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ORIGINAL ARTICLE **OPEN ACCESS**

Evaluation and Assessment of the relationship between the Inferior alveolar canal and Inferior border of mandible using Orthopantomogram

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ABSTRACT
The purpose of this study was to evaluate the available bone in the region of first premolar and molar, in long standing edentulous mandibles, in Haryana population, in both males and female, on both left and right sides of the mandible as influenced by the course of the mandibular canal. Digital panoramic radiographs of 50 edentulous patients were examined. The study group was divided into two main groups of 25 male and 25 female patients. Measurements were made in the premolar and molar region of mandible. All radiographs were made using a standardized manner by the same technician. Eight sites were measured on every panoramic radiograph in the mandible. In the mandible all vertical measurements distance were significantly greater in the edentulous males than in the edentulous females ($p<0.05$). The results of this study may guide clinicians to make primer decision of implant insertion area for implant supported prosthesis in edentulous patients.
KEY WORDS: *Residual alveolar ridge, Inferior alveolar nerve, Mandibular edentulous posterior region, Panoramic radiography, Vertical bone height.*

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INTRODUCTION

In this third millennium, dental implants have become an increasingly common and widely accepted treatment option for the rehabilitation of partially and fully edentulous patients. Hence, the goal of a prosthodontist has become restoration of the stomatognathic system to normal function, comfort, esthetics, speech, and health regardless of the atrophy, disease, or injury by use of implant therapy [1]. Despite the high success rate of dental implants, many complications are still being encountered during implant placement. Although, many of these complications can be resolved easily; however, in some cases, they may result in dental implant failure or even life threatening circumstances [2-3]. One of the most serious and easily avoidable complications is the alteration of sensation after implant placement in the posterior mandible. The prevalence of such a complication has been reported to be as high as 13% for inferior alveolar nerve. Nerve damage can result in mild paresthesia to complete anesthesia or even disabling dysesthesia. This occurs as a result of injury to the inferior alveolar nerve (IAN) from traumatic local anesthetic injections or, more importantly, during dental implants osteotomy or placement [4]. Hence, it is of utmost important to localize and identify the full path of the inferior alveolar nerve. Several methods have been used to localize the IAN during treatment planning. These include intraoral periapical radiography, panoramic radiography, computed tomography (CT), and cone beam computed tomography (CBCT) [5].

Although CBCT and CT provide the most accurate method for localizing the IAN and are considered as the gold standards as far as imaging is considered. Its high cost and level of radiation prevent it from becoming the standard of care, especially in the Indian scenario where cost economics dictate the dental treatment [6]. Therefore, conventional panoramic radiographs become the most popular and recommended method for localization of IAN in dental implantology. Most clinicians use conventional radiography (e.g., panoramic, periapical) to localize the IAN, which is sufficient in many cases. Hence, this study was undertaken to evaluate the available bone (in height) present below the IAN i.e., between IAN and the inferior border of mandible (at the premolar and first molar regions) using a digital orthopantomogram in the rural population of Haryana state.

MATERIAL AND METHODS

A total of fifty completely edentulous mandibular arches were examined in this study. Various parameters were measured by using Orthopantomogram on both the right and left sides of mandible. A detailed case history of the patient was carefully recorded and the study was detailed to the patients and written informed consent was obtained before the start of the study i.e before the panoramic radiographs were made. Then preliminary impressions were made using irreversible hydrocolloid material (Mariflex, Septodont, India) (Fig. 1). Subsequently, primary casts were poured using Gypsum Type III Dental stone (Kalstone, Kalabhai, India) (Fig. 2).

A Radiographic stent was fabricated on the obtained primary cast with the help of autopolymerising acrylic resin (DPI-RR Cold Cure, Dental Products of India Limited, India). Four metal balls of diameter 3.96 mm were placed in the stent, one each in the premolar and molar region on both left and right sides of the arch and were fixed with the help of modeling wax, the metal balls were placed for the calculation of magnification error in the panoramic radiographs (Fig. 3). The self cure powder and monomer liquid were mixed according to the manufacturer's instructions; the resin was manipulated in the dough stage to make the template (Fig. 4).

