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# Analysis of the relation between inferior alveolar nerve canal and the roots of impacted mandibular third molars in the local population of Punjab

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## ABSTRACT

**Background and Objective:** It is important to understand the proximity of the inferior alveolar nerve canal (IANC) and lower third molar before performing any surgical procedure. The aim of the study was to determine the proximity of the IANC to the lower third molar and the pattern of impaction among the population of Punjab, Pakistan.

**Methods:** This cross-sectional observational study was conducted from December, 2021 to November, 2022 in the Maxillofacial Surgery departments of four private dental institutes in Punjab. A total of 134 patients were recruited. The IANC proximity and impaction pattern of the lower third molars of both sides were assessed using cone beam computed tomography images. Statistical Package for Social Sciences was used for analysis and a *p*-value less than or equal to 0.05 was set as significant.

**Results:** There were 76 (56.7%) males and 58 (43.3%) females, with the majority belonging to the age range from 40 to 59 years. The mean proximity of IANC to the impacted third molar was  $1.87 \pm 2.33$  mm. Sixty-seven participants had IANC in close proximity (less than 1 mm) to the impacted third molar. IANC was positioned apically with the least proximity to the impacted third molar in 56% of the participants. Moreover, 20 (4.9%) impacted third molars, affecting mostly females, were in direct contact with the canal. Most of the impacted third molars were in vertical position [89 (66.4%)] followed by mesioangular [22 (16.4%)] and horizontal [21(15.7%)] positions, respectively.

**Conclusion:** Most of the patients with impacted third molars had IANC in close proximity (less than 1 mm) to the impacted tooth with a possible risk for nerve injury during surgical extraction making it imperative to assess the position of the IANC before performing dental procedures.

**Keywords:** Cone-beam computed tomography, inferior alveolar nerve, third molar, tooth impaction.

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## Introduction

The inferior alveolar nerve (IAN) is an unusual but potentially serious condition that can have long-term and even permanent consequences. It is not uncommon for the roots of mandibular third molars to be close to or even directly in contact with the inferior dental canal.<sup>1,2</sup> An IAN may be damaged during the extraction of a mandibular third molar if it is located near the roots which may cause altered sensation, numbness, or pain in the lower lip, chin, and tongue.<sup>3,4</sup>

The incidence of IAN-related injuries ranges between 8% and 22%, and as the nerve approaches the third molar, the probability of injury increases.<sup>5</sup> Surgical approach for the removal of wisdom teeth needs to be planned based on the relationship between the roots and the inferior dental canal.

A more careful and skillful technique is necessary to minimize the risk of nerve injury if the roots are located near the nerve canal or at a position such as intra-radicular or superior to the roots of the third molars. The possibility of nerve injury may require alternative treatment options, such as partial extraction, referral to a specialist, or monitoring the tooth's condition over time if the risk is deemed too high.<sup>6</sup>

Previously, conventional radiographic imaging has been used to assess the proximity of the inferior alveolar nerve canal (IANC) with the lower 3rd molars however, it does not provide adequate visualization. A Cone Beam computed tomography (CBCT) is costly, but an accurate and popular

technique for determining the relationship between the 3rd molar and the IANC.<sup>7,8,9</sup>

Little information is available in Pakistan about the proximity of the IANC with the lower 3rd molar. The study aimed to determine the position, and proximity of IANC with the impacted third molars in the local population of Punjab, Pakistan. This will aid in risk assessment, planning for surgical extraction, and safe and effective dental operations.

## Methods

This cross-sectional, observational study was carried out in the Maxillofacial Surgery Departments of four dental hospitals Punjab [Institute of Dentistry Combined Military Hospital (CMH) Lahore; University College of Dentistry Lahore; Shahida Islam Dental College, Lodhran; and Faryal Dental College Lahore] from 8th December 2021 to 12th November 2022. A sample size of 134 patients was calculated by using a stratified random sampling technique with a 95% confidence interval, and 5% level of significance.

After getting approval from the Institutional Review Board of CMH Lahore Medical College, Lahore, patients with the age range from 18 to 60 years with fully or partially impacted mandibular 3rd molars on either side were recruited from the Maxillofacial Surgery departments of the study centers. The age of the patients was categorized as young or early adulthood (18-39 years), middle adulthood (40-59 years), and old age (above 60 years).

