

# Comparative Evaluation of Morphometry of Mental Foramen using Orthopantomogram and Dry Bones in North Indian Population

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## ABSTRACT

**Introduction:** Mental Foramen (MF) holds strategic importance in clinical dentistry and oral surgery. Its accurate identification determines the effectiveness of nerve blocks and prevention of postoperative neurovascular complications.

**Aim:** To compare mental foramen on dry bones with their orthopantomogram and to find out if any difference and correlation exist between both modalities.

**Materials and Methods:** This descriptive, cross-sectional study was conducted at Anatomy Department of Government Medical College Amritsar, Punjab, India, from January 2018 to December 2021. It comprised of 200 dry human mandibles belonging to either sex, ranging from dentulous to partial dentulous. Orthopantomogram (OPG) of same mandibles were taken. Study was conducted in two phases. Phase I was dry bone phase and Phase II was radiographic phase. Distance of mental foramen from symphysis menti, posterior border of ramus, alveolar crest, lower border of body of mandible and distance between depth of the socket and mental foramen were evaluated. Student's

t-test for comparison and Pearson's correlation coefficient were applied to find any correlation between two modalities.

**Results:** Distance of mental foramen from symphysis menti, posterior border of ramus of mandible, alveolar crest and depth of socket showed statistically significant difference ( $p$ -value  $<0.001$ ) in between dry bone and orthopantomogram on both right and left sides. Actual bone length from mental foramen to symphysis menti, to posterior border of ramus and inferior border of body of mandible was more than it appeared on OPG. Distances obtained with OPG from MF to alveolar crest (dry bone: right= $13.49 \pm 3.46$  mm; left= $13.42 \pm 3.49$  mm and on OPG: right= $16 \pm 4.15$  mm; left= $15.42 \pm 3.84$  mm) and to depth of socket (dry bone: right= $2.48 \pm 1.58$  mm; left= $2.70 \pm 1.68$  mm and on OPG: right= $3.69 \pm 2.08$  mm; left= $4.26 \pm 1.99$  mm) were magnified.

**Conclusion:** The results of the present study depicted that structures were not equally magnified. Knowledge about magnification at particular region is important before proceeding any surgery in that region.

**Keywords:** Injuries, Mandible, Orthopantomography, Surgery, Tooth root

## INTRODUCTION

The Mental Foramen (MF) is a passageway on the outer surface of the mandible's body, it transmits the mental nerve and arteries that supply the lower lip [1]. Knowledge about MF is required to avoid post-operative complication in mental region like neuro-sensory disturbances, paralysis, haemorrhage, altered sensation, orofacial pain, atypical neuralgia [2]. Its knowledge is also required in surgical procedures like apical curettage of mandibular premolars, amalgam filling, periodontal surgery etc., to avoid injury to neurovascular bundle [1,3]. The level of difficulty to locate and palpate mental foramen externally increased due to lack of specific anatomical landmark. Ranging from maxillofacial to oral surgeries, knowledge about distance between surrounding structure and mental foramen is essential to fulfil successful procedure [4].

Dental implant is one of the great achievements in dentistry, due to its capability to restoring natural function of missing teeth without damaging surrounding tissue. Success of it revolves around availability of bone. The mental foramen is always at danger throughout the implant procedure. To maintain a safety margin, it is necessary to study the surrounding region of the mental foramen before proceeding with surgical treatments, especially with the rising tendency of orthognathic surgery in the mental region [5].

Panaromic radiography, Orthopantomogram (OPG) has attained popularity due to its ability to provide precise and brief view to identify the pathology and preplanning of treatment of the entire maxillofacial region with less radiation exposure [6].

Due to absence of a specific tooth or due to misplacement of tooth sometimes it may become difficult to locate mental foramen. In

such circumstances, MF can be located if the distance between the symphysis menti and the mental foramen is known [7]. Similarly, posterior border of mandible, lower border, upper border of body of mandible are the fixed and easily accessible anatomical landmarks, so distance from these landmarks helps to identify mental foramen.

