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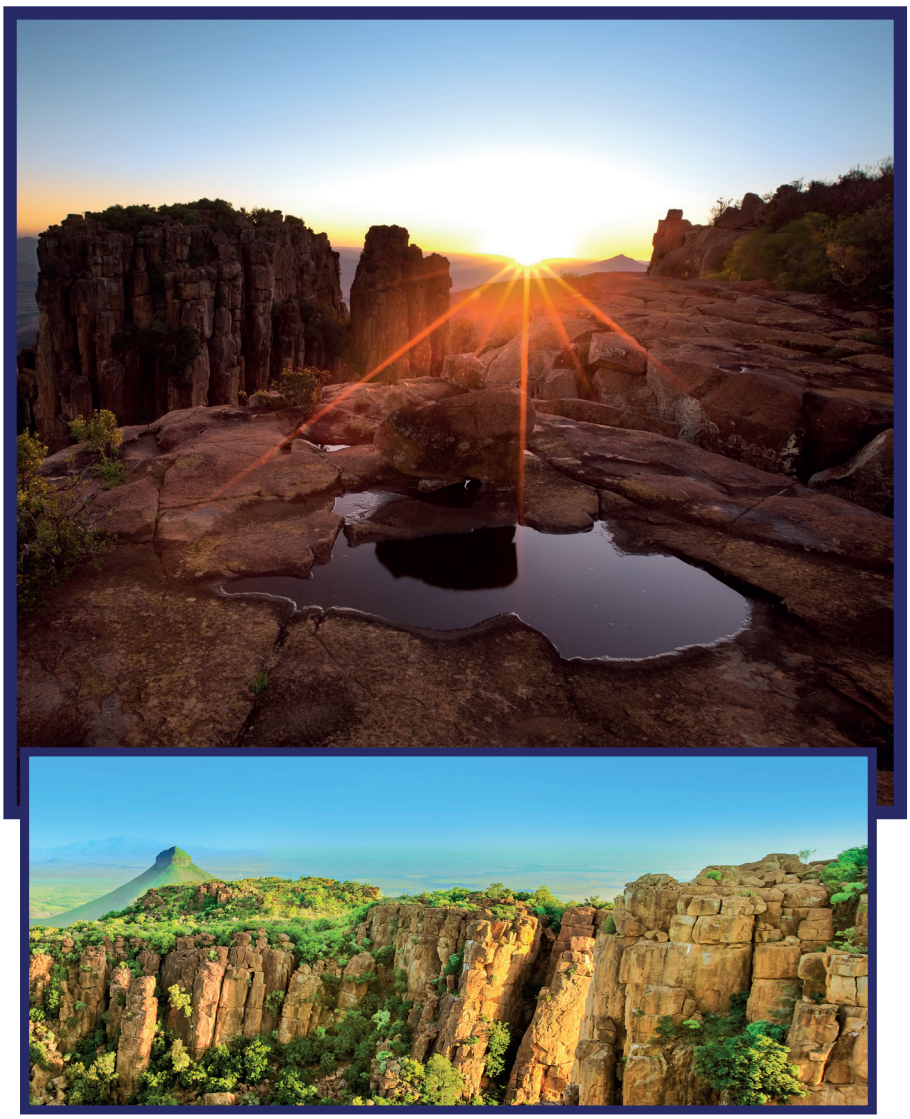

Valley of Desolation, Camdeboo National Park

The Valley of Desolation in the Eastern Cape is a geological phenomenon, a sheer cliff face declared a national monument that lies within the Camdeboo National Park. The Camdeboo National Park provides the visitor with insights into the unique landscape and ecosystem of the Karoo as well as splendid scenic beauty.

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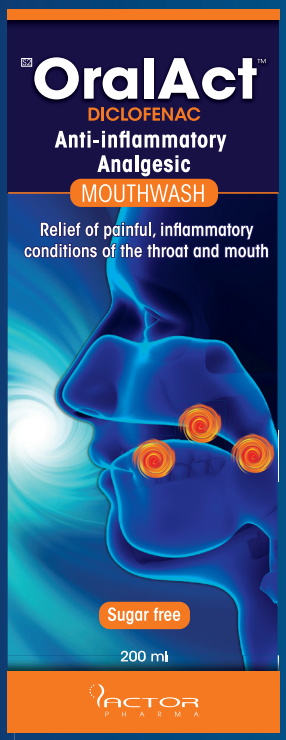

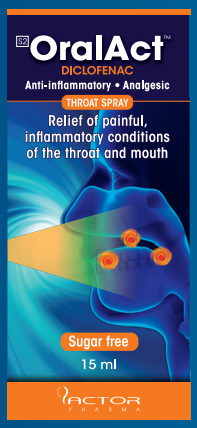

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Our Front Cover for this Issue...

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Professionalism in South African Dental Practice

SADJ July 2023, Vol. 78 No.6 p287-289

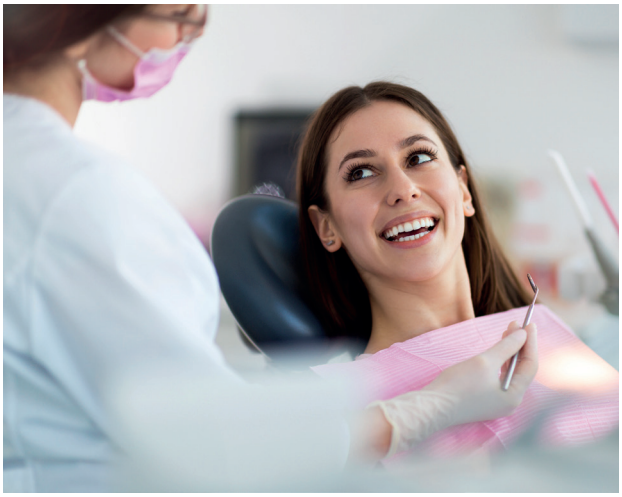
Prof NH Wood - ***BChD, DipOdont(MFP), MDent(OMP), FCD(SA), PhD***

A thriving healthcare system is built on professionalism, which influences the standard of patient treatment and promotes confidence among healthcare professionals. It is based on a holistic approach and includes a dynamic set of values and characteristics that are focused on the patient and the pursuit of excellence. Professionalism, which extends to include the entire field of dentistry, is fundamentally still anchored on the ethical provision of healthcare services.

In the field of dentistry, professionalism refers to a multidimensional strategy centred on patient care, evidence-based procedures and the never-ending pursuit of excellence. Integrity, honesty and transparency are the cornerstones of ethical dental care delivery. Dental practitioners must make judgments that are based on what is best for their patients while also respecting their autonomy and rights. This involves navigating difficult ethical conundrums.

Dentistry is a science that is always changing, and it relies primarily on evidence-based methods to direct treatment decisions. This requires keeping up with new developments in dental technology, research findings and treatment modalities. To give their patients the most effective and efficient care possible, dental professionals must critically analyse the available evidence and incorporate it into their practices. Furthermore, a dedication to ongoing learning and development is essential to professionalism in dentistry. The dentistry industry is always changing as a result of new methods, supplies and technological advancements. To be at the cutting edge of developments and to continuously improve their abilities, dental professionals must adopt an attitude of lifelong learning.

Professionalism goes beyond interactions with patients to include interactions with coworkers and the larger healthcare community. To guarantee seamless and thorough patient care, dental practitioners must promote a culture of respect and collaboration, working side by side with other healthcare professionals, specialists and support workers. Dental professionals can improve patient outcomes and treatment processes by encouraging interdisciplinary collaboration.
In today's diversified healthcare environment, cultural competence increasingly matters in addition to clinical expertise. Dental professionals must accept and appreciate their patients' different backgrounds and beliefs. In addition to enhancing patient-provider communication, culturally competent treatment lowers inequities, ensuring that oral health services are available to everyone in the community, and increases accessibility. Dental professionalism necessitates a strong feeling of responsibility and accountability. Dental professionals must take responsibility for their choices and actions, admitting when they are wrong and growing from their mistakes. Fostering personal and professional growth requires self-reflection as well as taking criticism from patients, co-workers and mentors.



CLINICAL COMPETENCE AND SKILL MASTERY

Clinical competency is a necessary attribute in dental practice, creating the foundation for safe, efficient and patient-centred care. The ability of dental professionals to diagnose, treat and manage a wide variety of oral health disorders has a direct bearing on the health of their patients.

Dentists need to have a broad knowledge base that includes not only dental anatomy but also a profound understanding of disease pathology to be considered clinically competent. This knowledge enables them to precisely identify oral health problems and create personalised treatment regimens that take into account the particular requirements of each patient. The quest for clinical competence requires a mastery of technical abilities just as much. Dental professionals must refine their motor abilities to perform difficult tasks with elegance since dental procedures call for precision and dexterity. Dental procedural proficiency promotes the best patient outcomes, reduces the risk of problems and increases patient happiness.

Clinical competency does not, however, exclusively depend on prior knowledge and abilities. With new developments in technology and research redefining treatment techniques and best practices, dentistry is a discipline that is constantly changing. Therefore, through programmes for continuous professional development (CPD), dental practitioners must embrace a commitment to lifelong learning. By accessing and absorbing the most recent research findings and technology breakthroughs, dentists can maintain their position at the forefront of dental innovation by participating in CPD. Dental professionals are equipped by this continual education to modify their clinical strategies and incorporate evidence-based procedures into their everyday practices, ensuring that patients receive the most modern and efficient care possible.

Keeping up with cutting-edge research and methods not only improves clinical proficiency but also promotes a sense

of fulfilment and pride in one's job. Dental professionals who actively seek out more education are better able to handle complex cases, produce superior patient outcomes, and win the respect and trust of both their peers and patients. Dental professionals can use a variety of internet resources, conferences and professional forums in addition to formal CPD to broaden their knowledge and hone their abilities. To develop clinical competence and foster the sharing of insights within the dental community, participating in case discussions and looking for mentorship from more seasoned colleagues can be quite beneficial.

Dental professionalism's fundamental components revolve around clinical competence and skill mastery. Dental professionals must constantly improve their technical skills and knowledge to deliver top-notch patient care. Dentists in South Africa will be well prepared to manage the various oral health needs of their patients with accuracy, confidence and compassion if they adopt a commitment to lifelong learning and keep up with the most recent developments in dental technology and research.

Dentistry hardly ever works alone. Providing thorough patient care necessitates cooperation with other medical specialists, dentists and support staff. A harmonised interdisciplinary strategy improves treatment results and promotes a climate of respect among healthcare organisations. This includes being aware of and accepting one's own skill and competency limitations, as well as knowing when to refer a patient to a colleague for treatment when a better result is assured.

ETHICAL DECISION-MAKING

The moral compass that directs every element of professionalism in dentistry is ethical decision-making. Fundamentally, dental ethics calls for an unrelenting dedication to upholding the greatest standards of honesty and transparency in all interactions with clients, co-workers and the general public. In their line of work, dental professionals frequently face challenging moral quandaries. These conundrums may involve selecting a course of therapy, disclosing information, allocating finite resources or taking patient preferences into account. It takes a conscientious and moral attitude to navigate these difficult situations, putting the patient's welfare and best interests above all else.

The idea of respecting patient autonomy is essential to ethical decision-making. This principle recognises that individuals have the freedom to choose their own oral health treatment in an informed manner. Dental professionals are required to participate in shared decision-making by giving patients pertinent information about their health, available treatments, possible dangers and advantages. Including patients in the decision-making process for their care develops a culture of trust and cooperation which, in turn, improves treatment outcomes and patient satisfaction.

A key component of ethical dental practice is informed consent. Before starting any treatment or procedure, dentists must get the patient's express agreement. Giving patients thorough information regarding the suggested course of action, potential alternatives, risks and anticipated results is necessary for obtaining their informed consent. To make decisions based on their unique beliefs and preferences, patients must be given the chance to clarify their understanding and ask questions. Another crucial component of moral dental practice is confidentiality. Dental professionals are required to protect patient data and regard patients' privacy. In addition to fostering a sense of confidence between dental professionals and their patients, upholding absolute confidentiality guarantees compliance with legal and ethical requirements.

The foundation of moral dental care is the idea of beneficence and nonmaleficence. The term "beneficence" refers to the obligation to act in the patient's best interest while attempting to maximise rewards and advance wellbeing. Contrarily, nonmaleficence places emphasis on the duty to treat the patient with kindness. Dental professionals must carefully consider the potential advantages of a therapy against any potential dangers or harm it may bring to the patient's health to strike a balance between these principles.

Dentistry involves making ethical decisions that go beyond dealing with specific patients. Dental practitioners must also think about how their activities may affect society and the larger community. Respecting moral principles increases public confidence in the dentistry industry and improves the standing and reputation of the field. Ethical issues develop alongside the development of dentistry. New ethical difficulties are brought about by emerging technologies such as telemedicine and artificial intelligence, which necessitate continual ethical contemplation and adaptation. Dental professionals are better equipped to traverse these changing ethical landscapes with insight and sensitivity if they embrace a culture of ongoing ethical dialogue and participate in ethical education and training.

Consequently, making moral decisions is essential to providing patient-centred care and establishing public confidence in the dentistry industry. Dental professionals in South Africa can uphold the highest ethical standards, guaranteeing the provision of compassionate and ethical care to their patients while preserving the reputation and integrity of the dental profession as a whole, by adhering to the principles of integrity, patient autonomy, informed consent, confidentiality, beneficence and nonmaleficence.

PRESENTABILITY, APPROACHABILITY, EFFECTIVE COMMUNICATION AND E MPATHY

Professionalism encompasses the areas of presentability, approachability and communication in addition to clinical knowledge and moral judgment. These elements are crucial in determining patient experiences, encouraging trust and enhancing the patient-dentist connection. Additionally, the general impression and reputation of the dentist office are influenced by professionalism in contacts with the personnel and the local population. The cultural diversity of South Africa is astounding. Dental practitioners need to be culturally competent and show they value and respect the variety of their patients. Cultural sensitivity promotes inclusive care that respects and takes into account individual variations.

Presentability:

The term "presentability" describes how dental practitioners dress and act. Maintaining a neat and professional appearance not only gives patients confidence, but it also shows pride in and dedication to the dentistry profession. This entails dressing appropriately, upholding standards of hygiene and keeping a tidy and orderly workspace. A dental professional's appearance sets the tone for a comfortable and reassuring patient encounter by being well-groomed and presentable. When patients regard their dentist as a competent, self-assured person who takes pride in their

appearance and the dental treatments they offer, they are more likely to feel at ease.

Approachability:
The warmth and openness with which dental practitioners interact with their patients, colleagues and the community is referred to as approachability. An atmosphere that is conducive to good communication and patient rapport is created by having a warm and friendly approach. Being approachable is especially important in dentistry since patients may experience worry and apprehension during dental procedures. Approachable dental professionals make an effort to actively listen to their patients' concerns and allay any worries or doubts they may have. They use compassion and empathy to create a welcoming environment where patients can express their dental needs and preferences.

Communication:
Patient-centred care is focused on effective communication. Dental professionals need to be effective communicators who can explain complicated dental concepts in a way that is both clear and understandable. To help patients understand, this entails speaking clearly, minimising jargon and utilising visual aids as needed. In addition to aggressively seeking patient input and including them in their treatment planning, clear communication also requires outlining treatment alternatives and procedures. Dental practitioners encourage patients to take an active role in their oral health by participating in shared decision-making, which promotes improved treatment acceptability and adherence.

Professionalism in communication extends beyond contacts with patients to include relationships with staff and the larger community. A happy and collaborative work atmosphere is fostered by respectful and effective communication with coworkers and staff, which develops teamwork and improves overall practice efficiency. To promote oral health across the community, dental practitioners are essential. Dentists can successfully convey the significance of oral health and preventive actions to preserve a healthy smile by participating in outreach programmes, educational efforts and public awareness campaigns.

PROFESSIONAL ACCOUNTABILITY AND RESPONSIBILITY

At the heart of professionalism in dentistry lies professional accountability and responsibility. Dental professionals are entrusted with the wellbeing of their patients and this stewardship demands unwavering commitment to upholding the highest standards of care, ethics and integrity.

In dentistry, accountability means accepting responsibility for one's choices and actions, as well as for the results of those choices. Dental professionals must understand that their patients put their faith and health in their hands and, as a result, they have a sacred duty to put their patients' needs first. Being accountable for patient care entails exercising caution when making decisions and performing clinical tasks. Dental professionals need to stay up to date on the most recent findings, recommendations and developments in the field and incorporate evidence-based methods into their treatment plans. To guarantee patients receive the most recent and efficient care possible, continuous self-evaluation and improvement are essential.

Self-regulation is yet another essential component of accountability. Dental professionals need to evaluate their performance, skills and potential for growth. Dentists show their dedication to improving patient care and the dental profession by holding themselves to high standards and actively looking for methods to advance their knowledge and abilities. Feedback, whether it comes from peers or patients, is an important tool for development and progress. Dental professionals can find ways to improve their practice and patient interactions by accepting comments with humility and an open mind. Dental professionals can improve their abilities, adjust to shifting patient needs and continuously advance as healthcare professionals by receiving constructive criticism.

Dental professionals must be ready to admit their errors and learn from them because nobody is perfect. For the purpose of preserving patient trust and promoting a culture of continuous improvement, transparency in the handling of errors is essential. Dental professionals show their dedication to patient safety and the pursuit of excellence by taking corrective action when errors are made and by putting plans in place to avoid them in the future.

Professional responsibility includes not only one's own practice but also the larger dental community and society. It is the duty of dental practitioners to promote oral health, equal access to care and the expansion of dental knowledge. Dental professionals can have a greater impact on addressing oral health disparities and societal dental needs if they actively participate in professional organisations and community outreach programmes.

Therefore, professionalism in dentistry must emphasise how crucial it is for professionals to be accountable and responsible. Dental professionals in South Africa can establish themselves as trustworthy and dependable partners in their patients' oral health journeys by accepting accountability for their actions, taking ownership of patient care, engaging in self-regulation and continuous improvement, and being open to criticism.

CONCLUSION

To ensure the delivery of high-quality care and protect the integrity of the dental profession, professionalism in healthcare, particularly within the field of dentistry, is crucial. A culture of professionalism will be promoted in South African dental practice by embracing the domains of clinical competence, ethical decision-making, effective communication, teamwork, cultural competency and professional accountability. As time goes on, it is our obligation as leaders, educators and dental professionals to address the developing professionalism-related issues and work together to instil a sense of pride and accountability in the upcoming generation of dental professionals.

Professionalism in healthcare, especially dentistry, is a fluid and ever-evolving idea that exceeds established limitations. It embodies a commitment to patient welfare, moral behaviour, research-based treatment, ongoing learning, teamwork, cultural sensitivity and individual responsibility. By embracing these aspects of professionalism, dental practitioners are more equipped to deal with the challenges of contemporary healthcare, ensuring that their patients receive compassionate, efficient and equitable oral care while preserving the highest standards of quality in their field. Professionalism continues to be the guiding principle that drives the success and influence of dentistry in South Africa and abroad, even as the dental community adjusts to the always shifting environment.

www.sada.co.za / SADJ Vol. 78 No.6

A survey into the impact of HPCSA investigations on health practitioners' mental health

SADJ July 2023, Vol. 78 No.6 p290-291

Mr KC Makhubele – CEO, South African Dental Association

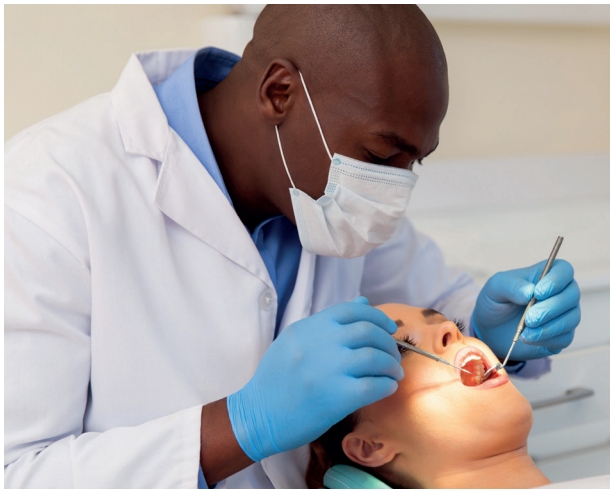
The Health Professions Council of South Africa (HPCSA) performs an essential role in regulating healthcare professionals and ensuring public safety. However, HPCSA investigations into health practitioners can have a significant impact on the mental health and wellbeing of those physicians and dentists involved.

Medical Protection recently surveyed its members who faced HPCSA investigations between 2018 and 2022 to gain insight into their experiences. The purpose of the survey was to assess the impact on their mental health, identify areas for improvement and provide recommendations for the HPCSA and the Department of Health to resolve these issues.

The Medical Protection survey included 204 respondents who had been the subject of HPCSA investigations. The respondents were asked how the investigations affected their mental health, personal affairs and careers. In addition, they were asked to provide anonymous commentary on their experiences. The collected data was analysed to identify key themes and make improvement recommendations supported by evidence.

