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Knob thorn (Acacia nigrescens)

The knob thorn tree is characterised by the shape of its leaves. Each leaf comprises of four to six leaflets, is rather large with lopsided bases and double pinnately compound. The rachis bends backwards and has small spines. This tree is deciduous, losing its leaves in winter and early spring. New leaves can be bright red in colour. In some cases, individual species of knob thorn trees do not grow knobs on their branches or trunks. It ranges from 5 m to 18 m in height and is fire-resistant. The common name for the knob thorn tree in Afrikaans and English refers to its typically knobbed thorns.

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Beyond the bottom line: Profit and purpose in dentistry

SADJ OCTOBER 2024, Vol. 79 No.9 P463-467

Prof NH Wood, Managing Editor, SADJ - BChD, DipOdont(MFP), MDent(OMP), FCD(SA), PhD

Imagine standing at the intersection of care and commerce, where every decision, whether to invest in cutting-edge technology, choose a premium material or offer a discounted service, has the power to shape not only the success of your practice but the very essence of your profession. This is the reality of modern dentistry: a delicate balancing act between profitability and purpose. In South Africa, where disparities in access and affordability magnify these decisions, the stakes are even higher. As dentists, how do we navigate this complex terrain? How do we honour our ethical commitments while ensuring the sustainability of our practices? Most importantly, can dentistry redefine success in a way that harmonises these seemingly conflicting priorities? The honest answers may surprise us all.

The balancing act in dentistry

The dental chair, once a place of straightforward treatment, has become the epicentre of a far more complex negotiation: balancing the escalating costs of modern care with the unchanging promise of patient-centred treatment. Today's practitioners face a daunting challenge. On one side are the soaring costs of advanced technologies, high-quality materials and the expectations of a discerning patient base. On the other side lies an ethical obligation to deliver care that is accessible, equitable and uncompromising in quality.

Across South Africa, where socioeconomic disparities are stark, this balancing act takes on an even greater weight. While some patients demand the latest cosmetic enhancements, others struggle to afford basic preventive care. The financial choices practitioners make are not just business decisions; they ripple outward, shaping the lives of patients, the reputation of the profession and the trust that forms its foundation. How does one weigh the cost of a cutting-edge CAD/CAM system against its potential to revolutionise restorative care? Can the benefits of using premium materials justify the strain it places on both patients' wallets and practitioners' sustainability? More importantly, can modern dentistry strike the elusive balance between profitability, quality and accessibility – or are these ideals fundamentally at odds?

Philosophies in dentistry: Profit vs service quality

In the ever-evolving world of dentistry, profit is often cast as the antagonist in debates about professional integrity and patient-centred care. Yet, the truth is far more nuanced. Profit, when guided by ethical intent, is not the enemy of dentistry – it is its enabler. Without financial sustainability, practices cannot thrive, innovate or even exist. The challenge lies not in pursuing profitability but in ensuring that it aligns with the core mission of dentistry: to improve oral health and overall wellbeing.

Consider this: it is profitability that funds the acquisition of state-of-the-art equipment capable of producing faster, more precise diagnoses. It is profitability that allows practitioners to invest in advanced materials, offering patients restorations that are both functional and aesthetic. And it is profitability that supports continuing professional development, empowering dental teams to refine their skills and adopt new treatment techniques. In this sense, profit acts as a driver of growth, pushing practices to stay at the cutting edge of care.

Yet, this is where the story takes a twist. The pursuit of profit can also tempt practices into prioritising high-margin procedures over essential care, straining the balance between financial success and service quality. A practice that invests in advanced equipment solely to maximise income risks alienating patients who perceive their care as transactional rather than compassionate. Similarly, focusing exclusively on cosmetic dentistry may generate impressive revenue but may sideline the needs of vulnerable populations requiring basic preventive care.

The tension between profit and service quality is not a binary choice, it is a spectrum that dentists must navigate with careful deliberation. Profit, when used as a tool for reinvestment and growth, elevates the profession. But when it becomes the sole metric of success, it risks undermining the trust and care that define dentistry.

The ethical obligation to provide high-quality care

Dentistry is a commitment to excellence and therefore service quality is not a feature of the profession; it is its foundation. Patients entrust their oral health and, by extension, their overall wellbeing to dental professionals, expecting care that is safe, effective and enduring. Yet, in the intricate dance of balancing costs and benefits, the promise of high-quality care often finds itself under pressure, particularly in resource-limited settings such as South Africa.

Providing top-tier care comes with a price. High-quality materials, advanced technologies and skilled personnel are the cornerstones of excellence, but they come at a significant financial cost to both practitioners and patients. In urban centres, where affluence may allow for cutting-edge practices, the tension is often less pronounced. However, in rural or underserved areas, where financial resources are stretched thin, maintaining service quality can feel like an uphill battle. Here, practitioners may face difficult choices: adopt less expensive but lower-quality materials, compromise on certain technologies or reduce the frequency of patient follow-ups to lower costs.

Globally, the consequences of prioritising profit over quality have been documented. For instance, a 2020 study in the Journal of Dental Research examined the long-term outcomes of cost-cutting practices in dentistry. It found that using subpar restorative materials to reduce expenses led to higher rates of failure and patient dissatisfaction, ultimately eroding trust and increasing costs through repeat interventions. Such

findings underscore the risks of allowing financial pressures to dictate clinical decisions.

In South Africa, this tension is compounded by stark socioeconomic disparities. Public sector dentists often work with limited budgets, affecting their ability to provide the same quality of care as their private sector counterparts, not to mention potentially concerning instances of noncommitment to service by practitioners themselves. Meanwhile, private practitioners may feel pressure to prioritise high-margin treatments such as cosmetic dentistry over preventive or restorative care, inadvertently neglecting the broader health needs of their communities. The result is a growing divide in access to high-quality care, with vulnerable populations disproportionately affected.

Service quality must remain a non-negotiable standard in dentistry. To ensure this, the profession must resist the temptation to let financial constraints compromise clinical excellence. Practitioners must advocate for sustainable practices that balance financial realities with ethical obligations, striving to provide the same level of care for every patient, regardless of economic status.

As we continue, we delve deeper into the cost-benefit calculations surrounding materials and technology. Can cutting-edge advancements coexist with equitable care? The stakes could not be higher.

Materials and technology: Cutting-edge or cost-effective?

In modern dentistry, materials and technology represent both the pinnacle of progress and the source of profound dilemmas. Each innovation – whether a new composite material, a CAD/CAM system or 3D printing technology – promises to elevate patient outcomes. Yet these advancements come at a cost, leaving practitioners to grapple with an essential question: when is the investment justified, and who ultimately bears the financial burden?

Advancing patient outcomes with high-quality materials

The allure of premium materials is undeniable. High-quality composites and ceramics offer durability, aesthetics and biocompatibility, setting new benchmarks for patient care. A well-crafted restoration using premium materials can last decades, reduce the risk of complications and enhance a patient's confidence with its lifelike appearance. However, these benefits come with a price tag that cannot be ignored.

For practitioners, the challenge lies in balancing the clinical advantages of these materials with their affordability for patients. Should a dentist always recommend the highest-quality material, even if it may strain a patient's budget? Or should they offer alternatives that, while cost-effective, may not meet the same standards of durability and performance? These choices are not merely clinical – they are deeply ethical, reflecting the practitioner's philosophy of care.

A 2021 study in the Journal of Prosthetic Dentistry demonstrated that premium ceramic materials used in crowns and bridges significantly reduced failure rates over five years compared to mid-tier alternatives. Yet the same study noted that the increased upfront cost often dissuaded patients, leading to compromises in their long-term oral health outcomes. This highlights a critical tension: the very materials that could prevent future complications are often inaccessible to those who need them most.

Emerging technologies and their return on investment

Parallel to the evolution of materials is the rise of transformative technologies. CAD/CAM systems, 3D printing and digital workflows are revolutionising the way dental treatments are planned and executed. These technologies enhance precision, reduce chairside time and allow for same-day

restorations, delivering undeniable benefits to both patients and practitioners.

However, these advancements come with steep financial implications. For many private practitioners, adopting such technologies represents a significant investment. The return on investment (ROI) is not always immediate, as it depends on patient demand, procedural volume and the efficiency gains achieved through their use. Studies analysing the ROI of CAD/CAM systems in private practices have shown mixed results. While high-volume practices often recoup their investment within three to five years through savings on laboratory costs and increased patient satisfaction, smaller practices may struggle to justify the expenditure. Moreover, the maintenance and training required to maximise these technologies can add hidden costs that further complicate the equation.

The balancing act

For South African practitioners, the calculus is particularly challenging. On one hand, embracing advanced materials and technology is crucial for staying competitive in an increasingly sophisticated market. On the other, the socioeconomic realities of many patients make it difficult to pass on these costs without risking accessibility. The question practitioners must ask themselves is not just whether they can afford these investments, but whether they align with their philosophy of care. Are these tools and materials being used to genuinely enhance patient outcomes, or are they becoming symbols of a practice's prestige? The answer lies in thoughtful decision-making, where clinical need, patient priorities and financial realities intersect.

Accessibility and equity in dentistry

Dentistry, while a cornerstone of healthcare, remains out of reach for many in South Africa. The promise of oral health for all often falters against an imposing barrier: cost. For vulnerable populations, where a dental appointment might mean sacrificing basic necessities, the idea of access to high-quality care feels like a distant luxury. This disparity challenges the profession to confront its dual identity as both a healthcare service and a business.

The cost barrier for vulnerable populations

In South Africa, access to dental care is starkly divided along socioeconomic lines. The private sector, with its advanced technologies and well-resourced facilities, caters predominantly to patients who can afford out-of-pocket payments or comprehensive insurance plans. Meanwhile, the public sector, overburdened and underfunded, struggles to meet even the basic oral health needs of the majority of the population. According to a 2020 study on healthcare equity in South Africa, dental services in public facilities often face significant resource constraints, leading to long waiting times and limited treatment options. Preventive care, arguably the most cost-effective intervention, is frequently inaccessible, leaving patients to seek treatment only in emergencies when their conditions are more advanced and costly to manage.

The result is a cyclical problem. Vulnerable populations are denied access to timely care, leading to worsened oral health outcomes that compound the existing inequities. Children miss school due to untreated dental pain, adults face difficulties maintaining employment because of poor oral health, and systemic conditions linked to oral diseases escalate healthcare burdens. These realities underscore the urgent need for a paradigm shift in how dental care is delivered and financed.

Balancing affordability with sustainability

The challenge, then, is clear: how can practitioners make high-quality care accessible to all without compromising the financial sustainability of their practices? The answer may lie in innovative approaches that reimagine the economics of dentistry.

One promising model is sliding-scale pricing, where treatment costs are adjusted based on a patient's income. This approach ensures that patients are not excluded from care due to financial constraints while still allowing practices to recover costs. Another strategy is the integration of public-private partnerships. These collaborations enable private practitioners to extend their services to underserved populations, often subsidised by government funding or nonprofit organisations. Such initiatives not only expand access but also strengthen the social role of private dentistry, fostering goodwill and long-term patient loyalty.

Community outreach programmes also play a pivotal role in bridging the gap. Mobile dental clinics, funded through partnerships or donations, bring care directly to rural and underserved areas, reducing geographic and financial barriers. By focusing on preventive care and early interventions, these initiatives address oral health disparities at their root, benefiting both patients and the broader healthcare system.

A call for innovation and commitment

Accessibility and equity in dentistry are not merely aspirational goals – they are ethical imperatives. The profession must move beyond traditional models of care delivery to embrace strategies that prioritise inclusivity. Practitioners have the power to lead this change, using their expertise and resources to advocate for systems that do not force patients to choose between financial survival and oral health.

As we explore the next section, we shift our focus to evidence-based decision-making, asking: what are the hidden costs of compromise, and how do long-term investments in quality and prevention pay off for both patients and practitioners?

Evidence-based decision-making: The true cost of compromise

The discussion on accessibility and equity inevitably brings us to a critical consideration: the cost of compromise. In the pursuit of making dental care affordable, the temptation to cut costs is ever-present. Yet, as the profession strives to extend its reach to vulnerable populations and balance affordability with sustainability, it must also confront a vital question: What are the hidden consequences of cost-cutting measures, and how do they impact patients, practices and the profession as a whole?

The long-term impact of cost-cutting

Compromising on materials and treatment protocols to save costs may seem like a practical solution in the short term, but the long-term consequences often tell a different story. Studies have consistently shown that the use of lower-quality materials or the omission of critical procedural steps can lead to higher failure rates, necessitating retreatments that are both costly and frustrating for patients and practitioners alike.

For instance, a 2021 study published in the International Journal of Prosthodontics examined outcomes of restorations performed using budget materials. The findings were sobering: while upfront costs were reduced by nearly 30%, failure rates tripled within five years, leading to increased retreatment needs and higher cumulative costs for patients. The study also highlighted how these failures erode trust in dental practitioners, as patients perceive repeated issues as a reflection of the provider's skill rather than the limitations of the materials used.

Beyond the financial implications, cost-cutting also poses ethical concerns. Providing suboptimal care to reduce expenses undermines the foundational promise of dentistry: to prioritise the patient's health and wellbeing. This is particularly concerning in underserved communities, where patients may already have limited trust in healthcare systems. Dentists must weigh the immediate financial savings of cost-cutting against the potential long-term damage to patient outcomes, professional reputation and the public's trust.

The value of preventive care

In contrast, preventive care stands out as a cornerstone of evidence-based decision-making, offering a cost-effective approach to managing oral health. By addressing issues before they escalate, preventive measures not only reduce the need for expensive interventions but also enhance patient satisfaction and outcomes.

Consider the impact of routine dental check-ups, fluoride treatments and patient education. A 2020 review in the Journal of Dental Research found that investing in preventive care reduced the incidence of advanced caries by 60% in high-risk populations, saving significant costs associated with restorative or surgical procedures. For private practitioners, this presents an opportunity to position their practices as proactive, patient-focused entities, fostering loyalty and trust while minimising the economic burden on patients.

Preventive care is not just about reducing costs – it's about aligning with the profession's ethical and clinical priorities. It bridges the gap between accessibility and quality, ensuring that patients receive care that is both affordable and effective. For practices, it reinforces the philosophy of long-term planning over short-term savings, creating a foundation for sustainable growth and excellence.

A path forward

The decisions dentists make today will shape the profession for years to come. As they navigate the complex interplay of cost, quality and accessibility, evidence-based decision-making offers a guiding light. By resisting the lure of quick fixes and embracing strategies rooted in long-term outcomes, practitioners can uphold the values of their profession while building trust and sustainability.

Philosophical reflections: Dentistry as a profession and a business

Dentistry has always walked a fine line between its dual identities: a healthcare profession grounded in trust, care and ethics, and a business reliant on profitability for sustainability. This duality, while seemingly contradictory, is the very essence of what makes dentistry unique. The art lies not in choosing one identity over the other but in harmonising them to create

a practice that serves both patients and practitioners with integrity.

Reaffirming the core values of dentistry

At its heart, dentistry is a profession rooted in service. The care we provide goes beyond repairing teeth or crafting restorations; it restores confidence, alleviates pain and often saves lives. Yet, the pressures of running a practice – a business – can blur these values. Financial sustainability is essential. Without it, practices close, innovation stalls and access diminishes. But when the scales tip too far toward profit as the primary driver, the profession risks losing sight of its purpose.

Consider the themes we've explored. The decisions around materials, technology and cost-cutting all stem from a balancing act between professional integrity and financial necessity. Each choice, whether to invest in cutting-edge equipment or offer more affordable alternatives, reflects the tension between serving individual patients and sustaining the broader practice. The question becomes: how do we maintain ethical standards while navigating these pressures? The answer may lie in embracing dentistry's duality as a strength rather than a conflict. By grounding every decision, financial or clinical, in the foundational commitment to patient welfare, practitioners can find a compass that guides them through the most complex dilemmas.

Redefining success in modern dentistry

Perhaps the moment of clarity for dentistry lies not in reconciling its dual identities but in redefining what it means to succeed. Is success simply a matter of growing the bottom line, or is it something more profound? Could it be measured by the impact on community health, the trust patients place in their practitioners and the reputation of a profession that has always strived to do right by those it serves?

This is where the lightbulb moment for dentistry emerges: profitability and purpose are not mutually exclusive. In fact, they are interdependent. A practice built on patient-centred care fosters loyalty, trust and referrals, creating a sustainable model for financial success. Similarly, a business that invests in ethical decision-making and community engagement builds a reputation that transcends immediate profit margins. In short, redefining success means seeing profit as the reward for good work, not the goal itself.

For South African dentistry, this reflection is particularly urgent. The disparities in access, the pressures of cost and the challenges of equity demand that the profession takes a stand. By reaffirming its core values and reimagining success, dentistry can become a beacon of hope in a healthcare landscape fraught with challenges. Dentistry is at a crossroads. The choices made today will shape the profession's legacy tomorrow. Practitioners, educators, policymakers and industry leaders must come together to embrace a vision of dentistry that honours its roots while adapting to the realities of modern practice. Profitability and patient-centred care are not enemies, they are allies when pursued with intention and integrity.

The path forward is not just about making better decisions, it is about reimagining what it means to thrive as a dental professional. By weaving together the lessons of cost, benefit and equity, we can forge a profession that remains true to its promise: serving patients with excellence, compassion and purpose.

Conclusion

Dentistry, at its core, is a profession defined by balance between science and art, innovation and tradition and, most critically, profitability and purpose. This editorial has explored the intricate dance between cost and benefit, shedding light on the challenges practitioners face while affirming the values that guide the profession. The path forward requires thoughtful decisions grounded in evidence, ethics and empathy. By embracing dentistry's dual identity as both a business and a calling, practitioners can create practices that are not only sustainable but deeply impactful. The true measure of success is not just the numbers on a ledger but the trust we build, the care we provide and the communities we uplift. In honouring this balance, we ensure the future of dentistry remains bright, resilient and true to its noble purpose.

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CPD questionnaire on page 510

The Continuing Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.

Artificial intelligence in dentistry: bridging knowledge and practice

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Mr KC Makhubele – CEO, South African Dental Association

In recent years, the field of dentistry has witnessed significant advancements through the integration of artificial intelligence (AI). The book Artificial Intelligence in Dentistry, edited by Kaan Orhan and Rohan Jagtap, serves as a comprehensive guide that explores the vast potential of AI in enhancing dental practice. This article summarises key insights from the book, highlighting the transformative impact of AI on dental diagnostics, treatment and education.

AI-supported pathways in dental diagnostics

The integration of AI in dental diagnostics is a significant advancement in the efficacy and accuracy of disease detection and management. The book explores a variety of AI-supported pathways that are transforming the way dental professionals diagnose and evaluate oral health conditions.

The analysis of dental radiographs is one of the primary implementations of AI in diagnostics. Traditional methods of interpreting X-rays may be subjective and susceptible to human error. AI algorithms, particularly those that are based on deep learning, have been trained on extensive datasets of radiographic images, which has allowed them to accurately identify patterns and anomalies. These algorithms have the ability to detect dental caries in its early stages, identify periodontal bone loss and evaluate the severity of periapical lesions, frequently prior to the clinical manifestation of these issues.

AI is also instrumental in the diagnosis of obstructed teeth and the planning of their surgical extraction. AI systems can foresee the complexity of impaction and recommend the most suitable surgical approach by analysing radiographic data, thereby reducing complications and enhancing patient outcomes.

An additional substantial application is the evaluation of crown and root fractures. AI tools can improve the visualisation of fractures that may be challenging to identify using traditional methods, thereby enabling clinicians to make more informed decisions about treatment options. This is especially crucial in the prevention of superfluous extractions and the preservation of tooth structure.

AI-supported diagnostics are of assistance in the identification of root and canal morphology and the determination of working length in endodontics. The success of root canal procedures is contingent on the precise determination of the working length, and AI systems offer improved precision in measuring these critical parameters. Furthermore, AI assists in the identification of intricate root canal systems that can be difficult to navigate without the use of sophisticated imaging and analysis.

AI is capable of diagnosing temporomandibular joint (TMJ) disorders and detecting conditions such as obstructive sleep

apnoea (OSA). AI can analyse joint sounds and movements in TMJ diagnostics, providing non-invasive methods for evaluating joint health. AI systems can identify patients at risk for OSA by evaluating cephalometric radiographs and other data, thereby facilitating opportune interventions.

Additionally, AI is demonstrating its invaluable worth in the early detection of buccal mucosal lesions, including potentially malignant disorders. The prognosis of oral malignancies is significantly enhanced by early diagnosis, and AI systems can help in the screening of large populations, ensuring that high-risk individuals receive the requisite follow-up and treatment.

The book also delves into the role of AI in predictive analytics, including the estimation of the necessity for retreatments and the prediction of the eruption patterns of third molars. These predictive tasks are instrumental in the planning of future dental interventions and the counselling of patients regarding prospective oral health issues.

In general, the field of dental diagnostics is being revolutionised by AI-supported pathways, which provide unprecedented levels of precision, efficiency and predictive power. Dental professionals can enhance patient care by developing more precise diagnoses and implementing more effective treatment plans through the utilisation of these technologies.

Enhancing treatment planning and execution

AI's function is not limited to diagnostics; it also includes the facilitation of treatment planning and execution. AI technologies assist in the identification of optimal treatment pathways in specialities including Orthodontics, Endodontics, Prosthodontics and Oral and Maxillofacial Radiology. For instance, AI algorithms can evaluate the complexity of root canal systems, thereby facilitating the planning of procedures more efficiently for endodontists.

AI assists in the design of prosthetics with high precision, thereby guaranteeing a better fit and function, in the fields of restorative dentistry and implants. The efficacy of dental practices is not the only benefit of AI integration in these areas; it also improves clinical outcomes.

Innovations in dental education and research

The book also explores the transformative potential of AI in dental education. The integration of AI-driven tools into dental curricula is intended to provide students with the necessary skills for diagnostics and treatment planning. In a simulated environment, these tools enable students to practise and refine their abilities, thereby providing interactive learning experiences.

Furthermore, the book presents state-of-the-art research on the applications of AI in 3D and bioprinting, which are on the brink of revolutionising tissue engineering and dental prosthetics. These technologies have the potential to develop personalised dental solutions that are customised to the specific requirements of each patient.

ETHICAL AND LEGAL CONSIDERATIONS

As with any technological advancement, the incorporation of AI in dentistry is subject to ethical and legal considerations. The book offers a comprehensive examination of these aspects, providing practitioners with guidance on the responsible application of AI. The exploration of issues such as data privacy, informed consent and the medico-legal implications of AI-driven decisions ensures that dentists navigate this new landscape with caution and professionalism.

