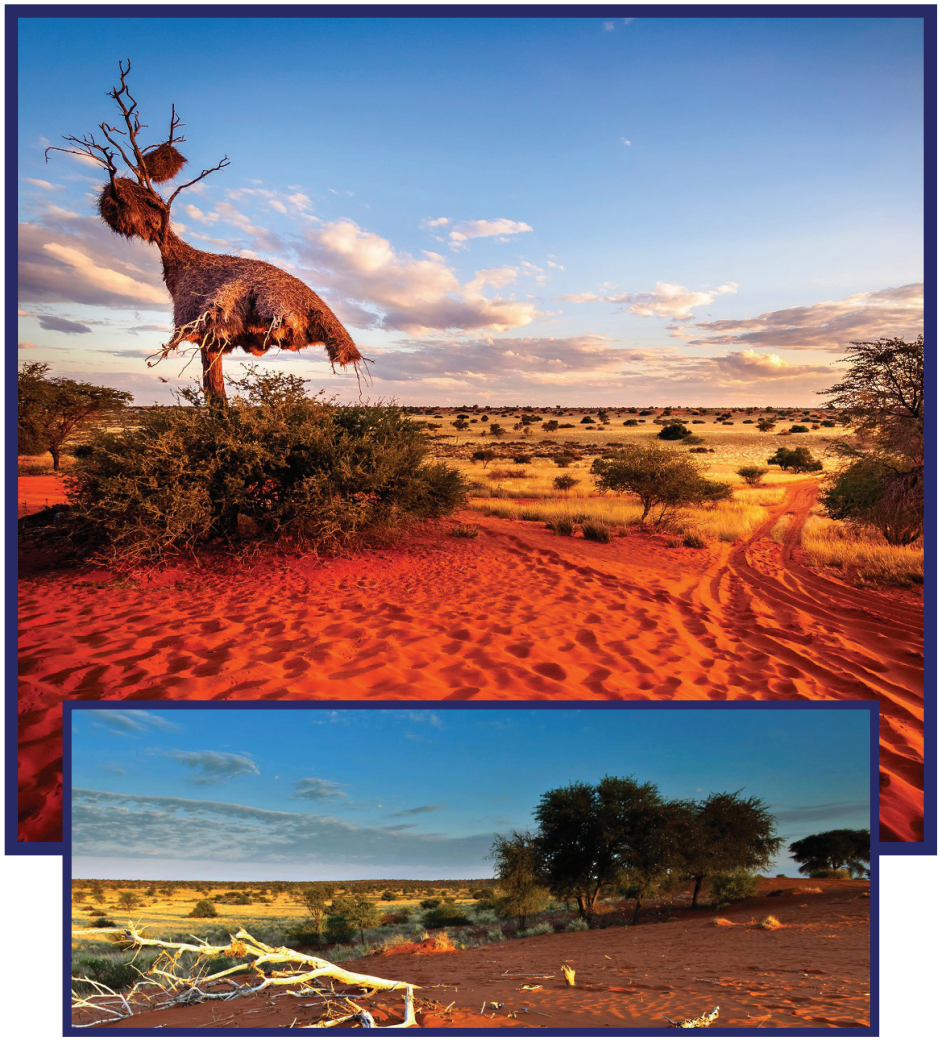
THE SOUTH AFRICAN DENTAL JOURNAL

SADJ

OCTOBER 2023
Volume 78 Number 9

ISSN No. 2519-0105 – Online Edition
ISSN No. 1029-4864 – Print Edition



Kgalagadi Transfrontier Park

Reaching out into both South Africa and neighboring Botswana, the Kgalagadi Transfrontier Park (meaning 'Great Thirst') is a desert wilderness with terrain that's totally unique. Amidst the salt pans, bushveld, and rust-red dunes of the Kalahari are hordes of plains game, such as wildebeest, springbok (South Africa's national animal), and gemsbok (its original namesake) that are hunted in turn by predators like lions, cheetah, and leopards. Surrounded by nothing but barren wilderness, the game viewing here is simply astounding.

SADA
THE SOUTH AFRICAN
DENTAL ASSOCIATION

Transform how you treat with the **Align™ Digital Platform.**

Treat your patients with a seamless end-to-end digital workflow.

Move all aspects of treatment and the patient experience forward with interconnected, interdisciplinary workflows and treatment solutions made possible by the Align Digital Platform.

Connect
Drive consumer demand & connect it to your practice

Scan & Diagnose
Capture patient data, enable doctor diagnosis & drive patient conversion

Plan
Digitally visualize & plan your ortho & restorative treatments

Treat
Delivery of customized, digitally designed aligners

Monitor
Virtual treatment tracking between visits & ongoing patient care

Retain
Maintain beautiful teeth for life

Sign up as an Invisalign Provider

align™ digital platform

invisalign® | iTero™ | exocad™

THE SOUTH AFRICAN DENTAL JOURNAL

SADJ

Published by:
CREATIVE SPACE MEDIA

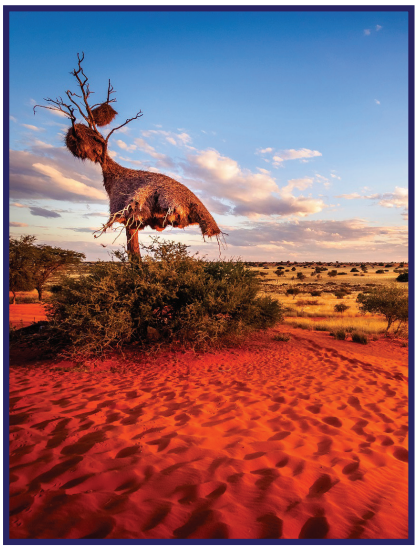
On behalf of:
SADA
THE SOUTH AFRICAN DENTAL ASSOCIATION

CONTENTS

Our Front Cover for this Issue...

Kgalagadi Transfrontier Park

Reaching out into both South Africa and neighboring Botswana, the Kgalagadi Transfrontier Park (meaning 'Great Thirst') is a desert wilderness with terrain that's totally unique. Amidst the salt pans, bushveld, and rust-red dunes of the Kalahari are hordes of plains game, such as wildebeest, springbok (South Africa's national animal), and gemsbok (its original namesake) that are hunted in turn by predators like lions, cheetah, and leopards. Surrounded by nothing but barren wilderness, the game viewing here is simply astounding.



