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Association between the position of impacted third molars and external root resorption of adjacent second molars observed through cone-beam computed tomography*

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ABSTRACT

Objective: To determine the association between the position of impacted third molars and root resorption of adjacent second molars observed through cone-beam computed tomography in patients who attended a dental teaching center in Lima, Peru. **Materials and methods:** A cross-sectional, retrospective, and observational study was conducted on 84 cone-beam computed tomography (CBCT) scans that met the selection criteria, evaluating 153 impacted third molars according to Winter's classification and their respective adjacent second molars. **Results:** Impacted third molars were found predominantly among women (57.1%; n = 48) and in patients aged 16 to 25 (59.5%; n = 50), with a predominance of the mesioangular position (77.8%; n = 119) and mandibular location (81.0%; n = 124). External root resorption of the second molar was observed in 13.1% (n = 20) of the total cases, mostly in women (70.0%; n = 14) and in patients aged 16 to 25 (60.0%; n = 12). The most frequent location was the cervical third (60.0%; n = 12), and the degree of resorption was mostly mild (80.0%; n = 16). A statistically significant association was observed between impacted third molars and external root resorption of the adjacent second molar ($p < 0.001$), as well as between the latter and the position of the impacted third molar ($p = 0.002$). **Conclusions:** There is an association between the position of the impacted third molar and root resorption of adjacent second molars, with the mesioangular position presenting the highest risk.

Keywords: root resorption; impacted tooth; third molar; cone-beam computed tomography.

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INTRODUCTION

Third molars are the most frequently impacted teeth and, due to their position and lack of space for eruption, they can cause various pathological complications, including root resorption of the second molar (1, 2). The prevalence of this pathology varies, with reports ranging from 8.5% to 15.8% (1, 3, 4).

External root resorption (ERR) is one of the pathological processes that affects the second molar in the presence of an impacted third molar. It is characterized by the irreversible loss of dental hard tissue from the external root surface of a permanent tooth (5). This condition can occur in both mandibular and maxillary second molars and is influenced by the position and orientation of the third molar.

A study found that the frequency of ERR in second molars was 33.4% in the mandible and 14.0% in the maxilla, and concluded that this condition is more common in the mandible and that mesioangular and horizontally positioned molars present a higher risk (6-9). Using Winter's classification, ERR occurred more frequently adjacent to horizontally impacted mandibular third molars (17.3%) (3). In addition, the prevalence of ERR was 18.4% in mandibular second molars, and this pathology should be suspected when there are horizontal and mesioangular third molars (10).

In Latin America, it has been reported that the prevalence of ERR in mandibular second molars was 47.7%, being significantly higher in male patients. Furthermore, it was indicated that the likelihood of the second molar being affected was 1.64 times greater when the third molar was impacted in a mesioangular position (11).

For maxillary second molars, ERR occurred more frequently when third molars were impacted in type D position (57%), according to Archer's classification (12). Cone-beam computed tomography (CBCT)-based studies identified factors associated with higher ERR frequency, including maxillary location, mesioangular inclination, and contact between the second and third molars. It was concluded that the greatest risk of ERR was associated with maxillary second molars (13). When a maxillary third molar is impacted in a mesioangular position, clinicians should assess for ERR in the adjacent second molar, and consider CBCT imaging (14) to achieve better visualization and guide the clinical diagnosis.

CBCT imaging can reveal both the presence and the extent of ERR in second molars (15). Several studies have assessed the extent of ERR in CBCT images using the criteria of Ericson et al. (19), classifying it as mild, moderate, or severe. These studies have also identified potential risk factors such as direct second–third molar contact, contact location, interdental angle, and third-molar inclination. Moreover, it is important to establish guidelines for the extraction of impacted third molars to prevent this pathology (8). In this regard, CBCT imaging may be recommended as a complement to conventional radiography when signs of contact with the mandibular canal are observed, or when overlap between the second and third molars appears in two-dimensional images. The decision to order CBCT should depend on whether the information obtained will alter the diagnosis and treatment plan (16).

ERR of the second molar may be prevented through early extraction of mesioangular and horizontally impacted third molars. However, this decision should be based on a careful risk–benefit assessment (5, 9, 17), as the absence of clinical symptoms constitutes a significant limitation (5). Further CBCT-based research is needed for the diagnosis of this pathology to generate validated scientific evidence that supports clinical decision-making and enables the establishment of appropriate and timely treatment plans.

The objective of this study was to determine the association between the positions of impacted third molars and the ERR of second molars observed on CBCT images of patients treated at a dental teaching center of a Peruvian university.