No similar study has been conducted on north Indian population to compare mental foramina and anatomical landmarks on dry bones with OPG. Hence, this study was conducted to compare mental foramina and nearby anatomical landmarks on dry bones with their corresponding OPG in North Indian population.

## MATERIALS AND METHODS

This descriptive, cross-sectional study was conducted in Anatomy Department at Government Medical College, Amritsar, Punjab, India, from January 2018 to December 2021. It comprised of 200 dry human mandibles belonging to either sex, ranging from dentulous to partial dentulous. Orthopantomogram of same mandibles were taken. Before starting this study, a synopsis was submitted to Institutional Ethical Committee of Institute and ethical clearance was obtained (letter No./GMC Asr/14359).

**Inclusion criteria:** Intact and well-formed mandible of no specific age varying from dentulous to partially dentulous mandibles were included in the study.

**Exclusion criteria:** Fractured, damaged and mutilated mandibles were excluded from study.

## Procedure

Study was conducted in two phases.

### • Phase I: Dry bone phase

All the mandibles were marked from number 1-200. A braided thread (Ethicon-Brand) was used to measure curved distances and a digital vernier calliper (Aerospace-Brand) with least count of 0.01 mm was used to measure the straight distances on dry bones.

### • Phase II: Radiographic phase

Digital panoramic radiographs, OPG, of same dry mandibles were taken in a private lab by ADVAPEX- machine with following exposure parameters-

i) Anode voltage: 65 kvp.

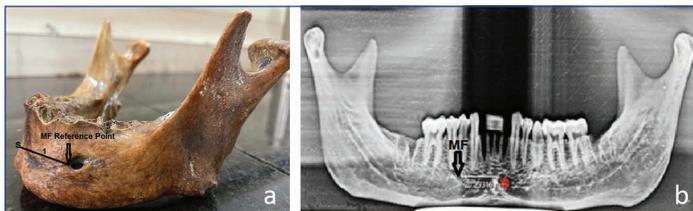
ii) Tube current: 10 mA,

iii) Exposure time: 14 Seconds.

Each dry mandible was centred in the focal trough of digital panoramic machine by reference line parallel to the symphysis menti. So that every time mandible was positioned on exact location to keep the method consistently standardised. All morphometric measurements were taken with software "ImageWorks-DICOM CD Viewer" and recorded on the predesigned proforma.

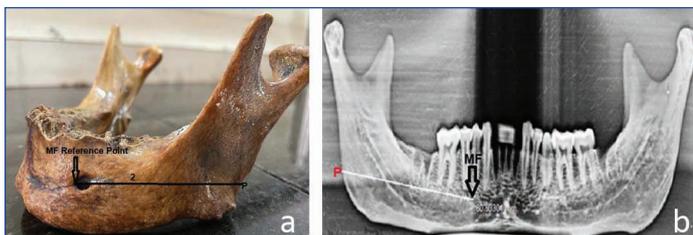
## Parameters Measured on Dry Bones and OPG

- Distance between anterior border of mental foramen and symphysis menti:** It was measured with unbraided silk thread. Unbraided thread was kept between anterior border of mental foramen and symphysis menti. It was marked with Indian ink pen (Luxor fine writer 05-brand) at designated points (anterior border of mental foramen and symphysis menti). Then distance between two marked points was noted by spreading it along metric scale (Nataraj-brand) [3,8,9] [Table/Fig-1a,b].



[Table/Fig-1]: a) (Dry bone): S-Symphysis menti, MF-Mental foramen, Distance between mental foramen and symphysis menti; b) (OPG): S-symphysis menti, MF-Mental foramen.

- Distance between anterior border of mental foramen and posterior border of ramus:** was measured with unbraided silk thread, by the same method as mentioned above [Table/Fig-2a,b] [3,9].