THE SOUTH AFRICAN DENTAL JOURNAL
SADJ

PRODUCTION OFFICE
Creative Space Media
Tel: +27 (11) 467 3341
Website: www.creativespacemedia.co.za

Publisher and Project manager
Yolandi Badenhorst – yolandi@creativespacemedia.co.za
Leani Thomson – leani@creativespacemedia.co.za

GENERAL AND ADVERTISING ENQUIRIES
James Chademana
Email: james@creativespacemedia.co.za
Tel: +27 (11) 467 3341

Design and Layout
Leani Thomson
Email: leani@creativespacemedia.co.za

Website smalls advertising / CPD Enquiries and Member contact detail update
South African Dental Association
Tel: +27 (0)11 484 5288
Email: marketing@sada.co.za

Published by: CREATIVE SPACE MEDIA

On behalf of: SADA THE SOUTH AFRICAN DENTAL ASSOCIATION

CONTENTS

Accredited by the Department of Education SADJ is published 10 times a year by E-Doc, a Division of Pharmcom CC, on behalf of The South African Dental Association.

The ethical imperative: continuing professional development in dentistry

SADJ October 2023, Vol. 78 No.9 p429

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

Dentistry is not a static art; it's a dynamic science. The landscape of dental care, with its technological advancements, evolving treatment modalities and shifting patient expectations, is in perpetual flux. To maintain the relevance and efficacy of our practice, we must acknowledge this inherent dynamism. The ethical framework of our profession compels us to adapt to change and growth, both for our patients' benefit and our professional responsibility. In our noble profession, where the pursuit of knowledge is as vital as the precision of our tools, we are often faced with the question of whether we fully embrace the journey of continuing professional development (CPD). It's a question that reaches the heart of our ethical commitment to the wellbeing of our patients, the integrity of our practice and the vitality of our profession itself.

Consider the ethical ramifications of stagnant knowledge and clinical practice. When we cease our pursuit of knowledge, we risk providing our patients with suboptimal care. Ethical practice requires us to provide the best available treatments. To do otherwise, to adhere to outdated methodologies, is to renege on our professional obligations. At the very core of our ethical responsibilities lies the principle of beneficence, a commitment to promoting the wellbeing of our patients. We have pledged to alleviate suffering and enhance oral health, and we are ethically bound to employ every means at our disposal to achieve this noble goal. This makes CPD a means by which we actualise our ethical commitments to patients, and not just an arbitrary grudge pursuit.

Could we assume that dental professionals who engage in CPD provide more accurate diagnoses and exhibit greater proficiency in advanced treatment techniques? We must attempt to answer this within ourselves, perhaps by considering a scenario where a dentist who regularly participates in CPD is better equipped to diagnose and address oral health issues, thereby preventing complications that could have arisen from delayed or inaccurate treatment.

The ethical duty to prevent harm also underscores the importance of CPD. Every month we see some component of non-maleficence, the principle of "do no harm", in our Ethics contributions. This carries an implicit obligation to safeguard our patients from outdated, ineffective or harmful treatments. CPD equips us with knowledge and skills to recognise and avoid such pitfalls, and to be able to source current and valid techniques and technologies, thus ensuring that our actions are always in our patients' best interests.

In light of the scarcity of studies investigating the impact of CPD interventions in dentistry, it is reasonable to theorise that patients who received dental care from practitioners engaged in regular CPD could have a lower incidence of complications and better overall oral health outcomes than patients who do not. It is therefore probable that a patient who receives timely and well-informed dental care from a dentist committed to ongoing professional development is less likely to experience complications, highlighting the tangible benefits of CPD. However, I would imagine this could only be true for those practitioners engaging in CPD activities with the intent to learn, integrate and improve their clinical competency and skills.

Dentists have a plethora of CPD options at their disposal to enhance their knowledge and skills, ensuring they remain at the forefront of dental practice. These activities are not only credible but also highly beneficial. These CPD interventions and activities for dentists encompass academic courses, research engagement and practical training sessions. These approaches to continuous learning empower dentists to provide advanced and evidence-based care, enhancing their clinical proficiency and patient outcomes.

Academic courses and postgraduate studies represent a stalwart component of credible CPD. Dentists can pursue master's programmes, diploma courses or other formal qualifications in various dental specialties. These structured programmes provide in-depth knowledge and clinical training, equipping dentists with additional skills and expertise. Another avenue includes peer-reviewed dental journals and research involvement that offer dentists opportunities for continuous learning. Dentists can engage in critical appraisal of research articles, stay abreast of the latest evidence-based practices and even contribute to the dental literature through research projects. This form of CPD not only enhances clinical knowledge but also encourages dentists to question and refine their practice. A dentist is more likely to adopt and successfully implement the latest evidence-based preventive measures if convinced by the evidence presented to them.

Hands-on workshops and practical training sessions form an integral part of CPD for many dentists seeking to increase their skill set. These sessions cover a wide range of topics, from advanced restorative techniques, dental implantology and orthodontics to the latest advancements in dental technology. Participating in these workshops allows dentists to hone their clinical skills, adopting new and improved methodologies in their practices. The intention is to achieve higher clinical efficiency and to be better equipped to manage complex cases.

The path of CPD is not merely a professional obligation; it is seen as an ethical imperative and a philosophical commitment. It aligns with the core principles of our profession, underscores our commitment to excellence and upholds the trust patients place in us. As ethical practitioners of dentistry, let us not only embrace CPD but celebrate it to fulfil our moral and philosophical duty to ourselves, our patients and our noble profession. As we engage in the unceasing quest for knowledge and the relentless pursuit of clinical mastery, we honour the ethical foundation upon which our profession stands and, in doing so, we renew our oath to the service of humanity through the art and science of dentistry.

FURTHER READING

1. Firmstone VR, Elley KM, Skrybant MT, Fry-Smith A, Bayliss S, Torgerson CJ. Systematic review of the effectiveness of continuing dental professional development on learning, behavior, or patient outcomes. J Dent Ed 2013; 77(3):300-315
2. Suliman Z, Kruger W, Pienaar JA. Continuing professional development (CPD): a necessary component in the workplace or not? J Med Lab Sci and Tech S Afr. 2020; 2(1):41-5

www.sada.co.za / SADJ Vol. 78 No.9

The Dental Professionals' hearing loss and its silent role in affecting our careers and systemic health

SADJ October 2023, Vol. 78 No.9 p430

Mr KC Makhubele – CEO, South African Dental Association

Introduction

In the bustling world of healthcare, dentistry often takes a backseat when it comes to discussions about occupational hazards. While the risks of musculoskeletal problems, exposure to infectious diseases, and stress are frequently acknowledged, there is a silent threat that looms over dental professionals - noise-induced hearing loss (NIHL). This article aims to shed light on the often-overlooked issue of hearing loss in the dental profession, emphasizing its profound impact on both careers and systemic health. Additionally, we will explore preventative measures to mitigate this burgeoning concern.

