Alkhulidi, R. A., et al., Yemeni J Med Sci. 2026; 20(3):20 -28
https://doi.org/10.20428/yjms.v20i3.3504
https://journals.ust.edu/index.php/yjms

OPEN ACCESS Original Article

Association between Mandibular Third Molar Impaction Patterns and Pathologies of the Adjacent Second Molar among a Sample of Yemeni Adults: A Radiographic Cross-Sectional Study

Raeef Ali Alkhulidi[1,2*], Khaldon Al-Buriahy[1,2], Omar Mustafa Alqurashi[1,2], Abdulqader Al Mashraqi[1,2], Mohammed Almekhlafi [1,2], Fadl Mahmood Yahya Abdullah[1,2], Linda Abdulqawi Hassan Mohammed[1,2]

[1] *Department of Dentistry, Faculty of Medicine and Health Sciences, University of Science and Technology, Taiz City Branch, Taiz, Yemen.*

[2] *Department of Dentistry, Faculty of Medicine and Health Sciences, University of Science and Technology, Aden, Yemen.*

ABSTRACT

Background: Impacted mandibular third molars are prevalent and can result in a number of pathologic conditions of adjoining mandibular second molars, such as distal caries, periodontal bone loss, and root resorption. It is important to know the pattern of impaction and risks involved in its early diagnosis and prophylaxis.

Objective: The aim of the study was to evaluate the connection between the impaction of the mandibular third molars and the pathological alteration of second molars in the Yemeni adults.

Methods: The study was a cross-sectional radiographic study of 250 panoramic radiographs from private dental clinics and image centers in Taiz, Ibb, and Sana in Yemen. Angulation (Winter classification), depth (Pell and Gregory), and related pathologies of the second molars of the impacted mandibular third molars were examined in 320 cases. Analysis of data was done through descriptive statistics and Chi-square tests.

Results: Mesioangular impaction was the most frequent (41.9), and then were the vertical (28.8) and horizontal impactions (18.4). Most common was class B impaction depth (47.5%). Second molar pathologies were found in 41.3% of cases, most frequently in distal caries (25.9%). The impaction angulation and second molar pathology were significantly related ($p < 0.001$), and mesioangular and horizontal impactions had the highest risk. Pathology also had a significant relationship with impaction depth ($p = 0.02$).

Conclusion: Mesioangular and deeper impactions are strongly correlated with increased risk of second molar caries, alveolar bone loss, and root resorption. These complications can be minimized through early radiographic assessment and early intervention.

Keywords: impacted third molar, second molar pathology, mesioangular impaction, distal caries, panoramic radiograph, Yemen.

**** Corresponding author address:*** *rayfalkhlydy6@gmail.com*

https://doi.org/10.20428/yjms.v20i3.3504
https://journals.ust.edu/index.php/yjms

INTRODUCTION

The third molar of the mandible is the most impacted tooth because it lacks space, has poor eruption direction, or is affected by heredity [1,2]. Impacted third molars may lead to a number of complications with neighboring structures, which affect mainly the mandibular second molar, including distal caries, root resorption, and periodontal bone loss [3, 4]. The tight contact of the two teeth is conducive to the build-up of plaque and bacterial intrusion, particularly in mesioangular and horizontal impactions [5, 6]. A number of studies have shown that impacted third molars and second molar pathologies have a significant relationship [4, 7-9]. The angulation of the impaction, depth, and eruption status determine the risk and severity of these lesions [10]. It is important to detect these relationships early before it is too late and to determine surgical decisions [11]. Despite the fact that much research has been carried out in different parts of the world, there is a scarcity of research in Yemen to determine the relationship between the impaction pattern and the second molar pathology. The available Yemeni reports were primarily on the prevalence of impaction [12,13] but not the clinical impact of impaction and association with second molar teeth pathologies. This means that more research is required to deliver local information, which can be used to institute preventive and treatment measures. Therefore, this study assessed the relationship between the patterns of impact of third molars of the mandible and second molar pathologies among Yemeni adults based on panoramic radiographs.

