

A Radiographic Study of the Anterior Loop and Mental Foramen in a Selected North Indian Population

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ABSTRACT

Background: The mental foramen is an important anatomical landmark and the possibility of the presence of the anterior loop mesial to the foramina is imperative to the dentist while performing various surgical procedures. **Objective:** To retrospectively visualize the anterior loop of the mental nerve in the panoramic radiographs. **Methodology:** Five hundred digital panoramic radiographs of patients who reported to Subharti Dental College, Meerut, taken between 2011 and 2013, were obtained from the Easy Dent Software. **Results:** At least one anterior loop was visualized in 73 (19%) radiographs out of 384 radiographs. The horizontal position of the mental foramen in relation to the lower teeth was most commonly below the apex of second premolar teeth (P4) on right side in 24.73% of radiographs while on left side was present in 29.4%. The most common radiographic appearance to be identified was the separated type (C2) which was found to be 14.06% and 17.70% on right and left side respectively. **Conclusion:** The anatomical landmark of the mental foramen is of paramount importance. The clinicians need to pin-point its location before the placement of implants in the foraminal region. Panoramic radiographs can be resourceful with its explicit depiction and confirmation of the presence of the anterior loop of the mental nerve. Injury to the mental nerve during implant placement can be avoided by identifying this anatomical landmark using advanced imaging modality and the surgical verification.

Key words: Anterior loop; mandible; mental nerve; panoramic radiograph

Introduction

The mental foramen is the important anatomical landmark that is found on the anterolateral aspect of the mandible and transmits the mental nerve and vessels. The most common location of the mental foramen according to Phillips *et al.* is between the premolars^[1] however variations in the position of the mental foramen have been analyzed. It may lie between the apices of lower premolars or below the apex of the second premolar.

Identification of the mental foramen and the possibility of the presence of the anterior loop mesial to the foramina; is imperative for the dentist, while performing various surgical procedures to facilitate surgical, local anesthetic and other invasive procedures

in the mental region of mandible in order to avoid any nerve damage. The development of implant techniques has increased the importance of mental foramen localization. Despite this fact, little attention has been given to its morphology, position and anatomical characteristics. Hence, this study has been conducted to investigate the size, dimensions, location of the MF and the presence of the anterior loop in a North Indian population.

Materials and Methods

Totally, 500 digital panoramic radiographs of patients who reported to Subharti Dental College, Meerut, taken between 2011 and 2013, were obtained from the Easy Dent Software. All panoramic radiographs were taken using (Vatech Inc., Hwaseong, Korea) with the recommended technique. The magnification factors reported by the manufactures were 1.14

The radiographs that were subsumed for the study were:

- High-quality radiographs with optimal resolution and without magnification
- The radiographs should not have any radiolucent/radiopaque lesion in the lower arch
- The radiographs with the evidence of fracture were repudiated

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- Any impacted/supernumerary teeth that could occult the appearance of the anterior loop of the mental foramen were not included
- The radiographs with positioning errors were excluded.

The age groups of the patients that were included for the study were split as follows: 20–29 years, 30–39 years, 40–49 years and 50 years and older.

The mental foramen was first identified according to the description by Yosue and Brooks.^[2] The radiographic appearance of the mental foramen was classified into following four types:

- Category I: Continuous type-mental canal was connected to the mandibular canal
- Category II: Separated type-mental canal does not show continuity with the mandibular canal
- Category III: Diffuse-foramina could be identified but with indistinct borders
- Category IV: Unidentified type-mental foramina could not be identified.

Then the anterior loop of the mental foramen was identified. The extent of the anterior loop of the mental canal of each radiograph was estimated by measuring the shortest distance from the two lines passing through the most anterior point of the mental foramen and the most anterior point of the mental canal to the nearest 0.5 mm.^[3] A Vatech ruler with graduated measurements was used [Figure 1].

