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IIUM Journal of Orofacial and Health Sciences (IJOHS) is a peer-reviewed biannual international journal dedicated to publishing high-quality scientific research in the field of orofacial sciences, health sciences and interdisciplinary fields, including basic, applied and clinical research. The journal welcomes review articles, original research, case reports and letters to the editor. Areas that are covered include, but are not limited to, dental sciences, oral microbiology and immunology, oral maxillofacial and craniofacial surgery and imaging, dental stem cells and regenerative medicine, dental biomaterials, oral maxillofacial genetic and craniofacial deformities, dental public health and health sciences.

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Strengthening postgraduate dental education: upholding standards while preserving human-centered care

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Introduction

Postgraduate dental education in Malaysia is undergoing rapid change. Two priorities are essential as the next generation of oral health professionals are educated by the dental profession to ensure the continued delivery of high-quality specialist care: adopting new technology and maintaining human-centered values. In addition to expanding postgraduate dental education beyond local geographic areas and maintaining globally recognized quality standards, postgraduate dental education programs must also be flexible to respond to the different community-based health needs that vary significantly across geographical, socioeconomic, and cultural contexts (Arany *et al*., 2023). In Malaysia's evolving educational landscape, how can postgraduate dental education ensure that standards of competence remain comparable across countries while remaining responsive to local needs?

International competency frameworks and competency-based programs

Competency-based frameworks of education have become increasingly important in postgraduate dental education because they enable comparisons of the quality of education and graduates' competencies across countries (Şahin & Ural, 2025). Recently the World Federation of Orthodontists (WFO) released international guidelines for postgraduate orthodontic education that utilize a competency-based framework to evaluate postgraduate education on an international basis (Ono *et al*., 2023). The guidelines identified several core competencies regardless of the training locations of postgraduate orthodontic programs, such as clinical skills, professionalism and communication. In response to the significant variability in program structure, duration and assessment methods in periodontics, the European Federation of Periodontology has similarly undertaken efforts to harmonize competencies and assessment approaches to

promote consistency in specialist periodontic education across Europe (Goldstein *et al*., 2024).

Although the trend towards developing global standards for education has good intentions, it also runs a risk of favoring some forms of educational models over others. Competency-based frameworks developed by high-resource countries with established assessment systems are less likely to transfer to regions with different scopes of practice, regulation, and patient populations (Shin *et al*., 2021). The question is not about whether we should go forward with competency-based education, but rather how to implement it that is relevant to our local needs while maintaining international credibility.

The integration of entrustable professional activities (EPAs), a competency-based evaluation method for determining when students are ready to function independently to complete specific professional activities, is a new trend in dental education (Ten Cate & Taylor, 2021). In my opinion, EPAs can be developed for many specialty areas within dental education. They could provide a framework to connect competency domains and specific clinical tasks by defining 'units of professional practice' that can be entrusted to students when they have demonstrated sufficient competence (Sethi *et al*., 2024). Successful implementation depends on providing extensive faculty development to ensure that all faculty members are trained in a reliable manner to use them to assess their students. This is in agreement with a cross-sectional survey of postgraduate dental faculty and trainees, which reported that 63% of faculty members felt that prior training was necessary for effective implementation of the EPAs, and thus the authors recommended "comprehensive faculty development programs" and faculty calibration sessions to ensure consistency in the evaluation process (Yousuf *et al*., 2025). However, EPA implementation may also be constrained by the practical challenges associated with incorporating them into current assessment systems without adding additional assessment burden (Andreou *et al*., 2024). In this context, international collaborations and benchmarking could provide a strategic approach to address the practical limitations by enabling shared development efforts, faculty calibration, and the standardization of assessments across institutions (Encandela *et al*., 2023).

Value-based education and education for sustainable development: expanding the mandate

Recently, two additional educational components that are becoming increasingly emphasized in postgraduate dental education are Value-Based Education (VBE) (Nafea *et al*., 2025) and Education for Sustainable Development (ESD) (Dixon *et al*., 2025). VBE places an emphasis on students developing a sense of ethical responsibility, professional integrity, empathy and social accountability as core competencies that will guide the students' clinical decision-making processes and interactions with patients. VBE could be explicitly included or incorporated in every aspect of a curriculum including the assessment process and clinical supervision to ensure that students demonstrate not only technical competence but also the moral compass that is required to lead the next generation of specialist dental professionals (Rehman *et al*., 2023).

The incorporation of ESD into the curriculum builds on the foundation of VBE by connecting the training of specialist dental professionals to the United Nations' Sustainable Development Goals (SDGs) specifically related to health equity, quality education and responsible consumption (Chand *et al*., 2025). The concept of sustainability in health care implies a stewardship of health systems along three complementary dimensions: systems resilience, the promotion of patient welfare, and equitable access to specialized care (Muteb Dgheman Al Shamry *et al*., 2024). This means having the financial and operational resources necessary to maintain viability in the face of changing populations' needs and an emphasis on long-term health outcomes and preventive efforts, whilst reducing inequities relating to

socioeconomic status and geographical areas.

Furthermore, a case-based and problem-based approach to learning in specialist dental programs is becoming a trend internationally and is supporting the development of ethical reasoning, shared decision-making and reflective practice (Wang *et al*., 2021). Several Malaysian dental institutions have developed blended models of curriculum design including modules that provide an opportunity for active learning and competency-based curricula in areas such as dental materials science and special care dentistry that can support student-centered approaches (Mohamed Rohani & Mohd Nor, 2021; Lin *et al*., 2023). These student learning experiences will empower specialists to respond to the rigors of clinical decision making, communicate risks effectively to patients and deliver patient-centered treatment options. As a matter of fact, these are the competencies needed to address the complex health challenges of the 21st century.

While VBE and ESD principles find increasing endorsement in higher education frameworks, the implementation remains a primary obstacle (Kuan, 2025). Dental specialist programs are already pressured to accommodate the ever-expanding components of clinical knowledge and technology in fixed training periods (Bamedhaf *et al*., 2025). Incorporating specific VBE and ESD components into specialist curricula would require difficult decisions about what existing content might need to be streamlined. Assessing values, attitudes, and behaviors is inherently challenging and Field *et al*. (2023) recognized the need for valid assessment methods that adequately address these dimensions without reverting to self-report or knowledge-based testing.

Integration of artificial intelligence in postgraduate dental education

Artificial Intelligence (AI) is making its way into disease diagnosis, treatment planning and educational resources for the dental profession. Genuine concerns have been raised about the use of AI. Glick *et al*. (2022) reported that inexperienced dental clinicians using AI assistance to inform their clinical decision-making exhibited an over-reliance on the AI recommendation. A scoping review has identified ongoing issues such as algorithmic bias, data privacy, variability in models and a lack of clinician input in the development of AI, and consideration of its ethical implications (El-Hakim *et al*., 2025). If these are not resolved, professional judgments of clinicians may be jeopardized and consequently put patients' welfare at risk of harm. Postgraduate dental education should therefore retain its emphasis on critical thinking and reflectivity so that specialists learn to make use of AI as an analytical assistant to professional judgment rather than as a replacement for it. When AI is introduced in a human-centered and ethically governed way, it can facilitate rather than detract from using the principles of VBE in the training of specialists, while protecting professional responsibility, and the ethics of implementing the new technology (Rokhshad *et al*., 2023).

Keeping the human at the center: rhetoric or reality?

The real question now arises: are humanistic competencies meaningfully implemented in postgraduate education and practice, or do they remain largely "filler" statements within curriculum documents?

Humanistic competencies are often afforded less curricular time, fewer faculty development opportunities and less rigorous assessment frameworks compared with technical and procedural skills (Morrow *et al*., 2023). Thus, many curricula find assessment of empathy, compassion and ethical reasoning difficult to achieve to the same degree of rigor that clinical competencies are assessed (Naguib *et al*., 2020).

Sauerbrei *et al*. (2023) highlighted recommendations such as protected curricular time for humanistic skill development, intensive faculty development initiatives modelling and teaching relational competencies, robust assessment

approaches for both empathy and ethical reasoning, and rich institutional cultures recognizing both humanistic and technical competencies. Morrow *et al*. (2023) suggested pairing "relational" skills with "technological" skills through human-AI caring models, demonstrating to students a model of patient care and education that combines high-tech and relationship-centered approaches. However, this is not possible without careful curriculum design, resources, and institutional support for implementation of these educational models. It begs the question of whether the structures that constitute dental postgraduate education today can sustain these dimensions of care in light of healthcare's rapid technological change, and the degree of substantive changes that we ought to make to cultivate the humanistic dimensions of care in the future. To what extent will we need to change our courses?

Conclusion

Postgraduate dental education needs to balance international standards with local relevancy, embrace new assessment frameworks in resource constraint environments and preserve humanistic competencies in an ever-increasing technological training environment. In Malaysia, this will be based on building upon dental education reforms and translating these reforms into postgraduate specialist training through locally adapted competency frameworks, strengthened faculty capacity, regional collaboration and coordinated partnerships, and responsive accreditation standards. Ultimately, the long-term sustainability of postgraduate dental education relies on a collective effort to produce specialists who are not only technically proficient but also grounded in ethics and social responsibility.

References

Andreou, V., Peters, S., Eggermont, J., Schoenmakers, B. (2024). Co-designing entrustable professional activities in general practitioner's training: a participatory research study. *BMC Medical Education*, 24(1), 549.

Arany, S., Eliav, E., Medina-Walpole, A., Caprio, T. V. (2023). Postgraduate dental resident education: a pilot in age-friendly "mentation" training. *Special Care in Dentistry*, 43(6), 765-771.

Bamedhaf, O., Salman, H., Tegginmani, S. A., Guraya, S. S. (2025). Environmental sustainability in the dental curriculum: a scoping review. *BMC Medical Education*, 25(1), 844.

Chand, K., Daniel, E., Kong, P. Y., Sivapalan, S. (2025). Mission 4.7: Building the capacities of educators in education for sustainable development - Report of a pilot educator training programme in Malaysia. Selangor (Malaysia): Sustainable Development Solutions Network.

Dixon, J., Martin, N., Vital, S., Davies, J. R., Murphy, D., Field, J. (2025). A model for sustainable curriculum development in dentistry. *European Journal of Dental Education*, 29(4), 681–690.

El-Hakim, M., Anthonappa, R., Fawzy, A. (2025). Artificial intelligence in dental education: a scoping review of applications, challenges, and gaps. *Dentistry Journal*, 13(9), 384.

Encandela, J. A., Shaull, L., Jayas, A., Amiel, J. M., Brown, D. R., Obeso, V. T., *et al*. (2023). Entrustable professional activities as a training and assessment framework in undergraduate medical education: a case study of a multi-institutional pilot. *Medical Education Online*, 28(1), 2175405.

Field, J., Martin, N., Duane, B., Vital, S., Mulligan, S., Livny, A., *et al*. (2023). Embedding environmental sustainability within oral health professional curricula-recommendations for teaching and assessment of learning outcomes. *European Journal of Dental Education*, *27*(3), 650–661.

Glick, A., Clayton, M., Angelov, N., Chang, J. (2022). Impact of explainable artificial intelligence assistance on clinical decision-making of novice dental clinicians. *JAMIA Open*, 5(2), ooac031.

Goldstein, M., Donos, N., Teughels, W., Gkranias, N., Temmerman, A., Derks, J., *et al*. (2024). Structure, governance and delivery of specialist training programs in periodontology and implant dentistry. *Journal of Clinical Periodontology*, 51(Suppl 27), 55–90.

Kuan, G. S. L. (2025). Embedding sustainability in higher education: A review of institutional strategy, curriculum reform, and digital integration. *International Journal of Science and Research Archive*, 15(2), 420-426.

Lin, G. S. S., Foong, C. C., Kumaresan, R. (2024). From outdated to outstanding: an institution's journey in reforming the dental materials science curriculum and lessons learned. *BMC Medical Education*, 24, 1189.

Mohamed Rohani, M., Mohd Nor, N. A. (2021). Dental students' perception on Disability Equality Training as part of the special care dentistry curriculum. *Journal of Dental Education*, *85*(5), 690–698.

Morrow, E., Zidaru, T., Ross, F., Mason, C., Patel, K. D., Ream, M., *et al*. (2023). Artificial intelligence technologies and compassion in healthcare: a systematic scoping review. *Frontiers in Psychology*, 13, 971044.

Muteb Dgheman Al Shamry, Hamoud Quryan Al-Ruwaili, Menwer Hassan Alanazi, Badr Naji Al-Sharari, Obaid Eid Alharbi, Sami Mubarak Alotaibi. (2024). The role of health services management in

building sustainable healthcare systems: A systematic review. *African Journal of Biomedical Research*, 27(3), 1005-1011.

Nafea, E. T., Alhussin, A. M., Alkuhayli, S. A., Aljohani, M. O. (2025). Shaping professional identity in dentistry: a cross-sectional study of value prioritization among undergraduate students. *BMC Medical Education*, 25, 1613.

Naguib, G. H., Sindi, A. M., Attar, M. H., Alshouibi, E. N., Hamed, M. T. (2020). A cross-sectional study of empathy among dental students at King Abdulaziz University. *Journal of Dental Education*, 84(1), 22–26.

Ono, T., Pangrazio-Kulbersh, V., Perillo, L., Artese, F., Czochrowska, E., Darendeliler, M. A., *et al*. (2023). World Federation of Orthodontists guidelines for postgraduate orthodontic education. *Journal of the World Federation of Orthodontists*, 12(2), 41-49.

Rehman, A., Sethi, A., Jamil, B., Mahboob, U., Ahmad, S., Khan, S., *et al*. (2023). Attitude towards professionalism among undergraduate and postgraduate dental students. *Journal of Khyber College of Dentistry*, *13*(04), 12–18.

Rokhshad, R., Ducret, M., Chaurasia, A., Karteva, T., Radenkovic, M., Roganovic, J., *et al*. (2023). Ethical considerations on artificial intelligence in dentistry: A framework and checklist. *Journal of Dentistry*, *135*, 104593.

Şahin, N., Ural, Ç. (2025). Exploring dental educational diversity: a cross-national examination of national dental qualification frameworks. *BMC Medical Education*, 25(1), 1014.

Sauerbrei, A., Kerasidou, A., Lucivero, F., Hallowell, N. (2023). The impact of artificial intelligence on the person-centred, doctor-patient relationship: some problems and solutions. *BMC Medical Informatics and Decision Making*, 23, 73.

Sethi, A., Haq, M. A., Zaidi, S. J. A., Baig, Q. A. (2024). Developing entrustable professional activities for undergraduate operative dentistry clerkship. *BMC Medical Education*, 24, 1505.

Shin, J.-Y. J., Man, K., Zhou, W. (2021). International and global issues - Differences in health systems, patient populations, and medical practice. In: Girman CJ, Ritchey ME (eds.), Pragmatic Randomized Clinical Trials: Using Primary Data Collection & Electronic Health Records. Amsterdam, The Netherlands: Elsevier, pp. 257–272.

Ten Cate, O., Taylor, D. R. (2021). The recommended description of an entrustable professional activity: AMEE Guide No. 140. *Medical Teacher*, 43(10), 1106–1114.

Wang, H., Xuan, J., Liu, L., Shen, X., Xiong, Y. (2021). Problem-based learning and case-based learning in dental education. *Annals of Translational Medicine*, 9(14), 1137.

Yousuf, A. M., Barakaat, A. A., Tahir, K., Sukhia, R. H., Fida, M. (2025). Evaluating faculty and trainee perceptions on entrustable professional activities in dental postgraduate training: a cross-sectional survey. *BMC Medical Education*, 25(1), 1172.

ORIGINAL ARTICLE Open Access

Perception on veneers in relation to Islamic perspective in Kuantan community

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Abstract

In aesthetic dentistry, veneer has widely performed cosmetic treatments in dentistry. It has gained increasing popularity due to rising social and psychological demands for improved dental appearance to get the 'idealized smile' or 'Hollywood smile'. This has raised ethical concern on dental treatment of overtreatment. Within Muslim communities, however, these procedures raise important concerns from the perspective of Islamic jurisprudence (*fiqh*). This study aimed to assess the Kuantan community's knowledge, perceptions, and understanding of veneer treatment within both dental and religious contexts based on clinical photographic given. A cross-sectional online survey was conducted through online platforms. A total of 250 respondents with mean age was 32.8 years (SD = 12.18), with 30% male and 70% female participants. Findings showed that overall knowledge of aesthetic dentistry and veneers was at a moderate level (52%). While 78.8% of respondents agreed that treatment decisions should be guided by intention (*niyyah*), only 24% correctly identified the *hukm* of veneers, and 43% remained unsure. No significant associations were found between knowledge and demographic or social variables. Although a significant difference was observed between knowledge and perception, their correlation was weak, suggesting that awareness does not necessarily translate into accurate understanding. These findings highlight limited comprehension of Islamic legal maxims concerning aesthetic dental procedures. While veneers may be permissible when addressing medical or psychological needs, their use solely for beautification remains prohibited. Therefore, a recommendation to broader the educational initiatives needed to enhance understanding of both the clinical and religious aspects of cosmetic dentistry.

Keywords: *aesthetic, cosmetic dentistry, ethic, fiqh*

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Introduction

The primary aim of restorative dentistry has traditionally been to reduce pain and prevent tooth decay. However, with rapid advancements in technology and the influence of social media, the focus of restorative treatment has evolved beyond function to include cosmetic enhancement (Alharkan, 2024). Facial attractiveness significantly influences social relationships and self-perception (Afroz *et al.,* 2013), and cosmetic dental treatments are increasingly sought to improve one's overall appearance and confidence (Ghorbani *et al.,* 2025).

In Malaysia, the National Survey of Adults 2010 (Ministry of Health Malaysia, 2020) reported that dental awareness has grown, largely driven by the belief that a smile and appearance can be enhanced through dental treatment, ultimately improving quality of life and psychological well-being (van Sambeek *et al.,* 2023). With the rise of platforms such as Instagram and TikTok, aesthetic standards in dentistry are being reshaped, as individuals are constantly exposed to digitally perfected smiles and beauty ideals (Rostamzadeh & Rahimi, 2025). This exposure has intensified the demand for cosmetic interventions, particularly among younger generations who view dental aesthetics as integral to personal branding and social identity (Alsurayyi *et al.*, 2022)

The utilization of artificial intelligent (AI)-powered simulations could predict the final restorative treatment. In parallel, technological innovations such as Digital Smile Design (DSD) have revolutionized treatment planning by allowing patients to visualize potential outcomes before undergoing procedures. This has shifted restorative priorities from purely clinical needs to patient-driven cosmetic desires, fostering a collaborative approach between dentists and patients (Jreige, *et al.,* 2022). The trends showed that minimally invasive treatment such as veneer that is ultra-thin shells that cover imperfections like stains, chips, or gaps is one of the most popular requested cosmetic treatments (AlJehani *et al.,* 2014; Villalobos-Tinoco *et al.,* 2025). Veneer needs systematic treatment planning and clinical care to design a smile that is symmetrical and in harmonious arrangement with teeth and facial elements. It corrects a wide range of dental issues; discoloured teeth, fractured and worn teeth, abnormal tooth morphology, correction of minor malposition, as well as uneven space and gap on the front teeth (Alothman & Bamasoud, 2018; Pini *et al.*, 2012). Increasingly, individuals dissatisfied with their dental appearance whether due to malocclusion, anterior traumatic injury, tooth loss, discolouration, or untreated decay are motivated not only by health concerns but also by the pursuit of an idealized smile shaped by online trends (Afroz *et al.,* 2013; Kaur *et al.,* 2017). However, in some cases, patients without any dental problem asked for veneers just to get a "killer smile or Hollywood smile". This notion has changed the practice of dentistry.

Recent review has raised concern on the cosmetic dental treatment. Dentists face pressure to perform procedures that may not be clinically necessary, raising concerns about overtreatment and informed consent (Rostamzadeh & Rahimi, 2025) as well as Islamic concern (Fatah *et al.*, 2017). According to the main Islamic jurisprudence (*fiqh*), having an illness is the reason for one to oblige in seeking treatment and medication as stated in the hadith narrated by Usamah bin Sharik which reads:

"Take medication. Indeed, Allah does not cause illness except he brings medicine; or he said: illness except for a disease (which cannot be cured) they said: O Messenger of Allah, what is that he said: that is oldness" (Al-Tirmidhi, 1996)

From this hadith, the *hukm* (Shariah ruling) resorting to veneer as to correct dental disorders that affect their function is permissible. However, resorting to veneers mere for beautification is not allowed as it is a mutilation of Allah creation as stated in the hadith narrated from Abdullah ibn Mas'ud which reads:

"Allah has cursed the women who make tattoos and the women who have this done, the women who pluck facial hair and the women who have this done, and women who widen the gap between their own or others' teeth for the sake of beauty, changing what Allah has created."(Muslim bin Hajaj, 2006)

Thus, the aim of this paper was to assess the knowledge on aesthetic dentistry and dental veneers in Kuantan community. In addition, it aimed was to determine factors toward knowledge on veneers and correlation on perception and knowledge on veneer in in relation to *fiqh*.

Materials and Methods

Sample size was calculated with consideration of dropout was calculated using GPower software. The inclusion criteria include those who are Kuantan resident, Muslim, age 18 years and above, able to comprehend Malay language and does not have cognitive disturbances. The exclusion criteria include those people who did not complete the online survey given. Prior to data collection, ethical approval was obtained from IIUM Research Ethics Committee (IREC) ID NO: 2021-030. Data collection was done using a self-administered structured survey-questionnaire using convenience sampling through various online platforms such as Whatsapp Messenger, Telegram Messenger, Instagram, Facebook in 3 months duration.

The questionnaire was divided into 4 sections (i) Demographic background, (ii) Knowledge on aesthetic dentistry and veneer treatment, (iii) Perception on veneers and *fiqh* (iv) Knowledge on veneers in relation to *fiqh*. An adaptation from two previous studies, a questionnaire was reconstructed to assess knowledge and perception on dental veneers and assessment on *fiqh* (Alfouzan et al. 2018; Fatah *et al.* 2017). In section (iv), a set of clinical photos of real cases were provided. These photographs had been validated by *fiqh* experts for their *hukms*. Respondents were asked to select the *hukm* of wearing veneers in those situations according to their understanding of Islamic principles. Questions on knowledge of aesthetic dentistry and veneers were validated by a dental expert. The questionnaire was in Malay language and underwent linguistic validation by a language expert. The questionnaire was pretested among IIUM students in a pilot study. An infographic poster was also provided at the beginning of the questionnaire to acquaint the respondents with the topic of veneers.

Data were analysed using Statistical Package for the Social Sciences (SPSS) version 23. To evaluate the knowledge on aesthetic dentistry, the knowledge was determined by their score. It was categorized into three groups which are low (score 2 and below), moderate (score 3-4) and high (score 5-6). For knowledge on dental veneers, it was categorized as poor knowledge (score 3 and below), moderately knowledgeable (score 4-6) and High knowledge (scores 7-10). The assessment of knowledge on veneers in relation to *fiqh* was also categorized by 3 groups: high (score > 5), moderate (score 3-4) and score 2 or less was considered as poor knowledge. The knowledge and perception of the respondents was assessed by using a 5-point and 7-point Likert scale. The association was assessed using Man-Whitney and Kruskal Wallis at set at $p<0.05$. The relation of perception and knowledge on veneer was analysed using Spearman Correlation.

Results

The total number of respondents was N=250. The mean age of the respondents was 32.8 (SD 12.2) years that comprised with 30% (n=75), male and 70% (n=175) female. 69.2% of the respondents have a tertiary level of education and 40.4% (n=101) have attended Islamic school or studied Islamic subject. Only 6% (n=15) of the respondents have received veneer treatment. The sociodemographic characteristics of the respondents were summarized in Table 1.

Table 2 exhibits the results of correct responses by respondents on questions relating to knowledge on aesthetic dentistry (AD) and dental veneers (DV). The majority of respondents answered correctly for all questions except for question item (d) only 32.8% (n=32) of respondents answered correctly on the side effect of tooth whitening. Table 3 summarized respondents' perception on veneers and *fiqh*. 39.6% of respondents agree with the statement '*Veneers treatments for aesthetic purposes are forbidden in Islam'*. About 35.6% (n=89) remain neutral and 78.8% (n=182) agreed that veneer treatment must be performed based on the patient's intention. The overall knowledge assessment was in Figure 1.

The results for knowledge on the Islamic jurisprudence of veneer treatment were summarized in Table 4. More than 50% of respondents are able to answer the *hukm* correctly as permissible in the clinical photos provided at a percentage of 57.6% (n=144), 66.0% (n=165), 65.6% (n=164), 67.6% (n=169) and 67.2% (n=168) respectively. However, less than 50% of respondents are able to answer correctly for the sixth photograph (perfect smile). There was no statistically significant association of the knowledge on veneer and *fiqh* with demographic background (p>0.05) and social background (p>0.05) as summarized as in Table 5. There was a significant difference between perception and knowledge towards veneers and *fiqh* (p<0.05). However, the correlation coefficient (r_s=0.235; p=0.000) indicates a statistically significant difference between perception and knowledge towards veneers and *fiqh*. However, it was poorly correlation between these knowledge and perception in Table 6.

Table 1. Respondents' demographic data.

Demographic Background	Frequency (%)
Age	
18-25	110 (44.0)
26-33	32 (12.8)
34-41	43 (17.2)
42-49	31 (12.4)
≥50	34 (13.9)
Gender	
Male	75 (30.0)
Female	175 (70.0)
Education level	
Secondary Level	43 (17.2)
Tertiary Level	173 (69.2)
Advanced Level	34 (13.6)
Social background	
Never attended Islamic school	149 (59.5)
Attended Islamic School	29 (11.7)
Studied Islamic Subject	72 (28.8)
Have received veneer treatment	15 (6)

Note: N= 250 respondents

Table 2. Knowledge on aesthetic dentistry and dental veneers.

Questions	Correct Response n (%)	Incorrect Response n (%)
Knowledge on Aesthetic Dentistry		
Indication		
a. Aesthetic dentistry focuses on improving appearances only	143 (57.2)	107 (42.8)
b. Whitening and bridging are some examples of aesthetic dentistry	218 (87.2)	32 (12.8)
Benefits		
c. Orthodontic treatment is among treatments in aesthetic dentistry	201 (80.4)	49 (16.6)
Disadvantages		
d. Tooth whitening will cause tooth hypersensitivity	82 (32.8)	168 (67.2)
e. Aesthetic treatment is expensive	196 (78.4)	54 (21.6)
f. The whiter the teeth, the healthier it is	168 (67.2)	82 (32.8)
Knowledge on Dental Veneers		
Indication		
g. Replace missing teeth	108 (43.2)	142 (56.8)
h. Anterior fractured teeth	170 (68.0)	80 (32.0)
i. Multiple stained anterior restorations	176 (70.4)	74 (29.6)
Benefit		
j. Change tooth colour	194(77.6)	56(22.4)
k. Change tooth shape	175(70.0)	75(30.0)
l. Closure of slight spaces between teeth	166(66.4)	84(33.6)
Disadvantage		
m. Require removal of tooth structure	170(68.0)	80(32.0)
n. May negatively affect the gums (over contoured)	28(11.2)	222(88.8)
o. May fracture due to specific way of eating	122(48.8)	128(51.2)
p. After removal of veneer, teeth can be originally as before treatment	103 (41.2)	147 (58.8)

Table 3. The perception on veneers and *fiqh*.

Variable	Strongly Disagree (%)	Neutral (%)	Strongly Agree (%)
1. Veneer treatments for aesthetic purposes is forbidden in Islam	62 (24.8)	89 (35.6)	99 (39.6)
2. Treatments to protect one's dignity is allowed in Islam	15 (6.0)	39 (15.6)	196 (78.4)
3. Treatments to increase working efficiency of teeth is allowed in Islam	16 (6.4)	35 (14.0)	199 (79.6)
4. Each treatment should be done based on the intentions (niat)	21 (8.4)	47 (18.8)	182 (78.8)
5. Veneer treatment done to increase self-confidence is allowed in Islam	27 (10.8)	73 (29.2)	150 (60.0)
6. Veneer treatments that bring more harm to patient is forbidden in Islam	25 (10.0)	42 (16.8)	183 (73.2)

Table 4. The knowledge on veneers in relation to *fiqh*.

Cases	Islamic Jurisprudence					
	Frequency (%)					
	Not sure	Mandatory Wajib	Prohibited Haram	Voluntary Sunat	Disliked Makruh	Permissible Harus
1. Median Diastema	69(27.6)	6(2.4)	6(2.4)	12(4.8)	13(5.2)	144(57.6)*
2. Multiple caries lesion	22(8.8)	45(18.0)	2(0.8)	13(5.2)	3(1.2)	165(66.0)*
3. Tetracycline stain	34(13.6)	30(12.0)	2(0.8)	17(6.8)	3(1.2)	164(65.6)*
4. Defective Anterior Composite Restoration	19(7.6)	42(16.8)	2(0.8)	16(6.4)	2(0.8)	169(67.6)*
5. Peg Shaped Lateral Incisors	40(16.0)	23(9.2)	2(0.8)	11(4.4)	6(2.4)	168(67.2)*
6. Perfect Smile	65(26.0)	17(6.8)	60(24.0)*	18(7.2)	35(14.0)	55(22.0)

Note. *Reflects the number of respondents that answered correctly for each question

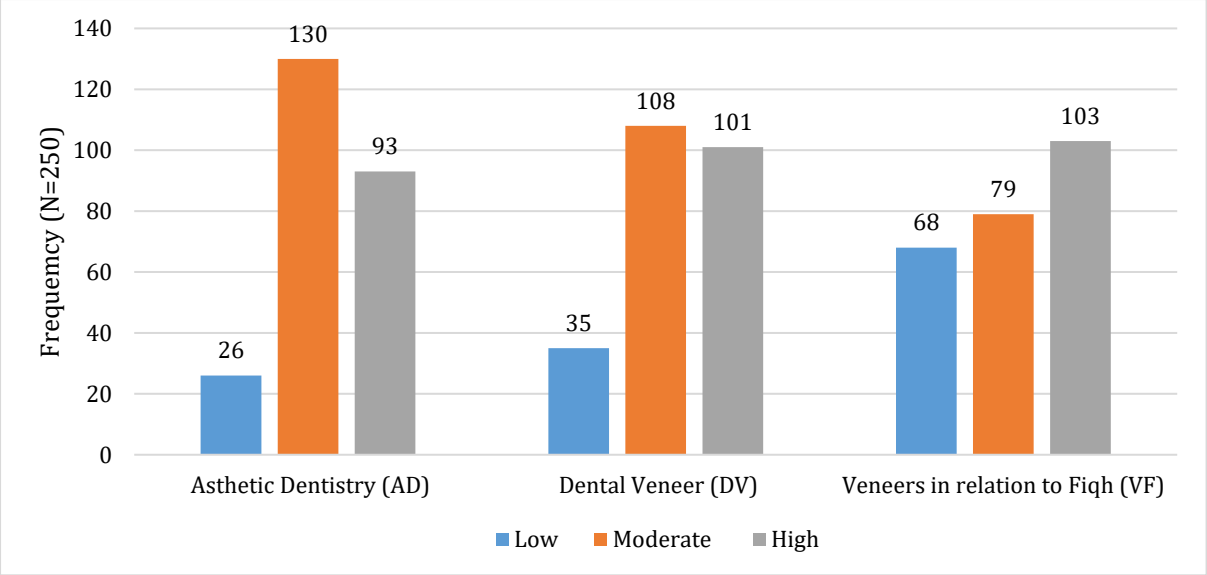

Figure 1. Assessment of knowledge on aesthetic dentistry, dental veneer and veneers in relation to fiqh in Kuantan community, Pahang, Malaysia

Table 5. The association of demographic & social background towards knowledge on veneer and *fiqh*.

Demographic Background	**Knowledge on Veneers and *Fiqh* Frequency (%)**			**p Value**
	Low	Moderate	High	
***Gender**				
Male	18 (24.0)	24 (32.0)	33 (44.0)	0.454
Female	50 (28.6)	55 (31.4)	70 (40.0)	
****Education Level**				
Secondary Level	11(25.6)	15(34.9)	17(39.5)	0.986
Tertiary Level	47(27.2)	54(31.2)	72(41.6)	
Advanced Level	10(29.4)	10(29.4)	14(41.2)	
***Social Background**				
Attended Islamic School	6 (20.7)	9 (31.0)	14 (48.3)	0.343
Studied Islamic Subject	15 (20.8)	26 (36.1)	31 (43.1)	0.345

**Man Whitney, **Kruskal-Wallis*

Table 6. Association of knowledge and perception on veneers and *fiqh*.

		Knowledge on Veneers and *Fiqh*			Correlation Coefficient*
		Low	Moderate	High	
Perception on Veneers and *Fiqh*	Least Agree	19 (42.2)	10 (22.2)	16 (35.6)	0.235**
	Neutral	24 (35.8)	26 (38.8)	17 (25.4)	
	Mostly Agree	25 (18.1)	43 (31.2)	70 (50.7)	

*Spearman Correlation Test ** p value= 0.000

Discussion

One of the objectives of this study was to assess the Kuantan community's knowledge on aesthetic dentistry and veneer treatments. This study explored the relationship between demographic and social factors, knowledge of dental veneers, and Islamic jurisprudential understanding (*fiqh*), alongside perceptions of their acceptability. The findings offer valuable insights into how educational background and religious exposure shape attitudes toward aesthetic dental interventions within an Islamic framework.

Our result showed that respondents' knowledge on aesthetic dentistry and dental veneers is currently at moderate level, with a value of 52% of respondents having moderate knowledge. Similar findings were found for community in Jedda and Riyadh (Alghamdi et al. 2020; Alshammery et al. 2020). However, on average, low level of knowledge was found in Middle Eastern society (Alfouzan et al 2018). On social demographic, there was no significant associations seen between gender, education level, or Islamic schooling and knowledge levels on veneers and *fiqh*. This suggests that awareness of religious implications in aesthetic dentistry may not be inherently linked to formal education or gender-based differences. Interestingly, respondents with tertiary and advanced education showed slightly higher proportions of high knowledge, though not at a significant level. This may reflect broader access to health information rather than targeted religious instruction.

The findings indicate that 60.4% of respondents may lack a comprehensive understanding of the *hukm* related to undergoing veneer treatment solely for aesthetic purposes. Moreover, only 6% (n = 15) reported prior experience with such treatment, a trend consistent with the observations of Fatah (2017). Notably, only 24% of respondents were able to correctly identify the *hukm* concerning veneers. In contrast, a substantial proportion (78.8%) agreed that treatment decisions should be guided by intention (*niyyah*). Taken together, these results suggest that the Kuantan community demonstrates limited knowledge of Islamic legal maxims in relation to dental aesthetic procedures. Furthermore, although a significant difference was observed between perception and knowledge, the correlation between these two variables was weak, possibly reflecting the respondents' limited understanding of both veneers and *fiqh*. As perception may create a pathway toward knowledge, but it does not necessarily translate into a deep or accurate understanding (Radecki & Jaccard 1995). This highlights the need for broader educational initiatives to enhance community understanding of the religious and ethical considerations surrounding cosmetic dental treatments.

Several factors must be considered when determining the *hukm* of veneer treatment in each patient's case. The degree of necessity for a particular procedure can be classified according to the principles of Maqasid al-Shariah, which recognize three levels of needs: essential (*darurah*), necessary (*hajiyyah*), and complementary (*tahsiniah*) (Hamdan *et al.,*2021). In addition, Islamic legal maxims (qawa'id *fiqh*iyyah) provide general rules that guide the determination of *hukm.* These maxims include five major principles: acts are judged by their goals and purposes, custom is the basis of judgment, hardship begets facility, certainty is not overruled by doubt, and harm must be eliminated. Within the context of cosmetic dentistry, treatments aimed at medical purposes, such as addressing pathological conditions, functional impairments, or sources of physical and psychological distress, may be permissible, as these circumstances elevate the treatment to the level of necessity (hajiyyah). However, procedures undertaken solely for beautification or aesthetic enhancement, without an underlying medical or psychological justification, are generally prohibited (*haram*) in Islamic jurisprudence (Hamdan *et al.,*2021; Yacob *et al.,* 2018). This ruling is consistent with the maxim that "acts are judged by their goals and purposes," as altering one's appearance for the sole aim of

beautification is regarded as a modification of God's creation without justifiable necessity.

The results indicated that 43% of patients were unsure of the *hukm* regarding veneer treatment, a finding consistent with the observations of Fatah (2017). While veneers are permissible in Islam, their indication should not be limited to beautification alone. Previous studies have shown that individuals who are frequently dissatisfied with their appearance are more likely to seek cosmetic dental treatment (De Jongh *et al.,* 2010). This raise concerns not only from a medical ethics perspective but also in relation to religious considerations. For Muslim practitioners, it is essential to ensure that treatment options offered to patients are aligned with Islamic jurisprudence (Sabarudin *et al.,* 2023). Careful assessment is therefore required to determine whether the procedure is intended to improve oral health or to alleviate emotional distress, rather than being motivated purely by aesthetic enhancement (Yacob *et al.,* 2018).

A solid foundation in Islamic *fiqh* is essential, as existing guidelines are broad in nature and often require interpretation on a case-by-case basis. In dentistry, certain treatments are guided by established indices that serve as concise and standardized tools for clinical decision-making. For instance, the Index of Orthodontic Treatment Need (IOTN) is used to assess the severity of malocclusion, while the DMFT index provides an objective measure of a patient's dental caries status (Faharani & Eslamipour, 2010; Becker et al 2007). By comparison, no such structured framework currently exists for veneer treatment in the context of Islamic jurisprudence. To minimize ambiguity and reduce confusion among both dental practitioners and patients, the development of concise, standardized guidelines grounded in Islamic principles is recommended for future implementation.

Several limitations were identified in this study, with gender and age group imbalance being the most prominent. The gender imbalance among respondents may have been influenced by the uneven distribution of questionnaires through online platforms, coupled with the use of convenience sampling during the movement restrictions imposed by the pandemic. Furthermore, the reliance on online distribution likely favoured younger adults, who are generally more proficient with and engaged in digital technologies compared to older adults. This discrepancy may have resulted in greater accessibility and higher response rates from the younger demographic (Olson *et al.,* 2010).

Conclusion

This study highlights that while the Kuantan community demonstrates moderate knowledge of aesthetic dentistry and veneers, significant gaps remain in understanding their Islamic jurisprudential implications. Although many respondents recognized the role of intention (*niyyah)*, misconceptions persisted regarding the *hukm* of veneers performed solely for beautification. The weak correlation between knowledge and perception suggests that awareness does not necessarily translate into accurate understanding.

Recommendation

To address these gaps, targeted educational initiatives should be integrated into community health programs, emphasizing both dental and religious perspectives. Dental schools are encouraged to incorporate modules on Islamic bioethics in clinical decision-making. Collaboration between dental practitioners, policymakers, and Islamic authorities is also recommended to develop concise, standardized guidelines that align with Maqasid al-Shariah, thereby supporting practitioners and patients in making ethically and religiously sound treatment decisions.

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References

Afroz, S., Rathi, S., Rajput, G., & Rahman, S. (2013). Dental esthetics and its impact on psycho-social well-being and dental self-confidence: a campus-based survey of North Indian university students. *The Journal of Indian Prosthodontic Society*, *13*(4), 455–460.

Alfouzan, A., Al-Sanie, A. A., & Al-Dhafiri, R. A. (2018). Arab societal awareness of dental veneers. *Journal of Contemporary Dental Practice*, *19*(3), 257–261.

Alghamdi, D., Aboalshamat, K., Salem, A., Binmahfouz, S., Alghamdi, A., Hassan, S., *et al.* (2020). Level of awareness of the population about dental veneers in Jeddah, Saudi Arabia. *Journal of Research in Medical and Dental Sciences, 8*(3), 253–260.

Aljehani, W. A., Alharbi, A. A., Alharbi, A. T., Alharbi, A. A., Alharbi, M. A., ALanazi, A. O., *et al.* (2022). Measuring the awareness, knowledge, and practice of the patients using veneer and lumineers and its effect on periodontium: a cross sectional study in Al-Qassim region. *International Journal of Medicine in Developing Countries*, *4*(2), 347-347.

Alharkan, H. M. (2024). Integrating digital smile design into restorative dentistry: a narrative review of the applications and benefits. *The Saudi Dental Journal*, *36*(4), 561-567.

AlJehani, Y. A., Baskaradoss, J. K., Geevarghese, A., & AlShehry, M. A. (2014). Current trends in aesthetic dentistry. *Health, 6*(15), 1941–1949.

Alothman, Y., & Bamasoud, M. S. (2018). The success of dental veneers according to preparation design and material type. *Open Access Macedonian Journal of Medical Sciences*, *6*(12), 2402–2408.

Alshammery, F., Alkanhal, N. A., Alabdulkarim, A. S., Alfaqeeh, S. A., Alshammery, D. A., Alotaibi, A. A., *et al.* (2020). Awareness among a convenient sample of Riyadh city population toward dental veneers. *Journal of Applied Dental and Medical Sciences*, *6*(1), 6-12.

Alsurayyi, M. A., Almutairi, W., Binsaeed, A. I., Aldhuwayhi, S., Shaikh, S. A., & Mustafa, M. Z. (2022). A cross-sectional online survey on knowledge, awareness, and perceptions of Hollywood smile among the Saudi Arabia population. *Open Dentistry Journal*, *16*(1).

Al-Tirmidhi, M. bin I. (1996). Sunan al-Tirmidhi (al-Jami' al-Kabir) (No. 1877). *Dar al-Gharb al-Arabi.*

Becker, T., Levin, L., Shochat, T., & Einy, S. (2007). How much does the DMFT index underestimate the need for restorative care? *Journal of Dental Education*, *71*(5), 677-681.

De Jongh, A., Oosterink, F. M. D., Van Rood, Y. R., & Aartman, I. H. A. (2008). Preoccupation with one's appearance: a motivating factor for cosmetic dental treatment*? British Dental Journal*, *204*(12), 691–695.

Department of Statistics Malaysia. (2021). State of Pahang population year 2021 [Internet]. Department of Statistics Malaysia Official Portal. https://www.dosm.gov.my/v1/index.php?r=column%2Fcone&menu_id=b2lJM0IwRGdGSjVnV1dOZktWVGYzdz09

Farahani, A. B., & Eslamipour, F. (2010). The relationship between ICON index and Dental and Aesthetic components of IOTN index. *World Journal of Orthodontics*, *11*(1), 43-8.

Fatah, F. A., Yacob, N., Ramli, H., Mohammad, N., Zahid, D., Salleh, A. Z., *et al.* (2017). Patient's perception towards cosmetic dentistry in relation to Islamic principle. *Advances in Science Letters*, *23*(5), 4925–4928

Ghorbani, Z., Esmaeili, S., Shahbazi, S., Jarrahzadeh, M., & Madihi, S. (2025). Self-esteem and its influence on the inclination toward esthetic dental treatments: a cross-sectional study. *BMC Psychology*, *13*(1), 140.

Hamdan, N. M., Anuar, M. R., Aminudin, H., Ar, N. N. H., Ms, M. F., & Azizul, S. M. (2021). The application of maqasid-oriented approach in Islamic bioethics: A case study on fatwa related to cosmetic, plastic and reconstructive surgery. *IIUM Medical Journal Malaysia*, *20*(1), 71–81.

Johnson, J. (2014). ADA patient smart: Dental veneers. ADA Patient Smart. Retrieved from https://www.mouthhealthy.org/~/media/ADA/Publications/Files/ADA_PatientSmart_Veneers.pdf

Kaur, P., Singh, S., Mathur, A., Makkar, D. K., Aggarwal, V. P., Batra, M., *et al.* (2017). Impact of dental disorders and its influence on self-esteem levels among adolescents. *Journal of Clinical and Diagnostic Research*, *11*(4), ZC05–ZC08.

Ministry of Health Malaysia, Oral Health Division. (20132020). Annual report 20132020. Ministry of Health Malaysia. Retrieved from http://ohd.moh.gov.my/v3/images/pdf/annual_rpt2013.pdf

Muslim bin Hajaj. (2006). *Sahih Muslim* (No. 2125). Dar Tayyibah.

Olson, K. E., O'Brien, M. A., Rogers, W. A., & Charness, N. (2010). Diffusion of technology: frequency of use for younger and older adults. *Ageing International*, 36(1), 123–145.

Pini, N. P., Aguiar, F. H. B., Leite Lima, D. A. N., Lovadino, J. R., Suga Terada, R. S., & Pascotto, R. C. (2012). Advances in dental veneers: materials, applications, and techniques. *Clinical, Cosmetic and Investigational Dentistry*, *4*, 9–16.

Radecki, C. M., & Jaccard, J. (1995). Perceptions of knowledge, actual knowledge, and information search behavior. *Journal of Experimental Social Psychology*, *31*(2), 107-138.

Rostamzadeh, M., & Rahimi, F. (2025). Aesthetic dentistry and ethics: a systematic review of marketing practices and overtreatment in cosmetic dental procedures. *BMC Medical Ethics*, *26*(1), 12.

Sabarudin, M. A., Fatah, F. A., Ramli, H., Yacob, N., Salleh, M. A. M. A., & Majid, M. N. A. (2023). patient-centred care dentistry and its relation with maqasid shari'ah: a narrative review. *Journal of Fatwa Management and Research*, *28*(1), 1-15.

van Sambeek, R. M., de Vos, R., Crins, L. A., Bronkhorst, E., Mehta, S. B., Pereira-Cenci, T., *et al.* (2023). Perception of oral health related quality of life and orofacial aesthetics following restorative treatment of tooth wear: a five-year follow-up. *Journal of Dentistry*, *136*, 104626.

