



Research Article

MORPHOMETRIC ANALYSIS OF MENTAL FORAMEN IN SOUTH INDIAN POPULATION-A CBCT STUDY

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ABSTRACT

Aim: The aim of this study was to determine the horizontal location, vertical location, shape of mental foramen and its relation with lingual cortex, lower border of mandible and apex of the teeth as seen on CBCT images.

Materials and Methods: CBCT records were randomly selected from the collection of 30 South Indian population and were evaluated for morphometric analysis of the Mental foramen.

Results: The mental foramen is located more frequently in the level of the apices of the second pre-molars, with an average distance to the lingual cortex of 5.26 mm, to the base of the mandible of 8.4 mm and to the apices of the teeth 3.75mm with predominantly round in shape in the south Indian population.

Conclusion: There is no single and widely accepted pattern of Mental Foramen and it is different among each and every population. Clinician must acquire adequate knowledge about mental foramen to perform any procedure and minimize complications.

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INTRODUCTION

Mental foramen is situated in the mandibular body region between the superior and inferior border. Generally, MF is positioned under the interval between the lower premolars.⁽¹⁾ The mental nerve and vessels passes through the MF. Mental nerve provides sensory sensation to the lower lip, chin, and also to the gingiva on the same side of the mandible.⁽²⁾ Structurally, the MF on either side of the mandible is usually single; yet, double or rarely many mental foramina have been noted. Infrequent, the MF can be absent.⁽³⁾

Mental foramina are usually located postero-superiorly. However various position and shapes of the MF have been described by numerous authors with respect to diverse ethnic groups. Another foramen that is noted even in the presence of MF is described as an Accessory Mental Foramen and it may vary in number. The most common location of the Accessory Mental Foramen is beneath the mandibular 1st molar teeth. It might allow the passage of the mental nerve branches.⁽⁴⁾ The frequency of occurrence of accessory mental foramina differ between various ethnic groups ranging from 1.8% to 12.5% depending upon the population studied.⁽⁵⁾

The mental foramen is a significant structure in the outer surface of the mandible. The area sandwiched between the mandible and the mental foramina is regarded as a safe area for performing numerous surgical procedures like bone graft removal, placement of plates for the fracture fixation,

mentoplasty and jaw correction surgeries because it shows less chance of damaging the adjacent neurovascular structures. It is the favorite location for the placing of osseointegratable implants in edentulous patients, since it has satisfactory bone morphology and supports adequate bone.⁽⁶⁾ Since, it has so much clinical relevance attention must be given for morphology and morphometry analysis of mental foramen to acquire effective nerve block and to prevent any post-surgical neurovascular damage in the mental foramen regions.⁽⁷⁾

Therefore this study aimed to determine the horizontal and vertical location and shape the MF and to evaluate the morphometric relation of mental foramen relative to the lingual cortex, lower border of mandible, apices of the teeth in CBCT images in south Indian population.

Aims and Objectives

Knowledge regarding mental foramen is very much essential in clinical practice to perform any surgical procedures in that area and to prevent any neurovascular damage post operatively. The aim of this current study was to determine the following parameter in the CBCT images of South Indian population and to compare our findings with international values.

1. Horizontal position of mental foramen.
2. Vertical position of mental foramen.
3. Shape of mental foramen.
4. To evaluate the morphometric relation of mental foramen relative to the lingual cortex, lower border of

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mandible, apices of the teeth and the shape in CBCT images

this the parameters were observed as shown in figure 3. SPSS software is used for performing statistical analysis.

MATERIALS AND METHODS

Thirty CBCT images were randomly collected retrospectively from the department of maxillofacial radiology at SRM Dental College. All CBCT images were of dentate South Indian patients.

The inclusion criteria for selecting the images includes

1. High quality images with respect to contrast and angulation.
2. Presence of all lower teeth from right first molar to left first molar is mandatory
3. All CBCT must not have any radiographic exposure or processing artifacts.

Exclusion criteria includes

1. CBCT images with any pathological lesion.
2. Incomplete eruption of lower permanent teeth
3. CBCT images of patients with orthodontic treatment.
4. Presence of crowding and spacing in the mandibular arch.
5. CBCT images with missing mandibular canine were excluded because of the probability of mesial premolar migration.