The Decibel Dilemma

Dental practitioners are exposed to a relentless barrage of noises that are integral to their daily routines. High-speed drills, ultrasonic scalers, suction devices, and even conversations with patients can generate noise levels exceeding 85 decibels, well above the recommended safe limit of 70 decibels set by the World Health Organization (WHO). Over time, this prolonged exposure takes a toll on the delicate structures of the inner ear.

The Consequences

The consequences of NIHL extend far beyond impaired hearing. Hearing loss among dental professionals can lead to communication breakdowns with patients, negatively affecting patient care and satisfaction. Furthermore, impaired hearing can hinder effective communication among the dental team, risking the safety and quality of procedures. The personal toll is also significant, as hearing loss can lead to social isolation, depression, and reduced quality of life.

Silent Systemic Health Implications

Beyond the immediate impact on hearing, NIHL has been linked to systemic health issues. Studies have shown that chronic exposure to high noise levels can trigger stress responses, leading to increased blood pressure and an elevated risk of cardiovascular diseases. Moreover, the constant strain on the auditory system can result in fatigue and cognitive impairment, affecting the overall well-being and performance of dental professionals.

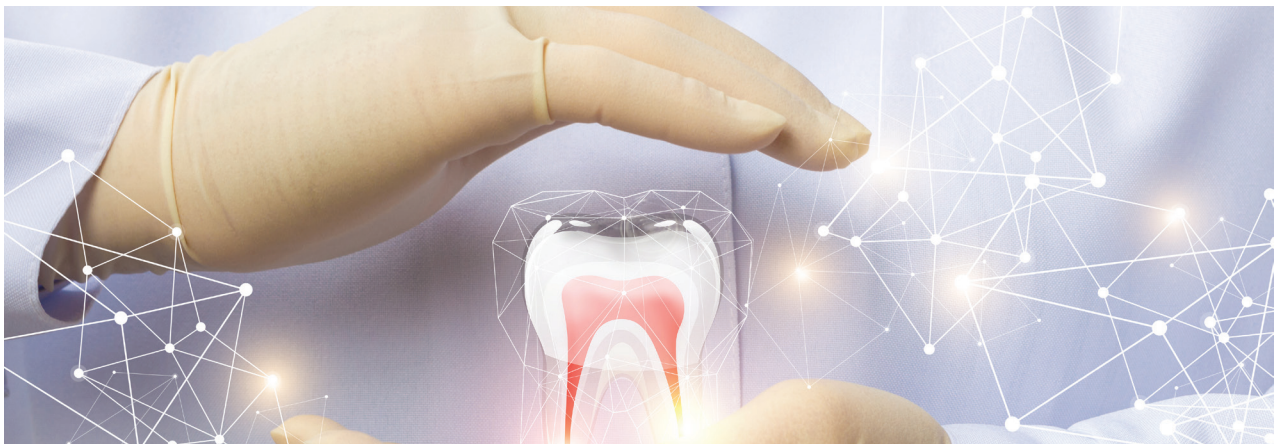
Preventive Measures

Awareness is the first step towards mitigating the risks of NIHL in the dental profession. Dental schools and institutions should incorporate noise exposure education into their curricula, emphasizing the importance of protective measures such as earmuffs and earplugs. Dental practices must also invest in quieter equipment and create noise-controlled environments.

Regular hearing screenings should become a routine part of dental professionals' healthcare, enabling early detection and intervention. Additionally, frequent breaks during the workday and the implementation of quieter dental instruments can significantly reduce noise exposure.

Conclusion

The true dental pandemic is the silent epidemic of hearing loss, affecting the careers and systemic health of dental professionals. It is high time that we recognize the risks and take proactive steps to address this issue. Through education, awareness, and preventive measures, we can ensure that the dental community thrives without sacrificing their auditory health. As guardians of oral health, let us not forget the importance of preserving our own ability to hear, communicate, and lead fulfilling lives while delivering exceptional care to our patients.



Dear Editor

SADJ October 2023, Vol. 78 No.9 p431

S Ahmed[1], RZ Adam[2], R Coetzee[3]

I refer to your editorial in the SADJ April 2022 77(3), and wish to highlight the need of the dental profession to take heed of rising antimicrobial resistance rates, and to focus on modifying their prescribing practices in an effort to mitigate this global crisis.

To understand and contribute to antibiotic stewardship, it is important that dental practitioners, including dental students, have the necessary knowledge of correct antibiotic prescribing guidelines and antimicrobial resistance. The overuse and misuse of antibiotics have contributed to the rise of antimicrobial resistance worldwide, with dentistry playing a part in the rise of antimicrobial resistance globally.

As a result of incorrect and overuse of antibiotics, many of these antimicrobial agents have become ineffective against simple infections.[1] When managing pain and swelling in dentistry, the correct diagnosis and eradication of oral infection forms an essential part of the dental treatment plan and the use of antibiotics should be limited as most dental infections respond well to clinical operative intervention.[2,3]

Dental outpatient antibiotic prescriptions and hospital inpatient prescriptions account for the most commonly prescribed medications, with dentists accountable for about 10% of all antibiotics prescribed globally.[4] Prescription of antibiotics in a dental setting for therapeutic and prophylactic measures is determined by specific clinical criteria. The guidelines and criteria for antibiotic prescribing in dentistry is explicitly stated in various guidelines published globally.[5,6]

Recent studies have assessed students' knowledge, attitudes and compliance to antibiotic prescribing guidelines and habits. Many of these studies have highlighted that although a large portion of students correctly prescribed according to antibiotic guidelines followed at their dental school, there was also a significant portion of dental students' knowledge that was inadequate. This highlighted the need of curriculum redesign.[7,8,9]

In South Africa, there is very little evidence about how the dental curricula fulfil antibiotic prescribing and antibiotic stewardship. The reality is that a dental student may never receive additional training on antibiotic stewardship following graduation, so it is imperative that appropriate undergraduate training be conducted.

The dental profession has a responsibility to contemplate the consequences of their antibiotic prescribing choices, as the effect on both the patient and community carries a risk. The dental profession (including dental students) in South Africa can play a valuable role in antibiotic stewardship by prescribing antibiotics judiciously and appropriately and ultimately contribute to decreasing antimicrobial resistance rates and preserving the effectiveness of antibiotics for future generations.

