Prevalence and Patterns of Permanent Tooth Impaction in Omani Dental Patients

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Abstract

Objectives: To determine the prevalence and anatomical patterns of permanent tooth impaction in adults at a single-centre dental hospital in Muscat, Oman, and to evaluate sex-specific differences in arch distribution, orientation, angulation and depth.

Methods: In this retrospective study at one dental hospital, all eligible panoramic radiographs acquired between December 2021 and December 2024 from patients aged ≥18 years were consecutively included (n = 1000). Two calibrated examiners jointly reviewed all images (with a third for disagreements) to record impaction status, FDI code, orientation (vertical/horizontal), angulation (modified Quek et al categories), numerical angle, laterality (unilateral/bilateral), and depth (Levels A-C). Data were analyzed in R (tidyverse, broom, gtsummary) with two-sided tests at $\alpha = 0.05$. Impaction prevalence and sex comparisons used Fisher's exact or χ^2 tests; odds ratios (95% CI) were obtained via logistic regression. Arch distribution and canine laterality were tested by binomial and χ^2 goodness-of-fit. Orientation, angulation, and depth were compared by χ^2 tests; continuous angles by Welch's t-test (Wilcoxon sensitivity).

Results: The sample comprised 477 males and 523 females (mean age 32.9 ± 15.1 years). Impaction was present in 500 patients; bilateral in 353 (no sex difference; OR 0.92, 95% CI 0.62–1.35, $p = 0.66$). Lower-arch impactions (302) outnumbered upper-arch (191; $p < 0.001$), and 11 supernumeraries were identified. Third molars accounted for 85.2% of impacted teeth; canines 6.6%. Vertical orientation predominated (352 vs 148; $\chi^2(1) = 4.05$, $p = 0.0495$). Distoangular angulation was most common in the maxilla and mesioangular in the mandible (both $p < 0.001$). Mean impaction angles did not differ by sex (39.3° vs 35.4°, $p = 0.115$). Depth distribution was 26.4% Level A, 37.8% Level B, and 35.8% Level C; men more often had Level C ($\chi^2(2) = 9.52$, $p = 0.008$).

Conclusions: Permanent tooth impaction affects half of this Omani sample, with third molars and lower-arch impactions predominating. Overall prevalence and bilateral rates were similar by sex; however, orientation and depth exhibited modest gender differences.

Keywords: Impacted Teeth; Prevalence; Panoramic Radiography; Oman

Introduction

Impaction of a permanent tooth occurs when its eruption into the oral cavity is impeded by bone, soft tissue, or an adjacent tooth, resulting in partial or complete retention below the occlusal plane.[1] Multiple factors contribute to this phenomenon, including insufficient growth of the maxillary and mandibular arches.[2] In modern diets, highly processed foods demand less masticatory effort, which may in turn reduce the functional stimulus necessary for optimal jaw development.[3] Genetic predisposition, aberrant positioning of the tooth germ, gender differences, and the presence of supernumerary teeth have also been implicated in the etiology of impaction.[4] Although many impacted teeth remain asymptomatic, they carry the potential for complications such as pericoronitis, pain, gingival bleeding, resorption of adjacent roots, malocclusion, caries, alveolar bone loss, and the formation of cysts or neoplasms.[5]

Third molars are by far the most frequently impacted teeth, with canines, premolars, and central incisors affected to a lesser extent.[6] Intraoral site also influences impaction rates; for instance, maxillary canines are impacted up to twenty times more often than their mandibular counterparts.[7] Reported prevalence of tooth impaction varies widely, from as low as 3% to nearly 69% in different populations.[8] Such heterogeneity reflects differences in genetic background, dietary habits, and access to dental care across regions. Despite numerous studies of impaction patterns in European and Asian cohorts, data remain limited for Middle Eastern populations, and even fewer investigations have examined the spectrum of impaction across all tooth types.

In Oman, a single study has reported that more than half of adult patients presented with at least one impacted third molar,[9] but comprehensive radiographic surveys of impaction involving other tooth categories or associated angulation and eruption level are lacking. Understanding the local distribution of impaction is critical for treatment planning, service planning, and anticipating common sequelae. In particular, detailed knowledge of impaction angulation, position relative to adjacent teeth, and depth of impaction informs surgical decision‑making and risk assessment. Furthermore, identifying which tooth types are most frequently impacted in an Omani patient population may aid clinicians in prioritizing early diagnosis and intervention. The present retrospective radiographic study therefore aimed to fill this knowledge gap by evaluating the prevalence and anatomic patterns of permanent tooth impaction in patients treated at a single dental hospital in Muscat, Oman.