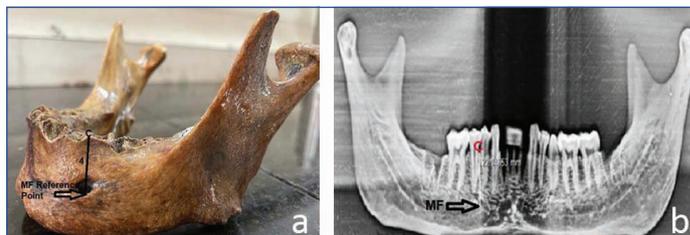
[Table/Fig-2]: a) (Dry bone): P-Posterior border of ramus of mandible, MF-Mental foramen, Distance between mental foramen and posterior border of ramus of mandible; b) (OPG): P-Posterior border of ramus of mandible, MF-Mental foramen.

- Distance between inferior border of mental foramen and inferior border of body of mandible:** It was measured with vernier calliper (Aerospace-brand) [Table/Fig-3a,b] [3,8,9].
- Distance between inferior border of mental foramen and alveolar crest:** It was measured with help of vernier calliper [Table/Fig-4a,b] [9,10,11].
- Distance between superior border of mental foramen and depth of the socket of tooth above:** It was measured by following given steps [Table/Fig-5a,b,c].

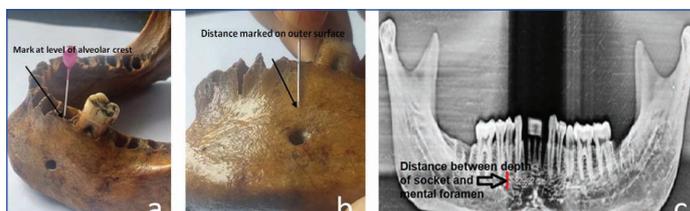
**Step (i):** First a needle was inserted into the socket of the tooth in line with mental foramen. If mental foramen was located in between



[Table/Fig-3]: a) (Dry bones): L-Lower border of body of mandible, MF-Mental foramen, Distance between lower border of mental foramen and lower border of body of mandible; b) (OPG): L-Lower border of body of mandible, MF-Mental foramen.



[Table/Fig-4]: a) (Dry bones): C- alveolar crest, MF- Mental foramen, Distance between lower border of mental foramen and alveolar crest; b) (OPG): C-Alveolar crest, MF-Mental foramen.



[Table/Fig-5]: a) (Dry bone) Needle kept in socket and marked at level of alveolar crest; b) Needle kept on outer surface of socket with marked point touching upper border of socket. Then another point marked at outer surface of mandible where tip of needle touched the outer surface of body of mandible; c) (OPG) Distance measured between depth of the socket and mental foramen.

the teeth, then the tooth to which mental foramen was more in line was observed and socket of that tooth was used to measure depth. [Table/Fig-5a].

**Step (ii):** Needle was marked with pen at the level of upper border of socket. [Table/Fig-5b].

**Step (iii):** Then the needle was kept on outer surface of socket with marked point touching alveolar crest of socket. Then another point was marked at outer surface of mandible where tip of needle touched [Table/Fig-5c].

**Step (iv):** After that distance between above marked point on outer surface and superior border of mental foramen was measured with the help of vernier calliper (Aerospace-brand).

## STATISTICAL ANALYSIS

Descriptive analysis was performed using Statistical Package for Social Sciences (SPSS) version 18.0. Range, mean±standard deviation were derived. Student's t-test was used to find out any statistical significant difference in dry bones and OPG, p-value <0.05 was considered significant, Pearson's correlation coefficient was calculated to find out correlation between dry bones and OPG.

## RESULTS

In present study, bilaterally in 124 mandible MF was located below the root of socket, followed by above the root of socket (in 28 mandibles) and at the level of root of socket (in 11 mandible) [Table/Fig-6].

Distance of mental foramen from symphysis menti (right and left p-value <0.001), posterior border of ramus of mandible (p-value <0.001 on both right and left side), alveolar crest (p-value <0.001 on right and left side), depth of socket (p-value <0.001 on both right and left side) showed statistically significant difference in between dry bone and orthopantomogram.