The majority of respondents (83%) experienced stress and anxiety as a consequence of the HPCSA investigations, according to the survey results. Some 46% of respondents reported a negative impact on their health and wellbeing and 42% reported a negative impact on their personal relationships. Unsettlingly, 11% of respondents reported having suicidal ideation during the investigation.

The survey also revealed several critical areas of concern, such as the tone of HPCSA communications, the handling of frivolous or baseless complaints, delays in the investigation process and the financial motivations perceived by some physicians. In addition, the lack of mental health support for doctors confronting investigations emerged as a critical issue.



Recommendations

Medical Protection formulated the following recommendations based on the survey results:

The HPCSA should re-evaluate the tone of its communications and embrace a more empathic and factual stance. It should be clearly communicated that the doctor under investigation is presumed innocent until proven culpable.

The HPCSA should improve its screening process to identify and promptly dismiss frivolous or spurious complaints. The council should discourage the active soliciting and encouragement of complaints against its registrants, which may result in minor or frivolous complaints and prolong the investigation process unnecessarily.

Delays and absence of updates: The HPCSA must address the issue of investigation process delays. It should provide doctors with an anticipated completion date and provide more frequent updates to reduce anxiety and uncertainty. The council should ensure that investigators participating in preliminary inquiry committees are sufficiently experienced and medically qualified to expeditiously close cases that do not require further action.

To combat the perception that the HPCSA is motivated by fines, the council should reassure the medical community that it is not financially led by the imposition of fines. Transparent reporting and communication of financial information can assist in dispelling this misconception.

Initial communication: The HPCSA should consider implementing strategies used by regulators in other jurisdictions to minimise the initial impact on the mental health of practitioners. This includes initiating contact by phone before sending a letter and averting email on Fridays. Priority should also be given to protecting physicians' privacy by avoiding naming other practitioners in correspondence.

Wellbeing support: The HPCSA should ensure that all investigation-related communications and materials contain obvious pointers to mental wellbeing support resources. Consideration should be given to instituting an independent, 24-hour-a-day, seven-day-a-week wellbeing

support service for practitioners facing investigations. In addition, including an acknowledgement of the potential stress and a timeline for the process in the initial notification letter can demonstrate compassion and alleviate the stress of enrollees.

The South African Dental Association (SADA) recognises that HPCSA investigations can have a significant impact on the mental health and wellbeing of dental professionals. SADA recognises the significance of upholding high standards of patient safety and ethical conduct. However, they underline the need for a balanced approach that considers the mental health of those being investigated throughout the investigation process.

SADA endorses the recommendations made by Medical Protection, including the revision of communication tone, the efficient handling of complaints, the dissemination of timely updates and the provision of adequate mental health support for practitioners. In addition, they advocate for the inclusion of healthcare professionals with relevant experience and credentials on investigative committees to ensure equitable and well-informed decisions.

Relevant Mayosi Report 2015 (Ministerial Task Team) findings:

The Ministerial Task Team released the Mayosi Report in 2015, which examined the HPCSA's operation and effectiveness. While the study's focus was on the medical profession, some of its findings are pertinent to the discussion of HPCSA investigations and their impact on mental health.

Significant concerns were raised regarding the protracted duration of investigations, delays in case resolution and insufficient communication with practitioners involved in the process. It was discovered that these factors contribute to increased stress, anxiety and uncertainty among healthcare professionals, which negatively impacts their mental health. The Mayosi Report emphasised the significance of streamlining the investigation process, providing healthcare professionals with timely updates and providing adequate support throughout the proceedings. It called for reforms that prioritise impartiality, transparency and the efficient resolution of cases, while also taking into account the welfare of practitioners.

In conjunction with the findings of the Mayosi Report, the Medical Protection survey results underscore the imperative need for comprehensive improvements to the HPCSA investigation process. These enhancements should address issues such as the tone of communication, the efficient management of complaints, the provision of timely updates and the provision of adequate mental health support for practitioners.

By implementing the recommendations provided by Medical Protection, considering the views of SADA and taking into consideration the findings of the Mayosi Report, the HPCSA and the Department of Health can work towards a more balanced and compassionate approach to investigations. A regulatory environment that prioritises the mental health of healthcare professionals while upholding patient safety and ethical practice will be healthier and more effective.

Continuous engagement and collaboration between the HPCSA, relevant professional associations such as SADA, and other stakeholders is essential for attaining these enhancements. It is possible to establish a regulatory framework that protects both the interests of patients and the mental health of healthcare professionals through collaboration.

To read the survey by Medical Protection, follow this link: https://www.medicalprotection.org/southafrica/about-mps/policy-and-public-affairs/hpcsa-investigations

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Prevalence of dental caries among learners with disabilities attending special education schools in the eThekwini District, KwaZulu-Natal

SADJ July 2023, Vol. 78 No.6 p292-

S Gumede[1], S Singh[2], M Radebe[3]

ABSTRACT

Introduction

Individuals with special healthcare needs may have poor oral health as a result of systemic and structural issues that make it more difficult to maintain optimal oral health status. As such, these individuals may require specialised, multidisciplinary oral healthcare. Furthermore, determining the severity of oral conditions among these people is necessary to establish the number of people affected and the services required to improve oral healthcare for these affected populations.

Aims and objectives

To determine the prevalence of dental caries among learners with disabilities attending special schools education in the eThekwini district, using DMFT/dmft and PUFA/pufa indices.

Design

A cross-sectional descriptive study design.

Methods

A proportional stratified random sampling method was used to select learners from 22 special schools in the eThekwini district (n=435). The sample was divided into subgroups known as strata (schools) and a systematic sampling technique was used in each school. The learners were further categorised according to the classification of Special Health Care according to the Individuals with Disabilities Education Act (IDEA). Data collection comprised an intraoral examination to determine the prevalence of dental caries (using the DMFT/dmft index) and the extent of untreated dental caries using the PUFA/pufa index.

Results

Out of the 488 students in the special schools approached, 435 consented to participate in the study giving a response rate of 89.14%. The prevalence of dental caries in the permanent and primary dentition was 53.6% and 22.5% respectively. The overall D (decayed) component recorded in permanent teeth was 740 (88%), the F (filled) component was 30 (4%) and M (missing) component was 77 (9%). Females had higher mean DMFT and PUFA scores while males had higher dmft and pufa scores. The DMFT and dmft scores recorded were highest in the 18-20 years age group at 3.70 ± 3.83 and the 6-8 years age group at 4.31 ± 4.00 respectively. The relationship between the DMFT and dmft scores and participants' age was seen as statistically significant, as these increased with age (p <0.001). The highest caries prevalence was found in the intellectual disability group (46.4%; n=393). The "untreated caries to PUFA ratio" was 2.5 to 1, indicating that 26% of the D + d component (in DMFT/dmft) had progressed mainly to pulpal involvement. The PUFA/pufa scores were higher in the 12-14 years age group at 0.46 ± 1.33 and 6-8 years age group at 2.06 ± 3.45 respectively when compared to the other age groups in the study sample.

Conclusion

The high number of dental caries recorded in the permanent and primary dentition and the low number of restored teeth in the study sample highlight the need for promotive, preventive and restorative oral healthcare programmes within this population.

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Author's contribution

1. S Gumede: Study conceptualisation, data analysis, manuscript preparation, writing and final editing (60%).
2. S Singh: Data analysis, manuscript preparation and editing (20%).
3. M Radebe: Data analysis, manuscript preparation and editing (20%).

Acknowledgments

None

Conflict of interest

The authors declare that there is no conflict of interest.

INTRODUCTION

Individuals with disabilities often face difficulties in oral hygiene maintenance which results in poor oral cleanliness when compared to the general population, who can usually manage their oral health[1]. Maintaining optimal oral health in disabled individuals is very challenging, as they also have compromised general health[2]. As a result, oral conditions exist among individuals with special needs and are influenced by factors such as the person's physical limitations, general illness, intellectual capacity, living situation, age and degree of impairment[3]. It is reported that these individuals have poorer overall oral health status, periodontal status, fewer remaining teeth and more untreated dental caries which are the most dominant unmet oral health problem in such

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individuals[3]. Ordinarily, individuals with special needs are primarily dependent on parents, siblings and caregivers – especially the young, severely impaired and institutionalised – for general care as well as oral hygiene[4].

There is also limited published evidence in South Africa (SA) on oral health in special schools education, particularly in KwaZulu-Natal (KZN). However, a few studies have been conducted – specifically, in Vhembe district, Limpopo province; in Johannesburg, Gauteng province; a study conducted in four provinces of SA ie Gauteng, Limpopo, KZN and Mpumalanga; and one study in KZN[5-8]. The current study set out to determine the prevalence of dental caries among learners in KZN special schools education (referred to as special schools) through use of the DMFT/dmft and PUFA/pufa indices. The DMFT/dmft index was used to measure the prevalence of dental caries and the PUFA index was used to assess the presence of oral conditions resulting from untreated caries and to record the clinical consequences of untreated dental caries[9-10].

METHODS AND MATERIALS

Study design

A descriptive cross-sectional study design was used to conduct the study.

Setting

Participants were drawn from the population of learners with disabilities attending special schools in eThekwini district, KZN province, SA. Data was collected between June and September 2022 during school hours and in accordance with Covid-19 protocols. The study was approved by the Biomedical Research Ethics Committee of the University of KwaZulu-Natal (BREC00003814/2022) and ethical guidelines were followed to ensure confidentiality in the management of data. Gatekeeper permission was obtained from the KZN Department of Education.

Study participants

The study population were students with special needs attending special schools within the 22 special schools of eThekwini district who gave consent to participate in the study.

Study size

According to the 22 special schools in eThekwini district that were part of the study, there were 4,875 enrolled pupils in these schools. Proportional stratified random sampling method was used to calculate the sample size of learners with special needs (participants). This sampling method was chosen because the population that was sampled was divided into subgroups know as strata (schools). The sample size from each stratum was obtained using this formula: (sample size/population size) x stratum size, that is 4,875 x 10% = 488 learners. However, only 435 learners consented to participate in the study; therefore, n=435.

Since the identified special schools in eThekwini district cater for a wide variety of disability types, the study did not stratify according to the disability types but stratified per schools. Systematic sampling technique was used for select potential participants in each identified school[11]. Systematic sampling involved selecting at random the first person from a list and then taking every third number or element (person) until the desired total of individuals was selected[12]. This number of learners was further distributed according to the following ages: 6-8, 9-11, 12-14, 15-17 and 18-20 years. The learners in the study sample were then categorised according to the classification of Special Health Care according to the Individuals with Disabilities Education Act or IDEA[13] as expressed in Table I above. The inclusion criteria hence included learners aged between 6 and 20 years. The study excluded learners who did not receive parental or caregiver consent and learners who did not meet the age requirement; those who were uncooperative and unwilling were also excluded from the study.

Table I: The Special Health Care classification

Disability type	Total participants (n)
Specific learning disabilities	9
Other health impairment	22
Autism spectrum disorder	54
Emotional disturbance	15
Speech or language impairment	2
Visual impairment including blindness	7
Deafness	47
Hearing impairment	11
Orthopaedic impairment	65
Intellectual disability	182
Traumatic brain injury	5
Multiple disabilities	16
Total	**435**

For the recruitment process, a meeting was first held with the school principal and educators to inform them of the proposed study. A meeting was also held with class educators and care-givers and all queries related to the study were addressed. Letters of invitation and the informed parental consent (IPC) form and an individual assent form (IAF) were sent to the parents via the class. A meeting was also held with interested parents to highlight the purpose and goal of the study. Both parental consent and child assent (where possible) were obtained and a child's refusal to participate in the study was upheld. Thus, voluntariness in study participation was maintained.

Data sources/measurement

A pre-designed data capturing sheet was then used to collect data on the demographic characteristics and dental caries status of the students. Intra-oral examinations were carried out to determine caries and the extent of dental caries using the DMFT/dmft and PUFA/pufa indices respectively. A designated space was provided by the schools for the review of each learner's IPC and IAF and to conduct the oral examinations. The dental examinations were noninvasive. Dental caries was evaluated by visual inspection under natural sunlight, with additional tactile inspection using mostly the mouth mirror, probe, explorer tweezers and sometimes tongue depressor if required. Sterile disposable clinical examination instruments were used for inspection.

Radiographic examinations were not undertaken.

The general demographic information data and the clinical dental examinations were collected/conducted by the researcher (a qualified dental therapist). Two research assistants (oral hygienist and dental assistant) were trained

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in data documentation. One recorded the sociodemographic details, while the other recorded the result of the oral examination as communicated by the researcher.

Variables

The independent variables were age and gender. The components of DMFT/dmft index formed part of the dependent variables to measure the prevalence of dental caries and the presence of restored and/or missing teeth among children with special needs education in this study. The DMFT/dmft index score was calculated as Decayed (D) + Missing (M) + Filling (F) = DMFT and the total DMFT scores divided by the total number of subjects examined was used to calculate the total population DMFT scores[14]. To quantify the various progressive stages of a carious lesion, a measuring system was developed – the PUFA (P-pulpal involvement, U-ulceration, F-fistula and A-abscess) index[15], which is mainly used as a complementary tool to caries indices like DMFT[16]. The PUFA index was used to assess the presence of oral conditions resulting from untreated caries and to record the clinical consequences of untreated dental caries and is c,,alculated in the same way as the DMFT[9].

Bias

To reduce inter-examiner variability and improve validity every fifth oral examination completed was re-examined as per World Health Organisation standards for oral health surveys[10]. Furthermore, the Cronbach's alpha coefficient was measured to ensure the internal consistency, or reliability, of a set of survey items. The Cronbach's alpha result for the current study was 0.730.

Data analysis

Data collected was transferred onto an Excel spreadsheet and analysed using the SPSS version 28.0 software. Descriptive statistics were utilised to investigate possible relationships between the variables such as age, gender, race and DMFT/PUFA scores obtained. For the calculation of inferential statistics, Pearson's chi-squared test was used to assess the possible relationship between the independent variables and the dependent variables and statistical significance was only reported when the p-value was <0.05.

RESULTS

Sociodemographic characteristics of participants and the overall DMFT and PUFA scores

Out of the 488 students in the special schools approached, 435 consented to participate in the study, giving a response rate of 89.14%. Of the 435 learners who participated in the study, 271 (62.3%) were male and 164 (37.7%) were female. Participants identified themselves as belonging to one of four major racial groups: African 367 (84.4%), Indian 46 (10.6%), Coloured 11 (2.5%) and White 11 (2.5%). The mean age of the study participants was 13 years (SD: 3.58). The majority were in the 15 to 17-year-old category, which made up almost one-third of the sample (29.2%; n=127) as shown in Table 2. The participants were from two educational subdistricts in the eThekwini district[17] – Umlazi at 283 (65.1%) and Pinetown at 152 (34.9%).

Overall, learners from the Umlazi district had a higher mean ± (SD) DMFT value of 2.25 ± 2.90 compared to participants from the Pinetown district who had a DMFT score of 1.38 ± 2.10. Females had a higher mean DMFT score of 2.09 ± 2.73 compared to males with 1.86 ± 2.75. The highest DMFT score was also noted on the 18-20-year age group at 3.70 ± 3.83. The DMFT score increased with age as illustrated in the next section and it was found to be statistically significant (p=0.001). Learners in Pinetown district had a higher mean dmft value of 0.99 ± 2.260 compared to participants from Umlazi who had a mean score of 0.91 ± 2.23. The highest dmft was noted in the 6-9-year age group at 4.31 ± 4.00. The relationship between the dmft score and participants' age was significant (p=0.001). The dmft score also increased with age as illustrated later in this section.

Learners from Umlazi district had a higher value of PUFA index of 0.46 ± 1.33 compared to participants from Pinetown district who had a mean PUFA index of 0.22 ± 0.70. The "untreated caries (n=295) to PUFA (n=116) ratio" was 2.5 is to 1 (41%) indicating that 26% of the D + d component had progressed mainly to pulpal involvement. Learners from Pinetown district had a higher value of pufa index of 0.56 ± 2.24 compared to participants from Umlazi district who had a mean pufa index of 0.37 ± 1.28.

Dental caries status in the permanent dentition

In the permanent dentition, the mean DMFT score was 1.97 ± 2.36. The prevalence of dental caries in permanent dentition was 53.6% (see Table 2). The highest mean DMFT score was recorded among the 18-20-year age group at 3.70 ± 3.83 as shown in Table 2. The highest caries prevalence in the study sample was found in the intellectual disability group (46.4%) (p=0.628) and the lowest in the speech or language impairment disability group (0.3%). The overall D component was 740 (88%), F component was 30 (4%) and M component was 77 (9%). The D component was the highest in the 18-20-year group at 132 (76%), with the F component of n=10 (6%) and M component of n=32 (18%) which is indicative of high unmet treatment needs and showing extraction as the main treatment option.

The overall mean PUFA score for the permanent dentition was 0.34 ± 1.01, and females had a slightly higher PUFA index score of 0.35 ± 0.94 compared to males with 0.34 ± 1.05. The mean PUFA score was highest in the 12-14-year age group at 0.46 ± 1.33 as shown in Table 2. Learners with traumatic brain injuries had the highest mean PUFA score of 1 ± 1.26, followed by participants with intellectual disability and multiple disabilities at 0.44 ± 1.25 as well as 0.44 ± 1.06; however, this data was not seen as significant.

Dental caries status in primary dentition

The prevalence of dental caries in primary teeth was 22.5%. The lowest caries prevalence was found in the speech or language impairment disability group (0%) and the highest was found in the intellectual disability group (38.8%) (p=0.537) predominantly in the 6-9-year group. The mean dmft score was 0.95 ± 2.36. The overall "decayed" component of 408 (99.52%) was the most prominent factor in dmft scores. The d component was the highest in the 6-9-year-olds at 288 (70%). The f component was only noted in the 10-11-year-olds at n=1 (1%) which is indicative of high unmet treatment needs.

The average mean dmft score within primary dentition was 0.95 ± 2.36. The mean dmft score was highest in the 6-8-year age group at 4.31 ± 4.00 as shown in Table 2. Learners with visual impairment, including blindness, had the highest dmft score 2.43 ± 2.06, followed by the participants with autism spectrum disorder 1.44 ± 2.69.

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The overall mean pufa score for the primary dentition was 0.44 ± 1.68, and males had a significantly higher pufa index score of 0.47 ± 1.88 compared to females with 0.37 ± 1.26. The mean pufa score was highest in the 6-8-year age group at 2.06 ± 1.26 with the p component at 134 (96%), f component at 3 (2%) and a component at 3 (2%). Learners with autism spectrum disorder and other health impairments such as dyslexia and ADHD had the highest mean pufa score 0.77 ± 2.05 as well as 0.77 ± 3.85 respectively; however, the low sample size in these categories is noted.

DISCUSSION

The study sample comprised more males (62.3%) and this finding is consistent with other studies carried out in SA and in other parts of the world[4,6-8,18-20]. According to Haddad (2020), males are one-third more likely than females to have a special need[21]. However, the gender distribution reported in this study is contrary to that reported by the Statistics South Africa Census 2011 which reported that the prevalence of disability was higher among females[22].

Additionally, dental caries in the permanent dentition was more prevalent in females (18-20-year age group), but caries in the primary dentition was more prevalent in males (6-8-year age group). Only a few observations were recorded for the F (filling) component. This finding suggests high unmet treatment needs in the study sample. Gender variations in dental caries prevalence have been consistently reported, with females often experiencing a greater prevalence and severity of disease at all ages. The reason for this gender imbalance is currently not understood; however, it could be partially explained by the different influences of genetic factors on the sexes[23,24]. Other authors postulated that it could be because females experience early eruption times, therefore had longer exposure time to cariogenic foods[25]. Additionally, it has been noted that the varying oestrogen levels in females between adolescence and menstruation slow down the salivary flow, alter its composition and ultimately make them more susceptible to developing cavities[24]. These findings are in line with other studies that indicated an association between the age of children with impairments and dental caries[3,26]. One possible explanation is the fact that children in the 6 to 8-year age group may have lower oral hygiene skills than children in other age groups[27]. This could have an impact on the rise in caries prevalence as compared to other age groups. Another reason could be the high percentage of deciduous teeth found in this group of learners and, because they have thinner enamel, they have a faster spread of caries from the enamel to the dentine than newly erupted permanent teeth[26,28]. On the other hand, exposure time also gives insight into why the prevalence of caries is higher in the 18-20-year-old group than in other groups[26,29].

The prevalence of dental caries reported in this study for primary dentition (22.5%) and permanent dentition (53.6%) is consistent with the findings of other studies conducted in South African special needs schools. In Gauteng province, a study reported the caries prevalence at 27.55% and 33.56% in primary and permanent dentition, respectively[6] while in KZN, Naidoo and Singh reported caries prevalence among school-going children with autism spectrum disorders at 51.7% and 40.8%, respectively[8]. In contrast to the current study's findings, a study conducted in Ile-Ife, Nigeria indicated dental caries rates of 22.8% in children with special needs[30]. In Port Harcourt, authors indicated that only 28.1% of their study participants had caries[31].