All the CBCT images were examined using well experienced maxillofacial radiologist with a minimum of 3 years of experience in the field. Images were examined using CS 3D Imaging program in paraxial cuts, from a 17inch LCD monitor with screen resolution of 1280×1024 pixels. The images were viewed at an observation distance of approximately 70 cm from the computer screen under proper lighting conditions. CBCT projections were analysed in different planes (tangential, cross-sectional, and axial). Mental foramen was identified in cross-sectional and axial views. 60 radiographs were analysed for horizontal and vertical location and shape of mental foramen according to variables depicted in Table 1.

Table 1 reveals Features of mental foramen studied on CBCT images

Feature	Description
Horizontal Position	In front of the first lower premolar tooth long axis
	In line with the first lower premolar tooth long axis
	Between the first and second lower premolar teeth long axis
	In line with the second lower premolar tooth long axis
	Behind the second lower premolar tooth long axis
Vertical Position	Above the level of the first and second lower premolar teeth apices
	Below the level of the first and second lower premolar teeth apices
	At the level of the first and second lower premolar teeth apices
Shape	Round
	Oval

The horizontal position of the MF with respect to the mandibular teeth was classified as foramen in line with the long axis of the tooth or as foramen in between two adjacent teeth as shown in Figure 1. This method was first stated by Green⁽⁸⁾. We used the ruler edge to identify the long axis of the near by tooth and the MF position was noted according to this. The vertical position of MF in relation to the lower premolar apex was illustrated as in Figure 2. shape of mental foramen was noted as round, oval. To evaluate the morphometric relation of mental foramen relative to the lingual cortex, lower border of mandible, apices of the teeth In the coronal reconstructions, the cut was located where the hypodensity corresponding to the opening of the mental foramen and from

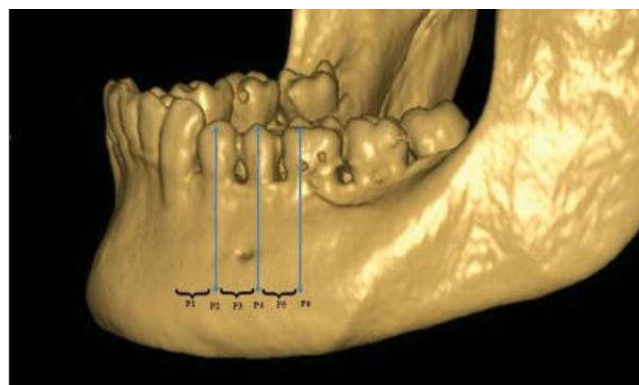


Figure 1 reveals Determination of the horizontal position of mental foramen. An image of a buccal surface longitudinal section of the bone was reconstructed using CBCT image. Courtesy (3)

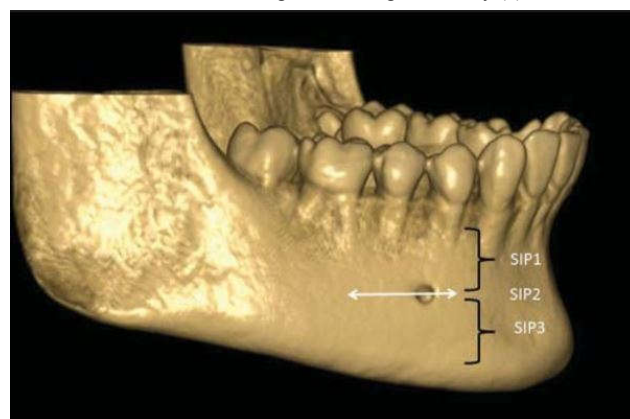


Figure 2 reveals the vertical position of mental foramen in relation to the apices of lower premolar teeth Courtesy (3)

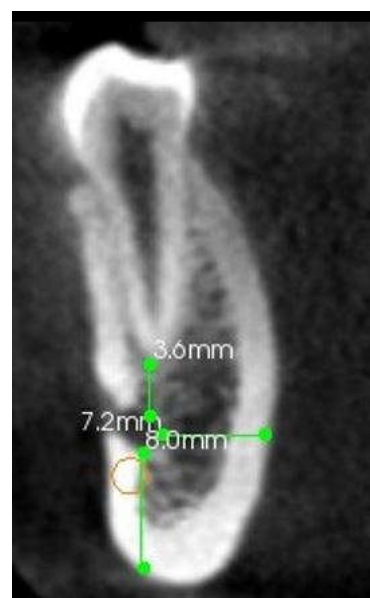


Figure 3 reveals evaluation of the morphometric relation of mental foramen relative to the lingual cortex, lower border of mandible, apices of the teeth In the coronal reconstructions. The hypodensity corresponding to the opening of the mental foramen and from this the parameters were observed