Methods

This retrospective observational study was conducted at one dental hospital in Muscat, Oman, and included all patients whose files dated from 2012 onward. From this pool, OPGs acquired between December 2021 and December 2024 were retrieved for analysis. All panoramic radiographs were first evaluated against our inclusion and exclusion criteria. To be included, an OPG had to display the complete permanent dentition without distortion, and the patient needed to be aged 18 years or older with documented sex. Radiographs were excluded if image quality was inadequate; if the patient had a history of maxillofacial surgery, a craniofacial syndrome, or congenital facial disease; if trauma or pathosis had disrupted normal dentition alignment; if any teeth exhibited incomplete root formation; or if essential demographic data were missing. Of the 1494 OPGs acquired during the study window, 494 did not meet prespecified criteria; the remaining 1000 consecutive, eligible radiographs were included. One thousand radiographs is a sufficiently large sample because, with an expected impaction prevalence of approximately 38.7%,[10] and a desired margin of error of ± 3% at the 95% confidence level (Z = 1.96), this size ensures adequate precision. During the examination period (January 2025-March 2025), two calibrated examiners reviewed all selected radiographs jointly to identify and classify impacted permanent teeth using the imaging software Sidexis 4 (Version 4.3, Dentsply Sirona, Bensheim, Germany), consulting a third examiner whenever consensus could not be reached.

Impaction was defined as any permanent tooth whose complete eruption into the occlusal plane had been obstructed by bone, soft tissue or adjacent teeth for more than six months beyond its expected eruption age. Discrepancies between examiners were resolved by consensus during joint review. Each patient was assigned a unique identifier from 1 to 1000. For patients with one or more impacted teeth, each tooth was recorded separately in a supplemental "impacted‑tooth" database, although patient‑level summaries (for example, presence versus absence of any impaction) were used for overall prevalence and demographic comparisons.

Data recorded for every patient included sex, age in years at the time of radiography and an impaction flag. For each impacted tooth, the following information was captured: (1) Tooth type was recorded using the FDI two‑digit code. The angulation of impaction was first noted as vertical if the long axis of the impacted tooth was oriented approximately parallel to the adjacent tooth's long axis, or horizontal if it was oriented nearly perpendicular. (2) A modified version of the Quek et al. (2003) angulation classification was applied to all impacted teeth.[8] In this approach, mesioangular indicates the long axis tilts toward the midline of the arch; distoangular indicates the long axis tilts away from the midline; buccolingual indicates the long axis is approximately perpendicular to the occlusal plane or tilts buccally or lingually without significant mesial or distal inclination; inverted indicates the long axis is completely horizontal or oriented upside down; and upright indicates the long axis is nearly parallel to the occlusal plane with minimal tilt in any direction. (3) Measurement of the numerical Angle between each tooth's long axis and the patient's occlusal plane was performed directly on the radiograph using the built-in "Measure Angle" tool in the imaging software. Continuous Angle values were retained as numeric data for statistical comparison between males and females. (4) Side was recorded per patient by examining the contralateral tooth: unilateral if an impacted tooth appeared on only one side of the jaw, and bilateral if the impacted tooth was found on both sides. (5) Depth of impaction followed one of two sets of definitions, depending on the tooth's location. For anterior and premolar teeth, the impacted crown was classified as Level A if it reached or exceeded the cervical line of the adjacent anterior tooth; Level B if the crown lay between that cervical line and the root apex of the adjacent tooth; or Level C if it lay below the root apex of the adjacent tooth. For molars, Level A impaction was defined by an impacted crown at or above the occlusal plane of the tooth immediately anterior (for example, first molar for a second molar impaction or second molar for a third molar), Level B if the impacted crown lay between that occlusal plane and the cervical margin of the tooth immediately anterior, and Level C if the crown lay below that cervical margin. When a patient had multiple teeth impacted in the same arch, each tooth's was recorded independently.