Could it be time to evaluate the undergraduate curriculum to ensure competency amongst dental practitioners when it comes to antibiotic prescribing guidelines?

Authors' information

1. Dr Suwayda Ahmed, *BChD, PDD, MSc,* Senior Lecturer, Department of Prosthodontics, Faculty of Dentistry, University of the Western Cape, South Africa. ORCID: 0000-0001-8174-6928
2. Prof RZ Adam, *BChD, MSc, PhD*, Associate Professor, Deputy Dean: Research, Faculty of Dentistry, University of the Western Cape, South Africa. ORCID: 0000-0002-2645-9878
3. Prof R Coetzee, Pharm.D, Associate Professor, School of Public Health, University of the Western Cape, South Africa ORCID: 0000-0002-8779-3458

Corresponding author

Name: Dr S Ahmed
Email: suahmed@uwc.ac.za
Tel: (021) 937 3091 / 082 537 5827

REFERENCES

1. Sukumar S, Martin FE, Hughes TE, Adler CJ, 2020. Think before you prescribe: how dentistry contributes to antibiotic resistance. Australian Dental Journal, 65(1), pp.21-29
2. Yu J, Nie EM, Jiang R, Zhang CY, Li X, 2020. Analgesic and antibiotic prescription pattern among dentists in Guangzhou: a cross-sectional study. Pain Research and Management, 2020, pp.1-6
3. Walsh LJ, Ford PJ, McGuire T, van Driel M, Hollingworth SA, 2021. Trends in Australian dental prescribing of antibiotics: 2005-2016. Australian dental journal, 66, pp.S37-S41
4. Thompson W, Teoh L, Hubbard CC, Marra F, Patrick DM, Mamun A, Campbell A, Suda KJ, 2022. Patterns of dental antibiotic prescribing in 2017: Australia, England, United States, and British Columbia (Canada). Infection Control & Hospital Epidemiology, 43(2), pp.191-198
5. Teoh L, Thompson W, Suda K, 2020. Antimicrobial stewardship in dental practice. The Journal of the American Dental Association, 151(8), pp.589-595
6. Goff DA, Mangino JE, Glassman AH, Goff D, Larsen P, Scheetz R, 2020. Review of guidelines for dental antibiotic prophylaxis for prevention of endocarditis and prosthetic joint infections and need for dental stewardship. Clinical Infectious Diseases, 71(2), pp.455-462
7. Thanissorn C, Park JS, Wang KN, Tennant M, Page AT, Kruger E. Australian dental students' knowledge on antibiotics prophylaxis for dental procedures. BMC Oral Health. 2022 Dec 23;22(1):633
8. AboAlSamh A, Alhussain A, Alanazi N, Alahmari R, Shaheen N, Adlan A. Dental students' knowledge and attitudes towards antibiotic prescribing guidelines in Riyadh, Saudi Arabia. Pharmacy. 2018 May 7;6(2):42
9. Struzycka I, Mazinska B, Bachanek T, Boltacz-Rzepkowska E, Drozdzik A, Kaczmarek U, Kochanska B, Mielczarek A, Pytko-Polonczyk J, Surdacka A, Tanasiewicz M. Knowledge of antibiotics and antimicrobial resistance amongst final year dental students of Polish medical schools – A cross-sectional study. European Journal of Dental Education. 2019 Aug;23(3):295-303

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16600

Knowledge and perception of oral health professionals regarding the National Health Insurance

SADJ October 2023, Vol. 78 No.9 p432-436

T Muofhe[1], N Makwakwa[2], D Pagollang Motloba[3]

ABSTRACT

Background

Oral health professionals (OHPs) are key stakeholders in the implementation of the National Health Insurance (NHI) in South Africa. Therefore, the views of this cohort on the NHI are invaluable to the successful implementation of the programme.

Aim

The aim of the study was to explore the perception of OHPs regarding the NHI.

Setting

This national study was conducted with eligible OHPs in South Africa.

Methods

A descriptive cross-sectional survey was conducted with 377 OHPs. Data was collected using an electronic semi-structured questionnaire. Statistical Package for Social Sciences version 28 was used to analyse data.

Results

Of the 377 respondents, the majority were female (58.9%), dentists or specialists (52.0%), public sector employees (53.6%), had a postgraduate qualification (58.4%) and had a maximum 10 years' working experience (67.6%). Overall, most participants (231 = 61.3%) were knowledgeable and had positive expectations about the NHI. Yet, 180 (47.7%) perceived the NHI would have a deleterious impact on the private sector and oral health in general 203 (53.8%). A total of 165 (43.8%) OHPs believed the NHI would fail, while 287 (76.1%) thought the NHI should be amended or combined (210 = 55.7%) with existing medical schemes.

Conclusion

OHPs were knowledgeable and positive about the NHI. However, serious concerns prevail in this cohort regarding implementation and impact of the NHI, especially in the private sector.

Keywords

Knowledge, perceptions, National Health Insurance.

Authors' information

1. Ms Takalani Muofhe, Oral Hygienist, Department of Community Dentistry, School of Oral Health Care Sciences, Sefako Makgatho Health Sciences University, Pretoria, South Africa. ORCID: 0009-0000-1127-411X
2. Dr Nokukhanya Makwakwa, Community Dentistry Specialist, Department of Community Dentistry, School of Oral Health Care Sciences, Sefako Makgatho Health Sciences University, Pretoria, South Africa. ORCID: 0000-0001-5669-795X
3. Prof D Pagollang Motloba, Community Dentistry Specialist, Department of Community Dentistry, School of Oral Health Care Sciences, Sefako Makgatho Health Sciences University. ORCID: 0000-0003-1379-7576

Corresponding author

Name: Prof D Pagollang Motloba
Email: Pagollang.Motloba@smu.ac.za

INTRODUCTION

Many countries in the world have considered universal health coverage (UHC) to create a more accessible and equitable health system. Various permutations of the UHC are operational in the United Kingdom (UK), United States (US), Canada, South Korea, Sri Lanka Brazil, Ghana and Nigeria.[1, 2,3,4] The UHC has achieved variable successes and failures in many jurisdictions. Fiscal challenges and the inability of governments to raise critical revenues has contributed to the demise of the UHC in most developing countries.[5] Other economic factors that threaten the success of UHC include a high unemployment rate, large informal sector and poor revenue collection mechanisms.