Future perspectives

Artificial Intelligence in Dentistry concludes by exploring the future potential of AI in the dental field. The book envisions a future where AI technologies are seamlessly integrated into every aspect of dental care, from routine check-ups to complex surgical procedures. As these technologies continue to evolve, they are expected to further improve the quality of care, increase accessibility and reduce costs.

Conclusion

Artificial Intelligence in Dentistry offers a comprehensive perspective on the transformative influence of AI on the dental field. AI technologies are poised to transform dental diagnostics, treatment and education by bridging the divide between knowledge and practical application. Dentists and specialists must remain informed about these advancements as the field continues to evolve, thereby ensuring that they fully leverage the potential of AI to improve patient outcomes and enhance patient care.

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Mercury levels in wastewater samples at a South African dental school

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Stephen M Sudi[1], Sudeshni Naidoo[2]

ABSTRACT

Dental amalgam is a commonly used restorative material in oral health care services in South Africa. It is composed of between 43-50% mercury. Over the past 40 years, advancing knowledge of mercury toxicity to the environment and life has led to concerns over the waste produced during the placement and removal of dental amalgam. The present study determined mercury levels in wastewater, described the application of the best management practices (BMPs) for dental amalgam use and investigated dental amalgam procurement patterns at the WITS Oral Health Centre, University of the Witwatersrand. The wastewater generated during the study period was diverted, collected and sampled. The samples were analysed for total mercury concentrations using USEPA method 245.7 – Cold Vapor Atomic Absorption Spectroscopy. A structured interview was used to investigate the application of the BMPs for dental amalgam use. The amalgam procurement records were accessed and analysed. The study found that the levels of mercury in wastewater samples ranged from 1.048mg/l to 108.762mg/l, there was an increasing procurement of dental amalgam over nine years and there was inadequate adherence to the BMPs. The mercury levels observed called for the urgent need to institute BMPs.

INTRODUCTION

Mercury is a recognised global environmental pollutant with various adverse health effects on animal and human life.[1] Mercury is released into the environment from geologic reservoirs and human activities and persistently circulates in the atmosphere, water, soil, plants and animals.[2] In the environment, mercury deposits in waterways and is converted to a highly toxic form of methylmercury through microbial methylation. Methylmercury ingestion in lower trophic levels leads to bioaccumulation and biomagnification in higher trophic levels of marine animals such as long-lived fish and marine mammals.[3] Human consumption of methylmercury may harm the nervous, cardiovascular, respiratory, immune and digestive systems. The developing nervous system is particularly sensitive to methylmercury, and exposure could lead to impaired neurological development.[4] To minimise the risk of environmental mercury contamination, the mining, usage and trade of mercury and mercury-containing products are subject to control under the Minamata Convention on Mercury (MCM).[5]

Dental amalgam is a commonly used restorative material in primary oral health care provision in South Africa.[6] Dental amalgam restorative material comprises 43-50% liquid mercury, which forms an intermetallic alloy with varying amounts of silver, tin, copper, zinc and palladium.[7] Two standards, ISO 24234:2021[8] and ISO 20749:2023,[9] provide the compositional specifications, requirements and test methods for dental amalgam products. The mercury component of dental amalgam has been controversial since its introduction.[10] The placement, removal and polishing of dental amalgam restorations and extraction of teeth containing dental amalgam generate mercury-containing waste in oral health care settings.[11] The waste is generated in an open system which, without proper waste management processes, can release up to 50% of consumed material into the environment.[12] The release of dental amalgam mercury to the environment occurs through the following pathways: atmosphere 50-70 tons/year; surface water 35-45 tons/year; groundwater 20-25 tons/year; and soil 75-100 tons per year. An estimated 40-50 tons/year of dental amalgam are recycled and 40-50 tons/year are processed through sequestration and secure disposal.[13]

In the MCM, dental amalgam is the only mercury-added product subject to a phase-down approach based on prevention, research for alternative materials and waste management practice.[14,15] Dental amalgam is banned in Sweden, Norway and Denmark, and restrictions have been introduced in Japan, Germany, Finland, Bulgaria, Mongolia, Vietnam and Thailand.[13] Standards, guidelines and provisions for dental amalgam use have been introduced in Canada,[16] the US[17] and the European Union.[18] Middle- and low-income countries rely on "affordable" dental amalgam to offset unmet restorative needs in their populations.[19] Dental amalgam's contribution to environmental mercury contamination in developing countries is recognised, but information on the extent and mitigation processes is lacking. Available estimates of dental amalgam usage in South Africa indicate that 70-100kg of dental amalgam was sold annually between 2009 and 2011, with a further 50kg of non-amalgamated mercury sold to dental practitioners.[20] Dental amalgam was previously reported to be widely used in the training of restorative dentistry in all four dental schools in South Africa (Lombard, et al., 2009). The amount of dental amalgam procured and used by the dental schools and the potential wastewater contamination have remained unreported. The World Health Organization (WHO) has adopted best management practices (BMPs) for

Authors' information
1. Stephen M Sudi, *DDS*, *MSc*, Faculty of Dentistry, University of Western Cape, Cape Town, South Africa. ORCID: 0009-0003-2223-7244
2. Sudeshni Naidoo, *BDS*, *LDS.RCS*, *MDPH*, *DDPH.RCS*, *MChD*, *PhD*, *Dip IRE*, *DSc*, Faculty of Dentistry, University of the Western Cape, Cape Town, South Africa. ORCID: 0000-0001-7424-8082

Corresponding author
Name: Stephen M Sudi
Email: ssudi@uwc.ac.za

Author's contribution
1. Stephen M Sudi – conceptualisation, methodology, investigation, draft preparation (60%)
2. Sudeshni Naidoo – draft preparation, review and editing (40%)

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dental amalgam use, which were previously developed by the American Dental Association.[21] The South African Dental Association (SADA) advocated the introduction of the BMPs for dental amalgam use to prevent environmental mercury contamination.[22] The extent of BMPs application in dental schools that use dental amalgam for training and treatment remains unreported.

The present study aimed (i) to determine mercury levels in wastewater, (ii) to investigate the application of best management practices for dental amalgam use, and (iii) to describe the procurement patterns of dental amalgam at the WOHC.

MATERIALS AND METHODS

Study setting

The study was conducted at the WITS Oral Health Centre (WOHC) of the School of Oral Health Sciences, University of the Witwatersrand. Ethical clearance was obtained from the Human Research and Ethics Committee of the University of the Witwatersrand (Ethics number M170908) and permission to conduct the study at the centre was obtained from the Hospital Research and Risk Committee. The WOHC provides clinical services and training through four polyclinics – P1, P2, P3 and P4 – a multi-skills technique laboratory (MSTL) and various support sections. Polyclinic supervisors managed the polyclinics and the MSTL. The restorative procedures using dental amalgam were performed in the P1, P2, P3 and occasionally in the P4 and the MSTL. The wastewater generated during operations was evacuated by four 50mm main lines connected to vacuum pumps, two each for P1, P2, P3 and MSTL. The vacuum pumps used at WOHC were Midmark, Classic-Series® CV10 Wet-Ring twin. The P4 polyclinic was excluded from the study due to the unfavourable vacuum system layout. The procurement of supplies and materials necessary for training and clinical operations was managed by the Central Procurement Section (CPS).

Study design

A cross-sectional study design was used to determine the levels of mercury in wastewater samples, dental amalgam uses and the application of best management practices for dental amalgam use at the WOHC. The dental amalgam procurement trends were obtained retrospectively.

The determination of the level of mercury in wastewater and dental amalgam use

The study period for determining levels of mercury in wastewater and dental amalgam use was seven days. Wastewater collection was facilitated by diverting the wastewater flow using a collection apparatus made of a sampling valve installed perpendicular to the main vacuum pipe, a vacuum hose with a lower ball valve, and a 20L container. Eight collection systems were installed on the four main vacuum lines proximal to the suction pump stations and trialled for collection efficiency.

During the study, the collected wastewater was poured into a plastic basin and manually agitated to obtain a uniform mixture. A 500ml test sample was obtained from the collected wastewater from the basin using a measuring jar and was kept in polyethene bottles previously. This step was uniformly performed for each polyclinic and MSTL. The remaining wastewater was measured to determine the total amount of wastewater collected from each mainline per day. The remaining collected wastewater was discharged to the main sewage line.

The control samples were 500ml "point-of-use water samples" collected in polyethene bottles from the steam distillers, which provide water used for irrigation/cooling in the dental chairs at polyclinics 1, 2 and 3, and from the three-way air/water syringe in the MSTL. The total number of samples obtained was 25 test samples and 25 control samples. The obtained samples were preserved by adding 10ml of 32% hydrochloric acid, followed by storage in a refrigerator at 4°C. The equipment used for test sample collection was thoroughly washed with SteriScrub soap containing chlorhexidine and water after each collection, rinsed with de-ionised water, dried and stored ready for next-day collection.

At the end of the study period, the 50 collected samples were removed from the refrigerator, placed in a cooler box filled with ice and transported to the Council for Scientific and Industrial Research (CSIR) – Water and Environment Laboratory in Pretoria for analysis. The total mercury levels in wastewater were determined through the US EPA method 245.7 – Cold Vapour Atomic Absorption Spectroscopy using a Hydra II Mercury Analyser. The use of dental amalgam was determined by observing restorative procedures performed in polyclinics 1, 2 and 3 and the MSTL during the study period. Information on the number of dental amalgam restorations removed or placed, the number of surfaces, the number and type of dental amalgam capsules and the amount of dental amalgam used was recorded in a data collection sheet.

Best management practices for dental amalgam use

The application of best management practices for dental amalgam use was determined through a structured interview with the clinic supervisors for polyclinics 1, 2, 3 and the technician. The interview questionnaire was based on the practical guide to integrating best management practices (WHO, 2010) into dental practice, with the main areas of focus including the use of amalgam capsules, retention and storage of amalgam waste, equipment maintenance, prevention of releases and disposal of dental amalgam waste. The interview was conducted on the sixth day of the study.

Dental amalgam procurement

The records of dental amalgam procured from April 2009 to March 2018 were accessed at the procurement office and central stores of the WOHC. The number of dental amalgam boxes issued, the number of capsules – ie the clinical utilisation unit – and the amount of dental amalgam calculated were entered into the data collection sheet.

Statistical analyses

The data was captured on a spreadsheet. Descriptive statistics were used to summarise the data. Trendline analysis was used to determine procurement trends. Spearman correlation analysis using Stata 15 was used to determine the correlation between dental amalgam used and mercury levels in wastewater. The level of significance was set at $P<0.05$.

RESULTS

Dental amalgam use and mercury levels in wastewater

The number of patients seen at P1, P2, and P3 during the study was 820, of which 163 (20%) received restorative treatment. The dental amalgam restorative material used

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was the "Permite" brand, in pre-dosed capsules of one/two spill sizes with regular setting time. The number of dental amalgam procedures performed was 28, comprising the removal of 9 amalgam restorations with 17 surfaces and the placement of 19 amalgam placements with 29 surfaces. The number and type of amalgam capsules were 41 one-spill and 72 two-spill capsules. The amalgam restorative procedures were performed by the fourth-. and fifth-year students.

The MSTL was used on days 1, 3, 5 and 7 of the study. Fifty-seven restorations consisting of 69 surfaces were removed, and 106 restorations with 146 surfaces were placed. The number and type of amalgam capsules used were 67 one-spill capsules and 146 two-spill capsules. The total amount of dental amalgam used at WOHC during the study period was 258.8mg, of which 85% was used in the MSTL and 15% was used in the polyclinics.

Fifty samples were submitted to CSIR for total mercury analyses. The samples comprised 25 control samples and 25 wastewater samples. The levels of mercury in all control samples were <1.0 µmg/l, while the levels of mercury from the wastewater samples ranged from a minimum of 1,048 mg/l in P2 to a maximum of 108.762mg/l in MSTL. The median mercury level in wastewater samples was 4.457mg/l, with an interquartile range of 15.804mg/l (2.303mg/l – 15,804mg/l). Table 1 summarises the amount of dental amalgam used, collected wastewater and mercury levels in the P1, P2, P3 and MSTL.

The application of best management practices

The use of dental amalgam in the form of pre-capsulated alloys of various sizes was the only BMP for dental amalgam use applied in the three polyclinics and the MSTL. Other BMPs, including the use of marked, wide-mouthed, airtight

Table 1. Dental amalgam used and mercury levels in wastewater

	Day of the study	Dental amalgam use (mg)	Wastewater collected (l)	Total mercury levels in wastewater (mg/l)
P1	1st	2304	4.6	3.130
	2nd	3068	5.7	18.843
	3rd	0	11.7	8.094
	5th	0	0.8	4.457
	6th	0	4.2	2.436
	7th	0	3.6	2.170
P2	1st	0	6.7	1.449
	2nd	5348	6.4	1.134
	3rd	0	11.7	7.135
	4th	0	0.8	3.342
	5th	0	5.1	2.881
	6th	3820	10.6	2.857
	7th	2292	6.1	1.508
P3	1st	1152	4.1	3.750
	2nd	16056	7.6	4.553
	3rd	5348	6.4	9.047
	5th	0	5.3	4.509
	6th	0	6.6	1.385
	7th	0	2.4	1.048
MSTL	1st	85868	1.9	85.373
	2nd	0	0.4	17.371
	3rd	32632	0.75	48.572
	5th	53284	1.4	67.744
	6th	0	0.5	37.943
	7th	47596	1.7	108.762
Total		**258768**	**117.05**	

There was a moderate correlation between dental amalgam use and mercury levels in wastewater (rs=0.4688), (p=0.0181).

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containers for storage of non-contact amalgam, used capsules, contact amalgam, extracted teeth, traps and filters, were not practised in all three polyclinics and the MSTL. Moreover, the following BMPs – using amalgam separators in the wastewater system, using disinfectants and line cleaners that do not contain chlorine or bleach, and disposing of amalgam waste with a compliant recycler – were not employed.

Dental amalgam procurement

The dental amalgam restorative material procured by WOHC was the "Permite" brand, in pre-dosed capsules of one and two spill sizes with regular setting time. The pre-dosed capsules were packaged in a box of 50 capsules. The one-spill size capsule contained 400mg alloy and 364mg mercury, while the two-spill capsule contained 600mg alloy and 552mg mercury. Over the nine years from April 2009 to March 2018, WOHC procured 454 Permite dental amalgam boxes, which contained 22700 dental amalgam capsules, of which 51.8% were two-spill capsules and 48.2% were one-spill capsules.

The pre-dosed dental amalgam capsules contained 21.91kg of dental amalgam, consisting of 11.43kg of alloy and 10.47kg of mercury. The median number of capsules procured was 700 for one-spill capsules and 1,500 for two-spill capsules. The trendline analysis revealed a slight increase in dental amalgam procured by the WOHC from the year 2009 to 2017 (0.1847, R^2 0.0953) (Figure 1).

DISCUSSION

The present study aimed to determine mercury levels in dental wastewater samples, investigate the application of BMPs for dental amalgam use and describe the dental amalgam procurement patterns at WOHC. The study's main findings were that the wastewater samples had a high mercury concentration, the BMPs for dental amalgam use were not adequately applied, and WOHC still procured and used dental amalgam for training and management of dental caries.

The mercury concentration in all wastewater samples was higher than the maximum concentration limit of 1.0mg/l allowed in any sewage, industrial effluent or other liquid discharged to the sewer by the City of Johannesburg Metropolitan Municipality Water services by-laws.[23] Discharging wastewater with a high mercury concentration harms the environment and life as it may prejudice downstream sewage effluent reuse by the municipality and water recycling/reuse. The total mercury concentration in wastewater from the WOHC was similar to that reported in a previous study: 45.2mg/l (n=13; SD=68.5) for the chair-side samples, 13.4mg/l (n=13; SD=9.8) for the 107-chair clinic and 5.4mg/l (n=12; SD=2.7) for the 30-chair clinic.[24]

The mercury levels in wastewater samples obtained from the polyclinics were lower than the MSTL by a factor of 10. The lower mercury levels in the polyclinics could be due to lower dental amalgam use and a higher number of procedures not using dental amalgam. A study from the United Arab Emirates similarly described the lower wastewater mercury concentration in clinics not offering or with lower numbers of dental amalgam treatments compared to those that offer primarily dental amalgam treatment.[25] The moderate correlation between the amount of dental amalgam used in the polyclinics and the MSTL and the level of mercury in wastewater can be attributed to a limited number of samples collected and a higher settling rate of dental amalgam particles in the wastewater flow. The detection of mercury in the wastewater samples due to flushing of dental amalgam particles in the wastewater lines on days when no amalgam was used, was described as the reason for the lack of correlation between dental amalgam use and mercury concentration in dental wastewater.[26]

The wastewater system layout at the WOHC necessitated the installation of the sampling apparatus proximal to the vacuum pump location in the main vacuum line for the polyclinics and MSTL. The wet-ring vacuum pumps used at the WOHC use water to lubricate and cool the pump housing

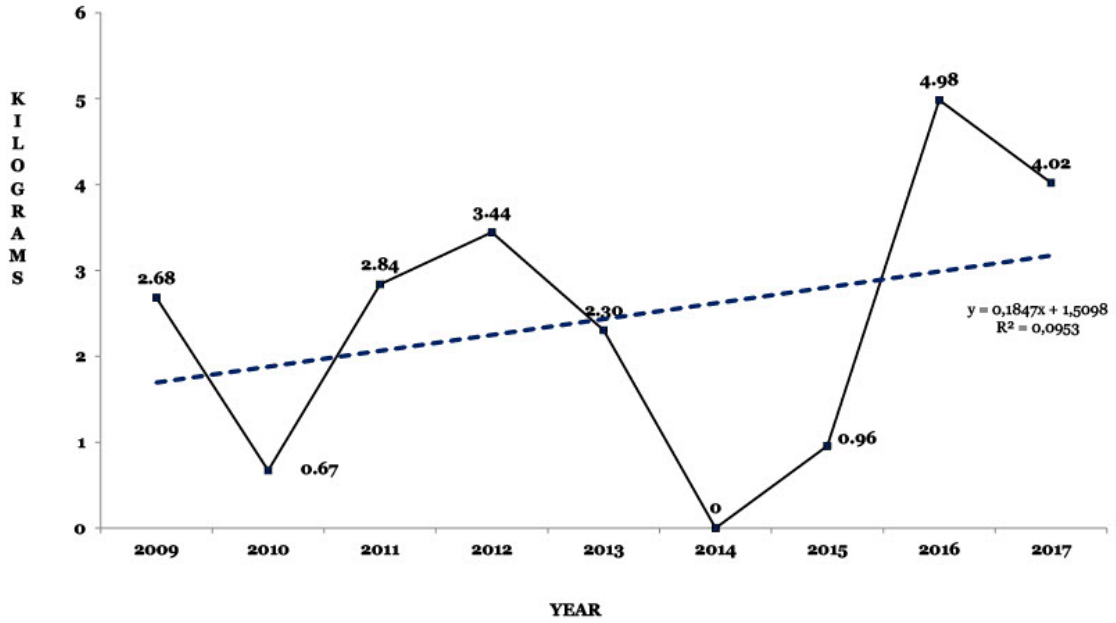

Figure 1. The amount of dental amalgam procured yearly by WOHC from 2009 to 2017.

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seal and contain a trap that protects the pump from solids in the wastewater. In a typical eight-hour working day, the pump uses 1,089.6 litres of water.[27] The above conditions make the mercury concentration of wastewater samples collected before the wet-ring vacuum pump higher than that of wastewater entering the sewer. Previous studies have used wastewater collected directly from the dental chair,[25] and dental chair and settling tanks.[24] The different options in vacuum line layouts, sampling points and pump types used in dental clinics' design might lead to widely varying wastewater mercury levels. The national sanitation policy emphasises the importance of industries and businesses connected to the sewage system to ensure that discharge does not risk the treatment process, quality and quantity of effluent.[35] The South African national norms and standards for sanitation services prohibit dilution of the effluent to achieve compliance with set concentration limits.[28] Rising utility costs and environmental concerns have led to a shift to the more efficient dry vacuum system and recycling of wet ring pumps.[29] The establishment of sampling points for dental wastewater should consider the fact that dilution occurs in wet ring pumps, unlike dry vacuum pumps.

The present study found that only a partial application of BMPs for dental amalgam use was adhered to, leading to contamination of the wastewater and the environment by mercury and other dental amalgam constituents. The inadequate application of the BMP is similar to that reported in other developing countries.[30-32] This could be due to a lack of national guidelines. The current guidelines on managing healthcare risk waste in South Africa do not adequately meet the current standards in amalgam waste management.[33]

The provision for separating amalgam waste into contact and non-contact waste, amalgam spill kits, specification of amalgam waste containers, measures to mitigate wastewater mercury contamination, and disposal methods is lacking. The healthcare waste management regulations in South Africa state that establishments are responsible for the waste from the point of generation until its final treatment and disposal.[34] Developing updated healthcare waste guidelines will facilitate proper amalgam waste management and ensure oral healthcare facilities do not contravene the country's waste management regulations.

There was a slight increase in dental amalgam procured during the study period. The increase in procurement was ascribed to an increased intake of first-year dental students, which doubled from 25 in 2011 to 50 in 2014. The variations in yearly procurement of dental amalgam observed in this study uncovered a need for accurate demand forecasting to prevent wastage and potential environmental contamination during long-term storage.

Dental amalgam restorative material continues to play an essential role in the pre-clinical training of dental students and the provision of restorative treatment at the WOHC. Procuring regular setting amalgam for pre-clinical training may contribute to the high amount of dental amalgam used in the MSTL. WOHC should consider the introduction of extended carving time (ECT) and slow carving (SC) dental amalgam formulations, which afford the operator a longer working time and could lower the amount of dental amalgam used for training.[36] There is a need for further investigations on the affordability and utility of dental amalgam restorative material, considering the cost of waste management, disease burden, practitioner skills and treatment coverage goals related to forthcoming universal health coverage.

The limitations of the present study include its short duration due to budgetary constraints, the inability to establish different species of mercury, and the nature of mercury due to analytical incapability in laboratory services.

CONCLUSIONS

The study revealed that the wastewater samples from WOHC contained total mercury levels ranging from 1.048mg/l to 108.762mg/l. The levels of mercury in wastewater were above limits allowable by the City of Johannesburg Metropolitan Municipality Water Services by-laws. The study also demonstrated an increasing procurement of dental amalgam over a nine-year period, most of which is used for training, and inadequate adherence to the BMPs for dental amalgam use was also identified.