RESULTS

The Mental foramina were studied on the 60(30 patients) CBCT images. Of the 30 patients included in our study, there 14 males and 16 females with male to female ratio of 4.6: 5.3

Horizontal position of mental foramen

Regarding the horizontal position of the mental foramen, On the left side 15 were noted between the first and second premolar apex, 11 were noted in line with the second premolar apex, 4 were noted between the apices of second premolar and mesial root of lower first molar while on the right side there were 11 noted between the first and second premolar apex, 15 were noted in line with the second premolar apex, 4 were noted between the apices of second premolar and mesial root of lower first molar as shown in Figure 4. There was significant difference between right and left side in the position of the mental foramen ($P > 0.05$). We found that in males the most common horizontal position of the MF was between the first and second lower premolar teeth while in females it was in line with the second lower premolar.

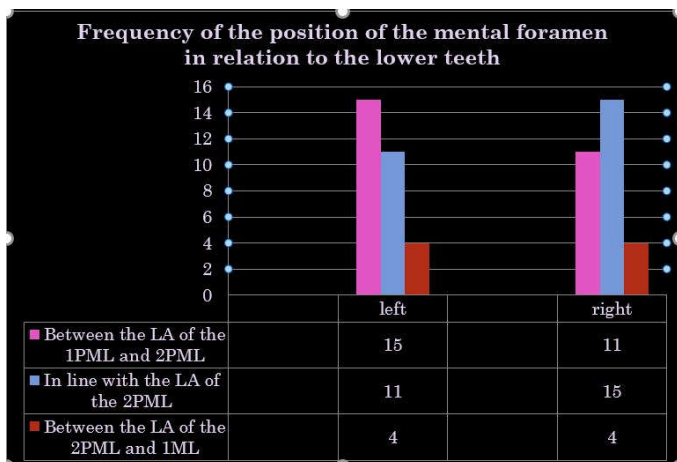


Figure 4 reveals the frequency of the horizontal position of the mental foramen in relation to the lower teeth

Vertical position of mental foramen

The vertical position of MF with respect to the lower premolar teeth apex is shown in Table 2. The most common vertical position was located below the level of the apices of lower premolar roots (76%).

Table 2 reveals Horizontal Position of Mental Foramen

Horizontal Position of the Mental Foramen	Left Side		Total in Left Side	Right Side		Total in Right Side	Total
	Male	Female		Male	Female		
Above the level of the first and second lower premolar teeth apices	3	6	9	7	2	9	18
Below the level of the first and second lower premolar teeth apices	1	0	1	0	0	0	1
At the level of the first and second lower premolar teeth apices	11	9	20	8	13	21	41
			30			30	60

Lower cortical area of mental foramen and the lower border of mandible (LBMF-LBM)

In transversal reconstructions, the cut was located where the hypodensity corresponding to the opening of the mental foramen and the average distance between the lower cortical area of mental foramen (LBMF) and the lower border of mandible (LBM) is 8.4 mm and there is a significant difference between the gender (male and female) and no significant difference in sides (right and left) ($p > 0.05$). See table 3 & Figure 5