The need for health reform has been part of the South African landscape for time immemorial. The debate about health financing reforms dates back more than 80 years. The Commission on Old Age Pension and National Insurance (1928) and the Committee of Enquiry into National Health Insurance (1935) were the first mechanisms to propose the establishment of a health insurance scheme for low-income employees in urban areas.[6] This idea remained dormant until the 1942, with the establishment of the Gluckman Commission.[4] This commission proposed (i) the establishment of a fully tax funded National Health Service (NHS) and (ii) establishment of a network of primary health care (PHC) centres to increase access to care for all South Africans.[4] These recommendations are key features of the current NHI model.

The 1980s witnessed health financing reforms and the proliferation of private health care services. Unfortunately, the privatisation of health care did not curtail health care costs and expenditures or improve access to care. Instead, the current two-tiered health system in South Africa continues to experience rising costs of care, wastage and inequity.[4,7] The seminal report by Professor Taylor titled the "Committee of Inquiry into a Comprehensive Social Security for South Africa"[7] represents the genesis of the NHI in South Africa. This committee is credited for providing a framework and the roadmap towards the realisation of the NHI. In August 2009, the Ministerial Advisory Committee on National Health Insurance was established which gave effect to the 2007 African National Congress (ANC) National Conference Resolution 53.[7]

https://doi.org/10.17159/sadj.v78i09.16600

Table 1: Descriptive characteristics of study participants (n=377)

Variable	n (%)
Gender	
Female	222 (58.9)
Male	155 (41.1)
Category of Professional	
Oral hygienist	111 (29.4)
Dental therapist	70 (18.6)
Dentist + Specialists	196 (52.0)
Qualification	
Bachelor's degree	182 (48.3)
Postgraduate diploma	99 (26.3)
Master's degree	96 (25.5)
Employment sector	
Public	202 (53.6)
Private	110 (29.2)
Both	65 (17.2)
Work experience (years)	
1-5	144 (38.2)
6–10	111 (29.4)
11-15	53 (14.1)
16+	69 (18.3)

Since the adoption of the NHI by the ruling party, several policy papers have been promulgated for public comment and debate, culminating in the 2017 White Paper on the NHI. Like most UHC schemes, the White Paper on NHI states that:

"National Health Insurance (NHI) is a health financing system that is designed to pool funds to provide access to quality, affordable personal health services for all South Africans based on their health needs, irrespective of their socioeconomic status. NHI is intended to ensure that the use of health services does not result in financial hardships for individuals and their families."

According to the gazette, the South African NHI will be implemented in three phases spanning a 14-year period. To date the NHI is yet to be implemented due to a plethora of challenges, namely financial and operational. Regarding financial challenges, South Africa has one of the highest GINI coefficients of 0.7 well above the Organisation for Economic Co-operation and Development (OECD) average of 0.3 and the BRICS average of 0.5; a small tax base, an underperforming economy and low economic growth.[8] These factors render the NHI costly to finance and too expensive to run. The state will be required to borrow beyond its ability to repay. Recent downgrades by credit rating agencies,[9] the energy crisis[10] and greylisting[11] have worsened the prospects of attracting borrowings for the country.[8]

Operationally, the state lacks the efficiency to effectively manage a large fund under a single-tier medical scheme. The failure of the public health system and GEMS provides uncontestable evidence of the lack of capacity of the state to implement the NHI. For most, the NHI is tantamount to a "health state-owned enterprise" (SOE) and likely to be exposed to corruption and mismanagement. Currently, most public health facilities in South Africa are underfunded, underresourced and in a state of disrepair. Hence the difficulty to attract and retain talent, despite massive shortages.

Global evidence indicates that the availability of human resources is the most critical success factor of any UHC. Confidence, buy-in and the attitude of health professionals towards health systems reforms is necessary for the successful implementation of any UHC scheme. Several studies have correlated physicians' opposition to the UHC to the ultimate failure and collapse of the plan.[12,13] Surveys undertaken among health professionals reveal a positive attitude towards the UHC. The idea of UHC is generally supported by health professionals worldwide.[12,14] However, the observed differences in perceptions about the UHC relate to the proposed structure and implementation of the schemes. There are limited studies in South Africa that canvassed the views and perceptions of health professionals on the NHI. It is still unknown whether doctors are willing to participate in the NHI and whether doctors are confident in the proposed structures for the successful implementation of the NHI. This study, which we believe is the first, seeks to appraise the views of oral health professionals about the NHI. The opinions expressed by this cohort are important in the development of the model for the delivery of oral health services under the NHI.

METHODOLOGY

Study design

This national descriptive cross-sectional survey included all oral health professionals (OHPs) in South Africa.

Study population

The lists of registered and practicing OHPs were obtained from the HPCSA and Dental Associations (SADA, OHASA, DENTASA, DPA). As of April 2020, there were 8056 registered

Table 2: Knowledge and expectations of respondents about the National Health Insurance

	Knowledgeable
The NHI is a financial innovation of the health system	291 (77.2)
The NHI is a morally necessary intervention by the state	265 (70.3)
The NHI will improve access to oral health services	258 (68.3)
The NHI will ensure that the government provides quality healthcare for all	260 (69.0)
Quality of healthcare will improve under the NHI	243 (64.5)
The NHI aims to eliminate high out-of-pocket payment	282 (74.3)
The same standard of care will be expected under the NHI from private and public healthcare providers	296 (78.5)
The NHI will ensure service providers are of the required standard	285 (75.6)
The NHI is a Health SOE (state-owned enterprise)	240 (63.7)
Overall, knowledge and expectations about NHI	**231 (61.3)**

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16600

Table 3: Perceived impact of the National Health Insurance on the oral health sector

	Agree
The funds for oral health under the NHI will be severely reduced	242 (64.2)
The NHI will lower the standards of oral health	159 (42.2)
The provision of oral health under the NHI will be compromised	158 (41.9)
Management of oral health under the NHI will be severely compromised	192 (50.9)
Overall, the NHI will have a negative impact on oral health sector	**203 (53.8)**

OHPs to constitute the sampling frame. Using the Raosoft software, the sample for the study was estimated to be 400 based on the following assumptions: (i) α= 0.05, (ii) precision (95%), (iii) finite population of all HPCSA registered OHPs. This number was further stratified by type of profession to achieve weighted or proportional representation.