METHODOLOGY

Study Design

This cross-sectional radiographic study was carried out in several private dental clinics and centers in Taiz, Ibb, and Sanna'a cities in Yemen between January and June 2025.

Study Population and Sampling

The study included panoramic radiographs (orthopantomograms, OPGs) of Yemeni patients aged 18 years and above who attended dental clinics for diagnostic or treatment purposes. Radiographs were selected based on clear visibility of both mandibular second and third molars. A total of 250 panoramic radiographs were reviewed using a purposive sampling technique.

Sample Size Calculation

The sample size was calculated using the single population proportion formula:

$n = Z^2 P (1 - P) / d^2$

Where:

n = required sample size

Z = Z statistic for a 95% confidence level (1.96)

P = estimated prevalence from previous studies

d = margin of error (0.05)

Based on a previously reported prevalence of impacted mandibular third molars of 20% in a Yemeni population [13], the minimum calculated sample size was 246 radiographs. To compensate for possible exclusions, 250 panoramic radiographs were included.

Inclusion Criteria

The study included patients aged 18 years or older who presented with at least one impacted mandibular third molar, as confirmed by radiographic examination. Only cases with high-quality panoramic radiographs, free from distortion and suitable for accurate assessment, were considered eligible for inclusion.

Exclusion Criteria

Patients were excluded if radiographs demonstrated periapical lesions or evidence of previous surgical extraction in the third molar region. Additionally, cases with incomplete or blurred radiographic images that could compromise accurate evaluation were omitted. Patients with systemic conditions known to affect bone metabolism were also excluded from the study.

Operational Definitions and Variables

An impacted third molar was defined as a tooth that had not erupted into the dental arch at the anticipated age for the following reasons: lack of space, obstruction, or abnormal position [14]. The angulation of impaction was categorized according to Winter's classification as vertical impaction (Figure 1), which occurs when the third molar's long axis is parallel to the second molar's long axis (between 10 and −10°); mesioangular impaction (Figure 2), which occurs when the impacted tooth is tilted toward the second molar in a mesial

https://doi.org/10.20428/yjms.v20i3.3504
https://journals.ust.edu/index.php/yjms

direction (between 11 and 79°); horizontal impaction (Figure 3), which occurs when the third molar's long axis is horizontal (between 80 and 100°); distoangular impaction (Figure 4), which occurs when the third molar's long axis is angled distally or posteriorly away from the second molar (between −11 and −79°); and others (between 101 and −80°) [15, 16].

The depth of impact was noted according to Pell and Gregory's classification: Level A (Figure 5): the impacted tooth's occlusal plane is at the same level as the second molar's occlusal plane (the highest part of the impacted third molar is on a level with or above the occlusal plane); Level B (Figure 6): the impacted tooth's occlusal plane is between the occlusal plane and the second molar's cervical margin (the highest part of the impacted third molar is below the occlusal plane but above the second molar's cervical line); and Level C (Figure 7): the impacted tooth is below the second molar's cervical margin [15, 17]. Pathologies of the second molar were evaluated based on the following: distal caries, root resorption, or alveolar bone loss to the impacted tooth.

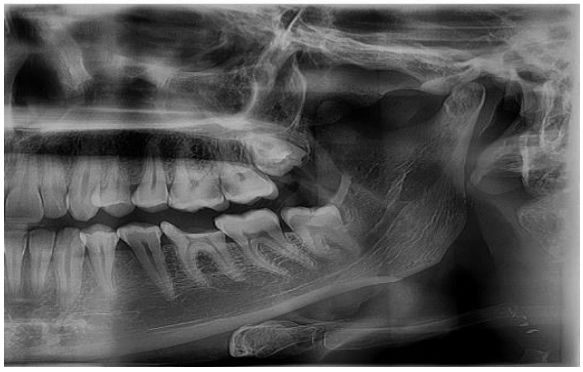

Figure 1: Vertical Impaction.