MATERIALS AND METHODS

This study was a retrospective, cross-sectional observational study. All CBCT obtained from patients who attended the Dental Teaching Center of Universidad Peruana Cayetano Heredia (CDD-UPCH), San Martín de Porres campus, Lima, Peru were evaluated (from August 2023 to July 2024). Only images meeting the selection criteria were included. Inclusion criteria were the presence of at least one impacted third molar with an adjacent second molar, patients aged 16 to 55 years, and artifact-free scans allowing adequate visualization of second and third molars within the field of view. Exclusion criteria included: pathology associated with the impacted third molar, follicular space larger than 5 mm, second molars with prosthetic crowns or orthodontic appliances, extensive caries, cystic or tumoral processes, malformations of second or third molars, motion or beam-hardening artifacts from metallic restorations, history surgery involving the second or third molar, and third molars with less than two-thirds root development.

Additionally, the principal investigator was trained in the use of the software by a specialist in Oral and Maxillofacial Radiology (OMFR) from UPCH with more than 10 years of experience. Subsequently, interobserver and intraobserver calibration were conducted for both the investigator and the specialist, using a random 10% of

eligible scans. In addition, a pilot study was performed using 10 CBCT images, in which 40 second molars were evaluated. All these procedures aimed to ensure the validity, reliability, and reproducibility of the results.

ERR of second molars and its relationship with impacted third molars were recorded and classified according to sex and age. ERR was defined as loss of dental hard tissue from the distal root surface of the second molar caused by contact with the adjacent third molar (18). Imaging criteria included a root surface hypodensity with contour discontinuity/irregularity and loss of dental structure, distinguishing ERR from distal caries (1, 11). Location (cervical, middle, or apical third) and the degree of involvement (mild, moderate, or severe) were recorded (19) (Figure 1).

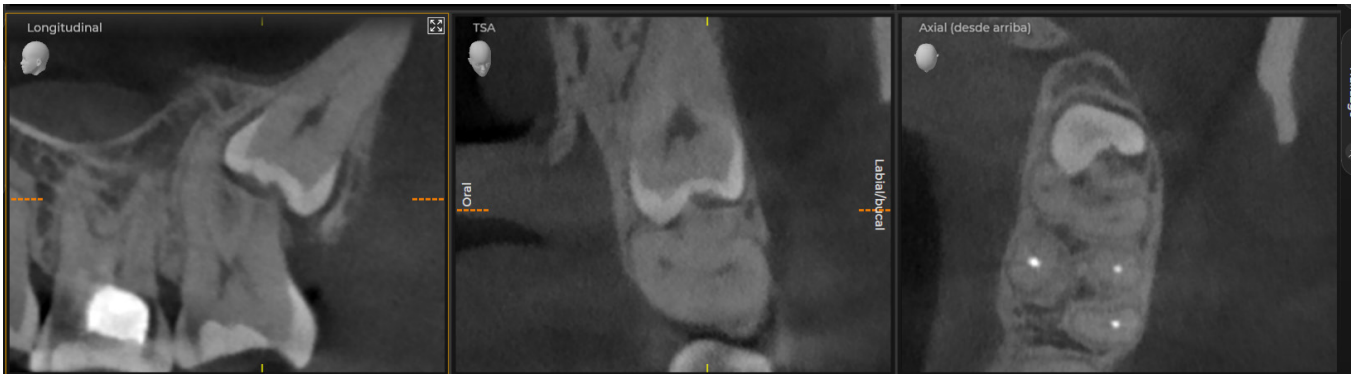

Figure 1. Tomographic sections showing severe external root resorption in a maxillary second molar. Images obtained from the archives of the Oral and Maxillofacial Radiology Service of the Dental Teaching Center of UPCH.

Impacted third molars were observed in the CBCT scans, and their position was determined using Winter's classification (20): mesioangular (the tooth's longitudinal axis is inclined toward the second molar), distoangular (the third molar's longitudinal axis is oriented distally or backward relative to the second molar's longitudinal axis), horizontal (the third molar's longitudinal axis is perpendicular to that of the second molar), and vertical (the third molar's longitudinal axis is parallel to that of the second molar). In turn, their location was identified either in the maxilla or in the mandible.

CBCT images were evaluated at the OMFR Service of the Dental Teaching Center of UPCH, beginning with multiplanar reconstruction (MPR) in axial, sagittal, and coronal sections, followed by 3D reconstruction, using Sidexis4 software on a Lenovo computer. Viewing conditions followed eye-strain reduction recommendations: 50-75 cm monitor distance and 30 s breaks every 20 min focusing at ~10 m (21).