RECOMMENDATIONS

- The Department of Health, the HCPSA, SABS and the dental community should develop, advocate and implement appropriate guidelines for managing dental amalgam waste in South Africa.
- The possibility of introducing the extended carving time (ECT) and slow carving (SC) dental amalgam formulations for restorative dentistry training should be investigated.
- An investigation on the cost-benefits analysis of dental amalgam, based on restorative treatment needs burden and the affordability through universal health coverage should be undertaken to inform the future training priorities and planning of waste management programmes.

Keywords

Dental amalgam, mercury, dental amalgam waste, best management practices for dental amalgam use

Conflict of interest

The authors declare that the research was conducted without any commercial or financial relationships that could potentially create a conflict of interest.

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Online CPD in 6 Easy Steps

The Continuing Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.

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Influential factors on dental students' online learning experiences during the Covid-19 pandemic, Gauteng

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Yolanda Malele-Kolisa,[1] Kim Forbay,[2] Natasha Kayamba,[3] Sibongile Sibeko,[4] Mpinane Tlakane,[5] Safiyyah Vally[6]

ABSTRACT

Aim

This study assessed the perceptions and practices of the 2021 dental student cohort toward online learning.

Methods

In 2021, a cross-sectional study was conducted using an online questionnaire to measure practices and perceptions at a tertiary dental school in Gauteng, South Africa.

Results

The study had a response rate of 49.4%, with 83 out of 168 students responding. Many of the respondents were female (73.5%). Most students (82%) lived in urban locations, with 62.6% residing at university or private residences. A significant proportion of the students (59%) were self-funding their studies.

All students had access to learning devices and the majority (95.2%) had internet access before the lockdown. The students reported their peers (39.8%) and their lecturers (28.9%) as a major influence on online platform use. Almost half (45%-49%) of the students believed that the packaging of online presentations influenced them to use e-learning. When asked about their level of motivation from using e-learning, nearly a third were either "least motivated" or "neutral" about using online tools.

Most students (73.5%) preferred not to contribute to online discussions but to observe. Of great concern is that nearly all (97.6%) did not even want the corrective feedback from lectures. Being able to navigate the online platform easily was significantly associated with having internet access before the lockdown (p-value=0.05). Females were more inclined to participate in online discussions than males (p-value=0.04).

Conclusion

In summary, while neutral views suggest room for improvement, the study highlights the potential of online learning platforms in dental education. This suggests innovative strategies are needed to make online learning more engaging and exciting. The findings highlight the importance of providing access to online learning tools and ensuring that students are motivated to use them. Regular monitoring through evaluation forms will help assess the effectiveness of online learning platforms.

Keywords

Education, dental, graduate.

Authors' information

1. Yolanda Malele-Kolisa, Head: Department of Community Dentistry, School of Oral Health Sciences, University of the Witwatersrand, Johannesburg, South Africa
   ORCID: 0000-0003-3368-9193
2. Kim Forbay, School of Oral Health Sciences, University of the Witwatersrand, Johannesburg, South Africa
   ORCID: 0000-0002-0762-8074
3. Natasha Kayamba, School of Oral Health Sciences, University of the Witwatersrand, Johannesburg, South Africa
   ORCID: 0000-0003-2479-0695
4. Sibongile Sibeko, School of Oral Health Sciences, University of the Witwatersrand, Johannesburg, South Africa
   ORCID: 0000-0001-6834-8407
5. Mpinane Tlakane, School of Oral Health Sciences, University of the Witwatersrand, Johannesburg, South Africa
   ORCID: 0000-0002-0942-6804
6. Safiyyah Vally, School of Oral Health Sciences, University of the Witwatersrand, Johannesburg, South Africa
   ORCID: 0000-0003-3096-4022

Corresponding author

Name: Yolanda Malele-Kolisa
Email: yolanda.kolisa@wits.ac.za

Author's contribution

1. Yolanda Malele-Kolisa – concept, design, intellectual content, literature search, data analysis, statistical analysis, manuscript preparation, manuscript editing and review, guarantor
2. Kim Forbay – concept, design, literature search, data acquisition, manuscript preparation
3. Natasha Kayamba – concept, design, literature search, data acquisition, manuscript preparation
4. Sibongile Sibeko – concept, design, literature search, data acquisition, manuscript preparation
5. Mpinane Tlakane – concept, design, literature search, data acquisition
6. Safiyyah Vally – concept, design, literature search, data acquisition, manuscript preparation

INTRODUCTION

The Covid-19 pandemic in 2020-2021 compelled universities worldwide to swiftly transition their teaching, learning and assessment to online platforms.[1] This abrupt shift, exemplified by the universities' Health Sciences faculties transitioning their entire curriculum to online formats, necessitated both faculty and students to adapt rapidly to the technological demands.[2] Online learning, a subset of distance education, leverages on internet technology to facilitate teaching and learning beyond the confines of a traditional classroom.[3] It offers flexibility, overcoming limitations of distance, space and time, and can be cost-effective.[4] Effective online teaching requires lecturers to be cognisant of varying skill levels and the potential online learning offers.[5] Employing interactive training methods, such as simulation, video, storytelling, gamified solutions, case studies and problem-based learning, can actively engage learners in the online environment.

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Dental health professionals play a crucial role in improving public health. Thus, it's vital to continually enhance their learning capacity and knowledge acquisition. Dental students need to grasp and apply the fundamental principles of dentistry. To meet these demands, online learning is increasingly being integrated into medical and dental education.[1]

Research conducted in Saudi Arabia[6,7] and Thailand[8,9] to gauge dental students' attitudes and readiness towards online learning revealed an acceptable level of individual student competency. However, there was limited readiness among participants and a bias against online learning still existed. A study in a New York College found that students believed e-learning could be successfully incorporated into dentistry, particularly in the clinical curriculum.[10] An Australian study reported a significant increase in academic performance and overall satisfaction with understanding the work using a blended learning model.[11]

In the South African context, a study by Queiros and De Villiers in 2016 showed that while most students preferred a paper-based teaching model, the online model was effective when preceded by the necessary training in the use of learning tools for interaction with lecturers and peers.[12]

Several factors influence the participation and engagement of dental students in online classes. These include instructor issues, personal issues, learners' motivational problems, time, support service problems, prerequisite skills, technical problems and social interactions.[2] Another study highlighted the negative impacts of the Covid-19 pandemic on students' physical and mental health, despite their positive adaptation to online learning and technology use.[1]

Therefore, students' assessment of the tools, their perceptions and evaluations are crucial when reviewing the success of any online learning system. This study assessed the perceptions and practices towards online learning among the 2021 cohort of dental students attending a tertiary training institution.

METHODS

A cross-sectional analytical study was conducted among an undergraduate dental and oral hygiene 2021-student cohort registered at a tertiary dental institution in Gauteng, South Africa. The entire group of students (168) registered for the 2021 year of study were invited to participate in the survey. Data collection occurred from April 2021 to June 2021. Data were collected using an online questionnaire administered through email. A five-point Likert scale, a 22-item questionnaire was adapted from that used by Turkyilmaz et al (2019).[6,10] The questionnaire collected data on students' perceptions regarding online learning. The expected responses were: On a scale of 1 to 5, with 1 being no motivation and 5 being very motivated, what would you say your motivation level is when using online tools for learning with regard to the following? Regarding online video presentations, please rate the following factors as to their influence on your academic performance on a scale of 1 to 5, with 1 being least influence and 5 being most influence. Lastly, on a scale of 1 to 5, what perceived impact would e-learning have on your oral health science learning?

The questionnaire was sent to the participants in 2021, following the permission of the relevant managers to engage students and approval from the Human Research Ethics Committee (Number H 21/01/34).

Data analysis

The researchers captured, cleaned and verified data from the questionnaires in Microsoft Excel and exported it to Stata version 14 (Stata Corp, College Station, TX, US), which was used for descriptive and inferential statistical analysis using Pearson chi-squared and Fischer Exact tests. The demographics, year of study and historical internet use were assessed to appraise students' preferences regarding online learning across the characteristics of the study sample. The outcome variables included the study cohort's perceptions and practices.

RESULTS

The response rate for this study was 49.4%, with 83 participants responding out of a possible 168 students.

Table 1: Socio-demographic characteristics of the sample

Characteristic		BDS n=71 (85.5%)	BOHSc n=12 (14.5%)	n= 83 (100%)
Gender	F	**51 (61.1%)**	**10 (12%)**	**61 (73.5%)**
	M	20 (24.1%)	2 (2.4%)	22 (26.5%)
Year of study	1	0	0	0
	2	23 (27.7%)	8 (9.6%)	31 (37.3%)
	3	11 (13.3%)	4 (4.8%)	15 (18.1%)
	4	30 (36.1%)	-	**30 (36.1%)**
	5	7 (8.4%)	-	7 (8.4%)
Area of residence where they come from:				
Township		6 (7.2%)	4 (4.8%)	10 (12%)
Suburb		61 (73.6%)	7 (8.4%)	**68 (82%)**
Village		4 (4.8%)	1 (1.2%)	5 (6%)
Method of funding:				
Self-funding		43 (51.8%)	6 (7.2%)	**49 (59%)**
Bursary/Loan		28 (33.7%)	6 (7.2%)	**34 (40.9%)**
Residence while attending university prior to lockdown:				
With family		27 (32.5%)	4 (4.8%)	**31 (37.3%)**
University residence		27 (32.5%)	3 (3.6%)	**30 (36.1%)**
Private residence		17 (20.5%)	5 (6%)	22 (26.5%)

The majority (73.5%, n=61) of the participants were female students, while most (82%, n=68) students reported living in suburban residences compared to very few who lived in rural areas (6%, n=5) (Table 1). Almost 40% of students lived with a family, while the majority (about 62.6%) stayed either in university residences or private residences. Self-funding for university studies constituted nearly two-thirds (59%), while the remainder were funded via bursaries or loans. (Table 1)

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Table 2: Access to online learning tools, mode of delivery and use of the computer and internet by all participants

Characteristic	BDS n=71 (85.5%)	BOHSc n=12 (14.5%)	n=83 (100%)
Devices available to students:			
Smartphone	69 (83.2%)	10 (12%)	79 (95.2%)
Laptop	65 (78.3%)	11 (13.3%)	76 (91.6%)
Tablet	19 (22.9%)	0	19 (2.9%)
Computer	7 (8.4%)	0	7 (8.4%)
Access to internet before lockdown:			
Yes	67 (80.7%)	12 (14.5%)	79 (95.2%)
No	4 (4.85%)	0	4 (4.8%)
Method of internet access			
Wi-Fi	26 (38.34%)	7 (58.33%)	33 (41.25%)
Wi-Fi & Cell phone	15 (22.06%)	2 (16.67%)	17 (21.25%)
Cell phone Data	14 (20.59%)	2 (16.67%)	16 (20.00%)
Fixed Home internet	13 (19.12%)	1 (8.33%)	14 (17.80%)
I can easily format a word document:			
Disagree	5 (7.04%)	0	5 (6.02%)
Agree	66 (92.96%)	12 (100%)	78 (93.98%)
I can easily navigate Sakai*			
Disagree	3 (4.23%)	0	3 (3.61%)
Agree	68 (95.77%)	12 (100%)	80 (96.39%)
Social factors which influenced your perception of online learning			
Peers	30 (42.25%)	3 (25.00%)	33 (39.76%)
Lecturers	20 (28.17%)	4 (33.33%)	24 (28.92%)
All	11 (15.49%)	3 (25.00%)	14 (16.87%)
Family	10 (14.08%)	2 (16.67%)	12 (14.46%)
Mode of delivery			
Online only	11 (15.49%)	0	11 (13.25%)
Traditional only	14 (19.72%)	4 (33.33%)	18 (21.67%)
Combination	36 (50.70%)	7 (58.33%)	43 (51.81%)
Attendance not related to mode of delivery	10 (14.08%)	1 (8.33%)	11 (13.25%)

* Sakai (university-unique-online platform)

All students had a device to access learning materials, while most (n=79; 95.2%) had internet access except n=4 dental students. Additionally, the majority (96.4%) of the students could use Microsoft Word to send emails and navigate Sakai (96%) (university-unique-online platform). The student peers influenced them the most about online learning (39.8%), followed by lecturers at 28.9%. Approximately half (n=43, 51.8%) of students preferred a blended approach of learning, where online and traditional learning were integrated. (Table 2)

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Table 3: Factors that impacted student experience of online learning

Level of influence of learning from online presentations	Least influence n (%)	Neutral n (%)	Most influence n (%)
Online presentation itself	10 (12.05%)	25 (30.12%)	48 (57.83%)
Depth of the content	10 (12.05%)	30 (36.14%)	43 (51.81%)
Mobile friendly content	9 (10.84%)	25 (30.12%)	49 (59.04%)
Modern "look and feel" of the content	10 (12.05%)	28 (33.73%)	45 (54.22%)
Level of motivation to utilise online tools	**Least motivated**	**Neutral**	**Very motivated**
Working on large projects alone	30 (36.14%)	30 (36.14%)	23 (27.71%)
Achieving goals and manage distractions	33 (39.76%)	36 (43.37%)	14 (16.87%)
Meeting deadlines	14 (16.87%)	28 (33.73%)	41 (49.40%)
Spending long hours working online on tasks	38 (45.78%)	28 (33.73%)	17 (20.48%)
Level of impact on e-learning	**No impact**	**Neutral**	**Greatest impact**
e-learning on understanding topic	14 (16.87%)	44 (53.01%)	25 (30.12%)
e-learning on oral health education	15 (18.07%)	42 (50.60%)	26 (31.33%)
Perceptions	**Agree**		**Disagree**
I would not prefer to contribute to online discussion forums and rather just observe	22 (26.51%)		61 (73.49%)
I would like opportunities to interact with my lecturer online	9 (10.84%)		74 (89.16%)
I would have liked activities that would have enabled me to obtain corrective feedback from lecturer	2 (2.41%)		81 (97.59%)

The mobile-friendly content and modern "look and feel" influenced students learning (57%-59%). More than half (51%-59%) of the students felt that online presentation packaging contributed the most to e-learning – meaning that the depth of content of the videos, whether the material is mobile friendly, how the presentation is and "feel" had the most influence on their academic performance. A third (30%-36%) of students reported neutral responses regarding the packaging level of influence by the online presentations. Online learning motivated students to meet deadlines (49%)

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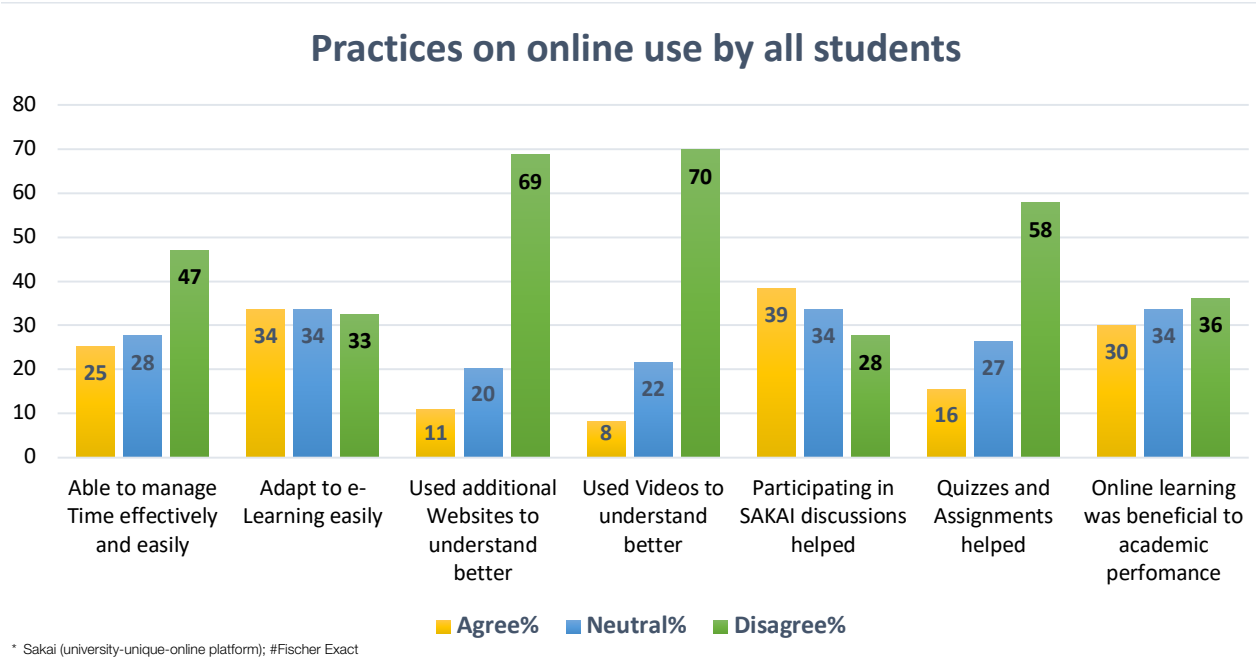

* Sakai (university-unique-online platform); #Fischer Exact

Figure 1. Practices of students regarding e-learning and online use

Working alone on large projects (36%) and managing distractions (40%) provided the least motivation to students. Generally, a third of students were neutral to the responses about the level of influence and motivation, while half (50%-53%) were neutral on the level of impact of online learning in their studies. (Table 3)

Students were also asked to share perceptions on engagement and feedback online. Most students preferred not to contribute to online discussions and would not want to interact with the lecturer online (73.5% and 89%, respectively), but rather observe. Of great concern is that nearly all did not even want the corrective feedback from lectures (97.6%)

Practices

The majority of students (95%) were computer literate and about two-thirds (61%) spent more than three hours on e-learning (not in figure). All students had relatively varied opinions with regard to the benefits of online learning. The highest proportions were generally negative about online learning. (Figure 1)

Easily navigating SAKAI was significantly associated with having internet access before lockdown (p=0.05). There was a difference between males and females with regard to their online participation, with females more readily participating in online discussions than males. There was no difference in keenness between dental and oral hygiene students. (Table 4)

DISCUSSION

The Covid-19 lockdown period necessitated a hasty transition from non-routinely used online platforms to compulsory use. The tertiary institution under study had an existing online platform that was not routinely used. The current study assessed the perception and practices of the 2021 oral health student-cohort regarding online learning during the 2020 Covid-19 lockdown period. The study had a good response rate for an online survey of 49.4%. Varying response rates have been reported in the literature ranging from 15% to 29% for web-based and email surveys, and a 30% response rate is considered reliable to generalise the results (13). Data collection occurred over three months, and monthly reminders were given to encourage participation.

Age and gender

The current study contributes to the literature as it revealed a difference between male and female students regarding their attitudes about online presentations. There were more females in the current study, and most readily participated in online activities. The results of the current study are similar to a study by Bahanan et al, 2022, where males preferred traditional learning and females tended to be inclined toward e-learning.[14] However, in the current study, there was no age or gender difference in preference for blended teaching models incorporating online learning and traditional learning. This agrees with several other studies that also did not display a difference in online use by age group nor gender.[9,11] A South African study reported that in developing countries, students' circumstances, the ownership and access to technological devices contribute to the student perception about online learning. The latter study failed to differentiate between age and gender as factors that contribute to student perceptions.[12]

Computer skills use and internet access

The participants in the current study reported a high level of computer skills and were able to operate and navigate the main online teaching platform utilised by the university, with ease. The online platform was utilised even before the lockdown period. Similar results were also reported, with undergraduate dental students in Saudi Arabia being computer literate. [9] In addition, the majority of the dental students in the Bahaman et al (2022) study had some knowledge of using the Blackboard platform before the Covid-19 pandemic. The experience led to easy adaption to and acceptance of their e-learning scheme.[14] The current study suggests that students were ready for e-learning adoption from a technological competency point of view.

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Table 4: Association between internet access, gender and online learning

Internet access	Easily navigate SAKAI			p-value#
	Disagree	Neutral	Agree	
Yes	2 (66.67%)	11 (91.)	66 (97.)	0.05
No	1 (33.33%)	1 (8.33%)	2 (2.94%)	
Total	3 (100%)	12 (100%)	68 (100%)	
Gender	**Attitude: Keen on participating in online discussion**			
	Agree	Neutral	Disagree	p-value
Female	20 (58.2%)	28 (82.35%)	13 (86.67%)	0.04
BDS	29 (85.29%)	30 (88.24%)	12 (80.00%)	0.75
BOHSc	5 (14.71%)	4 (11.76%)	3 (20.00%)	
Total	34	34	15	

Many (61%) of the students spent a minimum of three hours on online learning platforms. In contrast, a New York Dental College study found that 40% of the students spent less than one hour; however, 11% went above four hours.[14]

The success of e-learning adoption is also highly dependent on access to technology and having a good internet connection. Of the 83 student participants, the vast majority (n=79) had good internet access before the implementation of online learning; Wi-Fi was their main source of internet access. The study cohort reported high levels of technology accessibility, ensuring a good technological foundation for e-learning adoption in the institution amid the Covid-19 pandemic and subsequent lockdowns. An associated link between online competency levels through ease of navigating Sakai and having internet access before lockdown was also noted. Student peers were the primary motivator for using online learning, followed by lecturers at 28.9%.

Other degrees

The dental school in question only offers training for two degrees and no difference was found between any of the variables and the study category. This could be attributed to the very small number of degree programmes participants. A systematic review by Abdul and colleagues focused on the transition to online learning during Covid-19 by medical, biomedical, dentistry, nursing and veterinary students. The authors reported that nearly half of the students in all disciplines were moderately satisfied, while more than a third (37%) were highly satisfied with the online learning mode. Many of the students cited flexibility as a reason for their satisfaction.[15]

Funding method

The current study noted that the mode of online teaching was not associated with the funding method of students viz: self-funding or government funding. According to the literature, most students opt for online education due to the convenience and associated cost-effectiveness in institutions where a choice is available.[16] While there are direct costs associated with online learning, there are typically lower indirect costs. For example, reduced transportation costs, online study material and certain text books are available online.