On the other hand, some studies conducted in mainstream schools in Africa revealed a lower prevalence of dental caries than the current study. In Tshwane, South Africa a study reported a dental caries prevalence of 25.9% in permanent dentition and 30.2% in primary dentition[25]. In a systematic review and meta-analysis conducted in Africa, the overall caries prevalence was 36%[32]. It is interesting to note that a systematic review (1995 to 2019) reported a global prevalence of 46.2% dental caries in primary teeth and 53.8% in permanent teeth, which is consistent with the current study[33]. At the same time, studies conducted elsewhere in mainstream schools revealed overall caries prevalence that was higher than the current study. A study conducted in KZN revealed the caries rate of the study sample was 73%, while 27% was caries free[34]. These inconsistencies in the reported dental caries rates highlight the need for locally developed oral health promotion programmes that can address the specific unmet needs of the affected population.

This study reported that the highest caries prevalence was found in the intellectual disability group, and this may be due to the fact that the majority of the study participants come from this group. However, learners with traumatic brain injuries had the highest mean DMFT and PUFA score, followed by participants with intellectual disability and multiple disabilities respectively. Although, this data was not seen as significant, given the low sample size in these categories.

LIMITATIONS

The current study focused on learners with different types of disabilities attending special schools in KZN, thus providing a better picture of the prevalence of dental caries across the different disability types, despite several limitations. The study focused only on children who were enrolled in the identified schools and there could have been missed opportunities to identify such children who are not enrolled in schools. More research is required to compare those who attend special schools to those who do not so as to improve the sample's representativeness. The study also focused on the number of teeth affected by dental caries as opposed to the number of surfaces that were affected by caries. This information could have provided a clearer picture of the unmet treatment needs. It is recommended that dental caries diagnosis is conducted through clinical examination with the use of instrumentation and radiographic examinations as this provides a more accurate diagnosis. However, this study used only clinical examination and instruments, and that could have resulted in a possible underdiagnosis of caries, especially in interproximal areas, as well as dental abscesses that are not clinically visible. Future studies could include the Kappa score in data analysis to determine further statistical significance of the data.

RECOMMENDATIONS

Overall, the study findings have important practical and policy implications and could be of value to the KZN Department of Health, oral health professionals and the Department of Education for developing effective oral health and oral care programmes. The study findings further draw attention to the need for dental treatment, oral health education and oral health promotion in the identified population. Future research should focus on improving access to oral health education for children with disabilities, educating parents of disabled children about oral healthcare, improving access to topical fluoride applications, and implementing other

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Table 2: All categories of DMFT/dmft and PUFA/pufa scores

DMFT/dmft and PUFA/pufa							
	participants	DMFT/dmft					
Category	No:	DMFT			dmft		
	N(100%)	N(%)	Mean(SD)	p-values	N(%)	Mean(SD)	p-values
Overall DMFT/dmft							
Overall	435(100%)	847(100%)	1.95(2.74)		410(100%)	0.95(2.36)	
Gender							
Female	164(38%)	343(40.5%)	2.09 (2,73)	0.590	125 (30.5%)	0.76(2.04)	0.379
Male	271(62%)	504(59.5%)	1.86 (2.75)		285 (69.5%)	1.05(2.53)	
Age category							
06-08	67(15.4%)	23(2.7%)	0.36 (0.95)	0.001	289 (70.5%)	4.31 (4.00)	0.001
09-11	88(20.2%)	79(9.3%)	0.89 (1.27)		106(25.9%)	1.20 (2.00)	
12-14	106(24.4%)	257(30.3%)	2.42 (2.99)		13 (3.2%)	0.12 (0.54)	
15-17	127(29.2%)	314(37.1%)	2.46 (2.78)		2 (0.5%)	0.12 (0.54)	
18-20	47(10.8%)	174(20.5%)	3.70 (3.83)		0 (0%)	0(0.00)	
Subdistrict							
Umlazi	283(65%)	637(75.2%)	2,25 (2,99)	0.140	260(63.4%)	0,91(2,23)	0.064
Pinetown	152(35%)	210(24.8%)	1,38(2,10)		150(36.6%)	0,99(2,60)	
Race							
African	367(84.4%)	794(93.7%)	2.17(2.82)	0.713	353(86.1%)	0.96(2.42)	0.890
Indian	46(10.6%)	32(3.8%)	0.70(2.08)		38(9.3%)	0.83(2.24)	
Coloured	11(2.5%)	13(1.5%)	1.18(1.54)		3(0.7%)	0.27(0.62)	
White	11(2.5%)	8(0.9%)	0.73(1.56)		16(3.9%)	1.45(1.72)	
Level of study							
Junior phase	144(33.1%)	101(11.9%)	0.71(1.44)	0.001	384(93.7%)	2.66(3.47)	0.001
Intermediate phase	141(32.4%)	299(35.3%)	2.13(2.78)		25(6.1%)	0.177(0.63)	
Senior phase	150(34.5%)	447(52.8)	2.97(3.17)		1(0.2)	0.01(0.08)	
Location							
Rural	56(12.9%)	115(13.6%)	2.13(2.67)	0.288	35(8.5%)	0.63(1.96)	0.965
Peri-urban	261(60%)	567(66.9)	2.16(2.87)		263(64.1%)	1.01(2.49)	
Urban	118(27.1%)	165(19.5)	1.39(2.40)		112(27.3%)	0.95(2.24)	
Disability type							
Specific learning disabilities	9(2.1%)	3(0.3%)	0.33(0.70)	0.628	8(2%)	0.88(0.99)	0.537
Other health impairment	22(5.1%)	49(5.8%)	2.32(3.12)		27(6.6%)	1.23(2.19)	
Autism spectrum disorder	54(12.4%)	92(10.9%)	1.70(2.72)		78(19%)	1.44(2.69)	
Emotional disturbance	15(3.4%)	32(3.8%)	2.13(2.70)		1(0.2%)	0.06(0.24)	
Speech or language impairment	2(0.5%)	3(0.3%)	1.50(0.71)		0(0%)	0.00(0.00)	
Visual impairment including blindness	7(1.6%)	0(0%)	0.00(0.00)		17(4.1%)	2.43(2.06)	
Deafness	47(10.8%)	86(10.2%)	1.83(2.09)		17(4.1%)	0.36(2.06)	
Hearing impairment	11(2.5%)	21(2.5%)	1.91(3.96)		2(0.5%)	0.18(0.39)	
Deaf-blindness	0(0%)	0(0%)	0.00(0.00)		0(0%)	0.00(0.00)	
Orthopaedic impairment	67(15.4%)	122(14.4%)	1.82(2.42)		94(22.9%)	1.40(2.96)	
Intellectual disability	180(41.4%)	393(46.4)	2.18(2.95)		159(38.8%)	0.88(2.49)	
Traumatic brain injury	5(1.1%)	23(2.7)	4.60(3.85)		2(0.5%)	0.40(0.80)	
Multiple disabilities	16(3.7%)	23(2.7)	1.44(2.22)		5(1.2%)	0.31(0.85)	

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	PUFA/pufa					
	PUFA			pufa		
	N(%)	Mean(SD)	P-value	N(%)	mean(SD)	p-value
	148(100%)	0.34(1.01)		191(100%)	0.44(1.68)	
	57(39%)	0.35(0.94)	0.873	61(32%)	0.37(1.26)	0.909
	91(61%)	0.34(1.05)		130(68%)	0.47(1.88)	
	6(4%)	0.06(0.29)	0.145	140(73%)	2.06(3.45)	0.001
	19(13%)	0.22(0.80)		47(25%)	0.53(1.45)	
	48(32%)	0.46(1.33)		3(2%)	0.03(0.17)	
	54(37%)	0.43(1.03)		1(1%)	0.01(0.09)	
	21(14%)	0.45(0.99)		0(0%)	0(0.00)	
	110(74%)	0.39(1.14)	0.880	106(55%)	0.37 (1.28)	0.334
	38(26%)	0.25(0.70)		85(45%)	0.56 (2.24)	
	144(97%)	0.39(1.08)	0.984	168(88%)	0.46 (1.77)	0.541
	3(2%)	0.07(0.32)		10(5%)	0.22 (0.88)	
	1(1%)	0.09(0.29)		2(1%)	0.18(0.57)	
	0(0%)	0.00(0.00)		11(6%)	1(1.60)	
	24(16%)	0.17(0.87)	0.048	178(93%)	0.12(2.71)	0.001
	58(39)	0.41(1.13)		13(7%)	0.09(0.44)	
	66(45)	0.44(0.98)		0(0%)	0.00(0.00)	
	19(13%)	0.34(0.76)	0.578	2(1%)	0.04(0.19)	0.721
	106(72%)	0.41(1.16)		142(74%)	0.54(1.99)	
	23(16%)	0.19(0.67)		47(25%)	0.40(1.21)	
	0(0%)	0.00(0.00)	1.000	5(3%)	0.55(1.07)	0.974
	7(5%)	0.32(0.63)		17(9%)	0.77(1.93)	
	20(14%)	0.37(1.06)		42(22%)	0.77(2.05)	
	1(1%)	0.07(0.25)		0(0%)	0.00(0.00)	
	0(0%)	0.00(0.00)		0(0%)	0.00(0.00)	
	0(0%)	0.00(0.00)		2(1%)	0.29(0.45)	
	12(8%)	0.26(0.70)		5(3%)	0.11(0.42)	
	1(1%)	0.09(0.29)		0(0%)	0.00(0.00)	
	0(0%)	0.00(0.00)		0(0%)	0.00(0.00)	
	16(11%)	0.24(0.67)		26(14%)	0.39(1.13)	
	79(53%)	0.44(1.25)		94(49%)	0.52(2.09)	
	5(3%)	1(1.26)		0(0%)	0.00(0.00)	
	7(5%)	0.44(1.06)		0(0%)	0.00(0.00)	

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Table 3: Overall DMFT/dmft and PUFA/pufa scores according to age distribution

Age	06-09 years		10-11 years		12-14 years	
No:	67		88		106	
	n (%)	Mean(SD)	n (%)	Mean(SD)	n (%)	Mean(SD)
DMFT	23 (100%)	0.36(0.95)	79(100%)	0.89(1.27)	257(100%)	2.42(2.99)
D	22 (96%)	0.33(0.88)	74(94%)	0.84(1.28)	239(92%)	2.25(2.93)
M	1 (4%)	0.01(0.12)	4(5%)	0.05(0.26)	9 (4%)	0.08(0,31)
F	0 (0%)	0(0)	1(1%)	0,01(0,.11)	9(4%)	0,09(0,55)
dmft	289(100%)	4.31(4.00)	106(100%)	1.20(2.00)	13 (100%)	0,12(0,54)
d	288(66.7%)	4.29(3.98)	105(99%)	1.19(1.98)	13(100%)	0,12(0,54)
m	1(0.3%)	0.01(0,12)	0(0%)	0(0.00)	0(0%)	0(0,00)
F	0 (0%)	0(0.00)	1(1%)	0.01(0.10)	0(0%)	0(0.00)
Age	**06-09 years**		**10-11 years**		**12-14 years**	
No:	67		88		106	
	n (%)	Mean (SD)	n (%)	Mean (SD)	n (%)	Mean (SD)
PUFA	6(100%)	0.06(0.29)	19(100%)	0.22(0.80)	48(100%)	0.46(1.33)
P	6(100%)	0.06(0.29)	19 (100%)	0.23(0.80)	47(98%)	0.45(1.33)
U	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0(0%)	0 (0.00)
F	0 (0%)	0 (%)	0 (0%)	0 (0%)	0(0%)	0 (0.00)
A	0 (%)	0 (%)	0 (0%)	0 (0%)	1(2%)	0.009(0.10)
pufa	140(100%)	2.06(3.45)	47(100%)	0.53(1.45)	3100%)	0.03(0.17)
p	134(96%)	1.97(3.42)	46(98%)	0.25(1.43)	3(100%)	0.03(0.17)
u	0 (%)	0(0.00)	0 (0%)	0(0.00)	0(0%)	0(0.00)
f	3(2%)	0.04(0.36)	0(0%)	0(0.00)	0(0%)	0(0.00)
a	3(2%)	0.04(0.36)	1(2%)	0.001(0.11)	0(0%)	0(0.00)

appropriate interventions to better support children with disabilities.

CONCLUSION

The results of the current study illustrate that dental caries was most frequently recorded in the study population while very few restorations (fillings) were observed. This suggests that dental caries is common among children with disabilities in the identified schools in eThekwini district but that there are also unmet oral health needs, given the low number of restored teeth observed. The high number of dental caries recorded in the permanent and primary dentition and the low number of restored teeth in the study sample highlight the need for promotive, preventive and restorative oral healthcare programmes within this population.

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	15-17 years		18-20 years		p-value	Total-overall DMFT/dmft		p-value
	127		47			435		
	n (%)	mean (SD)	n (%)	mean(SD)		n (%)	mean(SD)	
	314(100%)	2.46(2.78)	174(100%)	3.70(3.83)		847(100)	1.95(2.74)	
	273(87%)	2.15(2.43)	132(76%)	2.81(2.94)	0.001	740(88)	1.71(2.43)	0.590
	31(10%)	0.24(0.76)	32(18%)	0.68(1.15)		77(9)	0.17(0.05)	
	10(3%)	0.08(0.64)	10(6%)	0.21(1.03)		30(4)	0.07(0.56)	
	2(100%)	0.12(0.54)	0(0%)	0(0.00)		410(100)	0.95(2.36)	
	2(100%)	0.015(0.12)	0(0%)	0(0.00)	0.001	408(99.52)	0.95(2.36)	0.379
	0(0%)	0(0.00)	0(0%)	0(0.00)		1(0.2)	0.002(0.04)	
	0(0%)	0(0.00)	0(0%)	0(0.00)		1(0.2)	0.002(0.04)	
	15-17 years		18-20 years		p-value	Total-overall PUFA/pufa		p-value
	127		47			435		
	n (%)	mean (SD)	n (%)	mean(SD)		n (%)	mean(SD)	
	54(100%)	0.43(1.03)	21(100%)	0.45(0.99)		148(100%)	0.34(1.01)	
	54(100%)	0.43(1.03)	21(100%)	0.45(0.99)		147(99%)	0.33(1.00)	
	0 (0%)	0 (0.00)	0 (0%)	0(0.00)	0.145	0(0%)	0.00(0.00)	0.873
	0 (0%)	0 (0.00)	0 (0%)	0(0.00)		0(0%)	0.00(0.00)	
	0 (0%)	0 (0.00)	0 (0%)	0(0.00)		1(1%)	0.002(0.05)	
	1(100%)	0.007(0.09)	0(0%)	0(0.00)		191(100%)	0.44(1.68)	0.909
	1(100%)	0.007(0.09)	0(0%)	0(0.00)		184(96%)	0.42(1.65)	
	0(0%)	0(0.00)	0(0%)	0(0.00)	0.001	0	0.00(0.00)	
	0(0%)	0(0.00)	0(0%)	0(0.00)		3	0.006(0.14)	
	0(0%)	0(0.00)	0(0%)	0(0.00)		4	0.009(0.15)	

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A correlation between the timing of skeletal maturity and dental development in black South African Patients

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ABSTRACT

Introduction

The growth potential of patients has a significant influence on the timing of orthodontic intervention and treatment modalities. Skeletal maturity and dental development are biological maturity indicators which can be used to determine the growth status of an individual.

Objectives

To correlate the dental maturational stages of black South African individuals with the stages of skeletal maturation and to determine the diagnostic accuracy of using dental developmental stages to identify an individual's skeletal maturity.

Design

Retrospective, cross-sectional study.

Methods

Skeletal maturity and dental development of 224 subjects were assessed using lateral cephalograms and panoramic radiographs, respectively. Statistical analyses included descriptive statistics, Spearman's correlation coefficient and positive likelihood ratios (LHR).

Results

The highest (r_s=0.759, p<0.001) correlation with skeletal maturity was identified for the second molar and the lowest correlation (r^s=0.662, p<0.001) for the canine. Positive LHR>10 combined with sensitivity and specificity testing revealed that the second premolar (stage E), second molar (stage F) and second molar (stage H) have the most significant diagnostic reliability to identify the pre-pubertal, pubertal and post-pubertal growth phases, respectively.

Conclusion

Dental development is a valuable diagnostic tool to assess skeletal maturation. The calcification of the second molar (stage F) is predictive of the pubertal growth phase.

Keywords

Skeletal growth, dental development, skeletal maturity, dental calcification, CVM

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INTRODUCTION

Timing of orthodontic intervention is fundamental during the treatment planning process, with special regard to growing individuals requiring growth modification treatment.[1] Dental as well as skeletal disharmonies may be corrected or improved by orthodontic treatment and initiating treatment at the ideal time in young patients has revealed favourable outcomes in the correction of skeletal discrepancies.[2]

The craniofacial structures experience a growth acceleration which is similar to other parts of the body during the pubertal growth spurt.[3] It is therefore essential that the orthodontist determines the growth status of young patients and in particular their proximity to the peak of the adolescent growth spurt for optimal treatment planning and utilisation of the patient's growth potential, before performing growth modification procedures. Furthermore, timeous referral of patients to orthodontists by general practitioners is critical to initiate orthodontic treatment at the most ideal time.[1] Chronological age is not a reliable method to estimate the skeletal growth status or physiological maturity of a young patient and should not be used to ascertain a patient's maturational state.[4,5] Instead of focusing on chronological age, the physiological maturity or biological age of a patient should be assessed.

The left hand-wrist analysis[6] has been reliably used in orthodontics to determine a patient's skeletal maturity; however, this method requires extra cost and radiation, and so does the median phalanx index (MP3) introduced by Hägg and Taranger in 1982.[7]

In view of the limitation of the hand-wrist and MP3 analyses, Hassel and Farman[8] introduced the cervical vertebrae maturation (CVM) analysis as an alternative method to assess skeletal maturation. Although this method has been found to be as reliable as the hand-wrist analysis[9], a lateral cephalogram is required to evaluate the maturation of the cervical spine and general dental practitioners may not have access to the requisite radiographic machine to acquire this image.

Apart from skeletal maturity, other biological indicators such as an increase in body height[10], voice changes, menarche[11] and dental development[12] can also be used to determine an

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individual's growth status; however, these are not popularly used in dentistry and the available literature focuses predominantly on skeletal maturity indicators to assess growth.

Dental development, similar to skeletal maturation, has been investigated in the past as a method to determine physiological maturity[12] and although individual variations among different populations were identified, high correlations have been demonstrated between dental calcification stages and skeletal maturity indicators.[13-16] The advantage of this method is that dental development can be analysed from a panoramic radiograph which is routinely used in orthodontics and general dental practice to evaluate a patient's oral health status and should be readily available for the majority of patients.[17-19] No additional radiographs are necessary, limiting radiation and cost to the patient.

The objectives of this study were to correlate the skeletal maturation stages of black South African patients to the stages of dental calcification as viewed on a panoramic radiograph and to determine whether dental calcification stages can be used accurately to determine a patient's physiological age.

MATERIALS AND METHODS

Ethics approval

The study protocol was approved by Sefako Makgatho University Research Ethics Committee (SMUREC) with ethics reference number SMUREC/D/114/2022: PG. The researcher was granted access to patient records by the CEO of Sefako Makgatho University Oral Health Centre and the Department of Maxillofacial and Oral Radiology to collect data for this research project.

Study sample

Lateral cephalograms and panoramic radiographs of patients who have visited the Orthodontic Department at Sefako Makgatho Health Sciences University in Ga-Rankuwa, South Africa were collected for this study. Overall, 523 patient records were searched for patients who satisfied the eligibility criteria for this study and the resulting sample consisted of 224 patients in total. The sample consisted of 104 males and 120 females with a mean age of 11.7 years (age range 9.7-16 years). This sample size satisfies the requirements to calculate the Spearman rank order correlation as proposed by Bonett and Wright[20] and is in line with similar studies.[4,21,22]

Individuals who fulfilled the following criteria were included in this study:

- Male and female patients from 7 to 18 years of age, following the sampling criteria of similar studies;[3,14,22]
- Black South African descent;
- Panoramic as well as a lateral cephalometric radiograph available, taken within the same month;
- Radiographs which exhibit high clarity, good contrast and without any noticeable distortions;
- No craniofacial or systemic anomalies or history of facial trauma; and
- No dental anomalies (caries, impactions or congenitally absent teeth).

Methodology

Demographic information, panoramic and lateral cephalometric radiographs of the study sample were collected from patient records. All radiographs were taken using a Carestream Kodak 8000C^{O} digital panoramic and cephalometric X-ray machine. The radiographs were taken by a radiographer, or a senior undergraduate dentistry student supervised by a radiographer, within the Department of Maxillofacial and Oral Radiology at Sefako Makgatho Health Sciences University. Digital as well as printed radiographs were collected – the hard copies were used for tracing purposes, whereas the digital copies were used to enhance the contrast or brightness of the radiographs when necessary to assist with the evaluation. Magnification errors were not significant in this study because proportional relationships between skeletal or dental structures were used instead of actual lengths.

