RESEARCH ARTICLE

Cone Beam Computed Tomography based evaluation of position of mental foramen and its relation to apices of mandibular posterior teeth in a sample of Pakistani population

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Abstract

Objective: To radiographically determine the mental foramen position, its distance to the nearest apex and the prevalence of anterior loop of mandibular nerve using cone-beam computed tomography scans.

Method: The cross-sectional study was conducted at the Aga Khan University Hospital, Karachi, from January to June 2020, and comprised cone-beam computed tomography scans of males or females of Pakistani origin aged 15-65 years with intact mandibular dentition and fully formed roots with matured apex. The scans were analysed to determine the horizontal position of mental foramen and to classify it according to the Tebo and Telford classification. The vertical distance from mental foramen to the nearest tooth apex was measured and the mandibular nerve configuration was determined. Data was analysed using SPSS 23.

Results: Among the 96 scans, the most frequent location of mental foramen MF was along the long axis of 2nd premolars for both right 50(52.1%) and left 49(51%) sides, followed by between 1st and 2nd premolars for both right 28(29.2%) and left 38(39.6%) sides. The mean minimum distance from mental foramen to the nearest root apex was 3.75±2.59mm and 3.99±2.26mm on right and left sides, respectively. There was bilateral symmetry on both sides. The most frequent mandibular nerve configuration on the right 69(72.6%) and left 75(78.1%) sides, with anterior loop being the least common; right side 3(3.2%) and 5(5.2%) left side.

Conclusion: The most common position of mental foramen was along the long axis of 2nd premolars while the anterior loop was the least common.

Keywords: CBCT, Mental foramen, Mandibular teeth, Pakistani population, Tebo and Telford classification, Mandibular nerve. (JPMA 72: 1963; 2022)

DOI: https://doi.org/10.47391/JPMA.3358

Introduction

Mental foramen (MF) is an important anatomical landmark located on the lateral surface of the mandible housing major neurovascular bundles.[1] This makes it an important structure to be considered due to the various surgical interventions in dentistry.

Precise identification of MF is thus critical to avoid damage to the inferior alveolar nerve canal (IAC) and its associated branches running through it while performing a mandibular procedure. Surgical procedures in the posterior mandible in dentistry, such as implant placement, microscopic peri-radicular surgery, cyst enucleation, genioplasty, and bone harvesting for grafting procedures, require consideration of all anatomic landmarks, including the MF.[2] The exact MF location is significant for the administration of accurate mental nerve block anaesthesia and to protect the nerve from trauma which may result in sensory dysfunction that maybe temporary or permanent.[3] However, the MF may be located anywhere from the mesial aspect of the 1st premolar to along the long axis of the 1st molar due to individual anatomical variations.[4] Also, there have been variations in the horizontal position of MF in different racial groups and populations of various geographical locations.[4-12]

Various studies have acknowledged that mental nerve trauma due to surgical procedures because of inappropriate prior assessment would result in altered sensation from 8.5% to 24% within a period of 3-16 months after implant surgeries.[5]

Historically, MF has been identified using various protocols. Phillips et al.[13] determined the position of MF by measuring on dry skulls directly, using periapical as well as panoramic radiographs. Kim et al.[14] assessed MF position on exposed mandibles directly in alive patients. Scariot et al.[15] dissected fresh frozen cadavers to measure the position of the MF in the United States. Ghimire et al. investigated MF position using panoramic radiographs.[12]

Though baseline knowledge has been established related to MF position, there has been a change in approach after the advent of cone beam computed

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tomography (CBCT). This technology aids in 3-dimensional (3D) assessment of the anatomical structures for pre-surgical treatment planning. Various studies[10,12] have been carried out which used 2-dimensional (2D) panoramic radiographs for MF identification, but it has its own major drawbacks with high distortion, low resolution, superimposition of structures and overlapping of roots. Panoramic radiographs have a routine magnification factor of about 20-36%, which significantly affects and deviates MF location on the radiograph than its true clinical location. On the contrary, CBCT is a 3D, high-resolution and accurate modality for measuring the correct location of anatomical structures.[16] Neves et al.[17] compared panoramic radiographs with CBCT scans for MF detection, and reported CBCT to have greater ability to detect MF.