The horizontal position of the mental foramen was classified in accordance with Tebo and Telford^[4] as following [Figure 2]:

- Foramen lying on a longitudinal axis passing between canine and first premolar (P1);
- Foramen lying on the longitudinal axis of the first

premolar (P2);

- Foramen lying on a longitudinal axis passing between first and second premolars (P3);
- Foramen lying on the longitudinal axis of second premolar (P4);
- Foramen lying on a longitudinal axis passing between second premolar and first molar (P5);
- Foramen lying on the longitudinal axis of first molar (P6).

Results

A total of 384 panoramic radiographs fulfilled the criteria and were examined out of 500 radiographs. The age groups of the patients that were included for the study were split as follows: 20–29 years, 30–39 years, 40–49 years and 50 years and older as shown in Table 1.

The male to female proportion was 1.6:1.

Horizontal position of the mental foramen in relation to the lower teeth:

Mental foramen was located most commonly below the apex of second premolar teeth (P4) on right side in 24.73% of radiographs while on left side was present in 29.4%. The second most common location of the mental foramen was between first and second premolars (P3). The frequency of occurrence of position 3 on right side was 9.37% while on left side was present in 10.15%.

However, no mental foramen could be appreciated in position 1 that is, between canine and first premolar and in position 6 that is, lying on a longitudinal axis of first molar [Table 2].

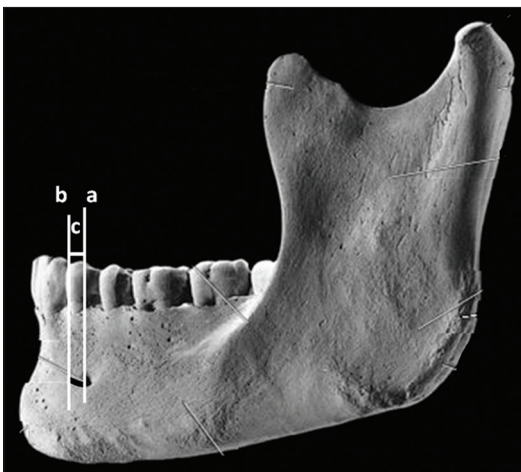


Figure 1: Reference points of the measurement for the anterior loop of the mental canal. (a) Point is the measurement of the deepest concavity of the mental foramen. (b) Point of the most anterior point of the mental canal. (c) Distance between the two points, that is, measurement of the length of the anterior loop of the mental nerve

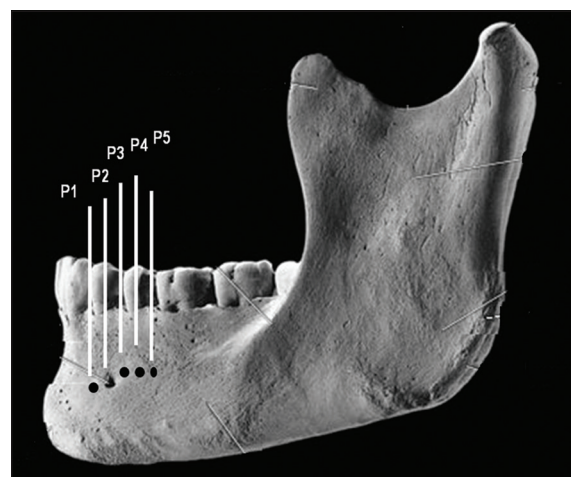


Figure 2: Horizontal position of the mental foramen. (P1) Foramen lying on a longitudinal axis passing between canine and first premolar. (P2) Foramen lying on the longitudinal axis of first premolar. (P3) Foramen lying on a longitudinal axis passing between first and second premolars. (P4) Foramen lying on the longitudinal axis of second premolar. (P5) Foramen lying on a longitudinal axis passing between second premolar and first molar. (P6) Foramen lying on the longitudinal axis of first molar

In most of the panoramic radiographs, the mental foramen was not identified (C4). It was unidentified in 59.11% on the right side and 54.94% on the left side.

