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Cone Beam Computed Tomography Assessment of the Relationship Between Impacted Mandibular Third Molars and the Inferior Alveolar Canal: A Retrospective Cohort Study

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KEYWORDS

Cone-beam computed tomography, Inferior alveolar canal, Impacted teeth, Third molar.

ABSTRACT:

Aim: This study aimed to identify radiographic indicators of the relationship between impacted mandibular third molar roots and the inferior alveolar canal (IAC) using cone-beam computed tomography (CBCT).

Methods and materials: CBCT scans of 76 adult patients requiring surgical extraction of impacted mandibular third molars were retrospectively collected from the Kamineni Institute of Dental Sciences, Nalgonda. Data were retrieved from electronic health records (October 2023–April 2024). A convenience sample was selected using non-probability sampling and categorized by gender and age groups: 20–30, 31–40, 41–50, 51–60, and 61–70 years. CBCT scans were evaluated for five parameters: (1) direct contact between the IAC and roots, (2) distance between the IAC and roots, (3) cortication of the IAC, (4) IAC position, and (5) IAC shape. Data analysis was conducted using SPSS version 24.0, with Chi-square or Fisher's exact tests to evaluate associations.

Results: Significant gender differences were observed in the mean contact and distance between the IAC and the root, whereas age differences were significant only for the distance. Other parameters, including the position, shape, and cortication of the IAC, showed no significant differences with respect to age or gender.

Conclusion: These findings highlight the importance of considering individual anatomical variations when planning surgical extractions of impacted mandibular third molars to reduce the risk of injury to the inferior alveolar nerve.

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INTRODUCTION:

Mandibular third molars, commonly known as wisdom teeth, often become impacted due to several factors, including insufficient space, limited skeletal growth, larger crown size, and late maturation.[1] While impacted mandibular third molars (IMTMs) can remain asymptomatic, they may also cause various symptoms and pathologies, such as pericoronitis, periodontal disease, distal caries, bone loss, root resorption of adjacent teeth, odontogenic cysts and tumours, jaw fractures, and infections.[2] The relationship between the impacted tooth and the inferior alveolar canal (IAC) is crucial in treatment planning to minimize iatrogenic damage to the inferior alveolar nerve (IAN), which can cause temporary or permanent paraesthesia.[3] The eruption status, position, and angulation of the IMTMs significantly influence the likelihood of these issues. Extracting an IMTM is a common dental procedure, though it can sometimes lead to IAN dysfunction, which is a particularly distressing outcome for many patients.[1] This dysfunction may present as tingling, numbness, or a burning or painful sensation in the ipsilateral lower lip, chin, gums, and teeth. The reported frequency of this complication ranges widely in the literature, from 0% to 17.4%.[4]

Cone-beam computed tomography (CBCT) has become increasingly used to overcome the limitations of 2D panoramic radiographs in the oral and maxillofacial field. CBCT offers three-dimensional (3D) imaging of anatomical structures such as teeth, jawbone, and the inferior alveolar nerve. It also provides advantages of lower radiation exposure and reduced costs compared to multi-detector CT. The cross-sectional images from CBCT can accurately determine the 3D positional relationship of the third molar in the bucco-lingual direction. [5] Although the relationship between impacted molars and the IAC has been explored, there is limited data on the demographic variations and specific CBCT-based parameters in the Nalgonda population. The present study aims to identify the radiographic signs of the relationship between impacted mandibular third molar roots and the IAC on CBCT images in Nalgonda Population. Additionally, the study hypothesizes that there is no significant relationship between the radiographic parameters (contact, distance, cortication, position, and shape of the IAC) and the impacted mandibular third molar roots on CBCT images, with no differences observed across gender or age groups.