Table 1: Description of the cervical stages (CS) according to Baccetti *et al*[11]

Cervical stage	Variables analysed	Observation	Peak mandibular growth
CS1	Lower border of vertebral bodies C2, C3 and C4	C2, C3 and C4 lower borders are flat, no concavities present	2 years after current stage
	Shape of C3 and C4 vertebral bodies	Trapezoid	
CS2	Lower border of vertebral bodies C2, C3 and C4	Concavity present at C2	1 year after current stage
	Shape of C3 and C4 vertebral bodies	Trapezoid	
CS3	Lower border of vertebral bodies C2, C3 and C4	Concavities present at C2 and C3	During the following year
	Shape of C3 and C4 vertebral bodies	Trapezoid or rectangular horizontal	
CS4	Lower border of vertebral bodies C2, C3 and C4	Concavities at C2, C3 and C4	Occurred 1 to 2 years earlier
	Shape of C3 and C4 vertebral bodies	Rectangular horizontal	
CS5	Lower border of vertebral bodies C2, C3 and C4	Concavities at C2, C3 and C4	Ended 1 year earlier
	Shape of C3 and C4 vertebral bodies	At least 1 is squared, other one rectangular horizontal	
CS6	Lower border of vertebral bodies C2, C3 and C4	Concavities at C2, C3, and C4	Ended 2 years earlier
	Shape of C3 and C4 vertebral bodies	At least 1 is rectangular vertical, other one squared	

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Table 2: Description of maturational stages of Demirjian *et al*[26]

Stage	Number of roots	Description
A	Single- and multirooted teeth	Calcification is initiated, appears like inverted cone/s at the superior part of the dental follicle. These points of calcification haven't fused yet
B	Single- and multirooted teeth	Calcification points coalesce to form one or more cusps, forming the outline of the occlusal surface
C	Single- and multirooted teeth	a. Enamel formation and calcification extend cervically, converging towards cervical area b. Dentinal deposition is initiated c. The curved superior border of the future pulp chamber is visible
D	Single-rooted teeth	a. Crown is completely formed and extends to the cementoenamel junction (CEJ) b. The superior pulpal border has a distinct curve which is concave towards the pulp chamber c - Root formation begins and is visible as a spicule
	Multirooted teeth	a. Crown is completely formed and extends to the CEJ b. The superior pulpal border has a distinct curve which is concave towards the pulp chamber and is umbrella shaped c. Root formation begins and is visible as a spicule
E	Single-rooted teeth	a. Pulp chamber larger than previous stage, the walls of the chamber form straight lines which meet at the pulpal horn b. Root length is shorter than the crown height
	Multirooted teeth	a. Initial formation of bifurcation area is visible as a semi-lunar shape or a calcified point b. Root length is shorter than the crown height
F	Single-rooted teeth	a. Pulp chamber walls form an isosceles triangle. Funnel shaped apex b. Root length is greater or equal to crown height
	Multirooted teeth	a. Bifurcation area is more developed, giving the roots a more distinct outline. The roots are funnel shaped b. Root length is greater or equal to crown height
G	Single- and multirooted teeth	Walls of the root canal are parallel, with the apex partially open (including distal molar roots)
H	Single- and multirooted teeth	a. Apex closed (including distal molar roots) b. The periodontal ligament space has a uniform width around the root complex

Radiographs were separated and the principal researcher was blinded to the patient's demographic details. This ensured the investigator was not influenced by the patient's age, gender or other radiograph. Patient demographics were collected from patients' hospital files; gender, ethnicity and date of birth were recorded for each study participant. The date of radiographic exposure was also noted, enabling the researcher to calculate the age of each participant at the time when the radiographs were taken. The selected age range covered the adolescent growth period and data from prepubertal, pubertal and postpubertal skeletal maturational stages were collected.

Assessment of skeletal maturity

The morphology of the second (C2), third (C3) and fourth (C4) cervical vertebrae bodies were evaluated from the collected lateral cephalograms and the skeletal maturity of each patient was determined using the cervical vertebral maturation stage (CVMS) method of Baccetti *et al*.[11] (Table 1). The validity and reliability of this technique to determine the skeletal maturity of an individual is well established within the literature.[9,23,24] For this study, participants were grouped into three groups of potential clinical interest according to their skeletal stage of maturation.[21,22,25]

Group 1: Prepubertal (CS 1)
Group 2: Pubertal (CS 2 and 3)
Group 3: Postpubertal (CS 4, 5 and 6)

Assessment of dental development

The stage of dental development was determined from the panoramic radiographs by using the Demirjian *et al.*[26] calcification stages (Table 2). Similar to comparable studies, this study only evaluated the permanent lower left canine, first premolar, second premolar and second molar and noted their stage of calcification (Stages A-H).[21,22] The assessment was restricted to teeth on the left side only because contralateral teeth have been found to develop symmetrically.[26] As with similar studies, the maxillary teeth were not examined for this study because superimpositions of maxillary structures can result in incorrect assessments.[15,22] Furthermore, the permanent incisors and first molars were excluded from this study because it is expected that root formation of these teeth should be complete or close to completion in the age range of the current population group[21] and third molars were not examined either due to their late development and high tendency of being congenitally absent.[27]

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Table 3: Overall stages of dental development for males and females

CVM stage	Frequency (%)					
	Pre-pubertal		Pubertal		Post-pubertal	
	Males	Females	Males	Females	Males	Females
D	-	-	3 (1.5) p = 0.095	6 (4.5)	-	-
E	3 (37.5)	-	12 (5.8) p = 0.818	9 (6.8)	-	-
F	5 (62.5)	-	71 (34.1) p = 0.168	55 (41.7)	1 (0.5) p = 0.657	4 (1.1)
G	-	-	71 (34.1) p = 0.407	39 (29.6)	37 (18.5) p = 0.508	73 (21.0)
H	-	-	51 (24.5) p = 0.139	23 (17.4)	162 (81.0) p = 0.446	271 (77.9)
Total	**8 (100)**	**-**	**208 (100)**	**132 (100)**	**200 (100)**	**348 (100)**

Statistical analysis

Descriptive and inferential statistics were performed using SAS (SAS Institute Inc, Cary, NC, USA), Release 9.4. Spearman rank order correlation coefficients were calculated between the CVM growth phases and dental calcification stages for each of the four individual teeth. Positive likelihood ratios with 95% confidence intervals were calculated for each individual tooth as measures of dental maturation stages for identifying growth phases. Sensitivity and specificity values, with 95% confidence intervals, were calculated for all the cases where the likelihood ratio was >10.

Intra-examiner as well as inter-examiner analyses were performed to determine the reliability and reproducibility of the study results.[28] The principal researcher assessed all the radiographs of the study population at two different occasions under the same conditions to establish the intra-examiner reliability. To evaluate the inter-examiner reliability, 10 sets of radiographs were randomly selected and assessed by another clinician of equal training as the principal researcher. The Spearman rank correlation coefficients between the overall first and second assessments, and between the two examiners, were calculated to measure intra- and inter-examiner reliability.

RESULTS

The assessments of the stages of dental calcification of males and females were statistically compared per CVM stage (Table 3) and no significant difference was found between genders and, as such, the further analyses in this study are presented as a single collective sample of 224 cases. Correlation analyses were performed to determine the reliability and reproducibility of this study. The Spearman rank correlation coefficient between the overall first and second assessments and between two examiners were calculated. The results for intra-examiner (r_s=0.99) as well as inter-examiner (r_s=0.98) measurements were highly significant (p<0.001), suggesting strong correlations for intra- and inter-examiner reliability and an almost perfect reproducibility of findings. The overall first assessments were used for the statistical analysis of this study.

Table 4 illustrates the distribution of participants by chronological age and the distribution of dental calcification stages per tooth according to the skeletal maturation stages are presented in Table 5.

Correlations between skeletal growth phases and dental calcification stages

Spearman rank order correlation coefficients were calculated between the CVM growth phases and dental calcification stages for each of the four individual teeth and the results are presented in Table 6. The correlation coefficients are all highly significant (p-values<0.001), with a maximum value for the second molar (r_s=0.759). The canine (r_s=0.662) revealed the lowest correlation.

Table 4: Distribution by chronological age

Age, years	Frequency (%)		
	Pre-pubertal	Pubertal	Post-pubertal
≤ 10	2 (100)	12 (14.1)	-
11 - 12	-	48 (56.5)	14 (10.2)
13 - 14	-	22 (25.9)	56 (40.9)
15 - 16	-	3 (3.5)	67 (48.9)
Total	**2 (100)**	**85 (100)**	**137 (100)**
Mean (SD)	9.7 (0.14)	11.5 (1.36)	13.9 (1.29)
Median (IQR)	9.7 (9.6 – 9.8)	11.4 (10.3 – 12.3)	14.0 (13.1 – 15.0)
Minimum / Maximum	9.6 / 9.8	9.0 / 15.3	10.3 / 16.0

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Table 5: Distribution of dental calcification stages according to pubertal growth phases

CVM stage	Frequency (%)		
	Pre-pubertal	Pubertal	Post-pubertal
Lower left canine			
F	2 (100)	25 (29.4)	-
G	-	24 (28.2)	2 (1.5)
H	-	36 (42.4)	135 (98.5)
Total	**2 (100)**	**85 (100)**	**137 (100)**
First premolar			
E	-	3 (3.5)	-
F	2 (100)	20 (23.5)	1 (0.7)
G	-	34 (40.0)	4 (2.9)
H	-	28 (33.0)	132 (96.4)
Total	**2 (100)**	**85 (100)**	**137 (100)**
Second premolar			
D	-	2 (2.4)	-
E	1 (50.0)	4 (4.7)	-
F	1 (50.0)	38 (44.7)	2 (1.5)
G	-	32 (37.6)	34 (24.8)
H	-	9 (10.6)	101 (73.7)
Total	**2 (100)**	**85 (100)**	**137 (100)**
Second molar			
D	-	7 (8.2)	-
E	2 (100)	14 (16.5)	-
F	-	43 (50.6)	2 (1.5)
G	-	20 (23.5)	70 (51.1)
H	-	1 (1.2)	65 (47.4)
Total	**2 (100)**	**85 (100)**	**137 (100)**

Likelihood ratios

Positive likelihood ratios (LHR) with 95% confidence intervals were calculated for each individual tooth as measures of the diagnostic accuracy of using dental calcification stages to identify skeletal growth phases. The results are summarised in Table 7, likelihood ratios of 10 or greater are bolded. In Table 8, sensitivity and specificity values, with 95% confidence intervals, were calculated for all LHR>10.

A positive LHR>10 identified the pre-pubertal growth phase associated with the first premolar (stage F, positive LHR of 10.6; 95% CI 7.0-15.9), second premolar (stage E, positive LHR of 27.8; 95% CI 5.1-150.7), and second molar (stage E, positive LHR of 15.9; 95% CI 9.6-26.3). Following sensitivity and specificity testing (Table 8), the second premolar (stage E) revealed the greatest diagnostic reliability to identify the pre-pubertal growth phase, with a specificity of 98.2%. The small sample size within the pre-pubertal group should be noted.

Table 6: Spearman rank correlation coefficients between skeletal and dental developmental stages

Tooth	Spearman correlation	p-value
Lower left canine	0.662	<0.001
First premolar	0.694	<0.001
Second premolar	0.700	<0.001
Second molar	0.759	<0.001

The pubertal growth phase (Figure 1) was identified by a positive LHR greater than 10 which was found to be associated with the canine (stage F, positive LHR of 20.4; 95% CI 5.0-84.1 and stage G, positive LHR of 19.6; 95% CI 4.8-80.9), first premolar (stage F, positive LHR of 10.9; 95% CI 3.3-35.6 and stage G, positive LHR of 13.9; 95% CI 5.1-37.8), second premolar (stage F, positive LHR of 20.7; 95% CI 6.6-65.0), and second molar (stage E, positive LHR of 11.4; 95% CI 2.7-49.1 and stage F, positive LHR of 35.2; 95% CI 8.7-141.4). The second molar (stage F) revealed the most significant diagnostic reliability to identify the pubertal growth phase with a LHR of 35.2 and specificity of 98.6%.

A positive LHR>10 of the second molar (stage H, positive LHR of 41.3; 95% CI 5.8-292.1) is indicative of the post-pubertal growth phase. The specificity is 98.8% which suggests high diagnostic reliability (Figure 2).

DISCUSSION

In this study the objectives were to correlate the dental maturational stages of black South African individuals with the stages of skeletal maturation and to determine the diagnostic accuracy of using dental developmental stages to identify the skeletal maturity of individuals within this population. Dental calcification stages, as described by Demirjian *et al*.[26], were identified from panoramic radiographs and correlated with the skeletal maturity of each participant, which was determined by the maturational status of their cervical vertebrae as observed from a lateral cephalogram.[11] The methodology of the present study was validated and

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Table 7: Positive likelihood ratios with confidence intervals of 95% concerning dental calcification stages to identify skeletal growth phases

CVM stage	Likelihood ratio (95% CI)		
	Pre-pubertal	Pubertal	Post-pubertal
Lower left canine			
F	8.9 (6.1 – 12.8)	**20.4** (5.0 – 84.1)	-
G	-	**19.6** (4.8 – 80.9)	0.05 (0.01 – 0.2)
H	-	0.4 (0.3 – 0.6)	2.4 (1.9 – 3.1)
First premolar			
E	-	-	-
F	**10.6** (7.0 – 15.9)	**10.9** (3.3 – 35.6)	0.03 (0.01 – 0.2)
G	-	13.9 (5.1 – 37.8)	0.07 (0.03 – 0.2)
H	-	0.3 (0.2 – 0.5)	3.0 (2.2 – 4.1)
Second premolar			
D	-	-	-
E	**27.8** (5.1 – 150.7)	6.5 (0.7 – 57.6)	-
F	**2.8** (0.7 – 11.4)	**20.7** (6.6 – 65.0)	0.03 (0.01 – 0.1)
G	-	1.5 (1.0 – 2.3)	0.7 (0.5 – 1.0)
H	-	0.1 (0.08 – 2.7)	7.1 (3.8 – 13.3)
Second molar			
D	-	-	-
E	**15.9** (9.6 – 26.3)	**11.4** (2.7 – 49.1)	-
F	-	**35.2** (8.7 – 141.4)	0.03 (0.01 – 0.1)
G	-	0.5 (0.3 – 0.7)	2.2 (1.5 – 3.4)
H	-	0.03 (0.0 – 0.2)	**41.3** (5.8 – 292.1)

considered to be reliable by similar previous studies[21,22,29]; however, the focus of this study was on black South African individuals.

In accordance with similar studies, the results from analyses carried out in this study yielded no statistically significant difference between genders and the results in this study were presented as a single combined sample.[22,25]

Despite an adequate sample size, this study was restricted to black South African individuals presenting for treatment at a single centre. This may limit the generalisability of the results to other populations and ethnic groups. Variability in the timing of skeletal maturation as well as dental calcification between different ethnic groups have been reported by previous studies and should be considered when interpreting the results from this study.[4,13,14,30] Ideally, population-specific data should be gathered and implemented for different ethnic groups.

Correlation between dental calcification stages and stages of cervical vertebral maturation

Spearman rank correlation coefficient values were calculated for each tooth to determine whether there is an association between dental development and skeletal maturity. In general, the correlation coefficients between the stages of dental calcification of the four individual teeth and the three CVM growth phases were found to be high, varying from 0.662 to 0.759 ($p<0.001$) in this study. These findings are indicative of a significant correlation between dental calcification stages and skeletal maturation and agree with comparable studies. [4,13,14,21,22,25,30] A systematic review and meta-analysis by Bittencourt *et al,*[31] however, reported that although the literature suggests a significant association between skeletal maturity and dental development, there is a great heterogeneity among studies and they concluded that standardised observational studies are necessary to strengthen the evidence and to confirm the use of dental calcification stages to accurately estimate the pubertal growth spurt.

In this study, the tooth which provided the highest correlation between its calcification stages and phases of CVM was the lower second molar. Uysal *et al*,[14] Litsas *et al*[22] and Lecca-Morales and Carruitero[32] reported similar results in Turkish, Greek and Peruvian subjects, respectively. An Italian study by Perinetti *et al.*[25] was also in agreement with these results. In contrast with the current findings, Valizadeh *et al.*[30] found the first premolar to have the highest correlation, whereas Krailassiri *et al.*[13] reported that the second premolar had the highest correlation with skeletal maturity among Thai individuals.

A South African study by Chertkow[4] in 1980 found that the lower canine had the highest correlation with skeletal maturity in caucasian subjects; however, his findings in black South African individuals were inconclusive due to earlier dental development in this population which led to most of the root development being complete by the time he studied them. Uys *et al.*[33] confirmed that racial differences exist during dental maturation and that black South African individuals mature earlier than caucasian individuals.

High correlation coefficients, however, only suggest a strong association between two variables and, despite the high correlations found by this and previous studies, further analyses are necessary to determine the diagnostic accuracy of dental calcification stages to predict the pubertal growth status of an individual. The majority of the previous studies[4,13,14,30,32] didn't comprehensively analyse the true diagnostic potential of dental calcification stages.

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Table 8: Sensitivity and specificity of positive LHR greater than 10

CVM stage	Growth phase					
	Pre-pubertal		Pubertal		Post-pubertal	
	Sensitivity %	Specificity %	Sensitivity %	Specificity %	Sensitivity %	Specificity %
Lower left canine						
F			29.4 (20.8-39.8)	98.6 (94.9-99.6)		
G			28.2 (19.8-38.6)	98.6 (94.9-99.6)		
H						
First premolar						
E						
F	100 (34.2-100)	90.5 (86.0-93.7)	23.5 (15.8-33.6)	97.8 (93.8-99.3)		
G			40.0 (30.2-50.6)	97.1 (92.8-98.9)		
H						
Second premolar						
D						
E	50.0 (9.4-90.6)	98.2 (95.5-99.3)				
F			44.7 (34.6-55.3)	97.8 (93.8-99.3)		
G						
H						
Second molar						
D						
E	100 (34.2-100)	93.7 (89.7-96.2)	16.5 (10.1-25.8)	98.6 (94.9-99.6)		
F			50.6 (40.2-61.0)	98.6 (94.9-99.6)		
G						
H					47.4 (39.3-55.8)	98.8 (93.8-99.8)

Diagnostic accuracy of using dental calcification stages to estimate skeletal maturity

Likelihood ratios (LHR), together with 95% confidence intervals (CI), were calculated for each of the calcification stages observed in the four teeth evaluated in this study to determine the clinical reliability of individual dental calcification stages to diagnose skeletal maturity and thereby estimate the pubertal growth status of an individual. A positive LHR is an estimate of the extent to which a specific dental calcification stage improves the odds of being present in a certain growth phase and LHR greater than 10 were considered to be significant.[34] Sensitivities and specificities were also calculated for the stages of dental calcification which had LHR>10 to comprehensively analyse the diagnostic performance of these stages.

Pre-pubertal phase of skeletal maturation

In the current study, the first premolar, second premolar and second molar revealed positive LHR greater than 10 to identify the pre-pubertal growth period. For the first premolar stage F and for the second premolar and second molar, stage E showed LHR>10. The canine didn't have a positive LHR>10 in the pre-pubertal group. The second premolar stage E presented the highest LHR (LHR 27.8) and together with a specificity value of 98.2%, this is suggestive of high diagnostic capability for the pre-pubertal growth phase. The reliability of the current results is, however, compromised by an inadequate number of participants (n=2) within this group. Further research focused on the pre-pubertal population will be necessary to obtain sufficient data to be analysed in this population. Data collection in this group is challenging because the available subjects who meet all the inclusion criteria is limited because it is not as common for patients this young, compared to adolescent patients, to present for orthodontic treatment.

Although the current pre-pubertal group had an inadequate sample size, some of the findings are consistent with similar studies. Perinetti et al.[25] and Litsas et al.[22] reported LHR>10 for the second premolar stage E (LHR 12.8 and LHR 11.1, respectively) as well. This study and that of Litsas et al.[22] didn't have any positive LHR>10 for the canine; however,

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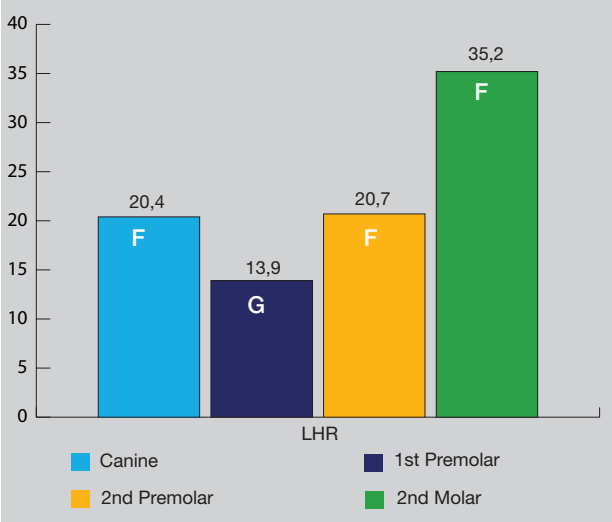

Figure 1: The most significant positive LHR>10 within the pubertal group.

