct measurement, despite considering the magnification rate.[5]

Comparison of width of mental foramen'd-c' between right and left sides

The left side measured more than right side but not significantly (Graph VI). In the study by Oliveira Junior et al, the width of mental foramen on left side was more than right side.[17] However, other studies have shown mental foramen to be symmetric, [18] and certain studies have only considered mental foramen on the right side for gender determination and morphometric analysis.[6]

CONCLUSION

In the present study mandibular measurements were used for gender determination. The study revealed that the mandibular bone height at premolar region was significantly more in male. When width of mental foramen was used to assess gender, it did not correlate. Thus mandibular bone height measurements in forensic dentistry could be useful in gender determination.

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