MATERIALS AND METHODS: A retrospective cross-sectional observational study was conducted on 76 CBCT images taken by the CARE STREAM 9600 CBCT machine in Kamineni Institute of Dental sciences, Nalgonda from patients of both genders who were indicated for surgical extraction of impacted mandibular third molars. The sample size was calculated using a statistical utility for estimating proportions. Based on an estimated proportion of 86.7%, a confidence level of 95%, and an allowable error of 8% the required sample size was determined to be 69. However, 76 CBCT images were included in the study to ensure robust results. The study was adhered to the principles outlined in the Declaration of Helsinki. Demographic data was collected from electronic health records spanning October 2023 to April 2024. The radiographs were selected in a nonprobability manner to obtain a convenience sample meeting the following inclusion criteria: CBCT images of adult patients aged 20 to 70 years with impacted mandibular third molars and good quality scans. The Exclusion Criteria were: CBCT images of patients under 20 years old and those with tumors or cysts around the mandibular third molar, poor quality CBCT scans. The CBCT scans were analyzed using Carestream Imaging Software 8.0.1.8 (9600), with contrast and brightness adjusted for optimal visualization and Data analysis was conducted using SPSS version 24.0, with Chi-square or Fisher's exact tests to evaluate associations . CBCT scans were divided based on gender and different age groups as follows: 20–30 years, 31–40 years, 41–50 years, 51-60 years and 61-70 years. A single oral radiologist evaluated all the CBCT scans in the axial, coronal, and sagittal views assessing five parameters between the impacted mandibular third molar root and the IAC:

1. Direct contact between the root and IAC (fig 1)
2. Distance between the IAC and root [0.1 to >6mm] (fig 1)
3. Position of IAC and root [buccal, inferior, lingual].
4. Shape of IAC [dumbbell, teardrop, oval, round] (fig 2)
5. Cortication of IAC (fig 3)

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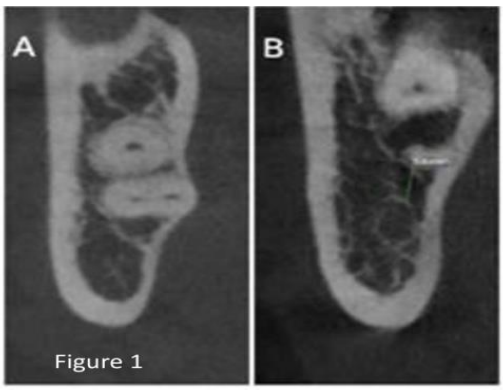

Figure 1: A) Contact between Roots and IAC B) Distances between Roots and IAC.

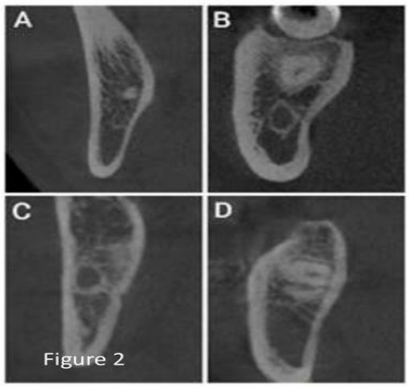

Figure 2: Shapes of IAC A) Dumbbell shape B) Oval shape C) Round shape D) Teardrop shape.

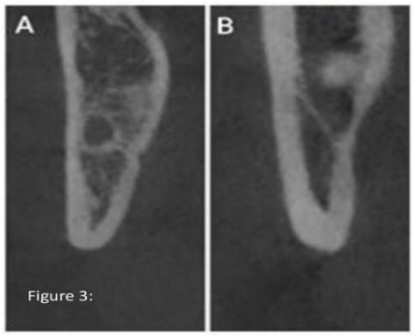

Figure 3: Cortication of IAC A) Cortication of IAC is Present B) Cortication of IAC is Absent.

STATISTICAL ANALYSIS: Data was collected using a structured proforma and entered into an MS Excel sheet for analysis with Statistical Package for the Social Sciences (SPSS: an IBM company, version 24.0, Armonk, NY, USA). The association between qualitative variables was examined using the Chi-square test or Fisher's exact test. Descriptive statistics for each variable were presented as mean, standard deviation, and standard error of the mean. A *p* value of less than 0.05 was considered statistically significant, while a *p* value of more than 0.05 was considered statistically insignificant.