Teaching preferences

The current study reported that half (52%) of the students preferred a mixture of both teaching methods. The same findings were noted among Saudi and USA New York College dental students.[6,10] In contrast, in a Croatian study, half of the dental students were motivated to learn exclusively online instead of in combination.[17]

With regards impact impact, in the current study most students were neutral regarding the impact of online learning on their understanding of the topic. At the same time, there were also varied opinions about the benefit of online learning towards their overall academic experience. In contrast, students in Saudi Arabia perceived online technology as essential for personal and learning purposes. Interestingly, the benefit was noted until the fourth year of study and for courses with higher theoretical content. Thereafter, in the senior clinical years, the cohort reported online learning to have little impact on the success of their studies.[6] The US cohort reported that incorporating e-learning in dentistry would be successful in the clinical curriculum in the long run after physical facilities are revamped and improved.[10]

Practice and perceptions

Despite students in the current study having access to online platforms and enabling support such as devices and internet access, they were neutral and few were motivated by working alone on large projects and managing distractions while online. Students were also neutral on how e-learning impacted their understanding of the topic of oral health science learning. Students generally had poor practices related to time management, using additional websites to complement, and disagreed that quizzes and assignments helped them. There were generally negative comments on their online practices. The negative response online was also evident when the students were not interested in the engagement and contribution towards online interactions and receiving corrective feedback from lecturers. A Ghanian university also cited the reluctance to interact and engage with students[18] and another South African study. [19] The noncommittal views and pessimism may be related to the shock resulting from the hastiness of having to be exclusively online due to the lockdown circumstances. As suggested by Mayes and co-authors, anonymity and good teacher facilitation may encourage contribution.[20]

It is encouraging to note that despite the students' views, how the online material was packaged did influence them the most. The content's "mobile-friendliness" and modern "look and feel" motivated them to use the online platform. There are lessons to learn from this study so that future improvements can be made to enable and support online learning platforms. The current cohort is of the calibre of

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the modern student generation who are skilled in the use of technology. These students have higher expectations of content in learning because the content in nonformal platforms such as social media competes with the learning sphere.[10] Indeed, the current results stride out from the perceptions about online learning less than 10 years ago. A South African study notes how online learning was viewed as inferior and not thorough enough to provide good learning to now, where it is a necessary enabling vehicle for optimal teaching and learning.[12] The latter authors highlight that the e-learning model results in connectedness among online learners. The model states that important facets include technology, students' self-sufficiency using computers as a primary requirement, and online interface. Facilitator-related activities, such as feedback and content structure, optimise e-learning use. All facets of the model are at play within the study. It was not enough that students were self-sufficient in computer use and internet access; the online material character and packaging were important factors. The facilitator or lecturer's contribution and corrective feedback are vital to achieving the benefit and productivity of online learning.

CONCLUSION

The study highlights the impact of technology integration on student learning outcomes, particularly in dentistry and oral hygiene education during the Covid-19 pandemic. The key findings and implications:

Adequate technological skills: The 2021 dentistry and oral hygiene cohort demonstrated sufficient technological and online skills. This readiness allowed for the implementation of online training platforms during the pandemic. Access to devices and the internet was prevalent, with Wi-Fi being the primary source of connectivity.

Neutral views on e-learning: The study revealed neutral or ambivalent motivation levels toward using online tools. Importantly, there was no outright rejection of online learning. Students reported mixed feelings about the impact of e-learning on their understanding and academic performance.

Influence of content packaging: Interestingly, students were significantly influenced by the packaging of online content. How the material was presented was crucial in their engagement with online learning. This finding underscores the importance of creating engaging and well-structured online learning materials.

Gender and internet access: Female students and those with pre-existing internet access before lockdown showed more enthusiasm and navigated online learning effectively. These factors could inform strategies to enhance student engagement and success.

It is recommended that lecturers be capacitated in their continuous training on online learning. Refresher courses can help educators stay updated and improve their content packaging. Beyond practical platform use, training should emphasise innovative approaches to making learning materials interesting and motivating. In summary, while neutral views suggest room for improvement, the study highlights the potential of online learning platforms in dental education. Regular monitoring through evaluation forms will help assess the effectiveness of online learning platforms. The promising prospects of online platforms extend to both undergraduates and academics, locally and globally.

Keywords

Education, dental, graduate

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Authors declare there are no conflicts of interest.

Conflict of interest

The authors declare there are no conflicts of interest.

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Mobile phone hygiene practices in healthcare settings: A mapping review

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SB Khan[1], Q Isaacs[2]

ABSTRACT

The aim of this review was to map the evidence related to knowledge, attitude, and hygiene practices of healthcare workers regarding mobile phones in a healthcare setting.

Methods

A comprehensive search across different scientific and health organization databases was conducted for all types of studies focusing on the aim. Primary outcomes included knowledge and attitude of mobile phone hygiene practices; and secondary outcomes are types of phone surface disinfectants and/ or protocols for phone use and disinfection.

Results

A comprehensive search yielded 646 articles. Following the criteria set for inclusion and using a 3-step screening process (titles, abstracts, and full text) for eligibility, a final number of 20 articles were included. Data were meticulously extracted independently by the two reviewers. Only 11 articles looked at knowledge and attitude, but most reviewed types of microbes harboured on mobile phones and related hygiene practices. Healthcare workers were aware of cross-contamination between hands and mobile phones, but disinfection compliance was substandard. Various surface disinfectants (70% alcohol-based solutions) were advised, and mediums included wipes/ swabs. Phone coverings (including cling wrap or plastic bags) are encouraged and limited mobile phone use in healthcare settings are advised.

Conclusion

Mobile phones are a necessity in healthcare settings. Researchers highlighted the importance of mobile phone disinfection as these devices are considered as a fomite. Evidence suggests the need for mobile use and disinfection protocols in all healthcare settings.

Keywords

Mobile phone; hygiene practices; mapping review; alcohol-based disinfectants; disinfectant media; phone coverings; mobile phone use protocol.

Authors' information

1. Prof Saadika B Khan, BChD, PDD, MSc, PhD, Department of Prosthodontics, University of the Western Cape, Cape Town, South Africa
2. Dr Qaanita Isaacs, BChD, MSc, Department of Oral Medicine and Periodontology, University of the Western Cape, Cape Town, South Africa

Corresponding author

Name: Prof Saadika B Khan
E-mail: skhan@uwc.ac.za

Author's contribution

1. Prof SB Khan – contributed to conception, protocol, data collection and analysis, manuscript preparation and manuscript finalisation (55%)
2. Dr Q Isaacs – contributed to protocol, data collection and analysis, manuscript preparation and manuscript finalisation (45%)

Conflict of interest

The authors declare no conflict of interest.

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Data availability statement

The datasets generated during and/or analysed during the current study are available from the corresponding authors on reasonable request. Data generated or analysed during this study are included in this published article.

ABSTRACT

Introduction

More than 5.07 billion people globally use mobile phones (MPs) daily. The use of these MPs has become an extension of the office and clinical practice for healthcare workers, including students. The mobile devices are one of the most highly touched surfaces, according to the Centres for Disease Control (CDC) and Prevention, and its use ranges from once every 15 minutes to once every two hours among healthcare workers.[1-2] The mobile devices act as the perfect substrate for colonisation of different microorganisms such as bacteria, fungi and the severe acute respiratory syndrome coronavirus 2 (SARS CoV-2) virus. This allows these microbes to flourish, which then serves as a vehicle in the transmission of nosocomial infections due to direct contact with the hands, face or mouth. This not only indicates the importance of hand hygiene, but also daily MP hygiene to prevent cross-contamination and to avoid transmission of these microorganisms.[1,3-4]

In light of infectious disease outbreaks experienced globally, Coronavirus disease (Covid) and Monkeypox (MPox), the subjects of hygiene practices and infection control are most relevant today.[4-5] Covid, a respiratory infection caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and MPox, caused by the monkeypox virus (MPox), are both contagious and transmitted directly through close physical contact and via respiratory droplets, small and large, respectively.[4-6] It has also been established that transmission may occur via indirect contact with a contaminated environment or from inanimate surfaces that act as potential sources of infection.[4,5,7-10] A dental or oral health professional may be the first to observe any signs or symptoms of MPox.[5] With the Covid-19 pandemic experienced globally, MPs were regarded as a lifeline in terms of communication. It was used for daily communication at work to allow continuance of everyday activities, including for remote working and teaching and learning, especially at universities when it was advisable not to attend campuses.[10] Subsequently, MPs have been

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included as an essential medium of learning and teaching at educational institutions (medical and dental) and continue to play a valuable role in this setting.[7,10-11]

In the clinical teaching setting, portable devices, including MPs, are used for assessment purposes to record students' scores for related clinical work.[10]

Healthcare workers, including medical and dental students, require the use of a mobile device for a number of diverse situations: viewing health-related news, communication with colleagues, to peruse medical guidelines and drug interactions, checking adverse events and health research, for medical or dental photography and radiology, sharing of medical documents, and of particular importance during the Covid-19 pandemic was through conducting patient tele-consultations.[1,10,12] It was also recommended as a tracking device during the pandemic and advised by governments to use in alerting people of other Covid positive cases in their vicinity and so ensure the safety of all in the prevention and spread of infections.[12] Thus, it has become an essential part of our work and lifestyle and has proven to change and enhance the lives of those who use it. However, by holding these mobile devices, texting, making calls or reading from it in public along with sharing of phones, various microorganisms can be transferred onto its surfaces and across the different surfaces where it is used.[13] Thus, due to its continuous daily use, these mobile devices may, therefore, be considered as "hotspots" for carrying and transmission of these microorganisms, including the SARS-Cov-2.[4,8-9,13-14]

It is apparent that respiratory viruses such as Corona, Coxsackie, Influenza, MPox virus, SARS and Rhinovirus have been shown to persist on surfaces for a few days.[2,5] By touching infected surfaces such as MPs, then touching the eyes, nose and mouth, people may become infected. Evidence suggested that SARS-CoV-2 may remain viable for hours and/or even days on a variety of materials.[1-2,15] The presence of the coronavirus is known to be more stable on plastic and stainless steel than on copper and cardboard and may be detected for up to 72 hours on these surfaces.[15-16] As MPs are neither disposable nor washable, it is a reservoir for microbes and the more time spent with the device, the greater the chances of microbial cross-contamination.[12,15] Similarly, mobile devices are stored in pockets and handbags and are used in different locations eg the toilet, gym, while dining out, and within healthcare settings, allowing contamination and creating an environment for cross-infection. This naturally increases the chances of microbial growth and the spread of nosocomial infections to patients, colleagues, family and friends.[2,15]

Low compliance of hand hygiene and, similarly, infection prevention and device disinfection protocols are found to be poor among healthcare workers including those related to mobile phones.[7,9,12] Evidence suggests that most healthcare workers fail to disinfect and decontaminate their MPs even though they are aware that it can act as a reservoir for microbes.[12] It has been reported that only between 8-13% of healthcare workers clean their devices regularly and about 93.7% had bacterial contamination on their hands after using an MP.[2,12,17] This evidence emphasises the need for proper hand and MP hygiene practices and related clinical protocols.[2,12,17] As stated, healthcare workers are aware of the importance of following an MP hygiene and disinfection routine but what is lacking, however, is a standardised disinfection protocol within healthcare settings.[7,11-12,18] For greater impact among healthcare workers, an evidence-based MP usage policy and disinfection protocol must be established to ensure it becomes the norm in healthcare settings – especially those connected to educational institutions – for successful implementation.[7,12,14]

The review aims to map out the evidence related to knowledge, attitude and practices of staff and students regarding mobile phone use and hygiene practices in a healthcare setting, in light of infectious disease outbreaks.

The objectives of the study were:
1. To map out and/or categorise the studies/evidence related to knowledge, attitudes and practices of workers in a healthcare setting toward mobile phone hygiene practices.
2. To identify different measures (disinfectants and medium) of cleansing mobile phones among workers in a healthcare setting
3. To guide the development of evidence-based and standardised protocols for mobile phone use including hygiene and disinfection practices in healthcare settings.

The research question that was addressed is:
What is the knowledge, attitude and hygiene practices of healthcare workers towards mobile phone use in healthcare settings?

METHODOLOGY

The study design that was used for this review is that of mapping or evidence synthesis.[19] The criteria for this design are similar to other review types.[19] A comprehensive search was conducted for all studies focusing on knowledge, attitude and mobile phone hygiene practices in a healthcare setting.

Search criteria

Inclusion criteria

1. Nature of the research focus is on pre-, during and post-Covid and mobile phone hygiene practices in a healthcare setting.
   Knowledge and attitudes of healthcare workers related to mobile phone hygiene practices.
   Current practices and procedures including types of mobile phone hygienic materials/surface disinfectants used.
   Company recommendations for mobile phone surface hygiene or disinfecting.

The outcomes for the review include:

Primary:	Knowledge and attitude of mobile phone hygiene practices.
Secondary:	Types of mobile phone surface hygiene materials/disinfectants. Procedures or protocols for mobile phone use and/or disinfection.

2. Comparisons
   Different educational or healthcare settings
3. Time period: 2019/01/01-2024/06/30
4. Cultural and linguistic range: English
5. Types of study design
   - Case studies
   - Health Group Reports (WHO, FDI, ADA, CDC)
   - Randomised controlled studies and clinical trials
   - Observational studies
   - Systematic reviews
   - Qualitative research

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Exclusion criteria
Research related to public mobile phone use and disinfection not covered by this mapping review.

Sources
The following databases and scientific working group sites were searched for relevant publications: Medline, Science Direct, Scopus and WHO, FDI, CDC, AMA websites. Reference lists of pertinent studies related to mobile phone use and hygiene practices were screened for additional research.

The key terms and medical subject headings were combined using Boolean operators. An example of the search string that was used is as follows:[20]

(Mobile phone OR smart phone) AND (hygiene practices OR knowledge OR attitudes OR surface disinfectants) AND (hospitals OR health clinic) AND (literature reviews OR reviews OR observational OR clinical trials OR randomised controlled trials OR qualitative research OR systematic reviews) AND (2019/01/01-2024/06/30).

The search strategy had to be kept broad to allow the maximum number of articles to be accessed as the research for this topic was not considered a priority prior to the Covid pandemic. In addition, minor changes to it were allowed to accommodate the differing search engines or databases.[20]

Study selection
A study eligibility form was created to guide reviewers to select appropriate articles from the database searches independently (SK/QI).[21] The researchers then excluded the duplicate articles selected from different databases using Mendeley. Articles were initially screened according to the titles. Following this, the selected articles were screened independently by the two reviewers (SK/QI) for the different sections according to their abstracts as per the inclusion and exclusion criteria and using their expertise as dental practitioners in a healthcare setting. After screening titles and abstracts, the two reviewers met to view any discrepancies, which were resolved through discussion.[21]

The two researchers then independently reviewed the full text version of the selected studies, and consensus was reached through discussion to determine final inclusion. When agreement could not be reached between the two reviewers, a third person (also a dental practitioner) was adjudicated at all stages of screening. The number of articles selected and reasons for exclusion was documented at each stage.

Data extraction
An evidence map provides a broad overview of the specific data from each included study that researchers agree are of value. A data extraction form was developed by reviewers and the data from each full text article was extracted in a standardised manner and summarised in a template that included the following:

- Authors, year of publication, title and geographical location
- Study design
- Setting (hospital, clinical, theatres, medical and dental educational)
- Participants (sample size, sex, staff, students)
- Tool/s
- Outcomes/conclusion
- Key results related to knowledge, attitude, hygiene practices and procedures and/or surface hygiene materials or disinfectants used
- Mobile phone hygiene protocols used at a healthcare setting
- Additional notes (funding, conflict of interest)

Data analysis and synthesis
The search results are reported using a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart, and all included studies were further evaluated according to the data extraction criteria as set out above.[21-22] It was important and necessary to group articles for the mapping of included studies. The characteristics of the included studies is reported descriptively – eg publication date, geographical location and study design – and these are summarised in a table. The extracted data was interpreted to address the review question and the findings synthesised in a narrative review and mapped out on a table. The evidence synthesis or mapping using a high-level map visualising the type of disinfectants used on mobile phones in a healthcare setting was also completed. This paper is reported using the PRISMA checklist as guideline for reporting secondary research.[21-22]

Results
For this mapping review or evidence synthesis, the review was registered with the institutional ethics review board (BMREC Reg No: BM21/9/7).

After searching all relevant databases, 646 articles were obtained following criteria set for inclusion and using a three-step screening process (titles, abstracts and full text) for eligibility and a final number of 20 articles were included (Figure 1).[1-2,7,9,11,16-17,23-35] Data were meticulously and independently extracted by the two reviewers (SK and QI) focusing on the outcomes set for this review.

PRISMA FLOW:
The four categories for reporting the searches and final study inclusion were accurately followed:

a) Identification: The search was extended not just to health databases but also to health working groups and networks due to the paucity of information related to the topic.
b) From the screening, it was noticed that the record numbers were initially high but after measuring these against the inclusion criteria, it reduced substantially. This was an indication of how the searches could be very wide where the different search engines include all terms, even those not applying to the study or review.
c) The inclusion of eligibility criteria and using a well described form aided the process.
d) Thus, the final sample for this review (n=20) seems low but highlights the importance of setting proper inclusion criteria (Figure 1).

The articles included for this review were studies conducted in different healthcare settings (hospitals, clinics, surgical areas, theatres) with different cohorts of healthcare workers (medical students, doctors in different medical disciplines, allied professionals) and in different healthcare disciplines

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Prisma Flow Diagram

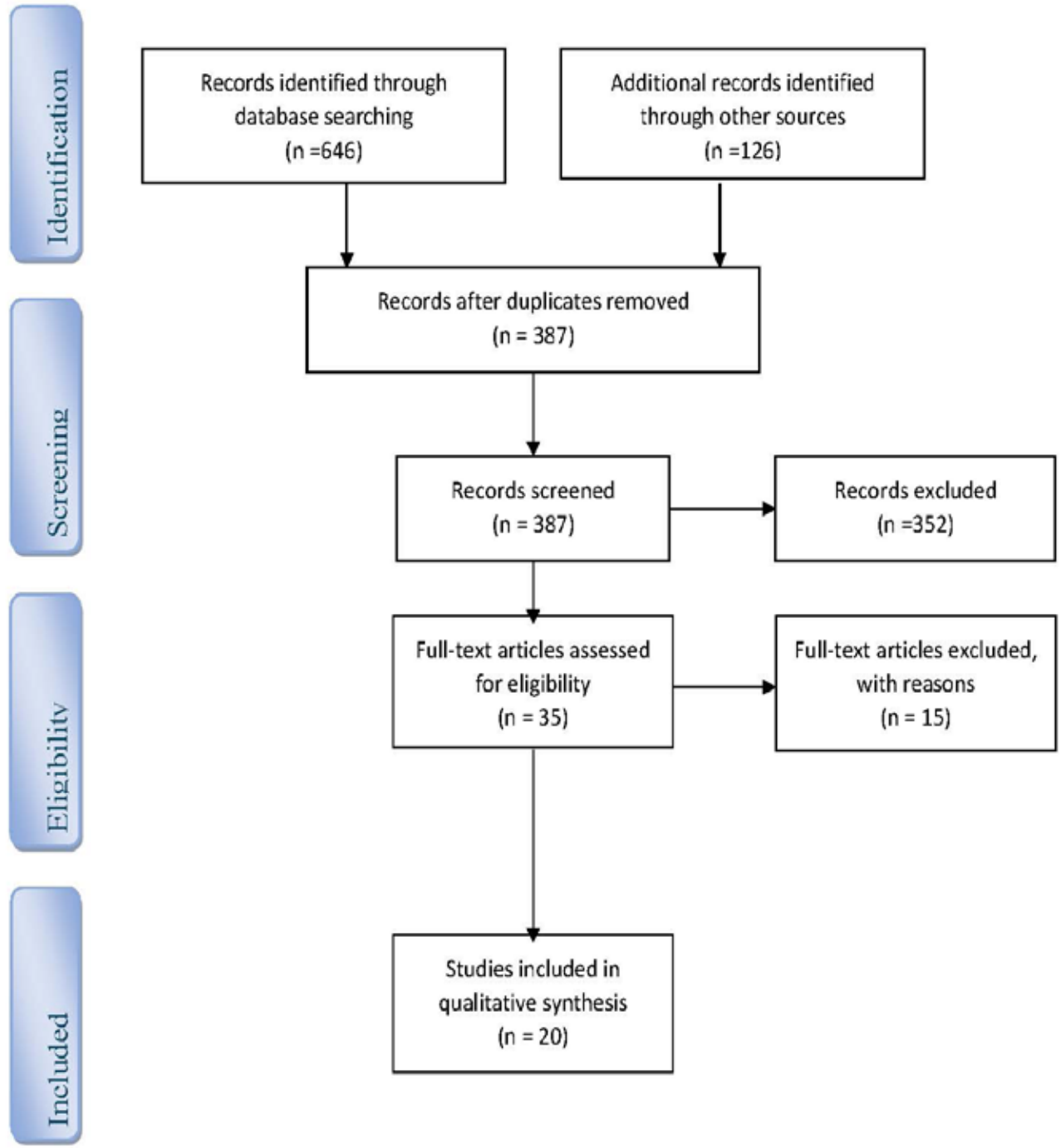

Figure 1. PRISMA FLOW Chart Indicating records for Mobile Phone Hygiene Practices

Characteristics of included studies (Table 1):

For this mapping review, the included studies used different study designs, sample size varied for the diverse group of parti cipants and the tool used was mostly a questionnaire, at times combined with swabbing of MPs.[2,7,11,25,27-31,33-34] Most participants included in these studies were questioned about their knowledge of MP hygiene practices.[1-2,7,25,27-30,33-35] Some studies extended their research objectives and included swabbing of MPs then analysed these for identification of microbes harboured on the devices.[11,28-31,33-34] Studies also looked at hygiene practices related to hands and MPs in the healthcare setting. In addition, researchers questioned participants about the MP disinfectants used to cleanse devices and whether it was sprayed, wiped or had covers. Thus, the outcomes varied across the studies (Table 1). In those studies where MP hygiene was elaborated upon, most suggested a concomitant hand hygiene protocol as a necessary and compulsory step due to suspicions of transference of microbes either way.[1,7,16-17,25,29,35]

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Table 1: Characteristics of included studies

