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Association of Depth of Impacted Maxillary Third Molar with the Prevalence of Radiolucencies and Pathologies Associated with the Adjacent Maxillary Second Molar with Respect to Gender

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ABSTRACT

Background: Impaction of maxillary third molars is a common clinical finding that can lead to various pathological changes in adjacent teeth, including periapical and pericoronal radiolucencies, distal dental caries, and external root resorption in the adjacent maxillary second molar. Factors such as the depth of impaction and patient gender may influence the prevalence and severity of these pathologies, but evidence remains inconclusive. Objective: To assess the association between the depth of impacted maxillary third molars and the prevalence of radiolucencies and pathologies in the adjacent maxillary second molar, with a focus on gender differences. Methods: A retrospective cross-sectional study was conducted on 235 orthopantomograms of patients aged 21 years and above presenting with impacted maxillary third molars. The depth of impaction was classified according to the Pell and Gregory system. The presence of periapical and pericoronal radiolucencies, distal dental caries, and external root resorption in adjacent second molars was evaluated. Data were analyzed using SPSS version 24.0, and associations were tested using Fisher's exact test, with a significance level set at $p \leq 0.05$. Results: Among the study population, 71.5% of third molars were classified as Class C impactions and 28.5% as Class B. No statistically significant association was observed between impaction depth and any of the assessed pathologies in either males or females ($p > 0.05$). However, periapical radiolucencies were more frequent in Class C impactions (67% in males, 78.9% in females), while external root resorption and distal caries were slightly more prevalent in Class B impactions among males. In females, all pathologies were predominantly associated with Class C impactions. Conclusion: Although no statistically significant relationship was identified, deeper impactions (Class C) demonstrated a greater tendency to be associated with pathological changes in adjacent second molars, particularly among females. These findings suggest that impaction depth remains a clinically relevant factor, and careful radiographic evaluation and timely intervention are recommended to prevent potential complications.

Keywords
Maxillary third molars, impaction depth, periapical radiolucencies, pericoronal radiolucencies, external root resorption, dental caries, gender differences

INTRODUCTION

Impaction of third molars is a common dental anomaly and a frequent topic of clinical and academic discussion. While mandibular third molar impactions are more extensively studied due to their higher prevalence and surgical complexity, maxillary third molar impactions also occur frequently and pose significant oral health challenges (1,2). Their presence can lead to a range of pathological conditions affecting both the impacted tooth and adjacent structures, particularly the maxillary second molar (3). These include pericoronal and periapical radiolucencies, external root resorption, and distal dental caries — all of which can compromise tooth vitality, function, and longevity (4,5).

The depth and angulation of impaction are critical determinants of these associated pathologies. Deeper impactions exert greater pressure on the adjacent second molar roots, contributing to external resorption, while anatomical positioning may facilitate plaque retention and subsequent caries development (6,7). Pericoronal radiolucencies, often indicative of dentigerous cyst formation, are also commonly observed around impacted third molars and can extend to involve the second molar (8). Although radiographic detection of such lesions is essential for diagnosis, histopathological confirmation remains the gold standard for definitive assessment (9).

Previous studies have highlighted that the extent and type of pathology associated with impacted third molars vary widely depending on anatomical and positional factors, including depth, angulation, and proximity to adjacent teeth (10,11). Mesioangular impactions and those classified as deeper

(such as Pell and Gregory Class C) have been consistently associated with more severe pathological changes, including root resorption and periapical alterations (12). However, much of the existing literature has focused on mandibular molars, leaving a relative gap in understanding the specific patterns and clinical consequences associated with maxillary third molar impactions.

Gender-related variations have also been explored, with evidence suggesting differences in eruption patterns, jaw dimensions, and impaction prevalence between males and females (13,14). While some studies propose that gender may influence the likelihood of impaction and the type of pathology observed, others argue that it does not independently affect the risk of radiolucencies, root resorption, or caries (15,16). These inconsistencies highlight the need for more focused investigations exploring the potential interplay between gender, impaction depth, and the occurrence of secondary pathologies.

Given these gaps, a clearer understanding of how the depth of maxillary third molar impaction relates to pathological changes in the adjacent second molar — and whether these relationships differ by gender — is essential for improving clinical decision-making, diagnostic protocols, and preventive strategies. Therefore, the present study aimed to investigate the association between the depth of impacted maxillary third molars and the prevalence of periapical and pericoronal radiolucencies, dental caries, and external root resorption in the adjacent maxillary second molars, with a specific focus on gender differences.