Below the root of socket (Number)					Above the root of socket (Number)				At the root of socket (Number)			
Dry bone	B/L	RT	LT	Total	B/L	RT	T	Total	B/L	RT	LT	Total
	124	15	7	146	28	6	6	40	11	2	0	13
OPG	90	16	18	124	26	4	11	41	12	3	2	17

**[Table/Fig-6]:** Showing the level of mental foramen in relation with root of socket.  
 B/L: Bilaterally; RT: Right; LT: Left  
 \*Calculation Add-up for socket  
 Dry=B/L 124+28+11=163, Right Side 15+6+2=23, Teeth Retained B/L=12, Teeth Retained on Right side=2, Total= 200.  
 Dry=B/L 124+28+11=163, Left Side 7+6+0=13, Teeth Retained B/L=12, Teeth Retained Left side=12, Total=200; \*OPG=B/L 90+26+12=128, Right side 16+4+3=23, Invisible B/L=35, Invisible Right=14, Total=200; B/L=90+26+12=128, Left side 18+11+2=31, Invisible B/L=35, Invisible Left=6, Total=200

Distance between mental foramen and inferior border of mandible on left side did not show any statistically significant difference (p-value=0.06). Actual bone length from mental foramen to symphysis menti, to posterior border of ramus and inferior border of body of mandible was more than it appeared on OPG. But Distances obtained from MF to alveolar crest (dry bone=right:13.49±3.46 mm; left: 13.42±3.49 mm and on OPG=right: 16±4.15; left: 15.42±3.84 mm) and to depth of socket (dry bone=right: 2.48±1.58 mm; left: 2.70±1.68 mm and OPG=right: 3.69±2.08 mm; left: 4.26±1.99 mm) were more in OPG [Table/Fig-7].

Parameters		Mean±SD		Range		p-value		Correlation coefficient (r)	
		Right	Left	Right	Left	Right	Left	Right	Left
MF-SM (cm)	Dry bones	2.50±1.97	2.58±0.24	2-3	2-3.6	<0.001**	<0.001**	0.674	0.561
	OPG	1.97±0.28	1.97±0.31	1.2-2.7	1.1-2.9				
MF-PB (cm)	Dry bones	7.03±0.54	6.88±0.53	5.3-8.3	5.5-8	<0.001**	<0.001**	0.474	0.530
	OPG	6.74±0.73	6.63±0.78	4.6-8.9	4.7-8.5				
MF-LB (mm)	Dry bones	11.91±1.69	11.65±1.89	8.04-16.65	5.02-17.85	0.0002**	0.06	0.509	0.596
	OPG	11.16±1.76	11.21±2.13	5.7-15.89	5.84-16.32				
MF-AC (mm)	Dry bones	13.49±3.46	13.42±3.49	5.57-22.55	4.79-22.36	<0.001**	<0.001**	0.735	0.788
	OPG	16±4.15	15.42±3.84	7.85-29.2	8.07-25.69				
MF-Depth of socket (mm)	Dry bones	2.48±1.58	2.70±1.68	0.25-7.56	0.03-8.81	<0.001**	<0.001**	0.716	0.807
	OPG	3.69±2.08	4.26±1.99	0.39-10.7	0.24-11.07				

**[Table/Fig-7]:** Showing statistical results of measured parameters.  
 \*\*p-value <0.001 was considered as highly significant; MF: Mental foramen; SM: Symphysis menti; PB: Posterior border; LB: Lower border; AC: Alveolar crest. Student's t-test, p-value, r-value; p-value <0.05 was considered as statistically significant

Pearson's correlation coefficient was calculated, r-values show a positive correlation between dry bones and OPG. A moderate correlation was found in distance from mental foramen to symphysis menti (right: r-value=0.674, Left: r-value=0.561), posterior border of mandible (right: r-value=0.474, left: r-value=0.530), lower border of mandible (right: r-value=0.509, left: r-value=0.596), alveolar crest (right: r-value=0.735, left: r-value=0.788), depth of socket on right side (r-value=0.716) and depth of socket on left side, a strong correlation was found (r-value=0.807). Mental foramen was invisible bilaterally in 35 OPGs, on right side it was invisible in 14 OPGs and in 6 OPGs on left side. So, practically it was not possible to measure above mentioned parameters on these OPGs with invisible mental foramen.