Magnification error in the radiograph was calculated by the formula: Actual bone height divided by magnified bone height is equal to actual size of metal ball bearing divided by magnified size of metal ball bearing. Digital panoramic radiograph was obtained with the radiographic stent placed in position in the patient's mouth for assessment of bone height in the premolar and molar region on both left and right sides of the mandible. All the obtained radiographs were then assessed on the computer screen in Planmeca Romexis viewer with fixed resolution parameter and the following distances were measured using viewer ruler tool (Fig. 5). Distance from crest of residual alveolar ridge to mental foramen on both left and right side of the mandible (Fig. 6). Distance from mental foramen to inferior border of mandible on both left and right side of the mandible. (Fig. 6) Distance from crest of residual alveolar ridge to inferior alveolar canal on both left and right side of the mandible. (Fig. 6) Distance from inferior alveolar canal to the inferior border of mandible on both left and right side of the mandible (Fig. 6).

Two groups were made which consisted of:

Group A- 25 completely edentulous male patients and

Group B- 25 completely edentulous female patients

For each group eight measurements were made which were as follows:

(i) - Distance from Crest of Residual Alveolar Ridge to Mental Foramen on left side of the Mandible (Fig. 7)

(ii) - Distance from Crest of Residual Alveolar Ridge to Mental Foramen on right side of the Mandible (Fig. 7)

(iii) - Distance from Mental Foramen to Inferior Border of Mandible on left side of the Mandible (Fig. 7)

(iv)- Distance from Mental Foramen to Inferior Border of Mandible on right side of the Mandible (Fig. 7)

(v) - Distance from Crest of Residual Alveolar Ridge to Inferior Alveolar Canal in molar region on left side of the Mandible (Fig. 7)

(vi) - Distance from Crest of Residual Alveolar Ridge to Inferior Alveolar Canal in molar region on right side of the Mandible (Fig. 7)

(vii) - Distance from Inferior Alveolar Canal to the Inferior Border of Mandible in molar region on left side of the Mandible (Fig. 7)

(viii) - Distance from Inferior Alveolar Canal to the Inferior Border of Mandible in molar region on right side of the Mandible (Fig. 7)

The measurements were done by using the ruler in the tools provided by the Digital panoramic viewer (Planmeca Romexis Viewer, Helsinki Finland 2006). The magnification ratio of the Panoramic image was 1:1 as given by the manufacturer.

STATISTICAL ANALYSIS

The mean values are expressed as mean ± standard deviation with confidence interval of 95%. Mean values of males and females on right and left sides were compared using student "t" test. A (p-value) less than 0.05 meant that there was significant difference between the mean value of two groups at 95% confidence level (mark as *). If p-value was less than 0.01, the significance level was 99% (mark as **), otherwise (p-value greater than 0.05) meant difference was insignificant.

RESULT AND DISCUSSION

This study consisted of 50 edentulous patients (25 male and 25 female) with 5-10 years of edentulism for determining bone height in premolar and molar region of mandible. Bone height was measured using orthopantomogram (OPG) was measured using bone gauge.

As seen in Table 1, the mean values for Distance between Crest of Residual Alveolar Ridge and Mental Foramen, Distance between Mental Foramen and Inferior Border of Mandible, Distance between Crest of

Residual Alveolar Ridge and IAN in molar region and Distance between IAN and Inferior Border of Mandible in molar region for Edentulous Males on Left and Right side of Mandible were 7.49, 8.86, 8.08 and 7.32 respectively.

The mean values for Distance between Crest of Residual Alveolar Ridge and Mental Foramen, Distance between Mental Foramen and Inferior Border of Mandible, Distance between Crest of Residual Alveolar Ridge and IAN in molar region and Distance between IAN and Inferior Border of Mandible in molar region for Edentulous Females on Left and Right side of Mandible were 6.47, 8.04, 6.99 and 6.75 respectively.

The mean values for Distance between Crest of Residual Alveolar Ridge and Mental Foramen, Distance between Mental Foramen and Inferior Border of Mandible, Distance between Crest of Residual Alveolar Ridge and IAN in molar region and Distance between IAN and Inferior Border of Mandible in molar region for Edentulous Male patients on Left side of Mandible were 7.38, 8.88, 7.99, and 7.35 respectively.