MATERIALS AND METHODS

This retrospective cross-sectional study was conducted at the Department of Oral and Maxillofacial Radiology, Sharif Medical City, Lahore, Pakistan, from August 2024 to August 2025. Ethical approval was obtained from the institutional ethics committee (Ref. No. SMDC/SMRC/147-20), and all procedures adhered to the principles of the Declaration of Helsinki. The study was designed to evaluate the association between the depth of impacted maxillary third molars and the prevalence of radiolucencies and pathologies in the adjacent maxillary second molars, with a focus on gender-related differences. The sample size was calculated using a 95% confidence interval, 5% margin of error, and an expected prevalence of impacted third molars of 18.8% based on previous literature (15). The minimum required sample size was determined to be 235 panoramic radiographs (orthopantomograms, OPGs).

Digital panoramic radiographs of 235 patients aged 21 years and above, each presenting with at least one impacted maxillary third molar and an adjacent second molar, were retrospectively retrieved from institutional records for analysis. Patients were included if they exhibited at least one impacted maxillary third molar, had the adjacent maxillary second molar present with no history of extraction or extensive restorative treatment, and possessed high-quality panoramic radiographs suitable for diagnostic interpretation. Patients were excluded if the adjacent second molars were grossly carious, previously extracted, or congenitally missing. Additionally, cases were excluded if the third molars exhibited pathological lesions that obscured anatomical landmarks or if patients had systemic conditions known to affect bone metabolism or tooth eruption, such as endocrine disorders.

All radiographs were independently evaluated by two calibrated oral radiologists, each with more than five years of clinical experience. Inter-examiner reliability was assessed using Cohen's kappa coefficient ($\kappa > 0.85$), which indicated substantial agreement. Any discrepancies in interpretation were resolved through consensus discussion. The depth of impaction of maxillary third molars was classified according to the Pell and Gregory system, modified for application in maxillary cases. In this classification, Class A impactions were defined as those in which the highest portion of the impacted tooth was level with or above the occlusal plane of the adjacent second molar. Class B impactions were defined as those in which the highest portion of the impacted tooth lay between the occlusal plane and the cervical line of the second molar. Class C impactions were defined as those in which the highest portion of the impacted tooth was located below the cervical line of the second molar.

The radiographic assessment focused on identifying pathological changes affecting the adjacent maxillary second molar in the presence of an impacted third molar. The outcomes recorded included periapical radiolucencies, which were considered indicative of apical periodontitis or other inflammatory processes; pericoronal radiolucencies, which suggested the presence of dentigerous cysts or other follicular pathologies; distal dental caries, defined as carious lesions located on the distal surface of the second molar; and external root resorption, characterized by radiographic evidence of apical or lateral root surface loss resulting from mechanical pressure exerted by the impacted third molar.

Demographic data, including age and gender, were recorded alongside radiographic findings. All data were entered into SPSS version 24.0 (IBM Corp., Armonk, NY, USA) for analysis. Descriptive statistics were calculated as means and standard deviations for continuous variables and frequencies and percentages for categorical variables.

The association between the depth of third molar impaction and the prevalence of each radiographic pathology was assessed separately for male and female patients using Fisher's exact test, given the small expected cell counts for some outcomes. A p-value ≤ 0.05 was considered statistically significant.

RESULTS

A total of 235 digital panoramic radiographs of patients with impacted maxillary third molars were included in the study. The mean age of participants was 32.62 ± 9.93 years, ranging from 21 to 58 years. Of these, 111 (47.2%) were male and 124 (52.8%) were female.

The majority of impacted maxillary third molars were classified as Class C (n = 168, 71.5%), followed by Class B (n = 67, 28.5%). No cases of Class A impaction were identified in the study population.

Table 1 presents the association between the depth of impaction and the prevalence of periapical and pericoronal radiolucencies, distal dental caries, and external root resorption in male patients. Statistical analysis using Fisher's exact test revealed no significant associations between impaction depth and any of the assessed pathologies. Although the results were not statistically significant, notable trends were observed. Periapical radiolucencies were more frequently identified in Class C impactions (67%) compared to Class B. In contrast, external root resorption and distal caries showed a relatively higher prevalence in Class B impactions, with 100% of resorption cases and 66.7% of caries cases occurring at this depth.

However, these findings should be interpreted cautiously due to the small number of events observed in certain categories. Similarly, no statistically significant associations were observed between impaction depth and the evaluated pathologies in female patients (Table 2). Despite the absence of significance, consistent patterns were noted: periapical radiolucencies (78.9%), pericoronal radiolucencies (100%), dental caries (100%), and external root resorption (100%) were predominantly associated with Class C impactions.

