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ORIGINAL PAPER

Radiographic Predictors of Extraction and Impaction Patterns of Third Molars among Adults in Saudi Arabia: a Retrospective Radiographic Study

Basma Ali ALMAGHLOUTH[a], Raghad Tariq AL JARBOUA[b], Haya Othman AL KHALDI[c], Fadak Hussain AL MARAR[d], Laila Hassan ALWUSAYBIE[e], Renad Fahad ALQAHTANI[f], Deema Ali ALSHAMMERY[g]

[a]Department of Orthodontics, Dammam Specialized Dental Center, Dammam Medical Complex, Eastern 1 Health Cluster, Dammam 32412, Saudi Arabia

[b]Department of Orthodontics, Fellowship in Orthodontics Program, College of Dentistry, Imam Abdulrahman Bin Faisal University, P.O. Box 1982, Dammam 31441, Saudi Arabia

[c]Department of Family Dentistry, Saudi Board of Family Dentistry program, Dammam Medical Complex, Dammam 32245, Saudi Arabia

[d]Department of General Dentist, College of Dentistry, Imam Abdulrahman Bin Faisal University, Dammam 31441, Saudi Arabia

[e]Resident, Saudi board of Orthodontics, Dammam Medical complex, Dammam 31441, Saudi Arabia

[f]Independent Researcher, Graduate of College of Dentistry, Imam Abdulrahman Bin Faisal University, Dammam 31441, Saudi Arabia

[g]Department of Preventive Dentistry, College of Medicine and Dentistry, Riyadh Elm University, Riyadh, Saudi Arabia

ABSTRACT

Background: *Third molar impaction is a prevalent dental condition with varying clinical presentations across populations. This retrospective study evaluated radiographic predictors and treatment outcomes of third molar impactions among adults in Saudi Arabia.*

Materials and methods: *A total of 791 panoramic radiographs obtained from patients referred to the Oral and Maxillofacial Surgery units at Dammam Medical Complex and Riyadh Elm University Hospital*

Address for correspondence:
Deema Ali Alshammery
Department of Preventive Dentistry, College of Medicine and Dentistry, Riyadh Elm University, Riyadh, Saudi Arabia
Email: deema@riyadh.edu.sa

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between 2018 and 2022 were analyzed. The angulation and level of impaction were assessed using the Pell and Gregory classification system. Statistical analyses, including logistic regression and chi-square tests, were performed to identify significant predictors of extraction.

Results: *The study cohort had a mean age of 35.3 ± 11.8 years, with females representing 53.1% of cases. Vertical impaction was the most common type (49.3%), followed by mesioangular (27.7%) and horizontal (14.8%). Tooth #48 (mandibular right third molar) was the most frequently extracted (43.7%), followed by tooth #18 (33.3%) and tooth #28 (31.6%). Logistic regression revealed that age 31–45 years, referral for extraction based on radiographic evaluation, impaction of tooth #48, Pell and Gregory Class II and Position B were significant predictors of extraction ($p < 0.05$).*

Conclusion: *Overall, 36.7% of cases required surgical extraction, whereas 63.3% were managed conservatively with periodic follow-up. These findings underscore the clinical value of early radiographic evaluation and individualized treatment planning to minimize complications associated with third molar impactions.*

Keywords: third molar, impaction, radiography, extraction, Saudi Arabia.

INTRODUCTION

Tooth impaction is a common developmental anomaly that occurs when a tooth fails to erupt into its correct position due to obstruction by adjacent teeth, bone, or soft tissues (1, 2). Among all teeth, third molars are the most frequently impacted, with a global prevalence estimated at approximately 24% (5). The prevalence varies widely across populations and is influenced by ethnicity, genetic background, environmental factors, and dietary habits. For example, studies have reported frequencies of 26.04% in the Delhi-NCR population (6), 54.3% in a neighboring Arab country (7), and relatively lower rates of 19.6%, 18.76%, and 16.5% in the Arab-Israeli region, the Asir region, and the Najran region of Saudi Arabia, respectively (2, 7, 8).

Although many impacted third molars remain asymptomatic and are often identified incidentally on radiographs (9), their presence can lead to pain, pericoronitis, cyst formation, or resorption of adjacent roots. Several regional studies have explored impaction patterns within Saudi Arabia. Level A depth impactions were reported in 46.6% of cases, while mesioangular impactions accounted for 40.8% (2). Other investigations showed that vertical impaction was the most common in Makkah (37.6%), Asir (52%), and Al Qassim (37%) (10, 11). On a global scale, a systematic review and meta-analysis demonstrated that mandibular third molar impactions are significantly more frequent than maxillary impactions, with odds 57.6% higher (5). The same study reported mesioangular impaction as the most prevalent type worldwide (41.2%), followed by vertical (25.6%), distoangular (12.2%) and horizontal (11.1%) orientations (5).