CHARACTERISTICS OF INCLUDED STUDIES						
	Publication	Design	Sample	Tool	Outcomes	Conclusion
1.	**Panigrahi et al. 2020**	Commentary			Apple/Samsung suggest 70% alcohol use but not on MP openings	Restrict MP use. No evidence MP hygiene reduce microbes; Use MP covers/headphones. HH important
2.	**Robertson 2020**	Cross-sectional study	N=53 HC Workers (ICU)		Know/aware of HH and MP disinfection	MP contaminated with virus. MP transmission of SARSCoV
3.	**Kumar et al. 2021**	Cross-sectional study	N=66 HC Workers	Questionnaire	89.4% clean MP + adhere to HH	Restrict MP use; No evidence MP hygiene reduce microbial transmission. HH recommended. Increase MP hygiene. Standard guidelines
4.	**Gian Loreto D'Alo 2020**	Opinion	N=108		3% clean MP daily; hygiene practices to counteract spread of pathogens	SARS-CoV spread from environment and inanimate surfaces to people. Hygiene important to reduce spread of microbes
5.	**Michael et al. 2020**	Cross-sectional study	N=1100 Medical students	Questionnaire	78% cleaned MPs 93% aware of cleaning	An increase in knowledge show an increase in MP cleaning
6.	**Bhargava et al. 2020**	Systematic review	N=4 articles		Reduce MP use, sanitise MP; UV cabinets a priority; Use disposable cover	Restrict MP use in high-risk areas Maintain HH
7.	**Tladi et al. 2020**	Literature review			93.7% bacterial contamination on hands after MP use	Recommend MP disinfection HH can eliminate cross-contamination
8.	**Husain et al. 2021**	Cross-sectional study	N=110 Doctors		51%=compliant with HH; 55%=cleaned MP	Junior and female DRs more meticulous in MP hygiene and HH
9.	**Agarwal et al. 2021**	Cross-sectional study	N=956	Questionnaire Telephonic interviews	> 50% used MP; Majority sanitised MPs 50% HH compliant	Regular MP disinfection. Increase HH awareness Develop disinfection protocol
10.	**Sethy et al. 2020**	Commentary	HC Workers		MP Alcohol-base damages. Cling wrap can be sanitised and is waterproof	Avoid direct disinfectant and MP damage Use cling wrap over MP
11.	**Olsen et al. 2021**	2 Experimental trials	N=42 MP N=165 MP	Questionnaire	98% MPs were contaminated. 56% never cleaned MP	CleanPhone sanitiser reduce microbial growth. Use lint cloth and alcohol wipe on MP
12.	**Dubljanin et al. 2022**	Cross-sectional study	N=492 Medical students	Questionnaire MP swabs	MP use with increase fungal infection	Decrease MP clinical use Develop surveillance and prevention strategies Increase MP hygiene awareness Introduce standard protocol
13.	**Yao et al. 2022**	Cross-sectional study	N=111 HC Workers	Questionnaire MP swabs	95.5% bacterial frequency, Aware MPs need to be cleaned	Cross-contamination: MP/ hands Use MP cover Increase HH Develop MP -hygiene guidelines
14.	**Lubwama et al. 2021**	Cross- sectional study	N=79 Medical students	Questionnaire MP Swabs	Different microbes present/detected 83% gram positive; 34% MP hygiene compliant	Increased bacterial counts on MP Include MP hygiene in curriculum and policies

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15.	**Tannhauser et al. 2022**	Before/ After study	N=295 HC Workers	Questionnaire MP swabs	99% bacterial count Increased MP use, 96% aware of MP hygiene, But 50% cleaned MP	Bacterial cross-contamination MP to be disinfected An increased MP use, increase MP hygiene intensity
16.	**Maurici et al. 2023**	Cross-sectional study	N=83 HC students	Questionnaire MP swabs	Increased bacterial load 89% used MP 13% never clean MP	Bacteria stay on surfaces for long periods; behavioural characteristics of owner impact types and number of microbes on MP
17.	**Gala 2020**	Cross-sectional study	MP in plastic bag	MP wiped with 70% isopropyl	Use MP with plastic bag cover, use alcohol to clean covered surface	MP disinfection MP plastic cover allows use in clinics MP plastic cover is hygienic and disposable
18.	**Huffman et al. 2019**	Before/after prospective study	N=153 HC Workers	Questionnaire MP swabs: dry and after UV disinfection	Bacterial contamination: Prior UV=20% After UV=4%	MP cleaning/ hygiene UV effective in eliminating and reducing bacteria from MP UV device easy to use in clinics HH included
19.	**Qureshi et al. 2020**	Cross-sectional study	N=100 HC Workers	Questionnaire MP Swabs	93% contaminated with Staph 55% cleaned MPs (alcohol swab)	MP Hygiene practices. Replace cracked screens and covers
20.	**De Groote et al. 2022**	Systematic review	N=5425 Hospital staff/ HC Workers	PRISMA Guidelines	a) Microbes (Staph) b) Disinfectants Contaminated MPs are microbe vectors	Restrict MP use Risk of nosocomial infection MP and HH protocol (WHO)

KEY: MP=Mobile phone; HC=Healthcare; ICU=Intensive care unit; UV=Ultraviolet; HH= hand hygiene; PRISMA= Preferred Reporting Items for Systematic reviews and Meta-Analyses; WHO= World Health Organization

(1, 2, 7, 9, 11, 16-17, 23-35)

Table 1: Characteristics of included studies

(radiology, ICU, oncology, anaesthesiology, orthopaedic ward) (Table 1).[2, 21]

Outcomes of this review (Tables 1 and 2)

In terms of study designs, most were primary studies, for example cross-sectional studies (N=11), before and after studies (N=2), and one clinical trial has been reported on Table 1. There were secondary studies such as systematic reviews (N=2), a literature review and some commentaries (Table 1). Only 11 studies looked at knowledge and attitude, and most studies reviewed MP hygiene practices (Table 1). Differences in terms of knowledge, awareness and attitude towards infection control practices related to MPs have been reported to exist.[11] Healthcare workers as the participants across different spheres of health care had knowledge of MP hygiene practices and what these entail, including the different methods to achieve this, thus awareness was reported to be present (Table 1). Studies that investigated these aspects specifically recorded how they cleaned mobile phones, what they used to clean it with and what the consequence of not cleaning was.[1,7,16,26-27,32,34] In addition, many researchers swabbed MPs and then determined the type of microbes that are harboured on uncleaned phones.[11-12,28-34]

From the questionnaire studies and the responses received from the participants, it was reported that healthcare workers were aware of cross-contamination. From the research, it was reported that microbes present were mostly due to transference between hands and MP, thus emphasising hand hygiene.[7,16-17,23,29-30] It was also reported in one study that females disinfected MP more frequently than their male counterparts.[24] Thus, most studies emphasised the inclusion of a regular hand-hygiene protocol when using MPs in healthcare settings.[1,7,16-17,25,29,33,35] The exploration of different MP hygiene products such as disinfectants, MP coverings or screens as well alternatives to these such as UV disinfection or plastic and cling covers was further discussed in the included studies.[1-2,7,9,11,16-17,23-35]

Mapping of the disinfectants used and recommended in these included studies, including the MP coverings that some participants introduced, are reported in Table 2. A number of disinfectants are advised by researchers and MP companies, for example 70% alcohol-based solutions and alcohol swabs (Table 2).[1,5] The use of these disinfectants was not advised in isolation by medical researchers only; different companies had investigated this aspect and made certain recommendations of what could be used on MP surfaces for disinfection, especially during the Covid pandemic where users developed a heightened sense of clean surfaces.[1,5]

In addition, other researchers also introduced the using of different media on MPs such as alcohol-based and non-alcoholic wipes or swabs (Table 2). The type of coverings referred to in the studies and included in this review are MP covers or screens, cling wrap and plastic bags.[1-2,7,16,23,26,29,31-32,34] Other protocols referred to by some researchers include limiting or restricting MP use in healthcare settings, using headphones, disinfecting stations when entering and exiting healthcare settings and alternately making use of measures such as UV-disinfecting devices stationed in these settings.[1,7,16,26,28,32-33,35]

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Most participants and researchers recognised the importance of having MPs on them and using these in healthcare settings, even in theatres.[2,12] This meant alternative hygiene protocols to contain cross-contamination between hands and MPs that would allow continued use of these devices needed to be explored. These included having MP coverings which are disposable and that can be disinfected using readily available disinfectants in clinics.[1-2,6,23-24,26,29-30,32,34] As a result, having phone coverings such as MP screens, cling wrap or placing devices inside plastic bags that could then be disinfected were encouraged instead.[1-2,6,23-24,26,29-32,34] Moreover, this limited damage to devices.[23] Having considered all factors and clinical protocols, many studies included comments to limit or abstain from MP use in healthcare settings, when possible.[1,7,16,28,35] Many researchers also emphasised hand hygiene protocols recognising its importance in curbing transmission of microbes across different surfaces and settings, which many were conscientised to during the Covid-19 pandemic (Table 1).[1,7,12,15-17,25,29,33,35]

MEDIUM USED FOR MOBILE PHONE HYGIENE									
NO	AUTHOR, COUNTRY, (YEAR)	Disinfecting spray/ swab/ wipes/cloth	Alcohol swabs	70% Isopropyl alcohol wipes	Biocidal agents	Screen protector/ Plastic cover	UV Dis-infection	Cling wrap	(Head phones; Plastic bags)
1	Panigrahi et al. India (2020)								
2	Robertson S. Brazil (2020)								
3	Kumar et al. India (2021)								
4	Gian L. D'Alo et al. Italy (2020)								
5	Michael et al. Malaysia (2020)								
6	Bhargava et al. India (2020)								
7	Tladi et al. South Africa (2020)								
8	Husain et al. UK (2021)								
9	Agarwal et al. India (2021)								
10	Mitanjali et al. India (2020)								
11	Olsen et al. Australia (2021)								
12	Dubljanin et al. Serbia (2022)								
13	Yao et al. China (2022)								
14	Lubwama et al. Uganda (2021)								
15	Tannhauser et al. Germany (2022)								
16	Maurici et al. Italy (2023)								
17	Gala. UK (2020)								
18	Huffman et al. US (2019)								
19	Qureshi et al. Pakistan (2020)								
20	De Groote et al. Belgium (2022)								

Table 2: Mapping of types of mobile phone hygiene materials used

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After the data was extracted and analysed from the included studies, it became apparent that a gap existed across healthcare settings specifically pertaining to changes related to protocols due to the Covid-19 pandemic. For this research, particularly related to MPs, the absence of a disinfecting protocol or even a protocol allowing MP use in healthcare settings was identified by several researchers, acknowledging its importance.[7,11-12,25,28-29,35]

DISCUSSION

This mapping review addressed the aim of this study, and it highlights important aspects of mobile phone use in a healthcare setting. MPs have become a necessary addition to healthcare workers' daily tools used in clinics, theatres, hospital waiting rooms and when examining and treating patients. Thus, preventing or inhibiting its use while working in healthcare settings is not an option for many healthcare workers. What has transpired, though, is the extended consciousness post the Covid-19 pandemic of the transference of microbes from hands to devices and vice versa and the impact of this on health and wellbeing. Consequently, with most of the included studies for this review, hand hygiene was continuously emphasised.[1,7,16-17,25,29,33,35] This aspect of cross-contamination was not mentioned by Khan et al (2022) when examining MPs of students and staff in both aerosol and non-aerosol generating clinics.[12] Moreover, the increase in related research in the different settings and exploring different disinfectant media that could align with strict Covid-19 clinical protocols were also explored.

In 2021, there was estimated 7.1 billion users of MPs which is projected to increase to 7.49 billion in 2025. These devices are touched by hands averaging 2,000 times per day and are known to house micro-organisms which are easily transmissible.[31] MPs used in healthcare settings is favoured among healthcare workers and is expected to increase in the future with the various activities this cohort extend themselves to, including tele-consultations.[33]

MP hygiene practices in HC settings

Healthcare workers have adapted to using MPs as a work aid to increase the quality of care through accessing point of care tools, allowing better decision-making, thus aiding superior patient outcomes.[27] Usage of electronic devices amid patient care was reported to be 78.8% by healthcare workers.[7] It has also been reported that up to 88% of healthcare professionals use MPs in clinical practice which are contaminated with a spectrum of micro-organisms at an average contamination rate of 68%.[27] This was similar to a study conducted among dental health professionals (students and staff) where different types of microbes were found on MP surfaces.[12]

It is generally accepted that an increase in knowledge and/or awareness increases the likelihood of disinfecting MPs.[2,7,28] Michael (2020) found that undergraduate students with higher levels of knowledge were 2.15 times more likely to clean their mobile phones when compared to those with lower levels of knowledge.[2] It was also observed that MP contamination predisposed the hospital community to hospital acquired infections.[11] In addition, the behavioural characteristics of MPs users are highlighted, and this relates to where they use these devices without following any particular hygiene protocols.[12,16] For example, working in aerosol and non-aerosol generating clinics, carrying it in their handbags, visiting bathrooms and dining without cleaning these across the different platforms to prevent cross contamination.[12,16] However, it was reported that actions for infection prevention such as hand hygiene and disinfecting of MPs among healthcare workers are inadequate, even though they are knowledgeable about these practices.[7,12]

It is important to note, however, that compliance and considerations regarding hand hygiene practices have increased slightly during and post the Covid-19 pandemic, and even now with the current Mpox scare.[30] Although more efforts are required to ensure healthcare workers follow the steps of hand hygiene within the appropriate clinical spaces and at the correct times.[25,30] Researchers have advised that WHO hand hygiene posters should be displayed in handwashing areas and practical, easy handwashing methods should be circulated.[35-36] In addition, and for ensuring best practice across clinical platforms, regular monitoring and reinforcement should be rendered.[25] The use of social media platforms has been recommended to increase awareness of these practices.[11]
Infection Prevention and Control Canada and the WHO has recommended hand hygiene before and after use of MPs, but compliance is poor, as mentioned previously.[33,35] Lack of hygiene practices related to hand washing and MP disinfection can be attributed to forgetfulness, lack of time and reinforcement, inadequate awareness of standard disinfection practices and fear of damaging devices.[7] The most common excuse pertained to fear of damaging the device can be attributed to unawareness of the correct method of disinfection.[7]

Microbial analysis revealed that bacterium isolated from MPs and those on the hands of healthcare workers had similar antibiograms and biochemical profiles.[17,25] Low compliance with MP disinfection may potentially reduce effects of hand hygiene procedures as clean hands may become contaminated again by microorganisms on the device.[9,27] The rate of bacterial contamination of healthcare workers' hands increased by 93.7% after MP use.[2] Increased levels of contamination are associated with an increase in duration of mobile phone use.[2,29,33] Huffman et al (2020) found a low percentage of bacterial growth on MPs because of cleaning these devices regularly in conjunction with hand hygiene.[33] Thus, re-emphasising the importance of hand hygiene prior to and after using MPs in addition to regular disinfecting of these devices.

Banning/restricting MP use in healthcare settings has been observed as an option to prevent infections and cross-contamination.[29] The study by Yao et al (2022) discovered that this instruction was only obeyed by 2.8% of workers as 68% was in opposed to the banning of MPs in the workplace.[29] It is therefore important to rather improve MP disinfection awareness and hygiene practices as opposed to restricting its use. The positive uses of MPs across the different clinical spaces for guiding diagnoses and appropriate treatments have been reported often, thus the option of banning its use is rather unrealistic.[10-12]

MP disinfectants

To date, the best method for MP disinfection for continued use in clinical practice has not been explored and established.[33] To reduce the potential risk of microbial transmission via MPs in healthcare settings, various methods have been suggested. Decontamination with 70% alcohol decreases the rate of contamination from 47,6%-100%.[2] Alcohol wipes,

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used by some, can effectively eliminate bacteria and is often easily accessible by healthcare workers but have shown to not eliminate all micro-organisms found on MPs.[33] They are also not a recommendation by Apple and Samsung for use on their products.[1,33]

Qureshi, et al (2020) recommended MP hygiene to include the change of screen covers and replacement of cracked screens with additionally wiping the device with an alcohol swab to decrease contamination and transmission of micro-organisms.[34] This was because of their study revealing that MPs with cracked screens and covers were more likely be associated with microbial colonisation.[34] Less or no contamination was associated with appropriate cleaning of MPs within a 24-hour period, emphasising the timing of instituting such a cleansing protocol.[34]

A systematic review investigating MP contamination and decontamination found a reduction of microbes of more than 80% when using a disinfectant.[35] The disinfectant, 70% isopropyl alcohol, was the most commonly used decontaminant for MPs and was renowned for being superior to other disinfectants.[35] Other means of disinfecting MPs found to be quite effective included placing MPs in ultraviolet (UV) boxes, though this was not common practice.[33]

MP hygiene protocols

From the studies included in this review, containing one completed in the present context, the absence of an MP hygiene and disinfecting protocol was mentioned by several researchers.[7,11-12,25,28-29,35] None has officially been introduced following the recommendations from these studies, but by merging the evidence synthesised, it would not be impossible to formulate a guideline for such a much-needed protocol. Hence, an attempt to mention possible inclusions in a protocol for MP use and MP disinfection in the context of a healthcare setting will be outlined below, using the evidence presented in this review.

A) Mobile phone use protocol

Include posters to share the MP use policy of the healthcare setting. Place these posters in strategic visible clinical locations. Posters can also be shared via social media. Some of the features to be included in the MP use protocol include:[1,7,16,28,35]

- Avoid or restrict using MPs in healthcare settings, if possible.
- Avoid MP sharing between healthcare workers.
- Avoid MP sharing between healthcare worker and patient.
- Use headphones as an alternative when using MPs.
- Avoid MP use across different platforms (clinics, bathrooms, dining).
- Place MP in specially sealed spaces when not in use.
- Have regular audits for compliance based on healthcare MP use policy.[1,7,16,28,35]

B) Mobile phone disinfection protocol

Include posters to guide healthcare workers with MP hygiene techniques. Place these posters in strategic visible clinical locations in healthcare settings. Posters can also be shared via social media.

- Some of the features to be included in the MP hygiene protocol include: [1,9,17,23,25-27,29,32-35]
- Limit or restrict use of MP in healthcare settings, if possible.
- Wash hands according to handwashing protocol before use of MPs.
- Wipe MPs with recommended disinfectant before use.
- Implement regular MP cleaning within a 24-hour cycle.
- Wash hands according to handwashing protocol after use of MPs.
- Regular audit for compliance with this MP disinfection protocol.
- Clean MP while in switched off mode.
- Avoid moisture in openings of MPs.
- Do not spray disinfectant directly onto the surface of the MP.
- Place covering over the MP (plastic screens, hard cover, cling film, plastic bags).
- Spray disinfectant on MP cover or plastic bag or cling film.[1,9,17,23,25-27,29,32-35]

CONCLUSION

Evidence suggests there is a need for MP hygiene awareness and a demand for protocols regarding MP use and MP disinfection among healthcare workers in healthcare settings. Standard disinfection protocols of MPs in healthcare settings should be directly related to hand hygiene protocols stipulated by the WHO.

Clinical recommendations

MP use and disinfection protocols in healthcare settings are recommended and an attempt to describe such protocols are shared above. Educational campaigns to highlight issues with MP use, disinfection and transmission of disease can be extended to social media advertisements encouraging MP users, which would be ideal for students.[2] The addition of these protocols early in the dental/medical curriculum when students are exposed to other disinfection protocols is another suggestion.[11] Lastly, clear posters and signage regarding HH and MP use and disinfection must be placed in specific locations in clinical spaces.

Future research

Prior to the Covid-19 pandemic, research related to MP hygiene and disinfection was not a priority. However, post this global health catastrophe and the reports related to the current MPox infection, researchers realised the urgency and importance of conducting this type of research. Much of this can be directed to the education of MP use and hygiene in different settings. The efficacy of (and practicality of) using different methods of disinfection on MPs such as sprays, wipes and UV devices may be explored. In addition, addressing compliance following placement of visible protocols can be studied, too. Moreover, conducting research to highlight cross-contamination from medical staff to patients and vice versa is a priority, especially considering that the MPox infection is regarded as a public health emergency.[5] Another area that needs to be addressed is cross-contamination between different locations within the healthcare settings (clinic to bathroom to dining areas).

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Peripheral compound odontoma: A rare case report

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V Peranovic,[1] BK Bunn,[2] P Gwengu[3]

ABSTRACT

Background

Odontomas are currently classified as benign mixed epithelial/mesenchymal odontogenic neoplasms which are located within the tooth-bearing regions of the jaws. Despite being considered neoplasms, the clinical characteristics of these lesions are much the same as hamartomatous lesions. Peripheral odontomas are rare entities that are located entirely within the adjacent soft tissue of the mucosa and/or gingiva. Apart from location, peripheral odontomas are morphologically, radiologically and pathologically indistinguishable from their intraosseous counterparts.

Case report

An 18-year-old female patient presented with an "irritation" on the mucosa of her hard palate posterior to the maxillary incisor teeth. She reported a small, tooth-like growth in the area which had been the same size for several years. Furthermore, she was asymptomatic with no other dental concerns and, in addition, she did not have any aesthetic or functional problems. Clinical examination revealed multiple tooth-like structures which had erupted as a mass posterior to tooth 11 and tooth 12. Radiographic examination confirmed the presence of a single, oval, well-circumscribed lesion partially encapsulated and superimposed over the mid aspects of the roots and partially over the crowns of the maxillary incisor teeth. The features noted are consistent with those of a peripheral compound odontoma.

Conclusion

Peripheral odontomas are exceedingly rare lesions which bear a resemblance and origin to their central intra-osseous counterparts. This case demonstrates a peripheral compound odontoma which had not disrupted or affected the adjacent dentition.

Authors' information

1. V Peranovic, BDS, DipDent (Oral Pathology), MDS (Maxillofacial and Oral Radiology), Department of Maxillofacial and Oral Radiology, School of Oral Health Sciences, Sefako Makgatho Health Sciences University, Pretoria, South Africa ORCID: 0009-0007-5657-3341
2. BK Bunn, BDS, FCPath (SA) Oral, MDent (Oral Pathology), Department of Operative Dentistry, School of Oral Health Sciences, Sefako Makgatho Health Sciences University, Pretoria, South Africa ORCID: 0000-0001-5699-4997
3. P Gwengu, DipOH, BDS, MpH, MDent (Comm Dent), Department of Operative Dentistry, School of Oral Health Sciences, Sefako Makgatho Health Sciences University, Pretoria, South Africa ORCID: 0000-0002-1429-2396

Corresponding author

Name: BK Bunn
Email: belindabunn@gmail.com
Tel: 082 708 5868

Author's contribution

1. V Peranovic – clinician who retrieved the case information, contribution to conceptualisation, writing and editing
2. BK Bunn – conceptualisation, writing, editing and submission
3. P Gwengu – writing and editing

Keywords

Odontoma, benign mixed epithelial/mesenchymal odontogenic neoplasm, compound odontoma, peripheral compound odontoma, extra-osseous compound odontoma, complex odontoma, hamartoma.