Table 1. Association between depth of impacted maxillary third molar and pathologies in adjacent second molar among male patients

Pathology	Class B n (%)	Class C n (%)	Total n (%)	p-value
Periapical radiolucencies – Present	32 (33.0)	65 (67.0)	97 (100)	1.000
Periapical radiolucencies – Absent	5 (35.7)	9 (64.3)	14 (100)	
Dental caries – Present	4 (66.7)	2 (33.3)	6 (100)	0.094
Dental caries – Absent	33 (31.4)	72 (68.6)	105 (100)	
External resorption – Present	2 (100)	0 (0)	2 (100)	0.109
External resorption – Absent	35 (32.1)	74 (67.9)	109 (100)	

Table 2. Association between depth of impacted maxillary third molar and pathologies in adjacent second molar among female patients

Pathology	Class B n (%)	Class C n (%)	Total n (%)	p-value
Periapical radiolucencies – Present	20 (21.1)	75 (78.9)	95 (100)	0.139
Periapical radiolucencies – Absent	10 (34.5)	19 (65.5)	29 (100)	
Pericoronal radiolucencies – Present	0 (0)	1 (100)	1 (100)	1.000
Pericoronal radiolucencies – Absent	30 (24.4)	93 (75.6)	123 (100)	
Dental caries – Present	0 (0)	4 (100)	4 (100)	0.571
Dental caries – Absent	30 (25.0)	90 (75.0)	120 (100)	
External resorption – Present	0 (0)	1 (100)	1 (100)	1.000
External resorption – Absent	30 (24.4)	93 (75.6)	123 (100)	

Overall, the analysis demonstrated that the depth of impacted maxillary third molars was not significantly associated with the presence of periapical or pericoronal radiolucencies, distal dental caries, or external root resorption in the adjacent second molar in either male or female patients ($p > 0.05$ for all comparisons). However, observable trends indicated that Class C impactions were more frequently associated with pathological changes in females, while Class B impactions showed a relatively higher prevalence of dental caries and root resorption in males. These trends, while not statistically significant, may warrant further investigation in larger, multicentric cohorts.

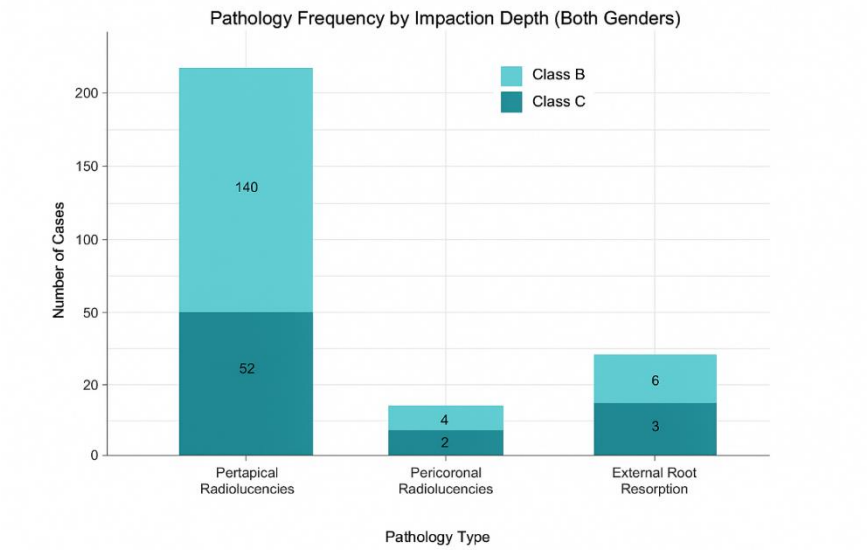

Figure 1 Pathology Frequency by Impaction Depth

The stacked bar chart illustrates the overall distribution of maxillary second molar pathologies associated with impacted maxillary third molars, categorized by impaction depth (Class B and Class C) across both genders. Periapical radiolucencies were the most frequently observed pathology, with 140 cases linked to Class C impactions and 52 cases to Class B. Pericoronal radiolucencies were rare, with only one case occurring exclusively in Class C impactions. Dental caries were more prevalent in Class C (6 cases) than Class B (4 cases), while external root resorption showed a slightly higher occurrence in Class B (2 cases) compared to Class C (1 case). The chart highlights that deeper (Class C) impactions are more commonly associated with pathological changes overall.

DISCUSSION

The present study investigated the relationship between the depth of impacted maxillary third molars and the prevalence of pathological changes in the adjacent maxillary second molars, with a specific focus on gender-based differences. The findings revealed no statistically significant associations between impaction depth and the occurrence of periapical or pericoronal radiolucencies, distal caries, or external root resorption in either male or female patients. However, distinct patterns emerged in the distribution of these pathologies across impaction depths and genders, which provide meaningful clinical insights.