Data collection and tool

A self-administered questionnaire was developed based on similar studies and was piloted on 25 OHPs. Necessary changes and corrections were implemented, and the data from the pilot was excluded from the analysis. The questionnaire consisted of five sections, namely: Section A: Demographics characteristics of the participants; Section B: Appraised knowledge about the NHI; Section C: Evaluated perceived impact of NHI on oral health sector; Section D: Assessed the perceived impact of NHI on the private health sector; and Section E: Asked the participants on the fate of NHI. The questions were scored on a 4-point Likert scale (1 to 4 representing strongly agree to strongly disagree). The questionnaire was developed in Microsoft Forms and emailed to eligible participants. Consent was sought prior to taking part in the study. Data was collected over a three-month period to reach the required sample size.

Data analysis

Statistical Package for Social Sciences (SPSS) version 28.0 was used for data analysis. The overall scores were computed by adding the scores of questions in section B, C, D and E. The dichotomous variables were created for the overall scores using the median as a cut-off point. Similarly, a dependent dichotomous variable was created based on two questions from section E (should NHI be aborted? and should NHI be amended?). The predictors of the outcome were entered into a multivariable logistic regression to calculate the adjusted odds ratios (AOR). All the inferential statistical tests were considered significant at α = 0.05 or 5%.

Ethical consideration

Ethical approval for this study was granted by one of the health science universities in South Africa. (SMUREC/D/119/2021: PG) Participants gave informed consent before commencing with the study. All the data was aggregated and anonymised and cannot be linked to any individual.

RESULTS

Demographic characteristics of practitioners

A total of 377 oral health professionals participated in the study, giving a response rate of 94.25% which was adequate for the study. Most of the participants were female (58.9%), dentists or specialists (52.0%), public sector employees (53.6%), had a postgraduate qualification (58.4%) and had a maximum 10 years' working experience (67.6%).

Knowledge of NHI by practitioners

Overall, most participants (231 = 61.3%) were knowledgeable and had positive expectations about the NHI. According to Table 2, most oral health practitioners understood the NHI to be a financial innovation (77.2%) with a strong moral basis (70.3%). Upon implementation of the NHI, 74.8% of the practitioners expected that out-of-pocket fees would be eliminated. As many as 75.6% OHPs believed that NHI would improve quality of care, making the standard of public and private care the same (78.5%). However, a significant number (63.7%) of the professionals believed the NHI was another state-owned enterprise targeting health care (Table 2).

Perceived impact of the NHI on the oral health sector

A total of 203 (53.8%) respondents believed the NHI would have deleterious impact on oral health. Most OHPs (64.4%) indicated that funding for oral health will be severely reduced under the scheme. Yet, there was overall positivity about the expected standards and provision and management of oral health under the NHI (Table 3).

Perceived impact of the NHI on the private sector

Some 180 (47.7%) respondents believed the NHI would have a negative impact on private practice and practitioners

Table 4: Perceived impact of the National Health Insurance on private sector

	Agree
Under the NHI, practitioners will find it easier to enter private practice	186 (49.3)
The NHI will increase the number of patients in private practice	218 (57.8)
The NHI will lead to reduced funding for private patients	235 (62.3)
Fees for service will reduce drastically under the NHI	229 (60.7)
The NHI will bankrupt the practitioners	171 (45.4)
The NHI will lead to closure of private practice	173 (45.9)
The NHI will bankrupt medical schemes	181 (48.0)
The NHI will wipe out existing medical schemes	163 (43.2)
Overall, the NHI will lead to deleterious impact on private sector	**180 (47.7)**

https://doi.org/10.17159/sadj.v78i09.16600

in the sector. As many as 43.2% of practitioners strongly agreed the NHI would wipe out medical schemes funds, bankrupt schemes (48.0%) and result in closure of practices (45.9%). While the NHI could result in an increase in number of patients (57.8%), the funding for oral health will reduce drastically under the NHI (62.3%). These features of the NHI will make entering private practice difficult for most practitioners (50.7%) (Table 4).

Views of the practitioners regarding the fate of the NHI

Few respondents indicated the NHI programme was likely to fail (165 = 43.8%) and therefore should be aborted (117 = 31.0%). This is contrary to a significant majority advocating for the NHI to be amended (76.1%) or combined with existing medical schemes (55.7%) (Table 5).

Multivariable logistic regression analysis was undertaken to model the relationship between outcome (abort or amend the NHI) and independent variables. The following predictors were included in the models, (i) knowledge of the NHI; (ii) impact of NHI on oral health; (iii) impact on NHI on private sector; and demographic variables. The logistic regression analysis revealed that the independent predictors of the need to abort the NHI are the perceived negative impact on oral health in general (OR = 3.42) and impact on private practice (OR = 2.21). Practitioners with adequate knowledge of the NHI did not favour abortion of the programme, but that it be amended instead (OR = 0.160) (Table 5).

DISCUSSION

This study investigated the knowledge and perceptions of oral health professionals regarding the proposed NHI. The results indicate that OHPs were more knowledgeable and informed about the proposed scheme (231 = 61.3%), which is consistent with observations by Adeniyi and Onajole. The increased levels of awareness and knowledge about the NHI among the OHPs can be attributed to their proximity and investedness in the policy, financing and health reforms. Naturally, OHPs will be inclined to participate, advocate and influence the conceptualisation and implementation of any health programme, including the NHI. There is consensus among the participants about the need for the NHI (265 = 70.3%) and the positive impact it might have on the health system (243 = 64.5%). Several South African studies indicate that the NHI is broadly accepted and preferred to the current two-tiered system.[15,16, 19] This sentiment is shared globally regarding any form of universal coverage and related health reforms.[16] The guiding principles of UHC are widely uncontested as a mechanism for the realisation of accessible health care for all without any financial hardship.[17]

The OHPs and other health professionals agree that, under the NHI, out-of-pocket payments will be eliminated, disparity between public and private health care minimised and the quality of care will be improved.[15] These findings provide evidence about the positive contribution of the NHI in ensuring equitable access to quality care for all.

However, serious concerns persist about the successful mplementation of the NHI and the impact its failure could have on the healthcare system in general. A total of 240 (63.7%) OHPs indicated that NHI was another state-owned enterprise (SOE) fraught with corruption and misappropriation of funds. Similar concerns of fraud and corruption constitute a major bane for the NHI.[15] SOEs play an important role in fostering economic growth through the provision of services that enable economic activity and development. The successful implementation of the HNI is dependent on the (i) ability of the scheme to secure critical and adequate funds (ii) strong governance and impeccable administration; and (iii) adequate resources such as infrastructure and personnel. With the current economic state, the country is unable to raise the estimated R256bn per year to fund the NHI.[18] South Africa is still flirting with the edge of its fiscal cliff, caused by poor service delivery, the energy crisis, deplorable financial management and corruption. Consequently, the state is thus unable to stimulate the economy, attract critical investments, create jobs and ultimately collect the tax to fund public projects such as the NHI.