Following data abstraction, all entries were exported to a CSV file and imported into R version 4.2.1 for analysis. Categorical variables were converted to factors with pre-specified level order. Age and Angle remained numeric. Tooth type was stored as a factor reflecting each FDI code encountered. Statistical analyses were performed in R (tidyverse, broom, gtsummary), with all tests two-sided at $\alpha = 0.05$. Prevalence of impaction was calculated overall and by sex, and compared using Fisher's exact or chi-squared tests (with Monte Carlo simulation when needed); odds ratios (95% CI) came from logistic regression. Among impacted teeth, arch distribution (1–2 = upper, 3–4 = lower) was tested against a 50:50 split via binomial and chi-squared goodness-of-fit; canine laterality (FDI ending in 3 categorized as Left [2–3] or Right [1–4]) used the same tests. Vertical versus horizontal counts were compared by sex using Pearson's chi-squared (simulated p-values as needed). Angulation categories were summarized by sex and tested via chi-squared. Continuous Angle measurements were described (mean ± SD, median, IQR, range) and compared by sex using Welch's t-test (Wilcoxon rank-sum as sensitivity). Levels of impaction (A, B, C) were summarized overall and by sex and compared with a chi-squared test (df = 2). Continuous variables are reported as mean ± SD and categorical variables as n (%).

Ethical approval for this study was obtained from the institutional ethics committee under reference ERIC-2024-224. As this investigation involved only retrospective review of de-identified radiographs, informed consent was waived. All study procedures complied with the Declaration of Helsinki.

Results

Of the 1000 patients, 477 (47.7%) were male and 523 (52.3%) were female. The overall mean age was 32.9 years (SD 15.1); males averaged 32.9 ± 15.2 years and females 33.0 ± 15.1 years. Tooth impaction was identified in 500 patients (50.0%), including 239 males (50.1% of males) and 261 females (49.9% of females). Bilateral impaction occurred in 353 patients (35.3%), affecting 171 males (35.8% of males) and 182 females (34.8% of females). The odds of bilateral impaction did not differ by gender (OR 0.92, 95% CI 0.62 to 1.35, p = 0.66).

Impacted teeth were far more common in the lower arch (n = 302, 60.6%) than in the upper arch (n = 191, 39.4%). Additionally, 11 supernumerary teeth (2.2%) were identified. Within the lower arch, third molars predominated (FDI 38 + 48 = 264 cases, 89.2%), with canines (n = 14, 4.7%) and other teeth (n = 18, 6.1%) less common. In the upper arch, third molars (FDI 18 + 28 = 162 cases, 84.8%) were most frequent, followed by canines (n = 19, 5.8%) and other teeth (n = 10, 5.2%). A binomial test confirmed significantly more lower-arch than upper-arch impactions ($p < 0.001$; $\chi^2(1) = 24.42$, $p < 0.001$). Of the 33 impacted canines, 20 (60.6%) occurred on the right side and 13 (39.4%) on the left side; although right-side cases were more common, this laterality difference was not significant ($p = 0.296$; $\chi^2(1) = 1.485$, $p = 0.223$).

Vertical impactions predominated overall (n = 352, 70.4%) over horizontal impactions (n = 148, 29.6%). When stratified by sex, 143 males (66.5%) and 193 females (74.8%) had vertical impactions, whereas 72 males (33.5%) and 65 females (25.2%) had horizontal impactions ($\chi^2(1) = 4.05$, $p = 0.0495$). As for the occurrence of the different angulations of impaction in the mandible, mesioangular impaction was most frequent (n = 308, 61.6%), followed by distoangular (n = 125, 25.0%), upright (n = 34, 6.8%) and transverse (n = 30, 6.0%). Among male patients, mesioangular, distoangular, upright and transverse impactions numbered 155 (65.4%), 53

(22.4%), 15 (6.3%) and 14 (5.9%), respectively. In female patients, the corresponding figures were 153 (59.1%), 71 (27.4%), 19 (7.3%) and 16 (6.2%). Although females showed a numerically higher rate of distoangular impaction (27.4% vs 22.4%), this difference did not reach statistical significance ($\chi^2(1) = 1.60$, $p = 0.206$). Additional analysis by arch revealed a mirror-image pattern: distoangular impactions significantly predominated in the upper arch, whereas mesioangular impactions were significantly more common in the lower arch (both $p < 0.001$). The mean angle of impaction in males was 39.3º (SD = 29.9º; median = 30º, IQR = 43.5º) versus 35.4º (SD = 25.2º; median = 31º, IQR = 32º) in females (Welch's t-test $p = 0.115$).