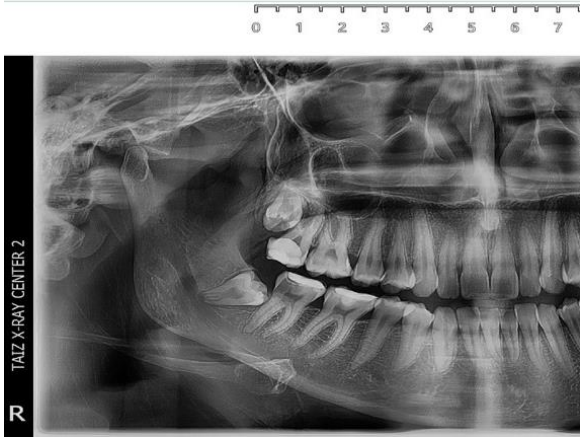

Figure 2: Mesioangular impaction

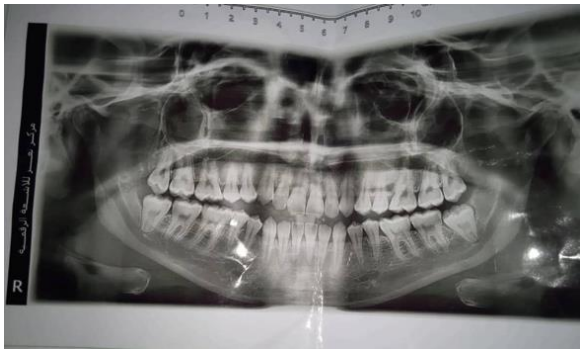

Figure 3: Horizontal Impaction.

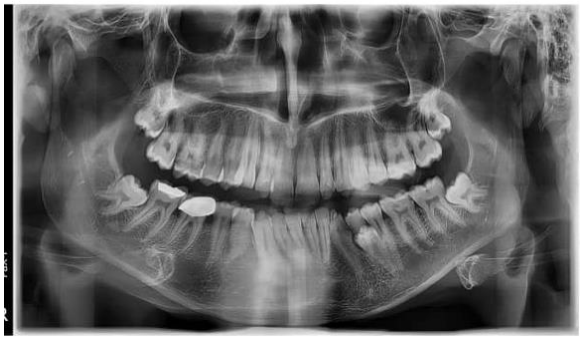

Figure 4: Distoangular Impaction.

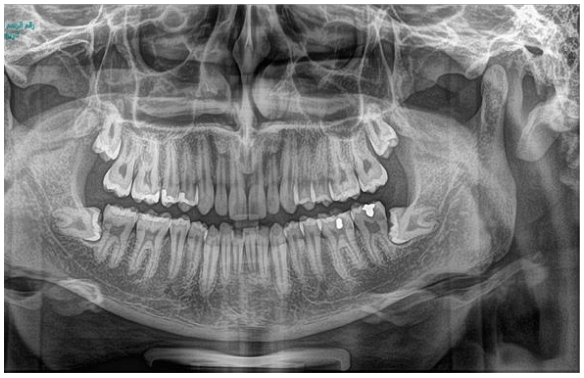

Figure 5: Level A Impaction.

