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Mandibular canal and it's relation with third molars: A CBCT assessment

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Abstract:
CBCT offers superior three-dimensional assessment of the mandibular canal-third molar relationship over conventional radiography. Sixty-five CBCT scans were evaluated using validated classification systems for vertical, horizontal and canal-variant relationships. No contact (Category A) was most common (61.5%), while apical and buccal canal positions were equally distributed (36.9% each). No accessory canals or gender-based differences were found ($p>0.05$). CBCT reliably stratifies surgical risk into low (61.5%), moderate (24.6%) and high (13.8%) categories, supporting its routine pre-operative use.

Keywords: Mandibular canal, impacted third molar, bifid mandibular canal

Background:
The mandibular canal traverses the mandibular body bilaterally, housing the inferior alveolar neurovascular bundle **[1].** The inferior alveolar nerve, a branch of the mandibular division of the trigeminal nerve, provides sensory innervation to the mandibular teeth, periodontal tissues, labial mucosa, chin and lower lip **[2, 3]**. The anatomical relationship between the mandibular canal and mandibular third molar roots is of significant clinical relevance **[4]**. The reported incidence of inferior alveolar nerve injury following third molar surgery ranges from less than 1% to 8% for temporary sensory disturbance **[5]**, with permanent deficit in approximately 0.5–2% of cases **[6].** CBCT provides three-dimensional information not obtainable from conventional radiography, enabling precise determination of the buccolingual position of the mandibular canal relative to tooth roots, accurate distance measurement, visualization of direct contact or root perforation and identification of anatomical variations including bifid or accessory canals **[8, 9].** Therefore, it is of interest to describe the use of CBCT in evaluation of mandibular canal and its relation with the mandibular third molars.

Materials and Methods:
This cross-sectional study was conducted at the Department of Oral Medicine and Radiology, NIMS Dental College and Hospital, Jaipur, over 14–18 months. Institutional ethics committee approval was obtained and informed consent was secured from all participants. A total of 65 CBCT scans were included after applying the selection criteria. CBCT scans were acquired using an Ez3D-i scanner at 85 kVp, 8 mA, with a 5×5 cm field of view and 1.0 mm cross-sectional interval. Patients were positioned upright with maximal intercuspation, relaxed lips and the Frankfort plane parallel to the floor. Cross-sectional and panoramic reformats were generated for analysis.

Three validated classification systems were applied:

[1] Vertical Relationship (Chaudhary *et al.* 2020): Category A – no contact; Category B – contact with intact cortical line; Category C – contact with defective cortical line; Category D – canal penetration **[7]**.

[2] Horizontal Position (Mehdizadeh *et al.* 2015): Type I – apical; Type II – buccal; Type III – lingual; Type IV – interradicular **[12].**

[3] Canal Variations (Naitoh *et al.* 2009): Types 1–5 representing retromolar, dental, forward, buccolingual and trifid canal configurations **[1].**

Ethical considerations:
The study was conducted in accordance with the Declaration of Helsinki (2013 revision). Approval was obtained from the Institutional Ethics Committee of NIMS University Rajasthan, Jaipur (Proposal number: IEC/P-554/2024). Written informed consent was obtained from all participants before enrolment.

Statistical analysis:
Statistical analysis was performed using Pearson chi-square and Fisher–Freeman–Halton exact tests. A p-value >0.05 was considered statistically non-significant.

Results:
A total of 65 subjects were included (44 males, 67.7%; 21 females, 32.3%). The mean age was 27.40 ± 7.86 years (range: 19–65 years), with a male-to-female ratio of approximately 2.1:1 (**Table 1**). Category A (no contact) (**Figure 4**) was the most prevalent vertical relationship, observed in 61.5% of cases (40/65), with a higher prevalence in males (68.2%) than females (47.6%). Combined Category B (**Figure 5**), Category C (**Figure 6**) and Category D (**Figure 7**) accounted for 38.5% of cases (25/65) (**Table 2**). Horizontal positioning showed equal distribution between apical (Type I, 36.9%) (**Figure 1**) and buccal (Type II, 36.9%) (**Figure 2**) positions. Lingual positioning (Type III) (**Figure 3**) was observed in 26.2% of cases. No interradicular positioning (Type IV) was identified in either gender group (**Table 2**). No accessory mandibular canal types were identified in either gender. All 65 subjects exhibited a single, standard canal configuration.