Impaction level distribution showed that Level A occurred in 132 cases (26.4%), Level B in 189 (37.8%) and Level C in 179 (35.8%); by gender, males had 54 Level A (23.5%), 79 Level B (34.3%) and 97 Level C (42.2%), and females had 77 Level A (29.6%), 107 Level B (41.2%) and 76 Level C (29.2%) ($\chi^2(2) = 9.52$, $p = 0.008$), indicating a significant gender difference in depth of impaction (Figure 1).

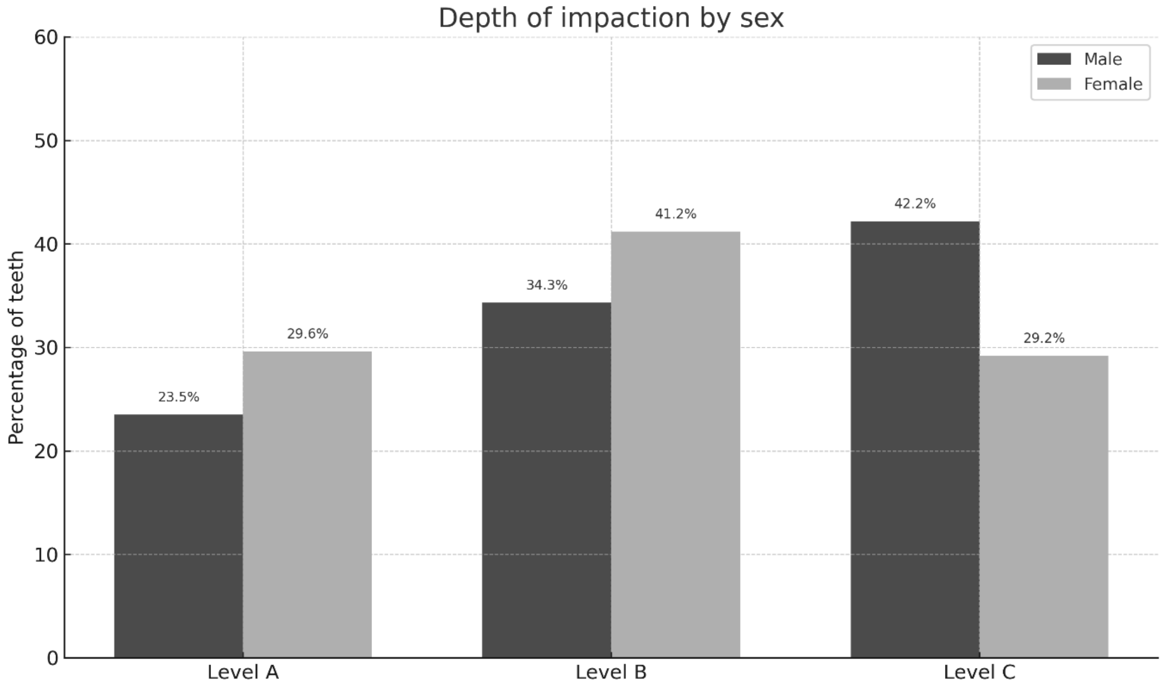

Figure 1. Depth of impaction (Levels A-C) by sex. Males showed a higher proportion of deeply embedded Level C impactions, whereas females more often presented with Level A and Level B, indicating a significant sex difference in impaction depth ($p = 0.008$).

Discussion

Clinical examination alone may not reveal the full extent of pathology within the oral cavity, and adjunctive imaging is therefore essential to achieve accurate diagnosis.[4] Panoramic radiography, in particular, provides a comprehensive view of the entire orofacial complex and is invaluable for treatment planning.[11] The prevalence and multifactorial etiology of tooth impaction have been extensively investigated,[10,12] and early identification of impacted teeth enables timely preventive interventions and more effective therapeutic outcomes.[13,14] Moreover, standardized classification schemes facilitate clearer communication among oral surgeons and help anticipate challenges and complications during surgical removal.[15] Despite these advances, research on permanent dentition treatment needs in Oman remains sparse,[9,16,17] as noted in a recent systematic review and meta-analysis.[18] Early identification of impacted teeth is critical to prevent future malocclusions and associated pathologies.[4,13] When detected early, surgical intervention can be less invasive, and orthodontic exposure with traction often allows successful eruption and functional use of the tooth.[19] Nevertheless, studies on the prevalence of tooth impaction remain relatively scarce.