Additionally, the NHI Bill poses serious governance and oversight challenges. The bill does not promote independence of the NHI board. Chapter 4 (12) of the bill states that "A Board that is accountable to the Minister is hereby established to govern the Fund in accordance with the provisions of the Public Finance Management Act". The minister is thereby empowered to appoint the board of the largest SOE in the country. The present bill does not provide safeguards and guarantees for an independent board; neither does the bill prescribe a mechanism to regulate and ensure that the minister is not corrupted. Instead, the bill has centralised the decision-making power in the minister, which presents a potential conflict of interest. Commentators suggest that the fund would be better served if it was accountable to parliament thereby limiting the vulnerability of the minister to potential external influences.

South Africa's public health system is not endowed with adequate and functional infrastructure. It is on record that the public health service has deteriorated to the brink of collapse or state of disrepair. These institutions are underresourced to be able to always provide basic services to all. Another challenge facing the public health service is the ability to recruit and retain talent. Human resources and infrastructure are critical for any health system reform to succeed.[8] Corruption, nepotism and mismanagement are blamed for the current status quo, further validating the assertions that unless the NHI Bill changes with respect to the governance and role of the minister, the NHI will not succeed.

Despite these fiscal and governance challenges faced by the health sector, only 180 (47.7%) of OHPs are of the opinion the NHI will have a deleterious impact on the private sector. Similar findings were reported by Bezuidenhout, in

Table 5: Fate of the National Health Insurance

	Yes
The NHI is likely to fail	165 (43.8)
The NHI should be aborted	117 (31.0)
The NHI should be amended	287 (76.1)
The NHI should be combined with existing medical schemes	210 (55.7)

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16600

Multivariable logistic regression of independent predictors of outcome (NHI should be aborted)

		β	p-value	OR (95% CI)
Gender	Female	-		1
	Male	.013	0.96	1.01 (0.57: 1.81)
Cadre	Oral Hygienist	-		1
	Dental Therapist	-0.63	0.17	0.54 (0.23: 1.22)
	Dentist and Specialist	-0.42	0.29	0.67 (0.33: 1.30)
Sector	Public	-	.	1
	Private	-0.19	0.56	0.83 (0.44: 1.57)
	Both	-0.74	0.08	0.48 (0.21: 1.08)
Qualification	Bachelor's degree	-		1
	Postgraduate diploma	0.44	0.23	1.55 (0.78: 3.17)
	Master's degree	0.80	0.03	2.22 (1.07: 4.60)
Experience (years)	0-5	-		1
	6-10	-0.27	0.44	0.76 (0.37: 1.53)
	11-15	0.31	0.48	1.34 (0.57: 3.23)
	16+	0.001	0.99	1.00 (0.49: 2.24)
Knowledge of NHI	Inadequate	-		1
	Adequate	-1.85	< 0.001	0.16 (0.09: 0.29)
Impact on Oral Health	Not negative	-		1
	Negative	1.23	< 0.001	3.42 (1.78: 6.56)
Impact on private practice	Not negative	-		1
	Negative	0.79	0.008	2.21 (1.23: 3.96)
Constant		-0.35	0.54	
Model Chi-square 167.1; p<0.001				
Percentage correctly predicted 80.9%				

which 5.49% of the respondents thought the NHI would destroy the private sector. We speculate that unsatisfactory consultation processes might contribute to diminishing trust in the NHI. Several groups in the health workforce have lamented the way consultations were undertaken, and their views canvassed.[19]

Overall, only 165 (43.8%) of OHPs believe the NHI will fail and must therefore be aborted (117 = 31.0%). On the contrary, 287 (76.1%) of OHPs indicated the NHI required amendments, including combining it with existing medical aid schemes (210 = 55.7%). Oral health practitioners understand the moral and ethical imperative of the NHI and the positive transformative impact it could have on the health system in general. However, concerns remain about the implementation of the NHI, hence calls to incorporate the NHI into the existing and predictable medical schemes.

CONCLUSIONS

This study found that oral health professionals had adequate knowledge about the NHI, its moral and social underpinnings and benefits. Although OHPs supported the implementation of NHI, concerns were raised regarding governance, corruption and mismanagement. The majority of practitioners indicated the NHI needed reform, including incorporation into existing schemes.

REFERENCES

1. Béland D, Rocco P, Waddan A. Obamacare and the politics of universal health insurance coverage in the United States. Social Policy & Administration 2016;50(4):428-51. https://doi.org/10.1111/spol.12237
2. Kwon S. Thirty years of national health insurance in South Korea: lessons for achieving universal health care coverage. Health policy and planning 2009;24(1):63-71. https://doi.org/10.1093/heapol/czn037
3. Gobah FF, Liang Z. The National Health Insurance Scheme in Ghana: prospects and challenges: a cross-sectional evidence. Global Journal of Health Science 2011;3(2):90. https://doi:10.5539/gjhs.v3n2p90
4. Adebisi SA, Odiachi JM, Chikere NA. The National Health Insurance Scheme (NHIS) in Nigeria: Has the policy achieved its intended objectives. AJES 2019;5(3):97-104
5. Jowett M, Kutzin J, Organization WH. Raising revenues for health in support of UHC: strategic issues for policy makers: World Health Organization; 2015
6. National Department of Health. National health insurance for South Africa: towards universal health coverage. Government Gazette 2015;1230:1-97. http://www.gov.za/sites/www.gov.za/files/National_Health_Insurance_White_Paper_10Dec2015.pdf (accessed 10 January 2016)
7. Freund B. The South African developmental state and the first attempt to create a national health system: Another look at the Gluckman Commission of 1942-1944. South African Historical Journal 2012;64(2):170-86. https://doi.org/10.1080/02582473.2011.640708
8. Pauw TL. Catching up with the constitution: An analysis of National Health Insurance in South Africa post-apartheid. Development Southern Africa 2022;39(6):921-34. https://doi.org/10.1080/0376835X.2021.1945911
9. Amollo R. In pursuit of health equity in South Africa A critique of the proposed national health insurance: legislation & policy review. ESR Review: Economic and Social Rights in South Africa 2009;10(3):14-17
10. Shisana O. A national health system: opportunities and challenges for South Africa: opening address. 2008.
11. Seekings J. The broader importance of welfare reform in South Africa. Social Dynamics 2002;28(2):1-38. https://doi.org/10.1080/02533950208458731
12. Blecher M, Jacobs T, McIntyre D. General practitioners and national health insurance results of a national survey. South African Medical Journal 1999;89(5)
13. Adeniyi AA, Sofola OO, Kalliecharan RV. An appraisal of the oral health care system in Nigeria. International dental journal 2012;62(6):292-300. https://doi.org/10.1111/j.1875-595X.2012.00122.x
14. du Venage G. South Africa comes to standstill with Eskom's load shedding. Engineering and Mining Journal 2020;221(1):18-18
15. Bezuidenhout S, Matlala M. Assessment of the knowledge of healthcare workers at Dr George Mukhari Academic Hospital, Ga-Rankuwa, South Africa regarding the South African National Health Insurance Scheme: understanding the National Health Insurance Scheme. African Journal for Physical Health Education, Recreation and Dance 2014;20(sup-1):234-43
16. Setswe G, Muyanga S, Witthuhn J, Nyasulu P. Public awareness and knowledge of the National Health Insurance in South Africa. Pan African Medical Journal 2015;22(1). https://doi.org/10.11604/pamj.2015.22.19.6131
17. Knaul FM, González-Pier E, Gómez-Dantés O, et al. The quest for universal health coverage: achieving social protection for all in Mexico. The Lancet 2012;380(9849):1259-79. https://doi.org/10.1016/S0140-6736(12)61068-X
18. Theron N, Erasmus M, van Lill W, van Niekerk A, Rich E. Comments on select aspects of the NHI White Paper: Occasional Note Econex: Trade. Competition & Applied Economics. Retrieved 2016
19. Khuzwayo PB. The views of primary health care nurses towards the National Health Insurance (Doctoral dissertation, University of the Witwatersrand, Faculty of Commerce, Law and Management, Graduate School of Public and Development Management) 2015