Despite these reports, data from Saudi Arabia remain limited to specific regions and comprehensive national estimates are scarce (3). The Oral and Maxillofacial Surgery Department at Dammam Medical Complex the largest Ministry of Health dental center in the Eastern Province manages a substantial number of third molar cases, while Riyadh Elm University Hospital, the largest private university hospital in Riyadh, also treats many patients requiring third molar evaluation and extraction. Therefore, this study aimed to investigate the radiographic patterns and predictive factors of third molar impactions among adults in Saudi Arabia, with emphasis on their prevalence, severity and clinical significance. ❑

MATERIAL AND METHODS

Patients and radiographic assessment

This retrospective study included patients in Saudi Arabia who presented to the Oral and Maxillofacial Surgery units at the Dental Specialized Centre in Dammam Medical Complex and Riyadh Elm University Hospital between January 2018 and December 2022 (4). Ethical approval was obtained from the institutional review board (IRB No. DEN-12). All residents of the Eastern

and Central Provinces during the study period were considered eligible, irrespective of age, gender, or nationality. Patients were referred to the Oral and Maxillofacial Surgery units for reasons including pain, pericoronitis, food impaction, swelling, suspected caries involving the second molar, periodontal breakdown adjacent to the third molar, cystic changes, orthodontic assessment of space limitations, or incidental radiographic findings requiring specialist evaluation.

Extraction was recommended when at least one of the following criteria was met: recurrent or persistent pericoronitis; caries or periodontal compromise affecting the second molar; pathological radiographic findings (cysts, root resorption, radiolucencies); difficulty cleaning leading to recurrent food impaction; orthodontic or prosthetic treatment requiring removal; unfavorable angulation increasing future risk of disease; patient-reported symptoms interfering with function.

Asymptomatic and radiographically stable teeth were managed conservatively.

Inclusion criteria required the presence of at least one impacted third molar in either jaw. Patients were excluded if they had a history of maxillofacial trauma, previous third molar extraction or pathology, incomplete clinical or radiological records, incomplete root formation, metabolic disorders, cleft lip and palate, systemic diseases, craniofacial anomalies, or syndromes such as achondroplasia, progeria, oxycephaly, or cleidocranial dysostosis (6, 8, 12).

Digital panoramic and lateral cephalometric radiographs were obtained using a J. MORITA 2D Veraviewepocs® unit (MFG Corp., Kyoto, Japan) operated at 65–90 kV and 5–10 mA. Additional bite-wing radiographs were acquired to assess developmental anomalies and impaction patterns, consistent with previous radiographic protocols (7, 13).

The depth and position of impactions were classified using the Pell and Gregory system (3, 4). Position A was defined when the occlusal plane of the impacted mandibular third molar was above the crown of the adjacent tooth; position B when the occlusal plane was between the cervical line and the occlusal plane of the mandibular second molar; and position C when the cervical line of the mandibular second molar was above the occlusal surface of the impacted third molar.

Impaction angulation was categorized as mesioangular, vertical, distoangular, or horizontal, following widely adopted classification criteria (5, 6). Demographic variables collected included age, gender, nationality and impaction location (mandibular or maxillary). All radiographs were independently assessed by three calibrated general dentists, and intra- and inter-observer reliability checks were performed to ensure diagnostic consistency (11, 14).

Sample size

Data were analysed using SPSS version 29 (IBM Corp., Armonk, NY, USA). Categorical variables, including gender, nationality, type of impaction, and associated anomalies, were summarised as frequencies and percentages (6). Comparisons of prevalence and impaction patterns by gender, age group, and nationality were performed using the chi-square test. Logistic regression analysis was applied to identify predictors of extraction in third molar impaction. A p-value ≤ 0.05 was considered statistically significant.

Statistical analysis

Data were analysed using SPSS version 29 (IBM, USA). Categorical data (gender, nationality, type of impaction, associated anomalies) were summarised as frequencies and percentages (7). Prevalence and impaction patterns were compared by gender, age group, and nationality using the chi-square test. Logistic regression analysis was performed to identify predictors of extraction in cases of third molar impaction. A p-value ≤ 0.05 was considered statistically significant. ❑

RESULTS

A total of 791 panoramic radiographs were evaluated for third molar impactions. Of these, 290 (36.7%) were referred for extraction, whereas 501 (63.3%) were advised periodic follow-up. The cohort included 371 males (46.9%) and 420 females (53.1%), with a mean age of 35.3 ± 11.8 years (range: 18–78 years).

