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CBCT ANALYSIS OF MANDIBULAR FIRST AND SECOND MOLAR ROOT APEX PROXIMITY TO THE MANDIBULAR CANAL IN A PAKISTANI POPULATION

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Abstract
This cross-sectional study at the Institute of Dentistry, CMH Lahore Medical College (Aug 2024–Feb 2025), evaluated the mean proximity of mandibular first and second molar root apices to the mandibular canal in 120 Pakistani participants using CBCT. Scans were acquired with standardized settings, and measurements were analyzed via specialized software. Results showed mean distances of 5.43 ± 1.41 mm for first molars and 4.13 ± 1.19 mm for second molars, with males exhibiting greater distances for second molars than females (3.86 mm vs. 4.30 mm). The difference between first and second molar distances was statistically significant ($p < 0.0001$). Findings indicate that second molar roots lie closer to the mandibular canal, especially in females, posing a higher risk of nerve injury. Age had no significant effect. CBCT is crucial for preoperative planning to reduce nerve damage risks during dental procedures.

INTRODUCTION

The proximity of the root apices of mandibular molars to the mandibular canal is a critical concern in dental practice, particularly in procedures such as root canal therapy, tooth extractions, and implant placements. The mandibular canal houses the inferior alveolar nerve (IAN), which is at risk of injury during these procedures, potentially leading to complications such as paresthesia or anesthesia.[1] Understanding the anatomical variations in this region is essential for reducing the risk of nerve damage, especially in diverse populations where these variations may differ significantly.[2]

Recent studies have highlighted the importance of advanced imaging techniques like Cone Beam Computed Tomography (CBCT) in assessing the spatial relationship between the mandibular canal and the root apices of molars. CBCT provides three-dimensional images that allow for precise measurement of the distance between these structures, aiding in the identification of high-risk cases where the IAN may be at risk.[3] For instance, a study by Kamburoğlu et al. (2018) found significant variations in the proximity of mandibular molars to the mandibular canal based on age, gender, and tooth type in a Turkish population.[4] Similarly, Koul et al. (2020) reported that males generally exhibit greater distances between the molars and the mandibular canal compared to females in an Indian population.[5] Despite the growing body of literature on this topic, there is limited data available concerning the distance between the mandibular canal and the root apices of mandibular molars in the Pakistani population. This gap in knowledge hinders the ability of clinicians in Pakistan to minimize the risk of iatrogenic injury during dental procedures involving these areas.[6] The present study aims to address this gap by evaluating

the mean distance between the mandibular canal and the root apices of the mandibular first and second molars using CBCT imaging in a Pakistani population.

Methodology

Study Design and Setting:

This cross-sectional study was conducted at the Institute of Dentistry, CMH Lahore Medical College, in six months i.e., 01-08-2024 to 01-02-2025.

Sample Size and Sampling Technique:

The sample size was calculated using the WHO formula, resulting in 120 participants, by using 95% confidence level, 0.05 absolute precision (α), and 5.67 ± 2.6 mm mean difference from mandibular canal to root apices.[7] A non-probability purposive sampling method was employed, selecting patients who presented for routine dental examinations and met the inclusion criteria. Adult patients aged 18 years and above, patients with unilateral or bilateral lower first and second molars, and patients who had undergone CBCT for endodontic purposes, implant planning, evaluation of dental anomalies, detection of resorptive defects, diagnosis of vertical root fractures or other relevant dental conditions with CBCT scans clearly show the mandibular canal, were included. Whereas, patients with incomplete field of view (FOV) scans, patients with prior orthodontic treatment involving the mandibular first and second molars, patients with previous extractions of mandibular first or second molars, patients with radiological evidence of conditions affecting molar and canal positions, and patients with CBCT scans indicating immature apices or abnormal eruptions were excluded to avoid bias in the study.

Data Collection and Analysis:

CBCT scans were obtained using a Villa scanner (Italy) with a 0.20-mm voxel size, 80 kV, 15 mA, and a 20-second exposure. Measurements were taken using designated software to ensure accuracy. Data were anonymized and entered into pre-structured tables for statistical analysis using IBM SPSS Statistics. A Shapiro-Wilk normality test was conducted to verify the normality of the data, and t-tests or Mann-Whitney U tests were used for comparisons.

Results

The study analyzed the proximity of the root apices of mandibular first and second molars to the mandibular canal in 120 participants. The results are as follows:

Table 1 shows the Shapiro-Wilk normality test, which assesses whether the data follows a normal distribution. The W-statistic and P-values for both the 1st molar distance (0.9613, P = 0.0016) and 2nd molar distance (0.9429, P = 0.0001) indicate that both variables deviate significantly from normality, as the P-values are less than 0.05.

Table 1: Shapiro-Wilk Normality Test Results (n=120)

Variables	W-Statistic	P-Value
Distance 1st Molar (mm)	0.9613	0.0016
Distance 2nd Molar (mm)	0.9429	0.0001

Table 2 shows mean and standard deviation (SD) for age (38.52 ± 12.76 years), 1st molar distance (5.43 ± 1.41 mm), and 2nd molar distance (4.13 ± 1.19 mm). Whereas, Table 3 summarizes the gender distribution in the study. Among the 120 participants, 49 (40.8%) are male and 71 (59.2%) are female, indicating a higher representation of females in the sample.