RESULTS:

Out of 76 cases, the age distribution is as follows: 40.8% are between 20-30 years, 26.3% are between 31-40 years, 15.8% are between 41-50 years, 11.8% are between 51-60 years, and 5.3% are between 61-70 years. Out of 76 cases, 69.7% are males and 30.3% are females.

Mean contact between the IAC and root in various age groups was as follows: 1.68 ± 0.48 in the 20-30 years group, 1.80 ± 0.41 in the 31-40 years group, 1.83 ± 0.39 in the 41-50 years group, 2.00 ± 0.00 in the 51-60 years group, and 1.75 ± 0.50 in the 61-70 years group. Upon comparing the mean contact between the IAC and root across these age groups, it was found that the differences in mean distances were not statistically significant ($p > 0.05$).

(Table 1)

Table 1: Mean contact between the IAC and root in various age group.

		N	Mean	Std. Deviation	F	p	Inference
Contact between	20-30	31	1.68	0.48	1.155	0.337(>0.05)	Not significant

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IAC and root	31-40	20	1.8	0.41			
	41-50	12	1.83	0.39			
	51-60	9	2	0			
	61-70	4	1.75	0.5			
	Total	76	1.78	0.42			

Mean contact between the IAC and root was 1.85 ± 0.36 in males and 1.61 ± 0.50 in females. A comparison of the mean contact between the IAC and root for males and females revealed that this difference was statistically significant ($p < 0.05$). This indicates that the mean contact between the IAC and root was significantly higher in males compared to females. (Table 2)

Table 2: Mean contact between the IAC and root by gender.

		N	Mean	Std. Deviation	t	p	Inference
Contact between IAC and root	Male	53	1.85	0.36	2.364	0.021	Significant

Mean Distances of IAC and root in various age groups was as follows: 2.84±2.01 in the 20-30 years group, 3.10±2.23 in the 31-40 years group, 3.83±1.76 in the 41-50 years group, 4.54±1.76 in the 51-60 years group, 6.83±2.37 in the 61-70 years group. Upon analysing the mean distances across these age categories, we identified a statistically significant discrepancy ($p<0.05$) concerning age groups. [Table 3]

Table 3: Mean Distances of IAC and root in various age groups.

		N	Mean	Std. Deviation	F	p	Inference
Distances of IAC and root	20-30	21	2.84	2.01	3.429	0.014(<0.05)	Significant
	31-40	16	3.1	2.23			
	41-50	10	3.83	1.76			
	51-60	9	4.54	1.76			
	61-70	3	6.83	2.37			
	Total	59	3.54	2.18			

The mean distance of the IAC and root was found to be significantly greater in males (3.92 ± 2.24) compared to females (2.32 ± 1.43), as shown in Table 4. This difference was statistically significant ($p < 0.05$), indicating that gender plays a role in the distance between the IAC and root.

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Table 4: Mean distance of IAC and root by gender.

		N	Mean	Std. Deviation	t	p	Inference
Distances of IAC and root	Male	45	3.92	2.24	2.508	0.015	Significant
	Female	14	2.32	1.43		(<0.05)	

Table 5 shows the distribution of IAC positions across different age groups. While the 20-30 age group had the highest proportion of both buccally (42.1%) and lingually (50%) placed IACs, the most common position for the 31-40 age group was inferior (33.3%). However, these differences were not statistically significant ($p > 0.05$), suggesting that age does not have a significant impact on the position of the IAC.

Table 5: Distribution of IAC positions across age groups.