In this retrospective study, the overall prevalence of impacted teeth was 50.0%, a figure that lies at the upper end of the global spectrum. Reported rates have varied widely from as little as 1.7% in Peru, Colombia, and Bolivia,[12] and 4.0–5.7% in Turkey,[20] to 4.5–13.2% in Saudi Arabia,[21-23], 18.4% in India,[24] 54.3% in Yemen,[25] and up to 73.9% among 20–29-year-olds in Brazil.[1] Such marked variation between populations supports the role of genetic and possibly environmental influences on impaction risk.[26]

In this cohort, third molars demonstrated the highest rate of impaction, with mandibular third molars affected more often than their maxillary counterparts. This finding is in line with two recent systematic reviews, which identified third molars as the most commonly impacted teeth across diverse populations.[26,27] The next most frequently impacted tooth was the canine, and, consistent with the broader literature, maxillary canines were more often impacted than mandibular canines. Published studies consistently rank the sequence of impaction prevalence as mandibular third molars, maxillary third molars, maxillary canines and then mandibular canines.[1,12,20,22-25]

In our Omani cohort, impacted teeth were substantially more frequent in the lower arch (60.6%) than in the upper arch (39.4%), in line with earlier observations that insufficient jaw size and mandibular space underlies most tooth impactions.[28-30] In cases of lower third‑molar impaction, it was found that the alveolar arch space behind the second molar was reduced in the majority of individuals and that skeletal factors namely the limited mandibular jaw length, a vertical condylar growth vector, and backward‑directed eruption of the dentition, each contributed to space deficiency.[26,28] The high proportion of lower‑arch impactions in Omanis suggests that similar morphological constraints exist in this population. Moreover, males in our sample exhibited more deeply positioned (Level C) lower impactions than females, consistent with findings that skeletal growth patterns, and perhaps delayed third‑molar maturation, further influence eruption success.[28] Furthermore, a modest tendency for vertical tooth retention was observed in females in our study.

Contemporary influences such as softer, processed diets may amplify these anatomical predispositions by reducing masticatory loading and thus limiting posteroinferior jaw development.[31] Genetic factors and a history of orthodontic interventions could also modulate mandibular arch form and jaw space.[16] In contrast, the upper arch generally maintains adequate room owing to its different growth trajectory and the absence of a rigid ramus structure. In a previous Omani study, maxillary spacing was observed in one quarter of cases, which may explain why upper impactions were less frequent in our sample.[16]

Several biological mechanisms may help explain the sex differences we observed in impaction depth and orientation. Gene-by-sex interactions in craniofacial and dental development suggest that partly different sets of genes modulate tooth formation and eruption in males and females, which may lead to subtle differences in eruption trajectories and impaction patterns.[32] Sex hormones also influence tooth eruption and peri-dental tissues; experimental work indicates that estrogen deficiency can slow eruption and alter gene expression in odontogenic regions, while hormonal fluctuations across the menstrual cycle can modify periodontal ligament metabolism and the efficiency of orthodontic tooth movement, pointing to a broader hormonal contribution to impaction dynamics.[33] Anatomical and developmental dimorphism provides a structural context for these effects: females tend to have smaller jaws and earlier eruption of permanent teeth than males, so relatively large teeth erupting earlier into a more constrained arch may have a higher likelihood of impaction and characteristic angulation patterns.[34] In contrast, the longer period of mandibular growth typically seen in males may create more distal space but can also allow teeth to migrate to deeper positions within the jaw before arresting, which is consistent with our observation of a higher proportion of deeply impacted teeth in men.

Regarding spatial positioning of impacted teeth, distoangular angulation was most common in the upper arch, whereas mesioangular angulation predominated in lower molars ($p < 0.001$). A recent retrospective review of 1397 OPGs also reported a higher frequency of distoangular impactions in the maxilla and mesioangular impactions in the mandible, consistent with our findings.[10] In the only prior Omani study of 1000 OPGs focusing on third molars, mesioangular impactions were most prevalent, followed by distoangular, but the authors did not distinguish between upper and lower arches.[9] That study did note a gender difference, with mesioangular impactions more common in males and distoangular more common in females, an association that was not present in our cohort.