## DISCUSSION

Angulation of central beam in panoramic machine compensates the curved body of mandible, still there were few parameters which were measured less on OPG than dry bones. The observed difference may be attributed to curved body of mandible and flat film cassette used to take panoramic radiograph [12]. In present study, distance of mental foramen from all the considered landmarks showed statistically significant (p-value <0.001) difference on both right and left side in dry bones and OPG (except from left side of lower border of mandible). Rate of magnification depends upon angle of radiation [13]. Individual jaw shape and size can also affect the magnification [14]. Mental foramen with ill-defined margins was considered as

invisible [15]. During facial and dental surgeries, location of mental foramen is important to block mental nerve [16]. In this study, maximum correlation was observed between distance from mental foramen to depth of socket and least was observed from mental foramen to posterior border of mandible.

A study conducted by Polakowska EZ et al., using cone beam computed tomography, most common location of MF was reported as below the level of apices of 1<sup>st</sup> and 2<sup>nd</sup> premolar, followed by at the level of apices of 1<sup>st</sup> and 2<sup>nd</sup> premolar and least common location was found above the level of apices of 1<sup>st</sup> and 2<sup>nd</sup> premolar. The present study was in agreement with Polakowska EZ et al's study as researchers also found most common location as below the level of apices of socket [16].

In present study, bilaterally in 124 mandible MF was located below the root of socket, followed by above the root of socket (in 28 mandibles) and at the level of root of socket (in 11 mandible). Similarly on right side majority of mental foramen was located below the root of socket, followed by above the root of socket and at the level of root of socket. Correspondingly on left side it was located below root of socket, followed by above the root. On left side, none of the foramen was located at the root of MF. Measurements with OPG were on higher side than bones.

A study conducted by Aung H and Mustafa NS found mean distance between apex of premolar and mental foramen as 1.4 mm on left side and 2 mm on right side on OPG, and 3.1 mm on left and 3.7 mm on right side with CT. The difference can be attributed to racial difference [17].

Mean distance from mental foramen to symphysis menti on dry bones was found to be more in compare to OPG. Difference between two modalities being statistically highly significant on both sides (p-value <0.001 for right; p-value <0.001 for left).

On comparing distance between mental foramen and posterior border of ramus of mandible, on dry bones and corresponding OPGs, a statistically significant difference was found on both sides (p-value on right and left side <0.001). Findings of the present study were varying in between observed by other researchers [4,18]. Findings were recorded less on OPG as compared with dry bones.

In the present study, mean distance of mental foramen to inferior border of body of mandible on right side on OPG was less than the left side. The difference was statistically significant on right side (p-value <0.0002) only. When compared findings on dry bones of present study with earlier ones, it was found that values were near to study done by Bala SS et al., and less than observed by other authors [4,18,19]. On OPG it was more than observed by Afkhami F et al., and Muinelo LJ et al., [20,21]. Values recorded with OPG were higher on right side and slightly lower on left side. No statistically significant difference was found on comparing right