INTRODUCTION

During embryonic tooth development, the interaction which occurs between the ectodermal and mesenchymal ("ectomesenchyme") tissue results in the well-timed, accurate and intricate development of both the deciduous and secondary teeth in a process of reciprocal induction. Interference, epigenetic or genetic alterations of normal tooth development may give rise to the development of a wide array of both benign and malignant odontogenic neoplasms. The majority of these are located within the bone in an intra-osseous location with relatively few identified in soft tissues alone.[1-3] Although, at present, the World Health Organization (WHO) still classifies odontomas as odontogenic neoplasms, their frequency of occurrence and nature are more akin to those of a hamartoma.[4] A hamartoma may be defined as a disorganised mass of tissue which is normal in structure and growth located within tissue at a site which it would ordinarily be located within.[5]

Peripheral variants of intra-osseous odontogenic neoplasms are identical in their structure and morphology except for their location outside of bone. They are generally located within the gingiva and mucosa.[4] At present, the WHO considers odontomas to represent "tumour-like" malformations composed of dental hard and soft tissues.[1,6] Odontomas are classified into two types – complex and compound. Both forms usually present clinically as small, well circumscribed, mixed radiopaque/radiolucent lesions within the maxillary and mandibular bone. Complex odontomas comprise an amorphous, haphazard mixture of dental hard and soft tissue while a compound odontoma comprises numerous tooth-like structures which contain dental hard and soft tissue in close proportion to what is seen in normal tooth structure. It is rare for odontomas to erupt exclusively within the surrounding soft tissue although these have been documented.[2,4,5,7-10] These are termed peripheral odontomas. Peripheral odontomas may be either compound or complex just as their intra-osseous counterparts are.

The objective of this paper is to document the presence of a peripheral compound odontoma which had erupted into the oral mucosa without affecting the adjacent dentition.

CASE REPORT

An 18-year-old female patient presented with a main complaint of an irritation on her palatal mucosa adjacent to the posterior aspects of tooth 11 and tooth 12. She reported that there was no associated pain, sensitivity or discomfort in this region. She did not complain of poor aesthetics or of any functional difficulties. There was no medical, social or

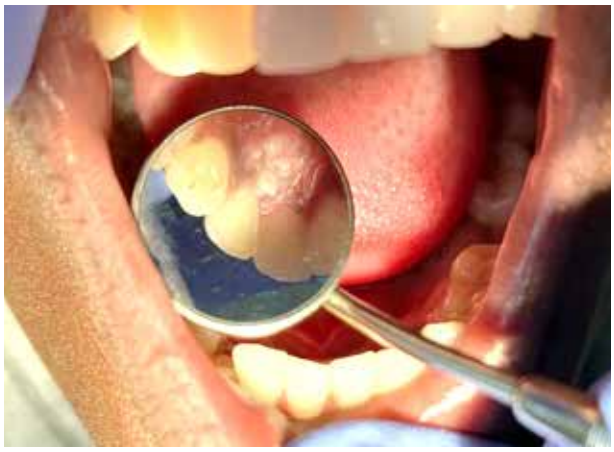

Figure 1. The clinical photograph above shows the intra-oral appearance of the patient's teeth in occlusion. From this view there is no evidence of pathology and no extra-oral abnormalities. (Left)
Figure 2. The clinical photograph above shows intra-oral presentation of the palatal aspect of teeth 11, 21, 22 and 23 with a mouth mirror. Reflected in the mirror is an erupted compound odontoma comprising numerous denticles. (Above)

family history of significance. There was no preceding history of trauma or evidence of infection. Intra-oral examination showed all permanent teeth to be present and well aligned in both dental arches. There were no missing teeth, no retained deciduous teeth, no supernumerary teeth and no evidence of diastema formation. The patient had no dental complaints. A class one occlusion was noted in which a mild crossbite was identified in the region of the right canine and premolar teeth (Figure 1).

Examination of the palatal mucosa showed a slight swelling located on the posterior aspect of teeth 11 and 12. The lesion appeared to comprise multiple protruding tooth-like structures resembling small crowns of teeth. On palpation, the swelling and calcified tooth-like structures were hard, non-tender and immobile. The surrounding palatal mucosa was normal in appearance, being non-erythematous with no evidence of inflammation or of ulceration (Figure 2).

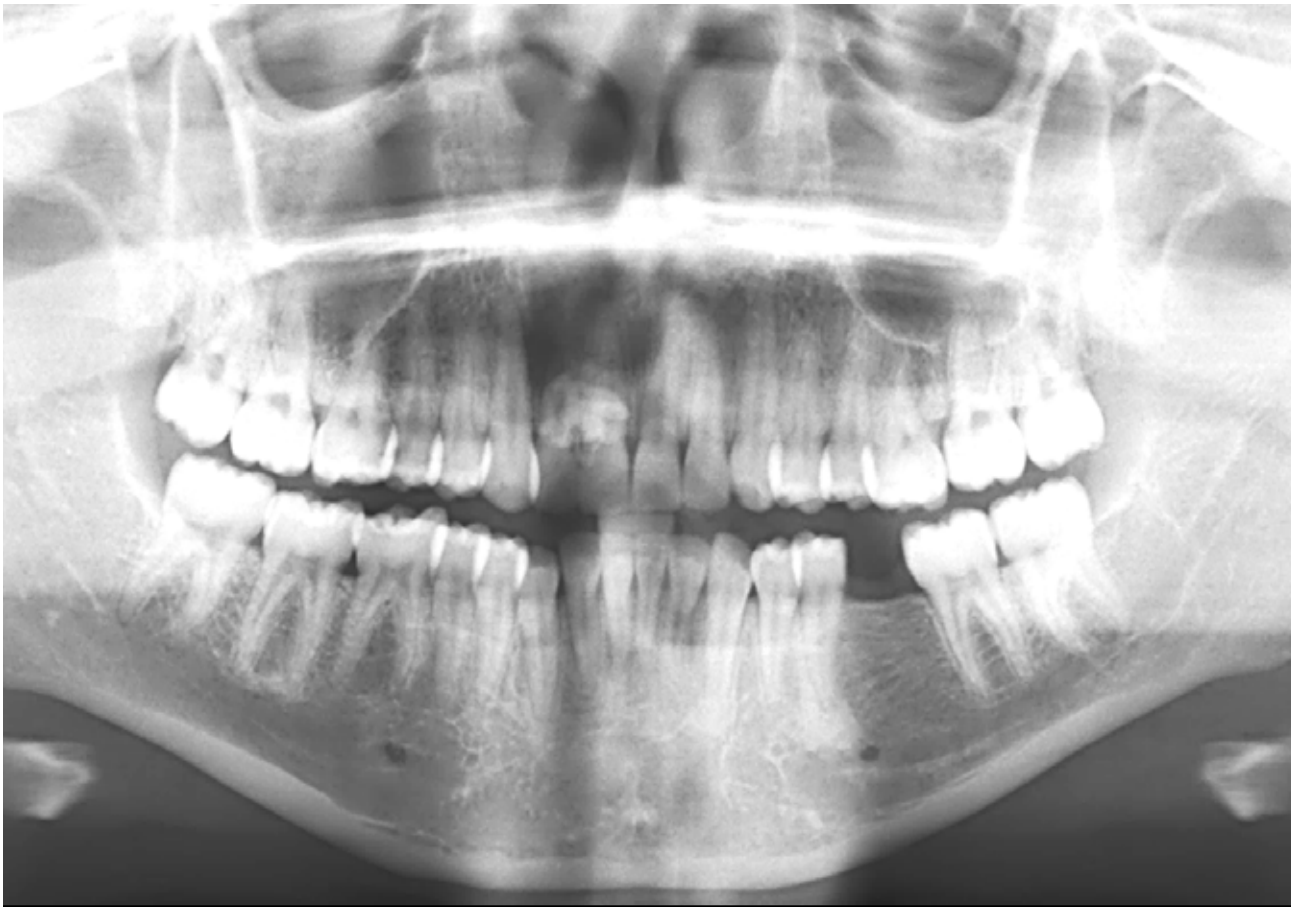

Figure 3. Panoramic radiograph showing the superimposition of an erupted compound odontoma on the palatal aspects of the roots and crowns of tooth 11 and tooth 12.

Figure 4. The clinical photograph depicts the multiple, somewhat misshapen, tooth-like structures which were obtained at surgical removal of the lesion. The denticles were attached to each other by minimal connective tissue and were separated easily.

Panoramic radiograph showed a single oval, well-defined lesion measuring 15mm in diameter, located in the anterior maxilla where it is superimposed over the roots of tooth 11 and 12 slightly obscuring them. The lesion had a predominantly radiopaque appearance but was distinctly composed of individual small tooth-like structures (denticles) surrounded on one aspect by a fibrous capsule. The surrounding anatomical structures were in no way affected by the lesion. There was no clinical evidence of tooth displacement, nor of root resorption. The adjacent teeth are all vital (Figure 3).

Under local anaesthesia, the odontoma was enucleated, resulting in excision of multiple tiny toothlets (denticles) with minimal attached soft tissue. These tooth-like structures were submitted for histology. The pathology report confirmed the presence of a compound odontoma (Figure 4).

DISCUSSION

Odontomas are classified as benign mixed epithelial-mesenchymal neoplasms by the World Health Organization.[11] Odontomas are typically located within the bone where they are identified as small round radiopaque/radiolucent anomalies either representing compound or complex varieties. Compound odontomas are encapsulated lesions comprising numerous miniature teeth/denticles. These tiny denticles are clustered together and are fully representative of pulpal tissue, dentine, cementum and enamel in the correct proportions but on a much smaller scale. Complex odontomas, conversely, are also well demarcated radiopaque lesions which comprise an amorphous mass of dental hard material including pulpal tissue which are arranged in a haphazard manner.[5] The consequences of odontomas include possible impaction of adjacent teeth or malpositioning of surrounding teeth. Furthermore, there have been reports documenting secondary infection within odontomas. It is extremely rare for an odontoma to spontaneously erupt without causing any complications to the surrounding dentition. An odontoma which erupts completely into the soft tissue with no remaining association to the underlying bone is termed an "erupted odontoma".[4] An odontoma which has partially erupted into the adjacent soft tissue which may or may not include eruption into the oral cavity but demonstrates some form of attachment to the underlying bone even if it is in the form of a ligament or part of a fibrous band or connective tissue capsule, the lesion is referred to as a peripheral odontoma. Peripheral odontomas are thus the soft tissue counterparts of their intra-osseous forms. Compound odontomas tend to occur within the anterior regions of the maxilla while complex odontomas are more frequently encountered in the mid to posterior regions of the mandible.[5,10]

Intra-osseous odontomas are the most prevalent odontogenic neoplasm with a documented frequency of 45.8%. True peripheral odontomas are a rare phenomenon. Most peripheral odontomas have been documented to occur in the maxilla and are generally identified as asymptomatic, slow-growing masses in children.[4] The denticles/tooth-like structures identified in compound odontomas may show variation in morphology but will all be composed of pulpal material surrounded by dentine, cementum and immature enamel.

It has been postulated that the WNT/Č-catenin pathway is activated in embryonic SOX2 positive dental stem cells which then play a role in the development and formation of odontomas.

The exact aetiopathogenesis of peripheral odontomas is not well known or understood. It has been proposed that small remnants or cell rests of the dental lamina (such as the cell rests of Serres) may retain the ability to undergo reciprocal induction with the surrounding mesenchyme resulting in the formation of organised (compound) or disorganised (complex) masses termed odontomas. A point of debate related to these lesions has been encountered in the literature. Odontomas could be classified as intra-osseous, peripheral or erupted. By definition, an intra-osseous odontoma is, as its name implies, located entirely within bone. The peripheral odontoma, likewise, is located entirely within soft tissue. The term "erupted odontoma" appears to be a misnomer as, in most cases, there remains superficial attachment to the underlying bone and, as such, should be regarded as intra-osseous odontomas, even if a small part of the odontoma partially erupts into the oral cavity.[4,12] Furthermore, the debate around the potential eruptive force and complete morphogenesis of a peripheral odontoma has ensued. However, since a true peripheral odontoma lacks a periodontal ligament or attachment to bone, there is virtually no potential for it to fully erupt with little evidence to suggest continued tooth development or maturation.[12,13] There are several plausible theories as to the origin of the peripheral odontoma.

As previously mentioned, it is suspected that random remnants of the dental lamina may represent the origin of the peripheral odontoma; however, there is no agreement as to what stimulates the activity of these rests to initiate proliferation.[14-17]

Alternative theories suggest origin from the basal surfaces of the oral epithelium or because of activated ectopic neural crest cells.[9]

The clinical and morphological appearance of a peripheral compound odontoma is unique enough to identify two possible differential diagnoses. In this scenario, one must definitively exclude the possibility of a supernumerary tooth. The recommended treatment of choice for peripheral odontomas is simple surgical excision for which no recurrences have been reported to date.

CONCLUSION

Peripheral compound/complex odontomas are rare odontogenic lesions which may perplex the uninitiated OHCW. The slow growth, lack of symptoms in association with the lesion and the lack of origin from the underlying bone, together with curative surgical removal as well as increased awareness of such lesions, may increase the detection and reporting rate of such cases to more accurately represent the prevalence of these lesions within the communities we serve.

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Lymphangioma: A Rare Intraoral Cystic Lesion

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A Odendaal[1], A Kassan[2], A Afrogheh[3]

CASE PRESENTATION

A 34-year-old female presented to an Oral and Maxillofacial surgeon with a complaint of a large painful cystic mass of her right upper lip. The patient mentioned that the lesion has been gradually increasing in size over the past few years. She also reported that the cystic mass was previously aspirated by an Oral and Maxillofacial surgeon who advised her to closely monitor the lesion. The patient had no medical history of note. She was taking Mypaid Forte tablets for pain relief and was using Gum Paroex 300 ml oral rinse twice daily. Extraoral examination was unremarkable. Intraoral examination revealed a 3 x 2 cm bluish submucosal cystic lesion of the right upper lip (Figure 1).

The clinical differential diagnosis included cystic benign and malignant salivary gland neoplasms that commonly involve the upper lip (pleomorphic adenoma, canalicular adenoma and mucoepidermoid carcinoma), arterio-venous malformations, namely hemangioma and lymphangioma, and mucocele (although a rare occurrence in the upper lip). An excisional biopsy was performed under local anaesthesia. The excised specimen was placed in formalin and sent to the pathology laboratory for histological evaluation.

Microscopic examination revealed dilated irregular large vascular channels lined by a single layer of flattened endothelial cells (Figures 2 a,b). Focally the ectatic vascular spaces contained aggregates of lymphoid tissue and endothelial cell proliferations (Figure 2 c). The endothelial cells were positive for the immunomarker D2-40 (podoplanin) (Figure 2 d). Based on the histolgical features and the immunhistochemical positivity for podoplanin, a diagnosis of cavernous lymphangioma was established.

DISCUSSION

Lymphangiomas are characterized by abnormal proliferation of lymphatic vessels that have no communication with the normal lymphatic system. Recently, lymphangiomas have been linked to a somatic mutation in PIK3CA gene, suggesting a neoplastic aetiology.[1] For the latter reason the World Health Organization (WHO) Classification of Tumours continues to use the term “lymphangioma” instead of vascular malformation.[2] Lymphangiomas are very rare and preferentially affect the head and neck region. Most cases occur in children and young adults. In the oral cavity, the most frequently affected anatomical location is the tongue, followed by the lip. Clinically, lymphangiomas are slow-growing often translucent cystic lesions.[3]

Oral lymphangiomas can be classified microscopically into (a) capillary (microcystic) lymphangioma, composed of small lymphatic vessels and (b) cavernous (macrocystic) lymphangioma, exhibiting large, dilated lymphatic vessels.[2] Histologically, lymphangiomas are characterized by the presence of several dilated vascular channels, that are lined by a single flattened layer of endothelial cells. The vascular spaces often contain a proteinaceous material (lymph). Intravascular and stromal lymphoid tissue is usually observed.[2] Some capillary lymhangiomas dissect around normal tissue structures and can cross tissue planes. These capillary lymphangiomas pose a high risk for recurrence and may be irresectable. Immunohistochemical staining for podoplanin – an endothelial lymphatic marker –and/or PROX1 is often used to differentiate lymphangiomas from haemangiomas.[4]

Surgical excision is the preferred treatment of choice for most cases since spontaneous regression of these lesions is rare.[3] Sclerotherapy is a minimally invasive, safe and highly effective procedure, ideal for recurrent/irresectable oral lymphangiomas.[5] Various sclerosing agents have been employed in the treatment of oral lymphangiomas. OK-432 is the ideal sclerosing agent with no perilesional fibrosis evident following use. Ethanolamine oleate (Ethamolin®) is the most widely and least toxic agent used with good clinical response rates.[6,7] Successful treatment of a case of a tongue lymphangioma with Everolimus (an mTOR inhibitor) targeting the PIK3A gene pathway has been reported.[8]

It is important for oral health care professionals to understand the clinicopathological presentation of this rare entity and include oral lymphangiomas in their differential diagnosis of cystic oral lesions. A better understanding of the etiopathogenesis of oral lymphangiomas may also help adopt appropriate and personalized therapeutic measures.

Fig 1. The clinical image shows a bluish large submucosal cystic lesion of the upper lip.

Authors' information

1. Anneze Odendaal, *BChD*; Department of Oral Medicine and Periodontology, Faculty of Dentistry, University of the Western Cape, Cape Town, South Africa
2. Ashwin Kassan[2] *BDS* (WITS), *MChD* (MFOS), *PDD* (IMPLANTOLOGY), *PDD* (FORENSIC PATHOLOGY) (UWC); Chief Specialist and part time senior consultant, Livingstone Hospital, Department of Oral and Maxillofacial Surgery
3. Amir Afrogheh, *BChD*, *MSc*, *MChD*, *PhD*; Department of Oral and Maxillofacial Pathology, Faculty of Dentistry, University of the Western Cape, Extraordinary Senior Lecturer, Division of Anatomical Pathology, Faculty of Medicine and Health Sciences, Stellenbosch University, Cape Town, South Africa

Reprint requests:
Amir Afrogheh, *BChD*, *MSc*, *MChD*, *PhD*
Department of Oral and Maxillofacial Pathology
Tygerberg Hospital, Cape Town, South Africa
Email: amir.afrogheh@nhls.ac.za

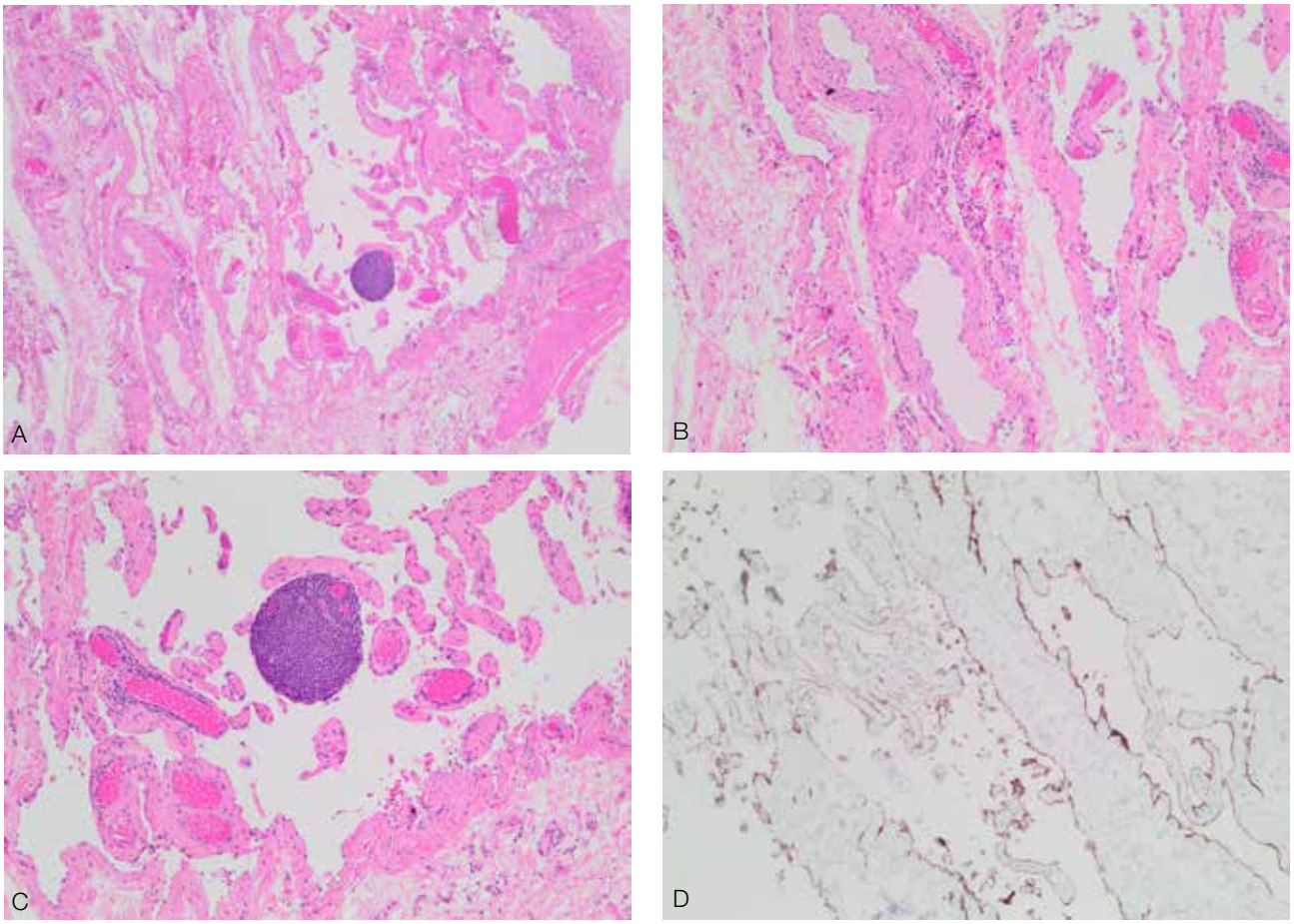

Fig 2. (a) The image shows multiple dilated vascular channels (H&E, x10). **(b)** The vascular channels are irregular in shape and are lined by a single layer of endothelial cells (H&E, x40). **(c)** an intravascular aggregate of lymphoid tissue is seen with papillary endothelial proliferations (H&E, x40). **(d)** Immunohistochemistry for D2-40, highlights the endothelial linings of the lymphatic channels (IHC, x40).