Villalobos-Tinoco, J., Floriani, F., Rojas-Rueda, S., Mekled, S., Conner, C., Colvert, S., *et al*. (2025). Enhancing smile aesthetics and function with lithium disilicate veneers: a brief review and case study. *Clinics and Practice*, *15*(3), 66.

Yacob, N., Ramli, H., Majid, M. N. A., & Fatah, F. A. (2018). Crown lengthening for aesthetic purposes from the islamic perspective: a case discussion. *Journal of Fatwa Management and Research*, *13*(1), 44-51.

ORIGINAL ARTICLE Open Access

Workforce entry preferences among final-year dental students in Malaysia: public or private sectors?

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Abstract

Limited job opportunities and restricted advancement in Malaysia's public dental sector have prompted graduates to explore private sector employment. This may lead to increased workforce mobility and possible instability across the sectors. This study aimed to investigate the workforce preference among the public and private final year undergraduate dental students in Malaysia. A validated questionnaire was disseminated in a cross-sectional study using stratified sampling methods among final year dental students in Malaysia. Chi-square test and multinomial regression were performed to determine factors related to workforce entry preference of the students. In multinomial regression, the public sector was set as the reference group versus the private and both sectors. SPSS version 26 was used for data analysis, with a p-value set less than 0.05. A total of 204 final year dental students' session 2022/2023 across 13 dental schools in Malaysia were recruited in the study. The majority of respondents have a high preference to work in both public and private oral health services at the same time (public = 58.5% vs private = 43.9%). Multinomial regression analysis showed that public university students had 83% lower odds (OR = 0.17; 95% CI = 0.05, 0.58; p= 0.005) of preference to work in private sectors compared to private university students. In conclusion, the majority of the final year undergraduate dental students preferred to work in both public and private sectors, with more students in the public institution preferring to work in government sectors. To ensure a seamless provision of oral healthcare services, the Ministry of Health Malaysia should come out with an efficient solution in regards with the issues of limited placement of new dental graduates in Malaysia.

Keywords: *dental, entrepreneur, government, Malaysia, workforce preference*

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Introduction

The projected target for dentist-to-population ratio in Malaysia is 1:4000 by the year 2020 (Oral Health Programme Malaysia, n.d.). As of June 2020, the dentist-to-population ratio in Malaysia is at 1:2816 (Ministry of Health Malaysia, 2021). The surplus of dentists in the country is mostly contributed to by the increase in dental graduates from local and international universities. There are currently 13 universities in Malaysia that offer basic dental degrees: six are run by the government and seven are from private institutions.

As a result of the increase in the number of new dental graduates, there has been a noticeable rise in the number of dental officers entering the Ministry of Health (MOH) as government dentists. In the year 2012, there were 514 new dental officers registered in the MOH (Oral Health Division Malaysia, 2013). Ten years later, in the year 2022, a total of 1,401 new dental officers joined the MOH (Oral Health Programme Malaysia, 2023). The remarkable increase in the number of newly registered dentists has led to a shortening of the compulsory service duration from three years to only one year in order to cater to the huge number of newly registered dentists.

Malaysia implements a two-tier health care system consisting of a universal and comprehensive care under the primary care of the public and private sectors (Chua & Cheah, 2012). The Dental Act of 1971 stipulated that all new dental officers must undergo a compulsory service that can only be performed in the government sector; thus, the government sector became the predominant employer of dentists in the country. However, with the implementation of the Dental Act of 2018, it has now allowed new dental graduates to serve in the private sector for their compulsory service starting in the year 2022. Currently, a freshly graduated dental officer can choose to work with the government/public or the private practice after a year of compulsory service (Oral Health Programme Malaysia, 2020). With a circular allowing government-employed dental officers working in private practices as a locum dentist off-duty, it has now become a choice of preference in the dental workforce (Ministry of Health Malaysia, 2006; Puryer & Patel, 2016). It instigates the future dental graduates to work in both sectors, private and public dental health services simultaneously, for better job security and stability in the future (Santos *et al.*, 2013).

However, there is an increase of almost 20% of dental officers who decided to leave the government sector between 2017 and 2021 in Malaysia (Oral Health Programme Malaysia, 2022). This is most probably due to the policy changes made by the government from a compulsory service to a contract basis for the dental graduates registered from 2017 onwards. Only half of the contract dental officers were offered a permanent post (Ministry of Health Malaysia, 2021). Due to the uncertainty in their future career pathway, new dental graduates must make a bold decision of either waiting for a permanent position in the government sector or securing a job in the private sector before the end of their compulsory service contract. Understanding the possible factors contributing to the change of workforce preferences among recent dental graduates may be important to prevent interrupted provision of dental services.

On a separate matter, family and colleagues showed to have a major influence on the dental undergraduates' career preference. They may decide to work in public or private sectors either of their own voluntary will or by coercion from family members (Yousuf *et al.*, 2019). Furthermore, parents of dental undergraduates who worked in the dental fraternity showed a strong influence on their children's career pathway (Halawany *et al.*, 2017). Having a family with an entrepreneurial background somehow may instil the interest and motivation among the new graduates to venture into the private sector while gaining informal learning of business skills (Georgescu & Herman, 2020).

The new policy of dental practitioners' recruitment in Malaysia provides a new dimension of career motivation, intention and preference among dental undergraduates. With the looming uncertainty in the future career pathway in the public dental service, it may lead to them having different views in regards of their career options (Che Musa *et al.*, 2020). Understanding the contributing factors that may influence their career decisions may provide useful insights into the current trend of workforce preferences among the new dental graduates. Thus, this study aims to investigate the workforce entry preferences and their contributing factors among the public and private undergraduate final year dental students in Malaysia.

Materials and Methods

Study design

This is a cross-sectional questionnaire survey conducted between October 2022 and January 2023. A total of 204 final year dental students' academic session 2022/2023 from both private and public universities in Malaysia (6 public and 7 private universities) voluntarily gave their consent to participate in this study. A stratified random sampling was executed in obtaining the sample from both institutions, with a ratio of private to public university of 1:1. An ethical approval was obtained from the Research Ethics Committee of Universiti Sains Islam Malaysia [USIM/JKEP/2022-192].

Data collection tools and procedures

A pre-test questionnaire was validated by content and face validity, showing an excellent score of >0.80 before it was distributed to all the respondents using Google Form via WhatsApp application. Necessary corrections and changes were made prior to the validity process. The questionnaire was divided into two sections. The first part consists of questions focusing on the career preferences*: What is your career plan post-graduation?* The answer options include "joining public sector", "joining private sector" and "joining both sectors". Questions on the factors that may contribute to the student's career preference, such as *"Do you have any entrepreneurial intentions?"* with a binary answer of "No" or "Yes", were also asked. Other questions are exhibited in Table 2. The second part of the questionnaire consists of questions related to the working preference that could influence the students' career preference (Refer to Table 3). The outcome of the career preference in the future will be either to work in the public, private or both sectors. A question on a post-graduation specialty choice was also asked to identify their specialty preference. The response provided was ranked from the highest to lowest number, arranged by sex and types of institution based on frequency. Tied responses with equal percentage were assigned the same rank, and the subsequent ranks were modified to reflect the tied position.

Statistical analysis

The analysis of the data was performed using IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp. Descriptive analysis was performed to describe the outcome and independent variables between both private and public universities. A final multinomial logistic regression was performed to indicate the factors associated with the outcome of career preference on the choosing to join either the public, private or both sectors for future career, with the public sector as the reference group. Factors in the analysis were considered statistically significant at the 95% confidence interval ($p<0.05$).

Results

Table 1 exhibits the sociodemographic characteristics of participants from both private and public universities. The mean age of participants was 23.8 and 23.2 for private and public universities, respectively. The majority of the students were female in both institutions, and most of them are single. In the private university, Chinese

were the majority (45.9%) while in the public university, Malay ethnic was the majority (96.2%). Both private and public universities stated that they have entrepreneurial intentions about 60.2% and 62.3% respectively. The majority of private university students stated that they have entrepreneurial family members compared to those in public universities (57.1% vs 49.1%). Students from both institutions claimed that mostly their family members' backgrounds are not in the dental field, have anticipated education debt, intend to undertake postgraduate studies and prefer to specialise in a specific field of dentistry (Table 2).

Figure 1 exhibits the career preferences of the dental students in both institutions. Most of the private university students intended to join the private sector, compared to the students in public universities who intended to join both sectors for their future career.

Table 1. Sociodemographic factors according to institutions (private vs public).

Sociodemographic characteristics	Private university (98 [48%])	Public university (106 [52%])
	n (%)	n (%)
Age (years in mean)	23.8 (SD=1.51)	23.2 (SD=0.66)
Gender		
Male	25 (25.5)	19 (17.9)
Female	73 (74.5)	87 (82.1)
Ethnicity		
Malay	28 (28.6)	102 (96.2)
Chinese	45 (45.9)	3 (2.8)
Indian	22 (22.4)	1 (0.9)
Others	3 (3.1)	0 (0.0)
Marital status		
Single	97 (99.0)	105 (99.1)
Married	1 (1.0)	1 (0.9)

Table 2. Contributing factors to career preference among public and private dental students.

Contributing factors	Private university		Public university	
	No	Yes	No	Yes
	n (%)	n (%)	n (%)	n (%)
Do you have any entrepreneurial intentions?	39 (39.8)	59 (60.2)	40 (37.7)	66 (62.3)
Do you have any entrepreneurial family members?	42 (42.9)	56 (57.1)	54 (50.9)	52 (49.1)
Do you have any family members in dentistry?	72 (73.5)	26 (26.5)	86 (81.1)	20 (18.9)
Do you have any anticipated education debt?	45 (45.9)	53 (54.1)	35 (33.0)	71 (67.0)
Do you intend to undertake postgraduate studies in the next 5 years?	34 (34.7)	64 (65.3)	37 (34.9)	69 (65.1)
In the longer term, would you like to specialise in a field of dentistry?	16 (16.3)	82 (83.7)	24 (22.6)	82 (77.4)

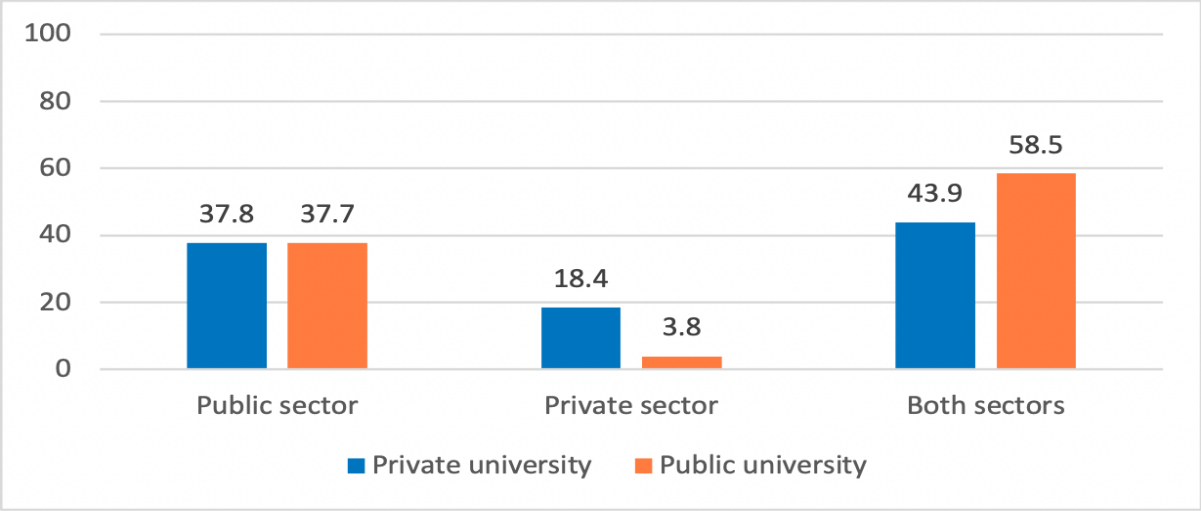

Figure 1. Career preference among dental students in Malaysia between institutions (private vs public).

Table 3 dictates factors that influence the students' career preference. Flexible working hours was one of the most significant factors among students who preferred the private sector (78.6%, p=0.003). Although not significant, students felt that employment benefits such as annual leave, sick pay and maternity leave had a high influence on their career preference across sectors respectively (p=0.937); public (73.1%), private (72.7%), both (70.2%). On the other hand, working in solo practice had less influence on their career preference (p=0.605); public (23.2%), private (26.3%), both (30.5%).

Table 3. Factors associated with preference to work in the public or private sector using the chi-square test.

Preferences	n	Career intentions			p-value
		Public	Private	Both	
		n (%)	n (%)	n (%)	
Working in solo practice	183	16 (23.2)	5 (26.3)	29 (30.5)	0.605
Fixed salary services	167	23 (39.7)	8 (40.0)	28 (31.5)	0.122
Flexible working hour	158	21 (30.0)	11 (78.6)	31 (41.9)	0.003
Benefit in terms of income and salary	117	21 (42.9)	6 (66.7)	40 (67.8)	0.103
Employment benefits (e.g., annual leave, sick pay and maternity leave)	84	19 (73.1)	8 (72.7)	33 (70.2)	0.937
Financial inducement (e.g., bonuses)	146	31 (58.5)	8 (47.1)	43 (56.6)	0.803
Family commitment	139	30 (55.6)	10 (62.5)	48 (69.6)	0.201
Debt accrued as student's loan	166	15 (24.2)	9 (45.0)	28 (33.3)	0.273
Working in high-quality environment	129	27 (55.1)	9 (64.3)	45 (68.2)	0.567
Working part time job	152	24 (40.7)	8 (44.4)	31 (41.3)	0.855

Table 4. Multinomial regression analysis for the association between workforce preference and its related factors among dental students in Malaysia.

Factors	Workforce preference							
	Private sectors				Both sectors			
	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)*	p-value	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)*	p-value
Age	0.78 (0.50, 1.22)	0.285	0.64 (0.42, 0.99)[a]	0.045	0.88 (0.69, 1.13)	0.320	0.87 (0.66, 1.14)	0.320
Sex								
Male	1.78 (0.62, 5.10)	0.283	1.23 (0.39, 3.87)	0.721	0.90 (0.46, 1.98)	0.897	0.91 (0.43, 1.92)	0.800
Female	1.00		1.00		1.00		1.00	
Types of institutions								
Public	0.21 (0.06, 0.66)[b]	0.008	0.17 (0.05, 0.58)[b]	0.005	1.33 (0.74, 2.41)	0.341	1.16 (0.62, 2.19)	0.645
Private	1.00		1.00		1.00		1.00	
Entrepreneurial intentions								
Yes	2.99 (1.00, 8.91)	0.050	3.87 (1.18, 12.49)[a]	0.025	1.55 (0.85, 2.82)	0.153	1.63 (0.88, 3.02)	0.118
No	1.00		1.00		1.00		1.00	
Entrepreneurial family members								
Yes	0.93 (0.36, 2.39)	0.872	-	-	1.10 (0.61, 1.98)	0.755	-	-
No	1.00				1.00			
Family members in dentistry								
Yes								
No	1.93 (0.67, 5.57)	0.224	2.14 (0.68, 6.68)	0.192	1.23 (0.60, 2.53)	0.584	1.39 (0.65, 2.93)	0.395
	1.00		1.00		1.00		1.00	
Anticipated education debt								
Yes	0.75 (0.29, 1.94)	0.553	0.82 (0.29, 2.27)	0.704	1.44 (0.79, 2.63)	0.240	1.39 (0.75, 2.57)	0.299
No	1.00		1.00		1.00		1.00	
Postgraduate studies intention								
Yes	0.65 (0.25, 1.69)	0.376	-	-	1.13 (0.61, 2.10)	0.705	-	-
No	1.00				1.00			
Specialize in field of dentistry								
Yes	1.28 (0.38, 4.28)	0.694	-	-	1.28 (0.62, 2.67)	0.506	-	-
No	1.00				1.00			

Public sectors as reference category; OR = Odds ratio; 95% CI = 95% Confidence interval

*Model was adjusted (multivariate) for variables age, gender, types of institution, entrepreneurial intention, family members in dentistry and anticipated education debt. Goodness-of-fit model is adequate, X^2=127.46, *df* =130, p=0.547. Nagelkerke R^2= 0.141. No interaction and multicollinearity detected.

[a]p<0.05; [b]p<0.01

Table 4 shows the results of the multinomial logistic regression analysis with the public sector set as the reference group. Types of institution was the only factors significantly associated with workforce preference at the crude level. It was found that public university students had 79% lower odds (OR = 0.21; 95% CI = 0.06, 0.66; p= 0.008) of preference to work in private sectors compared to private university students. After adjusting for other variables, age, types of institution and entrepreneurial intentions were the significant factors of workforce preference. The higher the students' age, the less likely they were to join private sectors (OR = 0.64; 95% CI = 0.42, 0.99; p= 0.045) compared to public sectors. Public university students had 83% lower odds (OR = 0.17, 95% CI = 0.05, 0.58; p= 0.005) of preference to work in the private sector compared to private university students. Students with entrepreneurial intentions had 3.87 times odds (95% CI = 1.18, 12.49; p= 0.025) of working in the private sector compared to those who have no entrepreneurial intention. On the other hand, students in public universities had 1.16 higher odd (95% CI = 0.62, 2.19; p= 0.645) of preference to work in both sectors compared to private university students; however, no significant association was found (p=0.645).

Table 5 dictates orthodontics and endodontics as the most preferred specialities ranked by the final year dental students according to sex and type of institutions. The least preferred by the students were oral radiology, forensic odontology and oral pathology and oral medicine.

Table 5. Specialty preference ranking based on gender and type of institutions (n=171).

Sex				Specialty	Type of institution			
Male		Female			Public		Private	
Rank	n (%)	Rank	n (%)		Rank	n (%)	Rank	n (%)
1	11 (25.6)	1	31 (24.1)	Orthodontics	1	22 (30.1)	1	20 (20.4)
2	10 (23.3)	2	25 (19.5)	Endodontics	2	16 (21.9)	2	19 (19.4)
3	6 (13.9)	4	16 (12.5)	Oral surgery	5	5 (6.8)	3	17 (17.3)
4	5 (11.6)	5	13 (10.2)	Periodontics	4	11 (15.1)	6	7 (7.1)
4	4 (9.3)	7	6 (4.7)	Prosthodontics	7	1 (1.4)	5	9 (9.2)
6	3 (6.9)	3	21 (16.4)	Paediatrics Dentistry	3	13 (17.8)	4	11 (11.2)
6	2 (4.7)	6	7 (5.5)	Conservative	6	2 (2.7)	6	7 (7.1)
8	2 (4.7)	9	2 (1.6)	Implantologist	11	0 (0.0)	8	4 (4.1)
9	0 (0.0)	8	3 (2.3)	Dental Public Health	7	1 (1.4)	9	2 (2.0)
9	0 (0.0)	11	1 (0.8)	Oral radiology	7	1 (1.4)	11	0 (0.0)
9	0 (0.0)	9	2 (1.6)	Forensic Odontology	11	0 (0.0)	9	2 (2.0)
9	0 (0.0)	11	1 (0.8)	Oral Pathology Oral Medicine	7	1 (1.4)	11	0 (0.0)

Discussion

The findings from this study revealed the career preferences of the public and private final year dental undergraduates in Malaysia. Due to the recent changes in the policy of dentist recruitment in the country, the new dental graduates are facing an unprecedented situation. Previously, all new dental graduates were ensured a permanent post in the government sector, which provided financial stability. However, the increased number of dental graduates each year has warranted a new approach to cater to the surplus of dentists.

Healthcare reform made by the Ministry of Health (MOH) has somehow coerced dental graduates to venture into the private sector. With the uncertainty of their future position in the government sector, many of them are willing to take whatever is offered on the table (Iskandar, 2023). The new dentists felt insecure and anxious working as contract dental officers with no guarantee of being absorbed as permanent dentists in the government sector. The possibility of not being employed as permanent dental officers in the government sector was the main cause of their worry and concern, as it may affect their financial stability in the future (Parkaran, 2024). Thus, the MOH should take into consideration the provisional health care delivery and services, including prospective jobs for future dental graduates.

The majority of the students in this study preferred to work in both sectors, which would promise a higher income generated (Batyrbekova *et al.*, 2022). This finding could be attributed to them having to pay the educational loan incurred throughout their students' years. Most dental students would anticipate educational debt from a government-funded scholarship or educational loan institution to pursue the dentistry course. Government-funded students are bonded to work in the public sector, whereas those who are self-funded are free to join the private sector after graduation. Hence, to lessen the burden, they will have to work harder for extra income or work in the private sector for a higher payroll in order to pay off their educational debt during studies and achieve work-life balance (Nashleanas *et al.*, 2014; Che Musa *et al.*, 2016). A recent study found that students desire dual-sector careers that optimise earnings, flexibility and societal contributions (Riad, 2025). This choice also reflects recognition of both sectors as well as system flexibility that allows part-time work in public institutions alongside private practice (Lukandu *et al.*, 2023; Che Musa *et. al.*, 2024).

Apart from that, pursuing a career as a private dental practitioner was relatively higher among the dental students at private universities compared to their counterparts. The explanation could be that mostly the students enrolled in private institutions are those from a higher economic background (Cheng *et al.*, 2022). In addition to that, having family members who are entrepreneurs themselves could have influenced the dental students to have entrepreneurial intention (Georgescu & Herman, 2020). Their entrepreneurial background acted as the motivation to open their own private practice, and the students viewed the family members as role models (Williams & Williams, 2012). According to Gujrati *et al.* (2019), family financial status has a major influence on the students' entrepreneurial intentions, which triggered their motivation to work in the private sector. The lack of support from low-income families could be a possible factor that hinders the students' motivation to venture into private practice (Cavalcante *et al.*, 2022).

From this study, both students from private and public universities stated that they have entrepreneurial intentions, which are in line with other similar studies (Yusoff *et al.*, 2015; Ministry of Higher Education, 2020; Khairuddin *et al.*, 2023). This finding gave the impression that dental graduates are willing to work in the private sector to enhance their entrepreneurial skills before embarking on their own dental clinic. However, although many of them expressed their entrepreneurial intentions, they still prefer to work in the public sector.

According to Che Musa *et al*. (2015), job security, altruistic attitude and having more time for family were some of the reasons they preferred to work in the public sector. The concept of altruism was highly regarded by Brazilian dental students, showing a general understanding that the purpose of dentistry is to provide oral health promotion and prevention, in which the majority of them preferred working in the public sector (Costa *et al.*, 2012).

Besides that, flexible working hours were the sole element that affected students' intentions for their career preferences, particularly those who decided to work in the private sector. While studies have acknowledged the impact of flexible hours on career preferences, most have shown a significant relationship with gender (Rashid *et al.*, 2013; Halawany *et al.*, 2017). As most respondents in our study were female, this could be the possible explanation why they would prefer to have flexible working hours in order to care for their families (Puryer & Patel, 2016; Scott *et al.*, 2020). Financial stability and flexible work schedules are important factors in making career choices, as reported in another study in Kenya (Lukandu *et al.*, 2020).

Additionally, most of the dental undergraduates in this study would prefer to pursue postgraduate training for career advancement, financial stability and work-life balance (Puryer & Patel, 2016; Che Musa *et al.*, 2016). This finding is similar to the studies among dental students in Saudi Arabia and Iran (Dastjerdi *et al.*, 2012; Al-Hallak *et al.*, 2018). From this study, the most and least preferred specialties are in agreement with other reported studies (Puryer & Patel, 2016; Halawany *et* al., 2017; Siddiqui *et al*., 2022). It is found that female students chose specialisation training as a need despite discouraging factors such as towering cost and extensive duration (Naz *et al.*, 2022). More opportunities for scholarships are provided in the government sector, whilst those working in the private sector must apply for educational loans to further their specialist training (Che Musa *et al.*, 2016). Similarly, Siddiqui *et al.* (2022) reported that most students would choose government institutions if they were to pursue specialisation training.

Furthermore, this study also found that the higher the students' age, the less likely they were to join the private sector. This is most probably due to the age factor and family commitment, as people become less inclined to switch jobs and prefer to settle for job security and stability, including becoming less interested in joining the rat race (Finegold *et al.*, 2002). Females mostly favoured a work-life balance compared to men (Batyrbekova *et al.*, 2022). Nevertheless, the age range of this sample is quite small; thus, the findings should be interpreted with caution and further investigation is needed to confirm the association.

There are some limitations in the present study. The students involved in this study only cover 30% of the total final year dental students in Malaysia, consisting of Malay, Chinese, Indian and other ethnicities. The unbalanced distribution of ethnicity between the public and private tertiary institutions could have influenced the result. Not only that, as this study involved self-reporting questionnaires, it came with its own possible biases that may affect the findings. Nevertheless, in contrast to previous findings by Che Musa *et al.* (2016), this study offered a distinct perspective on the current undergraduates' career preference after a change was made in the employment of dental health workers.

Conclusion

The majority of the dental undergraduate students in Malaysia preferred to work in both public and private sectors. Dental students in public institutions mostly preferred to work in the government sector. Dental undergraduate students who have entrepreneurial intentions were most likely to choose working in the private than the public sectors. Flexible working hour is the main determining factor that influences the final year dental students' intention to choose the private sector as their career preference. As for the implications, a win-

win solution in regards with the work placement and job posting among new dental graduates should be conceived to entice and retain the dental officers serving in the public sector. Realising the entrepreneurial intentions among dental graduates, the academic institution may consider including a course on private practice management in the dental curriculum, as early exposure to those who are keen to open their own private dental practice after graduation.

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References

Al-Hallak, K. R., Nassani, M. Z., Heskul, M. M., Doumani, M. D., & Darwish, M. (2018). Reasons for choosing dentistry as a career among dental students in Saudi Arabia. *European Journal of Dentistry*, 12(02), 275-280.

Batyrbekova, G., Çoban, T., Hekimoğlu, C., Yildirim, D., Merve, B.Ü., Güncü, B., & Cakir, B. (2020). Future expectations, career choices and related factors among dental students: a cross sectional study. *European Oral Research*, 56(2), 88-95.

Cavalcante, M.A.D., Sousa-Filho, J.M., & Lessa, B.D.S. (2022). Entrepreneurial intentions and education: Effects on low-income students. *Journal of Education for Business*, 228-236.

Che Musa, M.F., Bernabé, E., & Gallagher, J.E. (2015). Students' motivation to study dentistry in Malaysia: an analysis using confirmatory factor analysis. *Human Resources for Health*, 13, 1-9.

Che Musa, M.F., Bernabé, E., & Gallagher, J.E. (2016). Career expectations and influences among dental students in Malaysia. *International Dental Journal*, 66(4), 229-236.

Che Musa, M.F., Bernabé, E., & Gallagher, J.E. (2020). The dental workforce in Malaysia: drivers for change from the perspectives of key stakeholders. *International Dental Journal*, 70(5), 360-373.

Che Musa, M. F., Morgan, J., Harper, P., Bernabé, E., & Gallagher, J.E. (2024). Scenario modeling for dentistry in Malaysia: Utilization, privatization, and specialization. *Journal of International Oral Health*, *16*(5), 403-413.

Cheng, F.C., Lee, M.C., Wang, L.H., Lin, W.J., Liu, T.H., Liu, S.Y., & Chiang, C.P. (2022). The current dental school admissions: An overview of the admission process and the geographical distribution of dental school enrollees in Taiwan. *Journal of Dental Sciences*, 17, 1342-1349.

Chua, H.T., & Cheah. J.C.H. (2012). Financing universal coverage in Malaysia: A case study. *BMC Public Health*, 12(Suppl 1), S7.

Costa, S.D., Silveira, M.F., Durães, S.J., Abreu, M.H., & Bonan, P.R. (2012). Perceptions of dental students regarding dentistry, the job market and the public healthcare system. *Ciencia & Saude Coletiva*, 17, 1285-1296.

Dastjerdi, M.V., Mahdian, M., Dastjerdi, E. V., & Namdari, M. (2012). Study motives and career choices of Iranian medical and dental students. *Acta Medica Iranica*, 417-424.

Finegold, D., Mohrman, S., & Spreitzer, G.M. (2002). Age effects on the predictors of technical workers' commitment and willingness to turnover. *Journal of Organizational Behavior*, 23, 655–674.

Georgescu, M.A., & Herman, E. (2020). The impact of the family background on students' entrepreneurial intentions: An empirical analysis. *Sustainability*, 12(11), 4775.

Gujrati, R., Tyagi, V., & Lawan, L.A. (2019). Family financial status and students' entrepreneurial intention: The mediatory role of entrepreneurship education. *Journal of Management*, 6(3), 21-28.

Halawany, H.S., Binassfour, A.S., AlHassan, W.K., Alhejaily, R.A., Al Maflehi, N., Jacob, V., *et al.* (2017). Dental specialty, career preferences and their influencing factors among final year dental students in Saudi Arabia. *The Saudi Dental Journal*, 29(1), 15-23.

Iskandar, I. M. (2023, April 1). More than 3,000 contract doctors may resign this month. *New Straits Times*. Retrieved from, https://www.nst.com.my/news/nation/2023/04/895158/more-3000-contract-doctors-may-resign-month

Khairuddin, Z.N., Sauh, S.M., & Asmaai, M. (2023). Entrepreneurship Education at Higher Learning Institutions (HLI): Policy Mismatch and Recommendations. *Malaysian Journal of Business, Economics and Management*, 19, 27-33.

Lukandu, O. M., Koskei, L. C., & Dimba, E. O. (2020). Motivations for a career in dentistry among dental students and dental interns in Kenya. *International Journal of Dentistry*, 2020(1), 1017979.

Lukandu, M. O., Koskei, L. C., & Dimba, E. O. (2023). Perceptions and preferences for dental specialties among undergraduate students and dental interns in Kenya. *South African Dental Journal*, *78*(5), 251-257.

Ministry of Entrepreneur Development and Cooperative. (2022). *National Entrepreneurship Policy 2030. Malaysia: An Outstanding Entrepreneurial Nation 2030*. Putrajaya.

Ministry of Health Malaysia. (2006). *Execution of off duty work (locum) by registered medical and dental officers.* Secretary General Circular Letter no. 5/2006. Putrajaya. Ministry of Health Malaysia.

Ministry of Health Malaysia. (2021). *Health indicators 2021*. Retrieved from, https://www.moh.gov.my/moh/resources/Penerbitan/Penerbitan%20Utama/HEALTH%20INDICATOR/Petunjuk%20Kesihatan%202021/mobile/index.html#p=1

Ministry of Higher Education Malaysia. (2020). *Entrepreneurship action plan Higher education institutions (EAP-HEIs) 2021-2025*. Putrajaya.

Ministry of Higher Education Malaysia. (2020). *MOHE guide to entrepreneurship integrated education (EIE).* Putrajaya.

Nashleanas, B.M., McKernan, S.C., Kuthy, R.A., & Qian, F. (2014). Career influences among final year dental students who plan to enter private practice. *BMC Oral Health*, 14, 1-7.

Naz, A., Darvesh, S.A., Hanif, S., Khani, M.H., Jawad, A., & Bibi, T. (2022). Choice of dental specialty and career inclination among dental students in Karachi, Pakistan. *Pakistan Journal of Medical & Health Sciences*, 16(11), 132.

Oral Health Programme Malaysia, Ministry of Health Malaysia. (n.d.) *Dental manpower*. Retrieved from, https://hq.moh.gov.my/ohp/index.php/en/allcategories-en-gb/2-uncategorised/123-dental-manpower

Oral Health Division Malaysia. (2013). *Annual Report 2012*. OHD, Ministry of Health Malaysia.

Oral Health Programme Malaysia. (2020). *Annual Report 2019.* OHP, Ministry of Health Malaysia.

Oral Health Programme Malaysia. (2022). *Annual Report 2021*. OHP, Ministry of Health Malaysia.

Oral Health Programme Malaysia. (2023). *Annual Report 2022.* OHP, Ministry of Health Malaysia.

Parkaran, K. (2023, April 22). 2,100 contract doctors on waiting list for permanent posts. *Free Malaysia Today*. Retrieved from, https://www.freemalaysiatoday.com/category/nation/2023/04/22/4800-contract-doctors-on-waiting-list-for-permanent-post

Puryer, J., & Patel, A. (2016). The career intentions, work-life balance and retirement plans of dental undergraduates at the University of Bristol. *British Dental Journal*, 220(4), 183-186.

Rashid, H., Manoharan, A., Abufanas, S., & Gallagher, J.E. (2013). Motivation for a career in dentistry: the views of dental students in the United Arab Emirates. *International Dental Journal*, 63, 259-265.

Riad, A., Elsheikh, L., Domnori, S., Doris Fratila, A., Carter, C., Kaya, D. D. & EDSA Delegates. (2025). Career aspirations of dental students: insights from a multinational study using social cognitive career theory (SCCT). *Frontiers in Oral Health*, *6*, 1577870.

Santos, B.F., Nicolau, B., Muller, K., Bedos, C., & Zuanon, A.C. (2013). Brazilian dental students' intentions and motivations towards their professional career. *Journal of Dental Education*, 77(3), 337-344.

Scott, A., Holte, J.H., & Witt, J. (2020). Preferences of physicians for public and private sector work. *Human Resources for Health*, 18, 59.

Siddiqui, M., Sultan, A., Mehta, A., & Juneja, A. (2022). Career intentions, choices, and motivation of undergraduate dental students toward dentistry. *Archives of Medicine and Health Sciences*, 10(1), 136-140.

Williams, N., & Williams, C.C. (2012). Evaluating the socio-spatial contingency of entrepreneurial motivations: A case study of English deprived urban neighbourhoods, *Entrepreneurship & Regional Development*, 24(7-8), 661-684.

Yousuf, W., Kazmi, S.M., Quraeshi, S., & Khan, M. (2019). Motivation and future intentions of dental students in Karachi, Pakistan. *Pakistan Journal of Medical Research,* 58(1), 26.

Yusoff, M.N.H., Fakhrul Anwar Zainol, F.A., & Ibrahim, M.D. (2015). Entrepreneurship Education in Malaysia's public institutions of higher learning—A review of the current practices. *International Education Studies*, 8(1), 17-28.

ORIGINAL ARTICLE Open Access

Evaluating the effect of Tualang honey on the viability and migration of human gingival fibroblasts

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Abstract

Tualang honey, produced by the wild bee species *Apis dorsata*, is predominantly found in the South Asian region, particularly in Malaysia. Tualang honey has attracted scientific interest for its antimicrobial, anti-inflammatory, and wound-healing properties, highlighting its potential for therapeutic use. The study aimed to assess the effects of Tualang honey on the viability and migration of human gingival fibroblasts (HGFs) using MTT and scratch assays. HGFs were cultured in standard fibroblast medium at 37°C in a 5% CO_2 humidified incubator. Cells were seeded at 5×10^3 cells/well in a 96-well plate and incubated for 24 hours before being treated with varying concentrations of Tualang honey, with the negative control receiving only growth medium. After 24 hours, cell viability was assessed using the MTT assay and absorbance was measured at 570 nm. For the scratch migration assay, cells were seeded at 10×10^3 cells/well in a 24-well plate and incubated for 24 hours. A scratch was made on the cell layer, followed by treatment with Tualang honey at various concentrations, a negative control (untreated cells), and a positive control (0.1% Gengigel mouthwash). Images were captured at 0-, 24-, and 48-hours using Image-Pro Express software. This study demonstrated that Tualang honey at concentrations of 2.5% and below promoted high cell viability (above 88%), while concentrations ≤0.3% significantly enhanced cell migration. These findings indicate that Tualang honey, when applied at appropriate concentrations, is non-cytotoxic and promotes cell proliferation and possesses strong potential for periodontal tissue healing applications. Therefore, it shows potential as a natural agent for enhancing periodontal wound healing.

Keywords: *human gingival fibroblast, Tualang honey, viability and migration, wound healing*

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Introduction

Honey has long been recognized for its medicinal value and is increasingly studied for its therapeutic potential. Beyond its role as a natural sweetener, honey possesses a range of bioactive compounds, including enzymes, flavonoids, and phenolics, which contribute to its antioxidant, anti-inflammatory, and antimicrobial properties (Abu Bakar *et al.,* 2017). Traditionally, it has been used to manage digestive, hepatic, respiratory and cardiovascular conditions (Ezz El-Arab *et al*., 2006) and is known to enhance immune function and support wound healing (Medhi *et al*., 2008; Molan, 2001; Tonks *et al*., 2003). Recent studies also

highlight its potential anticancer effects, suggesting a promising role in disease prevention and adjunctive therapy (Bansal *et al*., 2005; de Luna *et al*., 2023).

In Malaysia, Tualang honey (TH) stands out among local varieties such as Kelulut and Acacia for its notable antimicrobial and wound-healing properties. Tualang honey, produced by *Apis dorsata* bees from the giant Tualang tree (*Koompassia excelsa*) in the Malaysian rainforest, is a polyfloral honey with a rich composition of phenolic compounds, flavonoids, and other bioactive constituents. It has been shown to possess strong antioxidant, anti-inflammatory, and antimicrobial properties, which contribute to its therapeutic potential (Azman *et al*., 2024). Studies have shown that Tualang honey effectively inhibits wound-infecting bacteria through both bactericidal and bacteriostatic actions (Aspar *et al.,* 2020; Tan *et al.,* 2009). In addition to its antimicrobial properties, TH has been shown to enhance cellular activities essential for wound repair. For instance, Yaacob *et al.* (2012) reported that TH protected keratinocytes from UVB-induced DNA damage and inflammation by reducing oxidative stress markers and suppressing pro-inflammatory cytokines. Additionally, Syazana *et al.* (2011) found that methanolic extracts of TH modulated fibroblast proliferation, particularly in keloid fibroblasts, suggesting its potential to promote balanced tissue regeneration and minimize scarring. These findings support the therapeutic application of TH in wound management, complementing evidence from other medicinal honeys like Manuka, Acacia, and Buckwheat that promote keratinocyte and fibroblast activity (Ranzato *et al.*, 2012; Ranzato *et al.*, 2013).

Cell migration is a crucial step in the wound healing process, where cells such as keratinocytes, fibroblasts, and endothelial cells move toward the wound site to restore tissue integrity. In the in vitro wound healing models, such as the scratch assay, this migration is observed as cells fill the artificially created gap over time. The efficiency of cell migration reflects the wound's ability to heal, and it is influenced by various factors including cytokines, growth factors, and bioactive compounds. Enhancing cell migration is often a key target in developing treatments to accelerate wound closure and tissue repair (Hofmann *et al*., 2023). Human gingival fibroblasts (HGFs), which are abundantly found in the connective tissue of the periodontium, play a crucial role in producing and maintaining the connective tissue matrix (Naruishi, 2022). Previous studies have shown that HGFs play a key role in repairing periodontal tissue, especially during the later stages of inflammation and wound healing. Their ability to migrate is essential for tissue repair, as they move toward the wound site to perform their functions in response to specific signals in the environment (te Boekhorst *et al.,* 2016). Honey application may help enhance HGF migration and support their wound healing ability.

Periodontal tissue healing remains a clinical challenge, with current treatment options often limited by cost or effectiveness. Tualang honey, a natural product with known bioactive properties, may serve as a safe and affordable alternative. This study aims to evaluate the wound-healing potential of honey by assessing its effects on cell viability, proliferation, and wound closure in a scratch assay model relevant to periodontal tissue healing.

Materials and Methods

Study design

This in vitro experimental study investigated the effects of varying concentrations of Tualang honey on human gingival fibroblasts, using MTT and scratch assays to evaluate cytotoxicity, cell migration, and wound closure. The tests were carried out at the School of Dental Sciences, Universiti Sains Malaysia, Malaysia.

Materials

Human gingival fibroblasts (HGF) cells were purchased from American Type Culture Collection (ATCC) Rockville, MA, U.S.A. Tualang honey was purchased from Federal

Agriculture Marketing Authority (FAMA), Malaysia. Fetal bovine serum (FBS), minimum essential medium - α modification, penicillin-streptomycin, phosphate buffered saline, trypan blue, trypLE express and trypsin-EDTA (0.25%) were purchased from Gibco, (USA). GenGiGel® mouthwash was purchased from OralDent U.K. Dimethyl sulfoxide (DMSO) was purchased from Merck, Germany.

Method

Cytoxicity test using MTT assay

Human gingival fibroblasts (HGFs) were thawed and subcultured in fibroblast growth medium until they reached approximately 90% confluence. The cells were then trypsinized and seeded into a 96-well plate at a density of 5,000 cells per well (Yu *et al.,* 2015). Subsequently, the cells were incubated with Tualang honey at predetermined concentrations ranging from 10% to 0.16% (Ranzato *et al*., 2013; Yun, 2021), at 37°C in a 5% CO_2 for 24 hours. After incubation, 10 µL of MTT solution (5 mg/mL in phosphate-buffered saline) was added to each well, followed by a 4-hour incubation period. The medium containing excess MTT was then removed, and 100 µL of dimethyl sulfoxide (DMSO) was added to each well to dissolve the dark blue formazan crystals formed by viable cells. The plate was shaken at 300 rpm for 15 minutes to ensure complete dissolution of the crystals. Absorbance was measured using a spectral scanning multimode reader (Thermo Scientific Varioskan® Flash, Finland) at a wavelength of 570 nm. The experiment was conducted in triplicate, and three independent experiments were performed.

The average of the triplicates from the control and treatment wells was calculated and applied in the following formula to determine cell viability.

Cell Viability (%) =
(Average absorbance of sample wells / Average absorbance of negative control wells) × 100

To find the value of IC_{50}, the percentage concentration of honey was transformed in log10 and analysed with GraphPad Prism 9 software. The inhibition curve was fitted with nonlinear regression (variable slope).

Scratch wound assay model

The scratch or wound healing assay, first introduced by Todaro *et al.* (1965), is a widely established method for studying cell migration on a two-dimensional surface. Human gingival fibroblasts (HGFs) were cultured to 95% confluence in 24-well plates labeled A to F. The assay was performed following the protocol described by Grada *et al.* (2017), with minor modifications. A scratch wound was created using a sterile 100 µL pipette tip (0.57 mm orifice diameter) and a sterile metal ruler to ensure a straight line. The pipette was held at a consistent angle, and uniform pressure was applied to generate a clean, uniform gap with smooth edges and minimal cellular debris. After scratching, the monolayer was washed with PBS to remove detached cells. Each well was then replenished with 2 mL of medium containing different concentrations of Tualang honey (TH): 5%, 1%, 0.3%, and 0.02% for wells A to D, respectively (Liang *et al.,* 2007). Well E received 2 mL of complete medium as a negative control, while well F received 2 mL of medium containing 0.1% Gengigel mouthwash as a positive control. All cultures were incubated at 37°C in a humidified atmosphere with 5% CO_2.

Wound closure measurement

The migration process was documented by capturing sequential digital photographs of the gap using an inverted microscope. A snapshot method was employed, where the wound area was photographed at the beginning, 24 hours, and 48 hours at 10x magnification. Image-Pro Express software Media Cybernetics, Inc. USA was used for image analysis, and cell migration was assessed by measuring the gap size. Five points were measured in each image, and the average wound width was calculated using ImageJ software. The percentage of wound closure was counted by measuring and

calculating the differences between final wound width and initial wound.

Wound Closure Percentage (%) = (Initial wound area - Final wound area) / Initial wound area) × 100

The migration rate can be quantified by dividing the change in wound width by the time spent in migration. The data obtained from these experiments were calculated using Microsoft Excel and the rates of migration (R_M) was calculated using the following formulation:

$$R_M = (Wi - Wf) / t$$

where:
R_M = Rate of cell migration, measured in micrometers per hour (μm/hour)
Wi = Initial wound width, measured in micrometers (μm)
Wf = Final wound width, measured in micrometers (μm)
t = Time taken, measured in hours (h)

Data analysis

Data were analysed using IBM SPSS Statistics Version 26 (IBM Corp., USA). The Kruskal–Wallis test was used for the cytotoxicity data due to non-normal distribution, with significance set at $p < 0.05$. For the migration assay, percentage wound closure and HGF migration rates were plotted over time. As the sample size exceeded 30 ($n > 30$), the central limit theorem was applied. Means and standard deviations were calculated, and a univariate two-way ANOVA was performed. Bonferroni adjustment was used for multiple comparisons. Statistical significance was set at $p < 0.05$ with a 95% confidence interval.

Results

For the cytotoxicity test, a statistically significant difference was observed among the treatment groups ($p = 0.000$), indicating a dose-dependent cytotoxic response. At the highest concentration tested (10%), cell viability was significantly reduced to 16.63% ± 1.52, indicating pronounced cytotoxicity. A moderate reduction in viability was observed at 5%, with a mean value of 69.77% ± 24.46. In contrast, lower concentrations (2.5% and below) maintained high cell viability, exceeding 88%. Notably, 2.5%, 1.25%, and 0.62% concentrations exhibited viability levels above 90%, which is comparable to the control group, suggesting minimal or no cytotoxic effects. The effect of various concentrations of TH on cell viability after 24 hours of exposure is presented in Figure 1.

The inhibition curve demonstrates a clear dose-dependent reduction in cell viability with increasing concentrations of TH after 24 hours of treatment. The curve follows a typical sigmoidal pattern, indicative of a cytotoxic effect. The highest concentration (10%) showed the greatest inhibitory effect, reducing viability to below 20%, while lower concentrations, particularly from 2.5% and below, had minimal impact on cell viability. The IC_{50} (half maximal inhibitory concentration) appears to fall between 2.5% and 5%, suggesting this range is critical for transitioning from non-toxic to cytotoxic effects. The steep slope of the curve between these concentrations highlights a narrow therapeutic window (Figure 2).