The prevalence of impacted supernumerary teeth in our cohort was 2.2%, with most located in the anterior maxilla. Reported prevalence of supernumerary teeth in the general population ranges from 2.4% to 6%.[35] Although supernumerary teeth are relatively uncommon, an impacted rate of 2.2% is notable and may reflect genetic or environmental influences in this sample. Other studies have reported slightly lower rates of impacted supernumeraries, including 1.6% in India,[36] and 1.8% in Greece.[37]

Age-related patterns are influenced by the typical timing of different tooth impactions.[27] Impacted maxillary canines, the second most frequently impacted teeth after wisdom teeth, usually present even earlier (often by the early teens) and are typically managed in adolescence. As a result, relatively few impacted canines persist into later adulthood, which may explain their underrepresentation in radiographic studies of adult populations. In fact, an earlier Omani study focusing on late-teen and young adult patients (aged 19-26 years) reported that 54.3% had at least one impacted third molar.[9] This high prevalence among youths aligns with the idea that the late teens to mid twenties are the peak period for third molar impaction to be present or diagnosed. By contrast, in our study's older patients (for example, those in their 40s and above), the prevalence of retained impacted teeth was much lower. This decline with age is expected and has been noted elsewhere; for example, a recent study observed that only about 3% of patients over 40 years old in a UAE sample still had an impacted third molar on radiographs.[38] The sharp drop in impaction prevalence among older adults is largely attributable to the removal of third molars over time, either prophylactically or due to symptoms. In other words, many individuals who had impacted wisdom teeth in early adulthood no longer have them by middle age because the teeth have been extracted or, in fewer cases, have eventually erupted into functional position.

From a public health perspective, the high prevalence of impacted teeth in this adult, hospital-based cohort indicates a substantial and ongoing demand for surgical and restorative care and underscores the need for risk-based screening and early preventive strategies. Preventive management of impacted teeth requires adherence to established surgical protocols and begins with appropriate radiographic assessment in late adolescence and early adulthood to identify asymptomatic impactions, detect any associated cystic or neoplastic lesions, and recognise patients with multiple impactions who may warrant investigation for systemic disorders. Beyond extraction, impacted or supernumerary teeth may be repurposed as donor grafts in autotransplantation, a biologic rehabilitation strategy that has demonstrated high long-term success and can serve as a lower cost, growth compatible alternative to implants in younger patients.[39] In this context, local prevalence and pattern data can support planning of specialist oral surgery services, strengthen referral pathways between general dentists, orthodontists and oral and maxillofacial surgeons, and guide patient counselling about the timing of third molar and canine management. The decision to extract or retain an impacted tooth should remain individualised and guided by a careful assessment of the risk of future complications.

A key limitation of this study is its retrospective, single‑center design and reliance on two‑dimensional panoramic imaging, which may not capture three‑dimensional relationships or account for unrecorded factors such as prior orthodontic treatment, diet, or genetic influences, potentially limiting the generalizability of our findings. Because the cohort was restricted to adults (≥18 years), tooth classes that are often treated earlier, particularly canines, may be under-ascertained. Prior orthodontic traction or extraction before adulthood would not appear on adult panoramic surveys, so the adult prevalence reported here should not be interpreted as lifetime incidence for those teeth. Future work should use prospective, multi centre designs with three dimensional imaging and detailed records of orthodontic history, occlusal status and systemic factors to refine these estimates and clarify underlying mechanisms.

Conclusion

In this large, single-centre, adult hospital cohort drawn by systematic sampling, half of the patients had at least one impacted permanent tooth. Impacted teeth were far more common in the lower arch than in the upper arch, and third molars accounted for the vast majority of impactions in both arches. Vertical impactions predominated overall, with women showing a modest excess compared to men. A clear angulation pattern emerged by arch: distoangular impactions were most frequent in the maxilla, while mesioangular impactions predominated in the mandible. Depth of impaction also differed by gender, with men more often presenting with the most deeply buried (Level C) teeth. Canine impactions were uncommon and showed no significant side preference, and impacted supernumerary teeth were rare.

These results establish a detailed epidemiologic baseline for tooth impaction patterns in an understudied Middle Eastern population. They reinforce the importance of routine panoramic screening, particularly for lower third molars, and of applying standardized classification and measurement protocols to inform surgical planning. Prospective investigations that include three-dimensional imaging, detailed orthodontic histories, and exploration of functional and genetic factors are needed to clarify the mechanisms behind mandibular space restriction and arch-specific impaction risk. In the interim, these findings can help clinicians in Oman and similar settings anticipate common impaction scenarios, counsel patients appropriately, and plan interventions that minimise morbidity and support long-term oral health.

Disclosure

The authors declare no conflicts of interest. No funding was received for this study. The de-identified dataset and R analysis code are available from the corresponding author upon reasonable request.

