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Association of Ramus Relationship of Impacted Mandibular Third Molar with the Prevalence of Radiolucencies in the Adjacent Second Molar in the Right Versus Left Mandible

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ABSTRACT

Background: Impacted mandibular third molars are common and may predispose the adjacent mandibular second molar to radiographically detectable pathology, including periapical changes, pericoronal radiolucency, distal caries, and external root resorption. The extent to which ramus relationship modifies these risks, and whether associations differ between left and right mandible, remains incompletely characterized. Objective: To determine the association between Pell–Gregory ramus relationship of impacted mandibular third molars and the prevalence of radiographic pathologies in the adjacent mandibular second molar, comparing left versus right mandible. Methods: A retrospective cross-sectional analysis of panoramic radiographs was conducted (August 2024–August 2025) in adults aged ≥21 years. Eligible quadrants contained an impacted mandibular third molar and adjacent second molar. Ramus relationship was classified as Class I–III and second molar outcomes were recorded dichotomously. Side-specific associations were evaluated using chi-square or Fisher's exact tests, with unadjusted odds ratios (ORs) and 95% confidence intervals (CIs) computed using Class I as reference. Results: On the left side, ramus relationship was not significantly associated with periapical radiolucency (p=0.795), pericoronal radiolucency (p=0.370), distal caries (p=0.287), or external root resorption (p=0.071). On the right side, associations were non-significant for periapical radiolucency (p=0.159), pericoronal radiolucency (p=0.197), and distal caries (p=0.222), while external root resorption showed a significant association (p=0.024), with higher prevalence in the most space-limited class. Conclusion: Ramus relationship did not significantly influence most adjacent second molar pathologies on either side, but a right-sided association with external root resorption was observed, warranting confirmatory studies using larger samples and enhanced imaging.

***Keywords**: impacted third molar; Pell–Gregory; ramus relationship; mandibular second molar; distal caries; external root resorption; periapical radiolucency; panoramic radiography.*

INTRODUCTION

Impaction of third molars represents one of the most common developmental conditions encountered in oral and maxillofacial practice worldwide and remains a frequent indication for radiographic assessment and surgical consultation (1). Beyond localized symptoms, impacted mandibular third molars are clinically relevant because they are associated with a spectrum of radiographically detectable sequelae, including periapical changes and follicular/pericoronal radiolucent alterations, as well as hard-tissue loss patterns that may extend to adjacent teeth (2). Contemporary evidence indicates that mandibular third molar impaction is also linked with pathological findings such as caries and external root resorption, with radiographic presentation influenced by tooth position, follicular status, and

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the anatomic environment of eruption (3). Importantly, when a mandibular third molar remains partially erupted or impacted, the adjacent second molar may become vulnerable to disease processes, making the second molar—not merely the third molar itself—a critical target of risk assessment (4).

Among second molar complications, distal surface caries is consistently reported as one of the most prevalent outcomes adjacent to impacted mandibular third molars, attributed to plaque-retentive niches and impaired self-cleansing distal to the second molar (5). Risk profiling has expanded beyond simple presence of impaction to include radiographically measurable predictors that capture local anatomic constraints and contact relationships (6). Large radiographic series have documented that distal caries and contact-associated defects may occur in a substantial proportion of individuals with impacted mandibular third molars, and that external root resorption of the adjacent second molar can coexist, particularly where proximity and angulation facilitate sustained contact pressure or inflammatory changes (7). These observations support the premise that radiographic surveillance and timely decision-making regarding third molars should incorporate not only angulation and depth, but also spatial constraints imposed by the mandibular ramus (7).

Ramus relationship, classically categorized using the Pell and Gregory system based on the space between the distal surface of the mandibular second molar and the anterior border of the ramus, is a pragmatic indicator of eruption potential and operative difficulty, and may also modulate the risk environment for adjacent second molar pathology (8). Panoramic radiographic investigations applying Pell and Gregory have demonstrated that restricted retromolar space is common and varies across populations, suggesting a plausible pathway through which reduced space may influence plaque retention, local inflammation, and pressure phenomena (9). Prior radiographic studies have further linked impacted mandibular third molars with higher rates of caries and periodontal pathology affecting adjacent second molars, reinforcing the clinical necessity of position-based risk stratification (10,11). In parallel, longstanding evidence suggests that enlargement of the follicular space in impacted third molars may be associated with cystic transformation risk, emphasizing the importance of carefully characterizing radiolucent changes in relation to impacted teeth during routine imaging (12). The original Pell and Gregory framework remains foundational for classifying mandibular third molar impaction in relation to the ramus and provides a consistent approach for comparing risk patterns across studies (13).