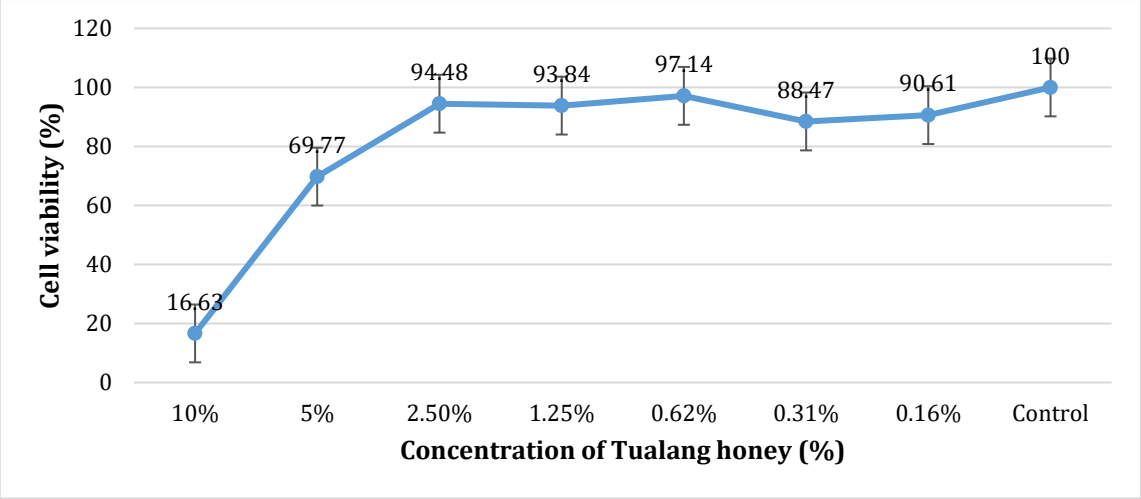

Figure 1. Cell viability of HGFs treated with various concentrations of Tualang honey using MTT assay after 24 hours.

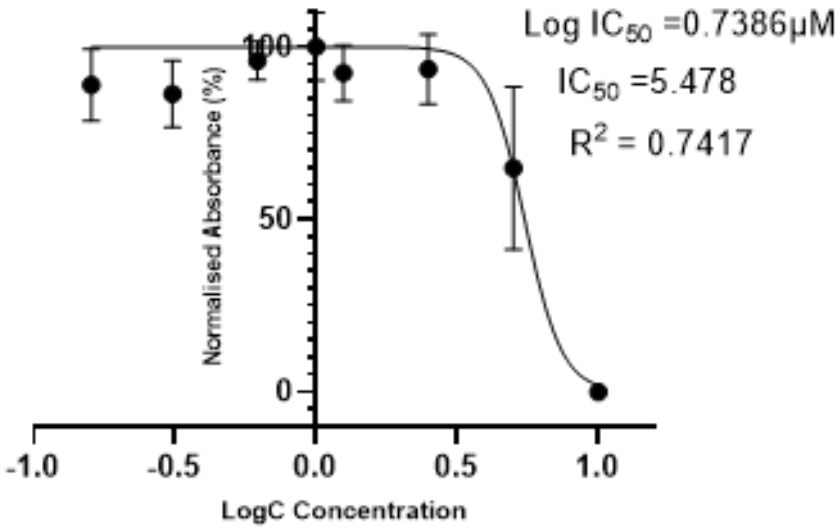

Figure 2. Dose-response inhibition curve of Tualang honey on cell viability.

Pairwise comparisons between each concentration of Tualang honey and the negative control revealed that only the higher concentrations (10% and 5%) caused statistically significant reductions in cell viability (Figure 3). Specifically, the 10% concentration showed a highly significant cytotoxic effect compared to the control ($p = 0.000$), while the 5% concentration also demonstrated a significant difference ($p = 0.027$). In contrast, all lower concentrations (≤2.5%) did not show any statistically significant difference in cell viability when compared to the control group ($p > 0.05$), indicating that these concentrations are non-cytotoxic under the tested conditions. These results further support the concentration-dependent cytotoxicity of Tualang honey, where significant inhibition of cell viability is only evident at concentrations ≥5%.

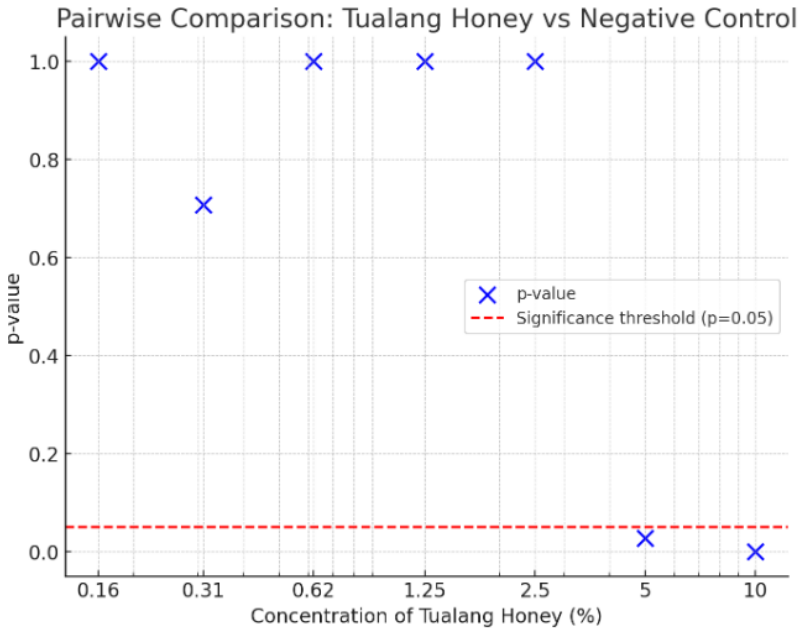

Figure 3. Pairwise comparison of HGF cell viability treated with Tualang honey at 24 hours, assessed by MTT assay.

Effect of Tualang honey on wound closure at 24 and 48 hours

The wound healing potential of Tualang honey was evaluated by measuring the percentage of wound closure at 24- and 48-hours post-treatment. A statistically significant difference was observed among all treatment groups at both time points ($p < 0.001$), indicating a concentration-dependent effect (Figure 4). At the highest concentration tested (5%), a negative wound closure was recorded at both 24 hours (−13.35 ± 0.37%) and 48 hours (−24.93 ± 0.5%), suggesting potential cytotoxicity or impaired cell migration. In contrast, lower concentrations demonstrated improved wound healing outcomes. Treatment with 1% honey yielded moderate wound closure (24.64% at 24 hours and 57.23% at 48 hours). The most effective responses were observed at 0.3% and 0.02% concentrations, with closure exceeding 50% at 24 hours and reaching 79.46% and 85.46% at 48 hours, respectively comparable to both negative and positive controls.

Effect of Tualang honey on the rate of human gingival fibroblasts migration

The migration rate of human gingival fibroblasts (HGFs) in response to various concentrations of TH was assessed at 24 and 48 hours, revealing a clear concentration-dependent trend (Figure 5). At 24 hours, the highest migration rate was observed in the positive control group (3.05 µm/h), followed closely by 0.3% TH (2.80 µm/h), 0.02% TH (2.77 µm/h), and the negative control (2.58 µm/h). In contrast, 1% TH exhibited a reduced migration rate (1.56 µm/h), while 5% TH showed a negative rate (−0.83 µm/h), suggesting a potential inhibitory or cytotoxic effect on cell motility. A similar pattern persisted at 48 hours, where the positive control maintained the highest rate (2.79 µm/h), closely followed by 0.3% TH (2.71 µm/h) and 0.02% TH (2.37 µm/h). The negative control showed a consistent rate (2.14 µm/h), whereas 1% TH remained lower (1.81 µm/h), and 5% TH continued to suppress cell migration (−0.77 µm/h).

Pairwise comparison of Tualang honey concentrations and HGF migration at 24 hours and 48 hours

Pairwise comparisons showed that 5% and 1% TH significantly reduced HGF migration rates compared to both control groups ($p = 0.000$) (Figure 6). In contrast, 0.3% and 0.02% showed no significant difference from the controls ($p = 1.000$). Migration increased significantly over time between 0, 24, and 48 hours ($p = 0.000$), indicating a time-dependent increase in cell movement.

Microscopic evaluation of HGF migration following treatment with Tualang honey

Wound widths measured at 0, 24, and 48 hours revealed a concentration-dependent response to TH (Figure 7). At 5%, wound width increased over time (91.19 µm to 113.99 µm), indicating impaired migration or cytotoxicity. The 1% group showed partial closure (107.54 µm to 46.45 µm), suggesting suboptimal healing. In contrast, 0.3% and 0.02% concentrations significantly reduced wound widths (107.82 µm to 27.09 µm and 123.46 µm to 18.98 µm, respectively), indicating enhanced HGF migration. The negative control also showed substantial closure (115.75 µm to 4.48 µm), with the 0.02% group closely matching this response, supporting its efficacy in promoting wound healing.

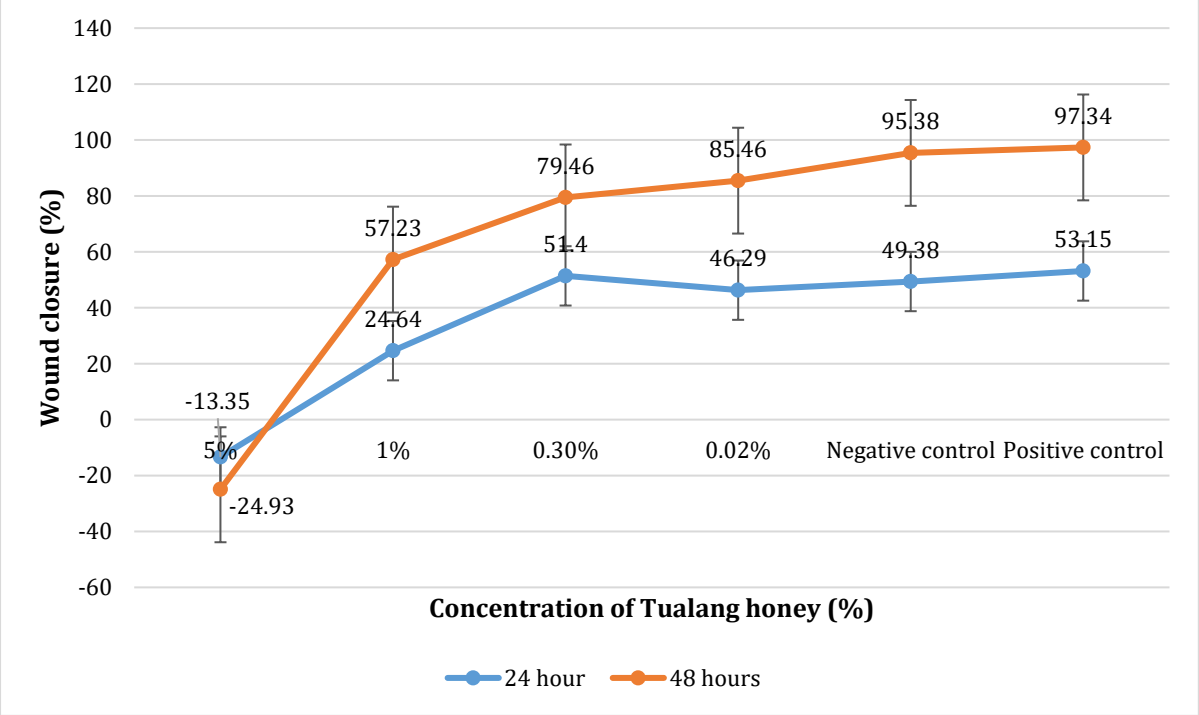

Figure 4. Percentage of wound closure at different concentrations of Tualang honey after 24 and 48 hours, based on scratch wound assay.

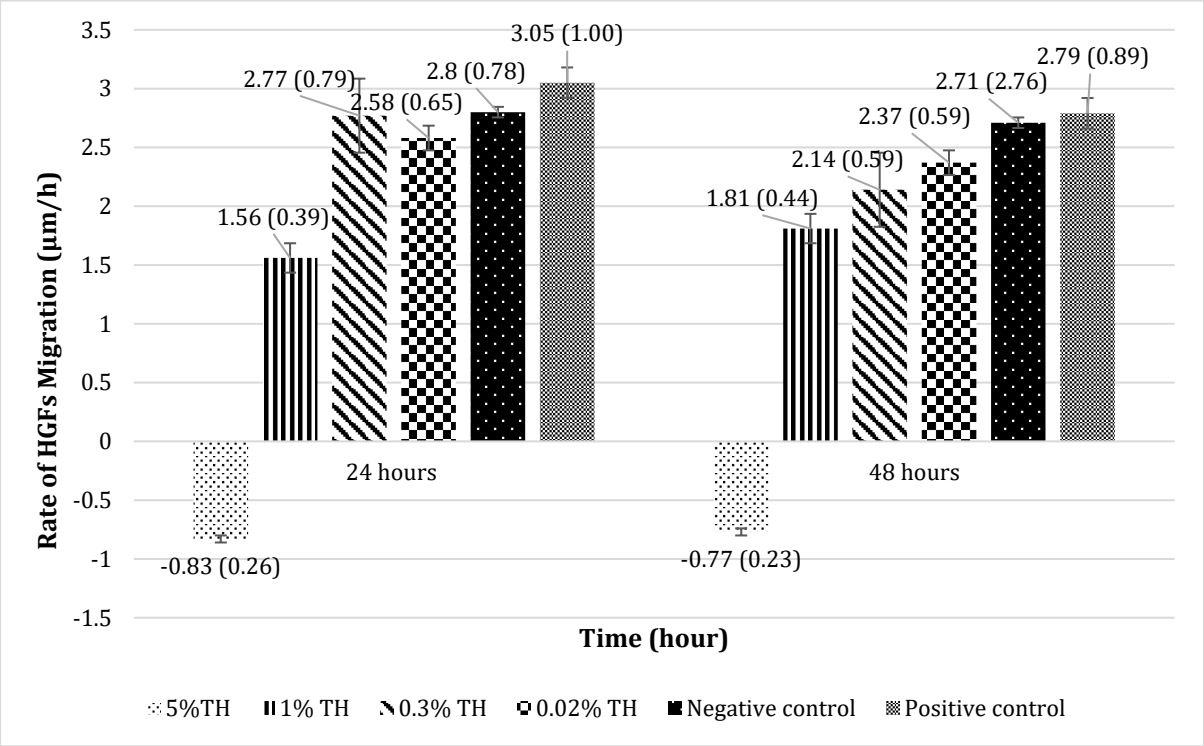

Figure 5. Rate of human gingival fibroblasts migration at various concentrations of Tualang honey at 24- and 48-hour using scratch assay.

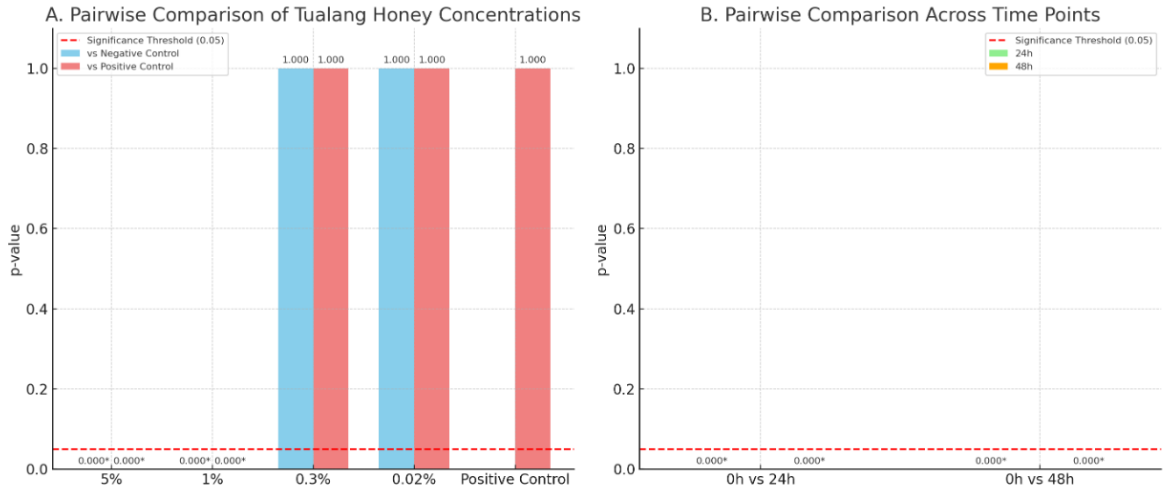

Figure 6. A. Pairwise comparison of Tualang honey concentrations (vs negative & positive controls). B. Pairwise comparison across time points (0h vs 24h, 0h vs 48h) using the scratch migration assay.

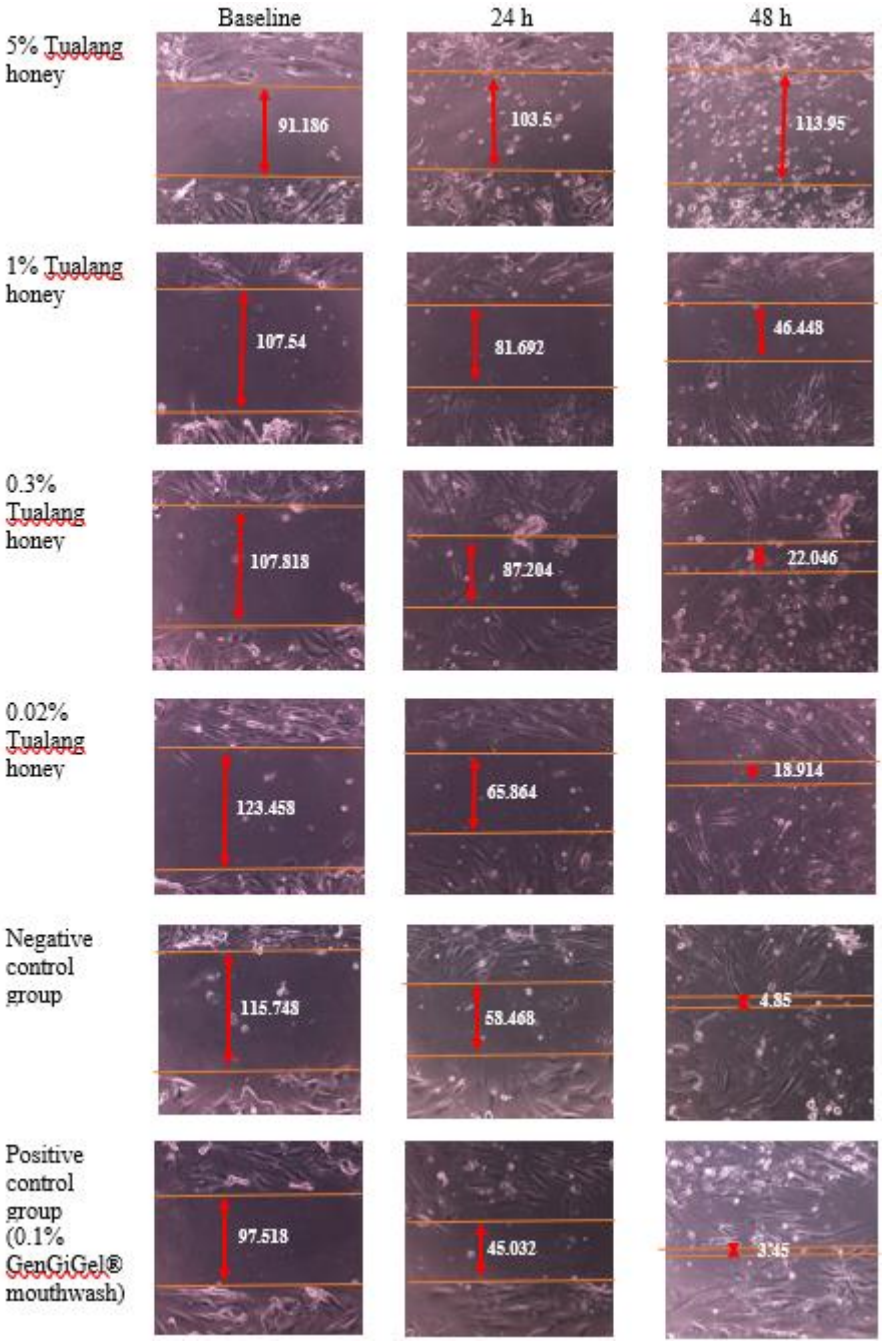

Figure 7. Microscopic images of scratch assays were captured at 100× magnification to evaluate migration of human gingival fibroblasts (HGFs) over 24 and 48 hours at various concentrations of Tualang honey and the control group (without treatment).

Discussion

Manuka honey is widely regarded as the gold standard among medical-grade honeys due to its unique methylglyoxal content and well-established antibacterial efficacy. However, Tualang honey, derived from the Malaysian rainforest, demonstrates a distinct mechanism of action that may complement or even surpass certain aspects of Manuka honey. Unlike Manuka, Tualang honey is exceptionally rich in polyphenols and flavonoids, which confer strong antioxidant properties and play a crucial role in modulating oxidative stress during wound healing. It also enhances fibroblast proliferation, reduces inflammatory cell

infiltration, and promotes tissue remodeling, highlighting a broader bioactive profile that supports wound repair. These findings suggest that while Manuka honey's activity is predominantly antibacterial, Tualang honey offers a multifaceted wound-healing mechanism through combined antioxidant, anti-inflammatory, and pro-proliferative effects (Fauzi *et al*., 2016). The study aimed to assess the effects of TH on the viability, wound closure, and migration of HGFs using MTT and scratch assays.

The results demonstrate that TH exhibits a concentration-dependent cytotoxic effect on HGFs. At the highest concentration tested (10%), a significant reduction in cell viability was observed, indicating strong cytotoxicity, while moderate effects were seen at 5%. High concentrations of honey may induce cytotoxicity in HGFs due to the combined effects of osmotic stress, low pH, hydrogen peroxide, and bioactive compounds (Gharzouli *et al.,* 2002; Molan, 1992). In contrast, concentrations of 2.5% and below did not significantly affect cell viability, suggesting they are non-toxic. These findings are consistent with previous reports demonstrating the biocompatibility of honey. Akmar *et al*. (2022) found that Kelulut and Acacia honey, at concentrations up to 2%, did not significantly reduce fibroblast viability. Similarly, Yun *et al.* (2021) found that Malaysian Kelulut honey maintains cell viability above 70% across a broad range of concentrations (3.125 to 200 mg/ml) and time points (24, 48, and 72 hours).

The IC_{50} values observed in this study range from 2.5% to 5%, indicating a critical concentration threshold for the transition from non-toxic to cytotoxic effects. The steep dose-response curve suggests that TH has a narrow therapeutic window, where slight increases in concentration may shift its effects from beneficial to harmful. This is supported by pairwise comparisons, which demonstrated that concentrations of 5% and above significantly reduced cell viability compared to the negative control, while concentrations below 5% showed no significant difference, indicating a lack of cytotoxicity. As this result was obtained in vitro, where cells are directly exposed to honey, the biological response may significantly differ in a more complex in vivo environment. Factors such as metabolic processes, immune responses, and tissue interactions could influence the actual impact in vivo.

The scratch assay demonstrated a concentration-dependent effect of TH on HGFs migration and wound closure. Lower concentrations of TH (0.3% and 0.02%) effectively promoted wound healing, as evidenced by significant wound closure and improved cell motility over 48 hours. In contrast, higher concentrations (1% and 5%) hindered fibroblast migration, with the 5% concentration showing negative migration, indicating a possible cytotoxic or inhibitory effect. Importantly, this is the first known study to assess the effect of TH on HGFs using a scratch assay, providing new insights into its wound healing potential in an oral context.

These findings are consistent with earlier studies involving various types of honey that support wound healing by enhancing cell migration. For instance, Ranzato *et al.* (2013) showed that acacia, buckwheat, and manuka honeys promoted fibroblast migration and wound closure potentially through distinct mechanisms. Similarly, Chaudhary *et al.* (2020) reported that Jamun honey at a 0.1% concentration significantly accelerated fibroblast migration and wound healing. Supporting this, Ranzato *et al.* (2012) found that low concentrations of honey (0.1%) also stimulated keratinocyte migration and re-epithelialization, highlighting honey's general capacity to enhance cell motility during tissue repair. Although direct studies on Tualang honey's effects on gingival fibroblasts are limited, Tan *et al.* (2014) demonstrated that TH facilitated migration of corneal epithelial progenitor cells, suggesting similar pro-migratory effects may occur in fibroblasts. In addition, Losageanu *et al.* (2024) observed that different types of honey enhanced fibroblast activity, further reinforcing honey's role in supporting wound healing processes.

Notably, Tualang honey at lower concentrations demonstrated comparable effects to a clinically established wound healing agent. When compared with the positive control used in this study, Gengigel mouthwash, which is a hyaluronic acid-based formulation, Tualang honey at concentrations of 0.3% and 0.02% demonstrated similar efficacy in promoting HGF migration. Previous research has confirmed that Gengigel is minimally cytotoxic and supports fibroblast migration, reinforcing its use in oral wound management (Marques *et al.,* 2024; Mercan & Salkin, 2019). These findings suggest that Tualang honey, at appropriately low concentrations, may serve as a natural alternative for enhancing oral wound healing, with effects comparable to a standard commercial product.

Conclusion

Although limited to in vitro conditions, Tualang honey demonstrated dose-dependent effects in both cytotoxicity and wound healing models. Lower concentrations (≤0.3%) were non-cytotoxic to human gingival fibroblasts and promoted cell migration and wound closure, while higher concentrations (≥5%) showed cytotoxicity. The findings contribute to the growing evidence of Tualang honey's therapeutic value in regenerative dentistry. Future studies should investigate the molecular pathways underlying its bioactivity, validate the effects in animal models and three-dimensional culture systems, and explore novel formulations such as hydrogels or scaffolds to optimize its clinical application.

Authors Contributions

Dr Siti Lailatul Akmar Zainuddin was involved in planning the study and supervised the research, Dr Zurairah binti Berahim was involved in planning the study, reviewed and edited the manuscript for clarity and content. Dr. Nor Azira binti Zahadi conducted the data collection and prepared the initial draft of the manuscript. All authors read and approved the final version of the manuscript.

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Ethical Approval Statement

There is no animal experiment carried out for this study.

Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

Declaration of Generative AI And AI-Assisted Technologies in the Writing Process

ChatGPT (developed by OpenAI) was used to assist with grammar checking, sentence rephrasing, and summarizing during the preparation of this manuscript. All AI-assisted content was carefully reviewed and edited by the authors to ensure accuracy, clarity, and alignment with the intended meaning. The authors take full responsibility for the content of the manuscript.

References

Abu Bakar, M. F., Sanusi, S. B., Abu Bakar, F. I., Cong, O. J., & Mian, Z. (2017). Physicochemical and antioxidant potential of raw unprocessed honey from malaysian stingless bees. *Pakistan Journal of Nutrition*, *16*(11), 888–894. https://doi.org/10.3923/pjn.2017.888.894

Aspar, M. M., Edros, R., & Hamzah, N. A. (2020). Antibacterial evaluation of malaysian kelulut, tualang and acacia honey against wound infecting bacteria. *IOP Conference Series: Materials Science and Engineering*, *991*(1).

https://doi.org/10.1088/1757899X/991/1/012065

Azman, A.S.S., Tan, J.J., Abdullah, M.N.H., *et al*. (2024). *Medicinal activities of Tualang honey: a systematic review. BMC Complementary Medicine and Therapies*, 24 (266).

Bansal, V., Medhi, B., & Pandhi, P. (2005). Honey--a remedy rediscovered and its therapeutic utility. *Kathmandu University Medical Journal (KUMJ)*, *3*(3), 305–309.

de Luna, F. C., Ferreira, W. A., Casseb, S. M., & de Oliveira, E. H. (2023). Anticancer potential of flavonoids: an overview with an emphasis on tangeretin. *Pharmaceuticals*, 16 (9). https://doi.org/10.3390/ph16091229

Ezz El-Arab, A. M., Girgis, S. M., Hegazy, E. M., & Abd El-Khalek, A. B. (2006). Effect of dietary honey on intestinal microflora and toxicity of mycotoxins in mice. *BMC Complementary and Alternative Medicine*, *6*(1), 6. https://doi.org/10.1186/1472-6882-6-6

Fauzi, A.N., Norazmi, M.N., Yaacob, N.S. (2016) Tualang honey promotes apoptotic cell death induced by tamoxifen in breast cancer cell lines. *Evidence-Based Complementary and Alternative Medicine*, 2016:3729051. https://doi.org/10.1155/2016/3729051

Gharzouli, K., Amira, S., Gharzouli, A., & Khennouf, S. (2002). Gastroprotective effects of honey and glucose-fructose-sucrose-maltose mixture against ethanol-, indomethacin-, and acidified aspirin-induced lesions in the rat. *Experimental and Toxicologic Pathology*, *54*(3), 217–221. https://doi.org/10.1078/0940-2993-00255

Hofmann, E., Fink, J., Pignet, A.-L., Schwarz, A., Schellnegger, M., Nischwitz, S. P., Holzer-Geissler, J. C. J., Kamolz, L.-P., & Kotzbeck, P. (2023). Human in vitro skin models for wound healing and wound healing disorders. *Biomedicines*, 11 (4). https://doi.org/10.3390/biomedicines11041056

Liang, C., Park, A. Y., & Guan, J. (2007). In vitro scratch assay : a convenient and inexpensive method for analysis of cell migration in vitro. *Nature Protocols*, *2*(2), 329–333. https://doi.org/10.1038/nprot.2007.30

Mandal, M. D., & Mandal, S. (2011). Honey: its medicinal property and antibacterial activity. *Asian Pacific Journal of Tropical Biomedicine*, *1*(2), 154–160. https://doi.org/10.1016/S2221-1691(11)60016-6

Marques, A. F. S., Silva, N. M., da Cruz, M., Marques, J., & da Mata, A. D. (2024). Hyaluronic acid-based gels for oral application: comparison of in vitro effects on gingival cells and bacteria. *Journal of Oral Biology and Craniofacial Research*, *14*(3), 238–244. https://doi.org/10.1016/j.jobcr.2024.03.001

Medhi, B., Puri, A., Upadhyay, S., & Kaman, L. (2008). Topical application of honey in the treatment of wound healing: a metaanalysis. *JK Science*, *10*(4), 166–169.

Mercan, U., & Salkin, H. (2019). Comparison of the effect of postoperative care agents on human gingival fibroblasts: a preliminary study. *European Oral Research*, *53*(2), 67–73. https://doi.org/10.26650/eor.20197456

Molan, P.C. (2001). The potential of honey to promote oral wellness. *General Dentistry*, *49*(6), 584–589.

Molan, P.C. (1992). The antibacterial activity of honey. *Bee World*, *73*(1), 5–28. https://doi.org/10.1080/0005772X.1992.11099109

Naruishi, K. (2022). Biological roles of fibroblasts in periodontal diseases. *Cells*, *11*(21). https://doi.org/10.3390/cells11213345

Ranzato, E., Martinotti, S., & Burlando, B. (2012). Epithelial mesenchymal transition traits in honey-driven keratinocyte wound healing: comparison among different honeys. *Wound Repair and Regeneration,* *20*(5), 778–785. https://doi.org/10.1111/j.1524475X.2012.00825.x

Ranzato, E., Martinotti, S., & Burlando, B. (2013). Honey exposure stimulates wound repair of human dermal fibroblasts. *Burns & Trauma*, *1*(1), 32–38. https://doi.org/10.4103/2321-3868.113333

Tan, H. T., Rahman, R. A., Gan, S. H., Halim, A. S., Hassan, S. A., Sulaiman, S. A., *et al.* (2009). The antibacterial properties of Malaysian tualang honey against wound and enteric microorganisms in comparison to manuka honey. *BMC Complementary and Alternative Medicine*, *9*, 34. https://doi.org/10.1186/1472-6882-9-34

te Boekhorst, V., Preziosi, L., & Friedl, P. (2016). Plasticity of cell migration in vivo and in silico. *Annual Review of Cell and Developmental Biology*, *32*(1), 491–526. https://doi.org/10.1146/annurev-cellbio-111315-125201

Tonks, A. J., Cooper, R. A., Jones, K. P., Blair, S., Parton, J., & Tonks, A. (2003). Honey stimulates inflammatory cytokine production from monocytes. *Cytokine*, *21*(5), 242–247. https://doi.org/10.1016/s1043-4666(03)00092-9

Yaghoobi, R., Kazerouni, A., & Kazerouni, O. (2013). Evidence for clinical use of honey in wound healing as an anti-bacterial, anti-inflammatory anti-oxidant and anti-viral agent: a review. *Jundishapur Journal of Natural Pharmaceutical Products*, *8*(3), 100–104. https://doi.org/10.17795/jjnpp-9487

Yu, L. X., Taib, H., Berahim, Z., Ahmad, A., & Zainuddin, S. L. A. (2015). The effect of Tualang honey on human periodontal ligament fibroblast proliferation and alkaline phosphatase level. *Sains Malaysiana*, *44*(7), 1021–1025. https://doi.org/10.17576/jsm-2015-4407-14

Yun, C. Z. (2021). Cytotoxic evaluation of malaysian kelulut honey on human gingival fibroblast cell line using mtt assay cytotoxic evaluation of Malaysian kelulut honey on human gingival fibroblast. *Journal of Dentistry Indonesia*, *28*(2), 88–93.

ORIGINAL ARTICLE Open Access

An audit of the quality of orthodontic consent form completion among IIUM postgraduate residents: first-cycle findings

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Abstract

Informed consent (IC) is both a legal and ethical requirement in clinical practice and holds particular importance in orthodontics due to the long-term nature of treatment. Comprehensive documentation of the consent process supports patient autonomy, enhances communication, and ensures professional accountability. This audit aimed to assess the quality and completeness of informed consent documentation within the Doctor in Orthodontics (DrOrth) postgraduate programme at the International Islamic University Malaysia (IIUM), as part of a Continuous Quality Improvement (CQI) initiative. A retrospective audit was conducted on 360 randomly selected patient records, managed by eight postgraduate residents between February and June 2024. Nine target criteria were assessed based on the Malaysian Medical Council's Guidelines for Consent for Treatment, with each criterion benchmarked against a 100% compliance standard. The sample represented approximately 45% of the total eligible patient population. All active orthodontic cases under postgraduate care were included. While the presence of consent forms was documented in 96.1% of cases, overall adherence to the nine target criteria varied between 84.7% and 96.1%. The highest compliance was observed for patient/guardian signatures and clinician documentation. However, the 'Benefits and Risks' section showed the lowest completion rate (84.7%), indicating a potential gap in documenting the treatment implications. Additionally, good effort found in 23.3% of forms which included documentation of 'Additional Specific Risks'. Consent forms were present in the majority of cases, the audit identified areas requiring improvement in the completeness of documentation. Targeted improvements, particularly in risks documentation, are recommended to enhance compliance with informed consent standards in orthodontic care.

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Introduction

Consent, as defined by Oxford University Press, refers to the act of giving permission for something to take place or agreeing to do something. In the context of healthcare, Informed Consent (IC) extends this concept by requiring that patients are adequately informed of the potential risks, benefits, and consequences of a proposed treatment before providing their agreement (Chougule *et al.*, 2025). Historically, medical practice was dominated by a paternalistic model, where decisions were primarily made by clinicians under the assumption that the

doctor knew best. Over time, this approach has evolved toward a patient-centred model of care that prioritises patient autonomy and shared decision-making (Bora *et al*., 2020; Yaakob, 2023).

In orthodontics, IC holds particular significance due to the long-term nature of treatment, which often spans several years. This necessitates sustained communication between clinicians and patients to ensure that individuals remain informed and actively involved in their care (Hazelan & Jahn Kassim, 2018; Meade *et al*., 2019). Such engagement aligns with the ethical duty to respect patient autonomy. Obtaining IC is both a legal and ethical obligation in clinical practice. As part of professional transparency and the duty of candour, healthcare providers are required to furnish patients with adequate information regarding the proposed treatment. The use of a written consent form serves as a standardised method to document that this process has been completed. Typically, these forms are filed within the patient's clinical records or notes as part of routine documentation. Given the ethical and legal significance of IC particularly in long-term treatments like orthodontics, it is essential to ensure that consent practices are not only performed but also properly documented, with all mandatory sections are appropriately filled, in accordance with established standards.

This audit, the first conducted following the commencement of the Doctor in Orthodontics (DrOrth) postgraduate programme at the International Islamic University Malaysia (IIUM) in 2021, was undertaken as part of the department's ongoing quality improvement activities to improve and maintain high standards of clinical practice. The DrOrth postgraduate programme at the IIUM is accredited by both the Malaysian Qualifications Agency (MQA) and the Royal College of Surgeons of Edinburgh (RCSEd)**.** Among its core educational outcomes is the cultivation of a strong duty of candour, reflecting a commitment to ethical transparency, patient-centred care, and professional integrity, principles that are fully aligned with the World Health Organization (WHO) standards for quality and safety in healthcare.

Aims

This audit was conducted to evaluate the quality of consent form completion and to identify areas for improvement as part of the Continuous Quality Improvement (CQI) process within the DrOrth postgraduate programme at the IIUM. Serving as the first cycle of a structured quality improvement initiative on informed consent, it aims to identify existing gaps, implement appropriate corrective measures, and strengthen compliance with Malaysia Medical Council (MMC) consent standards, thereby contributing to the continual enhancement of clinical governance and patient care quality within the programme.

Materials and Methods

The audit was conducted on patient records managed by the first and second cohorts of the DrOrth postgraduate programme at IIUM. Using the Raosoft sample size calculator, a minimum sample size of 260 was determined based on an estimated population of 800 patients with 99% confidence level. A 99% confidence level was chosen to ensure a higher degree of statistical certainty and to minimize the likelihood of Type I error (false positives), thereby enhancing the reliability and robustness of the findings, which is an important consideration for audits or studies aimed at informing clinical standards and quality improvement initiatives.

For confidentiality purposes, each consent form and its corresponding postgraduate residents were anonymised and identified using codes A to H, representing postgraduate residents 1 to 8. To ensure unbiased sampling, patient folders were randomly selected from the records room using the patient's name list of cases managed by the postgraduate residents, with 45 records retrieved for each postgraduate resident. An inter-rater check

was conducted to ensure the rigor and consistency of data extraction.

The documentation was assessed against the standards outlined in the "*Guidelines for Consent for Treatment of Patients by Registered Medical Practitioners"* issued by the Malaysian Medical Council (MMC).

A total of nine target criteria were assessed from the consent forms retrieved from the patients' records. All patients undergoing active treatment, under the care of postgraduate residents were included in the audit. No exclusion criteria were applied.

The audit aimed for 100% compliance with each criterion, which included the documentation of:

1. Presence of consent form in all active cases
2. Patient details
3. Treatment plan
4. Benefits and risks
5. Identification details of the patient or parent or guardian details
6. Signature of the patient or parent or guardian
7. Identification details of the treating clinician
8. Signature of the clinician
9. Corresponding date

Results

A total of 360 patient records across eight orthodontic residents were reviewed retrospectively from February till June 2024. These records were randomly selected, representing approximately 45% of the total eligible patient population. Overall, adherence to the target criteria was not fully met. Completion rates varied ranging from 84.7% to 96.1% (Figure 1) indicating that while certain items were well-documented, others showed notable gaps. The 'Consent form present' was the most consistently completed item, with a compliance rate of 96.1%, followed closely by 'Signature of Parent/Guardian' (94.2%), 'Clinician Signature' (93.6%), and 'Clinician Details' (92.5%). Documentation of 'Patient Details' (91.7%), 'Parent/Guardian Details' (91.3%), and the 'Treatment Plan' (89.4%) also showed relatively high completion rates. However, the 'Benefits and Risks' section was present in only 84.7% of the forms, highlighting a significant shortfall in communicating the full scope of treatment implications. The 'Presence of Date' was recorded in 88.6% of cases. In addition to the pre-determined audit target criteria, it was observed that 'Additional Specific Risks' were documented in the 23.3% of the consent forms reviewed.

Discussion

The findings from this audit align with those of previous pre-intervention studies, which similarly reported varied levels of completeness in informed consent documentation (Leng & Sharma, 2016; Prado & Waring, 2019; Tham *et al*., 2023). Overall, the audit demonstrated encouraging findings with consistently high completion rates across most of the target criteria. More than 90% of forms had key components completed including presence of consent form (96.1%), documentation of patient details (91.7%), clinician details (92.5%), inclusion of signatures from both clinicians (93.6%) and parents/ guardians (94.2%). This reflects commendable level of compliance with procedural documentation protocols. legal and ethical standards.

A particularly encouraging observation from this audit was the documentation of patient-specific or additional risks in 23.3% of cases. Although this was not part of the initial audit criteria, the presence of such entries is noteworthy. The documentation of risks specific to individual patients reflects a more patient-centred approach in consent. This not only supports ethical principles such as respect for autonomy and shared decision-making but also reinforces the legal validity of the consent process. Furthermore, it provides a useful reference for managing concerns, especially in cases where complications arise or where the adequacy of consent is later questioned.

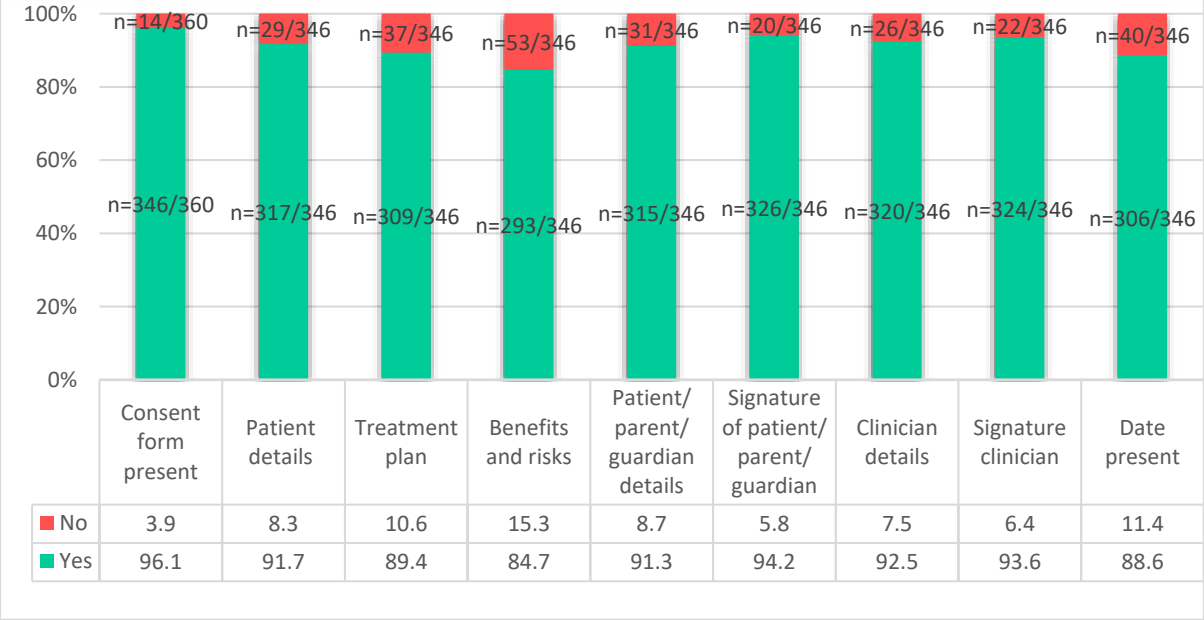

Figure 1. Bar chart illustrating the overall result of the first cycle. Results are presented mainly in percentages (supported by values). For all items following 'Consent form present', percentages were calculated based on the subset of cases where a consent form that was present.

Among the assessed criteria, the lowest level of compliance was observed in the documentation of 'Benefits and Risks' (84.7%). This may reflect an implicit reliance on the pre-printed general risk statements included in the consent forms which residents may have perceived as adequate. Extending beyond this specific issue, the reasons underlying incomplete or missing consent forms are likely multifactorial (Tham *et al.*, 2023). Suboptimal consent practices may stem from time constraints as well as a lack of awareness regarding the medico-legal and ethical significance of thorough informed consent documentation. It is important to note that incomplete documentation on the consent form does not necessarily imply that residents failed to communicate those elements during the informed consent process (ICP).

Nevertheless, a fully completed form functions as an important safeguard, enhancing both medico-legal protection and clarity in patient communication. A properly completed consent form, free from alterations or tampering reflects good clinical practice. Thorough documentation enhances legal defensibility by providing clear evidence that the patient was adequately informed and that consent was voluntarily given. The significance of precise and thorough documentation during the consent process has been emphasised in the medico-legal literature. For instance, a review in the context of orthopaedic surgery highlighted that proper recording and integration of consent forms into patient records were linked to a reduction in indemnity-related claims *(Bhattacharyya et al.*, 2005).

A key strength of this audit was its relatively larger sample size compared to previous audit in orthodontics (Prado & Waring, 2019). Large sample size allows generation of more representative and generalizable results. Nevertheless, it is important to acknowledge the limitations of this study. As a single-centre audit, the findings may not be fully applicable or transferable to other institutions with differing clinical practices or documentation systems. Furthermore, being a retrospective review, the analysis was dependent on the completeness and accuracy of existing records, which may have introduced information bias or limited the depth of interpretation.