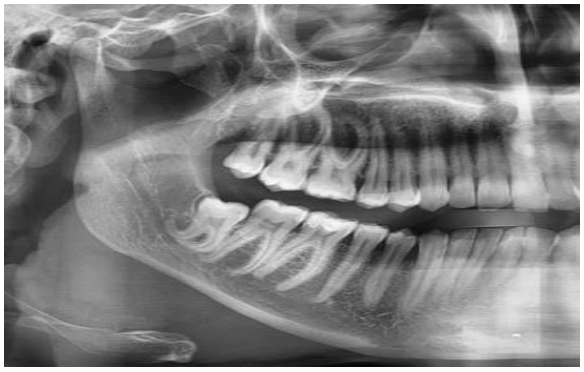

Figure 6: Level B Impaction.

https://doi.org/10.20428/yjms.v20i3.3504
https://journals.ust.edu/index.php/yjms

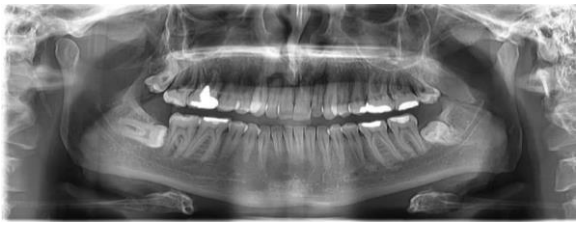
Figure 7: Level C Impaction.

Radiographic Assessment

All radiographs were evaluated in a digital viewing system to ensure that the lighting conditions would be the same for all evaluations. To avoid observer bias, both calibrated examiners (dentists and oral and maxillofacial surgery specialists) viewed the same radiographic images independently. Inter-examiner reliability between the two examiners was assessed with Cohen's kappa test, yielding a value of 0.89, indicating almost perfect agreement according to Landis and Koch [18].

Data Collection Procedure

This was a retrospective radiographic study. The panoramic radiographs were obtained from the digital archives of selected private dental clinics and radiographic centers after obtaining official permission. No direct contact with patients was made.

The principal investigator screened the archived panoramic radiographs according to the inclusion and exclusion criteria. Eligible radiographs were coded anonymously to ensure confidentiality. Each radiograph was evaluated independently by two calibrated examiners under standardized viewing conditions using a digital imaging system. The angulation of impaction was determined according to Winter's classification, and the depth was assessed using Pell and Gregory's classification.

The distal surface of the adjacent second molar was carefully examined for the presence of distal caries, root resorption, or alveolar bone loss. All collected data were recorded in a standardized Excel spreadsheet, including demographic variables (age, sex), impaction characteristics, and second molar pathology findings.

Ethical Considerations

The Medical Ethics Committee at the University of Science and Technology, Aden, Yemen, has approved the study [MEC/AD0131]. The participating radiographic centers and private dental clinics were also given a chance to be informed about the study before data collection. The study was based on a retrospective review of the available panorama radiographs; therefore, there were no personal contacts with the patients. Anonymization of all radiographs was done before assessment, and the identification details (names, phone numbers, or medical record numbers) were not captured. The study ensured the confidentiality and privacy of patients. The data obtained was only utilized for research purposes and was kept in a safe place with restricted access.

Statistical Analysis

Date analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics (frequency, percentage) were used to summarize data. The Chi-square test was applied to assess associations between impaction type and second molar pathology, with a p-value < 0.05 considered statistically significant.

RESULTS

As shown in Table 1, females constituted the majority of participants (58.4%), while males accounted for 41.6%. The most represented age group was 25–34 years (44.0%), followed by 18–24 years (36.8%), whereas ≥35 years represented the smallest proportion (19.2%).

Table 1: Demographic Characteristics of Participants (N=250)

Variable	Category	Frequency (n)	Percentage (%)
Sex	Male	104	41.6%
	Female	146	58.4%
Age group (years)	18-24	92	36.8%
	25-34	110	44.0%
	≥35	48	19.2%

Pattern of Impaction

Although 250 panoramic radiographs were included, a total of 320 impacted mandibular third molars were identified, as some patients presented with bilateral impactions. Therefore, the unit of analysis for tables 2, 3, and 4 was the impacted tooth rather than the patient. The most common impaction types were mesioangular impaction (Table 2), and according to Pell and Gregory's

https://doi.org/10.20428/yjms.v20i3.3504
https://journals.ust.edu/index.php/yjms

classification of impaction depth, Class B was most frequent (Table 3).