The most common radiographic appearance to be identified was separated type (C2) which was found to be 14.06% and 17.70% on right and left side, respectively.

This was followed by the continuous type (C1) of radiographic appearance, which was present in 13.54% and 16.40% on right and left side, respectively [Table 3].

Anterior loop of mandible

At least one anterior loop was visualized in 73 (19%) radiographs out of 384 radiographs. The anterior loops were present on the left side in 26 radiographs while in 20 radiographs it was present on the right side. However, mental loop was present bilaterally in 27 radiographs.

In female subjects aged 20–29 years, the anterior loop was most commonly visible on the left side (in 11.1%) of radiographs. In contrast, for the male subjects of the same age, the anterior loop was commonly visible on the right side (in 5.95%) of radiographs. While 4.8% of male subjects in this age group exhibited an anterior loop on left side.

In an age ranging from 30 to 39 years, no anterior loop was present bilaterally in female subjects. While mental loop was present in equal frequency on right and left side (5.5%).

On contrary, in male subjects mental loop present on right, left and both sides in the frequency of 10.2%, 8.2%, 10.2%, respectively.

The percentage of the anterior loop on the right and left side among female subjects ranging from 40 to 49 years is 3.8% and 7.7%, respectively. In comparison among male subjects, the presence of the anterior loop on the right side was 7.4% while on the left side was 5.5%.

Moreover, anterior loop bilaterally among male and female subjects were 14.8% and 7.7%, respectively.

Among female subjects with age ≥ 50 years, no anterior loop was present on the right side and on both the side of the mandible. However, only in one radiograph the mental loop could be appreciated on the left side. While among the male subjects, the presence of the anterior loop on right, left side and on both sides were 2%, 8.16% and 14.2% [Figures 3 and 4] [Table 4].

Average length of the anterior loop that was measured in our study was 8.21 mm.

Radiographic analyzes revealed the mean height of the mental foramen was 2.31 mm (range 0.5–4.6 mm), and the average width was 2.47 mm (range 1–6.1 mm).

Discussion

Position of the mental foramen

The most common location of the mental foramen by different authors among various races is depicted in Table 5.

In the present study, the most common location of MF is below the apex of second premolar tooth in 29.4% of Indian population. The same position of mental foramen was present in Kim *et al.*, (2006)^[5], Wang *et al.*,^[7] Kekere-Ekun,^[8] Neo,^[9] Santini and Land,^[10] Shankland,^[11] Ngeow and Yuzawati,^[12]

Table 1: Number of subjects according to the age group

Age group	Number of subjects
20-29	138
30-39	85
40-49	80
≥ 50	81
Total	384

Table 2: Distribution of occurrence of the mental foramen in various locations

Position	Right (%)	Left (%)
I	0	0
II	1.3	1.3
III	9.37	10.15
IV	24.73	29.4
V	4.68	4.42
VI	0	0

Table 3: Distribution of occurrence of the radiographic appearance of the mental foramen

Category	Right (%)	Left (%)
C1	13.54	16.40
C2	14.06	17.70
C3	13.28	10.93
C4	59.11	54.94

Table 4: Distribution of visible anterior loops according to age and gender of the subjects

Age (years)	Gender	Both sides	Right side	Left side	Absent
20-29	Female (54)	2	2	6	44
	Male (84)	3	5	4	72
30-39	Female (36)	0	2	2	32
	Male (49)	5	5	4	35
40-49	Female (26)	2	1	2	21
	Male (54)	8	4	3	39
≥ 50	Female (32)	0	0	1	31
	Male (49)	7	1	4	37
Total		27	20	26	311