Our study showed that periapical radiolucencies were the most frequent pathological finding, particularly associated with deeper (Class C) impactions. This observation aligns with previous studies reporting that deeper impactions exert greater pressure on the periodontal ligament and apical regions of the adjacent second molar, leading to inflammatory periapical changes (1,2). Similarly, pericoronal radiolucencies — although rare in this study — have been consistently described as potential indicators of follicular pathology, often representing dentigerous cyst formation adjacent to impacted third molars (3,4). The low frequency of pericoronal lesions observed in our cohort likely reflects the relatively asymptomatic nature of many maxillary third molar impactions and the retrospective design, which may have excluded more advanced cases.

External root resorption was infrequent overall, with only three cases identified, but showed a slightly higher prevalence in Class B impactions among male patients. This differs from several cone-beam CT studies reporting a stronger correlation between deeper impactions and root resorption of the adjacent tooth (5,6). The discrepancy may be attributed to the limitations of panoramic imaging, which can underestimate minor resorptive changes due to superimposition of anatomical structures (7). Moreover, the maxillary bone's relatively lower density and thinner cortical plate compared to the mandible may reduce the mechanical pressure exerted by impacted teeth, thereby explaining the lower prevalence of resorption reported here (8).

Dental caries affecting the distal surface of the second molar were observed in 10 cases, with a predominance in Class C impactions and among females. This finding is supported by previous research suggesting that deeper impactions create a retentive environment for plaque accumulation and bacterial colonization, predisposing the adjacent tooth to carious lesions (9,10). However, the small number of cases limits the strength of this conclusion and suggests that distal caries associated with maxillary third molars may be less common than with mandibular impactions, where occlusal loading and anatomical positioning exert a stronger influence (11).

Gender-related differences were also observed, with males exhibiting slightly higher frequencies of root resorption and caries in shallower impactions (Class B), whereas females demonstrated higher rates of all pathologies in deeper impactions (Class C). These findings echo previous literature suggesting that anatomical and eruption pattern variations between sexes — such as differences in jaw size, tooth angulation, and eruption timing — may influence the pathogenesis of adjacent tooth pathology (12,13). However, the lack of statistical significance in our results indicates that gender likely acts as a modifying rather than an independent risk factor, influencing the clinical expression of pathology in the presence of certain impaction characteristics (14).

The absence of statistically significant associations in this study should not be interpreted as evidence of no clinical relevance. The trends observed support the hypothesis that deeper impactions — particularly Class C — are more frequently associated with pathological changes, especially periapical radiolucencies and distal caries. This has important clinical implications, emphasizing the need for regular radiographic monitoring and early intervention, even in asymptomatic maxillary third molars, to prevent potential damage to adjacent teeth.

This study has several limitations that should be acknowledged. The reliance on panoramic radiography may have led to underestimation of subtle changes, particularly in the early stages of root resorption or small pericoronal lesions. The retrospective design also limited control over confounding variables such as impaction angulation, oral hygiene status, and systemic factors affecting bone metabolism. Additionally, the absence of Class A impactions in the sample restricts the generalizability of findings across all impaction types. Future studies incorporating cone-beam CT imaging, larger multicentric samples, and longitudinal follow-up would provide a more precise understanding of the biological interactions between impaction characteristics, gender, and associated pathology.

Despite the lack of statistical significance, the results of this study highlight key trends that are clinically meaningful. Maxillary third molars, particularly those with Class C impactions, warrant close monitoring for potential adverse effects on adjacent second molars. Early detection and timely prophylactic removal of high-risk impactions could reduce the incidence of preventable pathologies such as periapical inflammation, caries, and external root resorption. Incorporating these findings into clinical decision-making protocols could improve long-term oral health outcomes and patient management strategies.

CONCLUSION

Within the limitations of this retrospective radiographic study, no statistically significant association was found between the depth of impacted maxillary third molars and the prevalence of periapical or pericoronal radiolucencies, distal dental caries, or external root resorption in the adjacent maxillary second molars. However, distinct patterns emerged that hold important clinical relevance. Deeper impactions (Class C) were more frequently associated with periapical changes, pericoronal radiolucencies, and distal caries, particularly among female patients, whereas shallower impactions (Class B) showed a slightly higher tendency for external root resorption and caries among males.

These findings suggest that while impaction depth alone may not be a statistically significant predictor of pathology, it remains an important clinical indicator of risk, especially when considered alongside patient-related factors such as gender and anatomical variation. Routine radiographic surveillance and timely intervention for deeply impacted maxillary third molars — even when asymptomatic — may help prevent irreversible damage to adjacent second molars. Future studies using advanced imaging modalities and larger, multicentric samples are warranted to further elucidate the complex interactions between impaction characteristics and associated pathological outcomes.

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