Data were collected with a study-specific extraction form. Each CBCT volume was assigned a sequential code; no personally identifiable data were collected. The study was approved by the Institutional Research Ethics Committee (CIEI) of UPCH on March 4, 2025.

Finally, for variable analysis, absolute and relative frequencies were calculated. Associations were assessed with Pearson's chi-square test, considering a p-value <0.05 and a 95% confidence level.

RESULTS

Among patients with at least one impacted third molar, 57.1% (n = 48) were female and 42.9% (n = 36) were male. By age group, the most frequent was 16 to 25 years, representing 59.5% (n = 50) of the total, followed by 26-35 years with 27.4% (n = 23). The 36-45-year group accounted for 7.1% (n = 6), and the least frequent was the 46-55-year group with 6% (n = 5).

In total, 153 impacted third molars were identified. Of these, 77.8% (n = 119) had a mesioangular position, 15.7% (n = 24) a horizontal position, 5.2% (n = 8) a vertical position, and only 1.3% (n = 2) were in a distoangular position (Table 1). Most were mandibular with 81.0% (n = 124) and 19.0% (n = 29) were maxillary.

Table 1. Frequency of impacted third molars according to their position and location in the jaws.

Impacted third molar	n	%
Position		
Mesioangular	119	77.8
Distoangular	2	1.3
Horizontal	24	15.7
Vertical	8	5.2
Location		
Maxilla	29	19.0
Mandible	124	81.0
Total	153	100.0

ERR was present in 13.1% (n = 20) of second adjacent to impacted third molars (Table 2). Of these, 30.0% (n = 6) occurred in males and 70.0% (n = 14) in females. By age, the most affected group was 16–25 years (60.0%; n = 12), followed by 26–35 years (30.0%; n = 6), while the 36-45 and 46-55 age groups showed the lowest frequency (5.0% each; n = 1). ERR location was most frequently cervical (60.0%; n = 12), followed by middle (30.0%; n = 6) and apical thirds (10.0%; n = 2).

Regarding the severity of ERR in second molars associated with impacted third molars, mild resorption predominated among females (50.0%; n = 10), followed by moderate (10.0%; n = 2) and severe (10.0%; n = 2) degrees. In contrast, only mild ERR was found among males (30.0%; n = 6) (Table 3). In terms of age, the 16-25-year group mainly presented mild (50.0%; n = 10) and moderate (10.0%; n = 2) ERR; the 26-35-year group showed mild (25.0%; n = 5) and severe (5.0%; n = 1) ERR; the 36-45-year group exhibited only severe ERR (5.0%; n = 1); and the 46-55-year group exclusively presented mild ERR (5.0%; n = 1). Regarding location, most ERRs in the cervical third were mild (55.0%; n = 11), followed by moderate (5.0%; n = 1). In the middle third, mild (20.0%; n = 4), moderate (5.0%; n = 1), and severe (5.0%; n = 1) ERR were observed. Finally, in the apical third, one mild (5.0%) and one severe (5.0%) ERR case were recorded.

Table 2. Frequency of external root resorption (ERR) in the second molars according to sex, age, and location.

Second molar ERR	n	%
Absence	133	86.9
Presence	20	13.1
Sex		
Male	6	30.0
Female	14	70.0
Age (years)		
16-25	12	60.0
26-35	6	30.0
36-45	1	5.0
46-55	1	5.0
Location		
Cervical	12	60.0
Moderate	6	30.0
Apical	2	10.0
Total	20	100.0

Table 3. Degree of external root resorption (ERR) of second molars according to sex, age, and location.

Characteristic	Degree of ERR in the second molar						Total	
	Mild		Moderate		Severe			
	n	%	n	%	n	%	n	%
Sex								
Male	6	30.0	0	0.0	0	0.0	6	30.0
Female	10	50.0	2	10.0	2	10.0	14	70.0
Age (years)								
16-25	10	50.0	2	10.0	0	0.0	12	60.0
26-35	5	25.0	0	0.0	1	5.0	6	30.0
36-45	0	0.0	0	0.0	1	5.0	1	5.0
46-55	1	5.0	0	0.0	0	0.0	1	5.0
ERR location								
Cervical	11	55.0	1	5.0	0	0.0	12	60.0
Moderate	4	20.0	1	5.0	1	5.0	6	30.0
Apical	1	5.0	0	0.0	1	5.0	2	10.0
Total	16	80.0	2	10.0	2	10.0	20	100.0

A statistically significant association was found between impacted third molars and ERR in the associated second molars ($p < 0.001$) (Table 4). No significant differences were found by sex, age, or maxillary/mandibular location ($p > 0.005$). There was a significant association between ERR in the second molar and the position of the impacted third molar ($p = 0.002$), with the mesioangular position most associated, accounting for 85.0% (n = 17) of ERR cases.