Recommendations and Future Direction

In light of the audit findings, several strategies were proposed to improve the quality and completeness of informed consent documentation in orthodontic practice. One key recommendation was the integration of Continuous Dental Education (CDE) sessions aimed at raising awareness among residents and clinical staff regarding the audit outcomes. These sessions included guidance on the steps necessary to achieve full compliance with documentation standards while reinforcing the ethical and medicolegal importance of comprehensive IC practices. Additionally, the use of index dividers within patient records was recommended to facilitate quick access to consent forms during clinical procedures. This simple yet effective measure helps to streamline clinical workflow, enhances record organisation, and promote greater compliance with consent form completion.

To complete the audit cycle and assess the effectiveness of these proposed interventions, a follow-up audit is planned. This subsequent review will aim to achieve 100% completion rates across all existing criteria. Furthermore, the audit will introduce a tenth evaluation criterion i.e., the documentation of additional specific risks with a target of at least 50% inclusion. This new benchmark reflects a commitment to enhancing the quality of patient-centred care through more individualised and transparent consent practices.

By implementing these targeted, practical, and cost-effective measures, the orthodontic department can move towards improved compliance and a more robust informed consent process, ultimately contributing to better clinical outcomes and stronger patient-provider relationships.

Although this audit was conducted within a single institution, its findings provide valuable insights that may be applicable to other postgraduate clinical programmes. The recommendations emphasise the importance of consistent adherence to IC standards and structured quality improvement processes, which can be adapted by other institutions seeking to strengthen their clinical governance frameworks.

Conclusion

This audit identified areas for improvement in the completion of informed consent forms. All audit standards could be further enhanced. Targeted and low-cost strategies have been proposed to enhance documentation and clinical effectiveness. A follow-up audit will be conducted to assess the impact of these interventions and complete the audit cycle.

Acknowledgement

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Declaration of Conflicting Interests

The author(s) declare that there are no potential conflicts of interest with respect to the audit, authorship, and/or publication of this report.

Ethics

This audit was undertaken as a component of a larger research project approved by the IIUM Research Ethics Committee (IREC) under ID No. IREC 2024-033, at the International Islamic University Malaysia.

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References

Bhattacharyya, T., Yeon, H., & Harris, M. B. (2005). The medical-legal aspects of informed consent in orthopaedic surgery. *Journal of Bone and Joint Surgery*, *87*(11), 2395–2400. https://doi.org/10.2106/JBJS.D.02877

Bora, P., Agrawal, P., Bagga, D. K., & Nanda, M. (2020). Patient centric informed consent in orthodontic practice: an overview. *Journal of Critical Reviews*, *7*(17), 3225–3229. https://doi.org/10.31838/jcr.07.17.400

Chougule U, Sharma K, S. Kolekar S, V. Nerlekar H, Gupta S. Informed consent in surgery: legal and ethical considerations. *Journal of Neonatal Surgery*, 14(2S):21-30.

Hazelan, H. A., & Jahn Kassim, P. N. (2018). Implementing 'Good informed consent practices' in Malaysian healthcare facilities: balancing the demands of law and medical realities. *7th International Conference on Law and Society (ICLAS 7), (Unpublished)*, *11-13 April 2018*, *Kota Kinabalu*, *Sabah*.

Leng, C., & Sharma, K. (2016). An audit cycle of consent form completion: a useful tool to improve junior doctor training. *Indian Journal of Plastic Surgery*, *49*(1), 72–75. https://doi.org/10.4103/0970-0358.182246

Meade, M. J., Weston, A., & Dreyer, C. W. (2019). Valid consent and orthodontic treatment. *Australasian Orthodontic Journal*, *35*(1), 35–45. https://doi.org/10.21307/aoj-2020-031

Prado, N., & Waring, D. (2019). Improving the orthodontic consent process: amending hospital policy and implementing change. *Journal of Orthodontics*, *46*(1), 34–38. https://doi.org/10.1177/1465312518815547

Tham, Z. K., Mohd Taufik, S. A., Ong, E. Z., & Ramli, N. (2023). Audit on validity and adequacy of consent forms for ophthalmology laser procedures and angiography in a tertiary hospital. *Journal of Health and Translational Medicine*, *26*(2), 139–147. https://doi.org/10.22452/jummec.vol26no2.19

Yaakob, H. (2023). An overview of informed consent in dentistry in Malaysia. *Journal of Clinical and Health Sciences*, *8*(1), 34–42. https://doi.org/10.3917/jib.161.0143

ORIGINAL ARTICLE Open Access

Perceived knowledge and use of IOTN-DHC among dental officers in Sabah

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Abstract

This cross-sectional study assessed the knowledge and use of IOTN-DHC among dental officers in Sabah. A self-administered, anonymous, and structured questionnaire in the format of Google form were used. The questionnaire addressed socio-demographic characteristics, knowledge and use on IOTN-DHC. Data were entered into a standardised collection form and were analysed descriptively and inferentially. All respondents knew IOTN (n=224, 100.00%). More than half used both components (n=115, 51.34%). Most had training on IOTN-DHC (n=187, 83.48%). The main sources of training were workshop or course (n=128, 57.14%) and undergraduate training (n=109, 48.66%). More than half felt confident in using IOTN-DHC (n=135, 60.27%). Dental officers graduated from local public universities (n=54, 80.60%), had working experience five years and above (n=66, 72.53%), and had previous training (n=125, 66.84%) were confident. IOTN-DHC was used to assess treatment eligibility (n=220, 98.21%), to grade malocclusion (n=170, 75.89%), to communicate with colleagues (n=149, 66.52%), and to communicate with patients (n=69, 30.80%). Majority needed more training (n=210, 93.75%). Methods beneficial were hands on workshop or course (n=201, 89.73%), poster in surgery room (n=161, 71.88%), webinar (n=131, 58.48%), online educational materials (n=102, 45.54%), and textbooks (n=66, 29.46%). In conclusion, the perceived knowledge and use of IOTN-DHC among dental officers in Sabah were moderate. Graduated from local public universities, had longer working experience, and had previous IOTN-DHC training contributed to better confidence of the dental officers. Yearly training sessions are important to enhance the knowledge, use, and confidence in using IOTN-DHC.

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Introduction

Index of Orthodontic Treatment Need (IOTN) was developed in United Kingdom in year 1989 and is since widely used to assess the need and eligibility of children under 18 years of age for National Health Service orthodontic treatment. There are two components in this index; the Dental Health Component (DHC) and the Aesthetic Component (AC) (Brook & Shaw, 1989).

The DHC uses scale of 1 to 5 to rate treatment need, with grade 1 represents no treatment need, grade 2 represents little treatment need, grade 3 represents borderline need, grade 4 represents treatment required, and grade 5 represents great need for treatment. It evaluates the severity of malocclusion (Shaw *et al*., 1991) based on missing teeth, increased or decreased overjet, crossbite, crowding, and increased or decreased overbite. Along with a number grade, a letter is assigned to identify and record specific

deviant occlusal anomalies (Jawad *et al*., 2016).

IOTN-DHC is reliable over time (Cooper *et al*., 2000) and almost perfect reproducibility (Alwakeel & Barakah, 2023; Shaw *et al*., 1991). IOTN-DHC is a guide to prioritize patients who are more in need of orthodontic treatment (Negri *et al*., 2021). It ensures that limited allocations are fairly utilized for patients in need of treatment (Bhagyalakshmi *et al*., 2015) and would benefit most from the treatment. It has allowed orthodontists to standardise their approach in evaluating treatment need (de Oliveira 2003). Meanwhile, AC comprises of ten photographs to represent severity of malocclusion, ranging from 1 (most attractive) to 10 (least attractive). The AC does not reflect the patients' perception and AC alone is inadequate to identify the orthodontic treatment need (Hsu *et al*., 2014).

Currently, dental officers in the government service in Malaysia are encouraged to use IOTN-DHC to grade the orthodontic treatment need of the patients when they refer patients for orthodontic consultation (Program Kesihatan Pergigian, 2022). An audit done by Ringgingon *et al.* (2025) found that more than 20% of the orthodontic referrals by dental officers in the Federal Territory of Labuan had inaccurate IOTN scoring. Incorrect or inaccurate use of this index can have an impact on patient treatment and orthodontic service. Inappropriate referrals to the orthodontists can contribute to the waste of time and resources for both patients and clinicians, while failing to refer eligible patients can also mean patients missed the orthodontic treatment they need.

Therefore, this study assessed the self-perceived knowledge and self-reported use of IOTN-DHC among dental officers in government service in Sabah. The findings would be useful to determine whether the dental officers may need more training sessions on the knowledge and use of IOTN-DHC, and hence improve the efficiency and accuracy of orthodontic referrals.

Materials and Methods

This was a cross-sectional study. A self-administered, anonymous, structured questionnaire in the format of Google form were distributed to all dental officers in Sabah through their head of department. The inclusion and exclusion criteria were informed to the head of department to facilitate the distribution of the questionnaire to the target group. The information sheet regarding this study was attached together. Informed consent was considered given by the participants once they answered and submitted the questionnaire.

The inclusion criteria were dental officers who were working in government service in Sabah during the time of questionnaire distribution. The exclusion criteria was dental officers who had orthodontic postgraduate qualification. The sample size was 163 and was calculated using prevalence formula (Naing *et al*., 2022). Ethical approval for this study was obtained from the Medical Research and Ethics Committee (MREC), Ministry of Health Malaysia and registered with the National Medical Research Register (NMRR-ID-22-02532-MXK).

The questionnaire used in this study was not fully adapted from any previous study, but was newly developed by the researcher based on the findings from previous studies (Jawad *et al*., 2016; Ho-A-Yun *et al*., 2009; Puri *et al*., 2015). It was validated by two orthodontists and was pre-tested by dental officers prior to the start of this study.

This questionnaire addressed two aspects: socio-demographic characteristics, and knowledge and use on IOTN-DHC. Socio-demographic variables included age, gender, details on the dental school they graduated from, and the number of years they had served in the government service as dental officers.

In the knowledge and use of IOTN-DHC, there were eight questions. The participants were asked whether they had heard of IOTN,

which IOTN component they used, whether they had proper training in IOTN-DHC, details from where they had their IOTN-DHC training, whether they felt confident in using IOTN-DHC, their purpose of using IOTN-DHC, whether they needed more training in IOTN-DHC in future, and which methods they thought they might benefit from to improve their knowledge and use of IOTN-DHC.

The data were entered into a standardised data collection form. All variables were analysed descriptively using Stata 15. The differences between female dental officers and male dental officers with respect to knowledge and use on IOTN-DHC, and the confidence in using IOTN-DHC were tested using Fisher's exact test. The level of significance was set at 5% ($p < 0.05$).

Results

A total of 224 dental officers answered and submitted the questionnaire. The response rate was 80.0%. Mean age of the respondents was 29.35 ± 0.25 years. More than three-quarters of the respondents were females. The number of dental officers graduated from overseas universities, local private universities, and local public universities were almost equal. The mean working experience of the respondents as dental officers was 4.16 ± 0.23 years (Table 1).

Regarding the knowledge and use on IOTN-DHC, all respondents knew IOTN (n=224, 100.00%). Most of the respondents had training on using IOTN-DHC (n=187, 83.48%). More than half of the respondents felt confident in using IOTN-DHC (n=135, 60.27%). Majority of the respondents thought they need more training in using IOTN-DHC (n=210, 93.75%). The knowledge and use of IOTN-DHC between the female and male dental officers were found not statistically significant, p > 0.05 (Table 2).

Table 1. Demographic profile of the respondents.

Variables		n (%)	Mean ± SE (years)
Age		-	29.35 ± 0.25
Gender	Female	174 (77.68)	-
	Male	50 (22.32)	-
Graduated from	Overseas universities	79 (35.27)	-
	Local private universities	78 (34.82)	-
	Local public universities	67 (29.91)	-
Working experience		-	4.16 ± 0.23

Table 2. Knowledge and use on IOTN-DHC.

Questions on IOTN-DHC knowledge and use	Yes n (%)	No n (%)	*p* value *
Have you heard of IOTN?	224 (100.00)	0 (0.00)	-
Do you have training on using IOTN-DHC before?	187 (83.48)	37 (16.52)	0.280
Do you feel confident in using IOTN-DHC?	135 (60.27)	89 (39.73)	0.624
Do you think you need more training in using IOTN-DHC?	210 (93.75)	14 (6.25)	0.520

*Fisher's exact test

More than half of the respondents used both components of IOTN (n=115, 51.34%), followed by DHC only (n=102, 45.54%). Only 0.89% (n=2) used AC alone, and 2.23% (n=5) were not sure which component of IOTN they used (Figure 1).

The sources of their training were IOTN workshop or course (n=128, 57.14%), undergraduate training (n=109, 48.66%), and journal (n=13, 5.80%) (Figure 2).

The respondents used IOTN-DHC to assess treatment eligibility (n=220, 98.21%), to grade malocclusion (n=170, 75.89%), to communicate with colleagues (n=149, 66.52%), and to communicate with patients (n=69, 30.80%) (Figure 3).

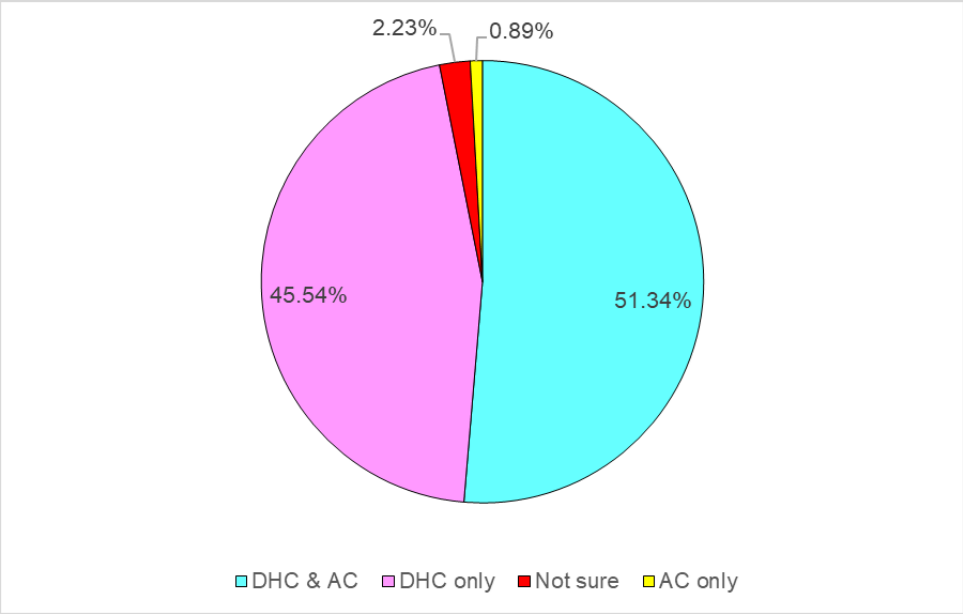

Figure 1. IOTN components used by respondents.

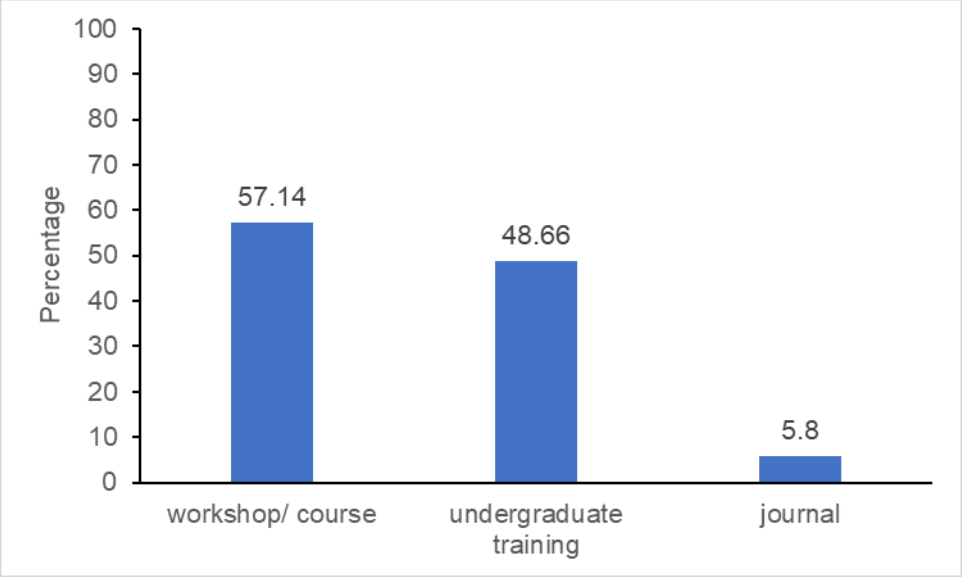

Figure 2. Training sources of the respondents on IOTN-DHC.

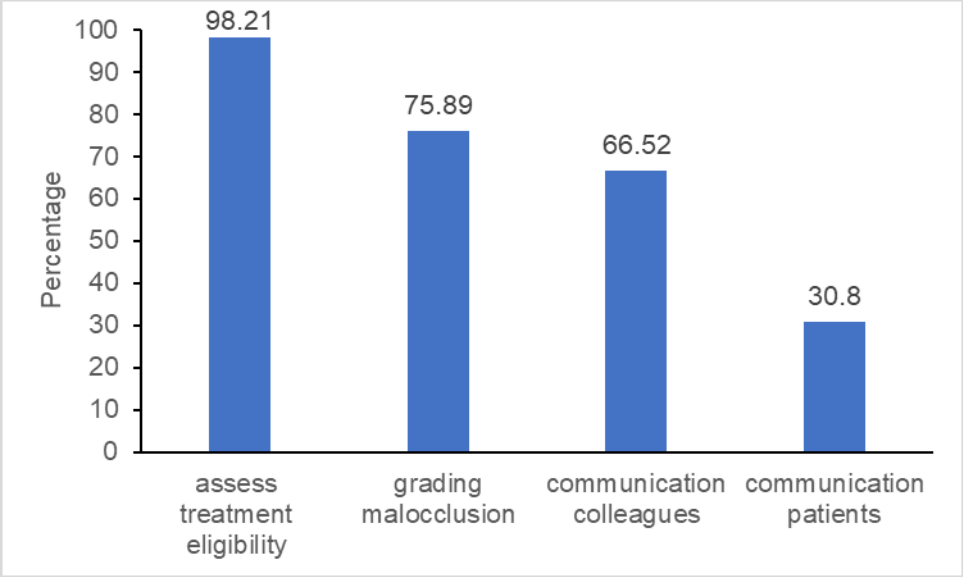

Figure 3. Purposes of using IOTN-DHC.

The highest percentage of dental officers graduated from local public universities (n=54, 80.60%) felt confident in using IOTN-DHC, followed by dental officers graduated from overseas universities (n=47, 59.49%). In contrast, more dental officers graduated from local private universities (n=44, 56.41%) felt not confident in using IOTN-DHC. These findings were statistically significant, $p < 0.05$) (Table 3).

Higher percentage of dental officers who had worked in the government service for five years and above (n=66, 72.53%) were confident in using IOTN-DHC than the dental officers who had worked less than five years (n=69, 51.88%) in service. These findings were statistically significant, $p < 0.05$ (Table 3).

More than two-thirds of dental officers who had IOTN-DHC training (n=125, 66.84%) were confident in using IOTN-DHC. Majority of the dental officers who did not have IOTN-DHC training (n=27, 72.97%), were not confident in using IOTN-DHC. These findings were statistically significant, $p < 0.05$ (Table 3).

Regarding the methods that the respondents felt were beneficial to encourage the use of IOTN-DHC, hands on IOTN workshop or course were the most popular (n=201, 89.73%), followed by IOTN poster put up in surgery room (n=161, 71.88%), webinar (n=131, 58.48%), educational material available online (n=102, 45.54%), and orthodontic textbooks (n=66, 29.46%) (Figure 4).

Table 3. Confidence in using IOTN-DHC among the dental officers.

Variables		Confidence		*p* value *
		Yes, n (%)	No, n (%)	
Graduated from	Overseas universities	47 (59.49)	32 (40.51)	0.000
	Local private universities	34 (43.59)	44 (56.41)	
	Local public universities	54 (80.60)	13 (19.40)	
Working experience	Less than five years	69 (51.88)	64 (48.12)	0.002
	Five years and above	66 (72.53)	25 (27.47)	
Had IOTN-DHC training before?	Yes	125 (66.84)	62 (33.16)	0.000
	No	10 (27.03)	27 (72.97)	

*Fisher's exact test

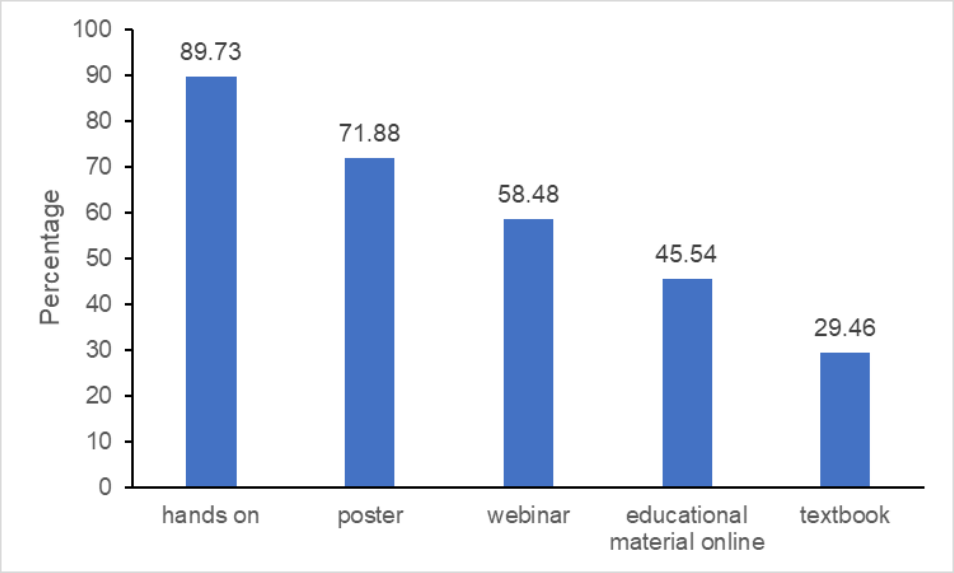

Figure 4. Methods beneficial to encourage the use of IOTN-DHC.

Discussion

IOTN acts as an educational tool to improve the diagnostic skill of the dental officers (Loke, 2007). It could be useful for prioritizing treatment due to lack of manpower and resources. This could reduce the long waiting list for orthodontic treatment, especially in government clinics (Wahab, 2007).

In this study, knowledge was the awareness gained by experience or lesson, while use was the practise of IOTN-DHC. There were high awareness and usage of IOTN-DHC among dental officers in Sabah. However, the number of respondents felt confident to use IOTN-DHC was lower than the number of respondents who had formal trainings. More than half of the respondents did not have undergraduate training on the use of IOTN-DHC. Moreover, a few of the respondents were unable to recognize DHC and AC. The IOTN diagnostic accuracy of the dental officers was found low (Loke & Tan, 2017). Orthodontic referral might not be very much emphasized or taught in undergraduate syllabus in some universities. The inadequacy in correctly applying the IOTN-DHC might be due to lack of clinical experience in assessing patients and making referrals (Bouskandar *et al.*, 2023). To strengthen the dental officers on knowledge and use of IOTN-DHC, undergraduate teaching by the lecturers, is essential.

Based on the responses, the major sources of IOTN-DHC training were at workshop and course. Yearly workshop and course to train or refresh the knowledge and use of IOTN-DHC among the dental officers, especially the new dental officers, are important (Jawad *et al.*, 2016; Ringgingon *et al.*, 2025). These could increase their confidence and competence in using IOTN-DHC. Moreover, almost all of the respondents were looking forward to more training sessions on IOTN-DHC, which showed positive eagerness to learn, despite more than 80% had training before.

In terms of confidence in using IOTN-DHC, the categories of dental officers who felt confident were dental officers who graduated from local public universities, dental officers who had longer working experience in government service, and dental officers who had previous IOTN-DHC training. These show that exposure to IOTN-DHC training and usage is very important to the dental officers' confidence.

IOTN-DHC poster put up at surgery room served as a quick reference for the dental officers when they need to refer patients for orthodontic consultation. More respondents sought educational materials online than

orthodontic textbooks due to convenience and updated information. However, orthodontic textbooks still served as important source of knowledge on IOTN-DHC.

Meanwhile, webinar allows knowledge delivery regardless of participants' location or time, especially sessions can be recorded and replayed. Webinar had gained popularity during the pandemic and lockdown period (Nepal, 2020). The advantages of webinar include cost and time savings since travel is not required, as well as ease of conducting and convenient knowledge sharing. However, the disadvantages of webinar are the dependence on technology, good internet access, barrier for effective interaction between the speaker and the participants, and participants might get distracted easily. Webinar continues as online educational platform even after the pandemic (Dev *et al*., 2022). Hence, webinar on IOTN-DHC might serve as a useful and convenient platform to reach all the dental officers in Sabah.

The limitation of this study is online questionnaire may lack of direct interaction between the researcher and the participants and no time limit to complete the questionnaire. This might lead to misinterpretation of the questions as the participants could not directly clarify their doubt. In addition, the findings were based on self-perceived knowledge and self-reported use of IOTN-DHC, which may not reflect actual competency. If time and resources permit, future studies could use on-site questionnaire administered at conferences, seminars, or workplaces to achieve higher engagement and immediate clarification of queries. Participants might be requested to score the IOTN-DHC based on malocclusion study models or photos within time limit. These will give more accurate information and deeper understanding of the knowledge and use of IOTN-DHC among the dental officers.

Conclusion

The perceived knowledge and use of IOTN-DHC among dental officers in Sabah were moderate. Graduated from local public universities, had longer working experience, and had previous IOTN-DHC training contributed to better confidence of the dental officers in using IOTN-DHC. Yearly training sessions on IOTN-DHC are important to enhance the knowledge, use, and confidence of the dental officers.

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Conflict of interests

The author declared no conflict of interest in this research

References

Alwakeel, R., Barakah, D. (2023). Applicability of IOTN Index for quality assessment of orthodontic treatment difficulty. *Journal of Indian Orthodontic Society*, 57(4), 268-272.

Bhagyalakshmi, A., Shivalinga, B.M., Balasubramanian, S., Suma, S. (2015). The Index of Orthodontic Treatment Need- a review. *International Journal of Recent Scientific Research*, 6(8), 5835-5839.

Bouskandar, S.Y., Muraikhi, L.A., Hodge, T.M., Barber, S.K. (2023). UK dental students' ability and confidence in applying the Index of Orthodontic Treatment Need and determining appropriate orthodontic referral. *European Journal of Dental Education*, 27(3), 489-496.

Brook, P.H., Shaw, W.C. (1989). The development of an index of orthodontic treatment priority. *European Journal of Orthodontics*, 11, 309-320.

Cooper, S., Mandall, N.A., Dibiase, D., Shaw, W.C. (2000). The reliability of the Index of Orthodontic Treatment Need over time. *Journal of Orthodontics*, 27, 47-53.

De Oliveira, C.M. (2003). The planning, contracting and monitoring of orthodontic services, and the use of the IOTN index: a survey of consultants in dental public health in the United Kingdom. *British Dental Journal*, 195, 704-706.

Dev, P., Thyavihally, B.Y., Waigankar, S.S., Agarwal, V., Pednekar, A.P., Shah, A. (2022). The value of webinars during COVID-19 pandemic. A questionnaire-based survey. *Indian Journal of Urology*, 38(3), 204-209.

Ho-A-Yun, J., Crawford, F., Clarkson, J. (2009). The use of the Index of Orthodontic Treatment Need in

dental primary care. *British Dental Journal*, 206, E16.

Hsu, E.E.H., Myo, Y.Y., Yee, H.H., Win, S.S. (2014). A study of Index of Orthodontic Treatment Need and perception of personal dental appearance among dental students. *Myanmar Dental Journal*, 21(1), 60-66.

Jawad, Z., Bates, C., Hodge, T. (2016). Can dental registrants use the Index of Orthodontic Treatment Need accurately? Part 1: Knowledge of IOTN among dental registrants. *British Dental Journal*, 220(10), 527-532.

Loke, S.T. (2007). Efficacy of training dental officers in the Index of Orthodontic Treatment Need (IOTN). *Malaysian Dental Journal*, 28(1), 24-31.

Loke, S.T., Tan, S.Y. (2017). Competency of primary care officers in referring patients for orthodontic treatment using IOTN. *Malaysian Dental Journal*, 2, 1-29.

Naing, L., Nordin, R.B., Abdul Rahman, H., Naing, Y.T. (2022). Sample size calculation for prevalence studies using Scalex and ScalaR calculators. *BMC Medical Research Methodology*, 22, 209.

Wahab, R.M.A. (2007). The expert says IOTN as a tool in prioritizing orthodontic treatment. *Malaysian Dental Journal*, 28(1), 32-33.

Negri, P., Vena, F., Lomurno, G., Coniglio, M., Cianetti, S., Gatto, R., Severino, M. (2021). Index of Orthodontic Treatment Need (IOTN) and distribution of malocclusion traits in a population of growing patients attending a public orthodontic service in Perugia (Italy). *European Journal of Paediatric Dentistry*, 22(4), 303-308.

Nepal, P.R. (2020). Role of webinars in medical educations during pandemic of COVID 19. *Eastern Green Neurosurgery*, 2, 1-2.

Program Kesihatan Pergigian. (2022). Garis panduan rujukan rawatan ortodontik di fasiliti perkhidmatan pergigian Kementerian Kesihatan Malaysia (KKM). *Kementerian Kesihatan Malaysia*, 1-17.

Puri, A., Ho-A-Yun, J., McGuiness, N.J. (2015). Use and knowledge of IOTN among GDPs in Scotland. *British Dental Journal*, 218, 399-404.

Ringgingon, L.P., Hway, B.C.X., Chin, M.H. (2025). An audit on orthodontic referrals by government dental officers in the Federal Territory of Labuan. *Malaysian Dental Journal*, 48(1), 19-24.

Shaw, W.C., Richmond, S., O'Brien, K.D., Brook, P., Stephens, C.D. (1991). Quality control in orthodontics: Indices of treatment need and treatment standards. *British Dental Journal*, 170(3), 107-112. https://doi.org/10.1038/sj.bdj.4807429

ORIGINAL ARTICLE Open Access

Interactive e-learning lessons in patient-centred interview: an international multi-centred collaboration project piloted among dental and oral health students at the University of Otago, New Zealand

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Abstract

This study examines the integration of e-learning tools into the Bachelor of Dental Surgery (BDS) and Bachelor of Oral Health (BOH) curricula at the University of Otago, aiming to enhance pre-clinical dental education. Through a multidisciplinary approach, our research team developed interactive e-learning lessons for pre-clinical dentistry skills, which were piloted among 15 BDS and BOH students in 2022. Students' feedback was gathered through focus group discussions allowing for qualitative analysis of their experiences. The findings indicated a strong potential for merging curricula across both programs, as similarities were identified in the didactic and simulated learning experiences. Students reported overwhelmingly positive interactions with the digital materials, highlighting enhancements in their engagement and motivation while expressing their desire for more interprofessional education (IPE). Suggested improvements included increasing collaborative learning opportunities and refining content delivery. This study informs the necessity of integrating e-learning tools within dental curricula to foster a collaborative educational environment that effectively prepares future dental professionals. Ultimately, it underscores the significance of aligning educational practices with contemporary learning methods including interprofessional education to improve patient care outcomes.

Keywords: *dental education, curricula development, digital learning, dental students, oral health students, student experience*

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Introduction

Digital education refers to the use of digital technologies, tools and online platforms to enhance teaching and learning processes. It involves interactive content, virtual classrooms, and personalised learning experiences that go beyond traditional textbooks, making education more engaging, flexible, and accessible (Haleem *et al.*, 2022). While advances in technology and evolving teaching philosophies have traditionally driven the ongoing reassessment of effective teaching methods, the primary catalyst for change in the coming century is likely to be the evolving ways in which students learn (Alenezi, 2023). The COVID-19 pandemic forced health professions educators to rapidly shift from conventional in-person instruction to virtual teaching. However, there is limited evidence on how effectively online learning tools can be integrated into a blended learning model to enhance pre-clinical dental education and support students before their initial patient interactions.

As an international multidisciplinary and multi-centred team of researchers, led by dental and oral health professionals including specialists in oral radiology, periodontology and an enterprise education company with expertise in dental education, our overarching goal was to develop new teaching material to be incorporated as blended learning activities for students in the early stages of their dental and oral health clinical education. Furthermore, with shared funding and resources our desire for a curricula development in multi-professional learning environments had to purposefully align with current teaching practices, to future proof a high standard of learning by effectively educate a global dental and oral health workforce. The novel character of this project rests in evaluating the effectiveness of using e-learning material as instructions to enhance the learning of dental and oral health students. The aim of this study was two-fold; first, it aimed at investigating where and how e-learning material would be appropriately incorporated to enhance the Bachelor of Dental Surgery (BDS) and Bachelor of Oral Health (BOH) curricula within the Faculty of Dentistry at the University of Otago, and where courses had the potential to be merged across the programmes. Second, it explored students' experiences of using the digital e-learning material and allowed for modifications according to students' feedback, to better suit their learning preferences, to keep students motivated and engaged.

Materials and Methods

Prior to conducting the study, Māori consultation was sought from the Ngāi Tahu Research Committee and the study was granted ethical approval from the University of Otago Ethics Committee (D21/287).

To gain a deeper understanding of current teaching and learning practices the Otago team of researchers (HO, LA, SC & ATS) started by scrutinizing the curricula for simulated education through course outlines and learning objectives for each programme and year cohort within their institution. From a learner-centred approach, this stock-take informed opportunities for when students would benefit from digital learning in accordance with student learning outcomes from within each programme's respective curriculum. The Otago research team then investigated merging the various teaching and learning activities, including didactic teaching (lectures and tutorials) as well as the more interactive online simulated pre-clinical learning activities. This was undertaken to combine coherent teaching modules across the BDS and BOH programmes.

Concurrently, digital learning tools in the form of interactive e-learning lessons for learning pre-clinical skills in dentistry were developed by an international team of dental professionals and educational researchers involving all authors of this study and their respective affiliations. To trial the innovation and to investigate how students would respond to the e-learning material, and how it would possibly be further improved, the first e-learning lesson in a

series of four lessons focused on patient-centred interview and was piloted with a group of students from the University of Otago.

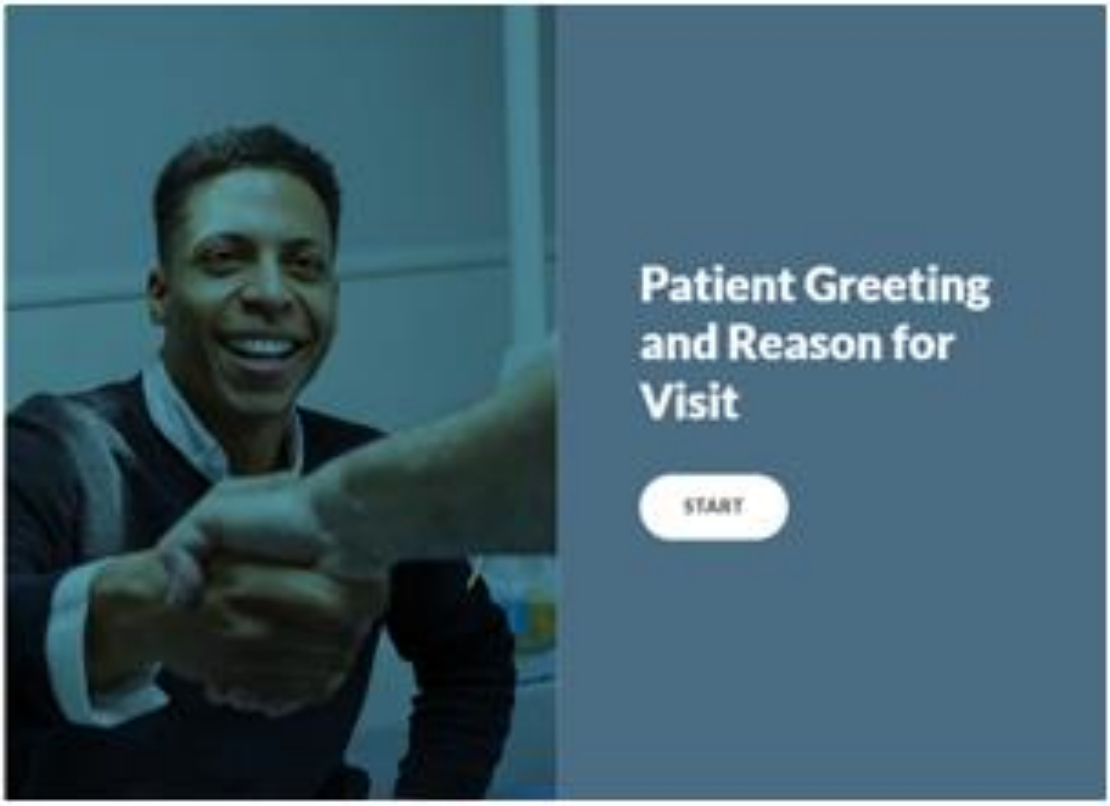

Figure 1. Image depicting the start page of the very first e-learning lesson on patient-centred interview named patient greeting and reason for visit.

Study participants and context of study

In the academic year of 2022, an email invitation was sent to all BDS and BOH students currently enrolled within the Faculty of Dentistry at the University of Otago, enquiring whether they would be interested in trialling a new educational approach for learning pre-clinical skills in dentistry by interacting with digital e-learning tools. Participants were self-selected and students who responded to the invitation were included if they were able to set aside appropriate time (approximately 30 minutes) to explore the material prior to attending a face-to-face focus group discussion (FGD) with a small number of peers, to discuss their experiences with using the tools. That way, students would be given the opportunity to give feedback on the material and highlight anything they deemed to be of importance for the outcome of their learning. Attending FGDs would be a chance for students to consider possible successes and potential barriers to learning pre-clinical skills when using digital e-learning tools. The email invitation included information about the study and a participant consent form for students to sign and send back by return email, whereafter study participants received access to the e-learning platform.

Approximately one week after being granted access to the e-learning platform, the FGDs with participants took place. Each FGD involved students from either one of the two programmes; to enable students to discuss issues or concerns freely without interference from students of the other programme. A semi-structured interviewing technique was used to ask participants open-ended questions during the FGDs (Table 1).

Table 1. Open-ended questions asked during focus group discussions with students.

Questions:
What were your overall impressions of the e-learning resource?
What was your favourite thing in the material, and why?
What did you think could have been done better?
Was there anything that you thought should be in the resource?
What difference would this have made to your learning if you had access to it in your pre-clinical year?
What were your impressions of the voice-over?
Do you have anything else you want to say about the resource?

The open-ended questions were designed to encourage participants to discuss their learning material in pre-clinical activities. The FGDs were held during students' lunch break with a light lunch provided and lasted for up to one hour. All FGDs were facilitated by HO and LA. Each focus group was carried out with students from either the BOH or BDS programme until a representative sample of students from both programmes had shared their views on the distributed material. Each FGD was audio recorded and transcribed verbatim. Analyses of the transcripts from the FGDs were carried out through a general inductive approach (Thomas, 2006) followed by qualitative content analysis (Elo *et al.*, 2014). The analysing process was initiated by HO and LA who individually read and coded the transcribed FGDs. They later met to discuss their individual coding to compare identified common themes and sub-themes. An audit trail of coding discussions was kept supporting rigour of the analysis process.

Results

Scrutinizing curricula

When scrutinizing the curriculum for BDS and BOH students, it appeared that much of the didactic teaching for learning pre-clinical skills and the pre-clinical simulated learning experiences were similar across the two programmes. This strongly indicated that merging such teaching activities would benefit both staff and students. Students would be able to sit in on lectures/tutorials together, and staff members would not have to teach the same topic twice. Furthermore, the curricula enlightened areas for improvements especially regarding the suitable timing for incorporating e-learning material with optimal inclusion for each programme and specific year cohort. For example, e-learning lessons about the initial interaction with a patient; how to great a patient and obtaining a thorough medical, social and dental history would be tailored for BOH1 and BDS2 students respectively, prior to students' first patient contact. After mastering the initial greeting of a patient and obtaining a thorough medical, social and dental history, students would learn how to assess their patients clinically. Such clinical assessment skills would start with an extra-oral examination of the head and neck followed by intra-oral examination of the soft tissues. Following consideration feedback from the students, all the assessment skills were prepared together by the international team of researchers and subject experts in the form of e-learning tools that would later be incorporated for dental and oral health students in each partner institution.

Focus Group Discussions

Altogether, 15 students across the BDS and BOH programmes volunteered to try out the material, resulting in five different discussion groups. The first group comprised three students from BOH3 and the second group was a combination of three students from both BDS4 and BDS5. The first two groups represented dental and oral health students who were experienced in treating patients compared with the last three groups that included more inexperienced oral health students who had

not yet started to see patients. These last three groups all involved students from BOH1. After the fifth FGD, data saturation was reached as no more themes could be identified. All participants were females except one male from the BOH programme. When students from the BDS and BOH programmes expressed their views and experiences with using the digital material as a supportive e-learning tool for learning skills in pre-clinical dentistry, the same three themes were identified within all FGDs. The three themes comprised (1) *evaluation of the resource*, (2) *ideas for improvements/enhancements* and (3) *perceived utility and application*. Each theme with common descriptive words articulated from students across the three FGDs are presented in Table 2.

Feedback from students attending the FGDs revealed overwhelmingly positive experiences from using the e-learning tools. Students near completion of their programmes experessed how helpful it would have been if these learning tools could have been available for them in their pre-clinical and early years of learning, prior to interacting with patients and starting their treatment of care. Students in the early years of their learning advised this would be a suitable complementary learning tool alongside pre-clinical face-to-face teaching.

Table 2. Three themes (1-3) with sub-themes identified from the FGDs.

(1) Evaluation of the resource (Overall impression)	(2) Ideas for improvement/enhancement	(3) Perceived utility and application
Helpful	Inclusion of a glossary	Learning at your own pace
Interesting	Videos embedded rather than linked	Useful for pre-learning
User-friendly	More information/reference links	Useful teaching tool
Eye-catching videos	Tests to be passed before moving on to next section	Useful revision tool
Needs instructions to have device sound on (for voice-over)	Ability to add student notes	Useful for reflection
Enjoyed seeing the tutors (familiarity, connection)	Summary notes	Suitable for learning together (BDS & BOH)
Attractive, well designed	List of apps or websites for further learning	-
Pop-up questions made students think	-	-

Students found the tool to be appealing and aesthetic. It was easy to navigate through the e-learning module, and they picked up on different learning styles:

I appreciated that you catered to each form of learning – both visual aid and those written aid as well which was quite good for me. (P1, BOH)

Students enjoyed the recognition of seeing their clinical tutor in one of the videos:

I love that [name of the tutor] was in it! I was like, I know you! I think the familiarity was helpful...It would be nice seeing familiar faces or hearing a familiar voice. (P2, BOH)

Ideas for improvements were expressed for both the content and the layout of the material, and one student suggested additional printed material.

I thought it would be cool to have a written version that students could take into clinic so that they don't have to watch a video in front af their patient. (P2, BDS)

Other students suggested enhancing the tool with 3D tooth morphology:

Tooth morphology is such a huge part of first year and that's one of the big things you really have to learn...like a model of a maxilla and a mandible and you just click the tooth and then you can 3D rotate it and it's awesome. (P2, BOH)

In addition, students from both programmes suggested including more interprofessional education (IPE) between the BDS and BOH programmes. One BOH student voiced that this kind of interprofessional education and collaborative learning, as well as sharing of patients, did not happen a lot within the Dental School. Furthermore, the participant questioned how students would learn how to work together in the real world, if they could not learn to work with each other during their undergraduate dentistry studies. Other students agreed that IPE would be suitable when sharing patients, to give them insight on what students from the other programme had been taught in lectures and pre-clinical activities, as well as increasing their confidence in recognising each professions scope of practice including limitations for providing care and knowing when to refer.

In the lectures we're told to always work as a professional team and that can often be quite confusing…The notes are completely different; the types of forms that are filled out are different so maybe using the tool to bring people together and everyone learn how referrals work. (P3, BOH)

Discussion

A limited number of students across all three-year levels of the BOH programme and more advanced students from the BDS programme (year 4 and year 5) at the University of Otago, New Zealand, expressed a high level of learning experience after piloting a digital tool for learning pre-clinic skills. Similar evidence of enhanced learning experience towards using e-learning in undergraduate teaching was found in a systematic review among undergraduate dental radiology students (Botelho *et al.*, 2019).

In terms of best practice to maximise simulation experience in dental education, and to enhance the efficiency of using virtual reality (such as e-learning) and simulation exercises (pre-clinic learning activities), Nassar and Tekian (2020) emphasised the importance of feedback and deliberate practice. The digital learning tools development for students in our study had an in-build mechanism to give instant feedback depending on how the student answered a specific question. This was referred from students themselves as the 'pop-up questions' that made them think. This mechanism of instant feedback is likely to have contributed to students' engagement and positive experience in using the tools including being user-friendly, having eye-catching features and a feeling of familiarity with the content.

Consistent with our study findings, in which students reported the tool to be effective for learning and revision, e-learning has been successfully utilised for real-time assessment and independent practice in simulated learning among junior dental students (Quinn *et al.*, 2003). Furthermore, a multi-centre study in Germany, reported that 90% of faculty staff viewed e-learning technology as being useful in gaining basic dental knowledge (Welk *et al.*, 2006).