Author	MF-SM (mm)		MF-PB (mm)		MF-LB (mm)		MF-AC (mm)		MF-Depth (mm)		
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	
Parveen S et al., [4] (2018)	Dry bone	29.01±1.24	28.84±1.12	72.23±1.28	79.61±1.76	17.1±1.43	17.51±1.25	17.54±1.83	17.74±1.36	-	-
Ilayperumal et al., [7] (2009)	Dry bone	24.87±6.07	24.77±6.07	-	-	-	-	-	-	-	-
Aung HH and Mustafa NS [17] (2012)	OPG	-	-	-	-	-	-	-	-	2.0	1.4
	Computed tomography	-	-	-	-	-	-	-	-	3.7	3.1
Reddy AJ et al., [18] (2018)	Dry bone	27.68±3.69	27.91±1.52	69.26±3.69	69.66±3.71	12.69±1.37	12.72±1.62	13.95±2.80	13.43±2.04	-	-
Bala SS et al., [19] (2017)	Dry bone	24.46±2.33	24.19±2.60	-	-	11.12±1.81	11.07±1.72	11.02±2.77	11.07±2.90	-	-
Afkhami F et al., [20] (2013)	OPG	27.77±3.20		-		10.72±2.37		17.80±2.45		55.44±5.61	
Muinelo LJ et al., [21] (2015)	Computed tomography	-	-	-	-	13.55±1.06		11.42±3.34		-	-
Deivanayagi M et al., [22] (2019)	Dry bone	15.52±2.75	-	-		-		-		-	
Present Study (2022)	Dry bone	2.50±1.97	2.58±0.24	7.03±0.54	6.88±0.53	11.91±1.69	11.65±1.89	13.49±3.46	13.42±3.49	2.48±1.58	2.70±1.68
	OPG	1.97±0.28	1.97±0.31	6.74±0.73	6.63±0.78	11.16±1.76	11.21±2.13	16±4.15	15.42±3.84	3.69±2.08	4.26±1.99

**[Table/Fig-8]:** Showing comparison of measured parameters with accessible literature [4,7,17-22].

MF: Mental foramen; SM: Symphysis menti; PB: Posterior border; LB: Lower border; AC: Alveolar crest; OPG: Orthopantomogram

and left side of dry bones ( $p$ -value=0.35), which is representing bilateral symmetry.

On the right side, distance between mental foramen and alveolar crest was found to be 13.49±3.46 mm on dry bones and 16±4.15 mm on OPG, while on left side it was found to be 13.42±3.49 mm on dry bones and 15.42±3.84 mm on OPG. The difference between dry bones and OPG was statistically significant on right and left sides. Results of present study were in consonance with Reddy AJ et al., [18]. Values obtained with OPG were more as compared with dry bones on both sides. No statistically significant difference was found on comparing right and left side of dry bones ( $p$ -value=0.72), which is representing bilateral symmetry [18]. [Table/Fig-8] presents the comparison mean distance as observed in present study with earlier authors [4,7,17-22].

It is evident that the value found in present study on dry bones was in line with Ilayperuma I et al., but less than when compared to study by Reddy AJ et al., and Parveen S et al., and more than the study done by Deivanayagi M et al., and Bala SS et al., [4,7,18,19,22]. On OPG it was found much lesser than study by Afkhami F et al., [20]. When dry bones and OPG were compared, findings were found less on OPG than dry bone. The difference can be attributed to curved body of mandible and flat film cassette [12].

Various divergent studies had been reported in literature in different population. So, its location in specific population plays an important role to achieve successful nerve block.

### Limitation(s)

Distance between mental foramen and depth of socket in dry mandibles with retained teeth (12 bilaterally, 2 on right side and 12 on left side) could not be measured due to chances of damage to bone. Gender variations were not considered in the present study.

### CONCLUSION(S)

There was statistically significant difference between distance of mental foramen from all the considered landmarks on both right and left side in dry bones and orthopantomograms ( $p$ -value <0.001), except from left side of lower border of mandible. In clinical situation where mental foramen is difficult to locate due to malposition or absence of tooth, the present study added information to literature

regarding localisation of mental foramen on orthopantomogram and on dry bones, and made it possible to precisely locate mental foramen from nearby anatomical landmarks. The results obtained from study could be an area of interest for clinicians and anatomists. It may play important role in developing new techniques, which will help to precisely locate mental foramen.

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