Table 3 reveals Morphometric Measurement of Mental Foramen

S.no	MF-LC		LBMF-LBM		Apex-UBMF		shape	
	Left	Right	Left	Right	Left	Right	Left	Right
1	3mm	7.8mm	10.3mm	12.1mm	2.1mm	2.2mm	Round	Round
2	6.8mm	6.3mm	8.7mm	8.8mm	5.2mm	4.7mm	Oval	Oval
3	5.2mm	4.8mm	11.0mm	9.1mm		7.8mm	Oval	Oval
4	4.9mm	4.4mm	10.9mm	10.7mm	5.3mm	5.0mm	Round	Round
5	7.8mm	7.2mm	9.3mm	7.3mm	4.6mm	4.3mm	Round	Round
6	3.9mm	4.2mm	9.4mm	10.4mm	7.4mm	11.1mm	Oval	Oval
7	9mm	6.6mm	13.6mm	12.1mm	2.5mm		Round	Round
8	4.9mm	7.4mm	9.4mm	8.1mm	0		Round	Round
9	5.6mm	6.0mm	8.4mm	9.1mm	2.5mm	1.8mm	Round	Round
10	7.3mm	5.9mm	6.4mm	6.4mm		5.7mm	Oval	Oval
11	5.5mm	9.3mm	7.9mm	9.5mm	6.9mm		Round	Round
12	6.4mm	7.2mm	7.6mm	8.0mm		3.6mm	Round	Round
13	4.0mm	3.4mm	9.3mm	9.3mm	5.6mm		Oval	Oval
14	4.3mm	1.9mm	8.3mm	8.4mm	3.1mm	3.9mm	Oval	Oval
15	5.1mm	5.2mm	6.5mm	6.4mm		3.5mm	Round	Round
16	5.7mm	4.3mm	7.8mm	7.9mm	6.0mm	4.9mm	Round	Round
17	6.5mm	4.7mm	10.7mm	7.1mm	4.5mm	4.5mm	Round	Round
18	4.9mm	5.8mm	9.0mm	8.3mm	3.5mm	2.2mm	Round	Round
19	6.9mm	6.9mm					Oval	Oval
20	4.8mm	4.0mm	7.4mm	6.2mm	2.1mm	3.0mm	Oval	Oval
21	5.1mm	3.1mm	8.5mm	7.2mm	0.8mm	2.4mm	Round	Round
22	3.6mm	3.3mm	7.6mm	7.1mm			Round	Round
23	7.5mm	7.3mm	7.5mm	9.3mm			Round	Round
24	7.0mm	5.9mm	9.4mm	10.1mm	4.7mm	4.8mm	Oval	Oval
25	4.8mm	4.6mm	7.2mm	7.8mm	2.3	2.4mm	Round	Round
26	4.7mm	3.6mm	7.6mm	7.3mm			Round	Round
27	3.8mm	4.1mm	6.9mm	7.2mm	1.8mm	2.1mm	Oval	Oval
28	3.6mm	4.2mm	7.3mm	8.0mm		1.2mm	Round	Round
29	4.1mm	4.7mm	7.2mm	7.6mm	2.1mm		Round	Round
30	4.2mm	3.8mm	8.0mm	6.9mm	1.2mm	1.8mm	Oval	Oval

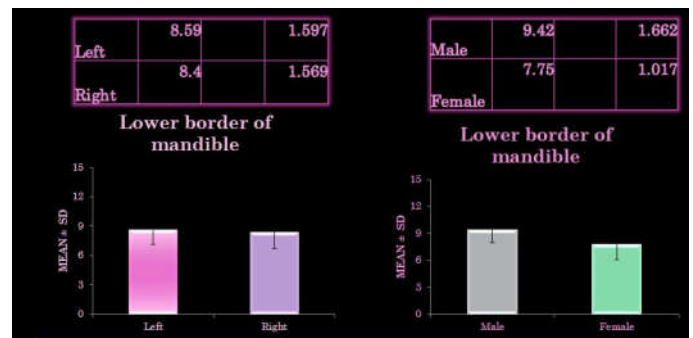


Figure 5 reveals distance between the lower cortical area of mental foramen (LBMF) and the lower border of mandible (LBM).

Upper cortical area of mental foramen and the tooth apex (UBMF-Apex)

In transversal reconstructions, the cut was located where the hypodensity corresponding to the opening of the mental foramen and the distance between the upper cortical area of mental foramen (UBMF) and the tooth apex (Apex) is 3.75mm and there is a significant difference between the sides (right and left) and also between the gender (male and female) ($p > 0.05$). See table 3 & Figure 6

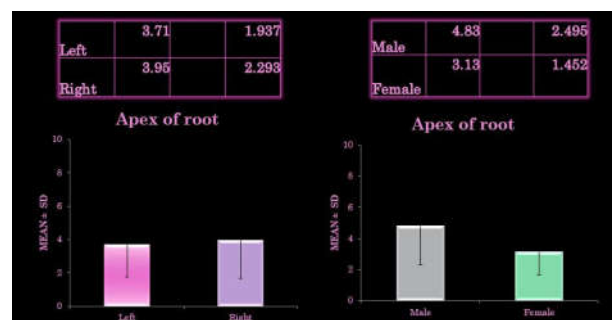


Figure 6 reveals distance between the upper cortical area of mental foramen (UBMF) and the tooth apex (Apex).