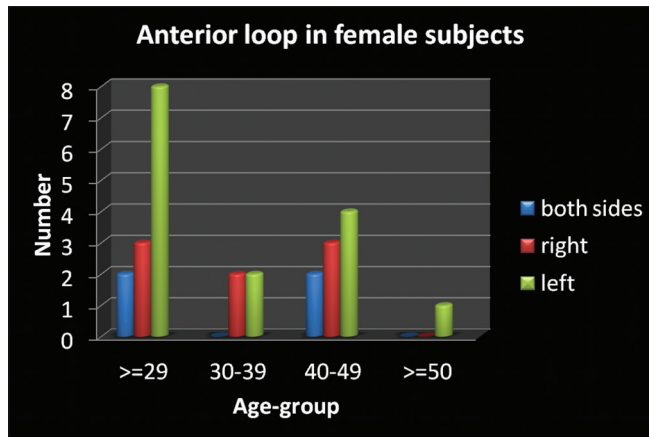


Figure 3: Distribution of the anterior loop among female subjects



Figure 4: Distribution of the anterior loop among male subjects

Table 5: Most common location of the mental foramen by different authors among various races

Authors (year)	Location of the mental foramen	Percentage of most common location	Race
Present study	Longitudinal axis of second premolar	29.4	Indian
Fishel <i>et al.</i> (1976) ^[6]	Between apices of premolars	70.4	Caucasian
Wang <i>et al.</i> (1986) ^[7]	Longitudinal axis of second premolar	59	Chinese
Kekere-Ekun (1989) ^[8]	Longitudinal axis of second premolar	69	Nigerian
Neo (1989) ^[9]	Longitudinal axis of second premolar	51 - left side 43 - right side	Indians
Neo (1989) ^[9]	Longitudinal axis of second premolar	69.4 - left side 66.1 - right side	Malays
Santini and Land (1990) ^[10]	Longitudinal axis of second premolar	52.9	Chinese
Santini and Land (1990) ^[10]	Between apices of premolars	65	British
Shankland (1994) ^[11]	Longitudinal axis of second premolar	-	Asian
Ngeow and Yuzawati (2003) ^[12]	Longitudinal axis of second premolar	69	Malay
Neiva <i>et al.</i> (2004) ^[13]	Longitudinal axis of second premolar	42	Caucasian
Apinhasmit <i>et al.</i> (2006) ^[14]	Longitudinal axis of second premolar	-	Thais
Bergman <i>et al.</i> (2006) ^[15]	Longitudinal axis of second premolar	42	Caucasian
Singh and Srivastav (2011) ^[16]	Longitudinal axis of second premolar	68.8	Indians

Neiva *et al.*,^[13] Apinhasmit *et al.*,^[14] Bergman *et al.*^[15] and Singh and Srivastav.^[16] However, the position of the mental foramen (29.4%) in our study was lower as compared to other studies.

Size of the mental foramen

In the present study, the average mean height of the mental foramen is 2.31 mm (range 0.5–4.6 mm), and the average width was 2.47 mm (range 1–6.1 mm). Comparison of size of mental foramen by various authors is shown in Table 6

Table 6: The comparison of size of the mental foramen by different authors

Authors (year)	Type of study	Average height (mm)	Average width (mm)	Race
Present study	Panoramic study	2.31	2.47	Indian
Neiva <i>et al.</i> (2004) ^[13]	Morphometric analysis on skulls	3.47	3.59	Caucasian
Igbigbi and Lebona (2005) ^[25]	Mandibles	Right - 2.43 Left - 2.71	Right - 5.05 Left - 5.00	Malawian

Table 7: Comparison of radiographic appearance of mental foramina: Present study versus Jacobs *et al.*^[17,18] on panoramic radiographs

Category	Jacobs <i>et al.</i> (%)	Present study (%)	
		Right	Left
Continuous	21	13.54	16.4
Separated	43	14.06	17.7
Diffuse	24	13.28	10.93
Unidentified	12	59.11	54.94

Category of the mental foramen

Radiographic assessment of the mental foramen must be interpreted prudently. Jacobs *et al.*^[17,18] in their study reported that mental foramen was detected on 94% of panoramic radiographs, but clear visibility was only attained 49% of time. Comparison of radiographic appearance of mental foramina: Present study versus Jacobs *et al.*^[17,18] on panoramic radiographs is shown in Table 7.