By age group, 43.2% of patients were between 31–45 years, 38.7% between 18–30 years and 18.1% above 45 years. Extraction was recommended for 42.1% of patients aged 31–45,

TABLE 1. Predictive factors of panoramic radiographic evaluation of third molar impaction treatment

Factors	Total	Treatment		OR (95% CI)	Sig.
		No extraction	Extraction		
Age (years) 18-30	306 (38.7)	198 (64.7)	108 (35.3)	1.5 (1.0-2.3)	0.067
31-45	342 (43.2)	198 (57.9)	144 (42.1)*	2.0 (1.3-3.1)	0.001
>45	143 (13.1)	105 (73.4)	38 (26.6)	--	
Male	371 (46.9)	239 (64.4)	132 (35.6)	0.9 (0.7-1.2)	0.550
Female	420 (53.1)	262 (62.4)	158 (37.6)		
Referral: Yes	359 (53.7)	156 (43.5)	203 (56.5)*	56 (25.8-122.2)	0.001
No	309 (46.3)	302 (97.7)	7 (2.3)		
Tooth #18	180 (22.7)	120 (66.7)	60 (33.3)	4.6 (2.6-8.2)	0.001
Tooth #28	270 (34.1)	152 (56.3)	118 (43.7)*	7.1 (4.1-12.2)	0.001
Tooth #38	196 (24.8)	134 (68.4)	62 (31.6)	4.2 (2.4-7.5)	0.001
Tooth #48	293 (37.0)	165 (90.2)	18 (9.8)	--	

CI: confidence interval. Numeric values in parentheses represent percentages. Asterisks (*) indicate statistically significant differences in proportions at the 5% level of significance. Referral 'Yes' indicates cases sent specifically for surgical evaluation/extraction based on panoramic radiographic findings. Referral 'No' refers to routine dental cases in which third molars were detected incidentally.

TABLE 2. Characteristics of impaction in relation to treatment

Characteristics	Tooth #18		Tooth #28		Tooth #38		Tooth #48	
	NE	E	NE	E	NE	E	NE	E
Vertical	78 (72.2)	30 (27.8)	86 (71.1)	35 (28.9)	53 (63.1)	31 (36.9)	47 (61.0)	30 (39.0)
Soft-tissue	12 (42.9)	16* (57.1)	13 (56.5)	10 (43.5)	24 (63.2)	14 (36.8)	21 (51.2)	20 (48.8)
Mesioangular	8 (42.1)	11* (57.9)	8 (47.1)	9 (52.9)	47 (49.5)	48 (50.5)	46 (52.3)	42 (47.7)
Distoangular	20 (87.0)	3 (13.0)	22 (78.6)	6 (21.4)	8 (57.1)	6 (42.9)	9 (60.0)	6 (40.0)
Horizontal	1 (100)	0 (0)	3 (60.0)	2 (40.0)	33 (53.2)	29 (46.8)	29 (59.2)	20 (40.8)
Buccal/lingual	1 (100)	0 (0)	2 (100)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Sig.	P=0.002		P=0.161		P=0.361		P=0.743	
Positions								
A	242 (61.1)	154 (38.9)	239 (61.8)	148 (38.2)	250 (62.3)	151 (37.7)	251 (63.2)	146 (36.8)
B	21 (51.2)	20* (48.8)	20 (52.6)	18* (47.4)	62 (50.8)	60* (49.2)	61 (49.2)	63* (50.8)
C	100 (74.6)	34 (25.4)	110 (71.9)	43 (28.1)	73 (70.9)	30 (29.1)	64 (67.4)	31 (32.6)
Sig.	P=0.004		P=0.029		P=0.007		P=0.008	

NE: no extraction; E: extraction. Percentages are shown in brackets. Asterisks (*) denote statistically significant differences in proportions at the 5% level.

35.3% of those aged 18–30 and 26.6% of those above 45 years. No significant difference in extraction rates was observed between males and females (35.6% *vs*. 37.6%, p = 0.550) (9). Among 359 patients referred for extraction based on panoramic radiographic findings, 203 (96.7%) underwent extraction ($p < 0.001$).

Of the 791 impacted third molars, 180 (22.7%) involved tooth #18, 270 (34.1%) tooth #28, 196 (24.8%) tooth #38 and 293 (37.0%) tooth #48. The most frequently extracted tooth was #48 (43.7%), followed by #18 (33.3%) and #28 (31.6%). Only 9.8% of tooth #38 impactions were extracted (Table 1).