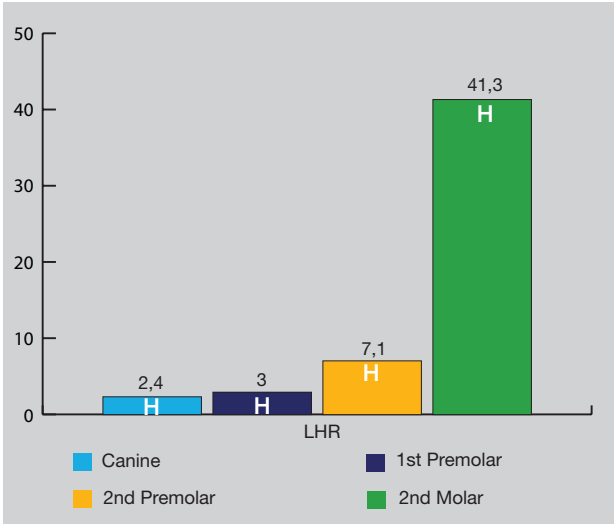

Figure 2: Distribution of LHR within the post-pubertal group.

Perinetti et al.[25] reported LHR>10 for the canine stage F (LHR 14.9). Contrary to the current findings, for the first premolar Litsas et al.[22] found LHR>10 for stages D (LHR 16) and E (LHR 20) and for the second molar, stage D (LHR 14.4). Results from Perinetti et al.[25] regarding the first premolar and second molar corresponded closely with that of Litsas et al.[22]

Pubertal phase of skeletal maturation

All four of the teeth evaluated in this study revealed positive LHR>10 within the pubertal group: Stages F and G for the canine and first premolar, stage F for the second premolar, and stages E and F for the second molar. The highest LHR was identified for the second molar stage F (LHR 35.2), which has a specificity of 98.6%. Although the large confidence interval (8.7-141.4) should be noted, these results are highly suggestive that second molar stage F of dental calcification (well-developed bifurcation area, funnel shaped roots, with the root length being equal or greater than the crown height) is a reliable diagnostic tool to identify the pubertal growth phase. These results correspond with the high correlation coefficient observed in this study between development of the second molar and skeletal maturation.

The current findings agree with results from Litsas *et al*.[22] Litsas *et al*.[22] similarly reported a positive LHR>10 for second molar stage F (LHR 13.6), finding it to be an accurate diagnostic parameter for identifying the pubertal growth period. Several other studies have also found a positive relationship between the second molar calcification stage F and various skeletal maturity indicators of the adolescent growth phase.[13,14,35] A recent study, based on patient records from the Burlington Growth Centre, reported gender differences and concluded that the pubertal growth phase can potentially be identified by second molar calcification stage F in females and stage G in males.[36] Most of the other studies were, however, limited by only considering the distribution of the dental calcification stages during skeletal maturation or by restricting their statistical analyses to correlation coefficients. Accurate diagnostic testing is necessary in addition to high correlation coefficients.

Contrary to this study, Perinetti *et al.*[25] didn't find any positive LHR>10 for any of the four teeth in the pubertal group, leading them to doubt the diagnostic capability of dental calcification stages. Methodological differences may be responsible for the variations between this study and the findings by Perinetti *et al.*[25]

Post-pubertal phase of skeletal maturation

According to the current results, only one tooth, the second molar, revealed a positive LHR>10 in identifying the post-pubertal growth phase. The second molar's stage H proved to have reliable diagnostic performance to accurately identify the post-pubertal growth period by yielding a LHR of 41.3 with a specificity of 98.8%. Findings by Litsas *et al.*[22] are comparable to these results: they also reported a positive LHR (LHR 18.9) for the second molar stage H during the post-pubertal phase. A LHR close to 10 (LHR 9.1) was found for second molar stage H by Perinetti *et al.*[25]: although their value was <10, it was significantly greater than other finding within the post-pubertal group. These results confirm that the completion of root formation of the second molar (stage H) is an indication that the pubertal growth peak has passed and the subject is in the post-pubertal period.

In summary the overall results from the current study are in line with similar studies.[14,22,25,35] A significant correlation was found between dental calcification stages and skeletal maturity. The second molar's stage F demonstrates diagnostic reliability to identify the peak adolescent growth phase within the population studied, whereas the second molar's stage H is an accurate indication that an individual is within the post-pubertal phase of growth. Certain characteristics of the second molar may be beneficial for using it as an indicator for skeletal maturity; for example, the second molar is generally not affected by dental irregularities, it develops around the time of puberty in most individuals and it can easily be assessed from a panoramic radiograph.[36] Determining the growth status of patients is essential for timely orthodontic referrals and for initiating orthodontic treatment at the most appropriate time.[11,21]

STUDY LIMITATIONS

Generalisability of the current study results is limited by:
The focus of this study was on black South African individuals only and due to ethnic differences observed during growth and development, these results may not be accurate for other ethnic groups.

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The study population was sampled from one centre only, therefore the results cannot be generalised to the entire black South African population.

The sample size within the pre-pubertal group was insufficient and the results could not be used to draw a conclusion within this group.

CONCLUSION

The correlation between skeletal maturity and dental development was investigated within a black South African population and from the results it can be concluded that a significant correlation exists between these variables.
Dental maturation of the lower left second molar (stage F), as visible on a panoramic radiograph, can accurately be used as a diagnostic tool to predict the pubertal growth phase for the study population. Completion of root formation (stage H) of the second molar is predictive of the post-pubertal phase.

The clinical relevance of this study enables clinicians to identify the pubertal and post-pubertal growth phases of patients from an intra-oral or a panoramic radiograph as a first diagnostic tool. This will contribute to timely orthodontic referrals and appropriate timing of orthodontic intervention.

Conflict of interest

The authors declare that they have no conflict of interest.

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CPD questionnaire on page 326

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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Pulpotomy: An alternative treatment modality to conventional root canal treatment

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ABSTRACT

Introduction

Vital pulp therapy is considered a successful treatment modality in primary and immature permanent teeth. The development of bioactive material has led to vital pulp therapy and pulpotomy treatment becoming a popular treatment modality in permanent teeth. This literature review investigates pulpotomy procedures on permanent teeth as a viable option, as opposed to conventional root canal treatment, as presented in the case report included.

Aim

The aim of this study is to evaluate literature on the reported success of pulpotomy treatment in mature permanent teeth. For this reason, the study specifically reviewed literature detailing the use of pulpotomies including the materials required for the procedure.

Method

The literature review is focused on studies using MTA and bioactive alternatives as pulpotomy material. An electronic search was done on EBSCOhost to source 58 articles published from 1979 to 2022.

Results

Literature investigated reports that pulpotomy treatment with bioactive materials shows promising results and therefore the possibility exists of it being a suitable treatment option or alternative to conventional root canal treatment.

Keywords

Apexification, dental pulp, root canal therapy, partial pulpotomy, vital pulp therapy.

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Conflict of interest

The authors have no conflict of interest to declare.

INTRODUCTION

Vital pulp therapy (VPT), as a possible therapeutic intervention in the treatment of both primary and permanent teeth, is well documented.[1,2] The long-term health of the dental pulp is reliant on the correct diagnosis and subsequent treatment.[3] VPT is a viable treatment option in permanent teeth with normal/healthy pulps or pulpitis (for example: apexogenesis, indirect pulp capping, direct pulp capping, partial pulpotomy and complete pulpotomy).[2] The standard treatment options in permanent teeth with irreversible pulpitis or necrotic pulp are regenerative endodontics, conventional root canal treatment and apexification.[4,5] It is advised that clinicians familiarise themselves with these pulp therapies, taking into consideration the restorability of the tooth as well as alternative VPT treatment therapies.[5]

The American Academy of Paediatric Dentistry (AAPD) guidelines define when pulpotomy procedures can be performed: "A pulpotomy is performed in a tooth with extensive caries without evidence of radicular pathology when caries removal results in a carious or mechanical pulp exposure."[6]

Pulpotomy treatment is indicated in primary teeth with exposed vital pulps or reversible coronal pulpitis. Pulpotomies can also be considered in immature permanent teeth with pulpal exposure due to caries or trauma. This can also be performed as an emergency procedure in permanent mature teeth until such time as root canal treatment can be performed.[7] Coronal pulpotomy in comparison to conventional RCT procedures are less costly and not considered as technically demanding and time consuming.

VPT aims to maintain tooth functionality and vitality.[8] In the past, VPT has predominantly been used in primary and immature permanent teeth; however, with the development of bioactive materials, the use of these materials in permanent teeth with mature root apices is gaining popularity. Performing a coronal pulpotomy on permanent teeth, which implies the amputation of pulp tissue down to the cervical line with bioactive material, has been suggested as an alternative to a traditional RCT.[9]

According to the AAPD guidelines, a partial pulpotomy is the treatment of choice following traumatic or carious pulp exposure in immature permanent teeth, whereas coronal pulpotomy is the treatment of choice in immature teeth with pulpal inflammation. The primary objective of performing a pulpotomy is to preserve radicular pulpal tissues that may help to complete apexogenesis in immature permanent teeth.[7]

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Coronal pulpotomy differs from partial pulpotomies whereby only partial removal of coronal pulp is performed. A pulpotomy procedure is performed when the coronal pulp is either inflamed and/or infected and subsequently amputated.[10] The remaining radicular dental pulp is then covered with the appropriate material to protect the pulp from further injury and to facilitate healing.[7,11]

Clinical decision-making and correct diagnosis in considering coronal pulpotomy treatment as an alternative treatment modality over conventional RCT in mature permanent teeth with irreversible pulpitis is paramount.[9]

Review of literature

Conventional RCT, indicated in permanent mature teeth with pulpal and periradicular diseases, consists of the complete removal of pulp tissue from the root canals of the tooth, the disinfection of canals and final restoration/prosthesis. Root canal treatments are considered to have high overall success rates estimated at 86.02%.[12] Results of 86% at 2-3 years, 93% at 4-5 years and 87% at 8-10 years survival rates of endodontically treated teeth have been reported.[13] However, considerable loss of tooth structure is one of the negative outcomes of performing RCT. The most common denominator in the failure after root canal treatment is tooth fracture and loss due to compromised remaining tooth structure.[8,14,15] Coronal pulpotomy treatment is a more conservative therapy and aids in preserving tooth structure in a minimally invasive manner.[9] Pulpotomy treatments are also less technically challenging and demanding than standard root canal treatments.[7]

Various studies have reported high rates of poor quality of obturation (25-62%) and apical periodontitis (45%) associated with root filled teeth.[16,17,18] Healthy pulps are still the best option to fill a root canal with and it should not be assumed that just because the pulp is damaged that it will need to be removed completely.[19] However, RCT in teeth with pulpal and/or peri-radicular diseases is still considered the standard care.[20, 21] Unfortunately, survival rates of these teeth are significantly reduced after root canal treatment compared to vital teeth.[14] Plausible causes might include the lack of a proprioceptive mechanism, loss of dental hard tissue and the loss of a damping effect.[22,23]

Advances in bioactive materials have recently provided an alternative treatment option in teeth with irreversibly inflamed pulps. Most bioactive materials are calcium silicate-based material (ProRoot MTA (Dentsply Sirona, Switzerland), Biodentine (Septodont, Saint-Maur-des-Fossés, France) and calcium-enriched mixture (CEM) (Yekta Zist Dandan Company, Tehran, Iran). Both these materials are biocompatible and capable of inducing cementogenesis, dentinogenesis and osteogenesis.[24,25]

Due to the biocompatibility and superior sealing ability, mineral trioxide aggregate (MTA) and CEM have been found to produce better success rates than calcium hydroxide.[9] Dentine bridge formation and pulpal health were more predictable and successful after MTA pulpotomy treatments.[26,27]

Since its introduction, MTA has attracted a fair amount of attention from the endodontic field due to many of its advantages compared to traditional endodontic material. This includes its sealing ability, biocompatibility and the ability to form dentine bridges due to the induction and proliferation of pulp cells. Many studies show that MTA is the material of choice for vital pulp therapy, while other studies found no significant differences when comparing MTA to similar material.[28-34] Conflicting results exist as to MTA being the material of choice for vital pulp therapy in primary and young permanent teeth.[28-34]

The use of bioactive material has created a new awareness of pulp regeneration and vascularisation as well as leading to many scholars focusing on alternative treatment options, for example coronal pulpotomy treatment in permanent teeth with reversible pulpitis. Several studies have shown success rates comparable to traditional RCT.[35] Studies conducted on coronal pulpotomies also show success rates comparable to traditional root canal treatment in teeth with pulpal disease.[36,37,38]

A concern with coronal pulpotomies in permanent teeth is the uncertainty of the pulpal status before commencing treatment, as well the unpredictability and lack of long-term scientific evidence regarding success rates of treatment.[39] Teeth in which full pulpotomy treatment is considered are generally nonresponsive to sensibility tests.[43] The radicular pulp should therefore be considered healthy in the absence of contradicting clinical or radiographic signs.
Eghbal *et al*.[40] reported that upon histologic examination, there was no inflammation on pulpal tissue after direct placement of MTA on vital pulp tissue. Additionally, Asgary *et al*.[41] showed similar results in their multicentre trial, comparing coronal pulpotomies using CEM, with RCT in permanent teeth with closed apices and irreversible pulpitis. No differences in success rates were reported between pulpotomies and standard RCT in either 6- or 12-month follow-ups. However, pulpotomies performed better radiographically compared to the RCT group.[37] A study done by Alqaderi *et al.*[42], which performed pulpotomies with MTA on permanent teeth in children, indicated for traditional root canal treatment, presented a success rate as high as 90%.[43,44] Taha *et al*.[43] reported success rates of 100% at one year and 92.7% success at a period of three years follow-up. Similarly, studies by Simon *et al*.[45] as well as Taha *et al.*[44] reported high clinical and radiographic success in their prospective study in permanent teeth with mature apices and irreversible pulpitis performed by using Biodentine during complete coronal pulpotomy.

Asgary *et al*.[41] illustrated a case in which a molar tooth with irreversible pulpitis and condensing osteitis was treated with a coronal pulpotomy using CEM cement. The tooth was clinically asymptomatic, and complete healing of periradicular tissue had taken place at a two-year follow-up investigation. Root canal calcifications were not evident in contrast to calcifications frequently seen in clinical practice using calcium hydroxide pulpotomy.[41]
Asgary *et al*.[37] compared root canal treatments with coronal pulpotomies (CEM pulpotomy) and showed no significant difference in the success rates during a five-year follow-up between these two treatment modalities. Linsuwanont *et al*.[46] reported a clinical success rate of 87.3% in their study on MTA pulpotomy treatment in 66 carious exposed permanent teeth at a 62-months follow-up evaluation.

Alqaderi *et al*.[42] evaluated the success rate of cervical pulpotomy treatment in mature permanent irreversibly inflamed teeth. Success rates were reported as high as 94% in year one and 92% in year two. Pulpotomies performed using Bioactive materials resulted in higher success rates

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than those performed using calcium hydroxide. The author of this systematic review proposed coronal pulpotomy as a viable treatment option in irreversibly inflamed permanent teeth.[26]

Baranwal *et al*.[47] conducted a pulpotomy study and found contradicting results compared to the study done by Asgary[41], using Biodentine instead of MTA in the treatment of human permanent molar with irreversible pulpitis. After the first year an overall success rate of 87% was reported using Biodentine. This might be due to its adequate sealing ability, compressive strength and biocompatibility. The additional calcium release of ions in Biodentine compared to MTA and calcium hydroxide-based materials was also evident in this study. When Biodentine is used as a capping material, pulp mesenchymal stem cells develop to odontoblast-like cells, due to the TGF-b1 growth factor release, resulting in tertiary dentine formation. Both partial and complete pulpotomies developed a degree of dentine bridge formation, running the risk of developing root canal calcifications which is less apparent in partial pulpotomies.

A review done by Cushley *et al*.[48] evaluated the clinical success rate of pulpotomies in permanent teeth presenting with symptomatic irreversible pulpitis. The success rate of coronal pulpotomy was found to be 97.4% clinically and 95.4% radiographically at the 12-month follow-up.[48]

Li et al.[49] systematically reviewed the comparison between MTA pulpotomies and calcium hydroxide pulpotomies. Pulpotomies performed using MTA revealed to have a higher clinical and radiographic success rate at one year follow-up than that of calcium hydroxide pulpotomy.

Positive outcomes at two- to three-year follow-up periods have been reported in cases of mature teeth with irreversible pulpitis treated by means of pulpotomy procedures. Defective restorations causing microleakage was reported as the main reason for coronal pulpotomy failures[50]. Hence, it is crucial for the success of the VPT that there is coronal restoration and satisfactory sealing with bioactive material. Regular evaluations and recalls of restorations are of great importance to ensure marginal integrity and longevity[9].

In a study by Kunert *et al*.[51] pulpotomies were performed on 273 teeth using different restorative options. The best results in terms of coronal seal were achieved by using a prosthetic crown, followed by amalgam, while the use of composite yielded poor results.[51]

Endodontic treatment can be complex and is influenced by various factors such as unusual canal shapes, dilacerations, unusual number of canals as well as root canal calcifications.[52] It would be of great advantage to be able to practice a less expensive, and less technically demanding, alternative technique.[53] Vital pulp therapy would be such an alternative, as suggested by a recent systematic review.[54]

The overall success of VPT in caries exposed teeth depends on the technique employed, the extend of pulp tissue inflammation and the period of observation.[28] The possibility of failure of vital pulp is far less in younger patients compared to older patients opening new possibilities in endodontics, as observed by Bjorndal *et al.*[55]

Case report

An 11-year-old male patient reported with a history of irreversible pulpitis before his previous dentist removed the inflamed coronal pulp tissue from the pulp chamber on his right, maxillary first molar. The tooth was temporarily restored with a polycarboxylate restoration (Figure 1).

A high resolution CBCT scan revealed patent root canal systems in the mesiobuccal, distobuccal and palatal root canal systems with immature apices (Figure 2).

After access cavity preparation it was noted that there was vital bleeding pulp tissue at the canal orifices of the root canal systems (Figure 3a). It was decided to do partial pulpotomy using MTA. A 3.5% sodium hypochlorite solution was used to disinfect the exposed pulp tissue and to control the bleeding from the exposed pulp tissue.[56-58] MTA Flow (Ultradent) was mixed and preloaded in a syringe according to the manufacturer's instructions. A 3-4mm layer of the MTA material was dispensed onto the pulp floor, over the exposed pulp tissue at orifice level (Figure 3b).

The MTA material was covered with a thick layer of Vitrebond (3M/ESPE) light-cured glass-ionomer cement (Figure 4a) before the rest of the temporary restorative material was removed. A class II composite resin restoration was placed as a definitive restoration (Figure 4b). Figure 4c shows the

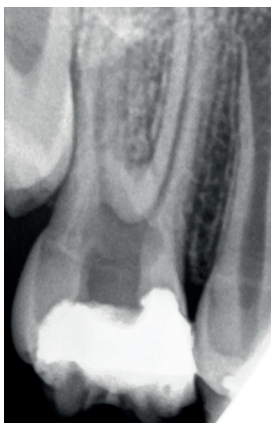

Figure 1. Preoperative periapical radiograph of a right, maxillary first molar after removal of inflamed pulp tissue in the pulp chamber.

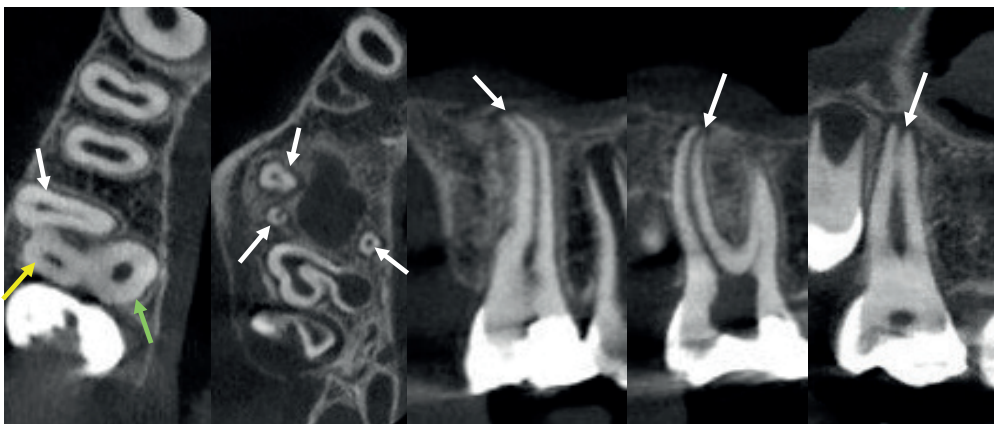

Figure 2. High resolution CBCT images of the right, maxillary first molar depicting the preoperative root canal anatomy: (a) Axial view at the level of the coronal third of the roots showing a very oval shaped mesiobuccal root (white arrow) and round distobuccal (green arrow) and palatal (yellow arrow) roots with patent root canal systems; (b) Axial view at level 0.5-1mm from the apex of the roots showing mesiobuccal, distobuccal and palatal roots with two immature apices (white arrows); (c) Coronal view of the mesiobuccal root canal system ending in an open apex (arrow); (d) Coronal view of the distobuccal root canal system ending in an open apex (arrow); (e) Coronal view of the palatal root canal system ending in an open apex (arrow). Note that all three root canal systems are patent without any calcifications present.