The mean values for Distance between Crest of Residual Alveolar Ridge and Mental Foramen, Distance between Mental Foramen and Inferior Border of Mandible, Distance between Crest of Residual Alveolar Ridge and IAN in molar region and Distance between IAN and Inferior Border of Mandible in molar region for Edentulous Female patients on Left side of Mandible were 6.44, 7.97, 7.13, and 6.82 respectively.

The mean values for Distance between Crest of Residual Alveolar Ridge and Mental Foramen, Distance between Mental Foramen and Inferior Border of Mandible, Distance between Crest of Residual Alveolar Ridge and IAN in molar region and Distance between IAN and Inferior Border of Mandible in molar region for Edentulous Male patients on Right side of Mandible were 7.60, 8.84, 8.16 and 7.29 respectively.

The mean values for Distance between Crest of Residual Alveolar Ridge and Mental Foramen, Distance between Mental Foramen and Inferior Border of Mandible, Distance between Crest of Residual Alveolar Ridge and IAN in molar region and Distance between IAN and Inferior Border of Mandible in molar region for Edentulous Female patients on Right side of Mandible were 6.51, 8.12, 6.84 and 6.68 respectively.

Table I: Descriptive analysis of Bone Height (mm) in Premolar and Molar region for Edentulous Male patients on Left and Right side of mandible showing Mean, Standard Deviation with minimum and maximum range within them.

	Males Group A			Females Group B		
	Mean (mm) ± Standard Deviation	Minimum Range (mm)	Maximum Range (mm)	Mean (mm) ± Standard Deviation	Minimum Range (mm)	Maximum Range (mm)
(i)	7.38 ± 3.26	3.12	14.72	6.44 ± 3.04	2	12.4
(ii)	7.60 ± 3.33	3.28	15.08	6.51 ± 2.90	2.48	11.2
(iii)	8.88 ± 1.40	6.96	11.92	7.97 ± 1.86	5.12	10.72
(iv)	8.84 ± 1.07	7.36	10.56	8.12 ± 1.81	4.16	10.72
(v)	7.99 ± 3.21	3.28	14	7.13 ± 3.29	1.84	13.04
(vi)	8.16 ± 3.24	3.36	13.68	6.84 ± 2.82	1.92	10.72
(vii)	7.35 ± 1.18	5.52	9.84	6.82 ± 1.68	4.16	10.24
(viii)	7.29 ± 1.14	5.76	9.92	6.68 ± 1.26	4.32	9.44

Table 2 showed that, upon comparison of Bone Height in Premolar and Molar region for Edentulous Male and Female patients on Left and Right side of mandible showed significant difference between Males and Females in:

- Distance between Mental foramen and Inferior Border of Mandible($p<0.01$), and
- Distance between IAN and Inferior Border of Mandible in molar region ($p<0.033$).

Table 2: Comparison of Bone Height (mm) in Premolar and Molar region for Edentulous Male and Female patients on Left and Right side of mandible showing Mean, Standard Deviation and Significance between them.

s.no	Males Group A Mean± S.D	Females Group B Mean± S.D	Significance (p-value)
(i)	7.38 ± 3.26	6.44 ± 3.04	0.3
(ii)	7.59 ± 3.33	6.50 ± 2.90	0.222
(iii)	8.88 ±1.40	7.97 ± 1.86	0.056
(iv)	8.83 ±1.06	8.11 ± 1.81	0.093
(v)	7.99 ± 3.21	7.13 ± 3.29	0.356
(vi)	8.16 ± 3.24	6.84 ± 2.82	0.131
(vii)	7.35 ± 1.18	6.82 ± 1.68	0.201
(viii)	7.29 ± 1.13	6.68 ± 1.25	0.078
p value significance < 0.05*			

Table 3 shows statistical correlation which showed a strong positive correlation between the Distance between Crest of Residual Alveolar Ridge and Mental Foramen, and Mental Foramen and Inferior Border of Mandible ($p<0.01$)

Table 3: Karl Pearson's correlation coefficient among Bone height (mm) in Premolar and Molar region.

		(i)+ (ii)	(iii)+ (iv)	(v)+ (vi)	(vii)+ (viii)
(i)+ (ii)	Pearson Correlation	1			
	Sig. (2-tailed)				
(iii)+ (iv)	Pearson Correlation	.264**	1		
	Sig. (2-tailed)	0.008			
(v)+ (vi)	Pearson Correlation	.940**	.321**	1	
	Sig. (2-tailed)	0	0.001		
(vii)+(viii)	Pearson Correlation	0.067	.689**	0.064	1
	Sig. (2-tailed)	0.509	0	0.526	
** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).					