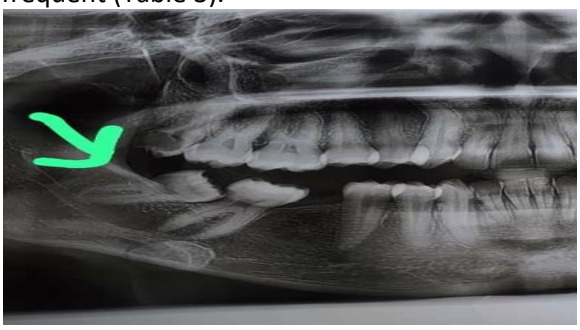

Figure 8: Distal Caries in the Second Molar

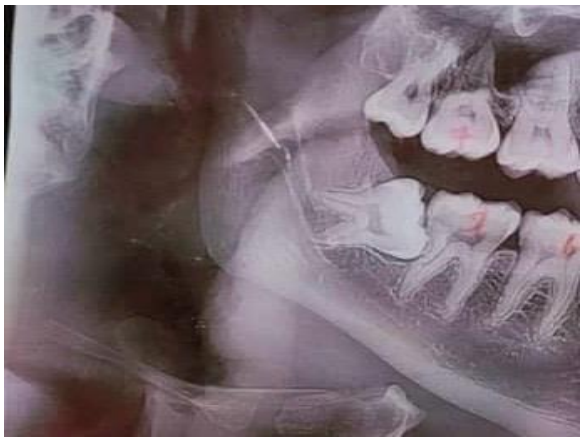

Figure 9: Alveolar bone loss between second and third molars

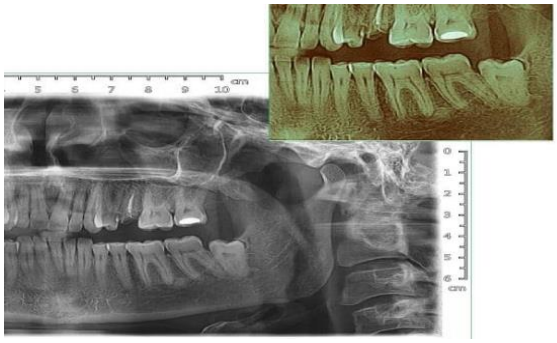

Figure 10: Root resorption of the second molar

Table 2: Categories of angulation of impacted mandibular third molars (according to winter's classification)

Impaction Type	Frequency (N)	Percentage (%)
Mesioangular	134	41.9%
Vertical	92	28.8%
Horizontal	59	18.4%
Distoangular	35	10.9%
Total	320	100%

Table 3: Impaction depth of mandibular third molars (according to pell and Gregory's classification)

Impaction Depth	Frequency (N)	Percentage (%)
Class A	109	34.1%
Class B	152	47.5%
Class C	59	18.4%
Total	320	100%

Prevalence of Second Molar pathologies

Pathologies in the second molar were found in 41.3% of cases. The most common finding was distal caries (25.9%).

Table 4: Prevalence of Second Molar Pathologies

Type of Pathology	Frequency (N)	Percentage (%)
Distal caries	83	25.9%
Bone loss	34	10.6%
Root resorption	15	4.7%
Total affected second molars	132	41.3%
Normal second molars	188	58.7%
Total examined	320	100%

Association between Impaction Type and Second Molar Pathology

There was a significant association between impaction angulation and the occurrence of second molar pathologies ($p < 0.001$). Mesioangular and horizontal impactions had the highest risk for second molar lesions (Table 5). Similarly, deeper impactions (class B and C) were more frequently associated with second molar pathology than superficial ones ($p = 0.02$) (Table 6).