Table 1: Demographic characteristics of the study population (N = 65)

Variable	Male	Female	Total
Gender n (%)	44 (67.7%)	21 (32.3%)	65 (100%)
Age (M ± SD) years	26.66 ± 8.64	28.95 ± 5.80	27.40 ± 7.86
Age Range (years)	19 – 65	19 – 65	19 – 65

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Table 2: Association between gender and CBCT-based mandibular canal characteristics

Classification	Category/Type	Male n (%)	Female n (%)	Total n (%)	p-value
Chaudhary *et al.* **(2020) [7]**					
	Category A (No contact)	30 (68.2%)	10 (47.6%)	40 (61.5%)	0.111[a]
	Category B (Contact, intact line)	8 (18.2%)	8 (38.1%)	16 (24.6%)	0.081[a]
	Category C (Contact, defective line)	3 (6.8%)	3 (14.3%)	6 (9.2%)	0.331[b]
	Category D (Canal penetration)	3 (6.8%)	0 (0%)	3 (4.6%)	0.545[b]
Mehdizadeh *et al.* **(2015) [12]**					
	Type I (Apical)	15 (34.1%)	9 (42.9%)	24 (36.9%)	0.493[a]
	Type II (Buccal)	19 (43.2%)	5 (23.8%)	24 (36.9%)	0.130[a]
	Type III (Lingual)	10 (22.7%)	7 (33.3%)	17 (26.2%)	0.363[a]
	Type IV (Interradicular)	0 (0%)	0 (0%)	0 (0%)	NA
Naitoh *et al.* **(2009) [1]**					
	Accessory canal types (1–5)	0 (0%)	0 (0%)	0 (0%)	NA

[a]Pearson Chi-square test; [b]Fisher–Freeman–Halton exact test; NA – not applicable (constant variable)