References

1. Pedro FL, Bandéca MC, Volpato LE, Marques AT, Borba AM, Musis CD, Borges AH. Prevalence of impacted teeth in a Brazilian subpopulation. The journal of contemporary dental practice. 2014;15(2):209-13.

2. Breik O, Grubor D. The incidence of mandibular third molar impactions in different skeletal face types. Australian dental journal. 2008;53(4):320-4.

3. Santosh P. Impacted mandibular third molars: Review of literature and a proposal of a combined clinical and radiological classification. Annals of medical and health sciences research. 2015;5(4):229-34.

4. Yildirim D, Yilmaz HH, Aydin U. Multiple impacted permanent and deciduous teeth. Dentomaxillofacial Radiology. 2004;33(2):133-5.

5. Rokbah MQ, Al-Moudallal Y, Al-Khanati NM, Hsaian JA, Kokash MB. Effects of German chamomile on symptoms and healing after mandibular third molar surgeries: a triple-blind split-mouth randomised controlled trial. International Journal of Surgery Open. 2023;56:100639.

6. Kaczor-Urbanowicz K, Zadurska M, Czochrowska E. Impacted Teeth: An Interdisciplinary Perspective. Advances in clinical and experimental medicine: official organ Wroclaw Medical University. 2016;25(3):575-85.

7. Kuftinec MM, Shapira Y. The Impacted Maxillary Canine. (II) Orthodontic Considerations and Management. Quintessence International. 1984;15(9):921

8. Quek SL, Tay CK, Tay KH, Toh SL, Lim KC. Pattern of third molar impaction in a Singapore Chinese population: a retrospective radiographic survey. International journal of oral and maxillofacial surgery. 2003;32(5):548-52.

9. Al-Anqudi SM, Al-Sudairy S, Al-Hosni A, Al-Maniri A. Prevalence and pattern of third molar impaction: a retrospective study of radiographs in Oman. Sultan Qaboos University Medical Journal. 2014;14(3):e388.

10. da Silva Menezes CG, Sartoretto SC, Louro RS, de Moraes JB, Moraschini V. Prevalence of impacted teeth: A radiographical retrospective Rio de Janeiro population-based study. Journal of Maxillofacial and Oral Surgery. 2024;23(1):75-80.

11. Perschbacher S. Interpretation of panoramic radiographs. Australian dental journal. 2012;57:40-5.

12. Tetay-Salgado S, Arriola-Guillén LE, Ruíz-Mora GA, Aliaga-Del Castillo A, Rodríguez-Cárdenas YA. Prevalence of impacted teeth and supernumerary teeth by radiographic evaluation in three Latin American countries: A cross-sectional study. Journal of Clinical and Experimental Dentistry. 2021;13(4):e363.

13. Rahal N, Tahraoui CH. Dental Impaction: Detecting, Warning Signs, and Prevention Strategies. International Dental Journal. 2024;74:S397-8.

14. Sockanathan L, Ahmad NS, Zakaria AS. Early Detection and Interceptive Orthodontic Treatment of Impacted Canine: A Case Report. International Journal of Clinical Pediatric Dentistry. 2024;17(6):706.

15. Kharat S, Udmale SS, Nath AG, Bhole GP, Bhirud SG. Classification of Impacted Teeth from Panoramic Radiography Using Deep Learning. InInternational Conference on Distributed Computing and Intelligent Technology 2024(pp. 257-270). Cham: Springer Nature Switzerland.

16. Al Jadidi L, Sabrish S, Shivamurthy PG, Senguttuvan V. The prevalence of malocclusion and orthodontic treatment need in Omani adolescent population. Journal of orthodontic science. 2018;7(1):21.

17. Qutieshat A, Al Harthy N, Javanmardi S, Singh G, Chopra V, Aouididi R, Al Hanashi O, Al Arabi A. Prevalence of mesio-distal dilaceration in patients presenting for initial orthodontic care: A retrospective study. Journal of Orthodontic Science. 2023;12(1):13-8

18. Shivanna PB, Gopalakrishna VB. Prevalence of orthodontic treatment needs in permanent dentition in the population of Gulf Cooperation Council countries: A systematic review and meta-analysis of observational studies. Journal of Orthodontic Science. 2023;12(1):39.

19. Bolooki H, Hameed O, Sherriff M, Minhas G. Positional factors affecting the surgical management of impacted permanent mandibular canines. Journal of Orthodontics. 2022;49(4):441-7.