https://doi.org/10.20428/yjms.v20i3.3504
https://journals.ust.edu/index.php/yjms

Table 5: Association between Impaction Angulation and Second Molar Pathology

Impaction Angulation	Pathology Present (n,%)	Pathology Absent (n,%)	p-value
Mesioangular	76 (56.7%)	58 (43.3%)	
Vertical	22 (23.9%)	70 (76.1%)	
Horizontal	30 (50.8%)	29 (49.2%)	
Distoangular	4 (11.4%)	31 (88.6%)	
Total	132 (41.3%)	188 (58.7%)	
Chi-square test			p < 0.001

Table 6: Association between Impaction Depth and Second Molar Pathology

Impaction Depth	Pathology Present (n,%)	Pathology Absent (n,%)	p-value
Class A	30 (27.5%)	79 (72.5%)	
Class B	73 (48.0%)	79 (52.0%)	
Class C	29 (49.2%)	30 (50.8%)	
Total	132 (41.3%)	188 (58.7%)	
Chi-square test			p < 0.02

DISCUSSION

The purpose of the current study was to examine the correlation between the pattern of the third molar impaction of the mandible and the presence of the pathological alterations in the neighboring second molars among the adults in Yemen. In the current analysis, the mesioangular direction was the most common, followed by vertical, horizontal, and distoangular. This distribution corresponds with previous findings reporting mesioangular impaction as the most common in the mandible [9,19-21]. This angulation is commonly thought to be high, as there is a small retromolar space and a natural mesial inclination of the mandibular third molar on eruption.

As per the classification of Pell and Gregory, Class B was the most prevalent as far as the depth of impaction was concerned. Other researchers have also associated similar findings, where they found that third molars located partially below the occlusal plane are the most common [19,22]. This middle level can easily be partially erupted and form a stagnant zone that is favorable to food impaction and bacterial growth.

Regarding pathological outcomes on the immediately neighboring second molar, the present research revealed that there was a significant percentage of cases with distal caries, bone loss, or root resorption. Such results are in line with other studies that have reported that affected third molars have a strong relationship with distal caries and periodontal destruction of the neighboring tooth [4,6,11,19,22,23]. The close space between the mesially inclined third molar and the distal surface of the second molar creates a niche for the retention of bacterial plaque that encourages carious and periodontal lesions.

The angulation of impaction was compared with second molar pathology, and a strong connection was observed ($p<0.001$). Pathology rates were the most significant in mesioangular and horizontal impactions, and the lowest risks were observed in vertical and distoangular impactions. These findings are in line with the results of previous studies [6,23,24] and Syad et al. [25], who showed that mesioangular impactions form the most significant causes of distal cervical caries of the second molar. The poor contact surface of the two teeth is attributed to this relationship, making retention of plaque easy and cleaning of the teeth difficult.

Also the depth of impaction was identified to contribute significantly to the incidence of second molar lesions. Class B and C cavities were more likely to be deeper in distal than superficial bone loss. This finding is consistent with a previous study [11]. This supports the view that deeper positioning reduces accessibility to oral hygiene and promotes anaerobic bacterial activity, which results in skeletal destruction of the periodontium.

Clinically, these results demonstrate the need for timely radiographic assessment and frequent follow-up of affected third molars, even in patients without any symptoms. A large number of lesions in the second molar can be invisible and manifest only at the later stage when there is a need to perform restorative or surgical treatment. Preventive extraction of affected third molars with undesirable angulation or depth can be thus considered to maintain the welfare of the second adjacent molar [24].

Limitations

This research has various limitations. It is cross-sectional, which means that it cannot create a clear cause-effect connection between third molar impaction and second molar pathology. Moreover, panoramics, as convenient and common, might not be able to highlight minor lesions as well as CBCT imaging. Finally, the

sample was not representative of the whole population because the areas used to select it were not extensive in Yemen.

Recommendations

It is suggested that future research utilizing CBCT and having a larger population size (including multicenters) will help in better understanding the extent of distal caries and bone loss due to impacted third molars. Preventive education, early diagnosis, and personalized management approaches should be stressed by clinicians in order to reduce the long-term harm of the second molars.