Current literature suggests different MF locations.[18-20] One study reported MF position using orthopantomogram (OPG),[21] whereas two studies used adult human mandibles.[22,23] There is no concrete study related to 3D MF visualisation in Pakistani population using CBCT scans. The current study was planned to fill the gap by radiographically determining MF position, its distance to the nearest apex and the prevalence of anterior loop of mandibular nerve using CTBT scans.

Materials and Methods

The cross-sectional study was conducted at the Aga Khan University Hospital (AKUH), Karachi, from January to June 2020. After approval from the institutional ethics review committee, the sample was determined using the World Health Organisation (WHO) calculator version 2.0[20] in the light of literature[12] while keeping the anticipated population proportion 0.6, absolute precision 0.05 and level of confidence 95%. The estimated sample size was inflated by 10%. A prior consent before conducting a 3D scan is taken routinely in order to use it for future research purposes.

CBCT scans of males or females of Pakistani origin aged 15-65 years with intact mandibular dentition and fully formed roots with matured apex were obtained retrospectively. The included scans were related to healthy individuals without any history of serious illnesses that could affect tooth or jaw development, conditions affecting bone remodelling, such as Paget's disease, or acromegaly, and the absence of developmental anomalies, such as ectodermal dysplasia, facial clefts or craniofacial syndromes. Scans with teeth showing root resorption or calcifications, low-quality radiographs, history of orthodontic treatment and usage of medications that could affect bone remodelling, such as bisphosphonates, were excluded.

The CBCT images had been taken using the Sirona Dental system (D-64625 Bensheim, Germany) operated at 85kVp and 7mA. The contrast and brightness of the images had been adjusted by using the image-processing tool in the software to ensure optimal visualisation. Cross-sectional images in the coronal and tangential planes were reconstructed by using GALAXIS version 1.9 (SICAT GmbH & Co. KG, Bonn, Germany) on a 17-inch personal computer monitor to assess MF position. Mandibular nerve was traced up to the foramen, including the anterior loop of the nerve.

Two trained examiners analyzed the CBCT scans in order to ensure accuracy and report the position of MF using Tebo and Telford Classification (1950).[20] There are six different MF positions in this classification in relation to the mandibular posterior teeth in dentate individuals (Figure-1); Class I, mesial to the first premolar; Class II, in line with the long axis of the first premolar; Class III, between the first and second premolars; Class IV, in line with the long axis of the second premolar; Class V, between the second premolar and the first molar; and Class VI, distal to the first molar. Long axis of the teeth was determined using the line tool in the software to record the horizontal MF position. The vertical distance from the MF to the nearest tooth apex was measured in millimeters (mm) using the digital scale in the software. The mandibular nerve configuration was determined as either linear, perpendicular or anterior loop after tracing (Figure-2).

Data was analysed using SPSS 23. Descriptive statistics were expressed as mean ± standard deviation or median and interquartile range IQR). Inter- and intraclass correlation coefficients (ICCs) were calculated. Paired t-test was used to assess bilateral symmetry. $P \leq 0.05$ was considered statistically significant.

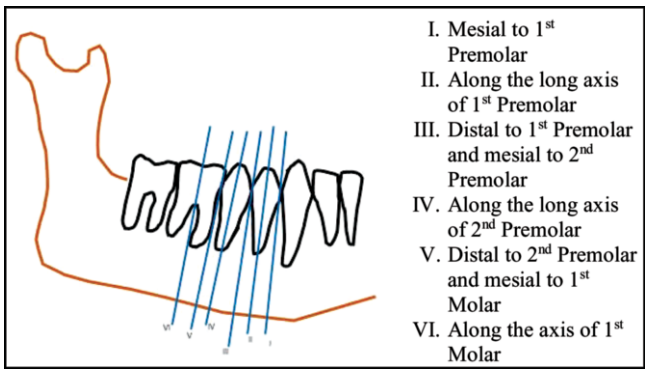

Figure-1: Tebo and Telford Classification of the position of mental foramen (MF).