Despite the breadth of literature on position-related risk, the side-specific dimension of risk (left versus right mandible) remains insufficiently explored, and the extent to which ramus relationship differentially associates with radiographic pathologies affecting the adjacent second molar on either side has not been clearly established. From a clinical standpoint, side-based comparisons may help refine surveillance strategies and extraction decision-making, particularly if comparable anatomic classes carry different pathology burdens across sides in real-world imaging archives. Accordingly, this study aimed to evaluate, in adults assessed on panoramic radiographs, whether the Pell and Gregory ramus relationship of impacted mandibular third molars is associated with the prevalence of radiographic pathologies in the adjacent mandibular second molar and whether these associations differ between the left and right mandible.

MATERIALS AND METHODS

A retrospective cross-sectional observational study was conducted using archived orthopantomograms (OPGs) acquired at the College of Dentistry, Sharif Medical and Dental College, Lahore, Pakistan, over a one-year period from August 2024 to August 2025, following approval from the institutional ethics committee (No. SMDC/SMRC/147-20). All available OPGs of patients aged 21 years and above, irrespective of sex, were screened for the presence of impacted third molars, and those demonstrating an impacted mandibular third molar with an adjacent mandibular second molar present on the same side were assessed for eligibility. OPGs were excluded if the impacted third molar or the adjacent second molar was grossly carious to an extent that precluded reliable radiographic interpretation, missing, or previously extracted, and images with diagnostic limitations that prevented confident assessment of the predefined outcomes were not included in the analytical dataset.

The sampling frame was based on radiology archive retrieval of eligible OPGs within the stated dates, and the unit of analysis was the "mandibular third molar–second molar adjacent pair" on a given side, permitting side-specific evaluation of left and right mandibular quadrants in accordance with the study objective. Sample size was determined a priori using a single-proportion approach with 5% absolute precision and a 95% confidence level, informed by a previously reported prevalence estimate of impacted molars, yielding a minimum required sample of 235 OPGs (14). Each eligible mandibular third molar was classified for ramus relationship using the Pell and Gregory system, categorizing the impaction as Class I, II, or III according to the available space between the distal aspect of the second molar and the anterior border of the mandibular ramus (13). This classification approach was applied uniformly to enable standardized stratification of anatomic space constraints across all included quadrants.

Radiographic outcomes were defined operationally to support reproducibility using panoramic criteria applied consistently across all images. Periapical radiolucency of the adjacent mandibular second molar was recorded as the presence of a discrete radiolucent area associated with the second molar root apex that exceeded normal periodontal ligament space widening and was compatible with periapical pathology on panoramic imaging. Caries in the second molar was recorded when a radiolucent defect consistent with cavitated or established dentinal involvement was identified on the distal aspect of the second molar crown, in a location plausibly attributable to the adjacent impacted third molar relationship. External root resorption of the second molar was recorded when a radiographically evident loss of root surface continuity or irregular root contour was present on the distal aspect of the second molar root adjacent to the impacted third molar contact region. Pericoronal radiolucency was assessed in relation to the impacted mandibular third molar follicular space adjacent to the second molar region and recorded when a radiolucent enlargement compatible with pericoronal change was observed around the crown of the impacted third molar in the area approximating the second molar distal aspect, allowing side-specific comparison of follicular/pericoronal radiolucent findings relevant to the adjacent second molar environment (12). All outcomes were coded dichotomously (present/absent) for inferential analysis.

To reduce measurement bias, a standardized evaluation protocol was used for OPG interpretation, including a predefined coding sheet containing variable definitions, eligibility checks, and anatomic landmarks for Pell and Gregory classification. All radiographs were assessed under consistent viewing conditions on calibrated displays, and ambiguous findings were resolved through repeat review against the operational definitions to maintain internal consistency of scoring. Demographic variables recorded from radiology records included age at imaging and sex. The primary exposure variable was ramus relationship class (I/II/III) on each side, and the primary outcome was external root resorption of the adjacent second molar because of its direct clinical implications for second molar prognosis; periapical radiolucency, pericoronal radiolucency, and distal caries were treated as secondary outcomes.