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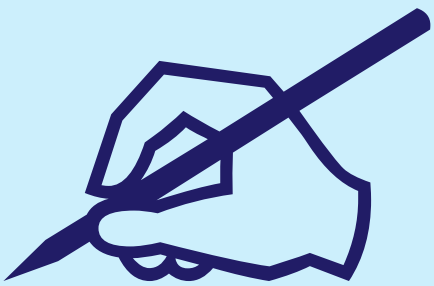
CPD questionnaire on page 510

The Continuing Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.



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What's new for the clinician – summaries of recently published papers (October 2024)

SADJ OCTOBER 2024, Vol. 79 No.9 P501-504

Edited and compiled by Prof V Yengopal, Faculty of Dentistry, University of the Western Cape

1. CLEANSING EFFICACY OF ELECTRIC ORAL-B® IO™ ULTIMATE CLEAN VERSUS ORAL-B® GENIUS® WITH THE CROSSACTION BRUSH HEAD: A RANDOMISED-CONTROLLED STUDY

Introduction

The huge number of electric toothbrush brands and models available to the consumer nowadays is evidence of the constant evolution in electric toothbrush design and performance to improve plaque removal performance in the mouth. Various manual and powered toothbrushes and brush head designs are available in the market. Powered toothbrushes have become increasingly popular due to their ease of use, highly effective plaque removal and positive impact on oral health.[1] Many advanced toothbrush models have incorporated bristle head designs, such as multi-level, criss-cross arrangements and rounded ends, to enhance plaque removal further. Additionally, several systematic reviews and meta-analyses have shown that powered toothbrushes are more effective than manual toothbrushes in reducing plaque and gingivitis in both the short and long term.[1]

Oscillating-rotating technology (O-R) with a round brush head was introduced by Oral-B® in 1990. Over the past few decades, the size and design have been modified several times to improve the cleansing efficacy, patient compliance and brushing experience. The Oral-B® CrossAction brush head with angled bristles has been the leading O-R head in various of brush series (Fig. 1a). Alongside the angled bristles, the head has micro-pulse bristles designed to eliminate interdental plaque. In 2020, Oral-B® launched the new iO™ series that merges the oscillation-rotation mechanism with micro-vibrations produced at the site of plaque removal.[1] The handle of iO™ toothbrushes features a linear magnetic drive, which differs from the gear-based motor used in older O-R brushes. It is compatible with a new set of round brush heads with an increased diameter 2mm larger compared to the CrossAction brush head and the CrissCross bristles have a tuft-in-tuft design to ease interdental cleansing efficiency (Fig. 1b). Due to the brush head sizes, swivelling the brush head into the interdental spaces is no longer possible and is not recommended.

Polak and colleagues (2024)[1] undertook an independent clinical trial that sought to compare the cleansing efficacy of two brush heads with different brushing technologies, the Oral-B® iO™ Ultimate Clean brush head and the CrossAction brush head with the previous O-R technology. The null hypothesis posits no significant differences regarding full-mouth plaque indices between the two types of toothbrushes and brush heads.

Materials and methods

Thirty adult volunteers who met the following inclusion criteria were invited to participate in this trial. They were ≥ 18 years, made home use of an O-R toothbrush and had more than five teeth per quadrant. Exclusion criteria were a dental or medical profession or education, community periodontal index of treatment needs (CPITN) grade 3 or 4, pregnancy or breastfeeding, systemic diseases or conditions that were associated with an increased risk of infection or necessitated concomitant antibiotic therapy with dental treatment, existing caries lesions requiring treatment, dental implants and mental and behavioural disorders that could impede (verbal) communication. Teeth with direct or indirect restorations were not excluded.

This was a randomised-controlled, examiner-blinded, crossover study that investigated the cleansing efficacy of toothbrushing with the Oral-B® iO™ Ultimate Clean brush head versus Oral-B® Genius® with the CrossAction brush head (Figs 1a & 1b). The study design consisted of four appointments for each study participant. At the initial consultation, the participants received comprehensive

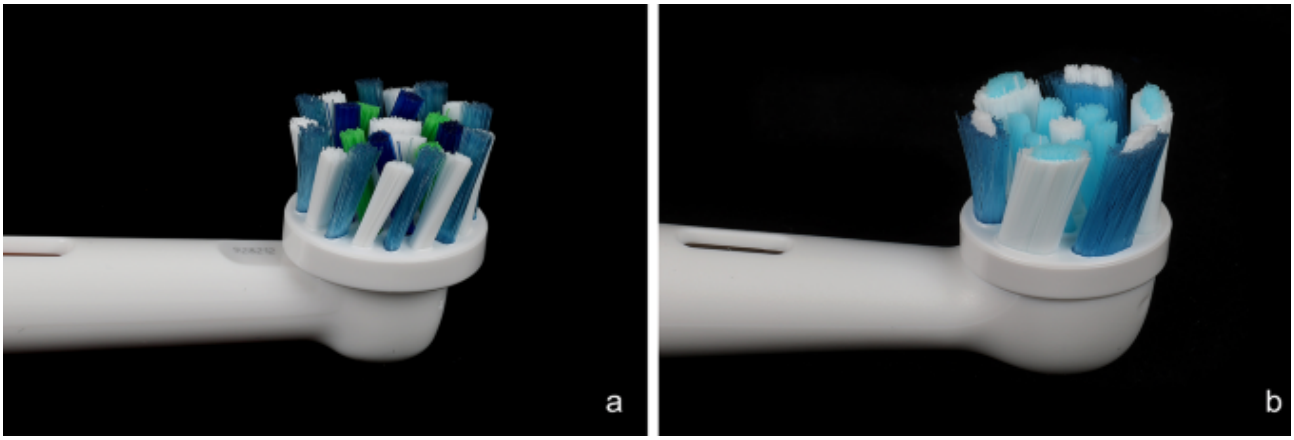

Fig 1a & 1b: (a) Oral-B® CrossAction brush head with angled bristles. The bristle tufts of the two outer tings are alternately of different lengths with a height difference of 1mm. (b) Oral-B® iO™ Ultimate Clean toothbrush head with a 2mm increased diameter and CrissCross bristles.

information regarding the research protocol and participants received the necessary toothbrushing products. Each cleaning cycle began with a new brush head.

Baseline data included the Rustogi Modified Navy Plaque Index (RMNPI) after plaque disclosing with 2Tone and the gingival bleeding index (GBI). The RMNPI divides each buccal and lingual tooth surface into nine sections (A-I) to indicate the presence or absence of plaque dichotomously. RMNPI is the percentage of biofilm adhering sites to measured sites. It enables differentiation between the marginal areas of the teeth (A-C), interdental areas (D-F) or overall tooth surfaces (A-I). To evaluate gingival inflammation by GBI, a periodontal probe (PCP 12) was inserted into the gingival sulcus, and bleeding was assessed dichotomously at six sites per tooth. The percentage of bleeding sites to measured sites was calculated. One trained and blinded investigator conducted all clinical assessments.

Participants were allocated to either group A, which used the Oral-B® iO™ Ultimate Clean brush head, or group B, which used the Oral-B® Genius CrossAction brush head. Calibrated study assistants instructed to the participants to ensure that the data collection remained blinded and unbiased for the examiner. Participants were instructed to refrain from interdental hygiene and use any chemical rinsing solution during the study period. Subjects of group A received hands-on training using the Oral-B® iO™ with the Ultimate Clean brush head according to the manufacturer's instructions. Similarly, subjects in group B who were asked to brush their teeth with the Oral-B® Genius® CrossAction brush head were also generously instructed. Both toothbrushes were held at a 90° angle to the tooth surface for five seconds on each tooth surface and then moved slowly along the gumline to follow the contour of the teeth. After detailed instruction, professional tooth cleaning was conducted with airflow polishing (Airflow®) and ultrasonic devices if necessary.

After completing the 28-day trial period using the assigned test products, the study participants presented for their second appointment. Their oral hygiene indices were re-examined, followed by a 14-day washout period, when the subjects resumed their normal cleaning routine. Participants were reassessed after 14 days (third visit). Again, oral hygiene indices were recorded, followed by a full plaque disclosure, thorough instruction for the second test product, and professional tooth cleaning. Analogous to the first test cycle, the study participants used the other assigned toothbrush (those who used Oral-B® iO™ in the first part were now allocated to the Oral-B® Genius® CrossAction brush headgroup) for 28 days before attending their fourth and final appointment for a hygiene index examination and professional tooth cleaning.

Results

Seventeen women and 13 men with a mean age of 33.53 ± 7.53 years (range 20-66 years) finished the study (dropout rate 0%). This study analysed 871 teeth.

At baseline, the median of the overall RMNPI was 40.05% (IQR 28.63-47.64). The two study groups had no statistically significant differences in baseline data. After 28 days of using the iO™ brush head without interdental cleaning, the median overall ç decreased to 25.09% (19.16-34.70). This value was statistically significantly lower than the median overall RMNPI attained after 28 days of using the CrossAction brush head as a control procedure (median overall RMNPI 30.60%; IQR 23.45-36.39) ($p = 0.029$).

The RMNPI splits every buccal and lingual tooth surface into nine sections (A-I) and was calculated as a percentage of biofilm adhering sites to measured sites. The iO™ brush head showed statistically significantly lower plaque levels after 28 days of home use compared to the conventional oscillating-rotating toothbrush with the CrossAction brush head (control) for full-mouth data ($p = 0.019$), approximal buccal sites ($p < 0.001$), marginal lingual/palatal ($p < 0.001$) and for marginal buccal sites ($p = 0.027$).

Subgroup analysis revealed the higher cleansing efficiency of the Oral-B® iO™ brush head was attributable to approximal and marginal sites. There was a statistically significantly lower plaque index after 28 days of cleaning with the iO™ compared to the CrossAction on marginal lingual/palatal sites (median 36.85% versus 56.10%; $p < 0.001$) and on marginal buccal sites (median 40.24% versus 49.18%; $p = 0.027$). In addition, the iO™ exhibited a significantly lower plaque index than the CrossAction at approximal buccal sites (19.48% and 40.54%, respectively; $p < 0.001$). In contrast, no statistically significant difference existed in approximal lingual/palatal areas.

Statistical analysis revealed that unlike the plaque indices, gingival bleeding indices showed no statistically significant differences between the baseline and the test phase or between the different brush heads. At baseline, the median GBI was 1.54% (0-6.26). After using the iO™ for 28 days without any kind of interdental cleaning the median GBI was 0% (0-0.01). After 28 days of cleaning with the CrossAction, the median GBI was 0% (0-0.14).

Conclusion

The Oral-B® iO™ electric toothbrush displayed enhanced plaque removal efficiency compared to the conventional oscillating-rotating technology (Oral B Genius).

Implications for clinical practice

This study highlights the potential benefits of advanced toothbrush technologies for plaque reduction.

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2. THE EFFECTS OF CHLORHEXIDINE GEL AND TRANEXAMIC ACID APPLICATION AFTER TOOTH EXTRACTION ON THE RISK OF ALVEOLAR OSTEITIS FORMATION: A DOUBLE BLIND CLINICAL STUDY

Alveolar osteitis (AO) (also known as dry socket or alveolitis), one of the primary complications of tooth extraction, manifests as severe pain in and around the extraction site within 1-3 days post-extraction. The incidence rate varies depending on the type of tooth extracted, but generally it occurs in 1-4% of cases following extraction. It is 10 times more common in lower teeth compared with upper teeth, with a 45% occurrence rate in mandibular third molars.[1]The signs and symptoms of AO typically begin 2 to 4 days after tooth extraction and mainly involve severe, intense pain radiating to the ear and neck. The surrounding mucosa is

erythematous. The alveolar socket may be empty and dry or contain blackish necrotic clot fragments and food debris that can be easily removed with an appropriate instrument. Halitosis is pronounced. Usually, there is no swelling in the face, fever, purulent discharge or lymphadenopathy. On probing examination, the walls of the alveolus are very sensitive.

For the treatment of alveolitis, the extraction socket is irrigated to remove accumulated food debris and infected tissues. Afterward, alveogyl (Septodont) can be placed in the socket to alleviate pain. Alveogyl contains butamben as an anaesthetic, eugenol for pain relief and iodoform as a disinfectant. Nonsteroidal anti-inflammatory drugs (NSAIDs) and antiseptic mouthwashes are prescribed. Ensuring the presence of a clot in the socket is crucial for healing.

Although treatment options for alveolitis are limited, there are numerous clinical practices to prevent its occurrence and reduce its incidence. Methods such as chlorhexidine (available as a gel, solution, spray, cream or toothpaste) , antibiotics, analgesics and irrigation of the socket with lidocaine gel can be used, but no treatment method has been universally accepted as successful.[1]

Transamine is found in the form of trans-4-aminomethylcyclohexane-1-carboxylic acid. It belongs to a class of drugs called antifibrinolytics, which facilitate and preserve blood clot formation. It is used to control postoperative bleeding, stopping bleeding during surgery and preserving the formed clot.[1]Chlorhexidine and tranexamic acid have been extensively studied in the literature. However, there is a lack of comparative research evaluating these two materials specifically for the prevention of AO. Gumrukcu and colleagues from Turkey (2024)[1] undertook a trial that sought to examine the effects of chlorhexidine and tranexamic acid on the incidence of AO.

Materials and methodsA total of 96 healthy patients (mean age: 38, range: 19-62 years) with indications for extraction of molar and premolar teeth were included in this trial. A total of 113 teeth (85 molars, 28 premolars) were enrolled in the study. Randomisation was applied when grouping the teeth included in the study (groups were subdivided into a, b and c and then randomly assigned). All extractions were performed by the same surgeon. Postoperative evaluations and data collection were carried out by a different surgeon.

For inclusion, patients were aged between 18 and 65 years, had lower jaw premolar and molar teeth with extraction indications, and had regular oral hygiene practices. Patients were excluded if they were allergic to substances to be used in medication or operation (artikain, tranexamic acid, chlorhexidine), had antibiotic use within 30 days before extraction, had clinical and radiologic evidence of any pathology and infection in the surgical area within 30 days before or on the day of extraction (such as periapical pathology, pericoronitis), had routine use of oral antiseptics, had the presence of any immune system disease, systemic fever, lymphadenopathy (LAP) or other symptoms, women who were lactating or pregnant, used oral contraceptives or patients who neglected follow-up appointments (3-7 days).

The 96 patients who presented for tooth extraction were randomly divided into three groups:

Patients in group 1 were treated post-extraction with irrigation using saline only, followed by the placement of a gelatin sponge in upper third of the socket (a total of 30 patients).

Patients in group 2 were treated post-extraction with irrigation using saline, followed by the application of 2% chlorhexidine gel (absorbed in gelatin sponges) (Spongostan®) in upper third of the socket (a total of 30 patients).

Patients group 3 were treated post-extraction with irrigation using saline, followed by the application of tranexamic acid 50mg/ml injectable solution absorbed in gelatin sponges (Spongostan®) in the upper third of the socket (a total of 36 patients).

All tooth extractions were performed by using articaine anaesthetic solution, providing inferior alveolar and buccal nerve blocks. All extractions were conducted using the closed tooth extraction technique. After elevating the tooth with an elevator and loosening it, extraction was completed using a suitable forceps according to the tooth type. No extraction socket was primarily closed post-extraction. The extraction sockets were left to natural healing processes.

Patients were scheduled for follow-up visits on days 3 and 7 after tooth extraction. Pain and swelling levels were scored by patients using a visual analog scale (VAS) ranging from 0 to 10. Values between 1 and 3 were considered mild pain, 4 to 6 moderate pain, and 7 to 10 severe pain Additionally, forms recording the presence of halitosis, trismus and exposed bone socket were collected and analysed on days 3 and 7.

Results

In the study, AO developed in 12 out of 113 extracted teeth (10.6%), ranging in age from 19 to 62 years. It was observed in 11 molars (91.6%) and one premolar (8.3%). Among the patients, 34 (30.1%) were found to be smokers.

When the distribution of AO development frequency was examined among the groups, it was found that in group 1, AO occurred in five out of 31 teeth (16.1%); in group 2, it occurred in six out of 42 teeth (14.3%); and in group 3, it occurred in one out of 40 teeth (2.5%). Considering all extracted teeth (113 in total, comprising 85 molars and 28 premolars), AO developed in 12 teeth (10.6%). Of these teeth with AO, 11 were molars (91.6%) and one was a premolar (8.3%).

When evaluated by age groups, the number of teeth with AO was two (16.7%) in the 16-30 years age group, seven (58.3%) in the 31-45 years age group, and three (25%) in the 46-60 years age group. Among the teeth with AO across the three groups, when evaluated in terms of smoking status, it was determined that in group 1, out of a total of five teeth with AO, two were smokers; in group 2, the one tooth with AO belonged to a smoker; and in group 3, out of a total of six teeth with AO, one was a smoker. 3.5% of patients experienced trismus on day 3, 0.9% experienced trismus on day 7, 36.3% experienced halitosis on day 3 and 2.7% experienced exposed bone on day 7.

The average age of the patients was 37.95 ± 11.3 years. The average pain score on the third day was 2.27, and on the seventh day it was 0.51. The average swelling score on the third day was 2.0, and on the seventh day it was 0.81.
When looking at the average pain scores measured on the

third and seventh days, statistically significant lower pain and swelling scores were found in the absorbable gelatin sponge group on the seventh day compared with the third day ($p=0.001$).
After tooth extraction, a total of 11 sockets (9.7%) were found where the bone was exposed without mucosal coverage. Upon examining the relationship between alveolitis and exposed bone, it was determined that out of these exposed sockets, 10 were associated with alveolitis. When evaluated by groups, in group 1, five sockets had exposed bone, and four of these developed alveolitis; in group 2, one socket had exposed bone, and this developed alveolitis; in group 3, five sockets had exposed bone, and five of these developed alveolitis.

In the chlorhexidine group, the pain score on the seventh day ($p=0.042$) and the age criterion ($p=0.013$) were significantly higher compared with the other groups. Similar scores were obtained in the Spongostan and tranexamic acid groups.

In the tranexamic acid group, the swelling score on the seventh day was significantly higher compared with the other groups ($p=0.007$). Similar scores were observed in the Spongostan and chlorhexidine groups.

Conclusion

The researchers found that in the gelatin sponge group, pain and swelling scores significantly decreased on the seventh day. This outcome may be attributed to the gelatin sponge's support in promoting clot formation. The application of all three interventions (gelatin sponge, tranexamic acid and chlorhexidine gel) reduced the incidence of AO.

Implications for practice

Due to the small number of teeth that developed AO, more studies are needed to determine superiority in terms of reduction of AO.

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Online CPD in 6 Easy Steps

The Continuing Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.

Dentist responsibilities for emergencies

SADJ OCTOBER 2024, Vol. 79 No.9 P505-507

Mr P Govan – Head of legal, SADA head office

INTRODUCTION

A revealing measure of a dentist's level of care and commitment to patients' needs can be found in the way they deal with emergencies.

A dentist must care for regular patients and respond to their emergencies, either personally or through a roster of cooperating dentists.

Patients requesting emergency treatment are, at best, being inconvenienced and, at worst, may be in severe pain or distress. It usually arises when a practitioner is called out from his or her residence after normal practice hours, or a hospital, to render emergency treatment. It can also happen if the practitioner operates more than one practice and attends each practice for certain hours or days of the week, effective emergency arrangements have to be made for patients during times when the practitioner is not attending to the practice or when not staffed.

Dentists do not have many unanticipated after-hours emergency calls from their regular patients. Indeed, regular patients are often reluctant to disturb their dentist and choose to wait until working hours, if at all possible.

Emergencies

What qualifies as an emergency is subject to a wide variety of opinions, but obvious examples are a patient in acute pain, or with an abscess, or swelling, or excessive postoperative bleeding. Emergency care is care without which the patient will, or may, be subject to serious harm, including professional harm.

Ultimately, whether it is an emergency or not will depend on the dentist's professional judgment, combined with a patient assessment, as being the determinants of an appropriate response in an emergency or emergent situation.
A dental emergency also exists if professional judgment determines that a person needs immediate attention to deal with uncontrolled bleeding, uncontrolled swelling, traumatic injury or uncontrolled severe pain.

Dental emergencies cannot be isolated from medical emergencies. An abscess, for example, can evolve into a potentially life-threatening situation. For a dentist to ignore any or all foreseeable consequences of inaction is unprofessional and could well lead to the patient seeking a legal remedy on the grounds of negligence. It has been estimated that one or two life-threatening emergencies will occur in the lifetime practice of a general dental practitioner.

Duties of practitioners

The duty of care is an important professional and ethical responsibility.

From an ethical perspective, the provision of emergency care is based on the duty of care to protect the health of the patient, causing minimal harm in the process. A dentist should be socially responsible and act humanely in both professional and personal matters. For example, although there is no legal requirement to provide care and assistance in an emergency to a stranger one encounters outside normal professional settings, it would still be deemed morally questionable not to do so.

The preamble to the Health Professions Council of South Africa Ethical Guidelines is clear about the answer.[1] It states: *"To be a good health care practitioner requires a life-long commitment to sound professional and ethical practices and an overriding dedication to the interests of one's fellow human beings and society. In essence, the practice of health care professions is a moral enterprise."* It is in this moral context that all health care practitioners (private and public sector) are obliged to provide emergency care to all patients irrespective of the patient's ability to pay for services.[4]Thus from an ethical perspective, the provision of emergency or out-of-hours care is based on the principles of beneficence and non-maleficence. Beneficence refers to doing good and the active promotion of goodness, kindness and charity. The practice of dentistry is firmly rooted in the principle – first do no harm.

From a legal perspective, the preamble to the National Health Act[2] refers to section 27 (3) of the Constitution which provides that no one may be refused emergency treatment. Section 5 of Chapter 2 of the act says: *"A health care provider, health worker or health establishment may not refuse a person emergency medical treatment".* This is re-iterated in section 5.7: "*... in an emergency situation* practitioners shall be obliged to provide *care in order to stabilise the patient and then arrange for an appropriate referral to another practitioner or facility where the required care can be provided. Furthermore, in emergency situations, practitioners must provide health care within the limits of their practice, experience and competency."*

There is an ethical and legal responsibility on every dental practitioner working in any branch of dentistry to ensure that patients for whom responsibility has been accepted have access to emergency treatment outside of normal working hours and that such arrangements are made known to these patients.

These arrangements should cover any time the practitioner is away from the practice, including after regular business hours. Failure to ensure this may result in serious professional misconduct.

What arrangements must be made?

Patients may require emergency services either during or after regular office hours, or when a dentist is out of the office. All practitioners must have an emergency protocol in place so that a patient who has a dental emergency during regular office hours may be attended to in a timely fashion.