CONCLUSION

The current research revealed that there was a significant correlation between the pattern of mandibular third molar impaction and the occurrence of pathological alterations in the adjacent second molars in Yemeni adults. The mesioangular and horizontal impactions were identified to be the most risky as far as distal caries and alveolar bone loss are concerned, whilst deeper impactions (Class B and C) were more robustly associated with second molar pathology as compared to superficial locations. These results understand the significance of regular radiographic monitoring, early diagnosis, and timely treatment of affected third molars to prevent the second molars from developing long-term complications. There should be a comprehensive analysis and potential preventive extraction in situations where there is an unfavorable angulation or depth that predisposes the potential of pathology. More intricate research with a greater sample population and more precise imaging methods is suggested to give clearer answers to the process of development and preventability of these lesions.

Author's Contributions

Raeef Ali Alkhulidi contributed to conceptualization, methodology, data analysis, and manuscript drafting. Khaldon Al-Buriahy provided supervision and overall guidance for the study. Omar Mustafa Alqurashi, Abdulqader Al Mashraqi, Mohammed Almekhlafi, Fadl Mahmood Yahya Abdullah, and Linda Abdulqawi Hassan Mohammed were responsible for data collection. All authors reviewed and approved the final version of the manuscript.

Data Availability

The raw data supporting the findings of this study are available from the corresponding author upon reasonable request.

Funding

This study did not receive a special fund.

Conflict of Interest

The authors declare that there is no conflict of interest.

REFERENCES

1. Santosh P. Impacted mandibular third molars: review of literature and a proposal of a combined clinical and radiological classification. *Ann Med Health Sci Res*. 2015;5(4):229-234. doi:10.4103/2141-9248.160177
2. Trakinienė G, Smailienė D, Lopatienė K, Trakinis T, Šidlauskas A. Effect of genetic and environmental factors on the impaction of lower third molars. *Applied Sciences*. 2021;11(4):1824. doi:10.3390/app11041824
3. Chu FC, Li TK, Lui VK, Newsome PR, Chow RL, Cheung LK. Prevalence of impacted teeth and associated pathologies--a radiographic study of the Hong Kong Chinese population. *Hong Kong Med J*. 2003;9(3):158-163.
4. Arandi NZ, Jarrar A. Association between mandibular third molar impactions and distal carious lesions on the adjacent second molars: A cross-sectional study. *J Int Med Res*. 2025;53(3):3000605251324489. doi:10.1177/03000605251324489
5. Kindler S, Holtfreter B, Koppe T, et al. Third molars and periodontal damage of second molars in the general population. *J Clin Periodontol*. 2018;45(11):1365-1374. doi:10.1111/jcpe.13008
6. Poszytek D, Górski B. Relationship between the status of third molars and the occurrence of

dental and periodontal lesions in adjacent second molars in the Polish population: A radiological retrospective observational study. *J Clin Med*. 2023;13(1):20. doi:10.3390/jcm13010020