Table 4. Association between external root resorption (ERR) of the second molar and the impacted third molar according to sex, age, and location.

Characteristics	ERR of the second molar					p-value
	Absence		Presence			
	n	%	n	%	Total	
Impacted third molars						<0.001*
Absent	118	100.0	0	0.0	118	
Present:	133	86.9	20	13.1	153	
Sex						0.242
Male	109	43.4	6	30.0	115	
Female	142	56.6	14	70.0	156	
Age (years)						0.907
16-25	158	62.9	12	60.0	170	
26-35	72	28.7	6	30.0	78	
36-45	15	6	1	5.0	16	
46-55	6	2.4	1	5.0	7	
Location						0.744
Maxilla	116	46.2	10	50.0	126	
Mandible	135	53.8	10	50.0	145	
Position of impacted third molar						0.002*
Mesioangular	106	42.2	17	85.0	123	
Distoangular	12	4.8	0	0.0	12	
Horizontal	23	9.2	2	10.0	25	
Vertical	110	43.8	1	5.0	111	

* Statistically significant ($p < 0.05$). * Pearson's chi-square test.

DISCUSSION

ERR can be identified as loss of hard dental tissue on the root surface, and CBCT is the most effective imagine modality for its detection (22). In fact, its use is recommended in cases where third molars show superimposition with second molars on panoramic radiographs (2), as it significantly increases the detection rate of this condition (15).

In this study, the frequency of third molar impaction was higher in females and in the 16-25-year-old age group. This finding is similar to that reported by Palomares et al. (23) and Gebeyehu et al. (24), who found a higher prevalence in females and in the 18-30-year-old age range. The higher proportion in females may reflect sex-related growth differences, as females complete growth earlier, around the time third molars begin to erupt (25). Furthermore, this condition is more common among young individuals, since in adulthood, there is usually more space available and molars tend to become upright (26). The mesioangular position was the most frequent, which is consistent with findings from other studies (25-28). This pattern could be attributed to delayed development and maturation, the eruption pathway, and a lack of space. Additionally, impacted third molars were found predominantly in the mandible, which is consistent with previous studies (29, 30) and is probably related to the limited space and skeletal growth constraints in the mandibular region.

With regard to ERR in second molars, this study found a frequency of 13.1%, a value that differs from other studies showing a prevalence ranging from 8.5% to 15.8% (1, 3, 4). This variation may be due to methodological factors such as study design and sample selection. Regarding severity, mild ERR predominanted and was more frequent in females, which differs from the findings of Lacerda et al. (11) but is similar to those of Kou et al. (30). The latter observed a higher prevalence in the 26-35-year-old age group, whereas in this study, it was in the 16-25-year-old group. These differences may be explained by hormonal changes and by the age range of the population analyzed.

Regarding location, ERR was mostly found in the cervical third, consistent with similar studies (5, 6, 11, 17), possibly related to regional anatomical characteristics. Finally, an association was observed between impacted third molars and the ERR of the adjacent second molar, with a higher frequency when the impacted third molar was mesioangular. This finding is consistent with previous studies (6, 11, 17) and may be due to the contact area between both teeth, which creates favorable conditions for greater resorption.

The limited sample size is a study limitation; future research should expand the sample and include multiple academic centers. A strength of this study was the detailed classification of third-molar position and ERR severity.

CONCLUSIONS

The highest frequency of impacted third molars was observed in females and in patients aged 16-25 years, predominantly mandibular and mesioangular. Although the overall prevalence of ERR in second molars associated with impacted third molars was low overall; it was more frequent in this subgroup with lesions mainly in the cervical third and predominantly mild. Finally, an association was observed between impacted third molars and ERR in adjacent second molars, with mesioangular impaction showing the greatest impact.

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The authors declare no conflict of interest.

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Ethics approval:
The study was approved by the Institutional Research Ethics Committee of the Universidad Peruana Cayetano Heredia, under Certificate CIEI-E-78-11-25.

Authorship contribution
JTAS: conceptualization, methodology, writing.
VERG: Methodology, writing, review.

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