The importance of diagnosis and treatment planning in Dentistry cannot be overemphasized more so, in Implant dentistry where the presence vital structures can interfere with implant placement. The placement of endosseous dental implants to rehabilitate edentulous regions of the mouth has become a very popular treatment option especially, in the posterior mandible which is one of the most favourable areas for implant placement as guided by the quality and the quantity of available bone [2]. Hence, an in depth knowledge of all the vital structures in the vicinity of surgical site is of utmost importance for a practitioner. Gintaras Juodzbalys et al studied the incidence of injury to IAN and concluded that it remains a serious complication and is reported to vary from 0 to 40%, in implant related inferior alveolar nerve (IAN) injuries [7]. They concluded that the damage to IAN resulted from either traumatic local anaesthetic injections or while implant site preparation or placement.

Panoramic x-ray machines which produce cross-sectional images with curved layer linear tomography are useful in various situations. Radiographs are most important diagnostic tool for placement of dental implants. Recent advances in the design of panoramic radiograph machines have increased their

potential use in the longitudinal clinical evaluation of dental implants. Therefore, the role of radiographs is the essence of diagnosis as far as implantology is concerned.

The present study was conducted to evaluate the available bone (in height) present below the IAN i.e., between IAN and the inferior border of mandible (at the premolar and first molar regions) using a digital orthopantomogram and bone mapping in 50 edentulous patients (25 males and 25 females) with 5-10 years of edentulism, and resident of Haryana state.

All the measurements obtained in the study were recorded in standard magnification and resolution inherent in panoramic radiography. The contrast for measurement of bone height was kept similar for all the panoramic radiographs.

Upon statistical analysis, the mean distance from the mental foramen to inferior border of mandible in edentulous male and female patients with 5-10 yrs of edentulism (A (iii+iv) and B (iii+iv)) was found out to be 8.86 mm and 8.04 mm respectively, in 52 % of the cases this distance was in the range of 5-10 mm(Table I). Moogala and Sanivarapu in 2014 reported this distance to be 13.4 mm in edentulous mandibles in population of coastal Andhra Pradesh region [8]. Chung et al conducted a similar study and concluded that this distance was 15.5 mm in males and 14.0 mm in females in Koreans [9]. In 2004 Neiva et al reported that mental foramen was 12mm from the apical portion in Caucacians [10].

The mean distance between crest of mandible and mental foramen in edentulous male and female patients with 5-10 years of edentulism (A (i+ii) and B (i+ii)) was 7.49 mm and 7.38mm respectively, and in 68% of cases this distance was in the range of 5-10 mm (Table I). Moogala and Sanivarapu reported this distance to be 10.01 mm in edentulous mandibles in population of coastal Andhra Pradesh region. In course of mandible atrophy, the dental ridge becomes lower, and this is why Levine et al measured the distance from the edentulous alveolar crest to the superior aspect of the mandibular canal (MC) of 50 patients who had a radiographically identifiable MC and at least one mandibular first molar. Results showed that the superior aspect of the MC was 17.4 mm inferior from the alveolar crest[6]. Similarly, Watanabe et al analyzed CT data of 79 Japanese patients (52 male and 27 female) and found that the distance from the alveolar crest to the MC ranged from 15.3 to 17.4 mm. It is clear that the distance between the MC and the atrophic alveolar ridge is variable in dimension and should be assessed in each particular case [11].

The mean distance from inferior alveolar canal to the inferior border of mandible in molar region in edentulous male and female patients with 5-10 years of edentulism (A (vii+viii) and B (vii+viii)) was 7.32 mm and 6.75 mm respectively, in 84% of the cases this distance was found to be in range 5-8 mm (Table I). The mean distance from crest of mandible to the inferior alveolar canal in molar region in edentulous male and female patients with 5-10 years of edentulism (A (v+vi) and B (v+vi)) was 8.08 mm and 6.99 mm respectively, in 64% of the cases this distance was found to be in the range 5-10mm (Table I). However according to our results, short implants may be considered a reasonable alternative for rehabilitation of severely resorbed mandibles with reduced height, to avoid performing bone reconstruction before implant placement. Juodzbalys et al reported that in 70% of cases the mandibular canal and inferior alveolar neurovascular bundle stretches throughout the mandible body forming an “S” shape curve[7]. It approaches the lingual surface of the mandible in the area of the molars, and, stretching forwards to the front part, comes closer to the vestibular surface. In order to plan a proper dental implantation method and select implants of a relevant dimension, it is important to be aware of the position of the mandibular canal in connection with the side compact lamellas. Also it may help in nerve repositioning procedures i.e. namely, lateralization and fenestration [12-13].

