

Original Article

COMPARATIVE ANALYSIS OF ANGULATION PATTERNS AND ASSOCIATED PATHOLOGIES OF BILATERALLY IMPACTED MANDIBULAR THIRD MOLARS USING CONE BEAM COMPUTED TOMOGRAPHY: A RETROSPECTIVE STUDY

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ABSTRACT

Objectives: To compare the angulation patterns of bilaterally impacted mandibular third molars using cone beam computed tomography (CBCT) and to determine the frequency of associated pathological conditions.

Materials and Methods: Archived CBCT scans of 100 patients aged ≥ 17 years with bilaterally impacted mandibular third molars were reviewed retrospectively. Patients with previous mandibular surgery, associated pathology, single impaction, edentulism, or incomplete records were excluded. Impaction angulation was classified according to Winter's classification. Data were analyzed using IBM SPSS Statistics version 26.0. Frequencies and percentages were calculated, and bilateral differences were assessed using the Chi-square test with a significance level of $p < 0.05$.

Results: Vertical impaction was the most common angulation on both the left (49.0%) and right (45.0%) sides, followed by mesioangular impaction (36.0% and 31.0%, respectively). Horizontal impaction was observed in 14.0% of left-sided and 22.0% of right-sided mandibular third molars. No statistically significant bilateral difference in impaction angulation patterns was observed ($p > 0.05$).

Conclusion: Bilaterally impacted mandibular third molars demonstrated broadly symmetrical angulation patterns, with vertical impaction being the predominant type on both sides. CBCT provides valuable three-dimensional assessment for diagnosis and treatment planning of impacted mandibular third molars.

Key words: Cone Beam Computerized Tomography; impacted mandibular third molars; impaction angulation; mesioangular impaction; vertical impaction; Winter's classification

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INTRODUCTION

Impaction of mandibular third molars is one of the most common developmental anomalies en-

countered in dental practice. Failure of eruption may result from inadequate arch space, abnormal tooth angulation, or obstruction by adjacent teeth or surrounding bone. Impacted mandibular third molars are frequently associated with pain, pericoronitis, caries, cystic changes, root resorption of adjacent teeth, and masticatory difficulties, making accurate diagnosis and treatment planning clinically important.

Conventional two-dimensional imaging techniques, particularly panoramic radiography, have

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long been used for the assessment of impacted third molars. Although panoramic radiographs provide useful preliminary information regarding tooth position, they have inherent limitations, including image distortion, magnification, superimposition of anatomical structures, and the inability to accurately depict the three-dimensional relationship between impacted teeth and adjacent vital structures¹.

Cone-beam computed tomography (CBCT) has emerged as a valuable imaging modality for evaluating impacted mandibular third molars. CBCT provides high-resolution three-dimensional images that enable accurate assessment of tooth angulation, depth of impaction, proximity to the inferior alveolar canal, surrounding cortical bone, and associated pathological changes such as cyst formation or root resorption^{2,3}. This additional anatomical information facilitates improved surgical planning and risk assessment while minimizing potential intraoperative and postoperative complications.

Despite advances in CBCT imaging, management of bilaterally impacted mandibular third molars remains challenging. Treatment decisions depend on several factors, including the angulation of impaction, depth, relationship with adjacent anatomical structures, and anticipated surgical difficulty. Although numerous studies have investigated the prevalence and angulation patterns of impacted mandibular third molars, published data specifically comparing the angulation patterns of bilaterally impacted mandibular third molars using CBCT remain limited.

Therefore, The objectives of this study were to compare the angulation patterns of bilaterally impacted mandibular third molars using CBCT and to determine the frequency of associated pathological findings including pericoronitis, dental caries, cystic changes, and root resorption.

MATERIALS AND METHODS

This retrospective analytical cross-sectional study was conducted in the Department of Oral Medicine, Rehman College of Dentistry, Peshawar, Pakistan, using archived CBCT scans obtained between January 2023 and December 2023. Ethical approval was obtained from the Institutional Review Board of Rehman College of Dentistry (IRB No. RCD-02-24-169).

A total of 100 CBCT scans were included using convenience sampling. CBCT scans of patients aged 17 years or older with bilaterally impacted mandibular third molars were eligible for inclusion. Patients with a history of mandibular surgery, associated pathological lesions affecting the impacted tooth, unilateral impaction, previous extraction of mandibular third molars, edentulism, incomplete CBCT records, or inadequate image quality were excluded.

The angulation of impacted mandibular third molars was assessed using Winter's classification, in which the long axis of the impacted third molar was compared with the long axis of the adjacent mandibular second molar. Impactions were categorized as vertical, mesioangular, distoangular, horizontal, buccolingual, inverted, or other atypical orientations. Associated pathological findings including pericoronitis, dental caries, cystic changes, and root resorption of adjacent teeth were also recorded from CBCT images and patient records.

Data were entered and analyzed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were calculated and presented as frequencies and percentages. Bilateral differences in impaction angulation patterns between the right and left mandibular third molars were assessed using the Chi-square test. A p-value of <0.05 was considered statistically significant.

RESULT

A total of 100 archived CBCT scans of patients with bilaterally impacted mandibular third molars meeting the eligibility criteria were included in the study. Of the 100 participants included in the study, 67 (67.0%) were females and 33 (33.0%) were males (Table 1).