Positive reception & engagement

Student participating in our study expressed how joyful it was when seeing their tutor

acting on the screen. From a student learning point of view, there are conflicting opinions in the literature in regards to familiarity and learning outcomes, with Lee *et al.* (2020) indicating that video modelling reduces learning effectiveness when students are seeing a familiar face, compared to Griffiths (2024) who presented results similar to our study findings, indicating enhanced student learning outcomes when seeing a familiar face in a video or hearing a familiar voice of an instructor. In addition, this familiarity created an additional layer of credibility and provided engagement and motivation among learners which was also evident among students in our study.

Curriculum merging potential

Irrespective of which programme or year level of study, all participants in our study agreed that e-learning would be convenient when learning pre-clinical dental skills, as well as being a useful tool for revision and reflection in the more advanced years of their dental education. Since both dental and oral health students have the same foundation of basic dental knowledge, it was appreciated that students also realised this connection.

Practical improvements suggested

When asked about the potential for incorporating interprofessional learning as a teaching modality, all students responded positively to learn with, from and about each other's' profession through IPE activities. Ideas for improvements raised by the students in terms of both layout and content of the e- learning tools were all very valid and manageable. These suggestions were later brought back to the international team of researchers to be further discussed throughout the continuation of the development process for the remainder of the e-learning material.

Strengths and limitations

A small number of study participants was a limitation of this study as only a few students from each programme (BDS and BOH respectively) opted to try out the e-learning tools. This self-selected sample poses limitation in terms of generalisability. In addition, this pilot only included one from a series of four e-learning lessons, so experiences from this one lesson might not translate to all content. However, similar ideas were brought up for discussion in each of the five FGDs, irrespective of their programme or level of learning and it was a strength that the same themes were identified from within all five focus groups. Therefore, target satisfaction for the number of participants was reached early on with no additional FGDs required. Another strength was that the FGDs were carried out with students from both programmes with a mix of student cohorts; from early learners with no previous patient experience up to an advanced level of learners, involving students who were soon to be graduating with lots of experience treating patients. Furthermore, given that student feedback echoed what was found when scrutinizing the curricula, in particular regarding the suggestion of merging content that are similar across both programmes, as well as to include more interprofessional education and collaborative learning, was another positive outcome from this research study, highlighting the appropriateness of collecting student voices via discussions in focus groups.

Conclusion

E-learning tools have gain positive reception among undergraduate dentistry students in a pilot project within the Faculty of Dentistry at the University of Otago. Scrutinizing the curricula for BDS and BOH students at Otago not only illuminated a need for incorporating the e-learning material into the curricula but also clarified in what year level of learning each of the e-learning lessons would be most appropriately incorporated. Learning together was highlighted during the FGDs and positively loaded as a way for students to interact across the two dentistry programmes, because students wanted to learn together and were curious to learn with, from and about each other's professions, ultimately in a blended learning

approach. This kind of interprofessional learning would not only enhance student learning outcomes within the education curricula, but would eventually serve as a vehicle for dental and oral health professionals to start working together to ultimately improve on patient care and treatment outcome.

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References

Alenezi, M. (2023). Digital learning and digital institution in higher education. *Education Sciences*, *13*(1), 88.

Botelho, M. G., Agrawal, K. R., & Bornstein, M. M. (2019). A systematic review of e-learning outcomes in undergraduate dental radiology curricula—levels of learning and implications for researchers and curriculum planners. *Dentomaxillofacial Radiology*, 48(1), 20180027.

Elo, S., Kääriäinen, M., Kanste, O., Pölkki, T., Utriainen, K., & Kyngäs, H. (2014). Qualitative content analysis: A focus on trustworthiness. *SAGE Open, 4*(1). https://doi.org/10.1177/2158244014522633

Griffiths, S. R. (2024). *Examining how instructor visibility and familiarity in video-based instruction influences learning gain, cognitive load, and social agency in a secondary school science context* [Doctoral dissertation, Griffith University]. Griffith Research Online. Retrieved from ,https://research-repository.griffith.edu.au/items/0a91031e-e6bb-43d0-81d8-532199f64c01

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: a review. *Sustainable Operations and Computers*, *3*, 275-285.

Lee, L. K., Lui, A. K. F., Au, O. T., Ng, S. C., & Wu, N. I. (2020). Teaching and learning with video modelling: production with limited budget and influence of familiar faces on learning effectiveness. *International Journal of Innovation and Learning*, *27*(4), 364-380.

Nassar, H. M., & Tekian, A. (2020). Computer simulation and virtual reality in undergraduate operative and restorative dental education: a critical review. *Journal of Dental Education*, *84*(7), 812-829.

Quinn, F., Keogh, P., McDonald, A., & Hussey, D. (2003). A pilot study comparing the effectiveness of conventional training and virtual reality simulation in the skills acquisition of junior dental students. *European Journal of Dental Education*, *7*(1), 13-19.

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation, 27*(2), 237-246. https://doi.org/10.1177/1098214005283748

Welk, A., Splieth, C., Seyer, D., Rosin, M., Siemer, M., & Meyer, G. (2006). German dental faculty attitudes towards computer-assisted simulation systems correlated with personal and professional profiles. *European Journal of Dental Education*, *10*(2), 87-95.

REVIEW ARTICLE Open Access

Oral complications of diabetes mellitus and their underlying pathogenic mechanisms: a narrative review

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Abstract

Diabetes mellitus (DM) is a syndrome of abnormal carbohydrate metabolism causing tremendous mortality and morbidly worldwide. To date, there is no permanent curative treatment for diabetes and the patients have to rely on modification of their lifestyle and on the available timely medication. Understanding pathophysiology and complications of DM is crucial for clinicians and dental care providers in order to provide a proper management. Complications of DM are multisystemic with inevitable involvement of oral cavity. Diabetic patients have increased frequency of periodontitis, xerostomia, tooth loss, delay in wound healing, and impaired response to infection. Dental complications of DM exert medical, psychological, economical and national burden. This narrative review aims to outline the oral complications of DM and their underlying pathogenic mechanisms in the recent literature. The review concluded that; the commonest oral complications of DM are xerostomia, tooth decay, periodontal disease and gingivitis, oral candidiasis, altered taste sensation, oral mucosa alterations, and delayed wound healing. The important underlying pathogenic mechanisms include oxidative stress, alterations in salivary amylase protein, high level of sodium-glucose cotransporter 1 (SGLT1) protein, impaired neural structure and function, use of sodium glucose transporter 2 (SGLT2) inhibitor, the influence of the IL-23R gene polymorphism, and formation of advanced glycation end products (AGEP).

Keywords: *diabetes mellitus, oral complications, pathogenic mechanisms*

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Introduction

Diabetes mellitus (DM) is a syndrome of abnormal carbohydrate metabolism that is characterised by hyperglycaemia associated with a relative or absolute impairment of insulin secretion in addition to a variable degree of insulin resistance. It is one of the top 10 causes of death worldwide caused 4 million deaths in 2017 (Ismail *et al*., 2021). To date, there is no permanent curative treatment for diabetes and the patients have to rely on modification of their lifestyle and on the available timely medication.

Diabetes is one of the four major non-communicable diseases (NCD) causing devastating burden on health, economy, productivity, and on social life. According to the World Health Organisation's (WHO) latest statistics, DM caused death of 2 million people worldwide in 2019. Moreover, deaths due to DM increased by 3% in the period

between 2000 and 2019, in comparison to the other causes of NCD (WHO, 2023). Globally, around 463 million people live with diabetes (Ministry of Health Malaysia, 2020). In Malaysia, it is estimated that 3.9 million (18.3%) of the adult population had raised blood sugar in 2019 (Ministry of Health Malaysia, 2020). The incidence of type-1 DM alone, has been increasing globally since the 1950s, with an average annual increase of 3–4% over the past three decades (Akil *et al*., 2021). The prevalence of type-2 DM alone in Malaysia, was estimated to be 14.39%, which is considered among the highest figures in Asia. On the other hand, the prevalence of prediabetes was 11.62%, indicating the expected trend of diabetes in Malaysia will be increasing (Akhtar *et al*., 2022).

Diabetes mellitus has been classified into different subtypes with the most common one in adult population is called as type-2 DM representing more than 90% of overall cases of DM. On the other hand, the commonest type of DM affecting children is type 1 (Elsayed *et al*., 2023).

According to the American Diabetes Association (ADA), diabetes can be classified into four main categories (Figure 1) (Chiang *et al*., 2014; Elsayed *et al*., 2023)

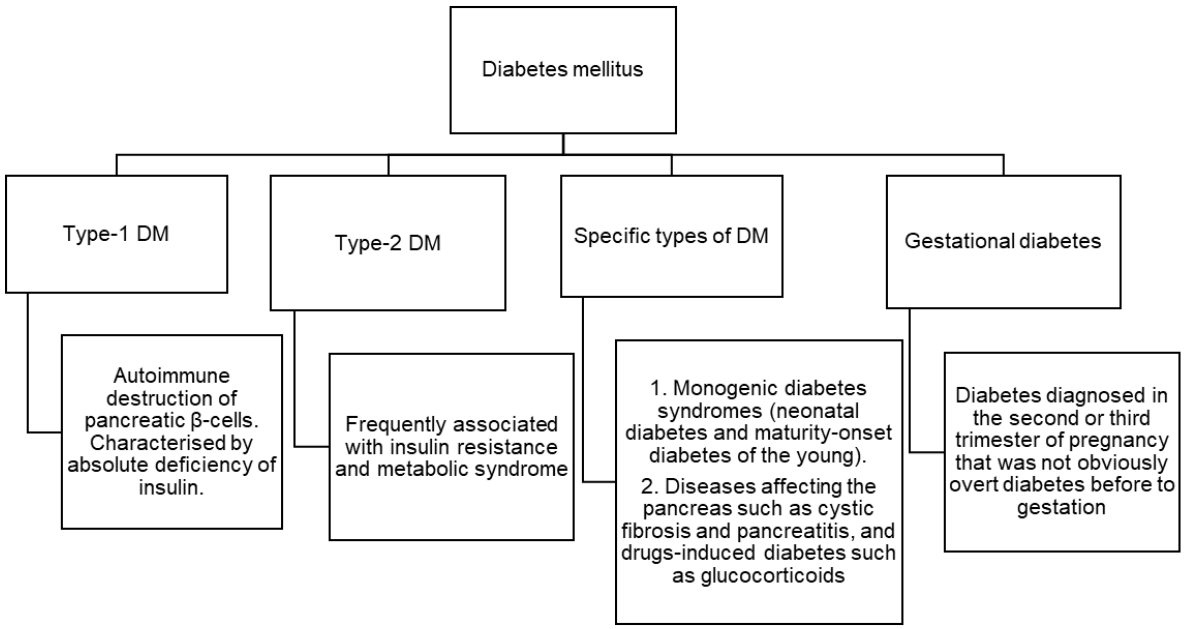

Figure 1. Main categories of diabetes mellitus.

Understanding pathophysiology and complications of each type of DM is crucial for clinicians including dental care providers in order to provide a proper management (Busa *et al*., 2022). However, it is important for stakeholders to consider the following fact during management of DM: "poor control of diabetes will end up with systemic complications regardless the type of DM".

In type-2 DM, the underlying pathogenesis of the onset of diabetes is attributed to a progressive defect in insulin secretion from β-cells on the background of insulin resistance owing to an interaction between environmental and genetic factors (Bellou *et al*., 2018). The pathogenic mechanisms are attributed to an interaction of multiple factors such as lifestyle, medical condition, hereditary, psychosocial and demographic risk factors such as high-level serum uric acid, sleep quality/quantity, smoking, depression, cardiovascular disease, dyslipidaemia, hypertension, aging, ethnicity, family history of diabetes, physical inactivity, and obesity (Ismail *et al*., 2021). However, the pathogenic mechanism behind type-1 DM is a multifactorial autoimmune

destruction of pancreatic β cells, resulting in a deficiency of insulin synthesis and secretion (Akil *et al*., 2021). Complications of DM are multisystemic, and manifested clinically as peripheral neuropathy, peripheral vascular disease, nephropathy, retinopathy, cardiac and cerebrovascular vasculopathy. However, complications of DM are not limited to these body systems (Tomic *et al*., 2022). Impact of diabetes on oral health represents another serious complication of diabetes. Patients with diabetes found to have a higher chance of developing oral mucosal lesions when compared to healthy individuals (Kataria Rinki *et al*., 2019). Diabetic patients have increased frequency of periodontitis, xerostomia, tooth loss, delay in wound healing, and impaired response to infection (Velasco-Ortega *et al*., 2016).

Dental complications of DM exert medical, psychological, economical and national burden. Dental professionals in particular and public health sector in general, are advised to be aware of the inter-relationship between diabetes and oral health. One of each ten diabetic patients found to be affected by periodontitis. Which represents a considerable percentage to alert the diabetes stakeholders (Genco & Borgnakke, 2020). Nazir *et al*. (2018), reported that more than 90% of diabetics have evidence of oral manifestations (Nazir *et al*., 2018). This review will highlight the important oral complications of diabetes and aims to emphasise the underlying pathogenic mechanisms for their development.

Diabetic oral complications and their pathogenic mechanisms

A vast number of oral complications have been reported to be associated with diabetes mellitus, involving both soft as well as hard tissues of the oral cavity (Figure 2). The reported oral manifestations linked to DM include xerostomia, loose tooth and tooth decay, periodontal disease and gingivitis, oral candidiasis and mucormycosis, burning mouth syndrome, altered taste sensation, aspergillosis, oral lichen planus, geographic tongue and fissured tongue, delayed wound healing, and increased incidence of infection, salivary dysfunction, oral neurosensory disorders, impaired tooth eruption, and benign parotid hypertrophy (Rohani, 2019).

Xerostomia

Xerostomia is defined as the subjective feeling of a dry mouth due to dysfunctional involvement of the salivary glands (Kim, 2023). Saliva contributes to oral homeostasis through lubricating and protecting oral mucosa, in addition to its role in the early stages of digestion (Fouani *et al.,* 2021). Diabetes mellitus is a well-known cause of salivary glands dysfunction.

In diabetes, insulin deficiency is associated with hyperglycaemia, which consequently results in osmotic diuresis and loss of considerable fluid volume. These pathophysiological changes will result in a status of hyposalivation (Bhat *et al*., 2021). The underlying pathology in diabetic salivary dysfunction involves, recurrent microbial infection of salivary glands, oxidative stress, alterations in salivary amylase protein, high level of sodium-glucose cotransporter 1 (SGLT1) protein which plays a key role in xerostomia through salivary water reabsorption in salivary ducts and consequently reduces salivary flow, and reduction in nitric oxide which is required for salivary secretion (Fouani *et al*., 2021).

Oral mucosal alteration and taste dysfunction

Taste is transmitted by taste pathways from taste buds located in the mucous membrane of tongue, epiglottis, soft palate, and pharynx to the sensory cortex of the brain. Taste impairment (dysgeusia) is alteration of this normal gustatory function that may result in complete taste losses (ageusia), partial reductions (hypogeusia), or over-acuteness of the sense of taste (hypergeusia). On the other hand, taste impairments are not life-threatening conditions, but they can cause sufficient discomfort and lead to appetite

loss and changes in eating habits, with effects on general health (Risso *et al*., 2020). Approximately 3% of Type-1 DM and 5% of Type-2 DM have been found with ageusia or inability to detect tastes (Ahmad *et al*., 2019). The taste function is dependent on special sensory receptors located in the taste buds of the tongue and mediated by the chemosensory gustatory system (Sjöstrand *et al*., 2021). Furthermore, many diabetic patients showed numbness and tingling sensation of the tongue due to neuropathy (Kumari & Gnanasundaram, 2021). Neuropathy affects the nerves of the taste buds will results in an altered taste sensation. Diabetic neuropathy is a devastating chronic complication, and the most emphasized diabetic neuropathy is the peripheral symmetrical polyneuropathy (Smith *et al*., 2022). Diminished taste perception has been linked to the increased tendency toward consumption of beverages with a higher sweet taste intensity which could increase risk of obesity and its complications (Verhulst *et al*., 2019). Taste dysfunction has been reported to occur more frequently in patients with poorly controlled diabetes compared to health controls (Khan, 2018).

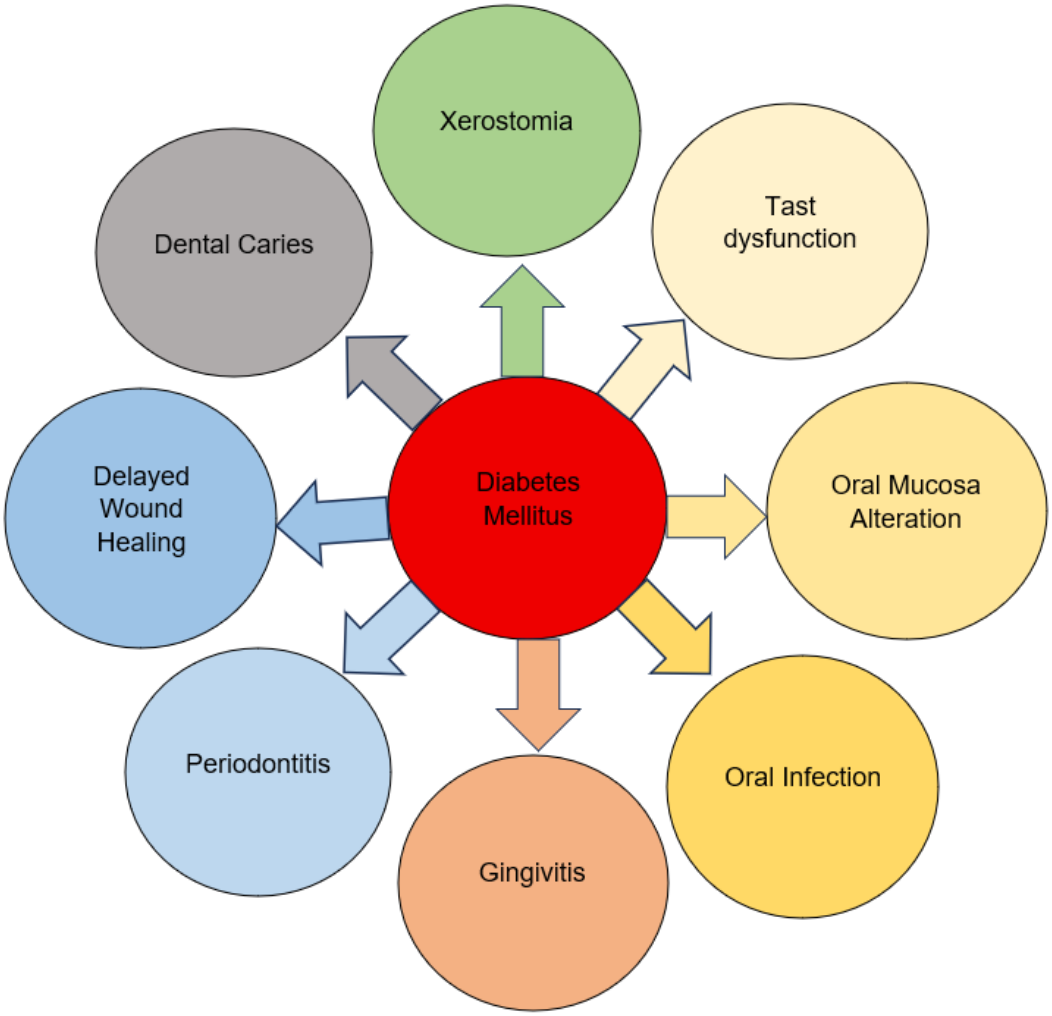

Figure 2. Common oral complications of diabetes mellitus.

Kushwaha *et al*. (2022) reported a significant alteration of taste sensation in association with elevated level of fasting blood glucose and HbA1c in patients with type-2 DM with regard to sense of sweet foods. This finding may be attributed to the

pathogenic effect of DM on the neural structure and perhaps on neural function. On the contrary, Nettore et al. (2024) showed that in type-1 DM the reduced taste modalities were sour, salt, and bitter, but the sweet modality was not affected. These interesting findings may indicate the difference in the natural history of taste impairment and pathogenesis in the common two types of DM.

Oral infections

The incidence of oral infection is high in diabetic patients owing to the impaired physiological defence mechanisms (Bhat *et al*., 2021). Pathogenesis of oral bacterial infection is initiated by bacterial irritation of the periodontal tissue; this will bring about a defensive reaction through recruitment of inflammatory cells and subsequent release of various inflammatory mediators to destroy the bacteria. This defence mechanism against bacterial infection will be accompanied by increase in vascularization, vascular permeability, in addition to increased number of inflammatory cells in gingiva cause swelling, redness, and bleeding (Gürsoy *et al*., 2024).

Diabetic patients have higher incidence of fungal oral infections. A strong association has been shown between oral candidiasis and diabetes mellitus in comparison to non-diabetics (Wijesuriya *et al*., 2024). Susceptibility of diabetic patients to oral candidiasis may be attributed to administration of sodium glucose transporter 2 (SGLT2) inhibitor and the influence of the IL-23R gene polymorphism (Alawya & Catartika, 2024).

Gingivitis and periodontitis

Periodontal tissues are commonly affected in diabetes mellitus. Periodontitis is defined as a chronic inflammatory disease of root cementum, gingiva, periodontal ligament, and alveolar bone, that is initiated and sustained by an aberrant host immune response against resident bacterial biofilm on the teeth (Teeuw *et al*., 2017). Periodontitis is not a solely local oral disease, but it has been considered also as a manifestation of systemic diseases like diabetes mellitus (Mainas *et al*., 2023). Gingivitis in cases of DM develops due to dryness of the mouth and failure of the antibacterial function of saliva. In cases of DM, microbial induced gingivitis will not regress if the patient is subjected to dental management like scaling and polishing, it will improve only by therapeutic control of DM. Furthermore, untreated gingivitis in patients with uncontrolled DM eventually will end up with periodontitis (Kumari & Gnanasundaram, 2021).

Diabetic patients have a higher risk of approximately three to four times of developing periodontitis in comparison to the healthy population (Turner & Bouloux, 2023). Prevalence of periodontitis in diabetic patients in comparison to non-diabetics found to be 59.6% to 39% respectively (Rohani, 2019). Disturbed glycaemic control is the main leading cause for development and progression of periodontal disease. Although the pathophysiological relationship between diabetes and periodontal disease still under investigations, there are some pathogenic mechanisms indicated the link between the two diseases. Chronic hyperglycaemia is characterised by formation of advanced glycation end products (AGEP), that trigger and promote inflammatory response involving overproduction of cytokines, tumour necrosis factor alpha (TNF-α), and C-reactive protein (Turner & Bouloux, 2023). On the other hand, active periodontitis is characterized by impaired release of inflammatory mediators such as interleukins IL-1β and IL-6, TNF-α, prostaglandin E2 (PGE2), metalloproteinases, adipokines, and chemokines. It has been concluded that there is an interplay pathogenic mechanism (Figure 3) between diabetes and periodontal disease. Poor glycaemic control found to be associated with progression of periodontitis, and untreated periodontitis is associated with refractory control of diabetes (Santonocito *et al*., 2022).

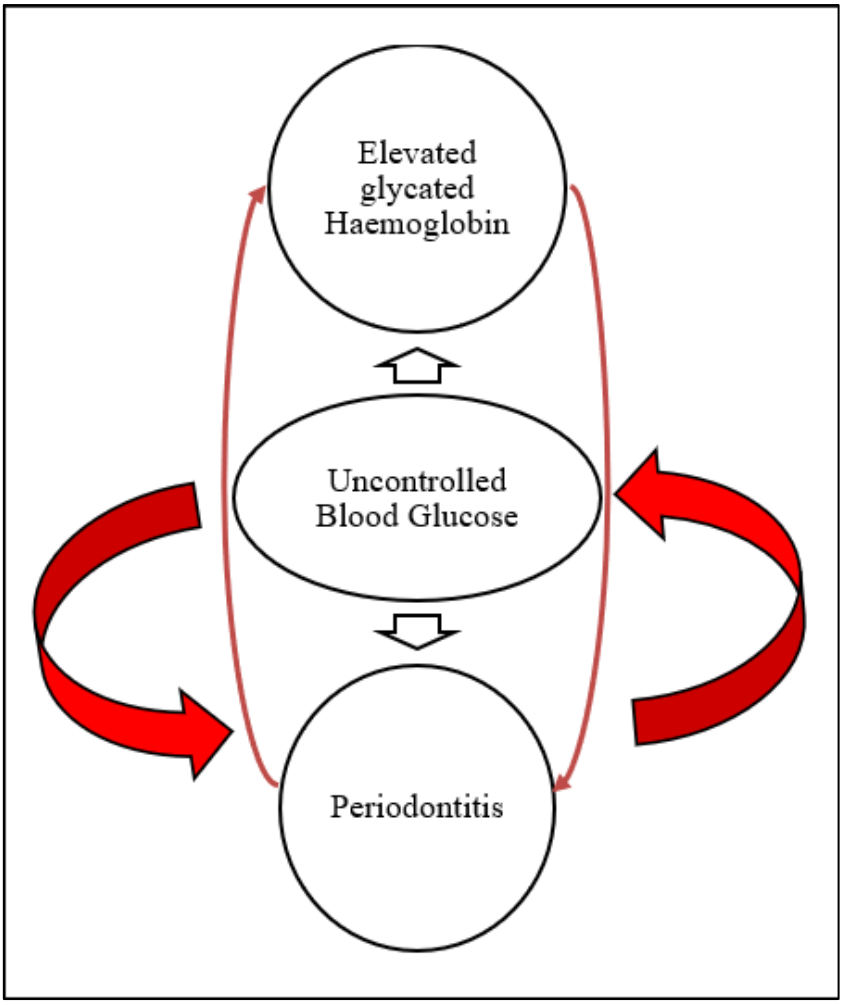

Figure 3. Proposed pathogenic interplay mechanism between glycaemic status and periodontitis.

Delayed wound healing

Healing is the body's response to injury to restore normal structure and function. Poor soft tissue regeneration and delayed osseous healing in patients with diabetes are well-known complications of oral surgery. The long-term complications of diabetes occur due to damage to the micro-vessels nourishing the tissues and organs of the body. The body's ability to heal a wound depends on a healthy blood supply which is needed to deliver nutrients to the cells that provide the protective defence against infection and those that cause inflammation. High blood sugar in the setting of DM is associated with paralysis of inflammatory cells and impaired tissue defences. Additionally, insufficient insulin level will further impair healing and regenerative functions in body tissues (Ahmad *et al.*, 2019). Elevated HbA1c above 6.5%, significantly increase the risk of infections after surgical dental interventions and increases the risk of delayed wound healing. For this reason, it is advisable to obtain better control of glycosylated haemoglobin figures. However, in the case when there is an ongoing periodontal pathological process which are suspected to contribute further to a poorer diabetic control, and at the same time there is a need for surgical intervention, the treatment should not be delayed in order to achieve better metabolic control of the disease. In these cases, post-surgical wound care should be maximized, and clinical considerations should be made on the convenience of using antibiotics in each specific case (González- Moles & Ramos-García, 2021).

Dental caries

The association between DM and dental caries has been investigated by a vast number of clinical studies. However, the pathogenic mechanisms remained complicated. The prevalence of dental caries in diabetic patients found to be not different between type-1 and type-2 DM (Bhat *et al*., 2021). Saliva is responsible for oral pH homeostasis (G. Dipalma, 2023), however, hyperglycaemia is accompanied by elevated glucose level in the saliva (Cui *et al*., 2022). Reduction of oral pH following glucose metabolism by oral microbiota will create a cariogenic environment causing demineralization of tooth enamel and dentin (Mbembela *et al*., 2023). Diabetes found to alter the overall function of salivary glands contributing not only to the development and progression of dental caries through creating acidic environment but by inducing a significant deterioration in the overall function of the salivary glands through deregulation of several key-salivary proteins such as: sodium-glucose cotransporter-1 (SGLT1), aquaporin 5 (AQP 5), and nitric oxide synthase (Fouani *et al*., 2021).

Conclusion

Oral complications of DM are a major concern for the patients, dental health care providers, and related stakeholders, exerting multifaceted burdens. Some oral complications associated with DM have a known pathogenic mechanism; however, many others need to be explored.

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References

Akhtar, S., Nasir, J. A., Ali, A., Asghar, M., Majeed, R., & Sarwar, A. (2022). Prevalence of type-2 diabetes and prediabetes in Malaysia: a systematic review and meta-analysis. *PLoS ONE*, *17*(1 January). https://doi.org/10.1371/journal.pone.0263139

Akil, A. A. S., Yassin, E., Al-Maraghi, A., Aliyev, E., Al-Malki, K., & Fakhro, K. A. (2021). Diagnosis and treatment of type 1 diabetes at the dawn of the personalized medicine era. *Journal of Translational Medicine*, 19(1). https://doi.org/10.1186/s12967-021-02778-6

Alawya, A., Catartika, V.R. (2024). Fungal infection characteristic in type 2 diabetic mellitus: narrative review. *SAGO: Gizi dan Kesehatan,* 5(3). http://dx.doi.org/10.30867/gikes.v5i3.1790

Bellou, V., Belbasis, L., Tzoulaki, I., & Evangelou, E. (2018). Risk factors for type 2 diabetes mellitus: An exposure-wide umbrella review of meta-analyses. *PLoS ONE*, *13*(3). https://doi.org/10.1371/journal.pone.0194127

Bhat, A. R., Meghana, I. S. S., Thomas, B., Shenoy, N., Bhandary, R., & Sai Sreeja, S. (2021). Diabetes mellitus and potential oral complications – a review. *Romanian Journal of Diabetes, Nutrition and Metabolic Diseases*, *28*(4), 453–462. https://doi.org/10.46389/rjd-2021-1066

Busa, P., Kuthati, Y., Huang, N., & Wong, C.-S. (2022). New advances on pathophysiology of diabetes neuropathy and pain management: potential role of melatonin and DPP-4 inhibitors. *Frontiers in Pharmacology*, *13*. https://doi.org/10.3389/fphar.2022.864088

Chiang, J. L., Kirkman, M. S., Laffel, L. M. B., & Peters, A. L. (2014). Type 1 diabetes through the life span: a position statement of the American Diabetes Association. *Diabetes Care*, 37(7), 2034–2054. https://doi.org/10.2337/dc14-1140

Cui, Y., Zhang, H., Zhu, J., Liao, Z., Wang, S., & Liu, W. (2022). Correlations of salivary and blood glucose levels among six saliva collection methods. *International Journal of Environmental Research and Public Health*, *19*(7). https://doi.org/10.3390/ijerph19074122

Dipalma, G., Inchingolo, F., Patano, A., Guglielmo, M., Palumbo, I., Campanelli, M., *et al.* (2023). Dental erosion and the role of saliva: a systematic review. *European Review for Medical and Pharmacological Sciences*, *27*, 10651–10660.

Elsayed, N. A., Aleppo, G., Aroda, V. R., Bannuru, R. R., Brown, F. M., Bruemmer, D., *et al.* (2023). 2. classification and diagnosis of diabetes: standards of care in diabetes—2023. *Diabetes Care*, *46*, S19–S40. https://doi.org/10.2337/dc23-S002

Fouani, M., Basset, C. A., Jurjus, A. R., Leone, L. G., Tomasello, G., & Leone, A. (2021). Salivary gland proteins alterations in the diabetic milieu. *Journal of Molecular Histology*, *52*(5), 893–904. https://doi.org/10.1007/s10735-021-09999-5

Genco, R. J., & Borgnakke, W. S. (2020). Diabetes as a potential risk for periodontitis: association studies. *Periodontology 2000*, 83(1), 40–45. https://doi.org/10.1111/prd.12270

Gürsoy, U. K., Yilmaz, N., Yilmaz, D., Grönroos, S., & Gürsoy, M. (2024). Type 1 diabetes mellitus and host–bacterial interactions in the oral cavity. *Current Opinion in Endocrine and Metabolic Research*, *36*. https://doi.org/10.1016/j.coemr.2024.100536

Ismail, L., Materwala, H., & Al Kaabi, J. (2021). Association of risk factors with type 2 diabetes: a systematic review. *Computational and Structural Biotechnology Journal*, *19*, 1759–1785. https://doi.org/10.1016/j.csbj.2021.03.003

Kataria, R., Ishita, R., Anas, A., Pallavi, L., Chakraborty, P., Ajay, M., *et al.* (2019). Diabetes & dental health – a review. *Saudi Journal of Medicine*, *4*(4), 313–316.

Kim, Y. J. (2023). Xerostomia and Its Cellular Targets. *International Journal of Molecular Sciences*, *24*(6). https://doi.org/10.3390/ijms24065358

Kushwaha, J. S., Gupta, V. K., Singh, A., & Giri, R. (2022). Significant correlation between taste dysfunction and HbA1C level and blood sugar fasting level in type 2 diabetes mellitus patients in at a tertiary care center in north India. *Diabetes Epidemiology and Management*, *8*. https://doi.org/10.1016/j.deman.2022.100092

Mainas, G., Nibali, L., Ide, M., Mahmeed, W. Al, Al-Rasadi, K., Al-Alawi, K., *et al.* (2023). Associations between periodontitis, COVID-19, and cardiometabolic complications: molecular mechanisms and clinical evidence. *Metabolites*, *13*(1). https://doi.org/10.3390/metabo13010040

Mbembela, O., Ngarashi, D., & Nyamuryekung'e, K. K. (2023). Biochemical changes in salivary pH and its correlation to hemoglobin levels, calcium and phosphate ion concentrations among pregnant women, tanzania: a cross-sectional study. *Oral*, *3*(3), 325–336. https://doi.org/10.3390/oral3030027

Ministry of Health Malaysia. (2020). *National Diabetes Registry Report, 2013-2019*. Available from: www.moh.gov.my

Nazir, M. A., Alghamdi, L., Alkadi, M., Albeajan, N., Alrashoudi, L., & Alhussan, M. (2018). The burden of diabetes, its oral complications and their prevention and management. *Open Access Macedonian Journal of Medical Sciences*, *6*(8), 1545–1553. https://doi.org/10.3889/oamjms.2018.294

Nettore, I. C., Palatucci, G., Ungaro, P., Scidà, G., Corrado, A., De Vito, R., *et al.* (2024). Flavor and taste recognition impairments in people with type 1 diabetes. *Nutrition and Diabetes*, *14*(1). https://doi.org/10.1038/s41387-024-00322-1

Rohani, B. (2019). Oral manifestations in patients with diabetes mellitus. *World Journal of Diabetes*, *10*(9), 485–489. https://doi.org/10.4239/wjd.v10.i9.485

Santonocito, S., Polizzi, A., Marchetti, E., Dalessandri, D., Migliorati, M., Lupi, *et al.* (2022). Impact of periodontitis on glycemic control and metabolic status in diabetes patients: current knowledge on early disease markers and therapeutic perspectives. *Mediators of Inflammation*, *2022*. https://doi.org/10.1155/2022/4955277

Sjöstrand, A. E., Sjödin, P., Hegay, T., Nikolaeva, A., Shayimkulov, F., Blum, M. G. B., *et al.* (2021). Taste perception and lifestyle: insights from phenotype and genome data among Africans and Asians. *European Journal of Human Genetics*, *29*(2), 325–337. https://doi.org/10.1038/s41431-020-00736-2

Smith, S., Normahani, P., Lane, T., Hohenschurz-Schmidt, D., Oliver, N., *et al.* (2022). Prevention and management strategies for diabetic neuropathy. *Life*, *12*(8). https://doi.org/10.3390/life12081185

Teeuw, W. J., F Kosho, M. X., W Poland, D. C., A Gerdes, V. E., & Loos, B. G. (2017). Periodontitis as a possible early sign of diabetes mellitus. *BMJ Open Diabetes Research and Care*, *5*, 326. https://doi.org/10.1136/bmjdrc-2016

Tomic, D., Shaw, J. E., & Magliano, D. J. (2022). The burden and risks of emerging complications of diabetes mellitus. *Nature Reviews Endocrinology*, *18*(9), 525–539. https://doi.org/10.1038/s41574-022-00690-7

Turner, C., & Bouloux, P.-M. (2023). Diabetes mellitus and periodontal disease: education, collaboration and information sharing between doctors, dentists and patients. *British Journal of Diabetes*, *23*(1), 35–38. https://doi.org/10.15277/bjd.2023.403

Velasco-Ortega, E., Delgado-Ruiz, R. A., & López-López, J. (2016). Dentistry and diabetes: the influence of diabetes in oral diseases and dental treatments. *Journal of Diabetes Research*, *2016*. https://doi.org/10.1155/2016/6073190

WHO (2023). *World Health Statistics 2023 Monitoring health for the SDGs Sustainable Development Goals Health for All*. Retrieved from, https://www.who.int/publications/i/item/9789240074323

REVIEW ARTICLE Open Access

Advances in forensic odontology for human identification: a comprehensive review of methods, accuracy, and challenges

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Abstract

Forensic odontology provides significant possibilities for human identification in the absence of DNA and fingerprints. Dental tissues, impervious to environmental damage, offer distinctive characteristics for sex estimation, age assessment, ancestry identification, and comparative analysis. This review rigorously integrates conventional and novel methodologies. Odontometric and non-metric characteristics are extensively utilized for sex estimation and ancestry assessment, however accuracy differs among groups and inter-observer variability continues to exist. Age estimate methodologies, including Demirjian, Willems, Nolla, AlQahtani, Kvaal, and Cameriere, have significant dependability in children and adolescents, although their accuracy diminishes in adults owing to wider error margins. Recent advancements, such as cone-beam computed tomography, three-dimensional imaging, and artificial intelligence, demonstrate potential for automated and reproducible assessments. Nonetheless, validation studies are scarce, established methodologies are absent, and legal admissibility is ambiguous. Comparative identification remains extremely reliable with antemortem and postmortem information, while diminishing dental restorations compromise distinctiveness. Forensic odontology is essential; yet, advancement necessitates the incorporation of digital technologies, population-specific criteria, and a heightened focus on validation and ethical-legal standards.

Keywords: *comparative identification, dental profiling, forensic, human identification, teeth*

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Introduction

Whether a person is alive or dead, their identification has a tremendous impact on both the legal and social systems in which they are embedded. This identity is essential for ensuring the safety of living individuals in a variety of contexts, including banking operations, licenses, visas, passports, immigration, and other similar matters. For deceased individuals, the significance of identification is often brought up for a variety of reasons, including those that are single or multiple in nature (Ágnes Borsay *et al*., 2024). Identification is a field that perpetually pursues long-lasting information that is apparent, not only plain and easily acquired, but that is also thorough enough to prove its differentiation from other evidence.

Dental identification

The identification of teeth can be accomplished by two methods:

a) The process of dental profiling is carried out in situations when there is no sign of antemortem (AM) dental record. During the dental profiling or reconstructive identification process, information regarding the deceased person's race, age of death, and gender was gathered.

b) Comparative identification: The second aspect of forensic odontology is comparative identification where the AM records of the unidentified person are compared to the dental characteristics after the postmortem examination.

Reconstructive identification

In the absence of available preliminary identity information, dental profiling is performed, rendering AM data unretrievable. This situation occurs when remains are discovered at unrelated locations and are significantly degraded. Utilising PM dental profiling allows for the refinement of the search to relatively small, particular groups. The dental profile comprises a set of particular characteristics related to the hard and soft tissues of tooth anatomy. They support in identifying parameters such as age, race, sex, socioeconomic status and occupation of the deceased, systemic health, personal habits and dietary status (Swain *et al*., 2021).

A) Sex estimation

The initial step that forensic investigators undertake in the identification procedure is estimating an individual's gender. The forensic odontologist can aid in determining the gender of the remains by utilising the data gathered from the skull and dental fragments. Linear measurements like crown dimensions (Bu *et al*., 2023; Lukacs & Kuswandari, 2022; Dumančić *et al*., 2023), cusp dimensions (Eboh, 2019), and root lengths (Govindaram *et al*., 2018) are dental features that can be assessed by linear measurements. The incisor and canine indices (MCI) (Issrani *et al*., 2020; Kumar *et al*., 2019) as well as the crown index (Eboh, 2019) were all calculated from these linear data by one or more researchers who then performed further analysis. One study also calculated the cusp and the crown area measurements following the outline of the tooth occlusal surfaces (Riaz *et al*., 2024). The majority of the outcomes from these investigations concluded that males exhibit higher values than females. Research findings indicate that employing univariate and multivariate analyses for sex prediction may yield divergent results (Capitaneanu *et al*., 2017).

Beyond tooth size, research on non-metric characteristics, such as the distal accessory ridge (Dumančić *et al*., 2023), Carabelli's trait of maxillary molars (Chowdhry *et al*., 2023), shovelling of the upper central incisor (Walker *et al*., 2009) has revealed notable distinctions between males and females. Nonetheless, these findings were not validated for application in a sex prediction model. However, one study generated prediction model using the cusp numbering and the groove pattern on the maxillary posterior teeth (Riaz *et al*., 2024), having an accuracy above 75% which is considered acceptable as a forensic tool.

While odontometric measurements often achieve 70–85% accuracy across various populations, their reliability is reduced by inter-observer variability and population-specific differences. Non-metric traits such as Carabelli's cusp or shoveling provide useful supplementary indicators, yet most studies are based on limited samples and lack validation for predictive forensic models. Therefore, these traits should be considered supportive rather than definitive in sex estimation.

B) Age estimation

Various methods exist for ascertaining the ages of children, teenagers, and adults. Kurniawan *et al*. (2022) identified some methods commonly employed to determine the ages of children, adolescents, and young adults. Age estimation methods are separated into two categories: (i) children and young adults (until third molar eruption), and (ii) adults (when dental development has ceased).

The following methodologies determine the child/young adult age:

1. Demirjian method: This method uses panoramic radiographs to study all the mandibular teeth except third molar.
2. Willem's method: This is the modified version of Demirjian method (Fitri *et al*., 2022).
3. TCI Benindra method includes tooth coronal index based on association of the tooth with its dental pulp chamber) (El Morsi *et al*., 2015).
4. AlQahtani method is one of the new atlas methods involving all the teeth (maxillary and mandibular) (AlQahtani *et al*., 2010).
5. Nolla's technique method depends on the evaluation of 10 stages of tooth calcification starting from appearance of tooth bud formation till the closure of the apical foramen) (Kurniawan *et al*., 2022).

In children and adolescents, radiographic methods such as Demirjian, Willems, and AlQahtani provide relatively high accuracy (±1–2 years). However, their reliability declines significantly after the completion of third molar eruption.

The age estimation adults applied to the adults are as follows:

1. Kvaal Method: This method is based on the association of age with the tooth to pulp ratio) (Kvaal *et al*., 1995; Mittal *et al*., 2016).
2. Schour and Masslers method involves the development of the deciduous and permanent teeth, focusing in on the 21 chronological stages from 4 months to 21 years of age) (Jaquilin *et al*., 2018).
3. Moorer, Fanning and Hunt method studies the maturation stages for the tooth crown and root, which vary if the tooth is single or multirooted) (Phillips & Van Wyk Kotze, 2009).
4. Phulari & Dave, (2021) stated four categories of age estimation in adults as follows:

a. Methods evaluating histology

i) Combination of different regressive alterations of teeth.
ii) Evaluation of the dentinal translucency used as a single indicator.
iii) Evaluation of the deposition of secondary dentine deposition used as an indicator.
iv) Cementum thickness, presence or absence of the rings, and annulations.
v) Dentine and cementum fluorescence.
vi) Scanning electron microscopy for microscopic measurements.

b. *Methods evaluating radiographs*

i) Ration of the pulp-tooth dimension based on length (Kvaal), and based on: based on area and volume (Cameriere *et al*., 2006).
ii) Ikeda method using the tooth coronal pulp cavity index.
iii) X-ray micro-focus CT scanning of teeth
iv) Assessing the mental foramen and mandibular canal.

c. Biochemical methods

i) Aspartic acid racemisation
ii) Enamel uptake of Radioactive carbon-14 (carbon dating)
iii) Miscellaneous biochemical methods

d. *Genetic and epigenetic methods*

i) Human telomere shortening
ii) Deoxyribonucleic acid (DNA) methylation

In adults, methods such as Kvaal's pulp-to-tooth ratio, Cameriere's pulp area measurements, and biochemical approaches yield broader error margins (±4–10 years) and are often less reproducible. While histological and biochemical methods may improve accuracy, they are invasive and not always feasible in forensic casework. These limitations highlight the need for integrating multiple approaches and validating newer digital and biochemical techniques across populations.

Among the available approaches, Demirjian's method continues to be regarded as the most reliable and accurate standard for dental age estimation (Vistro *et al*., 2024).

C) Ancestry or race determination using dental characteristics

An individual possesses a trait when they exhibit certain feature or attribute that distinguishes them from others. A variety of potential manifestations of a specific trait may exist. Dholia and Manjunatha (2015) assert that the uniqueness of one population may be a trait of another. Caucasoids exhibit a higher prevalence of the Carabelli trait compared to Negroids, who demonstrate a lower prevalence of this feature (Yaacob *et al*., 1996; Rawlani *et al*., 2017). However, Negroids exhibit a much higher prevalence of additional permanent teeth (Irish, 2022; Thomas *et al*., 2023). As in the prior example, the mongoloid dentition exhibits shovelling as the greatest characteristic diagnostic trait observed on the palatal surface of the central incisors (Yaacob *et al*., 1996). The morphological characteristics of teeth allow for the classification of the Mongoloid population into two groups: Sinodonty, prevalent among Northeast Asian groups and characterised by derived mass additive traits, and Sundadonty, observed in Southeast Asian and Pacific populations, noted for its retained traits and relatively simpler dentition (Scott & Turner, 1997). All of these classifications are predicated on dental characteristics. A significant prevalence of shovelling and double scooping of maxillary central incisors, enamel extensions in the maxillary molars (M1), reduced, pegged, or absent maxillary third molars (M3), existence of deflecting wrinkles, and mandibular first molar exhibiting triple roots are characteristics associated with synodontia in populations. Conversely, Sundadont groups exhibit a markedly reduced incidence of the above traits, concurrently displaying a high prevalence of four cusped mandibular second molar (Calvin Jia Jun *et al*., 2023).