A significant difference was seen between Males and Females in Distance between Mental foramen and Inferior Border of Mandible ($p<0.01$), and Distance between IAN and Inferior Border of Mandible in molar region ($p<0.033$) (Table II). Cagrı Ural et al stated that all vertical measurements distance were significantly greater in the edentulous men than in the edentulous women ($p<0,05$) [14], Gershchenson et al reported that the location of the mental foramen in relation to the border of the mandible and teeth depended on age, tooth condition and the degree of resorption. In adults as age advances, mental foramen shifts toward the superior border of mandible. This can be attributed to tooth loss followed by bone resorption [15]. With the loss of teeth, there is change in the relative position from midlevel toward the upper border of the mandible. In severe cases of alveolar resorption the bone loss is so much that the incisive and inferior alveolar nerves are exposed out of bone and lie just below the mucosa which may cause pain on denture wearing. Hence, in this study the distance between crest of residual ridge and mental foramen is lesser than the distance between mental foramen and inferior border of mandible. A high positive correlation was seen between the distances crest of residual ridge to mental foramen and mental foramen to inferior border of mandible, (p value <0.008) (Table III).

On evaluating the results of the present study it is observed that there is significant difference between the bone height and width in premolar and molar regions between edentulous males and females in

Haryana population. A need has been felt that a further study on a larger sample of dentate and edentulous subjects should be continued with the use of Cone Beam Computed Tomography (CBCT) to consider the available bone in premolar and molar region in Haryana state population.

Fig1. Preliminary Impression Fig 2. Diagnostic Cast


Fig 3. Metal Balls stabilized Fig. 4 Radiographic Stent


Fig. 5 Digital Panoramic Fig. 6 Orthopantomogram

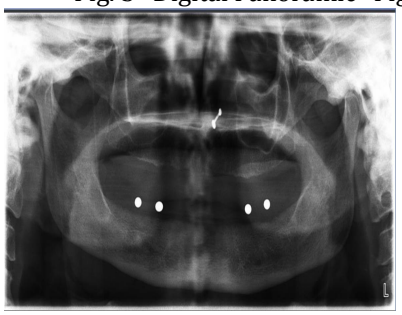
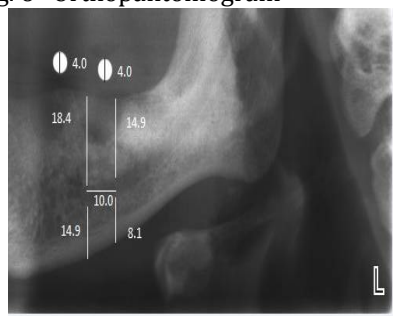
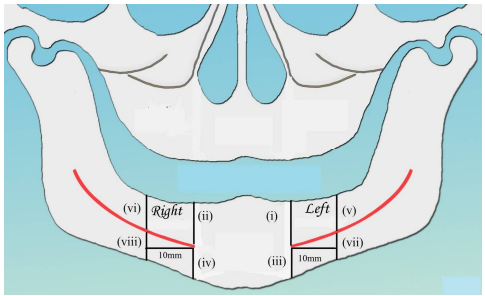



Fig 7. Bone Height Measurements



CONCLUSION

We may finally conclude from our study that the measurement of available bone height and width using orthopantomogram and bone gauge can be helpful in determining the mental foramen and its course; also is can be used as an aid in diagnosis and treatment planning for implant placement in mandibular posterior region. Any conclusive quantified evaluation cannot be done. Nevertheless this study has shown that mandible undergoes lot of dynamic changes post edentulousness and for any treatment modality related to implant prosthesis especially in the premolar region needs to be on individual diagnostic assessment. However, in the molar region and the premolar region blade implants are always an open treatment modality.

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