		Position of IAC						Total	p
		Buccal		Inferior		Lingually			
		No	%	No	%	No	%		
Age group	20-30	16	42.1	5	27.8	10	50	31	0.34, NS
	31-40	10	26.3	6	33.3	4	20	20	
	41-50	6	15.8	4	22.2	2	10	12	
	51-60	5	13.2	3	16.7	1	5	9	
	61-70	1	2.6	0	0	3	15	4	
	Total	38	100	18	100	20	100	76	

Table 6 reveals the distribution of IAC positions by gender. The p-value for the differences in positions of IAC between genders is 0.45, indicating no statistically significant difference (NS) in the distribution of IAC positions (Buccal, Inferior, Lingual) between males and females. Both genders exhibit similar patterns of IAC positioning, with males showing a slightly higher percentage in each position.

Table 6: Distribution of IAC Positions by genders.

		Position of IAC						Total	p
		Buccal		Inferior		Lingually			
		No	%	No	%	No	%		
Gender	Male	24	63.2	14	77.8	15	75	53	0.45
	Female	14	36.8	4	22.2	5	25	23	NS
	Total	38	100	18	100	20	100	76	

Table 7 presents the distribution of different shapes of the IAC across various age groups among 76 individuals. The distribution of IAC shapes (Dumbbell, Oval, Round, Tear drop) does not significantly differ among the various age groups. While certain shapes are more prevalent in specific age groups, such as oval and round shapes being more common in younger age groups (20-30 years), these differences are not statistically significant.

Table 7: Distribution of shapes of IAC across age groups.

	Shape of IAC								Total	p
	Dumbbell		Oval		Round		Tear drop			
	No	%	No	%	No	%	No	%		

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Age group	20-30	0	0	13	44.8	16	37.2	2	66.7	31	0.449
	31-40	1	100	7	24.1	12	27.9	0	0	20	
	41-50	0	0	5	17.2	7	16.3	0	0	12	
	51-60	0	0	2	6.9	7	16.3	0	0	9	
	61-70	0	0	2	6.9	1	2.3	1	33.3	4	
	Total	1	100	29	100	43	100	3	100	76	

Table 8 shows the distribution of different shapes of the IAC by gender among 76 individuals. The distribution of IAC shapes (Dumbbell, Oval, Round, Tear Drop) does not significantly differ between males and females. While males have a slightly higher percentage in most shapes, these differences are not statistically significant.

Table 8: Distribution of shapes of the IAC by gender.

		Shape of IAC								**Total**	**p**
		Dumbbell		**Oval**		**Round**		**Tear drop**			
		No	**%**	**No**	**%**	**No**	**%**	**No**	**%**		
Gender	Male	1	100	18	62.1	31	72.1	3	100	53	0.448
	Female	0	0	11	37.9	12	27.9	0	0	23	
	Total	1	100	29	100	43	100	3	100	76	

Table 9 reveals the mean and standard deviation of cortication values across different age groups. The p-value of 0.67 indicates that there is no statistically significant difference in cortication values among the age groups. The mean cortication values are similar across age groups, indicating that age does not significantly impact cortication value sample

Table 9: Mean and standard deviation of cortication values across different age groups.

		N	**Mean**	**Std. Deviation**	**F**	**p**	**Inference**
Cortication	20-30	31	1.16	0.37	0.578	0.67(>0.05)	Not significant
	31-40	20	1.15	0.37			
	41-50	12	1.17	0.39			
	51-60	9	1	0			
	61-70	4	1	0			
	Total	76	1.13	0.34			

Table 10 presents the mean and standard deviation of cortication values by gender among 76 individuals. The mean cortication of IAC was 1.17±0.38 in males and 1.04±0.21 in females. No statistically significant difference was observed between males and females. Therefore, gender does not significantly impact cortication values in this sample.

Table 10: Mean and standard deviation of cortication values by gender.