7. Marques J, Montserrat-Bosch M, Figueiredo R, Vilchez-Pérez MA, Valmaseda-Castellón E, Gay-Escoda C. Impacted lower third molars and distal caries in the mandibular second molar. Is prophylactic removal of lower third molars justified? *J Clin Exp Dent*. 2017;9(6):e794-e798. doi:10.4317/jced.53919
8. Demyati AK. Patterns of mandibular third molar impaction and its relationship with distal caries in the adjacent mandibular second molars: A retrospective study. *Saudi Dent J*. 2024;36(12):1544-1548. doi:10.1016/j.sdentj.2024.10.005
9. Skitioui M, Jaoui D, Haj Khalaf L, Touré B. Mandibular second molars and their pathologies related to the position of the mandibular third molar: A radiographic study. *Clin Cosmet Investig Dent*. 2023;15:215-223. doi:10.2147/CCIDE.S420765
10. Kang F, Huang C, Sah MK, Jiang B. Effect of eruption status of the mandibular third molar on distal caries in the adjacent second molar. *J Oral Maxillofac Surg*. 2016;74(4):684-692. doi:10.1016/j.joms.2015.11.024
11. Prasanna Kumar D, Sharma M, Vijaya Lakshmi G, Subedar RS, Nithin VM, Patil V. Pathologies associated with second mandibular molar due to various types of impacted third molar: A comparative clinical study. *J Maxillofac Oral Surg*. 2022;21(4):1126-1139. doi:10.1007/s12663-021-01517-0
12. Helmi JM, Hagar AA, Al-Jawfi KA, Al-dilami A, Al-Wesabi MA. Prevalence of impacted teeth among a sample of Yemeni population and their association with sex and age. *J Oral Res*. 2019;8(4):343-350. doi:10.17126/joralres.2019.051
13. Alhajj MN, Amran AG, Alhaidary S, et al. Prevalence and pattern of third molars impaction in a large Yemeni sample: a retrospective study. *Sci Rep*. 2024;14(1):22642. doi:10.1038/s41598-024-73556-9
14. Varghese G. Management of impacted third molars. In: Bonanthaya K, Panneerselvam E, Manuel S, Kumar VV, Rai A, eds. *Oral and Maxillofacial Surgery for the Clinician*. Springer; 2021. doi:10.1007/978-981-15-1346-6_14
15. Yilmaz S, Adisen MZ, Misirlioglu M, Yorubulut S. Assessment of third molar impaction pattern and associated clinical symptoms in a Central Anatolian Turkish population. *Med Princ Pract*. 2016;25(2):169-175. doi:10.1159/000442416
16. Winter GB. *Impacted Mandibular Third Molars*. American Medical Book Co.; 1926:241-279.
17. Pell GJ, Gregory BT. Impacted mandibular third molars: classification and modified techniques for removal. *Dent Digest*. 1933;39:330-338.
18. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics*. 1977;33(1):159-174.
19. Alsaegh MA, Abushweme DA, Ahmed KO, Ahmed SO. The pattern of mandibular third molar impaction and its relationship with the development of distal caries in adjacent second molars among Emiratis: a retrospective study. *BMC Oral Health*. 2022;22(1):306. doi:10.1186/s12903-022-02338-4
20. Hassan AH. Pattern of third molar impaction in a Saudi population. *Clin Cosmet Investig Dent*. 2010;2:109-113. doi:10.2147/CCIDEN.S12394
21. Quek SL, Tay CK, Tay KH, Toh SL, Lim KC. Pattern of third molar impaction in a Singapore Chinese population: a retrospective radiographic survey. *Int J Oral Maxillofac Surg*. 2003;32(5):548-552.
22. Haddad Z, Khorasani M, Bakhshi M, Tofangchiha M, Shalli Z. Radiographic position of impacted mandibular third molars and their association with pathological conditions. *Int J Dent*. 2021;2021:8841297. doi:10.1155/2021/8841297
23. Liu L, Zhang L, Lu S, Huang W, Song L, Xu B. Effect of mesioangular impaction of the mandibular third molars on the adjacent mandibular second

molars: An imaging study. *Curr Med Imaging*. 2023;19(6):623-630. doi:10.2174/1573405618666220921122006

24. Alsharif SB, Alsharif MB. Patterns of mandibular third molar impactions and its association with carious lesions and periodontal defects: A retrospective cross-sectional study. *Clin Cosmet Investig Dent*. 2025;17:481-490. doi:10.2147/CCIDE.S559569
25. Syed KB, Alshahrani FS, Alabsi WS, et al. Prevalence of distal caries in mandibular second molar due to impacted third molar. *J Clin Diagn Res*. 2017;11(3):ZC28-ZC30. doi:10.7860/JCDR/2017/18582.9509