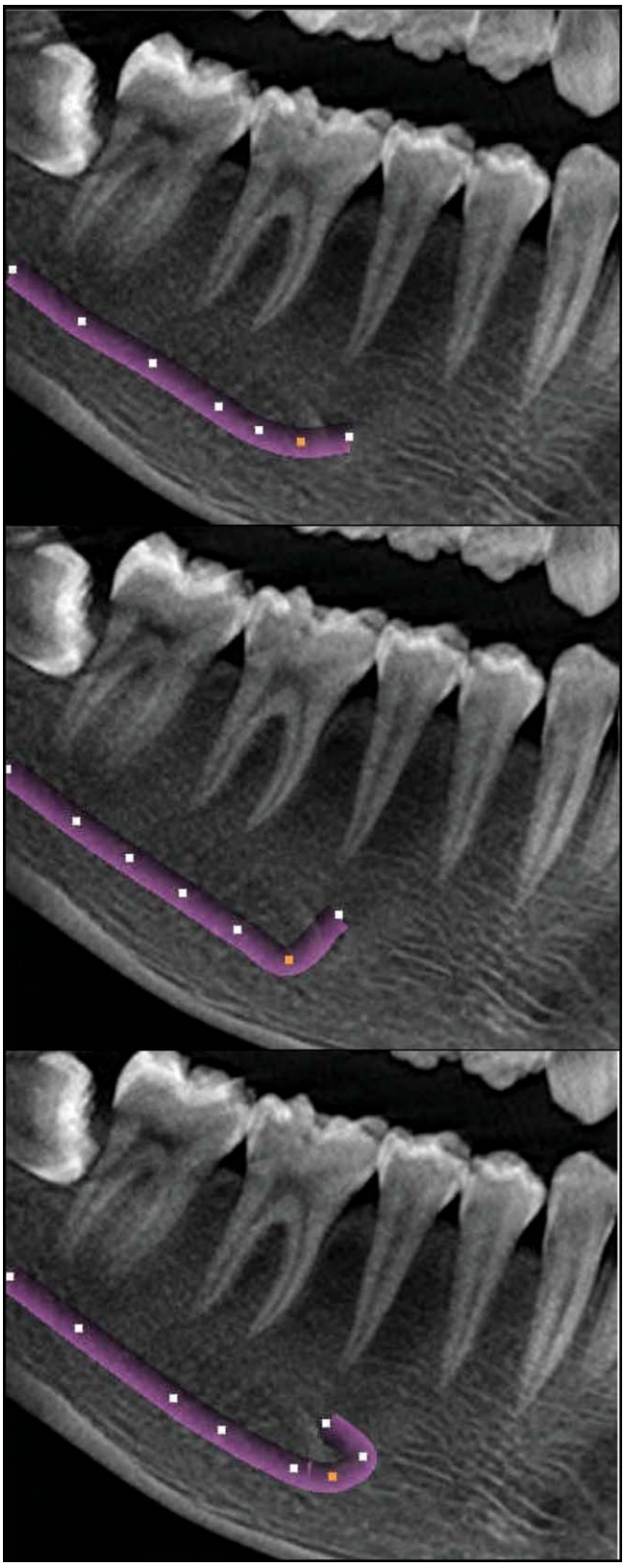

Figure-2: Mandibular nerve configuration on cone-beam computed tomography (CBCT). A: Linear, B: Perpendicular, C: Anterior loop.

Results

Among the 96 scans, the most frequent location of mental foramen MF was along the long axis of 2nd premolars for both right 50(52.1%) and left 49(51%) sides, followed by between 1st and 2nd premolars for both right 28(29.2%) and left 38(39.6%) sides. Neither of the two sides showed MF location along the long axis of the 1st premolars or molars (Table-1). The difference between right and left side symmetry was not significant (p=0.16).

Table-1: Mental foramen position and mental nerve configuration.

	Right n (%)	Left n (%)
Group 1	Nil (0)	Nil (0)
Group 2	2 (2.1)	4 (4.2)
Group 3	28 (29.1)	38 (39.6)
Group 4	50 (52.1)	49 (51.0)
Group 5	16 (16.7)	5 (5.2)
Group 6	Nil (0)	Nil (0)
Total	96 (100)	96 (100)

Table-2: Linear distance to mental foramen (MF) from the nearest apex (mm).