The most common impaction type was vertical (49.3%), followed by mesioangular (27.7%), soft-tissue (16.4%), horizontal (14.8%), distoangular (10.1%) and buccal/lingual impaction (0.4%). Soft-tissue and mesioangular impactions were significantly associated with extraction of tooth #18 (p = 0.002). Mixed impaction types were observed among extracted teeth #28, #38 and #48. Position B impactions of all four third molars were significantly associated with extraction (Table 2).

Mixed impaction types were observed among extracted teeth #28, #38 and #48. Position B impactions of all four third molars were significantly associated with extraction (Figure 1).

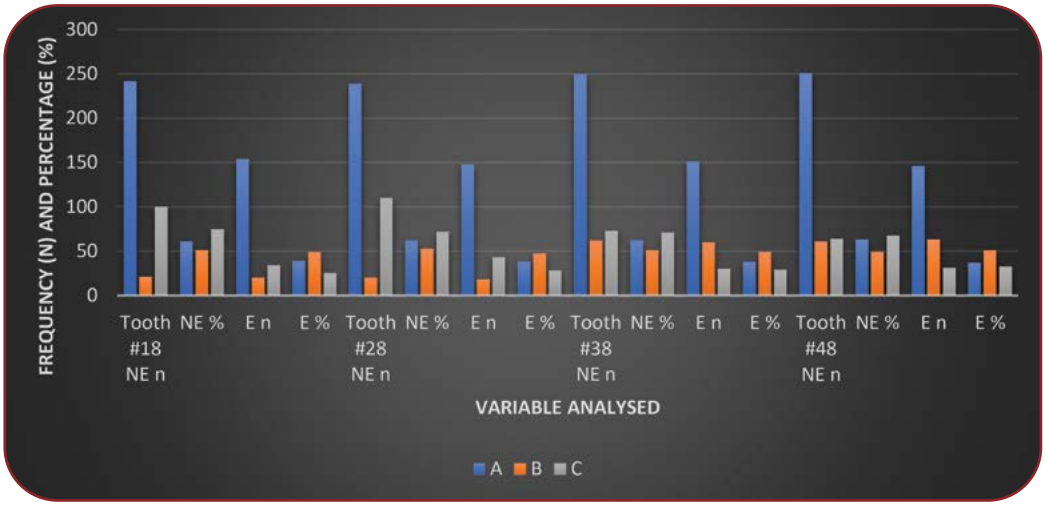

FIGURE 1. Teeth position in relation to treatment. A, B and C represent Pell and Gregory depth classifications: position A – occlusal plane of the third molar at or above the occlusal plane of the second molar; position B – occlusal plane between the CEJ and occlusal plane of the second molar; and position C – occlusal plane below the CEJ of the second molar (NE: no extraction; E: extraction; percentages are shown in brackets)

TABLE 3. Mandibular ramus in relation to treatment

Relation to ramus	Tooth #38			Tooth #48		
	Total	NE	E	Total	NE	E
Class I	484	312 (64.5)	172 (35.5)	497	314 (63.2)	183 (36.8)
Class II	120	62 (51.7)	58 (48.3)	111	61 (55.0)	50 (45.0)
Class III	20	12 (60.0)	8 (40.0)	14	6 (42.9)	8 (57.1)
Sig.	p=0.035			p=0.099		

In relation to the mandibular ramus, tooth #38 was most frequently Class I (61.2%), followed by Class II (15.2%) and Class III (2.5%). Extraction was significantly higher in Class II impactions (48.3%) compared with Class I (35.5%) and Class III (40%) ($p = 0.035$). For tooth #48, Class I was also most common (62.8%), followed by Class II (14.0%) and Class III (1.8%). A marginal association with extraction was observed for Class III ($p = 0.099$) (Table 3).

Associated dental anomalies included canine impaction (n = 14), microdontia (n = 13), supernumerary teeth (n = 10), hypodontia (n = 8), gemination (n = 2) and single cases of lymph node opacity and impacted molar. Extractions were most frequent in cases of canine impaction (eight of 14).

Logistic regression analysis identified age 31–45 years, referral for extraction based on panoramic radiograph findings, impaction of tooth #48, Class I mandibular ramus relation, and position B impactions as significant predictors of extraction ($p < 0.05$). ❑

DISCUSSION

This retrospective radiographic study investigated the prevalence, aetiology and patterns of third molar impaction among adults in Saudi Arabia. The results provide insight into the frequency and clinical management of impacted third molars in this population (9).