Presence of the anterior loop

The anterior loop has been identified for some time, but it has been regarded as of meager connotation. However, with the advent of acclimation of dental implants, there has been a substantial increase in interest among dentists regarding this structure. Several studies in the literature document and substantiate the presence of the anterior loop using various radiographic techniques and in dissected cadavers as shown in Table 8.

Table 8: Presence of the anterior loop in various studies: Percentage of occurrence and length of the loop

Authors and year	Technique	Percentage of occurrence	Length of the loop
Present study	Panoramic radiographs	19	8.21 mm
Misch and Crawford (1990) ^[19]	Panoramic radiographs	12	Mean: 5 mm
Arzouman <i>et al.</i> (1993) ^[20]	Panoramic radiographs	56 (Panelpipse) 76 (Orthoralix)	3.18 mm 3.45 mm
Solar <i>et al.</i> (1994) ^[21]	Dissected cadavers	59	Mean: 1 mm
Misch (1999) ^[22]	Panoramic radiographs	12	3 mm
Mardinger <i>et al.</i> (2000) ^[23]	Dissected cadavers	28	Range: 0.40-2.19 mm
	Periapical radiographs	19	Range: 0.5-2.95 mm
Kuzmanovic <i>et al.</i> (2003) ^[3]	Dissected cadavers	37	Range: 0.11-3.31 mm
	Panoramic radiographs	27	Range: 0.5-3 mm
Neiva <i>et al.</i> (2004) ^[13]	Dissected cadavers	88	Mean: 4.13 mm
Ngeow <i>et al.</i> (2009) ^[26]	Panoramic radiographs	40.2	

The incidence of the anterior loop in the present study was little higher as compared with the studies done by Misch,^[22] Misch, and Crawford.^[19] However, there is higher prevalence of mental loop in other studies by Arzouman *et al.*,^[20] Solar *et al.*,^[21] Mardinger *et al.*,^[23] Kuzmanovic *et al.*,^[3] Neiva *et al.*^[13] and Ngeow *et al.*^[26] Our study has shown that the authenticity of panoramic radiographs in recognizing the mental loop is constrained. Therefore, there are studies that have repudiated the importance of the anterior loop as a treatment planning consideration. The lower prevalence of mental loop in panoramic radiographs can be attributed to number of reasons. These include poor quality of radiographs with patient position, technician errors, and due to the presence of metal artifact superimposing the object of interest. The objects that lie outside the focal trough will result in distorted images. Sometimes there is also inability to distinguish mental foramen from the trabecular pattern of bone.

The various radiographic studies^[20,22,24] have indicated that the length of the anterior loop may vary between 0 and 7.5 mm. However, these measurements may not be correct. When identified radiographically and confirmed anatomically the length of the anterior loop may be overestimated or underestimated. Therefore, whenever clinicians are incredulous about the position of the mental foramen an alternative imaging technique may be needed for the implant placement in the mental foramen region to prevent injury to the mental nerve.

Nonetheless, we still decided to do this study using panoramic radiographs as imaging modality as it is the most customarily used tool in implant treatment planning. Moreover, no similar

study for the identification of the anterior loop of the mental nerve has been implemented on an Indian population so far.

In conclusion, the anatomical landmark mental of the foramen is of paramount importance. The clinicians need to determine its location before the placement of implants in the foraminal region. Panoramic radiographs are valuable, with their ability to confirm the presence of the anterior loop of the mental nerve. Injury to the mental nerve during implant placement can be avoided by identifying this anatomical landmark using this advanced imaging modality and the surgical verification.

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