Table 2: Descriptive Statistics (n=120)

Variables	Mean ± SD
Age (Years)	38.52 ± 12.76
Distance 1st Molar (mm)	05.43 ± 01.41
Distance 2nd Molar (mm)	04.13 ± 01.19

Table 3: Gender Distribution (n=120)

Gender	Frequency	Percentage
Male	49	40.8%
Female	71	59.2%

Table 4 categorizes patients into four age groups: 18-30 years (25.0%), 31-40 years (26.7%), 41-50 years (23.3%), and 51-60 years (25.0%). The distribution across age groups is relatively even, ensuring balanced representation for analysis.

Table 4: Age Group Distribution (n=120)

Age Group	Frequency	Percentage
18-30	30	25.0%
31-40	32	26.7%
41-50	28	23.3%
51-60	30	25.0%

Table 5 and Table 6 shows the stratification of the distances of the 1st and 2nd molars based on age groups and gender. The mean 1st molar distance varies from 5.13 mm (31-40 years) to 5.67 mm (18-30 years), while the mean 2nd molar distance ranges from 4.00 mm (41-50 years) to 4.34 mm (51-60 years). When stratified by gender, females have slightly lower 1st molar distances (5.42 ± 1.35 mm) compared to males (5.46 ± 1.52 mm), whereas females have higher 2nd molar distances (4.30 ± 1.15 mm) than males (3.86 ± 1.24 mm).

Table 5: Stratification Distance of 1st Molar and 2nd Molar by Age Group (n=120)

Age Group	Distance (Mean ± SD)	
	1st Molar	2nd Molar
18-30	5.67 ± 1.15	4.12 ± 1.20
31-40	5.13 ± 1.52	4.02 ± 1.22
41-50	5.49 ± 1.46	4.00 ± 1.19
51-60	5.57 ± 1.61	4.34 ± 1.19

Table 6: Stratification Distance of 1st Molar and 2nd Molar by Gender (n=120)

Gender	Distance (Mean ± SD)	
	1st Molar	1st Molar
Female	5.42 ± 1.35	4.30 ± 1.15
Male	5.46 ± 1.52	3.86 ± 1.24

Table 7 shows the results of a paired t-test comparing the 1st and 2nd molar distances. The T-statistic (10.842) and P-value (<0.0001) indicate a highly significant difference between the two measurements, confirming that the 1st molar distance is consistently greater than the 2nd molar distance in the sample.

Table 7: T-Test Results for 1st and 2nd Molar Distances (n=120)

Comparison	T-Statistic	P-Value
1st Molar vs 2nd Molar Distance	10.842	<0.0001

Discussion

The current study was conducted to find the distance of the root's apices of the first and second molars from the mandibular canal, based on data from 120 participants. In current study, the Shapiro-Wilk test showed that the distances for both the first and second molars didn't follow a normal distribution ($P < 0.05$), which means non-parametric tests were the right choice for further analysis. This isn't surprising, as earlier research has also found that anatomical measurements, especially in dental and craniofacial studies, often don't follow a normal pattern.[1,2]

The mean distance of the 1st molar to the mandibular canal was found to be 5.43 ± 1.41 mm, while the 2nd molar was closer at 4.13 ± 1.19 mm. This difference was statistically significant ($P < 0.0001$), as confirmed by the paired t-test (T-statistic = 10.842). These results are consistent with earlier research, such as the study by Kamburoğlu et al. (2018), which also reported that the 1st molar tends to be further from the mandibular canal compared to the 2nd molar.[1] The closer proximity of the 2nd molar to the mandibular canal suggests a higher risk of nerve injury during dental procedures involving this tooth, particularly in endodontic treatments or extractions.[3,4]

When stratified by age groups, the mean 1st molar distance ranged from 5.13 mm (31-40 years) to 5.67 mm (18-30 years), while the 2nd molar distance ranged from 4.00 mm (41-50 years) to 4.34 mm (51-60 years). Although these variations were observed, the differences across age groups were not statistically significant, indicating that age may not be a critical factor in determining the proximity of molar roots to the mandibular canal. This finding contrasts with some studies that have suggested age-related changes in mandibular anatomy due to bone remodeling and resorption.[5-8] However, the relatively even distribution of participants across age groups in this study (25% in each group) ensures a balanced representation, which strengthens the validity of these findings.

Gender differences were also explored, with females showing slightly lower 1st molar distances (5.42 ± 1.35 mm) compared to males (5.46 ± 1.52 mm), while females had higher 2nd molar distances (4.30 ± 1.15 mm) than males (3.86 ± 1.24 mm). These findings are consistent with previous research, such as the study by Uchida et al. (2009), which reported that males generally exhibit greater distances between the molars and the mandibular canal, likely due to larger mandibular dimensions.[4] The closer proximity of the 2nd molar in females suggests that female patients may be at a higher risk of nerve injury during dental procedures involving this tooth, emphasizing the need for careful preoperative planning and the use of advanced imaging techniques like CBCT.[8,9]

The study's findings underscore the importance of considering gender and tooth type when assessing the risk of nerve injury during dental procedures. The closer proximity of the 2nd molar to the mandibular canal, particularly in females, highlights the need for

tailored clinical approaches to minimize complications. These results are particularly relevant for dental practitioners in Pakistan, where population-specific data on mandibular anatomy is limited.[10-12]

Conclusion

In conclusion, this study found that the lower 2nd molar roots are closer to the mandibular canal than the 1st molar, with females showing closer proximity than males, suggesting a higher risk of nerve injury in women. Age did not significantly affect the measurements. These results emphasize the need for advanced imaging, like CBCT, in preoperative planning, particularly for female patients and second molar procedures, to reduce nerve injury risks during dental treatments.

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