They may be seen as soon as possible, or by another dentist in the office, either accommodated the same day or the next day.
When
the office is closed arrangements must be made for patients to contact the practitioner by putting proper notices on the premises, recorded messages on telephone equipment or emergency numbers (mobile numbers) on business cards supplied to patients or on the website.

As it not always going to be possible to provide emergency care personally, practitioners must also put in place some kind of emergency cover arrangements for periods of holidays, sickness, when attending courses, or some other reason for absence or after hours when the surgery is closed.

There are many ways to provide emergency coverage for patients and these include:

Treatment provided by a colleague within the same practice (employee dentists, associates, partners or fellow directors). You can arrange for the colleague in close proximity in the same building or down the street to cover for you. You can use the emergency dental clinic across town, or even practitioners who have formed emergency rotation service. The key is to make sure that the dentist on whom you are counting to cover for you is willing and available to do so. Make arrangements well ahead of time, and then contact the dentist again just before your needed coverage to make sure he or she has not forgotten those arrangements. It is also not professional to simply refer your patients if they require emergency treatment to the local private hospital or emergency facility with whom no prior arrangements have been made. This may constitute abandonment of the patient.

Practitioners participating in an emergency roster system (discussed below).

Emergency roster

It is also possible for practitioners to draw up an emergency roster whereby several dentists in one area join forces to provide out-of-hours cover on a rota basis even though practitioners are not necessarily gone or absent from their practices.

Dentists who choose to participate in a group on-call service and who are on call for some time have an obligation to provide appropriate emergency management for all patients who are directed to the service, regardless of who their primary care provider might be.
When participating dentists are not on call but are available during office hours, they should see their own patients of record and not automatically refer their emergency patients to the on-call service. These must be clearly communicated to patients.

Those dentists who choose not to belong to such an on-call group are obliged to manage their emergency patients at all times. If they choose not to participate, they must not rely on the group service to look after their patients of record, whether during or after regular office hours.

It is also unethical for a practitioner to be unavailable when on call for emergency duty on a rota basis or continually fail to be available when the practitioner is supposed to be on call. Patient care of other participating practitioners may be neglected or compromised and may result in a charge of unprofessional misconduct.

SADA recommends that on-call dentists offer patients the same terms of payment as those offered by the patients' regular dentists.

During an emergency visit, dentists must guard against doing only a cursory examination, taking a superficial medical and dental history, forgoing diagnostic tests and investigations and focusing only on the presenting condition. It is sometimes difficult to do otherwise as there may be pressure from the patient to sort out the immediate cause of their presenting problem – however, it is imperative that the patient is examined holistically and thoroughly.

Dentists on call who provide care for another dentist's patient are still required to keep treatment records. The patient's dentist should also be provided with reports or copies of the records, referral letters, radiographs or any other investigations that were carried out.

Precautions

In an out-of-hours emergency situation, dentists will sometimes find themselves seeing patients when no one else is present on the premises at all and, while every effort should be made to avoid these situations, the patient's needs and interests should always be the clinician's primary consideration.

It is generally unwise for a dentist to treat any patient without a third party being present, especially when a male dentist is treating a female patient.

The third party should be appropriately trained to assist the dentist in an emergency situation, but if the patient happens to be of the opposite sex to the dentist, this third party can also fulfil a second useful role as a chaperone. This will often be a dental assistant, but it could equally well be a parent/family member or other third party who is accompanying the patient.

In the South African context, unfortunately, extreme precautions are also sometimes necessary to guarantee practitioners' safety. It is recommended that dentists ensure that they are escorted to the surgery by a reliable third party or with the contracted security company present.

After-hours emergency care for patients of record only or not

The question that is often raised is whether dental practitioners are only responsible for making emergency arrangements for their patients or also for persons who are not patients of record.

Although a dentist is not obliged to provide treatment for every new patient who contacts the dental office, a patient with a dental emergency should be assessed and either provided treatment or referred to another practitioner, facility or emergency facility capable of treating the patient.

In respect of interactions with strangers or people to whom the dentist is not professionally committed, there is still a professional obligation (social contract) to go beyond the individual relationship where you are available for those who need help. Given that few dental emergencies are

life-threatening or need immediate attention (as opposed to medical emergencies), a roster of dentists or practices can deal with most cases, or the patient can be directed to a hospital or public clinic for after-hours palliative care or treatment.

With experience, a dentist can ask questions over the phone to triage the type and severity of need and sort out those who need immediate attention from those who can wait until the next day.

A dentist also needs to maintain a healthy life-work balance, and this is especially so if there is no other dentist to share the load, as happens in small towns. Opening a clinic, whether for one patient or a whole day, takes time, both for setting up and for shutting down. A simple half hour of treatment can be extended by an hour or more by setting up equipment, turning on compressors and computers, following infection control protocol and then closing down. While it may be a difficult decision to deny treatment to one patient, excessive fatigue or stress due to overwork will not be in anyone's interest in the long term.

If dental equipment is needed to provide temporary treatment, the dentist should pause before agreeing to treat the person. Is a dental assistant necessary to ensure safe treatment of the patient, to be a chaperone or witness, or to provide additional security for the dentist? If so, is an assistant or substitute available? Is there any barrier to providing acceptable treatment, such as safety and security of the dentist and staff travelling at night and opening the premises, using untrained assistance or having none at all, having consumed a small amount of alcohol, extreme fatigue, and so on? Disclosure of such issues should be made to the patient, consent obtained to proceed, and then documented in the records.

Practitioners should also be aware of complaints from health establishments in the vicinity of the practice against practitioners who refer their patients of record for emergencies and fail to have an emergency system in place.

It is a controversial situation if you are consulted by patients of your colleagues for emergencies. If your colleagues have failed to meet this obligation, you should call them and inquire about their emergency coverage policy. Colleagues who fail to provide emergency services are in violation of their ethical and professional duties.

Dentists are obliged when consulted in an emergency by patients not of record to make reasonable arrangements for emergency care. If you are in a small town or community that has only few dentists or no local or district clinic or hospital or emergency facilities, you may be obliged to handle the emergency situation, since the patient has no further option. In a more urban setting with many emergency rooms and facilities available, you may be able to justify referral to the medical facility or nearest dental emergency facility.

If treatment is provided to a patient of your colleague, the dentist, on completion of treatment, is obliged to return the patient to his or her regular dentist unless the patient expressly reveals a different preference. This is based on the patient autonomy and the practitioner has a duty to respect the patient's right to self-determination and confidentiality. The situation may be awkward as the dentist providing emergency care may be reluctant to accept the patient's request to change dentists.

The patient may be truly unhappy with his or her treating dentist or may be patronising you simply for your willingness to provide emergency treatment. If you agree to accept the patient into your practice, you should inform the patient's wishes to the prior dentist of record and request the transfer of records from him or her (after the appropriate release has been signed by the patient). So in this case patient autonomy may take precedence over the obligation to refer the patient back to the original treating dentist.

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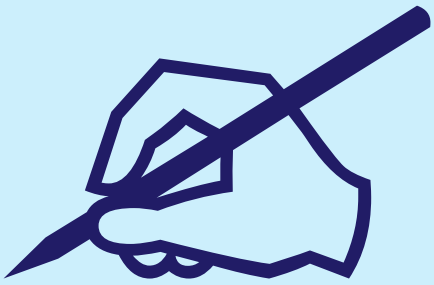
1. Health Professions Council of South Africa. General Ethical Guidelines for the Health Professions. Booklet 1. Guidelines for good practice in the health care professions. Pretoria, May 2008
2. National Health Act, 61 of 2003

CPD questionnaire on page 510

The Continuing Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.



Focal osteomyelitis with proliferative periostitis

SADJ OCTOBER 2024, Vol. 79 No.9 508-509

Zarah Yakoob.[1]

CASE

A 22-year-old female presented to our clinic with the main complaint of pain and swelling in the left mandible. The medical history revealed no co-morbidities. Extraoral examination revealed a draining sinus and a hard, firm swelling in the posterior left mandible. Intraoral examination revealed multiple carious teeth and healthy overlying mucosa. A panoramic radiograph was performed (Figure 1). Radiographic examination revealed a missing 18, impacted 28, 38, 48 and carious lesions on the 17, 15, 37 and 36. A periapical radiolucency is associated with the grossly carious 37 and in addition a convex radiopacity and onion skin-like periosteal reaction is noted, whereby numerous layers of new cortical bone is deposited in relation to the 37. The radiopacity extent includes the 37 area, with the affected bone appearing more sclerotic and dense. The adjacent cortical bone is normal. The periosteal reaction resulted in expansion of the cortical border, whilst remaining intact. There is a clear demarcation of the original cortical border and the new bone deposition (Figure 2). As the clinical and radiographic features were consistent with that of focal osteomyelitis with proliferative periostitis, a definitive diagnosis was made without the need for histological investigations. Subsequently, the grossly carious 37 was extracted and antibiotics was prescribed. The patient responded well to the treatment and treatment of the other carious lesions has commenced.

Figure 1. Panoramic radiograph revealing periosteal reaction in the posterior left mandible (yellow arrow)/ (Above)
Figure 2. Cropped panoramic radiograph of figure 2. The original cortex is seen (dotted line) and the onion skin-like laminations of new bone.(Right)

Authors' information
1. Zarah Yakoob.[1] *BChD*, *PDD* (Maxillofacial and Oral Radiology), MSc (Maxillofacial and Oral Radiology), *PGDip* General Management, *MBA* (GIBS Pret). Department of Oral and Maxillofacial Pathology, School of Dentistry, Faculty of Health Sciences, University of Pretoria, South Africa.
ORCID: 0000-0003-1966-5574.

Corresponding author:
Name: Zarah Yakoob
Contact details: zarah.yakoob@up.ac.za

Authors contribution:
Zarah Yakoob Primary author – 100%

INTERPRETATION

The entity of focal osteomyelitis with proliferative periostitis has been referred to as Garre's osteomyelitis and periostitis ossificans. In 1893 Carl Garre first described this form of periosteal reaction and it was subsequently termed Garre's osteomyelitis.[1,2] Many authors in recent years reported that Garre's osteomyelitis is considered a misnomer. The term periostitis ossificans is also considered incorrect as the periosteum itself does not ossify. Therefore, the most accepted term is focal osteomyelitis with proliferative periostitis. In the jaw bones, the posterior mandible and first molar region is the most common site. Due to the periosteal osteoblastic activity in younger individuals, this entity is common in children and adolescents and rarely found in the elderly. Odontogenic infections, in particular severe dental caries with associated periapical inflammation is the most commonly reported cause of focal osteomyelitis with proliferative periostitis.[3,4] There have been reports of other less common causes, including post operative infection after an extraction and periodontitis. In cases where there is no obvious source of infection, an immunologically mediated aetiopathogenesis should be explored.[5]

As a response to inflammation caused by a persistent low-grade infection, subperiosteal bone is formed over the surface of the affected bony area. Clinically, this results in a hard tissue-like swelling of the affected side, that may result in facial asymmetry. Pain may be associated and in severe cases trismus may occur. In addition, the overlying skin may present with signs of inflammation such as redness and sinus tracts. Intraorally, the affected mucosa typically appears normal.[1,2]

Histologically, the affected bone forms multiple layers of bone in a parallel fashion, with an intact cortex. Radiographically, a convex radiopaque area is seen in the affected area, with parallel layers in relation to the source of infection. Depending on the radiographic angulation, occasionally radiolucent layers can be seen as a soft tissue zone between the bony laminations and the original cortex. This radiographic appearance is often referred to as "onion skin".[3]

The thickened periosteum over time results in a thickened sclerotic bony appearance. These unique radiographic features can often be missed on a periapical radiograph. A panoramic radiograph, occlusal radiographs and cone beam computed tomography have the ability to visualise the new bone formation.[2]

As the cause of focal osteomyelitis with proliferative periostitis is usually as a result of odontogenic infection, it has been accepted that elimination of the cause and antibiotic therapy will result in resolution of the infection with eventual remodelling of the affected bone. The most common treatment option is extraction of the affected tooth, however, there have been reported cases of successful outcomes through endodontic treatment.[2,4]

AUTHORS DECLARATION

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Conflict of Interest

The authors declare that they have no conflict of interest.

Ethics approval

This study was approved by the University of Pretoria Ethics Committee (Reference no.: 599/2024). All procedures followed the ethical standards of the Helsinki Declaration of 1975, as revised in 2008.

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CPD questionnaire on page 510

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CPD questionnaire

Mobile phone hygiene practices in healthcare settings: A Mapping Review

1. **Select the CORRECT answer. Mobile Phones (MPs) are used in education for:**
   A. Communication,
   B. Remote working,
   C. Teaching and Learning, and
   D. Assessment
   E. All of the above

2. **Which answer is CORRECT. Mobile Phones are important in clinical practice where healthcare workers:**
   A. Viewing health-related news,
   B. Peruse medical guidelines and drug reactions,
   C. Discuss clinical cases with colleagues, and
   D. Sharing medical documents and photographs
   E. All of the above

3. **Select the INCORRECT answer. Mobile phones can NOT be disinfected using:**
   A. Alcohol swabs or wipes,
   B. Regular air blasts from the 3-in-1 syringe
   C. Biocidal agents,
   D. Screen Protectors (plastic covers or cling)
   E. UV Disinfection

4. **Which option is INCORRECT. Lack of hygiene practices related to hand washing and to mobile phones is due to:**
   A. forgetfulness,
   B. fear of damaging devices
   C. inadequate awareness of standard disinfection practices and
   D. beliefs that infectious-disease theories are false
   E. All of the above

5. **Select the CORRECT answer. MP Hygiene Protocol include the following:**
   A. Limit or restrict use of MP in healthcare settings,
   B. Wash hands according to handwashing protocol before use of MPs,
   C. Wipe MPs with recommended disinfectant before use,
   D. Implement regular MP cleaning within a 24-hour cycle and
   E. All of the above

Mercury Levels in Wastewater Samples at a South African Dental School

6. **Choose the CORRECT answer. Mercury in the environment**
   A. Originates solely from human activities
   B. Persistently circulates in the environment, plants and animals
   C. It affects human health through inhalation
   D. It is converted into toxic methylmercury by marine animals

7. **Which statement is CORRECT. Dental amalgam restorative materials**
   A. It is subject to a phase-out approach in the Minamata Convention
   B. Restrictions on its use have been introduced in South Africa
   C. 50% of dental amalgam may end up in the environment without BMPs
   D. Most dental mercury is released through the atmosphere pathway.

8. **Which of the following is CORRECT regarding dental amalgam mercury waste**
   A. t is generated in a closed system
   B. It is generated by the placement, removal, polishing, and extraction of amalgam-containing teeth.
   C. Without proper management systems, eighty per cent of the waste can enter the environment.
   D. The soil is not one of the pathways to the environment.

9. **Select the CORRECT option. The best management practices for dental amalgam use**
   A. Were developed by the World Health Organization
   B. Were adopted by the American Dental Association
   C. Have been adopted in the South African waste management guidelines
   D. Are yet to be adopted in the South African waste management guidelines

10. **Select the CORRECT statement. One of the following is true regarding wastewater**
    A. The allowable wastewater concentration of mercury in SA is 10mg/L
    B. Dilution of mercury levels is not a concern with wet ring suction pumps
    C. The waste generator is responsible for waste until final treatment/disposal
    D. A correlation exists between dental amalgam use and the mercury in wastewater.

Peripheral Compound Odontoma: A Rare Case Report

11. **Select the CORRECT answer. Odontomas are best classified as which one of the following:**
    A. A hamartomatous haphazard aggregate of dental hard and soft tissue
    B. A benign mixed tumour of odontogenic origin
    C. Peripheral forms of odontoma are choristomas
    D. Complex odontomas erupt as distinct tooth-like denticles as they mature

12. **Which of the following is CORRECT. Odontomas are exclusively located within bone except for which one of the following instances?**
    A. Eruption as a supernumerary tooth
    B. Malignant transformation and eruption due to bone destruction
    C. Location entirely within a mucosal site with no evidence of connection to bone
    D. Eruption into soft tissues in cases of known diastema or missing teeth

13. **Choose the CORRECT option. The compound odontoma is characterized by which one of the following features:**
    A. A predilection for occurrence within the posterior mandible
    B. Composed of haphazardly arranged dental hard and soft tissue
    C. Frequent maturation into a peripheral variant of compound odontoma
    D. Presents as an asymptomatic mixed radiopaque/radiolucent lesion on panoramic radiograph

14. **Which statement is CORRECT. The complex odontoma is characterized by which one of the following:**
    A. A tendency to involve both the maxilla and mandible synchronously
    B. Represents a risk for infection due to its composition of necrotic sheets of bone
    C. Represents a random haphazard collection of dental hard and soft tissue
    D. Described on radiograph as "a bag of marbles"

Radiology Corner: Focal osteomyelitis with proliferative periostitis

15. **Select the CORRECT answer. What is the most accurate term for the entity previously referred to as Garre's osteomyelitis and periostitis ossificans?**
    A. Garre's osteomyelitis
    B. Periostitis ossificans
    C. Focal osteomyelitis with proliferative periostitis
    D. Chronic sclerosing osteomyelitis

16. **Choose the CORRECT answer. Which of the following radiographic features is associated with focal osteomyelitis with proliferative periostitis?**
    A. Onion skin appearance
    B. Ground glass radiopacity
    C. Moth-eaten radiolucency
    D. Punched-out lesions

Evidence Based Dentistry:

17. **Which answer is CORRECT. The unit of interest in the Polak et al trial was**
    A. 13 men and 17 women
    B. Adults aged 20-66 years old
    C. 871 teeth
    D. RMNPI

18. **Select the CORRECT statement. In the Polak et al trial, which of the following statements most accurately reflects the findings**
    A. The iO™ brush head showed statistically significantly lower plaque levels after 28 days of home use compared to the conventional oscillating-rotating toothbrush with the Cross-Action brush head for full-mouth data ($p=0.019$), approximal buccal sites ($p<0.001$), marginal lingual/palatal ($p<0.001$) and for marginal buccal sites ($p=0.027$).
    B. The iO™ brush head showed statistically significantly lower plaque levels after 28 days of home use compared to the conventional oscillating-rotating toothbrush with the Cross-Action brush head for full-mouth data ($p=0.58$), approximal buccal sites ($p>0.001$), marginal lingual/palatal ($p<0.001$) and for marginal buccal sites ($p=0.34$).
    C. The iO™ brush head showed statistically significantly lower plaque levels after 14 days of home use compared to the conventional oscillating-rotating toothbrush with the Cross-Action brush head for full-mouth data ($p=0.019$), approximal buccal sites ($p<0.001$), marginal lingual/palatal ($p<0.001$) and for marginal buccal sites ($p=0.027$).
    D. The iO™ brush head showed statistically significantly lower plaque levels after 32 days of home use compared to the conventional oscillating-rotating toothbrush with the Cross-Action brush head for full-mouth data ($p=0.019$), approximal buccal sites ($p<0.001$), marginal lingual/palatal ($p<0.001$) and for marginal buccal sites ($p=0.027$).

19. **Select the CORRECT answer. In the Gumrukcu et al trial, which of the following groups had the lowest incidence of AO**
    A. Patients who had gelatin sponge only
    B. Patients who had chlorhexidine in gelatin sponge
    C. Patients who had tranexamic acid in gelatin sponge
    D. Patients who had saline in gelatin sponge

20. **Which answer is CORRECT. In the Gumrukcu et al trial, which of the following groups had the lowest prevalence of pain and swelling?**
    A. Patients who had gelatin sponge only
    B. Patients who had chlorhexidine in gelatin sponge
    C. Patients who had tranexamic acid in gelatin sponge
    D. Patients who had saline in gelatin sponge

Ethics: Dentist responsibilities for emergencies

21. **Select the CORRECT answer. What is a revealing measure of a dentist's level of care and commitment to patient needs?**
    A. The number of regular patients they have
    B. The number of hours they work per week
    C. How they deal with emergencies
    D. The amount of income they generate

22. **Which option is INCORRECT. Which of the following is NOT mentioned as a possible example of a dental emergency?**
    A. A patient with a cavity
    B. A patient with an abscess
    C. A patient with excessive postoperative bleeding
    D. A patient with uncontrolled swelling

23. **Select the CORRECT statement. According to the Health Professions Council of South Africa Ethical Guidelines, what is essential for a good healthcare practitioner?**
    A. Prioritising personal interests over professional duties
    B. Commitment to sound professional and ethical practices
    C. Ignoring the interests of fellow human beings
    D. Avoiding involvement in any emergency situations

24. **Which option is CORRECT. What is the legal obligation of a healthcare provider regarding emergency medical treatment?**
    A. They may refuse emergency treatment to any person.
    B. They must provide emergency medical treatment to everyone.
    C. They should provide emergency care only to patients who can pay.
    D. They can choose to provide emergency treatment based on personal preference.

25. **Choose the CORRECT answer. What should dentists do to ensure patients have access to emergency treatment outside of normal working hours?**
    A. Provide emergency care only to patients of record.
    B. Refuse emergency treatment to non-regular patients.
    C. Make arrangements for emergency coverage during absences.
    D. Limit emergency services to certain days of the week.

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To be kept as brief, clear and unambiguous as possible.

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The abstract shall consist of not more than 200 words.
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- Articles should be clear and concise.
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Please supply 4-5 Multiple-choice Questions (MCQ's) with 4 or 5 options per question related to your article. Questions must have only one correct answer, and indicate this correct answer clearly.

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Terblanche N. Principles of Periodontology, 4th ed. London: Butterworth, 1985: 96-101.

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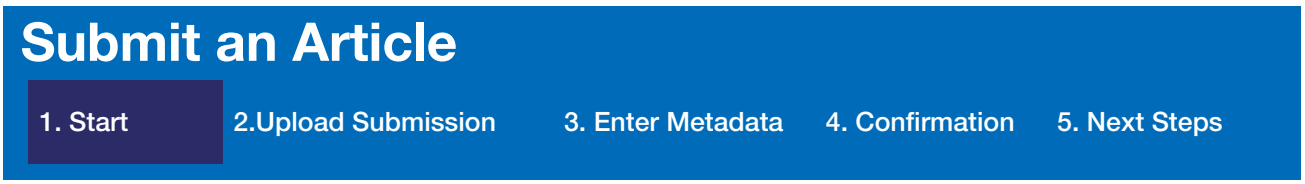

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References: 1. Milleman K, Bosma M *et al.* Twelve Week Efficacy of Virutally Supervised Mouthrinse and Flossing. **2.** Presented at AADOCR 2023 Annual Meeting, Abstract # 0550.

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