Mental foramen to lingual cortex (MF-LC)

In the transversal reconstructions, the cut was located where the hypodensity corresponding to the opening of the mental foramen was observed, the cases studied were distributed according to sides (right and left) and according to gender (male and female). The lingual edge was located, on average, 5.26 mm from the lingual cortex. Sides had no statistically significant influence, and neither did sex although an incidence of higher values had been verified in the men. ($p>0.05$). See table 3 & Figure 7

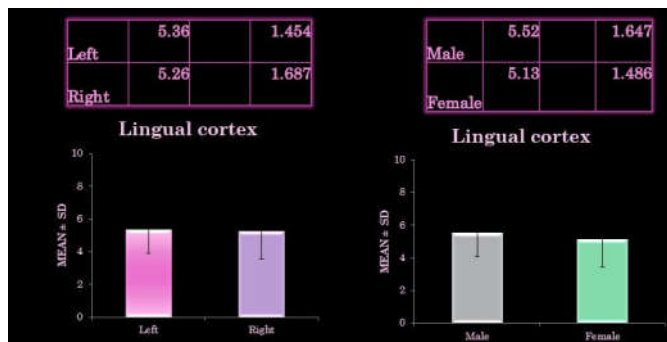


Figure 7 reveals distance between Mental foramen to lingual cortex (MF-LC).

Shape and various appearances of the MF in relation to the mental canal shows that majority of mental foramina was round in shape. See table 3 & Figure 8

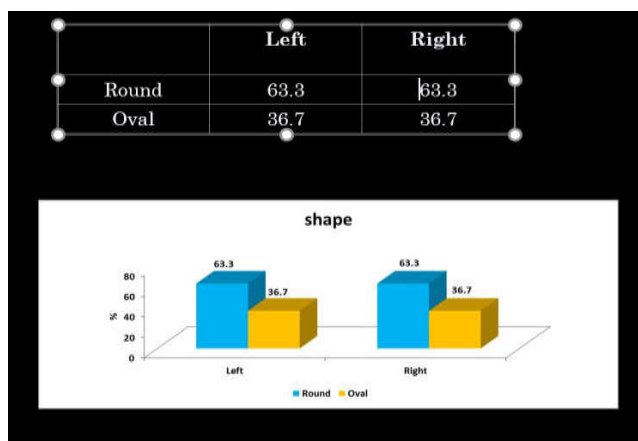


Figure 8 reveals the shape of the mental foramen.

DISCUSSION

Mental nerve not only supply teeth, but it also used to supply the incisive nerve and the anterior portion of the inferior alveolar nerve.⁽⁹⁾Anaesthesia of Mental nerve is an effective substitute for anaesthesia of inferior alveolar nerve. When we inject the local anaesthesia for the mental foramen, it diffuses through the mental canal that is too short (36mm) thereby, anesthetizing the inferior alveolar nerve itself which may prevent sensation from mandibular anterior teeth, bicuspid and soft tissue of the mental and lower lip area.⁽¹⁰⁾Knowing its exact location is extremely important in clinical situation. As far as our knowledge this is the first study to analyse about horizontal location, vertical location, shape of mental foramen and morphometric measures and compares it with sides and sexes in south Indian population.

Radiography is the most readily available non-invasive method for diagnosis and treatment planning of the mandible. OPG are frequently used in dentistry.⁽¹¹⁾Despite its huge advantage and tremendous use, it results in a high percentage of false

negative findings. It may cause sensory dysfunction because of the inferior alveolar nerve damage in the foraminal area. The foramen may confuse and misinterpret with a radiolucent lesion in the apical area of the lower premolar teeth.⁽¹²⁾

Conventional radiographic techniques capture a three-dimensional (3D) structure onto a two-dimensional plane. Resultant superimposition due to this many lead to complication in image interpretation and landmark identification, and this distortion and magnification can be way for anidentification errors. In Conventional radiographs as bone density increases the MF becomes harder to identify. CBCT has advantage of providing an overlap-free 3D reconstruction which gives better visualization of the anatomic structures. CBCT has low dose of radiation and cost than CT.⁽¹³⁾Aung *et al* studied the mental foramen in OPG and CBCT and says that the measurement obtained from CBCT is very precise when compare to the OPG.⁽¹⁴⁾Because of its tremendous advantages we used CBCT to study about Mental Foramen