Various races have variable tooth sizes. Linear tooth dimensions classify the global population as microdontic, mesodontic, or megadontic (Hanihara & Ishida, 2005). Microdontia affected Native Americans, Philippine Negritos, Jomon, and Western Eurasians. Hanihara and Ishida (2005) say the Megadontic population is Australian Aborigines, Melanesians, Micronesians, and sub-Saharan Africans, whereas the Mesodontic population is Polynesians and Southeast Asians. Consequently, in the absence of AM data, the profile may be simplified to the assessment of ancestry based on the metric and non-metric traits present in the individual.

Although ancestry-related dental traits are useful for narrowing population affinity, their diagnostic specificity is limited. Considerable overlap exists among global populations, meaning these traits cannot reliably establish individual identity. They should therefore be interpreted as supportive indicators within a broader forensic context rather than as standalone evidence.

The methods reviewed above demonstrate considerable variability in accuracy, reproducibility, and applicability across forensic contexts. While some approaches, such as age estimation in children, yield relatively narrow error margins, others—particularly those applied in adults or ancestry assessment—are less reliable due to broader variability and population dependence. To provide a concise overview, a comparative synthesis of the principal forensic odontology methods, outlining their reported accuracy, limitations, and forensic applicability, is presented below (Table 1).

Comparative dental identification

This is a critical stage in the process of discerning any unique traits that may facilitate the verification of identity based on individual-level similarities, such as establishing whether the individual in question matches the ante-mortem records. Franco *et al*. (2015) assert that the core concept is predicated on the notion that no two unconnected individuals possess similar dental features.

Table 1. Comparative summary of forensic odontology methods for human identification.

Method	Accuracy / Utility	Limitations	Forensic Applicability
Sex Estimation (Odontometrics, Non-metric traits, AI models)	70–85% accuracy depending on population; AI >80% in pilot studies	Population variation; inter-observer variability; limited validation	Supplementary evidence when DNA/skeletal markers unavailable
Age Estimation – Children & Young Adults (Demirjian, Willems, Nolla, AlQahtani)	±1–2 years	Less accurate after 18 years; third molar variability	Widely accepted for <18 years in forensic/legal contexts
Age Estimation – Adults (Kvaal, Cameriere, histological/biochemical methods)	±4–10 years	Accuracy declines with age; some methods invasive	Supplementary tool; not standalone for legal proof
Ancestry Determination (Shovel-shaped incisors, Carabelli's trait, Sundadont/Sinodont patterns)	Population trends observable	Overlap across groups; cannot identify individuals	Narrows down ancestry/population affinity
Comparative Dental ID (Radiographs, restorations, rugae, lip prints, AI superimposition)	High reliability with AM/PM records	Relies on record quality; fewer restorations due to better oral health	Court admissible under ABFO & Interpol guidelines

The American Board of Forensic Odontology, (2017) indicates that comparative identification may yield the following results:

1. Positive identification occurs when all records are congruent and exhibit no discrepancies. It is posited that a singular individual is accountable for all the discoveries. One tooth with adequate distinguishing characteristics can suffice for identification purposes.
2. The potential for identification – data from the AM and PM exhibiting consistent characteristics; nonetheless, the evidence lacks any distinguishing features.
3. Insufficient evidence, defined as evidence inadequate to reach a conclusion
4. Exclusion: records that exhibit a distinct delineation and seem to be incongruous.

The Interpol disaster victim identification (DVI) manual states that dental identification can be a trustworthy independent identifier if a positive match is made. Dental records contain identifiable data (Kiran *et al*., 2019). The distribution of teeth and the properties of restored, non-restored, missing, and decaying surfaces show unique patterns.

Unique dental features

Dental casts, 2D radiographs, as well as 2D and 3D images could be included in the records for the ante mortem and postmortem comparison. Radiographic examinations have a significant comparative value because of their unique characteristics. These characteristics include biological variability, which includes impacted teeth, broken down roots, jawbone structure, sinus cavities, and dental interventions such as morphology of the restoration, root canal therapy, oral surgery procedures, and the dental implants respectively (Campobasso *et al*., 2007). Comparative dental identification

is widely accepted under ABFO and Interpol guidelines, but its reliability depends heavily on the quality of available antemortem records. With declining restorative dental work in many populations, reliance on inherent dental morphology is becoming increasingly important. To add insult to injury, in the current scenario, when the oral health status has improved, a growing proportion of cases continue to be unclear since there are no restorations or other treatments performed on any of the teeth that are in good condition.

Santoro *et al*. (2019) found that the contour of teeth, which was caught in images of a smiling face, played a role in the process of identification in the study cast that was created by superimposing different photographs of the skull. In spite of this, aesthetic dentistry has caused potential loss of an identifying resource. This is due to the fact that people are altering their anterior teeth aesthetically, which naturally make up a smile pattern, in such a way that might not correspond with the actual smiles that were initially stored in the AM database. According to Moreira Andrade *et al*. (2022), the frontal sinuses and other cranial traits are considered to be reliable instruments for human identification.

Palatal rugae pattern and lip prints which are soft tissue structures, have also been examined in the AM and PM recordings. These structures have been analysed in addition to dental and cranial characteristics. It is possible for the palatal rugae to make a substantial contribution to human identity because they are a pattern that is fundamental to each individual and is unique to them. The palatal rugae are a feasible device in the field of forensic odontology (Syed *et al*., 2021). This is due to the fact that they are easy to reproduce and decrease the amount of variability. Furthermore, the slow loss of rugae, which happens at an average rate of one ruga every 15 (2) years after early adulthood (Suhartono *et al*., 2016), contributes to the enhancement of the utility of rugae in forensic investigations.

Within the realm of forensic investigations, cheiloscopy has been utilised to determine the identity of human beings. Even as early as the fifth week of intrauterine development, it is likely to distinguish a person's lip print. Based on the findings of Hamzah *et al*. (2021), it is possible to make comparisons between lip prints that are discovered at a crime scene and the lip print of a suspect. This results in length reduction and in width increase, giving it a thinner and elongated appearance (Kim *et al*., 2019). However, the appearance of the lips changes as a person gets older, resulting in a change in appearance. It is possible that this will lead to an incorrect diagnosis, particularly if the identification process takes place after a considerable amount of time has passed. According to Bhattacharjee & Kar (2024), the mobility of the crease pattern on the vermilion border of the lip might result in lip prints that are distinct from one another depending on the pressure, direction, and technique that was utilised in the process of making the imprint.

Since both the palatal rugae and lip prints are soft tissue measures, their usefulness in human identification is limited because they decrease with time as a result of decomposition and wound healing.

According to research conducted by Roy *et al*. (2019), the comparison of the groove patterns in maxillary first and second molar highlighted the individuality of these specific dental characteristics and proposed that this dental characteristic might be used for human identification. Later, another study showed positive uniqueness of the groove pattern on the maxillary posterior teeth by superimposing digital photographs of groove pattern tracing generated using 2D Hirox stereomicroscope (Riaz *et al*., 2023).

Comparative dental identification is widely accepted in forensic practice and endorsed by ABFO and Interpol guidelines. However, its reliability depends heavily on the availability and quality of antemortem records. In many regions, improved oral health and reduced reliance on extensive dental restorations have decreased the distinctiveness of dental features,

emphasizing the need to focus on inherent anatomical variations, digital imaging, and standardized comparison protocols.

Emerging digital imaging and forensic approaches

In the field of forensic odontology, several scientific analyses and data collection methods have undergone noteworthy developments in order to aid human identification. A two-dimensional (2D) approach, which includes the examination of radiographs and plaster dental casts, is the typical digital imaging technique that is utilised for the purpose of dental identification (Middleton *et al*., 2016). According to Campobasso *et al*. (2007), Radiographs are used in the AM and PM to compare dental treatments such prostheses, implants, and restorations. In the digital age, many two-dimensional (2D), three-dimensional (3D), and AI imaging technologies have been developed to improve forensic evidence for legal and medical use. These imaging methods show promise as forensic tools due to their precision and accuracy (Riaz *et al*., 2024; Bianchi *et al*., 2023).

Digital pictures in two dimensions and dental scans in three dimensions of dental casts are used in forensic investigations. This makes data storage and access easier. A sophisticated software for comparison identification is utilised in the process of data processing by superimposing 3D dental scans (Gibelli *et al*., 2019) and palatal rugae (Alselwi *et al*., 2022), among other comparison identification techniques. Dental profiling is a technique that allows for the evaluation of sex, race, and age through the use of two-dimensional and three-dimensional techniques. This is accomplished by capturing digital images using standardised devices that exhibit a high degree of accuracy and precision(Amornvit *et al*., 2021; Riaz *et al*., 2024).

DNA profiling (Panneerchelvam & Nor, 2023), analysis of the pelvic bone (Secgin *et al*., 2022), and skull inspection (Tan *et al*., 2020) are the methods that are considered to be the gold standards for determining a person's gender. In spite of this, there are instances in which the DNA obtained from the pelvis, the cranium, or both is so tainted by postmortem modifications that they are not capable of determining the gender of the deceased. As a result, tooth sex prediction has the potential to function as a supplementary method in circumstances where the gold standards are inaccessible.

More people are becoming aware of the importance of maintaining good oral hygiene, which has contributed to an improvement in oral health status and a decrease in the incidence of dental caries (Kramer & Splieth, 2022; Palanisamy, 2024). As a consequence of this, there are occasions in which the AM records do not contain any evidence of specific dental treatment, which is essential for correct identification. Thus, the distinctiveness of dental records must be dependent on additional biological cranial characteristics that are unique to the individual, such as the palate rugae, sinuses, and cheiloscopy. On the other hand, inflammation may have an effect on the sinuses, and cheiloscopy and palatal rugae are not able to endure decomposition.

Gender helps narrow AM dental record searches for human identification. Using these occlusal features may help determine a person's gender biologically. Occlusal qualities of teeth may be relevant when DNA contamination or deterioration is present and there is no other biological evidence, such as trauma or incineration-related cranial and post-cranial traits. Dental trauma and caries in the proximal region might also impair odontometric systems' measuring reference points. AM and PM dental records may be inconclusive without caries. Forensic dentists have to authenticate identity using biological evidence from healthy teeth. Thus, odontologists can compare and superimpose 2D and 3D postmortem digital photos taken of the deceased person.

Artificial intelligence (AI) and digital imaging technologies are increasingly applied in forensic dentistry for human identification. Machine learning algorithms,

particularly convolutional neural networks, have shown potential in dental feature recognition, segmentation of CBCT scans, and automated sex or age estimation, with accuracies often exceeding those of traditional odontometric methods (Mohan *et al.*, 2019; Raj *et al.*, 2021). These tools improve reproducibility by reducing inter-observer variability and can process large datasets rapidly, offering advantages in mass disaster victim identification (Bhattacharya *et al.*, 2020). Despite this promise, most studies are based on small and homogenous datasets, limiting generalizability across populations (Zhu *et al.*, 2022). Furthermore, the absence of standardized protocols and external validation restricts their acceptance in forensic practice. Until these limitations are addressed through multicenter studies, algorithm transparency, and clearly defined error margins, the legal admissibility of AI-generated findings will remain uncertain (Panchbhai, 2018; Patel *et al.*, 2023).

Nevertheless, with rigorous validation, AI has the potential to complement conventional forensic dental methods and significantly enhance the reliability of human identification. To move forward, large-scale multicenter studies and transparent reporting of algorithmic accuracy, reproducibility, and limitations are essential.

Admissibility of method by court of law

It is important that the methodology that is utilised in this investigation be selected on the basis of expert judgement in order to ensure that it adheres to legitimate scientific approaches and procedures. According to the Daubert rule (Daubert, 1993), there are specific criteria that should be considered when determining the reliability of a scientific theory or study. These criteria include the following:

1. the ability to be empirically tested;
2. the status of publication or peer review;
3. the acceptability of the known or potential error rate; and
4. the general acceptance within the scientific community.

Forensic odontology evidence can only be used in court if it meets certain requirements, such as the Daubert and Frye criteria. Daubert says that scientific evidence must be able to be tested, have known or possible error rates, be published in peer-reviewed journals, and be widely accepted by the relevant scientific community. Many odontology approaches, including sex and age estimation, are limited by demographic specificity and the lack of comprehensive validation studies demonstrating reproducibility and error margins, hence posing challenges under these standards. The American Board of Forensic Odontology (ABFO) and the Interpol Disaster Victim Identification (DVI) standard are two examples of professional groups that stress the necessity of comparative dental identification as the most reliable and legally accepted method in forensic dentistry. Comparative procedures are widely acknowledged for their direct linkage of antemortem and postmortem information, whereas techniques such as age or sex estimation are generally regarded just as supplementary evidence. To meet both scientific and legal criteria, forensic odontology needs to be more legally defensible by using the same methods, reporting mistakes clearly, and testing them on different groups of people. Beyond the discussion of admissibility, it is important to consider the parallel technological advances in digital imaging and innovative forensic approaches that have enhanced the scope of dental identification.

Conclusion

Forensic odontology remains a cornerstone of human identification when primary identifiers such as DNA and fingerprints are unavailable. Beyond describing available techniques, it is crucial to recognize their limitations: population variability, lack of universal standards, validation challenges in AI-driven tools, and ethical/legal concerns surrounding admissibility. Future research should prioritize standardized protocols,

large-scale population validation, and integration of digital imaging with AI under strict forensic guidelines. With these refinements, forensic dental evidence can achieve greater reliability and legal robustness worldwide.

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References

ABFO (American Board of Forensic Odontology). (2017). *American Board of Forensic Odontology (ABFO) Body Identification Information & Guidelines* (February Issue, p. 14). Retrieved from, http://abfo.org/wp-content/uploads/2012/08/ABFO-Body-ID-Information-Guidelines-Feb-2017.pdf%0A

Ágnes Borsay, B., Dóra Halasi, B., Kristóf Pórszász, R., & Attila Gergely, P. (2024). Importance of the details in person identification. *Legal Medicine*, *67*. https://doi.org/10.1016/j.legalmed.2023.102385

AlQahtani, S. J., Hector, M. P., & Liversidge, H. M. (2010). Brief communication: the London atlas of human tooth development and eruption. *American Journal of Physical Anthropology*, *142*(3), 481–490. https://doi.org/10.1002/ajpa.21258

Alselwi, A. A., Bin Khamis, M. F., & Abdullah, J. Y. (2022). Validity and reliability of palatal rugae morphometric assessment with 3D laser scanned models. *Brazilian Journal of Oral Sciences*, *21*, 1–11. https://doi.org/10.20396/BJOS.V21I00.8665924

Amornvit, P., Rokaya, D., & Sanohkan, S. (2021). Comparison of accuracy of current ten intraoral scanners. *BioMed Research International*, *2021*, 1–10.

Bhattacharjee, R., & Kar, A. K. (2024). Cheiloscopy: a crucial technique in forensics for personal identification and its admissibility in the Court of Justice Federal Bureau of Investigation. *Morphologie*, *108*(360), 1–8.

Bianchi, I., Oliva, G., Vitale, G., Bellugi, B., Bertana, G., Focardi, M., *et al.* (2023). A semi-automatic method on a small Italian sample for estimating sex based on the shape of the crown of the maxillary posterior teeth. *Healthcare*, *11*(6), 845. https://doi.org/10.3390/healthcare11060845

Bu, W.-Q., Ji, L.-L., Han, M.-Q., Wu, Z.-X., Sultan, B., Chen, T., *et al.* (2023). Accuracy comparison of tooth volume and mesiodistal diameter measurements for sex dimorphism based on cone-beam computed tomography: a study for the northern Chinese population. *Forensic Sciences Research*, *8*(2), 133–139. https://doi.org/10.1093/fsr/owad004

Calvin Jia Jun, L., Sharlini Bee Ying, Y., Nabila Hayati Shushilil Azam, N., Chander Manivannan, P., Gou Rean, W., *et al.* (2023). Mongoloid ancestry. *Journal of Oral Research*, *12*(1), 237–247. https://doi.org/10.17126/joralres

Cameriere, R., Brogi, G., Ferrante, L., Mirtella, D., Vultaggio, C., Cingolani, M., *et al.* (2006). Reliability in age determination by pulp/tooth ratio in upper canines in skeletal remains. *Journal of Forensic Sciences*, *51*(4), 861–864. https://doi.org/10.1111/j.15564029.2006.00159.x

Campobasso, C. p, Dell'Erba, A. S., Belviso, M., & Di Vella, G. (2007). Craniofacial identification by comparison of antemortem and postmortem radiographs. *American Journal of Forensic Medicine & Pathology*, *28*(2), 182–186. https://doi.org/10.1097/PAF.0b013e31806195cb

Capitaneanu, C., Willems, G., Jacobs, R., Fieuws, S., & Thevissen, P. (2017). Sex estimation based on tooth measurements using panoramic radiographs. *International Journal of Legal Medicine*, *131*(3), 813–821. https://doi.org/10.1007/s00414-016-1434-0

Chowdhry, A., Popli, D. B., Sircar, K., & Kapoor, P. (2023). Study of twenty non-metric dental crown traits using ASUDAS system in NCR (India) population. *Egyptian Journal of Forensic Sciences*, *13*(1). https://doi.org/10.1186/s41935-023-00329-2

Daubert. (1993). Daubert v. Merrell Dow Pharmaceuticals, Inc.: General acceptance rejected. *Santa Clara High Technology Law Journal*, *10*(1), 259–265.

Dholia, B., & Manjunatha, B. S. (2015). Occlusal morphology of permanent mandibular first and second molars in Gujarati population 4. *Journal of Forensic Dental Sciences*, *7*(2), 2–7.

Dumančić, J., Scott, G. R., Savić Pavičin, I., Anić-Milošević, S., Medančić, N., & Brkić, H. (2023). Canine crown sexual dimorphism in a sample of the modern croatian population. *Dentistry Journal*, *11*(7). https://doi.org/10.3390/dj11070175

Eboh, D. E. O. (2019). Odontometric sex discrimination in young Urhobo adults of South-South Nigeria. *Anatomy and Cell Biology*, *52*(3), 269–277. https://doi.org/10.5115/acb.18.221

El Morsi, D., Rezk, H., Aziza, A., & El-Sherbiny, M. (2015). Tooth coronal pulp index as a tool for age estimation in Egyptian population. *Journal of Forensic Science & Criminology*, *3*(2), 1–8. https://doi.org/10.15744/2348-9804.2.501

Fitri, B., Roosyanto, W., Kurniawan, A., Chusida, A., Marini, M. I., Rizky, B. N., *et al.* (2022). Children and adolescent dental age estimation by the Willems and Al Qahtani methods in Surabaya, Indonesia. *BioMed Research International*, *2022*, 1–4.

Franco, A., Willems, G., Souza, P. H. C., Bekkering, G. E., & Thevissen, P. (2015). The uniqueness of the human dentition as forensic evidence: a systematic review on the technological methodology. *International Journal of Legal Medicine*, *129*(6), 1277–1283. https://doi.org/10.1007/s00414-014-1109-7

Gibelli, D., De Angelis, D., Riboli, F., Dolci, C., Cattaneo, C., & Sforza, C. (2019). Quantification of odontological differences of the upper first and second molar by 3D-3D superimposition: a novel method to assess anatomical matches. *Forensic Science, Medicine, and Pathology*, *15*(4), 570–573. https://doi.org/10.1007/s12024-019-00140-3

Govindaram, D., Bharanidharan, R., Ramya, R., Rameshkumar, A., Priyadharsini, N., & Rajkumar, K. (2018). Root length: as a determinant tool of sexual dimorphism in an ethnic Tamil population. *Journal*

of Forensic Dental Sciences, *10*(2), 96–100. https://doi.org/10.4103/jfo.jfds_10_18

Hamzah, N. H., Jamaludin, U. K., Osman, K., & Gabriel, G. F. (2021). Digital approach for lip prints analysis in Malaysian Malay population (Klang Valley): scanning technique. *Jurnal Sains Kesihatan Malaysia*, *19*(01), 31–38. https://doi.org/10.17576/jskm-2021-1901-04

Hanihara, T., & Ishida, H. (2005). Metric dental variation of major human populations. *American Journal of Physical Anthropology*, *128*(2), 287–298. https://doi.org/10.1002/ajpa.20080

Irish, J. D. (2022). Hyperdontia across sub-Saharan Africa: prevalence, patterning, and implications. *Archives of Oral Biology*, *140*(March), 105463. https://doi.org/10.1016/j.archoralbio.2022.105463

Issrani, R., Iqbal, A., Alam, M. K., & Prabhu, N. (2020). 3D CBCT Analysis of odontometric variables for gender dimorphism in Saudi Arabian subpopulation. *Indian Journal of Forensic Medicine & Toxicology*, *14*(2), 1872–1880. https://doi.org/10.37506/ijfmt.v14i2.3211

Jaquilin, G. G., Chatra, L., Shenoy, P., Veena, K. M., Prabhu, R. V, & Kumar L S, V. (2018). Age determination by Schour and Massler method: a forensic study. *International Journal of Forensic Odontology*, *3*(1), 38–42. https://doi.org/10.4103/ijfo.ijfo

Kim, H., Lee, M., Park, S. Y., Kim, Y. M., Han, J., & Kim, E. (2019). Age-related changes in lip morphological and physiological characteristics in Korean women. *Skin Research and Technology*, *25*(3), 277–282. https://doi.org/10.1111/srt.12644

Kiran, R., Chapman, J., Tennant, M., Forrest, A., & Walsh, L. J. (2019). Detection of tooth-colored restorative materials for forensic purposes based on their optical properties: an in vitro comparative study. *Journal of Forensic Sciences*, *64*(1), 254–259. https://doi.org/10.1111/1556-4029.13851

Kramer, A., & Splieth, C. (2022). Health promotion through structured oral hygiene and good tooth alignment. *GMS Hygiene and Infection Control*, *17*, Doc08. https://doi.org/10.3205/dgkh000411

Kumar, K., Choudhary, S., & Singh, R. (2019). Assessment of various odontometric parameters in accuracy of sexual dimorphism. *International Journal of Oral Health Dentistry*, *5*(4), 191–194.

Kurniawan, A., Chusida, A., Atika, N., Gianosa, T. K., Solikhin, M. D., Margaretha, M. S., *et al.* (2022). The applicable dental age estimation methods for children and adolescents in Indonesia. *International Journal of Dentistry*, *2022*. https://doi.org/10.1155/2022/6761476

Kvaal, S. I., Kolltveit, K. M., Thomsen, I. O., & Solheim, T. (1995). Age estimation of adults from dental radiographs. *Forensic Science International*, *74*(3), 175–185. https://doi.org/10.1016/0379-0738(95)01760-G

Lukacs, J. R., & Kuswandari, S. (2022). Crown dimensions of Malay deciduous teeth: Sex dimorphism and tooth size in Asia. *Archives of Oral Biology*, *141*(December 2021), 105481. https://doi.org/10.1016/j.archoralbio.2022.105481

Middleton, A., Alminyah, A., Apostol, M. A., Boel, L. W. T., Brough, A., Develter, W., *et al.* (2016). Forensic odontology radiography and imaging in disaster victim identification. *Journal of Forensic Radiology and Imaging*, *6*, 28–30. https://doi.org/10.1016/j.jofri.2016.08.003

Mittal, S., Nagendrareddy, S., Sharma, M., Agnihotri, P., Chaudhary, S., & Dhillon, M. (2016). Age estimation based on Kvaal's technique using digital panoramic radiographs. *Journal of Forensic Dental Sciences*, *8*(2), 115. https://doi.org/10.4103/0975-1475.186378

Moreira Andrade, V., de Lima Gomes, S., Ulbricht, V., Martins Schmidt, C., Araújo, R., Sassi Etchegoyen, C. A., *et al.* (2022). Human identification by comparative analysis of frontal sinuses: study on computed tomography. *International Journal of Odontostomatology*, *16*(3), 352–358. https://doi.org/10.4067/s0718381x2022000300352

Palanisamy, S. (2024). Innovations in oral hygiene tools: a mini review on recent developments. *Frontiers in Dental Medicine*, *5*(August), 1–8. https://doi.org/10.3389/fdmed.2024.1442887

Panneerchelvam, S., & Nor, N. M. (2023). DNA Profiling in human identification: from past to present. *Malaysian Journal of Medical Sciences*, *30*(6), 5–21. https://doi.org/10.21315/mjms2023.30.6.2

Phillips, V. M., & Van Wyk Kotze, T. J. (2009). Testing standard methods of dental age estimation by moorrees, fanning and hunt and demirjian, goldstein and tanner on three south african children samples. *Journal of Forensic Odonto-Stomatology*, *27*(2), 20–28.

Phulari, R. G. S., & Dave, E. J. (2021). Evolution of dental age estimation methods in adults over the years from occlusal wear to more sophisticated recent techniques. *Egyptian Journal of Forensic Sciences*, *11*(1). https://doi.org/10.1186/s41935-021-00250-6

Rawlani, S. M., Rawlani, S. S., Bhowate, R. R., Chandak, R. M., & Khubchandani, M. (2017). Racial characteristics of human teeth. *International Journal of Forensic Odontology*, *2*, 38–42. https://doi.org/10.4103/ijfo.ijfo

Riaz, S., Atif, S., Syed, S., Rafi Chaudhry, A., & Zahid, E. (2024). Sex prediction according to digital analysis of the morphological characteristics of maxillary posterior teeth in a Pakistani population. *Journal of Taibah University Medical Sciences*, *19*(5), 974–980. https://doi.org/10.1016/j.jtumed.2024.09.002

Riaz, S., Khamis, M. F. Bin, Ahmad, W. M. A. B. W., Abdullah, J. Y., & Alam, M. K. (2024). Potential use of the cusp and crown areas of the maxillary posterior teeth measured with a two-dimensional stereomicroscope for sex determination. *Forensic Science, Medicine and Pathology*, *20*(2), 452–461. https://doi.org/10.1007/s12024-023-00651-0

Riaz, S., Khamis, M. F., Abdullah, J. Y., & Wan Ahmad, W. M. A. Bin. (2023). Uniqueness of groove patterns of maxillary posterior teeth in human identifcation. *Malaysian Journal of Microscopy*, *19*(1), 108–117.

Roy, J., Rohith, M. M., Nilendu, D., & Johnson, A. (2019). Qualitative assessment of the dental groove pattern and its uniqueness for forensic

identification. *Journal of Forensic Dental Sciences*, *11*(1), 42–47. https://doi.org/10.4103/jfo.jfds

Santoro, V., Mele, F., Introna, F., & Donno, A. De. (2019). Personal identification through digital photo superimposition of dental profile: a pilot study. *Journal of Forensic Odonto-Stomatology*, *37*(37), 21–26.

Scott, G. R., & Turner, C. G. (1997). *The Anthropology of Modern Human Teeth*. Cambridge University Press. https://doi.org/10.1017/CBO9781316529843 Contents

Secgin, Y., Oner, Z., Turan, M. K., & Oner, S. (2022). Gender Prediction with the parameters obtained from pelvis computed tomography images and machine learning algorithms. *Journal of the Anatomical Society of India*, *71*(3), 204–209. https://doi.org/10.4103/jasi.jasi

Suhartono, A. W., Syafitri, K., Puspita, A. D., Soedarsono, N., Gultom, F. P., Widodo, P. T., *et al.* (2016). Palatal rugae patterning in a modern Indonesian population. *International Journal of Legal Medicine*, *130*(3), 881–887. https://doi.org/10.1007/s00414-015-1272-5

Swain, N., Patel, S., Pathak, J., Sarkate, P. R., Sahu, N. K., & Hosalkar, R. M. (2021). Role of dental hard tissue in human identification. *Journal of Contemporary Dentistry*, *9*(3), 130–134. https://doi.org/10.5005/jp-journals-10031-1264

Syed, S., Alshahrani, I., Shiblee, M., Aseere, A. M., Dawasaz, A. A., & Togoo, R. A. (2021). Estimation of the individuality of the palatal rugae pattern. *Australian Journal of Forensic Sciences*, *53*(1), 62–74. https://doi.org/10.1080/00450618.2019.1607901

Tan, J. S., Yi, I., Ibrahim, L., Bahari, V., & Jayaprakash, B. P. T. (2020). Computer-aided superimposition via reconstructing and matching 3D faces to 3D skulls for forensic craniofacial identifications. *The Visual Computer*, *36*(2), 1739–1753. https://doi.org/10.1007/s00371-019-01767-7

Thomas, E., Oettlé, A. C., & Becker, P. (2023). Supernumerary teeth in a sample of South African dental patients. *South African Dental Journal*, *78*(02), 74–81. https://doi.org/10.17159/sadj.v78i02.16187

Vistro, A. A., Farooqui, S. S., Saeed, M. H., Maqbool, A., Ghauri, M. Q. K., Dherwani, V., *et al.* (2024). Evaluating the accuracy and reliability of the Demirjian method for dental age assessment: a systematic review: reliability of the Demirjian Method for Dental Age Assessment. *Pakistan Journal of Health Sciences*,*5(12)*. https://doi.org/10.54393/pjhs.v5i12.2138

Walker, S. C., Rye Mattick, C., Hobson, R. S., & Nick Steen, I. (2009). Abnormal tooth size and morphology in subjects with cleft lip and/or palate in the north of England. *European Journal of Orthodontics*, *31*(1), 68–75. https://doi.org/10.1093/ejo/cjn073

Yaacob, H., Nambiar, P., & Naidu, M. D. (1996). Racial characteristics of human teeth with special emphasis on the Mongoloid dentition. *The Malaysian Journal of Pathology*, *18*(1), 1–7.

CASE REPORT Open Access

Ossifying fibrous epulis: case reports and diagnostic insights into gingival swellings

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Abstract

Ossifying fibrous epulis, also known as peripheral ossifying fibroma in literature, is a relatively common, benign reactive lesion that exclusively affects the gingival tissue. It arises in response to chronic local irritation such as plaque accumulation, calculus, faulty restorations, or repeated trauma. Though non-neoplastic in nature, it can present as a slowly enlarging, firm, and fibrous mass, mimicking a range of other more aggressive or neoplastic conditions. Histopathological examination is paramount for achieving a definitive diagnosis. This report presents two cases occurring in young adults, highlighting the clinical features, diagnostic process, surgical management, and post-operative outcomes. The lesions, located in the anterior maxilla and mandibular gingiva respectively, shared common clinical traits including nodular appearance, surface colour resembling surrounding mucosa, and occasional bleeding upon provocation. Histopathological analysis in both cases revealed parakeratinised stratified squamous epithelium with focal degeneration, mineralized components such as trabeculae of bone and cementum-like materials, and chronic inflammatory cells infiltrate. Following surgical excision and removal of local irritants, healing was uneventful with no recurrence observed during short-term follow-up. This paper further elaborates on the histopathological spectrum, recurrence risk, and differential diagnosis of ossifying fibrous epulis, supported by a tabulated overview of similar gingival lesions. Recognising the clinical behaviour and key distinguishing features of this lesion is crucial in general dental practice to avoid misdiagnosis and ensure appropriate intervention. Early detection, thorough removal, and patient education are integral to effective management and prevention of recurrence.

Keywords: *gingival swelling, ossifying fibrous epulis, peripheral ossifying fibroma, reactive lesion*

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Introduction

Gingival tissues are frequently affected by various pathological conditions, often presenting clinically as localised or generalised swellings within the oral cavity. These lesions are among the most common findings during routine dental examinations and can arise due to various aetiological factors, including local trauma, microbial infections, or neoplastic processes (Effiom, Adeyemo & Soyele, 2011; Maturana-Ramírez *et al.*, 2015; Zhao *et al.*, 2023). The differential diagnoses of gingival enlargements are extensive, encompassing both reactive and neoplastic lesions (Agrawal, 2015; Brierley *et al.*, 2019).

Reactive lesions of the gingiva such as pyogenic granuloma, fibrous epulis, ossifying fibrous epulis, and peripheral giant cell granuloma constitute many cases encountered in daily clinical practice. These lesions typically develop in response to persistent local irritation from factors like dental plaque, calculus, faulty restorations, or ill-fitting prostheses (Zhao *et al*., 2023). Although non-neoplastic in nature, their clinical presentation may mimic more serious conditions, necessitating histopathological examination for definitive diagnosis.

In contrast, true neoplastic lesions involving the gingiva are relatively rare but hold significant clinical importance. Benign neoplasms, such as peripheral counterpart of odontogenic tumours and metastatic deposits, may occasionally present as gingival swellings. Malignant lesions, including primary squamous cell carcinoma and metastatic tumours from distant sites like the breast or lung, though uncommon, must also be considered in the differential diagnosis, especially in cases of unexplained rapidly growing masses (Brierley *et al*., 2019).

The clinical evaluation of gingival lesions should involve a comprehensive assessment, including a detailed medical and dental history, thorough clinical examination, radiographic analysis, and biopsy when indicated. Due to the overlapping clinical features of reactive, benign, and malignant lesions, a multidisciplinary approach is often necessary for definitive diagnosis and appropriate treatment planning.

This paper presents two cases of ossifying fibrous epulis, detailing their clinical presentation, diagnostic evaluation, and surgical management. In addition, it discusses relevant differential diagnoses for gingival swellings and highlights their key features for accurate diagnosis and appropriate treatment planning.

Case reports

Case 1

A 24-year-old female presented to Kulliyyah of Dentistry undergraduate dental polyclinic with a chief complaint of a swelling on her upper right gum. She reported that the lesion had been present for approximately two years and had gradually increased in size over that period. She did not report any associated pain or systemic symptoms. However, she noted occasional bleeding during toothbrushing and a history of repeated trauma to the area, particularly from brushing. The patient mentioned that she had sought treatment on three separate occasions for the same condition and was advised each time that the lesion would resolve with improved oral hygiene. She is a university student, single, and denies any history of sexual promiscuity.

Extraoral examination revealed no significant findings. Intraoral examination showed a solitary, sessile, erythematous gingival nodule on the buccal aspect of tooth 12, measuring approximately 10 × 4 mm. The lesion was oval in shape, firm in consistency, and extended labially, covering nearly half of the crown of tooth 12 (Figure 1).

The lesion was surgically excised under local anaesthesia without complications. The excised tissue sample was immediately fixed in formalin and subsequently submitted to the laboratory for histopathological examination.

Macroscopic examination:
The specimen consisted of a single piece of brownish soft tissue measuring approximately 10 × 3 × 3 mm. The tissue was bisected and submitted entirely in one block.

Microscopic examination:
Histopathological sections revealed parakeratinised stratified squamous epithelium of variable thickness, with focal areas showing surface degeneration (Figure 2A and 2B). The underlying connective tissue exhibited high cellularity within a background of mature fibrous stroma.

Scattered throughout the specimen were trabeculae of mature bone, cementum-like material, and areas of dystrophic calcification (Figure 2C). Inflammatory cell infiltrate was noted scattered within the tissue sections, predominantly composed of chronic inflammatory cells including lymphocytes and plasma cells.

Final diagnosis of ossifying fibrous epulis was rendered for this case, consistent with its clinical appearance and histopathological findings.

Follow up and outcomes:
The patient was reviewed two weeks following surgical excision. Clinical evaluation revealed satisfactory healing of the surgical site, with no evidence of complications or recurrence (Figure 3). The patient expressed satisfaction with the outcome of the procedure and reported no discomfort or concerns. Oral hygiene instructions were reinforced, and she was advised to maintain meticulous plaque control.

Figure 1. Intraoral photograph showing a reddish, sessile lesion on the labial gingiva of tooth 12.

Case 2

A 20-year-old Malay male presented to the undergraduate dental polyclinic with a chief complaint of a growth on his lower anterior gingiva. He reported that the lesion had been present for approximately three years. Initially appearing as a mild gingival swelling, the lesion gradually increased in size and became firmer after the first year. The patient noted mild discomfort associated with the lesion and ultimately sought treatment due to its unaesthetic appearance, particularly noticeable when smiling.

The patient was medically fit and had no history of significant systemic illness. He was a non-smoker, denied any parafunctional habits or high-risk behaviours and described himself as leading a generally healthy lifestyle. He is currently a university student.

Extraoral examination revealed no significant findings. Intraoral examination showed a slightly reddish swelling on the labial gingiva in the interproximal region between teeth 41 and 42 (Figure 4). The lesion was firm in consistency, ovoid in shape with a leaf-like appearance, and arose from the keratinised gingiva. It measured approximately 5 × 7 mm. Mild bleeding was observed upon manipulation of the lesion. The patient's overall oral hygiene was suboptimal, with evident supragingival calculus deposits on the lower anterior teeth.

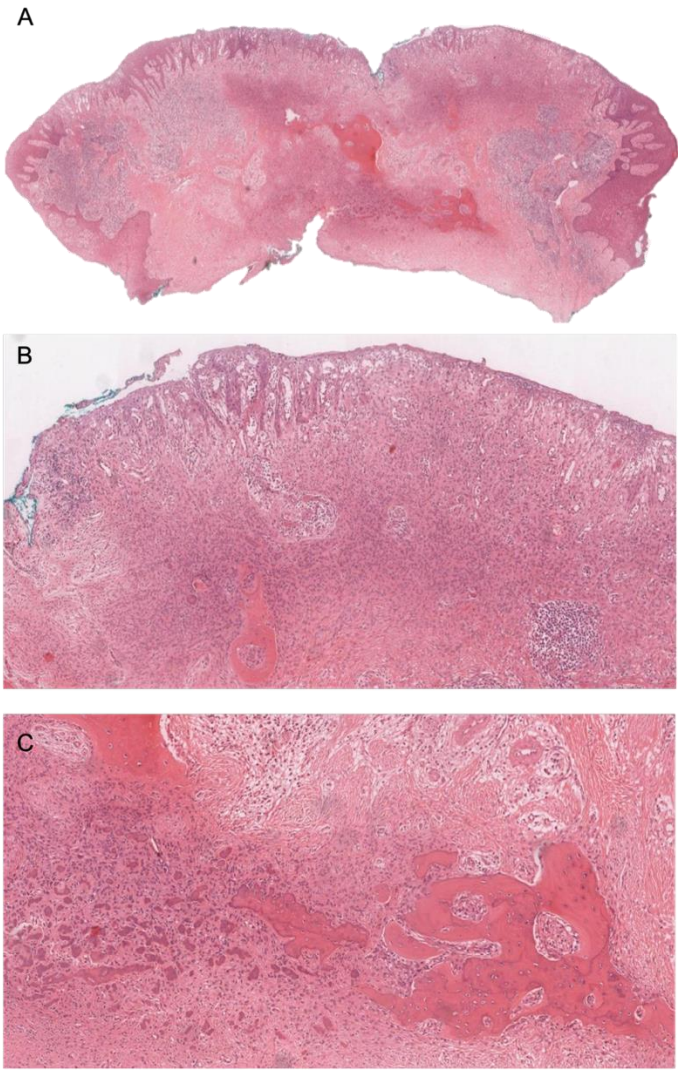

Figure 2. Histopathological features of the lesion under haematoxylin & eosin staining. (A) Low magnification image showing a sessile lesion with central ossification. (B) Areas of degenerated surface epithelium. (C) Ossified hard tissue of multiple sizes present at the central of the lesion surrounded by cellular fibrous connective tissue with occasional inflammatory cell infiltrates.

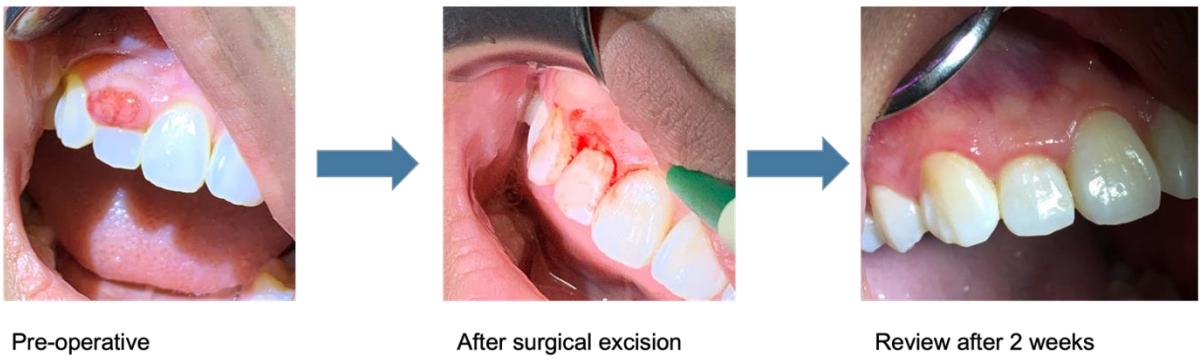

Figure 3. Clinical images illustrating the treatment sequelae of this case, including the preoperative presentation, immediate post-excision appearance, and postoperative healing outcomes.

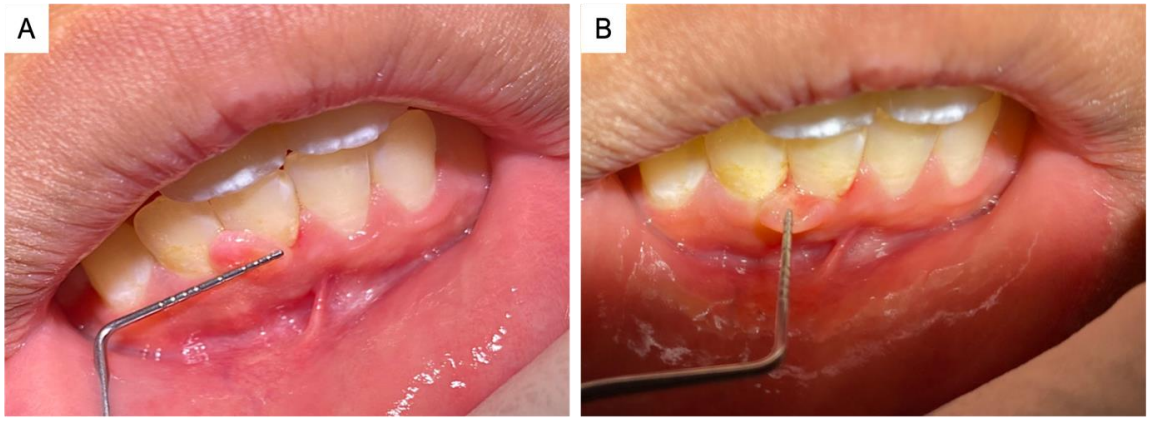

Figure 4. (A&B). Intraoral photograph showing the leaf-like appearance of a gingival swelling on the labial aspect of 41 and 42.

The lesion was surgically excised under local anaesthesia using a sterile scalpel blade. Digital pressure was applied with sterilised gauze to achieve haemostasis. A periodontal dressing (Coe-Pak) was placed over the surgical site to protect the area and facilitate healing. The excised tissue was immediately immersed in 10% buffered formalin and submitted to the histopathology laboratory for analysis.

Macroscopic examination:
A firm, whitish soft tissue specimen measuring approximately 4 × 5 × 3 mm. The sample was bisected and entirely submitted in one cassette for routine processing and embedding.

Microscopic examination:
Demonstrates mature fibrous connective tissue covered by parakeratinised stratified squamous epithelium (Figure 5A). In certain areas, the surface epithelium exhibited degeneration with focal neutrophilic infiltration (Figure 5B). The underlying stroma consisted of trabeculae of woven bone and areas of dystrophic calcification, dispersed within a fibrous matrix (Figure 5C). A dense inflammatory cell infiltrate, predominantly composed of chronic inflammatory cells such as lymphocytes and plasma cells, was observed throughout the connective tissue.

Based on the clinical presentation and histopathological features, the final diagnosis established for this case was ossifying fibrous epulis.

Discussion

Ossifying fibrous epulis (OFE) is a reactive, non-neoplastic lesion of mesenchymal origin that arises exclusively on the gingiva. Regarding its nomenclature, this entity has been described in the literature under various terms, including "peripheral ossifying fibroma", "peripheral fibroma with calcifications", "calcifying fibroma", "calcifying fibroblastic granuloma", and "fibrous epulis with ossification" (Takagi *et al*., 2024). Although "peripheral ossifying fibroma" (POF) is widely accepted, it is important to distinguish this lesion from central ossifying fibroma, which is a true neoplasm originating within the jawbone. To reduce terminological ambiguity and avoid conflating it with intraosseous neoplasms, we have opted to use the term ossifying fibrous epulis in this report, reflecting both its reactive nature and its peripheral gingival location. OFE typically develops in response to chronic local irritation or trauma, such as plaque accumulation, calculus, faulty dental restorations, or repeated mechanical injury during oral hygiene practices. It is believed to originate from cells within the periodontal ligament and periosteum, which possess the capacity to undergo metaplastic transformation into hard tissue-forming cells, such as osteoblasts or cementoblasts, under persistent inflammatory stimuli.