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immediate postoperative periapical radiograph. A periapical radiograph (Figure 5) and CBCT scan (Figure 6) at a five-year follow-up revealed pulp calcification in the root canal systems with mature apices.

In conclusion, with the use of MTA and other bioactive materials such as Biodentine and CEM, pulpotomies could be a viable alternative to conventional RCT in the management of symptomatic, caries exposed, mature permanent teeth, keeping in mind careful case selection.[28]

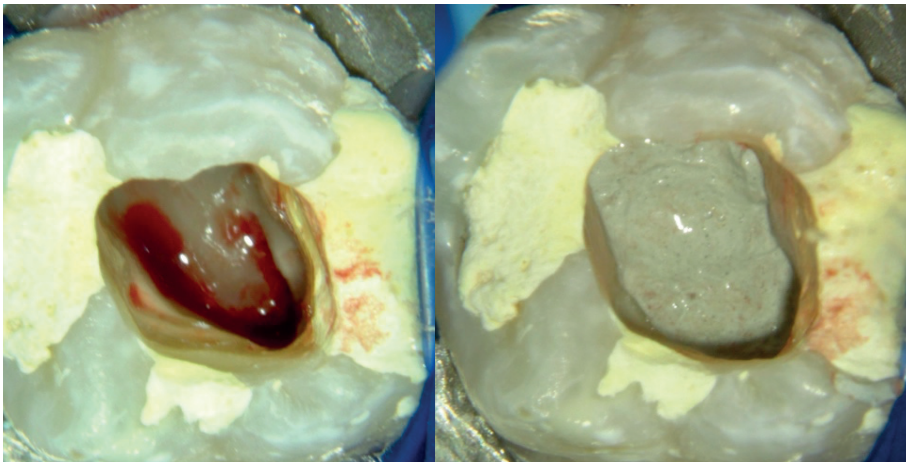

Figure 3. (a) Vital bleeding pulp tissue at the canal orifices of the root canal systems visible after access cavity preparation; (b) A 3-4mm layer of MTA Flow (Ultradent) material dispensed onto the pulp floor, over the exposed pulp tissue at orifice level.

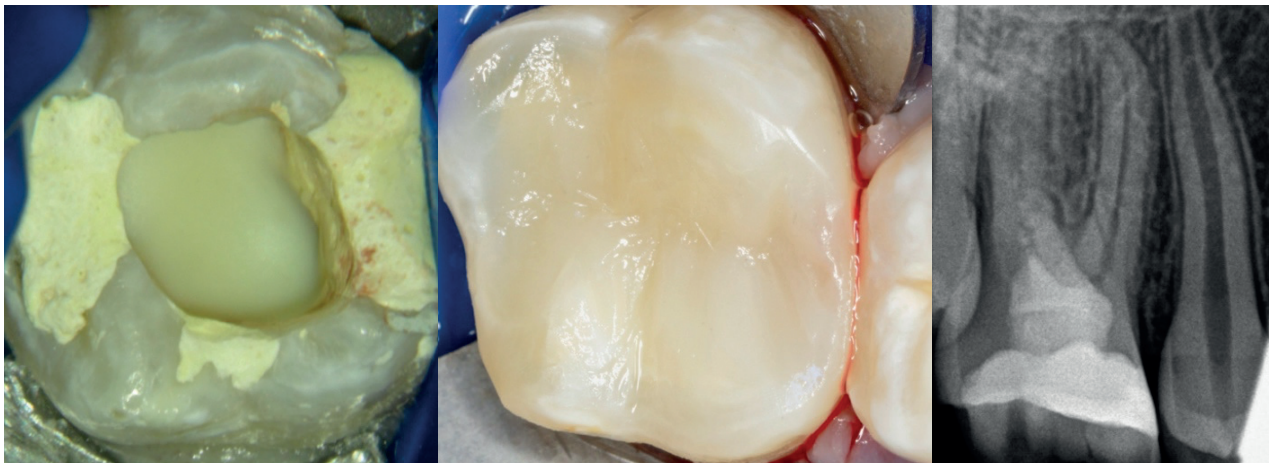

Figure 4. (a) The MTA material was covered with a thick layer of Vitrebond (3M/ESPE); (b) Class II composite resin restoration was placed as a definitive restoration; (c) Immediate postoperative periapical radiograph.

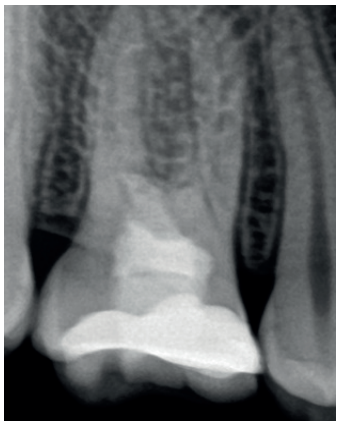

Figure 5. Periapical radiograph after 5 years. Note the evidence of root canal calcification.

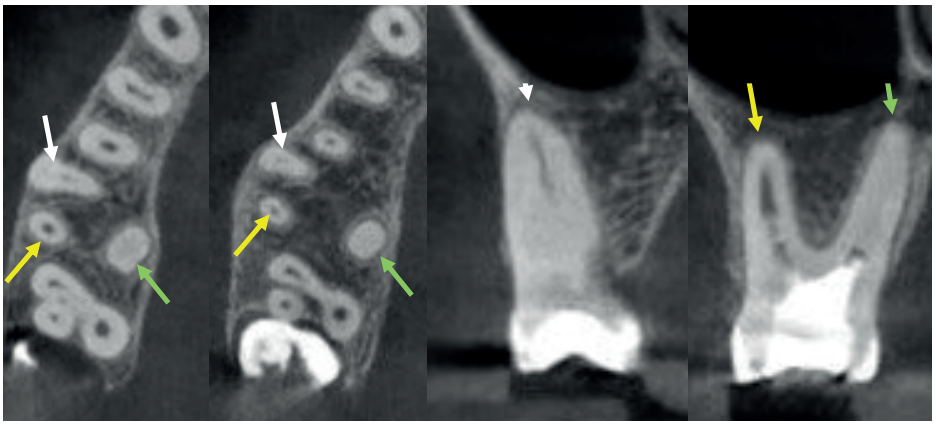

Figure 6. High resolution CBCT images at a 5-year follow-up visit depicting the new root canal anatomy: (a) Axial view at the level of the coronal third of the roots showing a partially obliterated mesiobuccal root canal (white arrow), completely obliterated palatal root canal (green arrow) and patent distobuccal root canal system (yellow arrow); (b) Axial view at the level of the apical third of the roots also showing a partially obliterated mesiobuccal root canal (white arrow), completely obliterated palatal root canal (green arrow) and patent distobuccal root canal system (yellow arrow); (c) Coronal view of the mesiobuccal root showing partially with a closed apex (white arrow). Note the coronal calcification of the root canal system with only some canal system visible towards the apical third of the root; (d) Coronal view of the distobuccal (yellow arrow) and palatal (green arrow) roots with closed apices. Note the patent distobuccal root canal system with evidence of pulp calcification in the midroot area of the canal. The entire palatal root canal system was calcified.

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Aggressive odontogenic myxoma of the maxilla in a 9-year-old child. Report of a case and literature review

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ABSTRACT

Odontogenic myxoma is a rare, locally aggressive benign tumour of odontogenic ectomesenchyme origin. The tumour may cause significant facial disfigurement and has a negative psychological impact on a child. Odontogenic myxoma has predilection for females in the second and third decades of life. The mandibular molar region is the most frequently affected site. It is imperative to detect the tumour early to avoid radical surgery and reduce local recurrences. This case study reports a case of a 9-year-old female patient who presented with an expansile tumour that affected the entire left maxilla, perforated into the left maxillary sinus and completely occluded the sinus.

Keywords

Odontogenic myxoma, maxilla, aggressive.

INTRODUCTION

Odontogenic myxoma (OM) is an aggressive benign odontogenic neoplasm of ectomesenchymal origin that intimately resembles the dental papilla of a developing tooth microscopically. The tumour accounts for 2-5% of cases in Africa, China and the US.[1] Two-thirds of OMs occur in the mandibular molar region whereas one-third occur in the maxilla, favouring the premolar-molar region. There is a female predilection within the second and third decades of life.[1-7] Histologically the tumour is characterised by the spindle and stellate cells that are embedded in an abundant myxoid-rich stroma.[1] This paper reports a case of a fast-growing maxillary OM in a 9-year-old female.

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Author's contribution

1. TC Ravele 40% (first author)
2. MMJ Masilela 40%
3. TC Dikgale 20%

Case report

A 9-year-old female patient presented to Pietersburg Hospital, Maxillofacial and Oral Surgery clinic with the main complaint of a slightly painful mass of the left maxilla of approximately 2 years' duration. On examination, she had a large non-ulcerated swelling on the left maxilla measuring 7cmx12cm which raised the ala of the nose and flattened the alar groove (Figure 1). Intra-orally, there was evidence of both buccal and palatal bone expansion.

Both the orthopantomogram image as well as the computerised tomography image revealed a well-circumscribed soap-bubble to ground glass, expansile radiolucent maxillary tumour of about 4cmx3.3cm involving the unerupted and displaced tooth 25 and root resorption of tooth 24 (Figure 2a). The tumour extended into the left maxillary sinus causing complete occlusion of the sinus (Figure 2b). Clinical differential diagnoses included adenomatoid odontogenic tumour, ameloblastoma, ameloblastic fibroma and odontogenic myxoma. All these tumours are common in younger patients, cause bone expansion and are usually radiolucent.

An incisional biopsy of the lesion was done and the specimen was sent for microscopic evaluation. The histological evaluation showed an infiltrating benign tumour composed of the spindle to stellate cells with eosinophilic cytoplasm in a myxoid-rich stroma with scattered vascular channels and sparse collagen fibrils. Numerous mast cells were also evident (Figure 3). The stromal cells stained diffusely and strongly positive for vimentin and Bcl-2 and patchy for smooth muscle actin (SMA) (Figure 4). There was no expression for h-Caldesmon. The proliferative index as detected by Ki-67

Figure 1. Frontal view showing expansile swelling of the left maxilla with raised left ala of the nose. Figure 1. Frontal view showing expansile swelling of the left maxilla with raised left ala of the nose.

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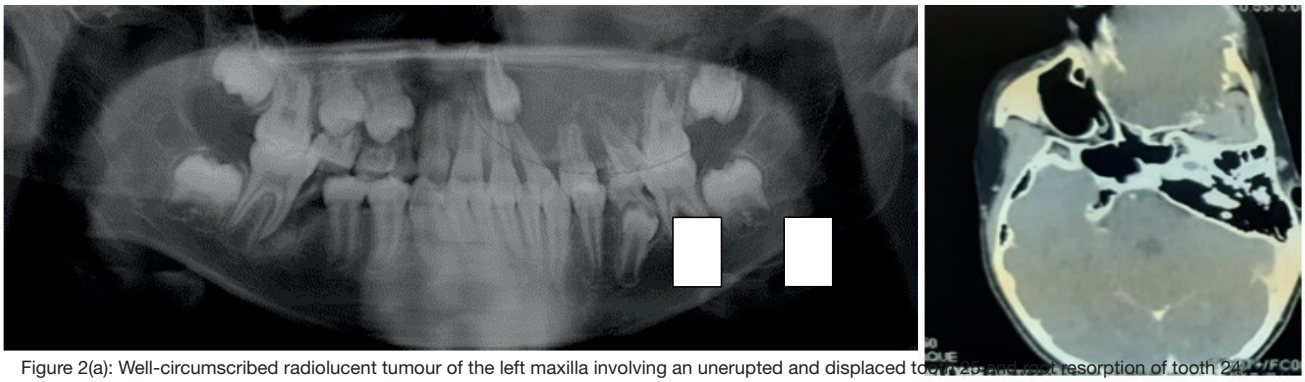

Figure 2(a): Well-circumscribed radiolucent tumour of the left maxilla involving an unerupted and displaced tooth 25 and root resorption of tooth 24
Figure 2(b): Expansile tumour of the left maxilla with total occlusion of the left maxillary sinus.

was less than 5%. The diagnosis of odontogenic myxoma was made.

Surgical management

Considering the extent of the tumour, a left hemi-maxillectomy was performed and could be classified according to the Brown classification system as vertical class II with a horizontal component b. Dieffenbach's modification of Weber Ferguson's approach was used to expose the tumour. A reconstruction plate was placed and secured with screws from the anterior part of the right maxilla extending to the left side of the zygomatic process to give more support to the remaining right maxilla. Soft tissue closure was achieved using polyglycolic 3/0 sutures on the mucosa and nylon 5/0 sutures on the skin (Figure 5).

The left hemi-maxillectomy excision specimen showed a bony hard tumour with both buccal and palatal bone expansion and associated dentition. A well-circumscribed gelatinous tumour was noted (Figure 6). The histological diagnosis was consistent with the incision diagnosis of OM.

DISCUSSION

OM is a rare benign odontogenic tumour of ectomesenchymal origin, known for its local invasiveness and recurrence.[2-4,8-9] Although OM is a rare tumour, its existence is well documented in the literature with the first case being reported in 1947.[10] The tumour accounts for 2-5% of all odontogenic tumours[3,11] and is the second most common odontogenic tumour after ameloblastoma.[4,12-13] A study undertaken in 2017, which aimed to analyse the pattern of distribution of odontogenic tumours in sub-Saharan Africa, found that OM accounted for 4.9% of all odontogenic tumours. These included 67 cases from Nigeria, 55 from South Africa, 41 from Tanzania, 35 from Kenya and 6 from Uganda.[13] In a 26-year retrospective study performed on odontogenic tumours manifesting in the first two decades of life in the South African rural population, OM was found to account for 4.7% of the cases.[12] A range of 0.5-17% was also reported to prevail in Asia, Europe and America.[2] The rarity of OM in the South African population is evidenced by studies undertaken in 2011 and 2016 whereby only 55 cases were reported over a period of 26 years and 29 over a period of 40 years respectively.[12,14]

OM is believed to arise from the ectomesenchyme and is perceived to be a tumour of dual fibroblastic-histiocytic origin with cells having myofibroblastic nature.[15] The pathogenesis is not clear; however, HMGA2 rearrangement and HMGA2 protein overexpression may be associated with tumorigenesis.[16] Recently, activating mutations in the MAPK/ERK signalling pathway have been identified in the tumour, which can serve as targets for pharmacological therapy.[17] The invasive behaviour of the tumour is facilitated by MMP-9 while MMP-1 helps to remodel the extracellular matrix and facilitates the dissemination of the tumour through the bone.[18-19]

Bcl-2, an antiapoptotic protein, indicates the proliferative activity of the tumour cells. Intense Bcl-2 staining correlates with tumour aggressiveness whereas poor Bcl-2 staining indicates a lack of aggressiveness. [20] As an antiapoptotic protein, Bcl-2 helps to establish the persistence of the proliferative tumour cells.[4] In our case, there was diffuse Bcl-2 staining of the stromal cells and a low proliferative index of 2-4% as indicated by Ki-67. These findings correlate with the aggressive nature of the case. Although resection with clear margins was achieved, the patient needs a close follow-up to guard against recurrence.

The scarcity of OM in children younger than 10 years has been observed in multiple studies. Although OM may occur in the age range of 1 to 80 years, most tumours are encountered in the second and third decades of life and shows a female predilection.[3-5,9,11-12,15,21-23] OMs are most commonly encountered in the posterior mandible as compared to the maxilla and, when occurring on the maxilla, the posterior region is the most affected.[2] No site predilection was observed in some studies.[12] Our patient was remarkable for both her young age and the fact that the lesion occurred in the maxilla.

Generally, OMs are slow-growing painless tumours.[14] Some of the reported major complaints are the presence of swelling and failure in tooth eruption.[5] Small OMs are usually asymptomatic whereas larger lesions cause

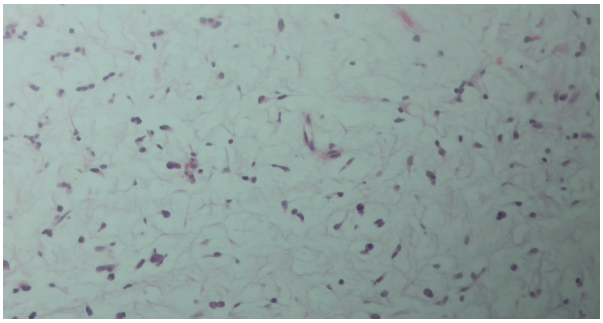

Figure 3: H&E – Haphazardly arranged spindle to stellate cells and mast cells in a myxoid-rich stroma. Magnification 20xhpf

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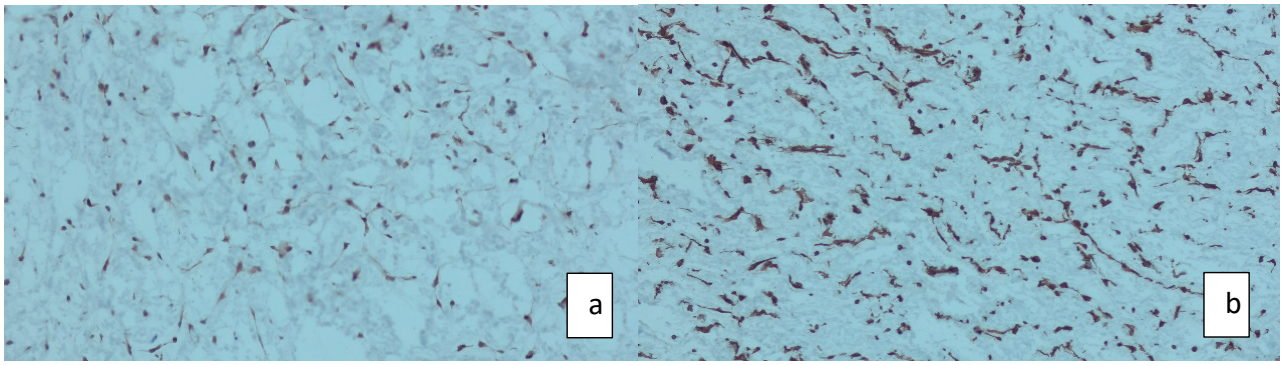

Figure 4: Demonstrates diffuse staining of Bcl-2 (a) and vimentin (b). Magnification 10xhpf

painless expansion.[21] In our case, we found that the lesion was slightly painful, with both buccal and palatal bone expansions causing facial asymmetry. Perforation and obliteration of the maxillary sinus were also observed and have not been commonly reported before.

Radiologically, most OM appears radiolucent and may be unilocular or multilocular with well-defined to ill-defined borders. The most common finding in a conventional radiograph is a multilocular radiolucency exhibiting soap-bubble, honeycomb or tennis racquet appearances. These features help to differentiate OM from malignant tumours as they are very destructive without trabeculation and bone septae.[1,6,11,24] The expansile nature of OMs commonly causes displacement of associated teeth instead of root resorption. Displaced teeth are usually vital.[2,14,25] The radiological features of our current case are consistent with those reported in the literature even though the uncommon feature of root resorption was also observed. The radiographic differential diagnoses include ameloblastoma, ameloblastic fibroma, aneurysmal bone cyst, glandular odontogenic cyst and central giant cell granuloma.

There is a tendency for patients to delay seeking medical intervention and the key contributors to late consultation are inaccessibility to healthcare facilities, low socioeconomic status and lack of knowledge.[14] Oral health education and proper screening cannot be overemphasised.

The gross examination of OM appears to be a greyish-white, homogenous to heterogeneous nodular mass with variable consistency and the cut surface exhibits a homogenous glistening gelatinous surface[9,24] which was similar to our case.

Histopathologically, OM is relatively easy to diagnose and is generally characterised by abundant myxoid stroma with spindle to stellate to round-shaped cells embedded within it. In some cases, tiny capillaries and sparse collagen fibrils are present. When there is dense collagen, the term fibromyxoma is used.[1,17,24,26] Mast cells may also be found and are believed to contribute to the degradation of extracellular matrix and differentiation of myofibroblasts in OM, favouring local invasion of the tumour.[4] Numerous mast cells (Figure 3) and myofibroblasts as highlighted by SMA (Figure 4) possibly contributed to the local invasiveness and aggressive behaviour observed in our case.