A written informed consent was taken from the participants. The confidentiality statement, information leaflet, and objectives of this study were mentioned on the written consent form. Patients under the age of 18 years, with developmental anomalies, or who did not have third molars were excluded from the study. To analyze the position of the

IANC with the impacted third molars, the participants' CBCT was mandatory. The proximity of the IAN canal from buccal, lingual, inter-radicular, and inferior aspects and its contact status with the roots of the third molars were determined. Moreover, the type (fully impacted or partially impacted) and pattern of the third molar using Winter's classification were noted by an experienced Dental Surgeon from the Oral Surgery department using the CBCT software (Planmeca Romexis 2021)<sup>10</sup> (Figure 1).

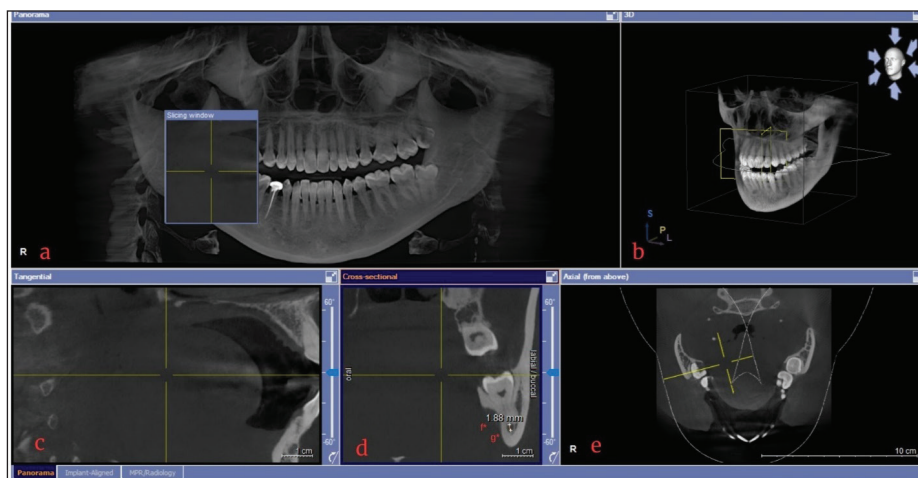
## Statistical analysis

The data were analyzed using IBM's Statistical Package for Social Science version 24 (IBM Corporation, New York, NY, 2014). Frequencies and percentages were calculated for qualitative variables. The means of quantitative variables were compared by using a *t*-test, while one-way ANOVA was applied for more than two variables. Categorical variables were compared by using the chi-square test. A *p*-value less than or equal to 0.05 was considered significant.

## Results

A total of 134 participants were enrolled in the present study. Among the participants, there were 76 (56.7%) males and 58 (43.3%) females, with the majority between the ages of 40 and 59 years. The mean proximity of IANC to the impacted third molar was  $1.87 \pm 2.33$  mm. Table 1 shows the association of IANC proximity with the demographics, impaction type, and root status of the third molars. Statistically, a significant association was found between IANC proximity to gender and impaction type (Table 1).

There was a significant difference between the position of IANC and its proximity to the third molar. Apically positioned canals had the least proximity to the lower 3rd molar, while



**Figure 1.** CBCT image for the investigation of the proximity of nerve (a) Panoramic view, (b) 3-D view, (c) Tangential view, (d) Cross-sectional image, f\* to g\*, the distance in millimeters, and (e) Axial plane.

**Table 1.** Relationship of age, gender, impaction status, and root status with the IANC proximity.

Demographics		Frequency	Percentage	Proximity (mm ± SD)	p-value
Age	18-39 years	6	4.5	1.45 ± 1.67	0.466*
	40-59 years	112	83.6	1.80 ± 2.30	
	60 years and above	16	11.9	2.51 ± 2.74	
Gender	Male	76	56.7	2.44 ± 2.58	0.001
	Female	58	43.3	1.13 ± 1.70	
Impaction type	Fully impacted	112	83.6	1.46 ± 2.07	0.001
	Partially impacted	22	16.4	4.53 ± 2.12	
Root status	Not fused	73	54.5	2.21 ± 2.32	0.052
	Fused	61	45.5	1.42 ± 2.37	

p-values were obtained through the t-test and ANOVA\*.