Horizontal position of mental foramen

In our study the most common horizontal position of the mental foramen on the left side was between the first and second premolar apex (50%) while on the right side it was in line with the second premolar apex (50%). In males the most common horizontal position of the MF was between the first and second lower premolar teeth while in females it was in line with the second lower premolar. There was significant difference between the side in the position of the mental foramen. Thomas Von Arx *et al*⁽¹⁶⁾, Kalender A *et al*⁽¹³⁾, Sekerci A *et al*⁽³⁾says that there was no difference neither in side nor in sex, some studies^(15,17) shows no significant difference between the gender. Udhya *et al*⁽⁴⁾says that location of Mental foramen may vary between different races within the same population and also among different population. In our study, no MF was located both anteriorly to the first premolar and at the level of the first molar. Similar result was shown by the study conducted by Polakowska *et al* (18) in polish patients. One can expect minimum 90% success rate of mental nerve block when the anaesthetic solution is deposited in the buccal vestibule in between two mandibular premolars. (19)

Vertical position of mental foramen

In our Study the most common vertical position of MF below the level of the apices of lower premolar roots(76%) which was similar to the result of other studies^(3,9,17). Increasing age directly correlates with more inferior locations of the mental foramen.⁽⁹⁾

Upper cortical area of mental foramen and the tooth apex

The alveolar bone crest shows variation based on periodontal status (13). Because of this in our study we didn't take any measurement from the alveolar crest instead we take measurement from the tooth apex. In our study distance measurement between the upper cortical area of mental foramen and the tooth apex shows that there is a significant difference between the sides (right and left) and also between the gender. Similar result was evident in the study conducted by Aung *et al* (14) in OPG and CT and by Sankar *et al* (20) in dry dentulous mandibles of India which shows statistically significant difference on both right and left side. Sobreiro *et al* (10) says that they did not find any difference when comparing the left and right side.

Lower cortical area of mental foramen and the lower border of mandible

In our study when we studied the position of mental foramen in relation to the inferior border of mandible there is a statistically significant difference between sexes which is similar to the result of other study^(6,20). In contrary Al-Muft *et al*⁽¹⁵⁾ found no difference between sexes. In our study there was statistically no significant difference between sides which was same as that of result of^(10,15,20) but differ from result of Saito *et al*⁽⁶⁾ which says significant difference between sides.

Mental foramen to lingual cortex

The lingual edge was located, on average, 5.26 mm from the lingual cortex. In our study Sides had no statistically significant influence, and neither did sex, although an incidence of higher values had been verified in the men. Our study has a positive correlation with studies performed by Pyun *et al*⁽²¹⁾, Saito *et al*⁽⁶⁾ where the measurement were 5.6mm and 3.1 mm respectively. Raju *et al*⁽²²⁾ studied that the distance from the mental foramen to the lingual cortex was found to be 3.38 (males) and 3.61(females) along the right side and 3.40(males) and 4.055(females) along the left side. Sides had no statistically significant influence, and neither did sex although an incidence of higher values had been verified in the men which was similar to Saito *et al*⁽⁶⁾ finding which says no statistically significant influence with age or sex.

Shape

Shape of the mental foramen is different among different populations. MahnazSheikhi *et al*⁽¹⁷⁾ says that the majority of Indians were reported to have round mental foramen. Likewise, our study which was conducted among south Indian also shows predominately round shape. Similar results were observed in other studies⁽²⁰⁾ to the result of our study which shows round shape predominately. Oval shape was predominately found in some^(10,15,17) other studies.

Our study results show that the mental foramen is located more frequently in the level of the apices of the second pre-molars, with an average distance to the lingual cortex of 5.26 mm, to the base of the mandible of 8.4 mm and to the apices of the teeth 3.75mm with predominantly round in shape.

CONCLUSION

There is no single and widely accepted pattern of Mental Foramen and it is different among each and every population. This makes it important to study in each and every population. Our study highlight variability in mental foramen with respect to side and gender in South Indian population. Clinician must acquire adequate knowledge about mental foramen to perform any procedure and minimize complications.

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