The majority of impactions were vertical (49.3%), followed by mesioangular (27.7%) and horizontal (14.8%). These findings are consistent with reports from Al Qassim (37%), Makkah (37.6%) and Asir (52%), where vertical impaction predominated (2, 10-12). In contrast, global data suggest mesioangular impaction is the most common pattern, accounting for 41.17% of cases in a systematic review of 49 studies (5). Such variation may reflect genetic, dietary and environmental influences on jaw growth and eruption patterns (6).

Although females demonstrated a slightly higher prevalence of impaction (53.1% *vs.* 46.9%), extraction rates did not differ significantly between sexes ($p = 0.550$). This trend parallels earlier studies reporting a modest but statistically insignificant female predominance (14, 15). Age also influenced treatment decisions: extractions were most frequent in the 31–45-year group (42.1%), followed by 18–30 years (35.3%), indicating that clinical complications commonly emerge in middle adulthood (15).

Mandibular third molars were more frequently indicated for extraction than maxillary coun-

terparts, consistent with prior literature (5, 13, 16). Tooth #48 (lower right third molar) exhibited the highest extraction rate (43.7%), followed by #18 (33.3%) and #28 (31.6%). Conversely, tooth #38 showed a notably lower extraction rate (9.8%), suggesting a reduced risk of pathology or less severe impaction (6).

The Pell and Gregory classification provided additional predictive value. Class II impactions were significantly associated with extraction (48.3%), underscoring the clinical relevance of impaction depth and angulation. Position B impactions similarly demonstrated higher extraction rates, confirming that positional characteristics are important predictors of surgical need (7).

Interestingly, most impacted third molars (63.3%) were managed conservatively with periodic follow-up rather than extraction. This aligns with the principle that not all impactions necessitate surgical intervention. Extractions should be reserved for symptomatic cases, such as those with pericoronitis, periodontal compromise, or risk to adjacent structures, while asymptomatic impactions may be safely monitored (8). Although metabolic syndrome was not the primary focus of this study, it is important to note the distinction between smoking-related metabolic disturbances and the classical obesity-driven metabolic syndrome. Smoking-associated metabolic changes arise from chronic systemic inflammation, oxidative stress, endothelial dysfunction, and altered lipid regulation, whereas obesity-related metabolic syndrome is predominantly linked to insulin resistance, visceral adiposity and adipokine dysregulation. This differentiation is relevant in understanding how systemic health may influence dental and periodontal outcomes in individuals presenting with impacted third molars.

Finally, several associated dental anomalies were identified, including canine impaction (14 cases), microdontia (13 cases) and supernumerary teeth (10 cases). Notably, canine impactions had a high extraction rate (57.1%), highlighting the importance of comprehensive radiographic assessment to guide management decisions (10).

Strengths of the study

- Large multicenter sample (n = 791) from two major tertiary dental centers
- Standardized radiographic assessment using a single imaging protocol
- High inter-observer agreement among calibrated evaluators
- Use of logistic regression to identify strong predictive factors.

Limitations of the study

- Retrospective design limits causal inference
- Panoramic radiographs cannot detect early periodontal or periapical changes
- Lack of CBCT confirmation for borderline or ambiguous cases
- Lifestyle variables (smoking, parafunctional habits) not evaluated.

Clinical implications

The findings of this study have several important clinical implications. Early radiographic identification of third molar impaction allows clinicians to stratify patients based on risk and recommend timely intervention for those who are more likely to develop complications. Position B impactions, mesioangular angulation and mandibular third molars – particularly tooth #48 – were shown to be strong predictors of extraction, indicating the need for closer monitoring and earlier referral in such cases. Understanding these predictors aids clinicians in reducing the incidence of pericoronitis, periodontal breakdown of second molars, and cystic changes associated with delayed treatment. Conversely, the high proportion of cases managed conservatively underscores the importance of individualized, evidence-based decision-making rather than routine prophylactic extraction.

This study provides the first combined dataset from both a large public oral surgery center and a major private university hospital in Saudi Arabia, offering a broader regional representation. It also identifies specific radiographic predictors – such as position B depth and Class II ramus relation – that significantly increase extraction likelihood, which have not been extensively quantified in prior Saudi studies. Additionally, the identification of tooth #48 as the strongest predictor of extraction provides clinically actionable insight for early management. ❑

CONCLUSION

This study provides important epidemiological evidence on third molar impaction in the Saudi population. Early radiographic evaluation

and judicious case selection for extraction remain essential to minimize complications and optimize outcomes. The findings underscore the need for evidence-based clinical guidelines tailored to local populations, while also highlighting that conservative management is appropriate in many asymptomatic cases. Future prospective studies incorporating long-term follow-up and clinical symptomatology are warranted to refine treatment protocols and strengthen decision-making in third molar management. ❑

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