**Table 2.** Position of IANC and its proximity to the impacted third molar.

Position of IANC	Frequency (n)	Percentage (%)	Proximity (mm ± SD)	p-value
Buccal	36	26.9	0.77 ± 1.51	<0.001
Lingual	14	10.4	0.31 ± 0.62	
Apical	75	56.0	2.91 ± 2.45	
Inter-radicular	5	3.7	0.00 ± 0.00	
Superior	4	3.0	0.00 ± 0.00	

p-values were obtained through the chi-square.

**Table 3.** Gender-wise comparison of third molar impaction status, root status, and contact status of IANC.

Variables		Total n (%)	Male n (%)	Female n (%)	p-value
Winters classification	Disto-angular	2 (1.5)	0(0)	2 (3.4)	0.09
	Mesio-angular	22 (16.4)	9 (11.8)	13 (22.4)	
	Horizontal	21 (15.7)	11 (14.5)	10 (17.2)	
	Vertical	89 (66.4)	56 (73.7)	33 (56.9)	
Root status	Not fused	73 (54.5)	53 (69.7)	19 (32.8)	<0.001
	Fused	61 (45.5)	22 (28.9)	39 (67.2)	
Contact status of IANC	No contact	114 (85.1)	45 (59.2)	19 (32.8)	0.02
	Contact	20 (14.9)	31 (40.8)	39 (67.2)	

p-values were determined using the chi-square test.

interradicular and superiorly positioned canals were most adjacent (Table 2).

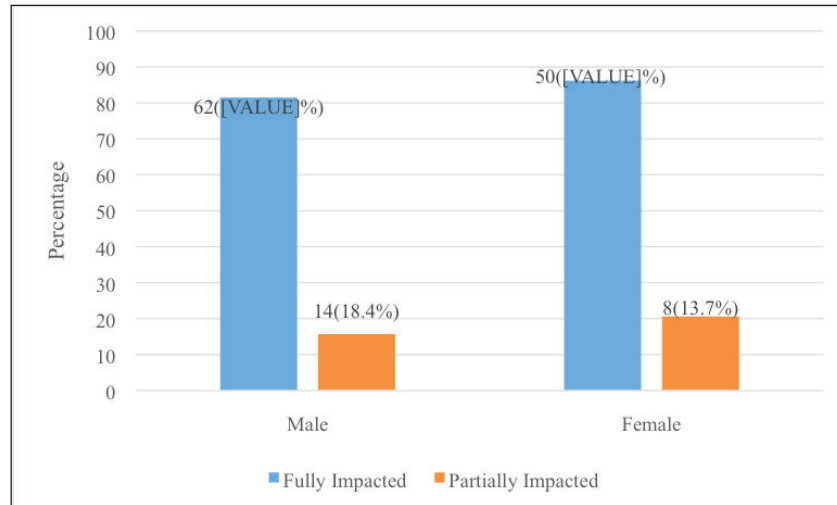
According to Winter’s classification system, most of the impacted third molars were in a vertical position [89 (66.4%)] followed by mesioangular [22 (16.4%)] and horizontal [21 (15.7%)] positions. A significant correlation between gender and root fusion status, and contact of the IANC with the roots of the third molar is shown in Table 3.

Figure 2 illustrates fully impacted third molars in 62 (81.5%) males and 50 (86.2%) females and there was no discernible difference between both genders (p-value = 0.35).

### Discussion

A number of factors contribute to the variation in IANC position among populations across the world, including genetic, developmental, and environmental differences. During the surgical removal of the lower wisdom teeth, the position of IANC is of critical importance. Furthermore, a lingually positioned or interradicular canal close to the lower wisdom tooth is more likely to cause an injury to the IAN.<sup>11</sup>

Gu et al.<sup>7</sup> and Kim et al.<sup>12</sup> reported that the majority of the Chinese (88.1%) and Korean (60%) population, respectively, had apically placed IANC, followed by buccally and lingual



**Figure 2.** Distribution of third molar impaction type with respect to gender.

placement. Moreover, only 1% of the Korean population had IANC passing between the roots of the lower third molar.<sup>7,12</sup> In a study conducted in Saudi Arabia, Shokry et al.<sup>13</sup> reported that most of the individuals had inferiorly positioned IANCs, followed by lingual and buccal positions. In Odisha and the Netherlands, CBCT analysis revealed a majority of patients had IANC placed inferior to the impacted lower third molar.<sup>14,15</sup> The findings of the present study are comparable to the studies conducted in the Korean and Saudi populations.