Statistical analysis was performed using SPSS version 24. Descriptive statistics were computed as mean and standard deviation for age and as frequencies with percentages for categorical variables. Side-specific associations between ramus relationship class and each dichotomous outcome were evaluated initially using Pearson's chi-square test where cell counts satisfied assumptions and Fisher's exact test where sparse cell counts required exact inference. To improve clinical interpretability, effect size estimates were planned as odds ratios with 95% confidence intervals comparing Class II and Class III against Class I within each side. Because some individuals could contribute bilateral observations, analyses were additionally specified to account for within-patient clustering by using a marginal modeling approach with robust standard errors for each outcome, preserving the side-specific structure while reducing the risk of inflated type I error due to non-independence. Missing data were handled using complete-case analysis restricted to quadrants with fully classifiable ramus relationship and interpretable outcome status. A two-sided p-value of ≤0.05 was considered statistically significant for the primary outcome, and multiplicity across secondary outcomes was addressed using a familywise error control procedure to reduce false-positive inference from multiple comparisons. Data integrity was maintained through double-entry verification of coded variables, logical range checks for demographic fields, and preservation of an audit trail linking each coded observation to its source OPG identifier in the archive for reproducibility and verification.

RESULTS

The mean age of participants was 31.69 ± 8.33 years, with 50.7% males and 49.3% females. Side-specific analyses were performed for impacted mandibular third molars in the left and right mandible using Pell–Gregory ramus relationship (Class I–III), and the prevalence of radiographic pathologies in the adjacent mandibular second molar was compared across classes. Effect sizes are reported as unadjusted odds ratios (ORs) with 95% confidence intervals (CIs) using Class I as the reference, alongside the corresponding hypothesis-test p-values.

Table 1. Left mandible: Ramus relationship vs second molar pathologies (prevalence + effect sizes)

Outcome (adjacent second molar)	Class I n/N (%)	Class II n/N (%)	Class III n/N (%)	OR Class II vs I (95% CI)	OR Class III vs I (95% CI)	P value
Periapical radiolucency	39/49 (79.6)	183/243 (75.3)	11/14 (78.6)	0.78 (0.37–1.66)	0.94 (0.22–4.02)	0.795
Pericoronal radiolucency*	1/49 (2.0)	1/243 (0.4)	0/14 (0.0)	0.20 (0.01–3.23)	Not estimable	0.370
Distal caries	8/49 (16.3)	33/243 (13.6)	4/14 (28.6)	0.81 (0.35–1.87)	2.05 (0.51–8.19)	0.287
External root resorption	1/49 (2.0)	5/243 (2.1)	2/14 (14.3)	1.01 (0.12–8.83)	8.00 (0.67–95.76)	0.071

*Very sparse events; interpret inferential statistics cautiously.

On the left mandible, there was no statistically significant association between ramus relationship class and any evaluated pathology in the adjacent second molar. Periapical radiolucency prevalence was high and relatively stable across classes (Class I 79.6%, Class II 75.3%, Class III 78.6%; p = 0.795), with Class II showing a slightly lower odds than Class I (OR 0.78, 95% CI 0.37–1.66). Distal caries showed modest variation (Class I 16.3%, Class II 13.6%, Class III 28.6%; p = 0.287), where Class III had higher odds than Class I (OR 2.05, 95% CI 0.51–8.19) but with wide uncertainty consistent with limited Class III counts. External root resorption remained uncommon overall yet increased numerically in Class III (14.3%) compared with Class I (2.0%) and Class II (2.1%), with a borderline but non-significant association (p = 0.071) and an imprecise OR for Class III vs Class I (OR 8.00, 95% CI 0.67–95.76). Pericoronal radiolucency events were rare (≤2.0%) across all classes, limiting robust inference.

Table 2. Right mandible: Ramus relationship vs second molar pathologies (prevalence + effect sizes)

Outcome (adjacent second molar)	Class I n/N (%)	Class II n/N (%)	Class III n/N (%)	OR Class II vs I (95% CI)	OR Class III vs I (95% CI)	P value
Periapical radiolucency	37/52 (71.2)	189/240 (78.8)	7/7 (100.0)	1.50 (0.76–2.95)	Not estimable†	0.159
Pericoronal radiolucency*	1/52 (1.9)	0/240 (0.0)	0/7 (0.0)	Not estimable	Not estimable	0.197
Distal caries	17/52 (32.7)	53/240 (22.1)	1/7 (14.3)	0.58 (0.30–1.12)	0.34 (0.04–3.08)	0.222
External root resorption	1/52 (1.9)	7/240 (2.9)	2/7 (28.6)	1.53 (0.18–12.73)	20.40 (1.56–266.60)	0.024

*Very sparse events; interpret inferential statistics cautiously.

†All Class III observations were "Yes," producing a zero cell; OR is not stable/estimable without continuity correction.