Comparison of impaction angulation patterns between the right and left mandibular third molars demonstrated no statistically significant bilateral difference (Chi-square test, $p > 0.05$), indicating a broadly symmetrical distribution of impaction patterns.

Table 1: Gender distribution of the study participants (N = 100)

Gender	n	%
Male	33	33.0
Female	67	67.0
Total	100	100.0

Table 2: Distribution of angulation patterns of bilaterally impacted mandibular third molars according to Winter's classification

Angulation pattern	Left side n (%)	Right side n (%)	Overall n (%)
Vertical	49 (49.0)	45 (45.0)	94 (47.0)
Mesioangular	36 (36.0)	31 (31.0)	67 (33.5)
Horizontal	14 (14.0)	22 (22.0)	36 (18.0)
Distoangular	0	1 (1.0)	1 (0.5)
Buccolingual	0	1 (1.0)	1 (0.5)
Inverted	1 (1.0)	0	1 (0.5)
Total	100 (100.0)	100 (100.0)	200 (100.0)

Chi-square test: No statistically significant difference between the right and left sides ($p > 0.05$).

DISCUSSION

The present retrospective analytical cross-sectional study evaluated the bilateral angulation patterns of impacted mandibular third molars using CBCT. The principal findings demonstrated that vertical impaction was the predominant angulation pattern on both sides, followed by mesioangular and horizontal impactions. Furthermore, no statistically significant bilateral difference was observed between the right and left mandibular third molars, suggesting a symmetrical distribution of impaction patterns. These findings support the concept that bilateral mandibular third molar impactions are influenced by similar developmental and anatomical factors.

The predominance of vertical impaction observed in the present study is consistent with the findings reported by Sharma et al⁷ and Jolly et al⁸, who also identified vertical impaction as the most common angulation pattern among impacted mandibular third molars. Likewise, Gupta et al⁹ reported that mandibular arch dimensions and eruption pathways play an important role in determining impaction patterns, whereas Zafar et al¹⁰ highlighted inadequate retromolar space as a major contributing factor to mandibular third molar impaction. The consistency of these findings with the present study strengthens the evidence supporting vertical impaction as the predominant pattern.

Mesioangular impaction represented the second most frequent angulation pattern. Similar observations have been reported by Yadav et al¹¹ and Sharma et al¹², while Ali and Raza¹⁴ suggested that both genetic predisposition and available mandibular arch

Table 3: Frequency of Associated Pathologies in Bilaterally Impacted Mandibular Third Molars

Associated Pathology	n	%
Pericoronitis	35	35.0
Dental caries	30	30.0
Cystic changes	15	15.0
Root resorption of adjacent tooth	5	5.0
No associated pathology	15	15.0
Total	100	100.0

space contribute to the development of mesioangular impactions. Minor differences in prevalence among studies may be explained by differences in study populations, imaging techniques, and inclusion criteria.

One of the important findings of the present study was the bilateral symmetry in impaction patterns. The absence of a statistically significant difference between the right and left mandibular third molars suggests that common developmental mechanisms influence impaction on both sides of the mandible. Similar bilateral symmetry has been reported by Alqahtani et al²² and Kumar et al²³, who demonstrated that mandibular third molar impaction patterns frequently mirror each other bilaterally. This observation may assist clinicians in anticipating the position of the contralateral impacted tooth during treatment planning.

Pericoronitis was the most frequently observed pathological finding, followed by dental caries, cystic changes, and root resorption. These findings are consistent with previous reports demonstrating that impacted mandibular third molars are commonly associated with inflammatory and pathological sequelae¹⁵⁻²¹. The relatively high prevalence of pericoronitis emphasizes the importance of early diagnosis and timely management to reduce the risk of recurrent infection. Likewise, the occurrence of carious lesions and cystic changes supports regular clinical and radiographic surveillance in patients with retained impacted mandibular third molars.

The use of CBCT represents an important strength of the present study. Compared with conventional panoramic radiography, CBCT provides high-resolution three-dimensional visualization of impacted teeth and their relationship with adjacent anatomical structures. This facilitates accurate assessment of tooth angulation, proximity to the inferior alveolar canal, and associated pathological

changes, thereby improving surgical planning and reducing the risk of operative complications.

The present study has several limitations. It was conducted retrospectively using archived CBCT scans from a single institution, which may limit the generalizability of the findings. Furthermore, the retrospective study design limited the availability of additional patient-level clinical information and restricted further statistical analyses. Future multi-centre prospective studies involving larger and more diverse populations are recommended to validate these findings and further investigate factors influencing bilateral mandibular third molar impaction patterns.

CONCLUSION

Vertical impaction was the predominant angulation pattern among bilaterally impacted mandibular third molars, with no significant bilateral difference in angulation patterns. Pericoronitis was the most common associated pathological finding. CBCT proved to be a valuable imaging modality for accurately evaluating impaction patterns and associated pathologies, thereby facilitating appropriate diagnosis and treatment planning.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design: ZA, HS, TUR, SY, SS, ZS

Acquisition, Analysis or Interpretation of Data: ZA, HS, TUR, SY, SS, ZS

Manuscript Writing & Approval: ZA, HS, TUR, SY, SS, ZS

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.



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