The histologic features of OM resemble a normal dental papilla; however, the clinical and radiographic features help to establish the diagnosis of OM. Differential diagnosis to be considered for a case of myxoid-rich OM is myxoid neurofibroma, hyperplastic dental follicle and chondromyxoid fibroma.[17] Myxoid neurofibroma tends to grow in fascicles, contains numerous mast cells and stains positive for S100. Chondrmyxoid fibroma has chondroid tissue within a myxoid stroma, unlike OM which is usually myxoid or has

Figure 5: Dieffenbach's modification of Weber Ferguson's approach – closed wound.

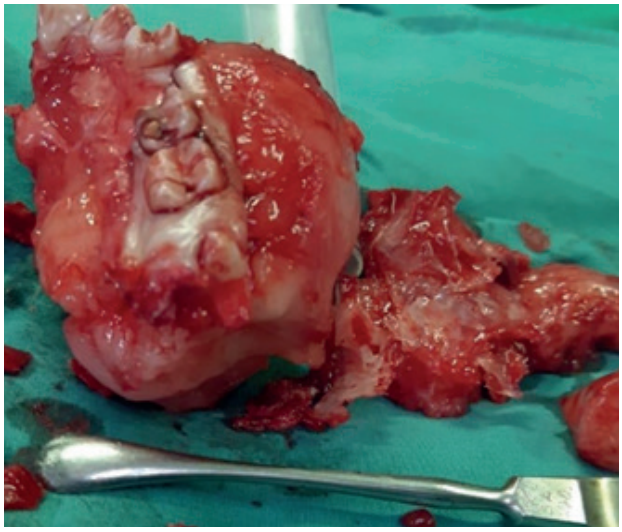

Figure 6: Left hemi-maxillectomy specimen, a well-circumscribed tumour with related teeth, showing both buccal and palatal bone expansion. Mucoid tumour fragments lying adjacent to the hemi-maxillectomy specimen.

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increased fibrous stroma.[5] Our case was predominantly myxoid with loosely arranged spindle to stellate-shaped cells. The tumour cells stained positive for vimentin and focally for SMA, but negative for h-Caldesmon, suggesting the possible myofibroblastic nature of the lesion.

Small lesions may be treated by curettage only but large lesions require wide surgical resection because OM are usually not encapsulated and have a tendency to infiltrate the surrounding bone.[1,24,26] In the present case, the patient was treated with hemi-maxillectomy resection and a reconstruction plate was placed and secured with screws from the anterior part of the right maxilla extending to the left side of the zygomatic process to give more support to the remaining right maxilla. No prosthetic construction was done to allow the growth plate to close completely and to co-ordinate long-term maintainance to rule out recurrence.

Postoperative complications such as transient dysfunction of the marginal mandibular branch of the facial nerve and loss of the microvascular flap may occur.[5] A recurrence rate of up to 25% may be seen[26-27] and is more likely to occur in cases that were treated with curettage only. However, lesions may recur even post extensive resection.[5] After a year, our patient remains disease free. Yet, despite the radical surgery, we continue to monitor the patient.

CONCLUSION

Odontogenic myxomas are rare, benign odontogenic tumours that can be aggressive and may cause facial disfigurement and have a negative psychological impact on a child. Early detection of these lesions can avoid radical surgery. In children with larger tumours, we recommend long-term follow-up to guard against recurrence. Prosthetic reconstruction can be done once growth is completed.

Informed consent

Informed consent was obtained from both the patient and the guardian to publish this case report. Ethics clearance was also obtained from the Ethics Committee with clearance number SMUREC/D/101/2023: (J) Journal.

Conflict of interest

None

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CPD questionnaire on page 326

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

SADJ July 2023, Vol. 78 No.6 p318-320

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

1. CLEANSING EFFICACY OF AN ORAL IRRIGATOR WITH MICROBURST TECHNOLOGY FOR ORTHODONTIC PATIENTS

Interdental cleaning devices in the form of dental floss and interdental brushes have traditionally being used as adjuncts to plaque removal in the interproximal areas of teeth. However, their routine use among younger adolescents has been reported in many studies to be less than optimal.

In orthodontic patients, fixed braces promote supra- and subgingival accumulation of biofilm by impeding oral hygiene resulting in an altered oral microbiome, enamel decalcification and gingivitis[1]. It was recently shown that patients with upper and lower multibracket appliances are affected significantly more frequently by gingivitis (65%) and white spot lesions (30%).[1] Additionally, in the predominantly young orthodontic patients, interdental spaces are often too narrow to use interdental brushes and flossing is challenging and time-consuming. Oral irrigators are easy to use even in the presence of orthodontic braces and are therefore favoured by many patients. Most oral irrigators use a stream of water only to mechanically remove plaque from interproximal areas but there are also oral irrigators which use a mixture of air and water, called microburst technology.

Wiesmüller and colleagues (2023)[1] reported on a randomised, single-blinded crossover study trial that sought to compare the cleansing efficacy of microburst technology with that of dental flossing in orthodontic patients with fixed braces after 4 weeks of home use. The null hypothesis was that there would be no difference between the two methods.

MATERIALS AND METHODS

Twenty adults who had fixed braces attached buccally at a minimum of four teeth per quadrant and existing contact points between all teeth were included in this trial. Patients were excluded if they were pregnant or had a history of oral or systemic diseases other than gingivitis. Teeth with ceramic restorations and implants were excluded from analysis due to different plaque adhesion compared to natural teeth. Data collection was performed from January 26 2021 to June 30 2021.

The cleansing efficacy of the microburst technology (*Airfloss*®, Philips) versus interdental cleaning with dental floss (*Superfloss*®, Oral-B) was evaluated in a randomised-controlled, examiner-blinded crossover study.
The study design consisted of four appointments for each subject.

At baseline, hygiene indices were evaluated using the Rustogi Modified Navy Plaque Index (RMNPI) after plaque disclosing and the gingival bleeding index (GBI). The RMNPI splits every buccal and lingual tooth surface into nine sections (A–I) that are assessed for the presence or absence of plaque. The index allows to draw a distinction between marginal areas of the teeth (A–C), interdental areas (D, F) or overall surface areas (A–I). RMNPI is calculated as the percentage of biofilm adhering sites to measured sites. For the assessment of the GBI, a periodontal probe (PCP 12) was inserted into the gingival sulcus to decide dichotomously at six sites per tooth (mesiobuccal–buccal–distobuccal–mesiolingual–lingual–distolingual) if bleeding occurred or not. The percentage of bleeding sites to measured sites was calculated. Teeth that were not integrated in the fixed orthodontic treatment were excluded. All examinations were conducted by one trained examiner.

Randomisation of the test products was computer generated prior to investigation and was conducted by study assistants, who also thoroughly instructed the subjects to use the products through hands-on training to ensure that the examiner did not know which product was used and so could collect the data blindly. *Airfloss*®, the oral irrigator with microburst technology, was filled with water and activated once per interdental space with the default setting of three sprays per activation. The participants were also instructed on how to use the control product *Superfloss*®.

Regarding toothbrushing, the participants were asked to stick to their usual routine and product. After detailed instruction with the first randomised assigned test product, professional tooth cleaning was conducted on the participants. After 28 days using the first test product, the study subjects presented for their second visit. The hygiene indices and inclusion/exclusion criteria were surveyed again. After a wash out phase of 28 days where the patients practiced their usual oral hygiene procedures, they presented for the third visit. Again, plaque was disclosed, and the subjects were thoroughly instructed to use the second product followed by a professional dental cleaning. In analogy to the first test phase, the subjects used the product for 28 days and then presented for examination of the plaque and gingival index in the context of the fourth and final appointment of the study.

RESULTS

Twenty individuals were recruited and 17 participants (seven females and 10 males) finished the study with a mean age of 27.12 ± 9.23 (range 18–49) years. The drop-out rate was 15%. One participant quit because of scheduling difficulties; two participants were excluded because of antibiotic treatment during the test phase. A total of 446 teeth were included in this study.

At baseline, the median of overall RMNPI (Plaque score) was 61.35% (53.29–69.56).

After 28 days of interdental cleaning with microburst technology, the median of overall RMNPI was 54.96%

(46.91–66.05). This was statistically significantly higher than after 28 days of interdental cleaning with the control procedure dental flossing (median of overall RMNPI 52.98%; range 42.75–65.60) (p = 0.029). Compared to baseline, a statistically significant difference could be seen after using the dental floss (p = 0.020), but not after using the oral irrigator (p = 0.105). Subgroup analysis revealed that the higher cleansing efficacy of the dental floss is mainly attributable to buccal and marginal areas and not to approximal areas. There was a statistically significantly lower plaque index after 28 days of dental flossing compared to microburst technology on marginal areas (median 61.25% and 68.45%, respectively; p = 0.010) but not on approximal areas (median 78.85% and 76.19%, respectively; p = 0.215).

At baseline, the median of GBI was 26.45% (range 14.49–31.55).

After 28 days of interdental cleaning with the oral irrigator, GBI was 12.96% (7.14–24.31) and statistically significantly higher compared to 8.33% (5.84–15.33) after interdental cleaning with dental floss (p = 0.030). Both tested products, the dental floss and the oral irrigator, reduced gingivitis in the statistically significantly compared to baseline (p < 0.005). Subgroup analysis revealed that unlike the plaque index, gingival bleeding was statistically significantly different not only at marginal sites but also at approximal sites. There was a statistically significantly higher gingival bleeding index after 28 days of home use of the oral irrigator compared to dental flossing on marginal areas (12.96% and 8.33%, respectively; p = 0.030) and on approximal areas (16.35% and 9.38%, respectively; p = 0.019). Again, the difference was more pronounced on buccal than on lingual/palatal surfaces. The GBI was also statistically significantly higher in anterior teeth after using the oral irrigator compared to dental flossing (median 9.72%, range 5.56–20.83 and median 5.56%, range 2.78–6.94, respectively; p = 0.012) but not in posterior teeth (median 14.10%, range 8.33–31.94 and median 8.54%, range 7.14–14.67; respectively; p = 0.056).

CONCLUSION

The researchers concluded that oral irrigators were still in need of substantial technical improvements and did not remove plaque and reduce gingival bleeding as efficiently as dental floss in regions that were easy to reach. However, in posterior regions, where the patients struggled with the application of dental floss, the oral irrigator showed similar results.

IMPLICATIONS FOR PRACTICE

Clinicians and patients should be cautious about the claims of clinical effectiveness made by product brochures and sales agents about the efficacy of oral irrigators.

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2. THE INFLUENCE OF SMOKING ON THE INCIDENCE OF PERI-IMPLANTITIS: A SYSTEMATIC REVIEW AND META-ANALYSIS

One of the most common conditions affecting implants is peri-implantitis which is a plaque-associated pathological condition characterised by inflammation in the peri-implant mucosa and subsequent progressive loss of supporting bone.[1] The onset of peri-implantitis might occur early, within 3 years of function in most cases, and it progresses in a non-linear and accelerating pattern.[1] Local and systemic factors have been shown to increase the susceptibility of developing peri-implantitis. Patients with a history of chronic periodontitis, poor plaque control and no regular maintenance care after implant therapy are known to have a higher risk of developing peri-implantitis. There is high quality evidence from systematic reviews that have also identified smoking as an important risk factor for periodontitis and periodontitis-associated tooth loss.[1] Reis and colleagues (2023)[1] reported on systematic review to assess the influence of smoking on the incidence of peri-implantitis according to the available evidence from prospective cohort studies.

METHODOLOGY

This review was performed according to the 2020 Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) reporting guidelines. The research question was as follows: What is the incidence of peri-implantitis in smokers with dental implants, when compared to non-smokers, in prospective cohort studies?

The breakdown according to PECOS was as follows:

- Population (P): Patients with dental implants.
- Exposition (E): Cigarette smoking.
- Comparison (C): Non-smoking.
- Outcome (O): Incidence of peri-implantitis.
- Study design (S): Prospective cohort studies.

The following inclusion criteria for studies were applied.

Inclusion criteria comprised:

- Prospective cohort studies that evaluate the incidence of
- peri-implantitis.
- Studies with smokers and a non-smoking control group.
- Studies that contain "incidence" or provide "risk prediction" of peri-implantitis.
- Studies that reported results related to the effect of smoking on the incidence of peri-implant diseases.
- Adult patients (18 years old and above).
- Original articles published in all languages.

Exclusion criteria comprised:

- Studies that do not evaluate the effect of smoking as an independent factor.
- Studies that did not present a diagnosis of peri-implantitits.
- Patients with immunological health conditions and/or other confounders (eg HIV-positive).

Four electronic databases – National Library of Medicine (MEDLINE-PubMed), SCOPUS, EMBASE and ISI Web of Science – were selected to search relevant articles. The databases were last searched on November 30 2022 and there were no time restrictions for when the studies were published. Main terms included "Peri-Implantitis", "Periimplantitis", "Smoking", "Cigarette" and "Tobacco". In addition, OpenGrey (http://www.opengrey.eu) and Grey Literature Report (http://www.greylit.org) were used to supplement the search for grey literature. The reference list of included studies was hand-searched to identify additional potentially relevant studies.

After searching on the electronic databases, the retrieved

articles were subjected to a three-phase screening process by two authors independently. In the first phase, titles and abstracts were selected based on the eligibility criteria. Studies appearing to meet the inclusion criteria, or those with insufficient information in the title and abstract to make a clear decision, were selected to evaluate the full manuscript. Lastly, full-text versions of potentially relevant studies were screened. Studies fulfilling all selection criteria were processed for data extraction. Disagreements were solved by discussion and consensus and consultation with a third reviewer if necessary.

Data from selected trials were independently extracted from the included studies by two reviewers and disagreements were resolved via discussion and consensus or by consulting a third reviewer.

The risk of bias was assessed using a modified version of the Newcastle–Ottawa scale (NOS) which assessed the selection of study groups (ie representativeness of current and former smokers), comparability of the groups, outcome (criteria used to assess tooth loss and adequacy of follow-up) and statistical analysis. Furthermore, NOS was converted to Health Research and Quality (AHRQ) standards to categorise the studies as good, fair and poor. The GRADE method (Cochrane library) and the GRADEpro tool were used to determine certainty of evidence for each outcome.

The analysis of the data was performed using Review Manager (RevMan) software, version 5.4.1. Smoking status was categorised into smokers and non-smokers. Random-effects meta-analyses was conducted for peri-implantitis incidence (dichotomous outcome) at patient and implant levels. A subgroup analysis was performed in the implant-based analysis to analyse separately studies that used the World Workshop definition of peri-implantitis. The estimates were presented as pooled risk ratios (RR) and their respective 95% confidence intervals (CIs). Statistical heterogeneity among studies was assessed with the Cochrane *Q* test and I^2.

RESULTS

After screening the titles of papers for possible inclusion, 486 articles were considered. After applying the inclusion and exclusion criteria, 480 papers were excluded and six were included in this review. These six prospective cohort studies comprised 702 patients and 1,959 implants. The follow-up period ranged from 3 to 16 years.

In terms of the quality of the included studies, four were rated good quality and two were rated fair.

For the pooled meta-analysis, there was a significant difference between smokers and non-smokers for the risk of peri-implantitis in the implant-based ($p < .0001$) and patient-based analysis ($p = .01$). A strong association between smoking and the risk for peri-implantitis was verified at the implant level (RR: 2.04, 95% CI: 1.46–2.85) and the patient level (RR: 2.08, 95% CI: 1.17–3.71). The subgroup analysis of the studies that used the World Workshop definition at the implant level also showed a higher risk for peri-implantitis development when comparing smokers and non-smokers. On the other hand, the study that did not use the World Workshop classification showed no significant difference between the groups.

The certainty of evidence from the GRADE approach for the incidence of peri-implantitis was rated as moderate for implant-based and patient-based analysis.

CONCLUSION

The reviewers concluded that the strength of the evidence suggesting that smoking is associated with peri-implantitis compared to non-smoking at the patient and implant levels was moderate.

IMPLICATIONS FOR PRACTICE

Smoking continues to be a major contributor and confounder to many oral and systemic diseases and oral health professionals MUST contribute to reducing the prevalence of this bad habit.

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Does providing "Compromised treatment" equate to "Compromised care" or could it be considered "Appropriatech"?

SADJ June 2023, Vol. 78 No.5 p321-322

LM Sykes[1], J Kok[2], PT Nethononda[3]

ABSTRACT

Teeth are sensory structures that play a part in many different aspects of a patient's life, including mastication, speech, smiling and aesthetics. As such they can affect both their functional and psychosocial wellbeing and quality of life. Unfortunately, these vital components can be lost due to caries, periodontal disease, dental trauma or iatrogenic damage. Dental practitioners should aim to provide treatment that will save and/or restore compromised or diseased teeth whenever possible. This may include direct or indirect restorations, endodontics, periodontal therapy and even reimplantation or autotransplantation in specific cases.[1] Despite the wide range of treatment possibilities, oral rehabilitation is often not available, accessible or affordable to all patients.[2] To try to "provide treatment for the many", cost-effective procedures may need to be considered. However, this cost-cutting cannot be achieved by "ignoring sound prosthodontic principles" and needs to have some form of quality control.[2] This paper will give a brief review of the controversial cervical margin relocation technique. It will then use this as an example for how a clinician can debate whether the provision of "compromised treatment" equates to inferior care, or if it could be considered appropriate for the given situation. They need to also ensure that the chosen treatment is safe, adheres to evidence-based principles and still provides quality of care.

INTRODUCTION

Large interproximal carious lesions located below the cementoenamel junction (CEJ) almost always require some degree of prosthodontic rehabilitation to restore the anatomy and function of the tooth in an appropriate manner. However, the preparation for indirect restorations poses both biological and technical operative challenges.[3] The main biological problem is the potential violation of the biological width, which typically requires a minimum distance of 3mm to be maintained between the restorative margins and the alveolar crest to prevent detrimental effects on the surrounding soft and hard tissues.[4] Technical challenges that arise include difficulties in tooth preparation, impression taking, adhesive cementation and finishing and polishing the margins, as well as difficulty in placing a rubber dam.[3]

Historically, the recommended procedures to expose the deeper margins located below the CEJ include clinical crown lengthening or orthodontic extrusion.[4] However, in private clinical practice it is often not possible or viable to refer the patient for these procedures due to patient unwillingness to accept invasive surgical procedures, or time constraints requiring multiple appointments.[3] They are also expensive, and can significantly increase overall treatment costs.[4] In addition, they generally require the services of specialist clinicians and are not readily available to the broad community of patients. In 1998, Dietsci and Spreafico introduced the cervical margin relocation technique (CMR), also known as the deep margin elevation technique.[5] This technique involves the placement of composite material in the deepest portions of the proximal areas to reposition the margin supragingivally, and aims to improve impression-taking, rubber dam isolation and adhesive cementation.[4,6]

A recent systematic review by Juloski, Koken and Ferrari (2018) revealed that the success of this technique depends on several factors, including the marginal quality of the adhesively bonded restoration, fracture behaviour of the treated posterior teeth, bond strength, material choice, application technique and treatment of the CMR prior to bonding of the indirect adhesive restoration. In a controlled study conducted by Ferrari et al. the effect of CMR on periodontal health was tested.[3,4] After a one-year follow-up, despite a 100% survival rate and no bone loss detected radiographically, the study found that 53% of the samples had bleeding on probing, which indicates an uncontrolled inflammatory process, and may compromise the success of CMR which depends on the absence of bleeding on probing and gingival inflammation.[4] This procedure is just one of the many examples where clinicians may have to decide whether they can clinically and ethically justify providing "a compromised treatment option to patients in need, but who cannot afford the "ideal intervention". It now serves as the background for the ensuing legal and ethical discussion.

Legal framework

The National Patient's Rights Charter (Booklet 3 of the HPCSA Guidelines)[7] stipulates that "everyone has the right to access health care services that include –

a. **receiving timely emergency care** at any health care facility that is open, regardless of their ability to pay;
b. **treatment and rehabilitation** that has been made known to them in a manner that allows them to understand such treatment and the consequences thereof;
c. **provision of special needs** to those who fall into the category of vulnerable patients;
d. **counselling** without discrimination, coercion or violence;

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2. J Kok 10%
3. P Nethononda 10%

e. **palliative care** that is affordable and effective in cases of incurable or terminal illness;
f. **a positive disposition** displayed by health care providers that demonstrates courtesy, human dignity, patience, empathy and tolerance;
g. **health information** that includes information on the availability of health services and how best to use these in a language or manner that is understood by the patient;
h. **informed consent** wherein they have a right to be given full and accurate information about the nature of their illness, diagnostic procedures, proposed treatment, risks associated with this, time and the costs involved, and the consequences of no treatment.[6]

Clinical and ethical factors to consider

In the above scenario, the aim is to save the tooth in a situation where either the patient cannot afford the ideal treatment, has no access to it or the practitioner is not skilled enough in this field to carry it out (In the case of the latter, their first obligation would be to refer the patient to an appropriate colleague).