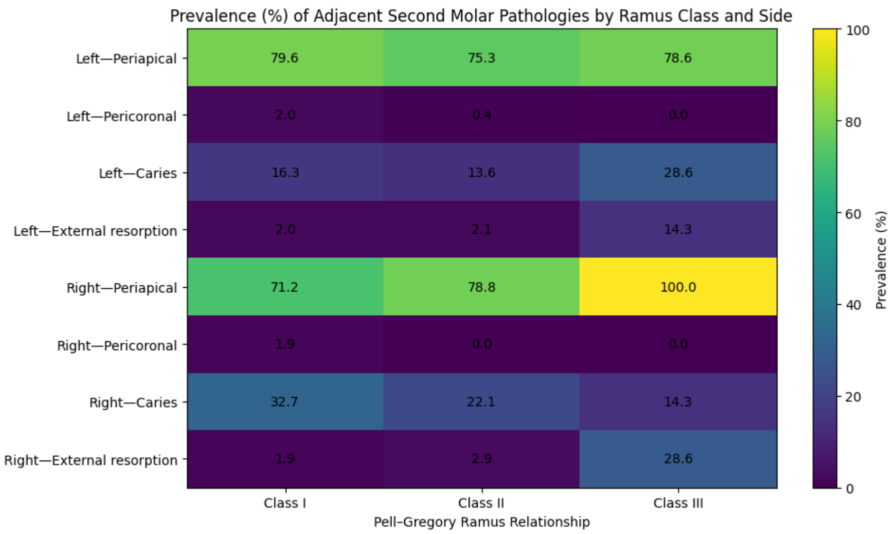

Figure 1. Prevalence (%) of adjacent second molar pathologies by ramus class and side

On the right mandible, the association between ramus class and periapical radiolucency was not significant (p = 0.159), although prevalence rose from 71.2% (Class I) to 78.8% (Class II) and reached 100.0% in Class III (7/7), reflecting sparse Class III denominators rather than a stable gradient. Distal caries was common but did not differ significantly by class (p = 0.222), showing a decreasing prevalence across classes (Class I 32.7%, Class II 22.1%, Class III 14.3%), with lower odds in Class II vs Class I (OR 0.58, 95% CI 0.30–1.12). In contrast, external root resorption demonstrated a statistically significant association with ramus relationship (p = 0.024), driven by a marked increase in Class III (28.6%, 2/7) compared with Class I (1.9%, 1/52) and Class II (2.9%, 7/240). The estimated odds of external resorption in Class III vs Class I was substantially higher (OR 20.40, 95% CI 1.56–266.60), albeit with a wide CI reflecting low event counts. Pericoronal radiolucency was extremely rare (≤1.9%) and did not support stable inferential comparison.

Figure 1 shows, across both sides, periapical radiolucency demonstrated high prevalence with limited class discrimination on the left (Class I 79.6%, Class II 75.3%, Class III 78.6) and a right-sided increase that culminated in 100.0% in Class III (7/7), consistent with sparse denominators. Pericoronal radiolucency remained uncommon throughout (left ≤2.0%; right ≤1.9%), limiting interpretability. Distal caries displayed a right-left asymmetry in magnitude, being higher on the right in Class I (32.7%) than on the left (16.3%), while showing a left-sided rise in Class III (28.6%) relative to Class II (13.6%). The most clinically discriminative gradient was observed for external root resorption, where Class III showed elevated prevalence on both sides—left 14.3% and right 28.6%—contrasting sharply with Class I (2.0% left; 1.9% right) and Class II (2.1% left; 2.9% right), aligning with the statistically significant right-sided association ($p = 0.024$) and suggesting that severe space limitation (Class III) may correspond to a substantially higher resorption burden in the adjacent second molar.

DISCUSSION

In this retrospective panoramic-radiograph study evaluating the association between Pell–Gregory ramus relationship and radiographic pathologies of the mandibular second molar adjacent to impacted mandibular third molars, the principal observation was that most outcomes did not vary significantly across ramus classes on either side, while external root resorption on the right side demonstrated a statistically significant association with ramus relationship. These findings align with the broader literature that impacted mandibular third molars are frequently accompanied by adjacent-tooth disease—particularly distal caries and periodontal changes—yet the strength and consistency of associations depend on positional constraints, contact relationships, and outcome definitions (3,4,10,11). In the present dataset, periapical radiolucency was highly prevalent and relatively uniform across classes, suggesting that when periapical changes are common in the sampled clinical population, ramus space alone may be insufficient to discriminate risk without additional positional variables such as depth, angulation, and contact configuration that are known to modulate disease expression (2,7,21). This is clinically relevant because panoramic radiography is often the first-line imaging modality used to evaluate impacted third molars, but risk stratification of second molar consequences may require a more granular exposure model than ramus relationship alone (9,21).