20. Şimşek HO, Ozkan G, Demetoğlu U. Prevalence and treatment approaches of impacted teeth in older adults. Turkish journal of geriatrics/türk geriatri dergisi. 2020;23(4).

21. Alamri A, Alshahrani N, Al-Madani A, Shahin S, Nazir M. Prevalence of impacted teeth in Saudi patients attending dental clinics in the Eastern province of Saudi Arabia: A radiographic retrospective study. The Scientific World Journal. 2020;2020(1):8104904.

22. Alalola BS, Almasoud FS, Alghamdi KB, Almalki LM, Alodan YA, Alotaibi SN, Alali SR. Comparing the prevalence of impacted teeth through radiographic evidence among orthodontic and general populations: A secondary data analysis. The Saudi Dental Journal. 2023;35(8):1053-7.

23. Swapna LA, Koppolu P, Al Ali HS, Almutairi AM, AlAssem AM, Almutairi AK, Alanazi BI, Aljurbua IA, Alshamrani AA. Prevalence of impacted and fuzzy teeth texture in Riyadh region: a retrospective digital radiographic study. Soft Computing. 2023:1-8.

24. Bhutania S, Ajilab V, Babub GS, Hegdeb S. Prevalence of impacted teeth in a south indian population using cone beam computed tomography: A retrospective study. Archives of Orofacial Sciences. 2022;17(2):157-67.

25. Hagar AA, Helmi JM, 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.(Impresa). 2019:343-50.

26. Carter K, Worthington S. Predictors of third molar impaction: a systematic review and meta-analysis. Journal of dental research. 2016;95(3):267-76.

27. Pinto AC, Francisco H, Marques D, Martins JN, Caramês J. Worldwide Prevalence and Demographic Predictors of Impacted Third Molars—Systematic Review with Meta-Analysis. Journal of Clinical Medicine. 2024;13(24):7533.

28. Björk A, Jensen E, Palling M. Mandibular growth and third molar impaction. Acta odontologica scandinávica. 1956;14(3):231-72.

29. Kaya GÖ, Aslan M, Ömezli M, Dayi E. Some morphological features related to mandibular third molar impaction. Journal of Clinical and Experimental Dentistry. 2010;2(1).

30. Krecioch J. Examining the relationship between skull size and dental anomalies. Bulletin of the International Association for Paleodontology. 2014;8(2):224-32.

31. Boughner JC. Implications of vertebrate craniodental evo‐devo for human oral health. Journal of Experimental Zoology Part B: Molecular and Developmental Evolution. 2017;328(4):321-33.

32. Sharma K. Genetic determinants and dynamics of permanent teeth emergence in Northwest Indian twins: A chronogenetic study. Homo. 2014;65(6):450-63.

33. Peruga M, Lis J. Correlation of sex hormone levels with orthodontic tooth movement in the maxilla: a prospective cohort study. European Journal of Orthodontics. 2024;46(3):1-9.

34. Bakri MM, Hezam AA, Qurishi AA, Alotaibi FI, Aljabri YS, Sharrahi HM, Hablool MO, Arishy LM. The influence of arch shape on the incidence of third molar impaction: A cross-sectional study. The Saudi Dental Journal. 2024;36(9):1221-6.

35. Anthonappa RP, King NM, Rabie AB. Prevalence of supernumerary teeth based on panoramic radiographs revisited. Pediatric dentistry. 2013;35(3):257-61.

36. Patil S, Maheshwari S. Prevalence of impacted and supernumerary teeth in the North Indian population. Journal of clinical and experimental dentistry. 2014;6(2):e116.

37. Fardi A, Kondylidou-Sidira A, Bachour Z, Parisis N, Tsirlis A. Incidence of impacted and supernumerary teeth-a radiographic study in a North Greek population. Med Oral Patol Oral Cir Bucal. 2011;16(1):e56-61.

38. Al-Madani SO, Jaber M, Prasad P, Maslamani MJ. The patterns of impacted third molars and their associated pathologies: a retrospective observational study of 704 patients. Journal of clinical medicine. 2024;13(2):330.

39. Raabe C, Bornstein MM, Ducommun J, Sendi P, von Arx T, Janner SF. A retrospective analysis of autotransplanted teeth including an evaluation of a novel surgical technique. Clinical oral investigations. 2021;25:3513-25.