Figure 1: Horizontal position type I – apical position of mandibular canal

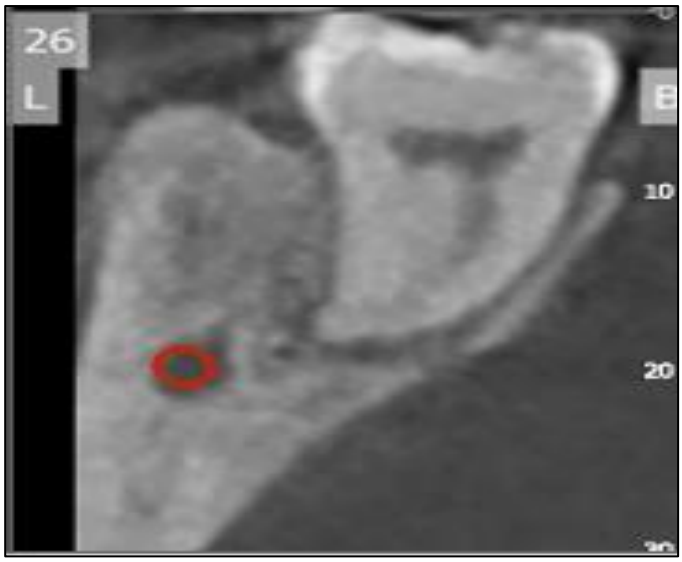

Figure 3: Horizontal position type III – lingual position of mandibular canal

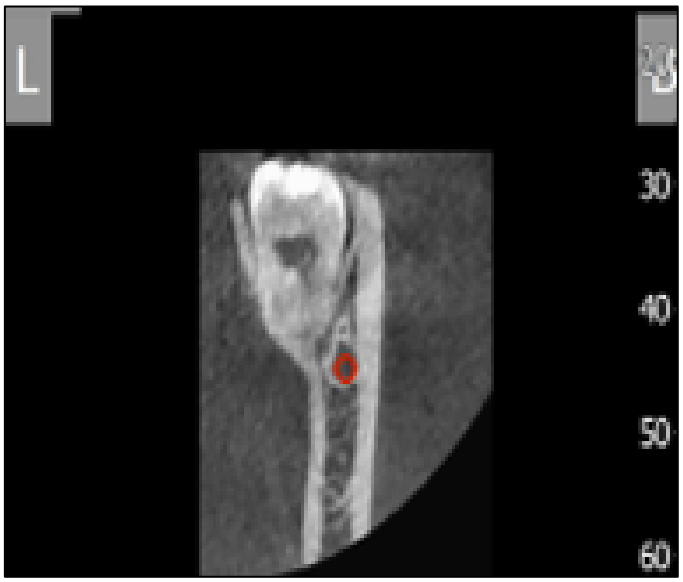

Figure 2: Horizontal position type II – buccal position of mandibular canal

Figure 4: Vertical relationship category A - no contact (mandibular canal and mandibular third molar)

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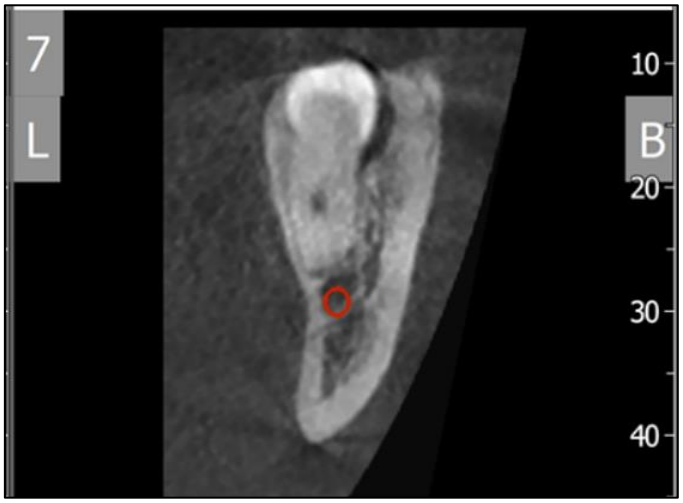

Figure 5: Vertical relationship category B - contact with intact cortical line (mandibular canal and mandibular third molar)

Figure 6: Vertical relationship category C- contact with defective cortical line (mandibular canal and mandibular third molar)

Figure 7: Vertical relationship category D - canal penetration

Discussion:

The present study evaluated the mandibular canal–third molar relationship in 65 subjects (mean age 27.40 ± 7.86 years), with male predominance (67.7%) **(Table 1)**, consistent with reported higher evaluation and extraction rates in males **[3, 13].** Category A (no contact) **(Figure 4)** was observed in 61.5% of cases using the Chaudhary *et al.* classification **(Table 2) [7].** This is broadly comparable to Nakagawa *et al.* who reported direct contact in 23.6% of cases, **[14]** and Kuribayashi *et al.* who identified contact in approximately 35% of cases **[11].** Apical (Type I) **(Figure 1)** and buccal (Type II) **(Figure 2)** canal positions were equally distributed (36.9% each) **(Table 2)**, with lingual positioning (Type III) **(Figure 3)** in 26.2% **(Table 2) [12].** Buccal canal positioning has been shown to facilitate safer surgical access **[9, 15].** The absence of interradicular (Type IV) **(Table 2)** positioning in this cohort contrasts with findings of Tantanapornkul *et al.* and Xu *et al.* who documented this variant at low prevalence **[16, 17].** The complete absence of bifid or trifid mandibular canals in this study contrasts with the reported prevalence range of 0.95% to 65% across populations **[10].** This may reflect population-specific anatomical variation and warrants investigation in larger, multicentric cohorts.

Conclusion:

The majority of cases showed no direct contact between the mandibular canal and the third molar (61.5%). Apical and buccal horizontal positions predominated equally, with lingual positioning less frequent; interradicular positioning was absent. CBCT enables accurate pre-operative risk stratification and surgical planning, reducing the risk of inferior alveolar nerve injury.

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