Can the dentist justify offering a compromised treatment? To answer this, they will need to consider and debate a number of pertinent questions including the following:

1. What is the short, medium and long-term prognosis for the tooth if NO treatment is done, and how will that affect the rest of the dentition and oral health?
2. What is the short, medium and long-term prognosis for the tooth if the compromised treatment is carried out?
3. Will the treatment affect the surrounding teeth and gingiva? If so, how?
4. Is the alternative treatment reversible should the patient later be able to afford a better modality?
5. What is the cost in terms of time and money as opposed to the ideal option?
6. Is the patient aware that this is not ideal and have they been informed of all the risks, benefits, time and financial implications and possibility of failure?
7. If treatment fails what will happen to the tooth? Could the tooth be restored or replaced and, if so, how and at what cost? In addition, who will carry these costs?. The dentist cannot be expected to provide additional services free of charge, and so patients will be liable. They should understand, accept and agree to these provisos.
8. What are the requirements with regard to maintenance and subsequent clinical upkeep of the tooth?
9. Is the proposed option defensible from a scientific, evidence-based, clinical standpoint?
10. What is the reported survival as well as success rate of the option?
11. What should be considered as acceptable survival and success rates?
12. Does the treatment comply with principles of "appropriatech"? Owen defined this as "using appropriate technology (both materials and methods) to provide cost-effective treatment without sacrificing biofunctional and prosthodontic principles".
13. Have all the available treatment options been conveyed to the patient and, if not, does this infringe on the patient's right to choose? In other words, is the clinician sure they are not behaving in a paternalistic manner in which they restrict the freedom or autonomy of their patients "for their supposed wellbeing or the greater good".[8]
14. Would the treatment plan and procedure pass the "reasonable dentist rule" if placed under scrutiny by colleagues?

Guiding principles

These principles are based on the guidelines set out by Beauchamps and Childress in 2001.[9]

1. **Beneficence** – what is in the patient's best interest? It is a reality in SA that not everyone can afford the ideal treatment, but they do deserve some form of care. The dentist should try by all means to save their teeth if that is their wish. If this means offering an inferior, nondamaging and suitable alternative, then we should feel comfortable to do so.
2. **Nonmaleficence** – "first do no harm" or try remove harm. If the intervention may cause harm it should not be considered; however, if inactivity will lead to tooth loss then the dentist is justified in trying this technique.
3. **Patient autonomy** – do they understand all of the above? The patient will be the one who must make the final decision, based on understanding and the professional advice of their doctor.
4. **Informed consent** – do they voluntarily agree to the treatment?

Once the dentist has completed a similar full and unbiased assessment of the patient's situation and needs, are confident they can clinically and ethically justify the proposed treatment, and believe it to be both beneficial and appropriate, then they should feel free to proceed. However, to safeguard themselves against possible repercussions or litigation from either the patient or a colleague they will be wise to take some necessary precautions. They should document the condition as it was at the time of initial assessment with good quality intra-oral photographs, relevant radiographs, full mouth dental, occlusal and periodontal charting and perhaps also study models. The patient should be aware that these diagnostic aids all carry a cost and should be willing to pay for these and their initial consultation. The records should also detail all verbal conversations, include a written treatment plan, and have this dated and signed by the patient before they embark on any clinical work.

CONCLUSION

In conclusion, a guiding rule to follow in life is "if you are going to do it, do it right or not at all". However, within the realities and limitations of a dental practice, what is "ideal" or considered "right" is not always possible due to physical, financial or psychosocial constraints. In that case the best advice would be to place the patient's best interest and wellbeing first and then carry out work in the least destructive and most appropriate and ethically defensible manner possible. At the same time, to always work according to the best of their abilities within the limitations of what is available, affordable and possible in any given situation.

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Maxillofacial Radiology
CASE REPORT

Mönckeberg arteriosclerosis

J Simpson[1], L Ebrahim[2]

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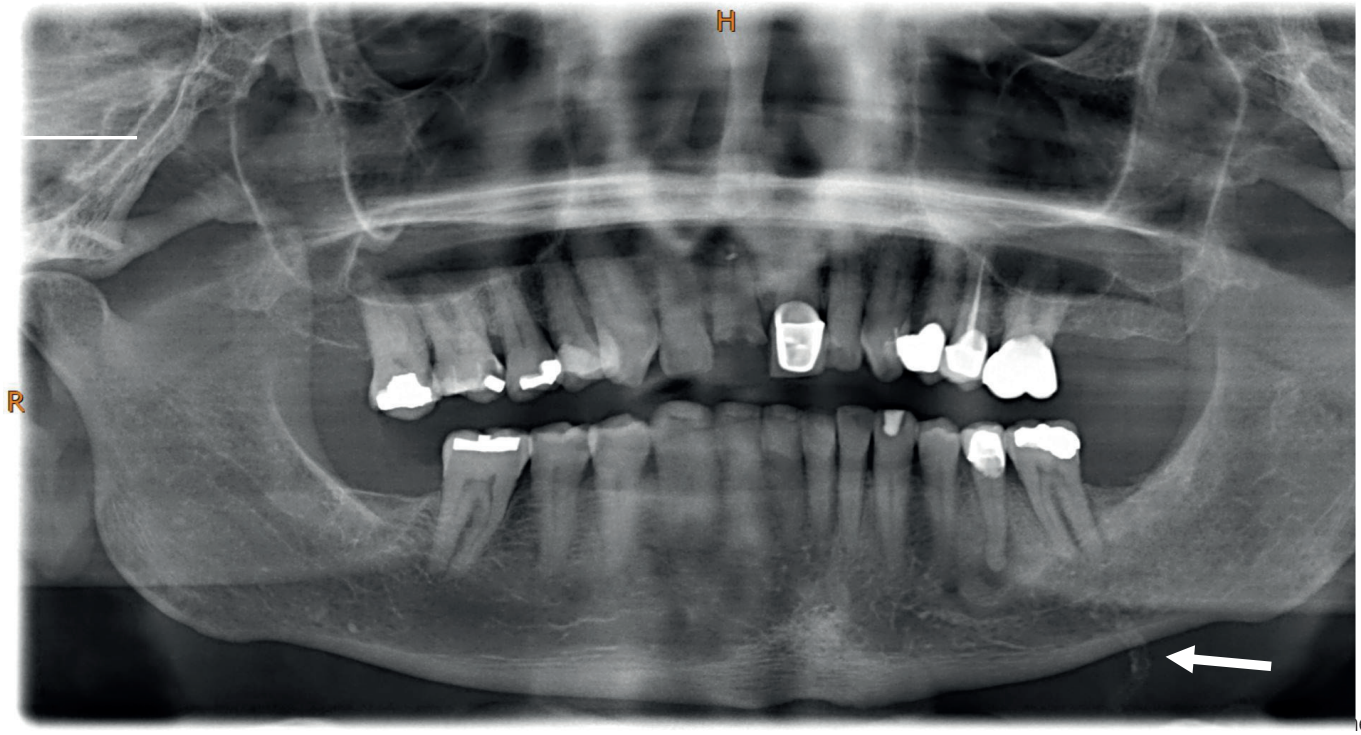
CASE

Patient 1: A 75-year-old male presented to the department for the extraction of the 11. Upon panoramic examination (fig. 1), a well-urvilinear "railroad track" opacity was noted across the inferior border of the left mandible (white arrow).



erapy.
The scan slices demonstrate "pipe-track" and "railroad track" hyperdensities along the course of the facial artery on CBCT examination.

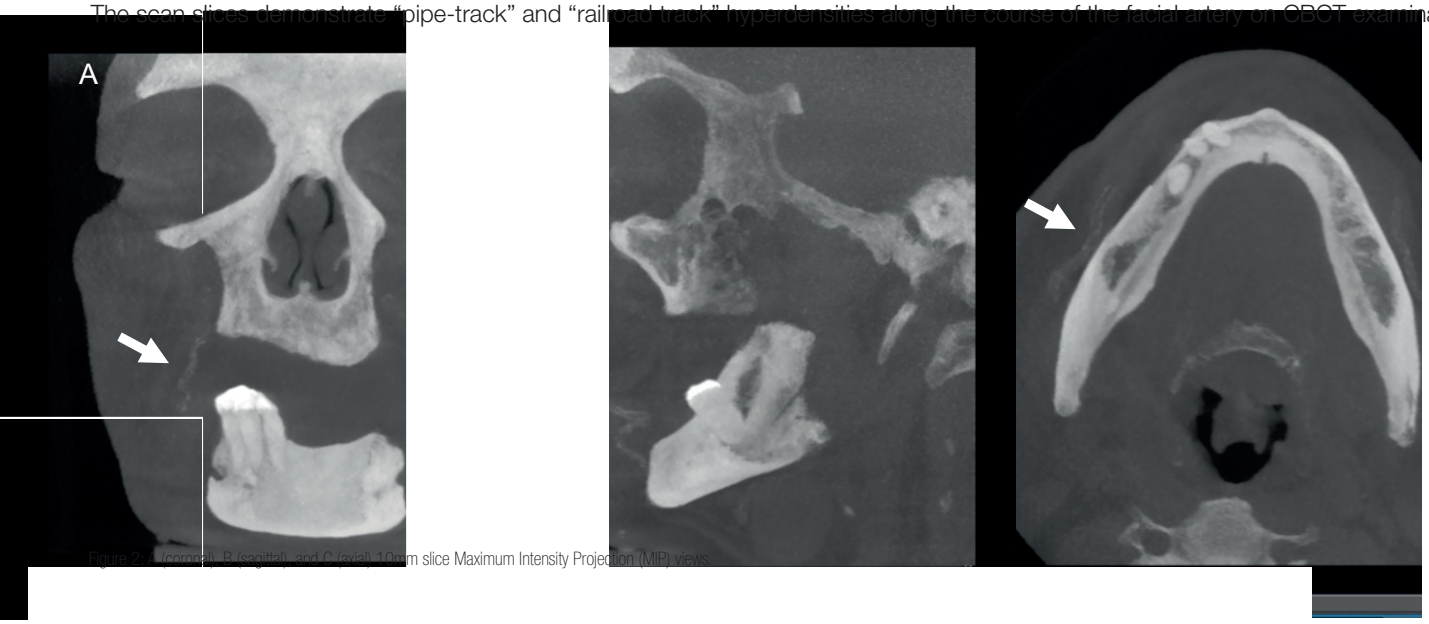


Figure 2: A (coronal), B (sagittal), and C (axial) 10mm slice Maximum Intensity Projection (MIP) views.

https://doi.org/10.17159/sadj.v78i06.????

INTERPRETATION

The incidental calcifications on the conventional (panoramic) and advanced (CBCT) radiographs are consistent with Mönckeberg arteriosclerosis (MAA). MAA, first described by Johann Georg Mönckeberg in 1903, is a type of vascular calcification occurring in the tunica media of small and medium muscular arteries. Elastic fibres, which are commonly found in the arteries, gradually start to degenerate, leading to the deposition of calcium within the medial layer of the arterial wall.[1] Instead of the lumen narrowing, stiffness of the vessel develops, resulting in increased vascular resistance, reduced arterial compliance, and the inability to properly vasodilate in situations of increased stress.[2] The loss of arterial elasticity may also lead to derangement in blood flow and injury to the endothelium, increasing the risk of thrombosis.[3]

Although the exact aetiology of MAA remains unclear, it is thought to be related to ageing, diabetes mellitus, male gender, and chronic kidney disease. It occurs frequently in the lower extremities but may occur in the head and neck region.[4] In patients with diabetes and chronic kidney disease, Mönckeberg arteriosclerosis can have serious cardiovascular effects. Higher levels of these calcifications can eventually lead to amputation due to interference with blood flow.[2] Medial artery calcifications in newly diagnosed type 2 diabetic patients have been proven to be the most powerful predictive marker of future cardiovascular mortality.[3]

Clinically, patients are generally asymptomatic, with the calcification usually being diagnosed as an incidental finding on radiographs.

On conventional radiography, the appearance of the calcified vessel can be described as a "pipestem" or "railroad track" artery, seen as a parallel pair of thin, radiopaque lines with a straight or winding path (as presented in Figure 1).[2] On advanced imaging, such as CBCT (Cone Beam Computed Tomography), MAA tends to be a more generalised form of arteriosclerosis than carotid artery atheromas and radiographically appears as multiple, circumferential "pipestem" hyperdensities along the arterial wall (as presented in figure 2).[5]

Other calcifications appearing within the same region as MAA on panoramic radiography include carotid artery and venous calcifications (phleboliths). Due to the two-dimensional nature of panoramic radiographs, image superimposition of adjacent structures is bound to occur. Calcifications within these structures, such as the carotid arteries or veins, may have a similar appearance to MAA. Carotid artery calcifications can be seen as curved, irregular, parallel radiopacities occurring either in the soft tissue of the neck or below C3 and C4 vertebrae, inferior and lateral to the hyoid bone. In the case presented in Figure 1, the opacity is found anterior to the angle of the mandible, overlying the inferior mandibular cortex, in the region of the facial artery. Figure 2 shows the localisation that is possible on CBCT images, with the hyperdensities being traceable along the path of the facial artery. Phleboliths, on the other hand, occur as round or oval lesions with a homogenously radiopaque centre, displaying a "target" appearance.[2]

Although there is no cure for MAA, identification of this calcification should lead the clinician to assess the patient's medical history closely for diabetes or renal disease,[2,5] prompting appropriate medical referral where necessary.

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2. L Ebrahim – 40%

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CPD questionnaire

Prevalence of dental caries among learners with disabilities attending special education schools in the eThekwini District, KwaZulu-Natal

1. What is the CORRECT answer. What was the proportion of males to females in the study?

A. 62.3% males, 37.7% females
B. 63.3% males, 36.7% females
C. 64.3% males, 35.7% females
D. 61.3% males, 38.7% females

2. Select the CORRECT answer. What was the mean DMFT score in the Permanent Dentition?

A. 2.36
B. 1.97
C. 3.70
D. 3.83

3. Which option is CORRECT. What was the mean PUFA score for participants with traumatic brain injuries?

A. 0.44
B. 1.26
C. 1.25
D. 1.06

4. Select the CORRECT age group. The majority group in the study was the _____-year-olds.

A. 15-17
B. 6-9
C. 12-15
D. 8-12

Aggressive Odontogenic Myxoma of the Maxilla in a 9-year old child. Report of a case and Literature review

5. Select the CORRECT answer. Odontogenic Myxoma is frequently encountered in the

A. Posterior mandible
B. Anterior maxilla
C. Posterior maxilla
D. Anterior mandible

6. Which of the following answers is CORRECT. Mutation has been identified in which signaling pathway

A. RANKL/RANK
B. MAPK/ERK
C. JAK-STAT
D. SHH

7. Which of the following options is INCORRECT. Differential diagnosis of myxoid-rich Odontogenic myxoma includes the following except:

A. Myxoid Neurofibroma
B. Osteoblastoma
C. Hyperplastic dental follicle
D. Chondromyxoid fibroma

8. Choose the CORRECT answer. Treatment of choice for large Odontogenic myxoma is:

A. Curettage
B. Enucleation
C. Marsupialization
D. Extensive resection

Pulpotomy: An Alternative Treatment Modality to Conventional Root Canal Treatment

9. Select the CORRECT answer. A possible non-vital treatment option for permanent teeth is

A. Cvek Pulpotomy
B. Conventional Root Canal Treatment
C. Indirect Pulp Caping
D. Direct Pulp Caping

10. Which of the following is CORRECT regarding the AAPD guidelines

A. A pulpotomy is performed in a tooth with radicular pathology.
B. A pulpectomy is performed in a tooth with reversible pulpitis.
C. An apexification is performed in a tooth with a vital pulp after traumatic exposure
D. A pulpotomy is performed in a tooth without radicular pathology

11. Which answer is CORRECT. Which of the following cells are recruited/ released during Calcium Silicate-based pulp capping material on a pulp?

A. Osteoblast-like cells
B. Odontoblast-like cells
C. Ameloblast-like cells
D. Dentinogenic Crest cells

12. Choose the CORRECT answer. Which of the following is commonly found in bioactive materials used in dentistry?

A. Calcium di-oxide
B. Calcium disilicide
C. Calcium silicate
D. Calcium hydroxide

13. Select the CORRECT answer. Tertiary dentine formation by odontoblast-like cells is due to the release of which of the following?

A. TGF-b1 growth factor
B. IGF-1 growth factor
C. EGF growth factor
D. EGF growth factor

Evidence-based Dentistry

14. Choose the most CORRECT option. In a cross-over trial

A. Both groups get different treatments
B. Each group gets its own treatment which is unique
C. The patients are swopped into the other group when they are completed with the one treatment
D. Both groups get both sets of interventions under investigation

15. Select the CORECT answer. In the Wiesmüller et al trial, the plaque score after 28 days of interdental cleaning was:

A. Statistically significantly higher than after 28 days of interdental cleaning with both the Airfloss and the Superfloss
B. Statistically significantly higher than after 28 days of interdental cleaning with the Superfloss only
C. Statistically significantly higher than after 28 days of interdental cleaning with the Airfloss only
D. Non-significant with both Superfloss and Airfloss

16. Which of the following is CORRECT. The results of the Wiesmüller et al trial suggest that:

A. oral irrigators performed just as well as dental floss
B. oral irrigators could replace dental floss as an adjunct for mouth cleaning
C. oral irrigators were still in need of substantial technical improvements to match the cleaning efficacy of dental floss
D. dental floss was ineffective for plaque removal in the interdental spaces.

17. Select the CORRECT statement. In the Reis et al systematic review,

A. the pooled meta-analysis showed a significant difference between smokers and non-smokers for the risk of peri-implantitis at the implant level and patient level
B. the pooled meta-analysis showed a significant difference between smokers and non-smokers for the risk of peri-implantitis at the implant level only
C. the pooled meta-analysis showed a significant difference between smokers and non-smokers for the risk of peri-implantitis at the patient level only
D. the pooled meta-analysis showed a no difference between smokers and non-smokers for the risk of peri-implantitis at the implant level and patient level

Radiology Corner

18. Select the CORRECT answer. Which two diseases can result in serious cardiovascular effects if found in conjunction with Mönckeberg arteriosclerosis?

A. Type I diabetes and chronic kidney disease
B. Type II diabetes and chronic kidney disease
C. Acute kidney injury and type II diabetes
D. Coronary heart disease and type II diabetes

19. Choose the CORRECT option. Which other calcifications appear within the same region as Mönckeberg arteriosclerosis on panoramic radiography?

A. Carotid artery calcifications and phleboliths
B. Carotid artery calcifications and lymph node calcifications
C. Tonsilloliths and phleboliths
D. Tonsilloliths and lymph node calcifications

20. Choose the CORRECT answer. What appearance would be used to describe Mönckeberg arteriosclerosis on a radiograph?

A. Cotton wool appearance
B. Ground-glass appearance
C. Railroad track appearance
D. Sunray appearance

Ethics – Compromised treatment

21. Select the CORRECT statement. In the context of the National Patient's Rights Charter, what does "informed consent" refer to?

A. The patient's right to refuse medical treatment
B. The patient's right to request a second opinion
C. The patient's right to receive complete and accurate information about their diagnosis
D. The patient's right to request a specific healthcare provider
E. The patient's right to be treated immediately to save them time and costs

22. Which of the following answers is CORRECT. What is the principle of "appropriatech" as defined by Owen?

A. Using the most expensive materials and methods for treatment
B. Using technology that is trendy and popular in the dental field
C. Using technology that is cost-effective without sacrificing biological and prosthodontic principles
D. Using the latest advancements in technology for all treatments
E. Using the cheapest materials and methods to allow more patients to be treated

23. Choose the CORRECT statement. Paternalism relates to:

A. The clinician acting in the patient's best interest
B. The clinician making every attempt to remove harm
C. The clinician ensuring the patient understand the proposed treatment
D. The clinician ensuring the patient voluntarily agrees to the treatment
E. The clinician making decisions for the patient based on their opinion

24. Select the CORRECT answer. Prior to giving informed consent, in terms of costs, a patient needs to know:

A. How much the initial and long term treatment will cost in terms of money
B. How long it will take to carry out the treatment, and maintenance requirements
C. How much the treatment will cost in terms of biological damage
D. All of the above are correct
E. Only a) and b) are correct

25. Which of the following statements is CORRECT

A. Compromised treatment may be carried out in certain specific situations
B. If compromised treatment fails the dentist should be responsible for subsequent costs
C. Survival and success are synonymous when considering treatment outcomes
D. Dentists should only carry out reversible treatment
E. Compromised treatment does not need to be evidence-based

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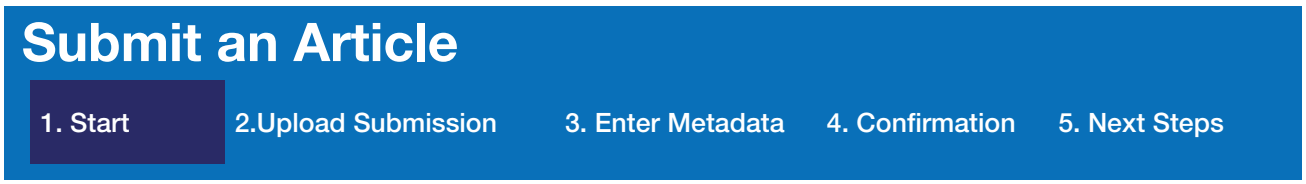

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