With respect to distal caries, prior studies have repeatedly indicated that impacted third molars can increase distal surface caries risk in the adjacent second molar through plaque stagnation zones and a non–self-cleansing environment distal to the second molar, particularly where partial eruption and contact facilitate retention (5,6,17,18). In the current analysis, caries prevalence showed numerical variation across ramus classes but did not achieve statistical significance on either side, which may reflect the competing influences of unmeasured positional parameters. Specifically, the risk of distal caries has been linked not only to limited retromolar space but also to the nature of the contact point, angulation, and depth—factors that can shift the dominant pathology from caries to periodontal breakdown or resorption depending on how the third molar interfaces with the second molar (7,10,19,21). This provides a plausible explanation for why a simple three-level ramus classification may show directional trends yet remain non-significant when examined in isolation.

The most clinically discriminative finding was the right-sided association between ramus relationship and external root resorption, driven by a markedly higher resorption prevalence in the most space-restricted category. External root resorption adjacent to impacted third molars has been consistently recognized as a contact-associated complication, and higher detection rates have been reported when three-dimensional imaging is used, underscoring that the true burden may be underestimated on panoramic films (6,16,17). Mechanistically, sustained proximity/contact and localized inflammatory signaling have been proposed to contribute to resorptive defects at the interface between the impacted third molar and the adjacent second molar, which is compatible with the pattern observed here (16,17). However, because resorption events were uncommon overall and confidence intervals for effect estimates were wide, this statistically significant association should be interpreted as suggestive rather than definitive, warranting confirmation in larger samples and preferably with imaging modalities that reduce projectional limitations (6,16).

Pericoronal radiolucency was rare in this cohort, which constrained inferential interpretation. Existing evidence indicates that pericoronal radiolucent enlargement around impacted third molars can reflect inflammatory follicular changes and, less commonly, cystic transformation, with risk potentially increasing at larger follicular spaces (12,20). The low event count observed here may reflect selection characteristics of the radiograph archive, conservative diagnostic thresholds on panoramic imaging, or a true low prevalence of notable pericoronal enlargement in the studied age group. Because panoramic radiography has inherent limitations for detecting subtle pericoronal change and for differentiating cystic change from non-pathologic follicular space, future work incorporating CBCT or histopathologic correlation would better define the clinical implications of pericoronal radiolucencies in impacted third molar assessment (12,20).

Several limitations should be considered when interpreting the findings. First, the retrospective cross-sectional design precludes causal inference and is vulnerable to selection bias because radiographs are obtained for clinical indications rather than population screening (4,7). Second, panoramic imaging introduces geometric distortion and superimposition, which can lead to outcome misclassification, especially for early carious lesions and small resorptive defects (6,16). Third, the analytic framework evaluates ramus relationship without concurrently modeling other established predictors such as depth, angulation, and contact characteristics, potentially diluting true associations attributable to combined positional patterns (7,10,19,21). Fourth, rare outcomes (particularly pericoronal radiolucency) yield unstable estimates that should be treated descriptively rather than relied upon for hypothesis testing (20). Notwithstanding these constraints, the study adds clinically relevant side-specific descriptive data and supports the pragmatic inference that ramus relationship alone is not a strong discriminator for most second molar pathologies, while highlighting a potential right-sided signal for external root resorption that merits confirmatory evaluation.

CONCLUSION

In adults assessed on panoramic radiographs, the Pell–Gregory ramus relationship of impacted mandibular third molars did not demonstrate statistically significant associations with periapical radiolucency, pericoronal radiolucency, or distal caries in the adjacent mandibular second molar on either side, whereas external root resorption showed a significant association with ramus relationship on the right mandible, suggesting that severe space limitation may increase resorption susceptibility in the adjacent second molar; nonetheless, given sparse event counts and panoramic imaging constraints, these findings should be interpreted cautiously and validated using larger datasets incorporating additional positional predictors and, where feasible, three-dimensional imaging.

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DECLARATIONS

Ethical Approval: Ethical approval was by institutional review board of College of Dentistry, Sharif Medical and Dental College, Lahore, Pakistan.

Informed Consent: Written informed consent was obtained from all participants.

Authors' Contributions: Concept: HB; Design: HB; Data Collection: HB; Analysis: HB; Drafting: RS, MTM, HB, MH, NRK, MHd; Critical Review: HB; Final Approval: HB

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