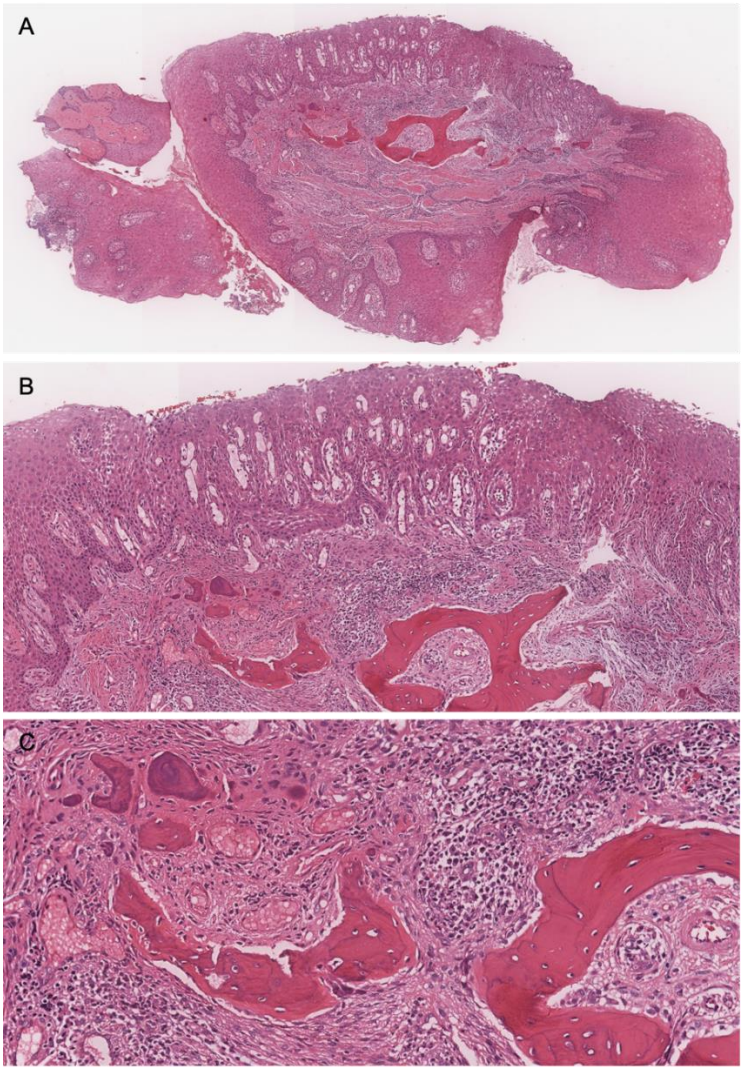

Figure 5. Histopathological features of the lesion under haematoxylin & eosin staining. (A) Low magnification image shows a soft tissue lesion covered by acanthotic surface epithelium. (B) Areas of degenerated surface epithelium with intense inflammatory cell infiltrates. (C) Ossified hard tissue of multiple sizes present within underlying connective tissue.

These lesions are most commonly localised to the interdental papilla or marginal gingiva, the areas particularly susceptible to both mechanical and inflammatory insult.

Demographically, OFE exhibits a marked predilection for females, particularly in the second and third decades of life, which may suggest an underlying hormonal influence, although the exact pathophysiological mechanisms remain unclear. This gender and age-related distribution have been consistently reported across multiple studies (Zhao *et al*., 2022), reinforcing the need to consider patient demographics in clinical suspicion and diagnosis. While the anterior maxilla is the most commonly affected site, likely due to its anatomical and functional exposure to irritants, lesions have also been documented in other areas of the oral cavity, including the posterior maxilla, mandible, and even edentulous ridges, albeit less frequently (Katanec *et al*., 2022; Krishna *et al*., 2022; Deepthi *et al*., 2024).

Clinically, reactive gingival lesions, particularly OFE are typically characterised by slow, progressive growth, a painless nature, and presentation as sessile or pedunculated swellings. Their benign appearance may lead to misdiagnosis or underestimation, especially during the early stages. However, the clinical presentation of OFE often overlaps with other gingival

enlargements such as fibrous epulis, pyogenic granuloma, and even early-stage neoplastic lesions. This underscores the importance of histopathological evaluation in establishing a definitive diagnosis and distinguishing reactive lesions from more serious pathologies.

In some cases, reactive gingival lesions may reach considerable sizes, and several reports in the literature have documented gingival overgrowths that clinically mimic malignant tumours (Sacks, Amrani & Anderson, 2012; Gulati *et al*., 2019; Takagi *et al*., 2024). Such exaggerated growth, particularly when associated with ulceration, rapid progression, or surface irregularities, may raise suspicion of malignancy and prompt further diagnostic work-up. In the present cases, the lesions had been persistent for over a year, demonstrating gradual enlargement and episodic bleeding, especially during tooth brushing. These clinical findings, along with a history of local trauma and absence of systemic symptoms, are consistent with chronic reactive gingival lesions. Despite their non-neoplastic nature, such lesions may pose aesthetic and functional concerns and therefore require timely surgical excision and appropriate follow-up.

OFE is a peripheral lesion confined to the soft tissues, with no involvement of the underlying alveolar bone. Accordingly, radiographic investigations typically reveal no osseous changes. Nevertheless, imaging remains a valuable adjunct to rule out bone involvement, assess the lesion's relationship to adjacent structures, and exclude other intraosseous conditions.

In general, gingival swellings or "lumps and bumps" are among the most commonly encountered lesions in routine dental practice (Brierley *et al*., 2019). They may present as localised or generalised enlargements and can arise from a wide spectrum of aetiologies, including reactive lesions, developmental anomalies, neoplastic growths, and infectious or inflammatory conditions. Accurate diagnosis is essential, not only to establish appropriate treatment but also to exclude malignant or aggressive pathologies that may mimic benign lesions in their early presentation.

A structured clinical approach is critical in differentiating among various gingival lesions. Important parameters include the lesion's duration, growth rate, colour, surface texture, consistency, bleeding tendency, and associated symptoms such as pain or discomfort. In addition, a thorough medical, dental, and social history, along with a focused extra- and intraoral examination, provides critical context for narrowing the differential diagnosis. Clinical differentiation from other gingival overgrowths remains a challenge due to overlapping presentations of these lesions.

Both cases presented in this report involved gingival swellings that were chronic, firm, and asymptomatic over extended periods, eventually prompting intervention due to aesthetic concerns or progressive enlargement. Although the lesions initially resembled fibrous epulis or pyogenic granuloma clinically, the definitive diagnosis of ossifying fibrous epulis (OFE) was established based on the histopathological identification of mineralised components, including bone, cementum-like material, and dystrophic calcifications.

The key to distinguishing OFE from other similar gingival lesions lies in histopathological evaluation, which typically reveals a fibrocellular connective tissue matrix interspersed with mineralised foci and chronic inflammatory infiltrates (Buchner & Hansen, 1987). For instance, fibrous epulis lacks calcification, peripheral giant cell granuloma is characterised by numerous multinucleated giant cells in a vascular stroma, and pyogenic granuloma features prominent capillary proliferation and inflammatory cells. Drug-induced gingival overgrowth, in contrast, is typically generalised, fibrotic, and associated with systemic medications such as phenytoin, cyclosporine, or calcium channel blockers. Table 1 tabulates an overview of differential diagnoses that clinicians should consider when evaluating gingival swellings.

Table 1. Comparative overview of differential diagnoses for a gingival swelling.

Condition	Clinical Features	Histopathological Features
Fibrous Epulis	Firm, painless, sessile swelling on gingiva; normal mucosal colour	Dense fibrous connective tissue with minimal inflammation
Pyogenic Granuloma	Red, lobulated, soft, bleeds easily; often associated with pregnancy or trauma	Granulation tissue with abundant capillaries and inflammatory cells
Ossifying fibrous epulis (OFE)	Firm, pink-red gingival mass; may be ulcerated; often in anterior region	Fibrous stroma with varying amounts of bone, cementum-like material, calcifications
Peripheral Giant Cell Granuloma (PGCG)	Bluish-red gingival lump; may cause "cupping" resorption of alveolar bone	Multinucleated giant cells in cellular fibrovascular stroma with haemorrhage, haemosiderin deposits
Parulis (Gumboil)	Soft, fluctuant swelling near non-vital tooth apex; purulent drainage; often painful	Inflamed granulation tissue with pus and neutrophilic infiltrate
Peripheral Ameloblastoma	Rare; firm, nodular gingival swelling; slow growing	Islands of ameloblastoma proliferation in connective tissue
Kaposi Sarcoma	Reddish-purple gingival nodules; often multifocal; associated with immunosuppression	Spindle cell proliferation with slit-like vascular spaces and extravasated RBCs
Drug-Induced Gingival Hyperplasia	Generalised gingival enlargement; often firm and fibrotic	Dense fibrous connective tissue; minimal inflammation

Microscopically, OFE is characterised by a parakeratinised stratified squamous epithelial surface, a cellular fibrous stroma, and varying degrees of mineralised material, including bone and cementum-like deposits. The surface epithelium may present as ulcerated in some cases, although it remains intact in others. In ulcerated lesions, the underlying connective tissue typically appears highly cellular, whereas lesions with an intact epithelial surface tend to show a more collagenised stroma. Buchner and Hansen (1987) provided a comprehensive description of the histomorphological spectrum of this lesion (referred to as peripheral ossifying fibroma (POF) in their report) which remains relevant to current diagnostic practice. The presence of mineralised components is a key histopathological feature that distinguishes OFE from other non-ossifying fibrous proliferations and supports its classification within the group of reactive ossifying lesions.

Management of OFE typically involves surgical excision with removal of local irritants and regular follow-up to monitor for recurrence. OFE is treated by complete excision down to the periosteum. Surgical care of the gingival tissue should be carefully handled especially to not damaging the interdental papilla for aesthetic postoperatively. Studies report recurrence rates between 8% and 20% (Zhao *et al*., 2022). Patient education and hygiene

reinforcement are critical steps in reducing recurrence of OFE. Evidence suggests that regular supportive periodontal therapy including thorough oral hygiene instruction, scaling, and root surface debridement plays a significant role in reducing the recurrence rate of reactive gingival lesions when compared to patients who do not receive such maintenance care. Poor oral hygiene has been consistently identified as a major contributing factor to lesion recurrence, emphasizing the importance of effective plaque control in long-term management. Individual oral hygiene practices are critical for preserving periodontal health over time, reinforcing the need for continuous patient education and follow-up (Zhao *et al*., 2023; Chien *et al*., 2024).

Conclusion

OFE is a benign, reactive lesion of the gingiva that necessitates accurate diagnosis and management to prevent recurrence. The cases presented in this paper underscores the importance of considering OFE in the differential diagnosis of gingival swellings and highlights the role of histopathological examination in establishing a definitive diagnosis. Complete surgical excision and elimination of local irritants, coupled with diligent oral hygiene practices, are pivotal in ensuring favourable outcomes.

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Conflict of Interest

The authors declare no conflicts of interest related to this publication.

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Ethical Considerations

Consent was obtained from the patient for the publication of clinical data and images included in this report.

References

Agrawal, A. A. (2015). Gingival enlargements: differential diagnosis and review of literature. *World Journal of Clinical Cases*, 3(9), 779.

Brierley, D. J., Crane, H., & Hunter, K. D. (2019). Lumps and bumps of the gingiva: a pathological miscellany. *Head and Neck Pathology*, *13*(1), 103–113. https://doi.org/10.1007/s12105-019-01000-w

Buchner, A., & Hansen, L. S. (1987). The histomorphologic spectrum of peripheral ossifying fibroma. *Oral Surgery, Oral Medicine, Oral Pathology*, 63(4), 452-461.

Chien, H. H., Park, J. V., Kalmar, J. R., & Javaid, S. (2024). Peripheral ossifying fibroma: a case report highlighting clinical features and management strategies. *International Journal of Clinical Case Reports and Reviews*, 16(5).

Deepthi, T. R., Mathew, P. A., Yeshoda, T. G., Khargekar, N., Kappiamkunnath, S., & Adarsh, V. J. (2024). Peripheral ossifying fibroma: a rare case report and review of literature. *Journal of Orofacial and Health Sciences*, 11(2), 86-88.

Efflom, O. A., Adeyemo, W. L., & Soyele, O. O. (2011). Focal reactive lesions of the gingiva: an analysis of 314 cases at a tertiary health institution in Nigeria. *Nigerian Medical Journal*, 52(1).

Gulati, R., Khetarpal, S., Ratre, M. S., & Solanki, M. (2019). Management of massive peripheral ossifying fibroma using diode laser. *Journal of Indian Society of Periodontology*, *23*(2), 177–180. https://doi.org/10.4103/jisp.jisp_431_18

Katanec, T., Budak, L., Brajdić, D., & Gabrić, D. (2022). Atypical peripheral ossifying fibroma of the mandible. *Dentistry Journal*, 10(1), 9. https://doi.org/10.3390/dj10010009

Krishna, V.K, Periasamy, S., Kumar, S.P., Bhat, S.V. (2022). Atypical presentation of peripheral ossifying fibroma in the mandible. *Cureus,* 14(2), e22375. https://doi.org/10.7759/cureus.22375

Maturana-Ramírez, A., Adorno-Farías, D., Reyes-Rojas, M., Farías-Vergara, M., & Aitken-Saavedra, J. (2015). A retrospective analysis of reactive hyperplastic lesions of the oral cavity: study of 1149 cases diagnosed between 2000 and 2011, Chile. *Acta Odontológica Latinoamericana*, 28(2), 103-107.

Sacks, H. G., Amrani, S., & Anderson, K. (2012). "Gigantiform" peripheral ossifying fibroma: report of a case. *Journal of Oral and Maxillofacial Surgery*, 70(11), 2610-2613.

Takagi, R., Mori, K., Koike, T., Tsuyuguchi, S., Kanai, K., Watanabe, Y., *et al.* (2024). A giant peripheral

ossifying fibroma of the maxilla with extreme difficulty in clinical differentiation from malignancy: a case report and review of the literature. *Journal of Medical Case Reports*, *18*(1). https://doi.org/10.1186/s13256-024-04529-9

Zhao, N., Yesibulati, Y., Xiayizhati, P., He, Y. N., Xia, R. H., & Yan, X. Z. (2023). A large-cohort study of 2971 cases of epulis: focusing on risk factors associated with recurrence. *BMC Oral Health*, 23(1), 229. https://doi.org/10.1186/s12903-023-02935-x

CASE REPORT Open Access

Anatomical variation of maxillary first molar with two roots and two canals: a rare case report

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Abstract

This case report describes the endodontic management of a maxillary first molar with an unusual anatomical configuration, consisting of a single buccal root and a single palatal root, each containing one root canal with a Vertucci Type I configuration. Cone-beam computed tomography (CBCT) confirmed the atypical root morphology and facilitated appropriate treatment planning. The case highlights the significance of recognizing anatomical variations and the utility of advanced imaging techniques in complex endodontic cases.

Keywords: *anatomical variation, cone-beam computed tomography, maxillary first molar, two-rooted maxillary molar*

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Introduction

The internal anatomy of the root canal system plays a crucial role in the success of endodontic therapy. A comprehensive understanding of root and canal morphology is essential to ensure thorough debridement, disinfection, and obturation of the root canal system, thereby reducing the risk of persistent infection and treatment failure (Schilder, 1974).

The maxillary first molar is widely regarded as one of the most anatomically complex teeth in the human dentition. It typically presents with three roots, mesiobuccal, distobuccal, and palatal, and often contains four canals, with a second mesiobuccal canal frequently reported (Pecora, 1992). However, considerable anatomical variations have been documented, including fused roots, single-rooted molars, C-shaped canals, and variations in the number and configuration of canals (Christie & Peikoff, 1991; Cleghorn *et al.*, 2006; Martins *et al.*, 2018).

Failure to recognize aberrant root canal morphologies may result in missed canals, inadequate disinfection, and subsequent endodontic failure. Vertucci classified root canal configurations into eight types (Table figure11) (Vertucci, 1984). Clinicians should remain vigilant for such variations and employ advanced imaging modalities when indicated.

Table 1. Vertucci's classification of root canal configurations (Types I–VIII).

Type	Configuration	Description
I	1-1	A single canal extends from the pulp chamber to the apex.
II	2-1	Two canals leave the chamber and merge into one before the apex.
III	1-2-1	One canal leaves the chamber, divides into two, and rejoins before the apex.
IV	2-2	Two separate canals extend from the chamber to the apex.
V	1-2	One canal leaves the chamber and divides into two with separate apical foramina.
VI	2-1-2	Two canals leave the chamber, merge in the root, and redivide before the apex.
VII	1-2-1-2	One canal leaves the chamber, divides, rejoins, and divides again before the apex.
VIII	3-3	Three distinct canals extend from the pulp chamber to the apex.

This case report describes the successful non-surgical root canal treatment of a maxillary first molar presenting with only two roots and two canals, exhibiting Vertucci's Type I configuration. The unusual morphology was confirmed using CBCT, highlighting the importance of 3D imaging in accurately diagnosing complex anatomical variations.

Case report

A 39-year-old female patient presented to the Department of Endodontics, SJM Dental College and Hospital, with the chief complaint of spontaneous pain in her maxillary right first molar, persisting for the past three days. The patient's medical history was non-contributory. Clinical examination revealed sensitivity to thermal stimuli and electric pulp testing, along with tenderness to vertical percussion. The pre-operative periapical radiograph showed caries extending to the pulp with associated periapical periodontal ligament widening (Figure 1).

Based on clinical evaluation and radiographic findings, the diagnosis was established as symptomatic irreversible pulpitis with symptomatic apical periodontitis. After administration of local anesthesia (2% lidocaine with 1:80,000 epinephrine), the tooth was isolated with a rubber dam. Following caries removal, the pulp chamber was irrigated with normal saline. Initial exploration identified a single buccal and palatal canal orifice. The buccal canal orifice appeared relatively large. No additional orifices were identified despite thorough inspection using ×4.5 magnification with prismatic loupes (Zeiss Eyemag Pro S; Carl Zeiss SpA, Arese, Italy) and a dental operating microscope (Labomed Prima DNT; Labomed Inc., USA) (Figure 2).

Figure 1. Pre-operative radiograph.

Figure 2. Access opening on maxillary first molar showing two root canal orifices.

To confirm the canal morphology, CBCT was performed (Carestream Dental, Rochester, NY, USA). CBCT imaging clearly demonstrated the presence of only two roots and two root canals with no evidence of fusion or additional canals (Figures 3A–C).

At the subsequent appointment, working length determination was carried out using an electronic apex locator (Root ZX Mini, J. Morita Corp., Japan), and confirmed radiographically (Figure 4A). Canal preparation was performed using the ProTaper Gold rotary system (Dentsply Sirona, Switzerland), following the manufacturer's protocol. Both canals were prepared up to size F4. A master cone radiograph was taken to verify fit and length (Figure 4B).

Irrigation was carried out with 5.25% sodium hypochlorite (Nice Chemicals Pvt. Ltd., Kochi, India), activated using the EndoActivator (Dentsply Sirona), followed by 17% EDTA (Nice Chemicals Pvt. Ltd.) for one minute per canal. The final rinse was performed with sterile normal saline (Infutec Healthcare Ltd., Indore, Madhya Pradesh, India). Canals were then dried with sterile paper points, and F4 ProTaper Gold Conform Fit gutta-percha cones (Dentsply Sirona) were placed at the working length.

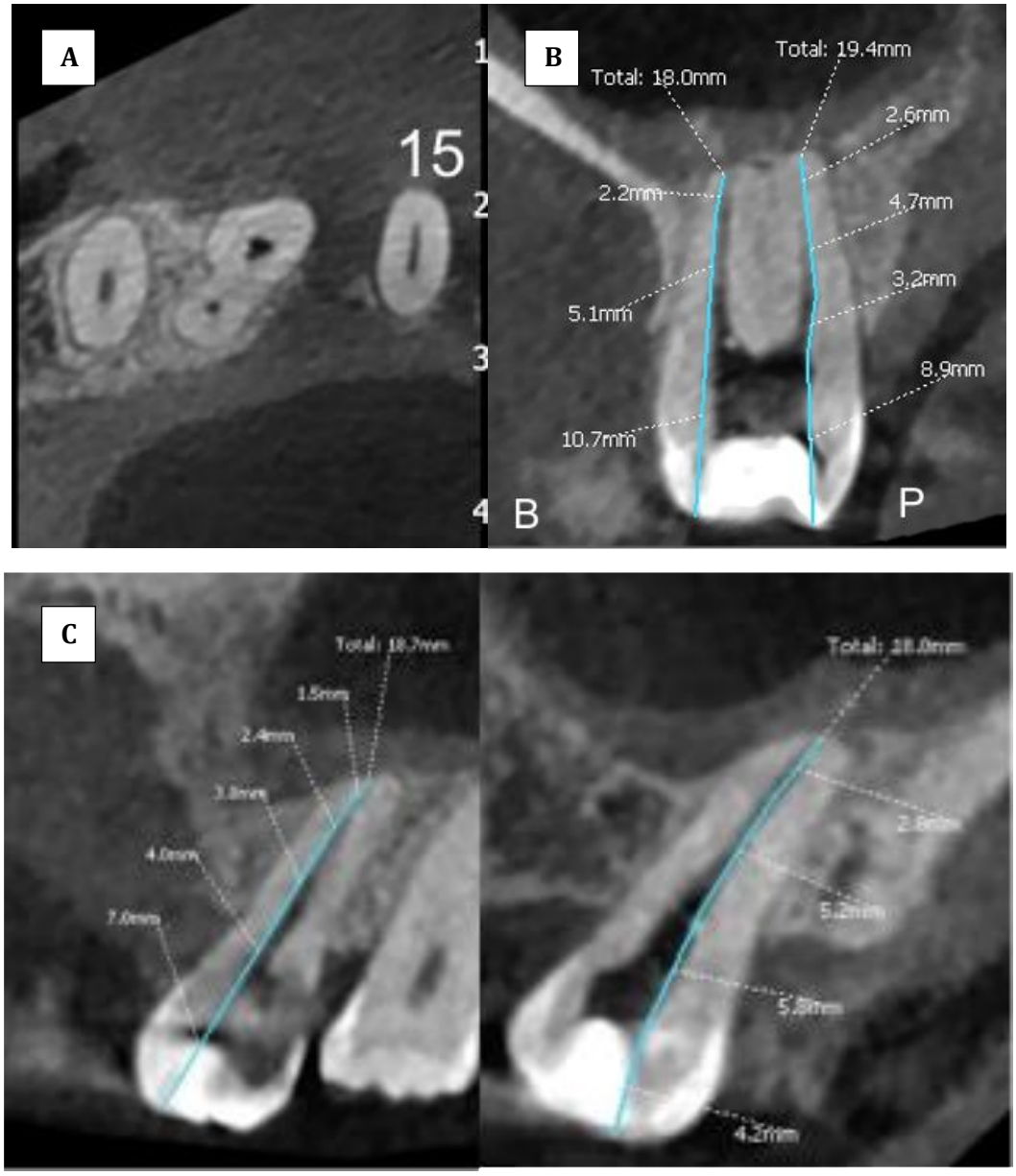

Figure 3. CBCT images showing two distinct buccal and palatal roots and root canals: (A) axial section, (B) coronal section, (C) sagittal section.

Obturation was performed using a resin-based sealer (AH Plus, Dentsply Sirona) and the continuous wave of condensation technique. Down-packing was accomplished using the System B unit (SybronEndo, USA), with a plugger selected to bind 4–5 mm short of the working length. Backfilling was completed using the Obtura II system (Obtura Spartan, USA) (Figure 4C).

The pulp chamber was cleaned with isopropyl alcohol, and the canal orifices were sealed with a flowable composite resin (Supraflow, R&S, France). The access cavity was restored using bulk-fill composite resin (Figure 5).

Due to misalignment of the tooth within the dental arch, full-coverage restoration was planned. The tooth was prepared for a metal crown designed to close the proximal gap and achieve proper occlusal alignment. The crown was cemented using Type I glass ionomer luting cement (Fuji I Glass Ionomer Cement, GC Corporation) (Figure 6).

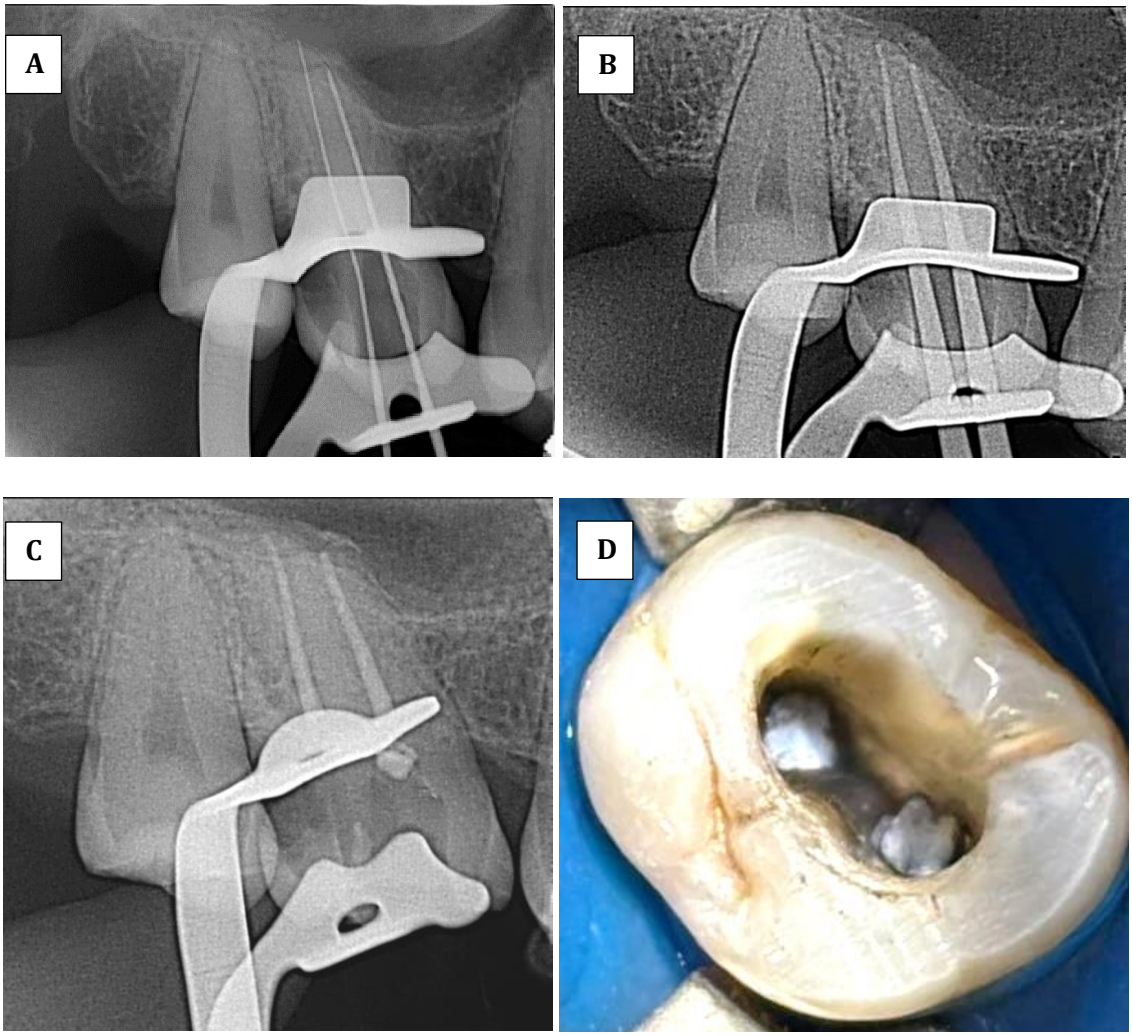

Figure 4. A: Periapical radiograph (PA) image of working length determination, B: PA of master cone verification, C: PA of 3 complete obturation, D: Clinical image of orifices after obturation.

Figure 5. Post-endodontic restoration with composite.

Figure 6. Correction of misalignment with full metal crown.

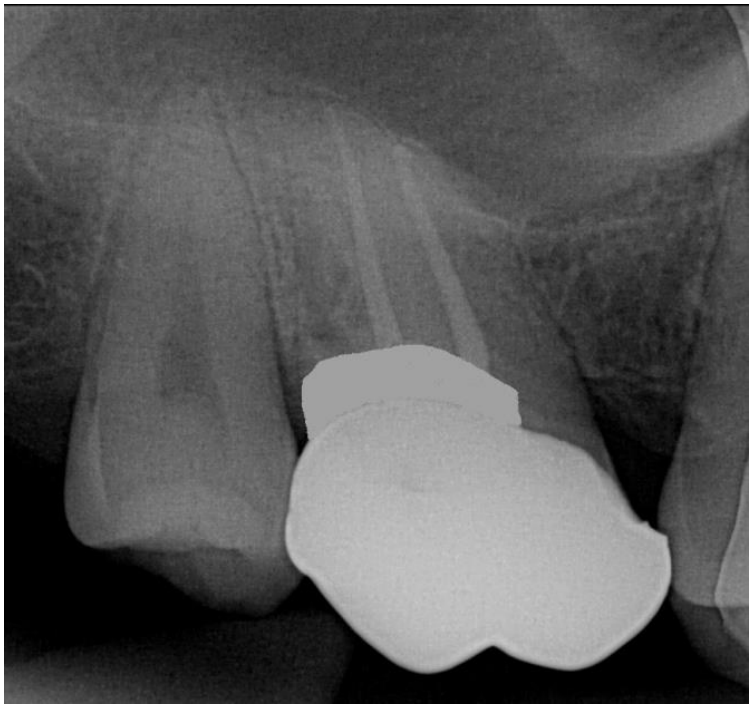

Figure 7. One-year follow-up. The patient reported no symptoms, and clinical and radiographic examination confirmed successful healing.

Discussion

Anatomical knowledge is fundamental to the success of endodontic therapy. The maxillary first molar is one of the most extensively studied teeth due to its frequent anatomical complexity. Typically, it presents with three distinct roots, mesiobuccal, distobuccal, and palatal, with the mesiobuccal root often containing two canals. However, deviations from this typical anatomy, such as root fusion or a reduced number of canals, although rare, can present significant diagnostic and therapeutic challenges (Ounsi & Simao, 2012).

This case presents a rare maxillary first molar variation with two roots, one buccal and one palatal, each containing a single canal. Comparable presentations have been reported: Rahimi & Ghasemi (2013) detailed a similar two-root, two-canal structure in a maxillary first molar, while a later 2018 case

report highlighted the effectiveness of CBCT in accurately identifying such unusual root canal morphologies, reinforcing the necessity of advanced imaging for complex anatomical cases

Recent studies have underscored the value of CBCT in visualizing complex root canal anatomy. Olczak & Pawlicka (2017) reported that all maxillary first molars examined had three roots, with the majority having four canals; only a minority exhibited variations such as an MB2 canal. Similarly, Magalhães *et al*. (2022) identified variations in the canal system, supporting CBCT's superiority over conventional radiographs.

Understanding root canal anatomy and anticipating potential variations are crucial for preventing procedural errors. In this case, confirmation of two roots and two canals facilitated a more conservative and precise access preparation, reducing the risk of iatrogenic damage.

Anatomical variations in the maxillary first molar most commonly involve differences in root number. CBCT studies report that approximately 5% of maxillary first molars have only two roots (Sharma *et al.*, 2022), and a mere 0.4% present with a single root. Cases featuring just one buccal and one palatal root are especially rare.

The development of multiple roots in molars is influenced by the epithelial root sheath, which forms the epithelial diaphragm (Yamamoto *et al*., 2015). Differential growth of this structure divides the root trunk into multiple roots. If this process fails or is altered, it may result in fusion of roots or a reduced number of roots. Fusion of the two buccal roots resulted in a single buccal root housing a single canal, while the palatal root remained separate (Gopikrishna *et al.,* 2008).

Large orifices may appear misleading and resemble a single canal, even when bifurcations or additional canals are present deeper within the root. Despite magnification, only two orifices were confirmed clinically and radiographically. Treatment was carried out with careful attention to cleaning and shaping protocols suited for this unusual morphology.

Root coalescence, especially of the buccal roots, is one of the more commonly reported anatomical aberrations of maxillary molars. Studies report that approximately 0.4% of maxillary first molars and 2.2% of maxillary second molars exhibit this variation (Demirtaş & Duman, 2023). Clinicians must always be prepared for such deviations.

The following Table 2 summarizes previously reported cases of maxillary first molars with two roots and two canals, highlighting the variation in root and canal anatomy across different studies:

Table 2. Reported cases of maxillary first molars with two roots and two canals.

Reference	Country	Gender	Ethnicity	No. of Canals	Features of the Root Canals	Vertucci Canal configuration	Symmetry
Shakouie *et al*. (2013)	Iran	Female	Not specified	2	Fused buccal roots with a single canal and a separate palatal canal	Type I	Not specified
Rahimi & Ghasemi (2013)	Iran	Female	Not specified	2	Two separate roots (buccal and palatal), each with a single canal	Type I	Not specified
Bansal *et al*. (2018)	India	Female	Not specified	2	One buccal and one palatal root, each with a single canal (Vertucci's Type I)	Type I	Yes
Soni *et al. (*2016)	India	Female	Not specified	2	One buccal and one palatal root, each with a single canal	Type I	Not specified
Liu *et al*. (2019)	China	Female	Not specified	2	Fusion between MB and DB canals, and a single palatal canal	Type II	Yes

This table summarizes previously reported cases of maxillary first molars with two roots and two canals, emphasizing the rarity of such anatomical presentations. The current case adds to the limited body of literature, highlighting the importance of thorough diagnostic assessment, including CBCT, in identifying and successfully managing atypical root canal anatomy.

Conclusion

This case highlights the importance of recognizing atypical root canal anatomy in maxillary first molars, specifically the rare presentation of two roots and two canals. Accurate diagnosis, facilitated by CBCT imaging and enhanced visualization through magnification, was critical to the successful outcome. One-year follow-up (Figure 7) confirmed the patient remained asymptomatic with satisfactory clinical and radiographic healing. Awareness of anatomical deviations, combined with meticulous treatment planning, is essential to achieving predictable endodontic results.

References

Bansal, P., Nikhil, V., Malhotra, P., Singh, V. (2018). Maxillary first molar with two roots and two root canals: a rare case report. *Endodontology*, 30, 84–87.

Christie, W.H., Peikoff, M.D., Fogel, H.M. (1991). Maxillary molars with two palatal roots: a retrospective clinical study. *Journal of Endodontics*, 17(2), 80–84. https://doi.org/10.1016/S0099-2399(06)81613-4

Cleghorn, B.M., Christie, W.H., Dong, C.C. (2006). Root and root canal morphology of the human permanent maxillary first molar: a literature review. *Journal of Endodontics*, 32(9), 813–821.

Demirtaş, Ö., Duman, Ş.B. (2023). Root canal anatomy of maxillary first molars in a Turkish population using cone-beam computed tomography. *Journal of Dental Materials & Techniques*, *12*(4), 168-174.

Gopikrishna, V., Venkateshbabu, N., Kandaswamy, D. (2008). Root canal anatomy of maxillary first molars: a review. *Journal of Conservative Dentistry*, 11(3), 73–81.

Liu, J., Que, K.H., Xiao, Z.H., Wen, W. (2019). Endodontic management of the maxillary first molars with two root canals: a case report and review of the literature. *World Journal of Clinical Cases*, 7(1), 79–88.

Magalhães, J., Velozo, C., Albuquerque, D., Soares, C., Oliveira, H., Pontual, M. L., *et al.* (2022). Morphological study of root canals of maxillary molars by cone-beam computed tomography. *Scientific World Journal*, *2022*, 4766305.

Martins, J.N.R., Alkhawas, M.-B.A.M., Altaki, Z., Bellardini, G., Berti, L., *et al.* (2018). Worldwide analyses of maxillary first molar second mesiobuccal prevalence: a multicenter cone-beam computed tomographic study. *Journal of Endodontics*, 44(10), 1641-1649.e1.

Olczak, K., & Pawlicka, H. Z. (2017). The morphology of maxillary first and second molars analyzed by cone-beam computed tomography in a Polish population. *BMC Medical Imaging, 17*(1), Article 68.

Ounsi, H.F., Simao, R.A. (2012). Root canal morphology of the maxillary first molar: a review. *The Saudi Dental Journal*, 24(3), 119–128.

Pecora, J.D., Woelfel, J.B., Sousa Neto, M.D., Issa, E.P. (1992). Morphologic study of the maxillary molars. Brazilian Dental Journal, 3(1), 53–57.

Rahimi, S., Ghasemi, N. (2013). Maxillary first molar with two root canals. *Sultan Qaboos University Medical Journal*, 13(2), 346–349.

Schilder, H. (1974). Cleaning and shaping the root canal. Dental clinics of North America, 18(2), 269–296. https://doi.org/10.1016/S0011-8532(22)00677-2

Shakouie, S., Mokhtari, H., Ghasemi, N., Gholizadeh, S. (2013). Two rooted maxillary first molars with two canals: a case series. *Iranian Endodontic Journal*, 8(1), 29–32.

Sharma, M., Gupta, S., Bhayya, D.P., Upadhyay, K., Pandya, D., Srivastava, A. (2022). CBCT analysis of maxillary first molar in Indian population. *International Journal of Clinical Pediatric Dentistry*, 15(3), 258–262.

Soni, D., Beniwal, A., Jain, R., Swarnkar, P., Meel, R. (2016). Two canals in maxillary first molar: a rare dental entity. *Journal of Evolution of Medical and Dental Sciences*, 5(2), 161-164. https://doi.org/10.14260/jemds/2016/37

Vertucci, F.J. (1984). Root canal anatomy of the human permanent teeth. *Oral Surgery, Oral Medicine, Oral Pathology*, 58(5), 589-599.

Yamamoto, T., Yamada, T., Yamamoto, T., Hasegawa, T., Hongo, H., Oda, K., *et al.* (2015). Hertwig's epithelial root sheath fate during initial cellular cementogenesis in rat molars. *Acta Histochemica et Cytochemica, 48*(3), 95–101.

CASE REPORT Open Access

Furcation management: a viable surgical for apical migration of the gingival margin on mandibular molar

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Abstract

Furcation involvement (FI) poses significant challenges in periodontal management due to anatomical complexities and limited accessibility for cleaning, often resulting in the progression of periodontal diseases if not properly addressed and treated. This case report presented a 50-year-old male patient with gingival recession and FI in the left mandibular molar, tooth 36. A furcation plasty (FP) procedure was performed under local anaesthesia, involving incision and flap reflection, exposure and debridement of the furcation area, and apical repositioning of the flap to facilitate plaque control and reduce disease progression risk. Post-operative healing was satisfactory, with no signs of inflammation observed at the two-week follow-up. Supportive periodontal therapy (SPT) was implemented to maintain long-term satisfactory clinical outcomes. This case highlights the efficacy of FP as a treatment modality for FI, emphasising the significance of meticulous and proper case selection.

Keywords: *apical migration, furcation plasty, gingival recession, molar*

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Introduction

Gingival recession is the apical migration of the gingival margin, leading to the exposure of the root surface, which can cause aesthetic concerns, hypersensitivity, and increased susceptibility to root caries and non-carious cervical lesion. It typically progresses gradually and is most common in individuals over 40 years old. It is commonly associated with factors such as periodontal disease, aggressive tooth brushing, occlusal trauma, and anatomical factors, including a thin gingival biotype and malpositioned teeth (Kassab & Cohen, 2003).

According to the National Health and Morbidity Survey (NHMS) 2020, nine out of ten of the Malaysian population suffer from periodontitis, with 14.5% of them observed with deep pockets (NOHSA, 2020). As it involves multi-rooted and furcation areas, treatment modalities pose additional challenges to the clinicians. This may be due to restricted access to the area and challenging morphology, which reduce the effectiveness of both non-surgical and surgical treatments and hinder the patient's ability to control plaque through self-care (Chiu *et al.*, 1991).

Notably, periodontitis involving the furcation area will increase the risk for tooth loss if the disease progresses and exhibits vertical and/or horizontal patterns of destruction (Dannewitz *et al.*, 2016). Accordingly, non-surgical periodontal therapy (NSPT) can be an option for managing periodontitis with furcation involvement (FI). However, according to Nibali *et al.*, (2016), the risk for FI doubles on molars when maintained under supportive periodontal therapy (SPT) (Nibali *et al.*, 2016). Therefore, furcation plasty (FP) can be considered as an option for furcation-involved molar management (Rasperini *et al.*, 2020).

Case report

A 50-year-old Chinese male patient was referred, complaining of discomfort on the lower left side without any other signs and symptoms. It was only after eating due to food impaction. He claimed to be healthy with no drug allergy. He was a symptomatic dental attendee with no history of smoking and a non-alcoholic person. He brushed his teeth once per day and used a water spray, seldom using the floss.

Intraorally, he had moderate oral hygiene, with calculus observed in the lower lingual anterior and molar areas. He also had generalised bleeding on probing with no deep pocketing detected (Table 1), and the highest Basic Periodontal Examination (BPE) score was 3 with FI. In particular, the tooth involved was tooth 36, which presented with recession, Miller Class I and mobile Grade I. Due to no response to pulp sensibility test and presence of periapical lesion, the tooth was diagnosed with previously initiated therapy with asymptomatic apical periodontitis and underwent root canal treatment and was restored with an all-ceramic crown (Figure 1).

The gingival recession with plaque accumulation involved 4 mm of furcation area on tooth 36. Furcation entrance size < 0.5 mm. Note that the smallest interdental brush is unable to go in. Hence, further furcation management is required to prevent plaque accumulation, which may progress into caries formation (Figure 2). Correspondingly, FP therapy was planned since the furcation is grade I with clinical attachment loss of < 3 mm of the tooth and without aesthetic concern. The patient was informed about the surgical procedures and complications, and consent was obtained.

Table 1. Six point periodontal pocket depth charting of tooth 36.

Six point periodontal pocket depth of tooth 36		
Mesiobuccal	**Midbuccal**	**Distobuccal**
4	5	4
Mesiolingual	**Midlingual**	**Distolingual**
4	4	4

Figure 1. Gingival recession of tooth 36 with furcation involvement.

Figure 2. Assessment of furcation using UNC-15 probe.

Incision and flap reflection (Figure 3A-E)

Local anaesthesia was given on tooth 36 for buccal infiltration and infra-alveolar nerve (IAN) block using mepivacaine hydrochloride acid 44 mg and adrenaline 22 µg. Internal bevel 1.0 mm away from marginal gingiva of tooth 36 was done. Releasing incisions were made using 15c scalpel blade at distal and mesial away from the papilla of tooth 36. A full-thickness mucoperiosteal flap was raised, exposing the furcation entrance (white box). Meanwhile, a partial thickness mucoperiosteal flap raised the alveolar bone level (blue box).

Furcation plasty on buccal of tooth 36

Scaling and root surface debridement (RSD) on the furcation were performed. At the same time, marginal soft tissue and granulation tissue were removed. Moreover, FP was conducted with a flame-shaped bur.

Apical reposition flap

The flap was apically repositioned. A simple interrupted suture was performed with polyamide non-resorbable 5.0 to secure the distal and mesial flaps. Cross-sutured with non-resorbable silk 4.0 was made to adapt the flap.

Post-operative care and maintenance

The patient was provided with post-operative care instructions, including recommendations for pain management, oral hygiene practices, and follow-up visits. The surgical site and healing were reviewed after two weeks. Post-operative healing was uneventful and satisfactory at the two-week review, with no signs of inflammation and good tissue adaptation The patient was maintained on a strict SPT programme to ensure the long-term success of the procedure.

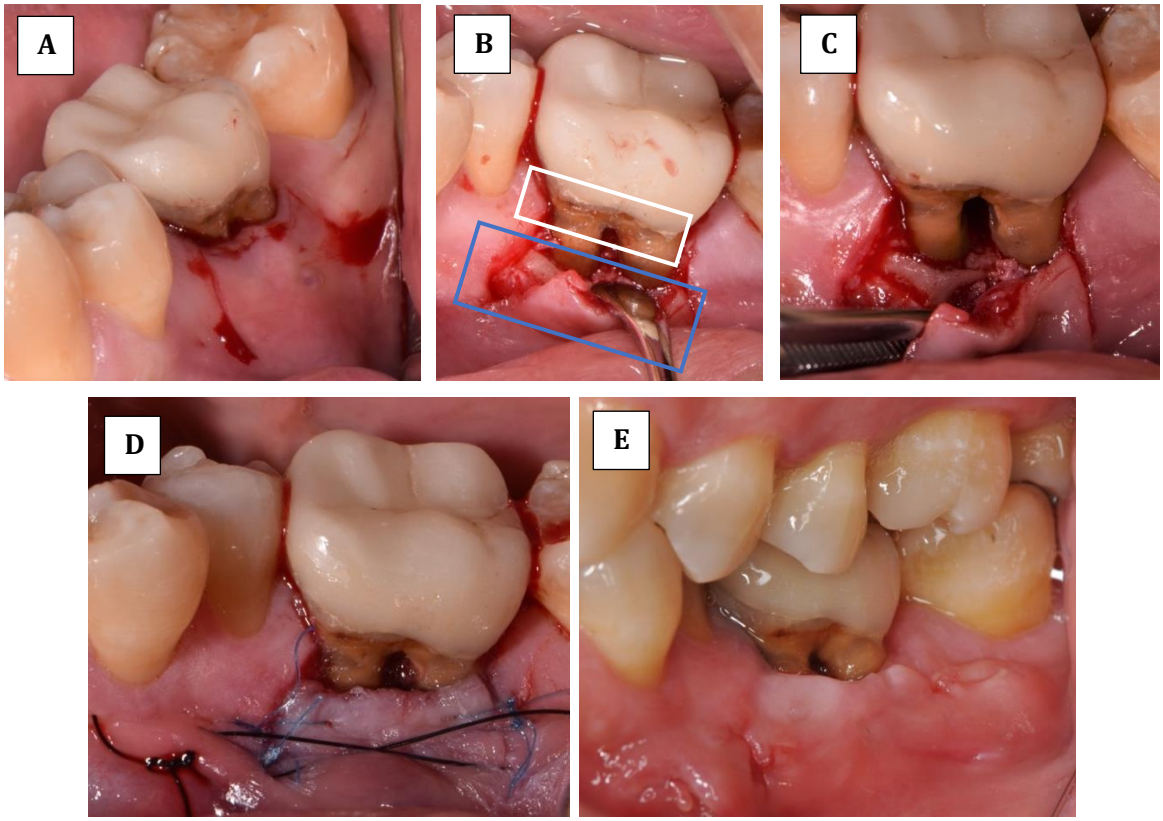

Figure 3. A: Access of tooth 36, B: Flap elevation, C: Debridement and furcation plasty, D: Apically positioned flap, E: Review after 2 weeks

Discussion

Furcation involvement is a condition in which periodontal disease progresses and leads to the loss of attached tissue surrounding the bifurcation and trifurcation area of multirooted teeth. It is mainly induced by the persistence of dental biofilm that may elicit a host inflammatory response.