	Minimum	Maximum	Mean ± Std. Deviation
Right	0.00	12.23	3.75 ± 2.59
Left	0.35	10.98	3.99 ± 2.26

Table-3: Mental nerve configuration.

IAC Pattern	Right n (%)	Left n (%)
Linear	69 (71.9)	75 (78.1)
Perpendicular	24 (25.0)	16 (16.6)
Anterior loop	3 (3.1)	5 (5.2)
Total	96(100)	96(100)

IAC: Inferior alveolar canal.

The mean minimum distance from MF to the nearest root apex was 3.75±2.59mm and 3.99±2.26mm on right and left sides, respectively (Table-2).

The most frequent mandibular nerve configuration in tangential and panorama view was on the right side 69(72.6%) and on the left side 75(78.1%), followed by perpendicular pattern on both sides 24(24.2%) and 16(16.7%), respectively. Anterior loop was the least common pattern; right side 3(3.2%) and left side 5(5.2%) (Table-3).

Inter ICCs ranged 0.89-0.95, indicating excellent reliability.

Discussion

The current study evaluated MF location, its distance to

the nearest root apex, bilateral symmetry and configuration of mandibular nerve in a sample of Pakistani population.

It is important for the operator to know the estimated MF position before carrying out procedures, like raising a flap, implants, endodontic surgeries maxillofacial and orthognathic surgeries, and cyst enucleation, to prevent severing of the mental nerve which may lead to nerve paraesthesia, anaesthesia, hypoaesthesia or hyperaesthesia.[9] Such nerve injuries due to close proximity of important anatomical structures is common.[24] Knowledge of this anatomical relationship will help in the administration of effective mental nerve block before dental procedures[14] and would also prevent related complications.

A number of studies have reported MF position to predict the success rate of mental nerve block anaesthesia. In the present study, the most common position of MF among Pakistani population was found to be below the 2nd premolars on both right and left sides. The results are in line with earlier reports.[9-11] In contrast, MF position has also been reported to be between the two premolars (56%).[25] In the present study, 29.2% MF were located in the horizontal position, making it the second most common location. Similar results have been reported earlier.[4,10] In the current study, the MF was most prevalent between the 1st and 2nd premolars. The reason for these different horizontal MF positions is the difference in ethnicities and origins of the population. Diet and feeding habits may also be a factor responsible for such variations which affect height and craniofacial development.[26]

Analysis for bilateral symmetry revealed no significant difference in our study, which is in concordance with previous studies.[27,28]

The mean distance of MF to the nearest root apex described in literature[7,29] is similar to the current results (3.87mm), but one study[25] reported a distance as high as 5mm.

Anterior loop is a mesial extension of the mandibular nerve canal which curves backward before its exit from the MF. Its anatomic prevalence is also important when dealing with the area surrounding the premolars. Many studies reported a high frequency of anterior loop. (Von Arx[25]: 70.1% , Uchida[27]: 71%), on the contrary, the current sample showed different results.

The strength of the current study is that it is the first of its kind to determine MF position in Pakistani population using 3D CBCT. A limitation of the study is its small sample size and the fact that it was done at a single centre.

Conclusion

The most common MF position was along the long axis of 2nd premolars, followed by between the two premolars on both right and left sides. There was bilateral symmetry in its position. The minimum distance of MF to the nearest root apex was 3.75±2.59mm and 3.99±2.26mm on right and left sides, respectively. The most common mandibular nerve configuration was the linear pattern.

Acknowledgement: We have no financial interest, arrangement or affiliations that would constitute any conflict of interest. Ethical review committee exemption was obtained prior to study. All authors have approved the manuscript and its submission to the journal.

Disclaimer: The manuscript was submitted to the Aga Khan University (AKU) for its Annual Surgical Conference 2020, and Turnitin saved it in the central repository which explains 91% plagiarism from the source paper.

Conflict of Interest: None.

Source of Funding: None.

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