		N	**Mean**	**Std. Deviation**	**t**	**p**	**Inference**
Cortication	Male	53	1.17	0.38	1.499	0.138 (>0.05)	Not significant
	Female	23	1.04	0.21			

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DISCUSSION:

Inferior alveolar nerve (IAN) damage and subsequent neurosensory disturbances following the extraction of impacted lower third molars are rare but serious complications, often leading to functional impairments and a reduced quality of life. For oral surgeons, preoperative risk assessment is essential to avoid or prevent IAN injury during third molar extraction. Some studies suggest that iatrogenic injury to the lingual nerve can occur during third molar surgery due to its close anatomical proximity to the cortical region of the molar, separated only by the periosteum. Detailed knowledge of this proximity can aid in determining whether and how to remove an asymptomatic third molar. [2,3]

In our study of 76 CBCT scans, we observed significant variations in the distances between the IAC and tooth roots across different age and gender groups, with p-values less than 0.05. Additionally, significant variations were noted in the contact between the IAC and roots across these groups ($p < 0.05$). However, other parameters showed no significant differences in the relationship between the IAC and roots when comparing different age and gender groups ($p > 0.05$).

These findings are consistent with previous studies. Chaudhary B et al. conducted a study on the relationship between the lower third molar and the mandibular canal. Their results revealed that most mandibular third molars had direct contact with the mandibular canal. This is similar to the findings of the present study. However, unlike their study, the majority of lingually placed mandibular third molars in the present study did not have contact with the mandibular canal. [6] Guang-Zhou Xu et al. reported that, in most cases, the IAC was positioned buccally, which is consistent with the findings of the present study. [7]

Similarly, in a study by Dongmiao Wang et al., the radiographic relationship between impacted third molars and the IAC was assessed in 136 cases. The results revealed that the majority of cases had a buccally positioned IAC with a round shape, which is also consistent with the present study. However, unlike the current study, direct contact between the root and the IAC, as well as cortication of the IAC, were not observed in most of Wang et al.'s cases.[8]

Similarly, a study by Nunes WJP et al. found that 11 of the 148 impacted mandibular third molars showed no signs on panoramic radiographs suggesting proximity to the mandibular canal. In contrast, the present study revealed different findings.[9] Yun Yang et al. noted that CBCT provides a more accurate assessment, enhancing the understanding of IMTM extractions and reducing the risk of nerve injury during procedures.[10]

A study by Santos KK, based on the Pell & Gregory and Winter classifications, reported that positions II and III favoured tooth impaction, resulting in 79.6% of mandibular third molars being impacted. In contrast, the present study identified different positions, including buccal, lingual, and inferior placements, which differ from Santos KK's findings.[11]

Some previous studies have suggested that CBCT images of impacted third molars and the IAC may indicate a risk of IAN injury.[12] However, a comprehensive understanding of the etiology, clinical anatomy, radiological examination, surgical treatment, and potential complications of impacted mandibular third molars, along with the development of new classification systems for impaction and extraction difficulty based on anatomical and radiological findings, is essential. These tools assist in evaluating impacted teeth and planning surgical procedures, thereby minimizing the risk to the IAC. [13]

LIMITATIONS:

The retrospective study design, coupled with inherent limitations of CBCT imaging—such as the potential for artifacts and concerns over radiation exposure—could impact the accuracy and reliability of the findings. The sample size of 76 CBCT images may not adequately represent the broader population, and the absence of control for variables such as ethnicity may have influenced the results. Additionally, being conducted at a single center, the findings may lack generalizability to other populations or clinical settings.

FUTURE SCOPE:

Future studies should involve larger, more diverse samples, multi-center collaboration, and prospective designs with clinical follow-up to validate and build upon these findings.

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CONCLUSION:

The findings from the study revealed that majority of the cases showed a buccally positioned IAC, with significant variations observed across different age groups and genders. The mean contact distance between the IAC and the third molar root varied slightly across age groups, with no significant differences. However, the mean contact was significantly higher in males compared to females. The IAC shape was predominantly round, followed by oval, with no significant differences across age groups or genders. Cortication of the IAC did not show significant variation across age groups or between genders. Statistically significant differences were noted in the distances between the IAC and root across different age groups and genders, with males showing greater distances than females. These results highlight the need to take into account individual anatomical variations when planning surgical extractions of impacted mandibular third molars to reduce the risk of injury to the inferior alveolar nerve.

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