The primary objective of this treatment was to enhance the patient's ability to maintain oral hygiene in a region affected by FI through FP. This aligns with Tonetti *et al.* (2017)'s vertical and horizontal subclassification system for furcation defects, which enables tailored decision-making in overseeing complex periodontal lesions (Reddy *et al.*, 2015; Tonetti *et al.*, 2022).

In the presented case, tooth 36 was presented with Miller Class I gingival recession with Grade I FI and minimal clinical attachment loss. Despite the Grade I classification, non-surgical management was deemed insufficient due to two key factors: 1) The extremely narrow furcation entrance (<0.5 mm) physically precluded access even for the smallest interdental aids (e.g., 0.4 mm brushes), rendering effective patient-performed plaque control impossible. 2) The associated gingival recession created a niche for plaque accumulation, presenting a significant risk for caries progression in the furcation area, which is notoriously difficult to restore." This clinical rationale follows the decision-making tree proposed by Reddy *et al.* (2015) from the AAP Regeneration Workshop, which recommends surgical access and defect modification (e.g., odontoplasty or osteoplasty) in early to moderate FI to create a maintainable architecture, especially when regenerative approaches are not feasible.

While NSPT remains essential in initial FI management, studies have demonstrated that molars with FI are at a significantly greater risk of tooth loss even under SPT.

Nibali *et al.* (2016) concluded that molars with FI had nearly double the risk of tooth loss compared to those without, highlighting the limitations of conservative approaches alone.

The use of FP, in this case, was deemed crucial as it enhances plaque control by removing soft tissue overhangs and recontouring the furcation area, thus improving access to professional debridement and patient self-care. Similarly, Bowers *et al.* (2003) emphasised that anatomical defects in molars, especially FI, negatively impact long-term tooth survival due to compromised oral hygiene access and plaque stagnation.

In cases where regeneration or tunnelling is contraindicated due to soft or hard tissue limitations, FP presents a viable alternative. In this case, this modality was guided by clinical findings, including the narrow entrance of the furcation (< 0.5 mm), mild vertical bone loss, and absence of aesthetic demands (Trombelli *et al.*, 2017). Moreover, careful case selection is critical for predicting treatment success based on gingival phenotype, amount of keratinised gingiva, root morphology, and patient motivation.

The long-term prognosis of teeth with FI undergoing surgical therapy is generally favourable if SPT is meticulously maintained. Tonetti *et al.* (2017) demonstrated that molars with Class II FI could be successfully preserved over time with adequate SPT and patient adherence. However, longitudinal studies are required to investigate long-term complications such as root sensitivity, re-infection, and cost-effectiveness of tooth retention versus implant replacement (Tonetti *et al.*, 2017).

Schwendicke *et al.* (2014) performed a cost-effectiveness analysis comparing molar retention strategies versus implants (Schwendicke *et al.*, 2014). The analysis demonstrated that when clinical outcomes were favourable, the preservation of molars via periodontal maintenance offered superior cost-effectiveness over time compared to replacement with dental implants (Schwendicke *et al.*, 2014). This underscores the therapeutic and economic justification for employing conservative surgical modalities such as FP in appropriately selected cases where anatomical and patient-related factors support long-term tooth retention.

A limitation of this case report is the short-term follow-up period. While initial healing was successful, the long-term efficacy of FP in preserving the tooth and facilitating hygiene can only be validated through sustained Supportive Periodontal Therapy (SPT) and monitoring over several years. Future follow-ups will assess parameters such as probing depth, attachment level, and patient-reported ease of cleaning.

Conclusion

In conclusion, FP serves to recontour anatomical defects and functions as a preventive strategy against progressive periodontitis and eventual tooth loss. It underscores the critical interplay between periodontal diagnosis, surgical planning, and patient compliance in sustaining long-term oral health outcomes. Nevertheless, a case must be carefully selected to ensure a better prognosis and prolonged tooth survival.

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References

Bowers, G. M., Schallhorn, R. G., McClain, P. K., Morrison, G. M., Morgan, R., & Reynolds, M. A. (2003). Factors influencing the outcome of regenerative therapy in mandibular Class II furcations: part I. *Journal of Periodontology*, 74(9), 1255-1268.

Chiu, B. M., Zee, K. Y., Corbet, E. F., & Holmgren, C. J. (1991). Periodontal implications of furcation entrance dimensions in Chinese first permanent molars. *Journal of Periodontology*, 62(5), 308-311.

Dannewitz, B., Zeidler, A., Hüsing, J., Saure, D., Pfefferle, T., Eickholz, P., *et al.* (2016). Loss of molars in periodontally treated patients: results 10 years and more after active periodontal therapy. *Journal of Clinical Periodontology*, 43(1), 53-62.

Kassab, M. M., & Cohen, R. E. (2003). The etiology and prevalence of gingival recession. *Journal of the American Dental Association*, 134(2), 220-225.

Nibali, L., Zavattini, A., Nagata, K., Di Iorio, A., Lin, G. H., Needleman, I., *et al.* (2016). Tooth loss in molars with and without furcation involvement- a systematic review and meta-analysis. *Journal of Clinical Periodontology*, 43, 156-166.

Oral Health Programme (2023) Fact Sheet National Health and Morbidity Survey (NHMS) 2020: National Oral Health Survey of Adults (NOHSA) 2020.

Rasperini, G., Majzoub, J., Tavelli, L., Limiroli, E., Katayama, A., Barootchi, S., *et al.* (2020). Management of furcation-involved molars: recommendation for treatment and regeneration. *International Journal of Periodontics & Restorative Dentistry*, 40(4), e137-e146.

Reddy, M. S., Aichelmann-Reidy, M. E., Avila-Ortiz, G., Klokkevold, P. R., Murphy, K. G., Rosen, P. S., *et al*. (2015). Periodontal regeneration-Furcation defects: a consensus report from the AAP Regeneration Workshop. *Journal of Periodontology*, 86(Suppl 2), s131-133.

Schwendicke, F., Graetz, C., Stolpe, M., Dorfer, C.E. (2014). Retaining or replacing molars with furcation involvement: a cost-effectiveness comparison of different strategies. *Journal of Clinical Periodontology*, 41, 1090-1097.

Tonetti, M.S., Christiansen, A.L., Cortellini, P. (2017). Vertical subclassification predicts survival of molars with class II furcation involvement during supportive periodontal care. *Journal of Clinical Periodontology*, 44, 1140-1144.

Tonetti, M. S., Cortellini, P., Graziani, F., Cairo, F., Lang, N. P., Abundo, R., *et al.* (2022). Management of stage I–III periodontitis—The EFP S3 level clinical practice guideline. *Journal of Clinical Periodontology, 49*(Suppl 24), 4–71.

Trombelli, L., Simonelli, A., Minenna, L., Rasperini, G., Farina, R. (2017). Effect of a connective tissue graft in combination with a single flap approach in the regenerative treatment of intraosseous defects. *Journal of Periodontology*, 88, 348-356.

CASE REPORT Open Access

Atypical features of mixed epithelial and stromal tumour of kidney: a case report with histopathology correlation

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Abstract

Adult cystic nephroma and mixed epithelial stromal tumours (MEST) are classified under the mixed epithelial and stromal tumour (MEST) family, which is a part of the 2016 World Health Organisation (WHO) renal tumour classification. They are rare, benign tumours which have similar imaging appearance as certain types of renal carcinoma. Hence, it is often regarded as malignant pre-operatively and histopathologically confirmed to be benign. We present a case of a 66-year-old lady who complains of gradual abdominal distension for 9 months, associated with loss of appetite, loss of weight and early satiety. Other than clinical findings that point towards ascites, the rest of her physical examination was unremarkable. Blood investigations including tumour markers were normal. Abdominal ultrasound and computed tomography (CT) showed a huge unilocular intra-abdominal cystic mass with enhancing solid component attached to the right kidney which was exerting significant mass effect to the surrounding structures. The patient developed impending abdominal compartment syndrome and underwent right nephrectomy with tumour excision. The final histopathological diagnosis revealed mixed epithelial and stromal tumour (MEST). The patient recovered well. Mixed epithelial stromal tumour (MEST) is a rare clinical entity. Ultrasound and CT imaging are the usual investigating modalities. Histopathological correlation is needed to reach the diagnosis. This case has an unusual and different radiological imaging appearance when compared to past literature and contributes an additional case to our collective knowledge of these lesions.

Keywords: *cystic nephroma, mixed epithelial stromal tumour, renal carcinoma*

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Introduction

Adult cystic nephroma and mixed epithelial and stromal tumours (MEST) are classified under the mixed epithelial and stromal tumour (MEST) family, as defined in the 2016 World Health Organization (WHO) classification of renal tumours. These lesions are rare, predominantly benign neoplasms that are often indistinguishable from certain types of renal carcinoma on diagnostic

imaging. They typically present as multilocular cystic renal masses with multiple septations on computed tomography (CT). Owing to their overlapping radiological features with malignant renal tumours, MEST is frequently regarded as malignant pre-operatively, resulting in radical surgical management, with the benign nature of the lesion only confirmed on post-operative histopathology. As such, MEST holds important clinical relevance, as misdiagnosis may lead to unnecessary radical or partial nephrectomy. Radical or partial nephrectomy remains the mainstay of treatment, with definitive diagnosis established through histopathology and immunohistochemistry. The present case is significant due to its highly atypical imaging appearance, which does not conform to the usual description in existing literature. To date, only a limited number of cases of unilocular giant MEST presenting with impending abdominal compartment syndrome have been reported worldwide, making this an exceptionally rare presentation.

Case reports

A 66-year-old lady with no underlying comorbidity presented with a 9-month duration of gradual abdominal distension associated with loss of appetite, loss of weight and early satiety. No bleeding per vagina or abnormal discharge. No fever or abdominal pain. Bowel output and urination were regular. She is Para 7 and has attained menopause 20 years ago. Her last childbirth was 27 years ago. No history of surgical intervention or family history of malignancy. Other than generalized abdominal distension up to the xiphisternum with positive fluid thrill, her physical examination was unremarkable. Her infective markers, renal function, and tumour markers (AFP, CEA, CA 19-9, CA 125, CA 15.3, Beta-HCG) were normal.

Bedside abdominal ultrasound (Figure 1) showed a large cystic mass occupying almost the whole abdomen with presence of solid component at the superior aspect of the mass (near to the right hypochondrium).

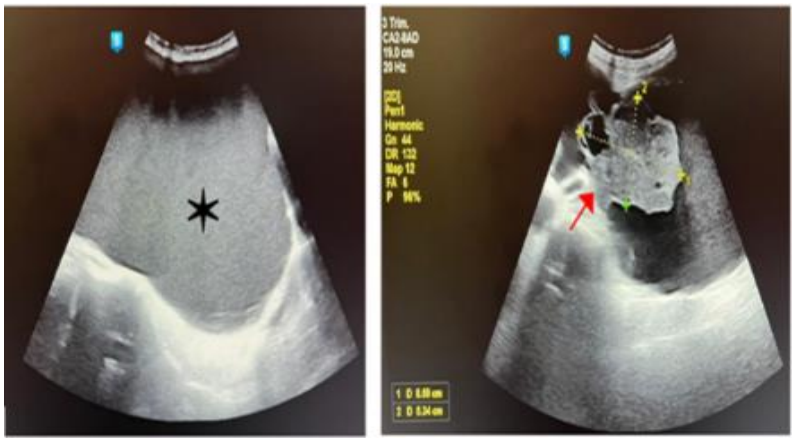

Figure 1. Ultrasound images showing large cystic mass with echogenic material within (*), and a hyperechoic solid component (red arrow) within the mass.

Initial CT scan showed a huge uniloculated cystic mass extending from the mid abdomen until the pelvic region, which measures approximately 18.0 x 25.1 x 33.3 cm. No intralesional calcification. An irregular enhancing solid component is seen at the superior part of the mass, which is attached to the mid-pole of right kidney (Figure 2). The mass displaces the right kidney superior-medially, and displaces the inferior vena cava (IVC), right adrenal, pancreas and bowel loops to the left side of the abdomen. There is a clear plane of demarcation between the mass and these structures. No enlarged intraabdominal lymph node. The IVC is patent and normal in calibre. A clinical impression of cystic renal tumour was made.

A repeated CT abdomen one month later showed that the cystic mass has increased in size, exerting more mass effect and displacing its surrounding structures (Figure 2). The ratio of maximal anteroposterior to transverse abdominal diameter is borderline measuring 0.83 (normal <0.8). Hence, impending abdominal compartment syndrome was suspected based on imaging and clinical deterioration.

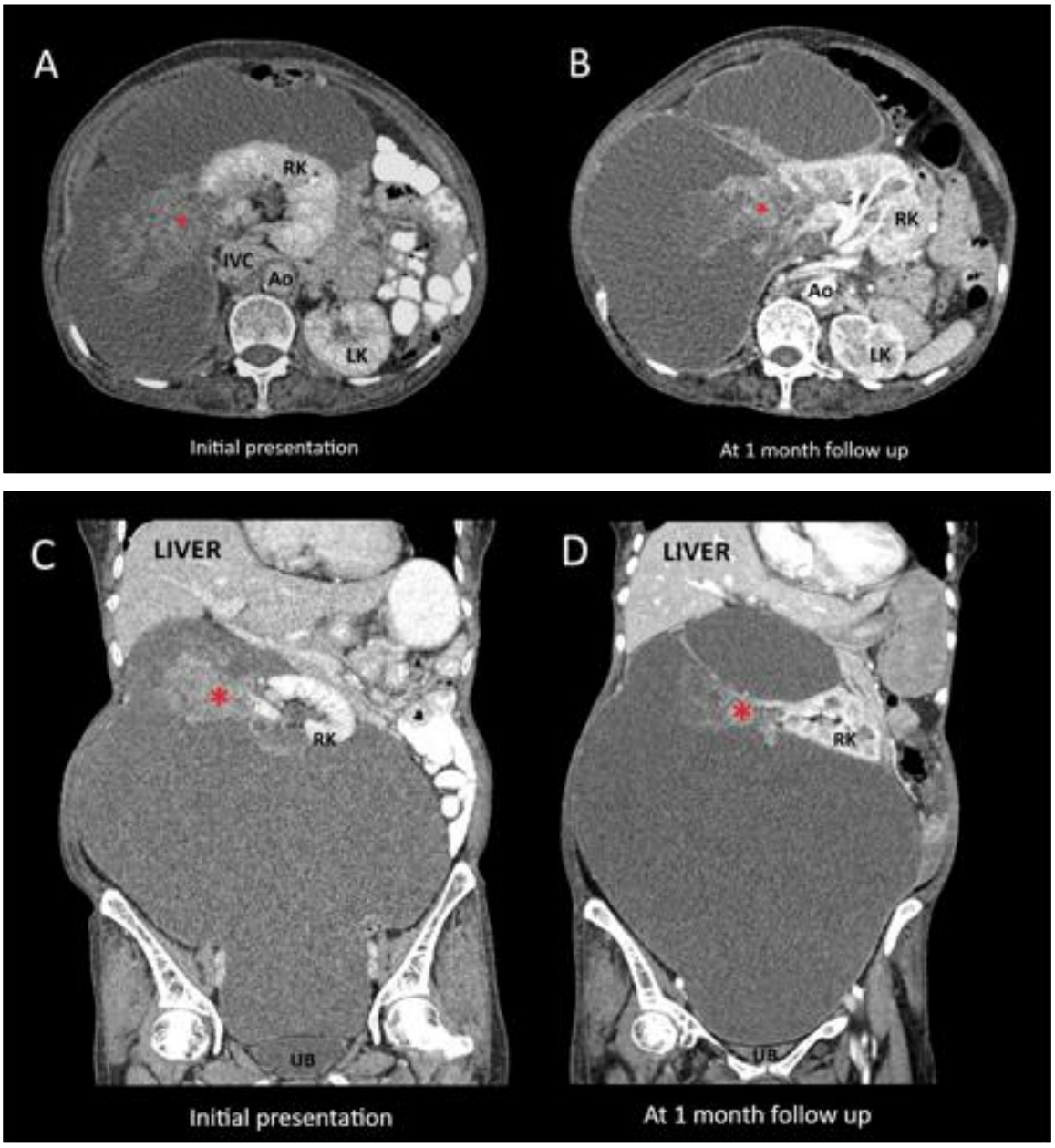

Figure 2. Contrast-enhanced CT Abdomen images demonstrating a large cystic mass occupying the entire abdominal cavity with progressive increase in tumour size and mass effect related to the cystic component at one month follow up. Axial image (A) and coronal image (C) at initial presentation showed a large cystic mass occupying the entire abdominal cavity and displacing the right kidney as well as the other solid organs. Solid enhancing component is seen attached to the mid-pole of the right kidney (red asterisk). Axial image (B) and coronal image (D) at 1 month follow-up illustrating further interval enlargement of the cystic component with increasing mass effect and displacement onto the surrounding structures. Abbreviations: RK - right kidney; LK - left kidney; IVC - inferior vena cava; Ao – aorta; UB – urinary bladder.

A semi-urgent operation for right nephrectomy and tumour excision was planned. Upon entering the abdominal cavity, a huge cystic mass was seen arising from the retroperitoneal region and is continuous with the right kidney. The right ovary, right fallopian tube and right suprarenal gland were adherent to the cystic mass and these organs were removed along with the mass. The patient recovered well post-surgery.

Gross pathology showed a large cystic mass measuring 28 x 23 x 11 cm. The cyst contains haemorrhagic fluid with blood clots. It is uniloculated and the wall thickness ranges between 1-5mm. The kidney is identified on the wall of the cyst. A haemorrhagic solid nodule measuring 7 x 6 x 5 cm was seen at the mid pole with vesicle-like lesion.

Microscopically, it has a fibrous cyst wall, devoid of epithelial lining and replaced by necrotic material, foamy macrophages and haemosiderin-laden macrophages (Figure 3). The cyst wall is infiltrated by dense mixed inflammatory infiltrates, mostly consisting of lymphocytes, plasma cells and histiocytes. There is also granulation tissue with prominent reactive fibroblasts. The vesicle-like lesions are composed of epithelial and stromal components. The epithelial component exhibits flattened to cuboidal cells; some forming glandular structures. The stromal component exhibits variable cellularity and is composed of spindle to epithelioid cells reminiscing ovarian and endometrial stroma. Sections of the mid-pole haemorrhagic nodule also display varying epithelial and stromal elements. No cellular atypia or abnormal mitotic figures seen.

Immunohistochemical studies showed the epithelial cells are positive for CKAE1/AE3, EMA and PAX8 (Figure 3). The stromal cells exhibit CD10, ER, PR, WT1, SMA, and vimentin positivity. Final histopathological interpretation is mixed epithelial and stroma tumour of the kidney (MEST).

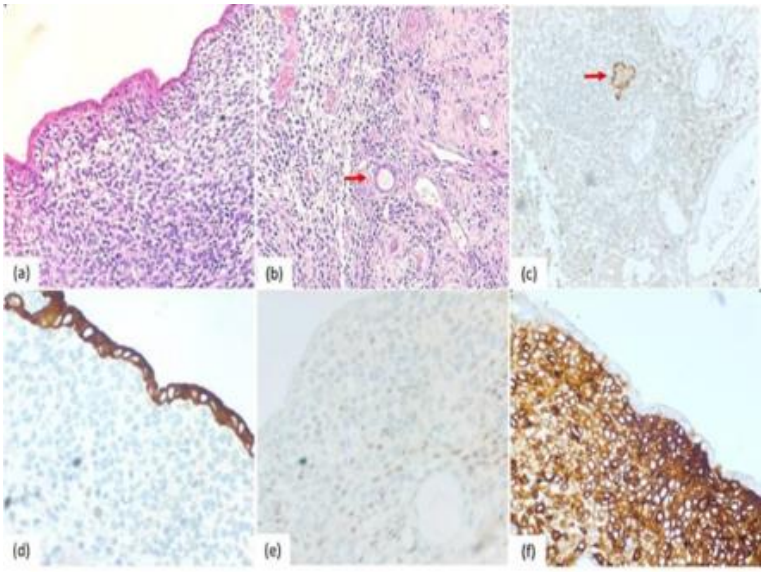

Figure 3. Morphological and immunohistochemical features of mixed epithelial and stromal tumour (MEST). All images were obtained from whole-slide digital scans (original magnification 200×). (a) The cyst is lined by simple flattened to cuboidal epithelial cell with bland nuclei and eosinophilic cytoplasm. The stroma consists of fibrous tissue resembling ovarian stroma (H&E, 200×). (b) Scattered small cysts (red arrows) are seen in the solid areas (H&E, 200×). (c–f) Immunohistochemical analysis using the immunoperoxidase method with DAB chromogen visualisation. (c) The epithelial cells exhibit strong nuclear positivity for PAX8 (red arrow) and (d) diffuse cytoplasmic positivity for CKAE1/AE3 (200×). (e) The stromal cells are positive for ER and (f) CD10 (200×).

Discussion

Mixed epithelial stromal tumours (MEST) were previously radiologically categorised into two patterns: cystic renal masses with septa and nodular components (type A) and solid masses with cystic areas (type B) (Wang *et al.*, 2013). This historical distinction has largely been superseded by the World Health Organization (WHO) classification of kidney tumours 2016, which recognises these entities as part of a single MEST family with a morphological spectrum ranging from the predominantly cystic adult cystic nephroma (ACN) to more solid tumours classified as MEST. They account for 0.2% of all renal tumours as well as distinctive neoplasms with biphasic epithelial and stromal component (DeFanti & Nodit, 2013; Karasavvidou *et al.*, 2022). Despite their benign biological behaviour, these tumours pose a significant diagnostic challenge due to their close radiological resemblance to malignant renal neoplasms, often resulting in aggressive surgical management.

The largest known tumour in the MEST spectrum reported by Sawant *et al.* (2017) measured 31 × 19 × 19.6 cm and demonstrated a multilocular architecture. In contrast, the tumour in our patient measured 28 × 23 × 11 cm and represents, to our knowledge, it is the largest reported unilocular MEST. This architectural distinction is clinically relevant, as unilocular morphology is exceedingly rare within the MEST spectrum and further complicates pre-operative radiological characterisation. Furthermore, our case is unique in that the tumour progressed rapidly and resulted in impending abdominal compartment syndrome, a complication that has only rarely been described in association with renal tumours and has not been well documented in MEST within existing literature. To our knowledge, there has been no previously published case of a giant, predominantly cystic, unilocular MEST causing impending abdominal compartment syndrome identified in international literature to date in PubMed and Google Scholar.

There is a marked female predominance with a reported ratio of approximately 10:1 (Sharma *et al.*, 2017), and patients are typically peri-menopausal women (Tsakiris *et al.*, 2024). Hormonal influences have been implicated, including associations with gonadotropin-releasing hormone agonists and oestrogen therapy (Verma *et al.*, 2024). Our patient's demographic profile aligns with these observations. While many patients are asymptomatic, with tumours detected incidentally, symptomatic cases may present with flank pain, haematuria, or a palpable abdominal mass (Tatsuya *et al.*, 2021).

Both ACN and MEST are typically solitary, unilateral, well circumscribed, and unencapsulated, with reported sizes ranging from 2 cm to 24 cm (Picken *et al.*, 2018). Classical descriptions of MEST on contrast-enhanced computed tomography (CECT) include multiloculated, multiseptated cystic masses with delayed enhancement of septa or solid components (Sharma *et al.*, 2017). ACNs typically present as multiloculated cystic lesions with thin septations and without a significant solid component. Septal enhancement may be present. Haemorrhage, calcification and fat may be seen in both, but these features are not consistently observed. In our case, CECT demonstrated a large, unilocular, almost entirely cystic renal mass with minimal solid enhancing component. The lesion was devoid of septations. It deviates markedly from the expected radiological appearance of both adult cystic nephroma and MEST. Table 1 compares the classical radiological features of ACN and MEST reported in the literature with those of the present case, while Figure 4 depicts the corresponding imaging differences.

Table 1. Radiological comparison between classical MEST, Adult Cystic Nephroma (ACN), and the present case.

Feature	Classical MEST	Classical ACN	Present Case
Typical Morphology	Predominantly solid mass with multiple cystic components	Predominantly cystic, multiloculated mass	Predominantly cystic, unilocular mass
Loculation	Multiloculated	Multiloculated	Unilocular
Septations	Common, often thick	Common, thin fibrous septa	Absent
Solid Component	Common, variable size	Minimal or absent	Small focal solid component
Contrast-Enhanced CT Appearance	Delayed enhancement of solid components and septa	Septal enhancement may be present	Enhancing solid component without septations
Bosniak Classification	Usually Bosniak III–IV	Usually Bosniak III	Bosniak IV–like appearance due to solid enhancement
Calcification	Rare	Rare	Absent
Growth Behaviour	Slow-growing	Slow-growing	Rapid interval growth
Mass Effect	Usually limited	Usually limited	Severe mass effect with impending abdominal compartment syndrome
Typical Pre-Operative Diagnosis	Renal cell carcinoma	Multilocular cystic renal neoplasm	Cystic renal malignancy

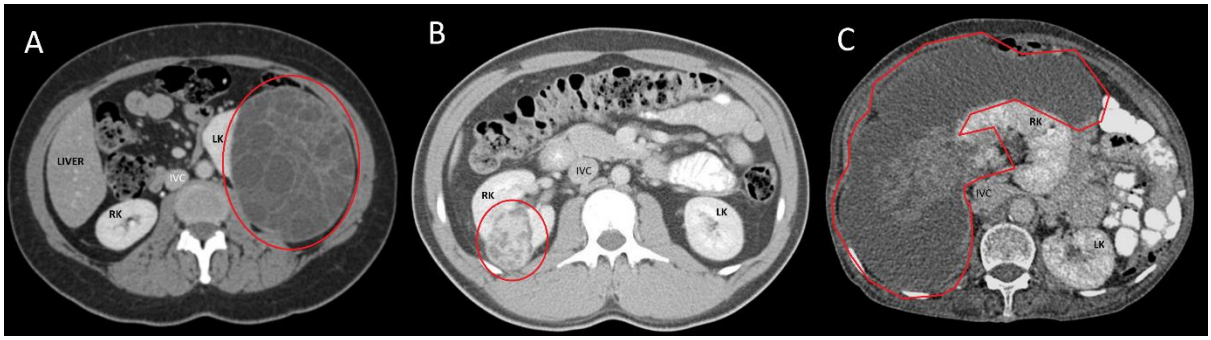

Figure 4. Contrast-enhanced axial CT images illustrating the radiological spectrum of cystic renal lesions: (A) Adult cystic nephroma (ACN) demonstrating a well-circumscribed multiloculated cystic mass with thin enhancing septations and no solid enhancing component (red outline). *Adapted from* Kakish (2026). **(B)** Mixed epithelial and stromal tumour (MEST) showing a complex right renal mass with both cystic and enhancing solid components (red outline). *Adapted from* Sheldon (2026). **(C)** Imaging from the present case demonstrating a unilocular cyst with a minimal enhancing solid component and no internal septations (circled outline). Abbreviations: RK - right kidney; LK - left kidney; IVC - inferior vena cava.

Radiologically, MESTs are almost always indistinguishable from malignant cystic renal tumours (Tsakiris *et al.*, 2024), and many reported cases carry a pre-operative diagnosis of renal cell carcinoma, with the benign nature of the lesion only established after surgical excision (Stamatiou *et al.*, 2008). This diagnostic dilemma was particularly pronounced in our patient as the extreme size due to rapid tumour growth, unilocular configuration, and aggressive mass effect culminating in impending abdominal compartment syndrome clearly distinguish this case from the majority of previously reported MESTs. Percutaneous biopsy was not feasible because of bleeding risk and concern for tumour seeding. As such, radical nephrectomy served as both a diagnostic and therapeutic intervention in this case.

Gross pathological examination of MEST typically reveals mixed solid and cystic components, with cysts commonly containing clear serous fluid (Michal *et al.*, 2004; Turbiner *et al.*, 2007). In our case, the cyst contained haemorrhagic fluid with blood clots and areas of necrosis, features that are atypical and infrequently reported in benign MEST. Haemorrhagic MESTs have only rarely been mentioned in the literature, including reports by Sukov *et al.* (2007), Wang *et al.* (2015) and Varghese *et al.* (2023) reinforcing the unusual nature of this presentation**.** These pathological features likely contributed to the aggressive radiological appearance and heightened clinical suspicion for malignancy.

Microscopically, ACN and MEST have some overlapping histological features. MEST has a solid-cystic architecture which is made up of stromal and epithelial components (Verma *et al.*, 2024). The stromal component can be paucicellular to hypercellular and have a wide spectrum of morphology (Adsay *et al.*, 2000; Antic *et al.*, 2006; Caliò *et al.*, 2016; Michal *et al.*, 2004; Turbiner *et al.*, 2007). It can be fibrous and oedematous, dense and collagenous, have slender to plump spindle cells, have focal areas of smooth muscle differentiation or have ovarian type stroma with luteinisation. Sometimes, adipose tissue can be present. The epithelial component of MEST has clustered or scattered cysts and glands of varying sizes and architecture. The cells lining the cysts and glands have a broad spectrum of morphology such as flat, cuboidal, columnar, hobnail, urothelial like, clear cell and ciliated. Its cytoplasm can be eosinophilic, amphophilic or vacuolated. Occasionally, the small cysts contain eosinophilic material reminiscent of thyroid follicles. Cellular atypia, calcification, mitotic figures, necrosis, and haemorrhage are rare

(DeFanti & Nodit, 2013; Tatsuya *et al.*, 2021; Verma *et al.*, 2024; Wang *et al.*, 2013). ACN histologically consists of multilocular cysts lined by flat to cuboidal epithelium and separated by fibrous septae. Mature tubules may also be seen in the fibrous septa (Picken *et al.*, 2018; Sharma *et al.*, 2017; Tatsuya *et al.*, 2021; Verma *et al.*, 2024). According to Turbiner *et al.* (2007), the diagnosis of ACN was defined as a tumour composed of large cysts, microcysts and tubules with stroma consisting of variable spindle cells as well as dividing septa less than 5 mm in size. If any lesion within the MEST family spectrum does not fulfil these criteria, it is classified as MEST.

On immunohistochemistry studies, the epithelium stains strongly for renal lineage markers PAX8, cytokeratins AE1/AE3 and for CK7 (Karasavvidou *et al.*, 2022). The stromal component express positive CD10, ER, PR, SMA and WT1 (DeFanti & Nodit, 2013; Demir *et al.*, 2022; Karasavvidou *et al.*, 2022; Sharma *et al.*, 2017; Tinguria & Chorneyko, 2023; Wang *et al.*, 2013). Table 2 compares the histopathological and immunohistochemical features of classical MEST and ACN reported in the literature with those observed in this case.

Table 2. Histopathological comparison between classical MEST, Adult Cystic Nephroma (ACN), and the present case.

Feature	Classical MEST	Classical ACN	Present Case
Overall Architecture	Mixed solid–cystic	Predominantly cystic	Predominantly cystic with focal solid nodule
Cyst Configuration	Multiple cysts of varying size	Multiloculated cysts	Single large unilocular cyst
Epithelial Lining	Variable (flat, cuboidal, hobnail, glandular)	Flat to cuboidal epithelium	Flattened to cuboidal epithelium
Stromal Component	Prominent, often ovarian-type	Fibrous septa with mature tubules and minimal stroma containing spindle cells	Prominent stromal component resembling ovarian/endometrial stroma
Septa	Present	Present (<5 mm thick)	Absent
Haemorrhage	Rare	Rare	Present (haemorrhagic fluid and blood clots)
Necrosis	Rare	Rare	Present
Cellular Atypia	Absent	Absent	Absent
Mitotic Activity	Absent or rare	Absent	Absent
Immunohistochemistry – Epithelium	PAX8+, CK AE1/AE3+, EMA+	PAX8+, CK+	PAX8+, CK AE1/AE3+, EMA+
Immunohistochemistry – Stroma	CD10+, ER+, PR+, SMA+, WT1+	Usually ER/PR negative or weak	CD10+, ER+, PR+, SMA+, WT1+
Final Diagnosis	MEST	ACN	MEST (despite ACN-like architecture)

In short, adult cystic nephroma and MEST share overlapping microscopic features, with MEST demonstrating a solid–cystic architecture composed of epithelial and stromal components (Verma *et al.*, 2024). Although necrosis and haemorrhage are considered rare histological findings in MEST, both were present in this case, further underscoring its atypical nature. Immunohistochemical staining confirmed the diagnosis, with epithelial markers positive for PAX8 and cytokeratins, and stromal components expressing CD10, ER, PR, SMA, and WT1, consistent with previously reported profiles (DeFanti & Nodit, 2013; Karasavvidou *et al.*, 2022).

The differential diagnosis for a large cystic renal mass is broad and includes malignant cystic renal cell carcinoma, cystic nephroblastoma, angiomyolipoma with cysts, and other rare entities (Joshi & Beckwith, 1989; Sun *et al.*, 2014).

Furthermore, the unusual constellation of features observed raises the question of whether further refinement or sub-classification within the MEST spectrum may eventually be warranted, a hypothesis that would require validation through larger case series or registry-based studies rather than isolated case reports. At present, neither advanced imaging modalities nor urinary biomarkers permit a confident pre-operative diagnosis of MEST. These tools may provide supportive information but lack sufficient specificity to distinguish MEST from other complex cystic renal lesions. Histopathological examination continues to represent the diagnostic gold standard. Pre-operative biopsy may be considered in selected cases with appropriate precautions, though bleeding risk and tumour seeding remain concerns.

Although MEST lesions are almost always benign, rare cases of malignant transformation, recurrence, and peritoneal seeding have been reported (DeFanti & Nodit, 2013; Sun *et al.*, 2014; Tatsuya *et al.*, 2021; Verma *et al.*, 2024). Certain signs such as an absence of lymphadenopathy and distant metastases as well as normal tumour marker levels, are the usual guides for the clinician to suspect a benign entity. But in cases like ours, these signs may not be reliable as both MEST family and multilocular cystic renal neoplasm of low malignant potential (MCRNLMP) which are indistinguishable from the other, have a low incidence of recurrence and metastasis. Given the atypical and aggressive presentation in our patient, this case underscores the importance of post-operative surveillance, even in histologically benign MEST, particularly when unusual features such as massive size, haemorrhage, necrosis, and rapid growth are present.

Conclusion

This case highlights that MEST may present with highly atypical features such as a unilocular giant cystic mass and rapid progression leading to abdominal compartment syndrome. Radiology alone is insufficient, histopathology and immunohistochemistry remains gold standard for diagnosis. Surgical excision is almost always the treatment of choice as there is radiological diagnostic dilemma given their similar presentation and appearance to malignancy, a high number of differential diagnoses and difficulty in obtaining biopsy. Active surveillance post-resection is recommended given rare reports of recurrence and malignant transformation.

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References

Adsay, N. V., Eble, J. N., Srigley, J. R., Jones, E. C., & Grignon, D. J. (2000). Mixed epithelial and stromal tumor of the kidney. *The American Journal of Surgical Pathology*, 24(7), 958–970.

https://doi.org/10.1097/00000478-200007000-00007

Antic, T., Perry, K. T., Harrison, K., Zaytsev, P., Pins, M., Campbell, S. C., *et al.* (2006). Mixed epithelial and stromal tumor of the kidney and cystic nephroma share overlapping features: reappraisal of 15 lesions. *Archives of Pathology & Laboratory Medicine,* 130(1), 80–85. https://doi.org/10.5858/2006-130-80-measto

Biyani, C., Wilkinson, C., Palit, V., Bardapure, M., Thomas, J., Browning, A., & Gill, K. (2013). Adult multilocular cystic nephroma: Report of six cases with clinical, radio-pathologic correlation and review of literature. *Urology Annals*, 5(1), 13. https://doi.org/10.4103/0974-7796.106958

Caliò, A., Eble, J. N., Grignon, D. J., & Delahunt, B. (2016). Mixed epithelial and stromal tumor of the kidney. *The American Journal of Surgical Pathology*, 40(11), 1538–1549. https://doi.org/10.1097/pas.0000000000000733

Choy B. Mixed epithelial and stromal tumor. PathologyOutlines.com website. Retrieved 20 June 2024, from http://www.pathologyoutlines.com/topic/kidneytumormixedepithelial.html

Chu, L. C., Hruban, R. H., Horton, K. M., & Fishman, E. K. (2010). Mixed epithelial and stromal tumor of the kidney: radiologic-pathologic correlation. *Radiographics*, 30(6), 1541–1551. https://doi.org/10.1148/rg.306105503

De Wall, J., Schroder, F., & Scholtmeijer, R. (1986). Diagnostic workup and treatment of multilocular cystic kidney difficulties in differential diagnosis. *Urology*, 28(1), 73–77. https://doi.org/10.1016/0090-4295(86)90190-1

DeFanti, L. E., & Nodit, L. (2013). Mixed epithelial and stromal tumor-cytologic findings of an unusual renal cyst. *Diagnostic Cytopathology*, 42(8), 680–682. https://doi.org/10.1002/dc.22964

Demir, H., Sahin, Z., Ozman, O., Demirbilek, M., Ozden, S. B., Gurses, I., *et al.* (2022). Mixed epithelial and stromal tumor family of kidney (adult cystic nephroma, mixed epithelial and stromal tumor): retrospective clinicopathological evaluation. *Turkish Journal of Pathology*. https://doi.org/10.5146/tjpath.2022.01575

Janes, W. C. I., & Harvey, D. (2022). An aggressively enlarging benign mixed epithelial stromal tumor (MEST) of the kidney. *Cureus*. https://doi.org/10.7759/cureus.31475

Joshi, V. V., & Beckwith, J. B. (1989). Multilocular cyst of the kidney (cystic nephroma) and cystic, partially differentiated nephroblastoma. Terminology and criteria for diagnosis. *Cancer*, 64(2), 466–479. https://doi.org/10.1002/1097-0142(19890715)64:2

Kakish, E. (2026). *Adult cystic nephroma* [Case study]. Radiopaedia.org. https://doi.org/10.53347/rID-190688

Kamel, M., Farias, J., Laryea, J., & Gokden, N. (2015). Peritoneal seeding following incomplete resection of mixed epithelial stromal tumor of the kidney: first case report. *Urology Annals*, 8(1), 114. https://doi.org/10.4103/0974-7796.171493

Karasavvidou, F., Mitrakas, L., Tzika, S., Zachos, I., Anagnostou, A., & Tzortzis, V. (2022). Mixed epithelial and stromal tumor-adult cystic nephroma of the kidney: a case report with immunohistochemical analysis. *Journal of Surgical Case Reports*, 2022(9). https://doi.org/10.1093/jscr/rjac387

Lane, B. R., Campbell, S. C., Remer, E. M., Fergany, A. F., Williams, S. B., Novick, A. C., *et al.* (2008). Adult cystic nephroma and mixed epithelial and stromal tumor of the kidney: clinical, radiographic, and pathologic characteristics. *Urology*, 71(6), 1142–1148. https://doi.org/10.1016/j.urology.2007.11.106

Michal, M., & Syrucek, M. (1998). Benign mixed epithelial and stromal tumor of the kidney. *Pathology - Research and Practice*, 194(6), 445–448. https://doi.org/10.1016/s0344-0338(98)80038-1

Michal, M., Hes, O., Bisceglia, M., Simpson, R. H. W., Spagnolo, D. V., Parma, A., *et al.* (2004). Mixed epithelial and stromal tumors of the kidney. A report of 22 cases. Virchows Archiv, 445(4), 359–367. https://doi.org/10.1007/s00428-004-1060-y

Picken, M. M., Bova, D., Pins, M. R., & Quek, M. L. (2018). Mixed epithelial and stromal tumor of the kidney with extension into inferior vena cava: case report and discussion of adult biphasic cystic renal lesions and the significance of vascular involvement. *Case Reports in Pathology*, 2018, 1–6. https://doi.org/10.1155/2018/8234295

Saber, M., & Gaillard, F. (2008). Cystic nephroma. Radiopaedia.org. https://doi.org/10.53347/rid-4949

Sawant, A. S., Savalia, A. J., Pawar, P., Narwade, S., & Chaudhari, R. (2017). A case report of largest documented multilocular cystic nephroma removed by thoracoabdominal approach. *Journal Of Clinical and Diagnostic Research*. https://doi.org/10.7860/jcdr/2017/25612.10244

Sharma, A., Andankar, M., & Pathak, H. (2017). A rare presentation of cystic nephroma in a young adult. *Asian Journal of Urology*, 4(2), 128–130. https://doi.org/10.1016/j.ajur.2017.01.001

Sheldon, J. (2026). Mixed epithelial and stromal tumour of the kidney [Case study]. Radiopaedia.org. https://doi.org/10.53347/rID-26149

Stamatiou, K., Polizois, K., Kollaitis, G., Dahanis, S., Zafeiropoulos, G., Leventis, C., & Lambou, T. (2008). Cystic nephroma: a case report and review of the literature. *Cases Journal*, 1(1). https://doi.org/10.1186/1757-1626-1-267

Sukov, W. R., Cheville, J. C., Lager, D. J., Lewin, J. R., Sebo, T. J., & Lewin, M. (2007). Malignant mixed epithelial and stromal tumor of the kidney with rhabdoid features: report of a case including immunohistochemical, molecular genetic studies and comparison to morphologically similar renal tumors. *Human Pathology*, 38(9), 1432–1437. https://doi.org/10.1016/j.humpath.2007.03.022

Sun, B. L., Abern, M., Garzon, S., & Setty, S. (2014). Cystic nephroma/mixed epithelial stromal tumor. *International Journal of Surgical Pathology*, 23(3), 238–242. https://doi.org/10.1177/1066896914563391

Tatsuya, S., Hirotaka, A., Yuki, A., Akiko, T., Masahiro, H., Shigeo, O., *et al.* (2021). Radiologic features of mixed epithelial and stromal tumors of the kidney: Hyperattenuating on unenhanced computed tomography and T2-hypointensity on magnetic resonance imaging. *Radiology Case Reports*, 16(4), 858-862. https://doi.org/10.1016/j.radcr.2021.01.048

Tinguria, M., & Chorneyko, K. (2023). Mixed epithelial and stromal tumor: a rare renal neoplasm—case report with clinicopathologic features and review of the literature. *Case Reports in Pathology*, 2023, 1 11. https://doi.org/10.1155/2023/3528377

Tsakiris, S., Zerva, M., Paparidis, S., Gasparos, F., Tzoras, A., Samis, A., Bouropoulos, C., & Ferakis, N. (2024). Three dimensional (3D) laparoscopic nephron-sparing treatment of a huge cystic nephroma: a case report and literature review. *Cancer Diagnosis & Prognosis*, 4(1), 81–84. https://doi.org/10.21873/cdp.10290

Turbiner, J., Amin, M. B., Humphrey, P. A., Srigley, J. R., De Leval, L., Radhakrishnan, A., *et al.* (2007). Cystic nephroma and mixed epithelial and stromal tumor of kidney: a detailed clinicopathologic analysis of 34 cases and proposal for Renal Epithelial and Stromal Tumor (REST) as a unifying term. *The American Journal of Surgical Pathology*, 31(4), 489–500. https://doi.org/10.1097/pas.0b013e31802bdd56

Varghese, A. M., Priya, P. V., & Sankar, S. (2023). Mixed epithelial stromal tumour kidney: report of two cases, benign and with malignant transformation. *Scholars Journal of Medical Case Reports*, 11(3), 273–278. https://doi.org/10.36347/sjmcr.2023.v11i03.007

Verma, R., Verma, J., & Gupta, N. (2024). Multilocular cystic nephroma in an adult: a diagnostic quandary. *CEN Case Reports*, 13(5), 356–365. https://doi.org/10.1007/s13730-024-00852-8

Wang, C., Lin, Y., Xiang, H., Fang, D., Jiang, P., & Shen, B. (2013). Mixed epithelial and stromal tumor of the kidney: report of eight cases and literature review. *World Journal of Surgical Oncology*, 11(1), 207. https://doi.org/10.1186/1477-7819-11-207

Wang, Y., Yuan, J., Wang, J., & Fu, Q. (2015). Mixed epithelial and stromal tumor of the kidney: report of a rare case and review of literature. *International Journal of Clinical and Experimental Pathology*, 8(9), 11772–11775.

Weerakkody, Y., & Sheldon, J. (2013). Mixed epithelial and stromal tumour. Radiopaedia.org. https://doi.org/10.53347/rid-26139

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  Ahmad, A., Husain, A., Mujeeb, M., Khan, S. A., Najmi, A. K., Siddique, N. A. *et al.* (2013). A review on therapeutic potential of *Nigella sativa:* a miracle herb. *Asian Pacific Journal of Tropical Biomedicine,* 3(5), 337-352. https://doi.org/10.1016/s2221-1691(13)60075-1

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