Various populations have different relationships between the IANC and the lower third molar. In a study on the Western Australian population, it was found that 88% of the subjects had a close proximity between the lower 3rd molar and the IANC (<1 mm) which is associated with a high risk of nerve injury during extraction.<sup>16</sup> Previous studies conducted on the Korean, Indian, Nepali, and German populations found a close approximation of IANC to the roots of the lower 3rd molar in 28.3%, 67%, 46.8%, and 58% of the cases, respectively.<sup>17-20</sup>

Studies have supported the sexual dimorphism of the IANC canal, especially in the Southern and Eastern Indian populations.<sup>21,22</sup> In addition, a study conducted in the United States reported that third molars were significantly closer to IANC in women than in men.<sup>23</sup> This can be attributed to the different genetic, development, and dietary factors between males and females. However, studies conducted on Saudi Arabian, Nigerian, and Baltic populations have reported no significant difference between the males and females.<sup>24-26</sup> There were no gender-specific differences in the distance between the IANC and the third molar in the present study.

Inconstant information on gender-wise comparison of lower 3rd molar impaction status in different countries is available. However, studies conducted in India and Iran by Hashemipour et al.<sup>27</sup> and Padhye et al.<sup>28</sup> reported a higher

prevalence of third molar impaction in females. Regarding the impaction status of the lower wisdom, there was no difference between the genders in the current study.

Most of the participants in the current study had vertical impaction (Winter's classification). Mesioangular impaction is the second most frequent impaction described in the literature, which is in coherence with the results of the present study.<sup>21</sup> The vertical and mesio-angular patterns of angulation have statistically significant differences between females and males. The horizontal and disto-angular patterns in males remained statistically significant when compared to the same patterns in females.<sup>29</sup> A study on the relationship between lower third molars and mandibular alveolar canal showed no association between winter classification and proximity of IANC.<sup>30</sup>

A proper understanding of the impact trend and position of IANC is very important to reach a better treatment and management plan in clinical settings. The implication of this knowledge will not only help in surgical planning and extraction but also in risk assessment, training, safe and effective dental procedures, forensic investigations, and diagnosing medical conditions.<sup>2,6</sup>

## Conclusion

The close proximity between the IANC and the third molar roots emphasizes the potential risk for nerve injury during surgical extraction. For a variety of dental, medical, and forensic applications, it is crucial to understand the location of the IANC. There was a close relationship between the IAN and the third molar with the apically positioned canal having the least proximity to the third molar, especially in females and those with fully impacted third molars. Our findings highlight the importance of thorough radiographic analysis

before any surgical procedure involving the impacted third molars.

### Limitations of the study

The small sample size of the current study is one of the limitations. By employing random sampling and involving tertiary care hospitals, being the center for all types of populations, indiscriminate participation from the most representative subpopulation was ensured.

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### List of Abbreviations

CBCT	Cone beam computed tomography
IAN	Inferior alveolar nerve
IANC	Inferior alveolar nerve canal

### Conflict of interest

None to declare.

### Grant support and financial disclosure

None to disclose.

### Ethical approval

Ethical approval was granted by the IRB of the Institute of Dentistry, CMH Lahore Medical College, Lahore, Pakistan, vide Letter No. 599/ERC/CMH/LMC, dated 25-05-2022.

### Authors' contributions

**MA:** Conception and design of the study, drafting of the manuscript, analysis and interpretation of data.

**AN:** Conception and design of the study, data collection, and drafting of the manuscript.

**HH, KH, MT, SM:** Data collection, analysis and interpretation of data, and drafting of the manuscript with critical intellectual input.

**ALL AUTHORS:** Approval of the final version of the manuscript to be published.

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