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16651

Patient satisfaction with complete dentures received from an urban district hospital

SADJ October 2023, Vol. 78 No.9 p437-443

K Naidu[1], CP Owen[2]

ABSTRACT

Purpose

To assess some of the factors that may contribute to patient satisfaction with a complete denture service provided by a district hospital in South Africa.

Method

The participants were patients who had received mucosa-borne complete dentures at least one year previously. A questionnaire recorded demographics and treatment details either in person or telephonically. All patients were also asked to score a variety of factors related to satisfaction on a validated visual analogue scale. Associations were sought between patient demographics, treatment procedures and satisfaction.

Results

Sample size analysis required a sample size of 180 to detect at least a medium effect size, and 76 to detect large effect sizes. However, it was not possible to increase the sample size beyond 157 in the time available. Several associations were observed that were statistically significant, but most were of small effect. Even though 75% were upset at having lost their teeth, 64% reported that they had not minded wearing dentures. Overall there were high levels of satisfaction, irrespective of the treatment procedures used. There were few meaningful associations between patient characteristics and satisfaction scores.

Conclusion

It was clear that the patients had adapted well to their dentures. Patient satisfaction and patient adaptability are subject to many factors, and how patients cope, and what factors help remains unknown. It is clear the provision of this complete denture service in the public sector improved these patients' quality of life and that patients can adapt to mucosa-borne dentures provided in a public setting.

Authors' information
1. Karmisha Naidu, Department of Oral Rehabilitation, School of Oral Health Science, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa. ORCID: 0009-0004-6130-8284
2. CP Owen, Professor Emeritus, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa. ORCID: 000-0002-9565-8010

Corresponding author
Name: Prof CP Owen
Tel: +27 83 679 2205
Email: peter.owen@wits.ac.za

Author's contribution
1. K Naidu – 70%
2. CP Owen – 30%

Keywords
Complete dentures, patient satisfaction

ACKNOWLEDGEMENTS

Thanks are due to the hospital management, the nursing staff and, in particular, the participants, as well as the dentists who had provided the dentures. We are grateful to Dr P Gaylard for the statistical analysis.

This research was originally successfully submitted for an MScDent degree.

Funding/conflict of interest

The research received no funding and the authors declare no conflict of interest.

INTRODUCTION

Edentulousness impairs a patient's ability to chew and perform other oral functions, resulting in a wide range of health and oral health-related quality of life impacts that can be minimised by different types of fixed and/or removable prosthodontic treatment. Implant-retained overdentures have been proposed as the standard of care[1,2] for the edentulous mandible but this has been questioned on humanitarian,[3] socioeconomic and prosthodontic grounds.[4] Moreover, this applies to less than 1% of the world's population, who are estimated to have received implant therapy.[5] In addition, health, psychological, anatomical and economic constraints preclude implant therapy for many elderly patients.

For most edentulous patients, mucosa-borne dentures will be their only choice, provided they have access to this care; in many developing countries, including South Africa, there is a high demand but a limited supply of treatment from public dental clinics. Despite their limitations, though, complete dentures can greatly improve the quality of life for edentulous patients.[6,7]

Appearance, comfort, the ability to masticate and to speak without encumbrance are some of the factors which determine the success or failure of the denture.[8] Denture hygiene and care, the rate of resorption of the alveolar bone ridges, and the frequency with which dentures are replaced are also important factors influencing the satisfaction of dentures. Some patients adapt easily to wearing and using dentures while others may not. Thus, in addition to physical and physiological factors, the psychological traits of the patient and the relationship between the patient and clinician all play important roles in determining the level of satisfaction with complete dentures.[6,9-14] In addition, the dentist's experience has also been related to satisfaction.[15] While the literature has identified several factors affecting

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16651

patient satisfaction with complete dentures, some of which may be beyond the control of the clinician, it is nevertheless considered important to continue to assess patient satisfaction, to identify those factors which might result in an improvement in a denture service, especially in the public sector. Barriers to access such as the location of patients relative to the hospital or clinic and the means of travelling may also influence patient acceptance and satisfaction. In South Africa, many patients travel from far outlying areas to their nearest public dental health facility for treatment which includes fabrication of complete dentures. Due to the time it takes them to reach the hospital, and the cost, many do not return for follow-up visits once they have received their denture. Patients may accept their dentures even though some may be dissatisfied with them because of the barriers to attending again.

The purpose of this study was to survey patients who have received complete dentures from a public clinic at least one year post insertion, to determine their satisfaction with their complete dentures and to investigate any associations between clinical data, patient satisfaction and the demographic characteristics of the patients.

METHODS AND MATERIALS

Ethical approval was granted by the Human Research Ethics Committee of the University of the Witwatersrand (clearance number M160734) and permission was obtained from the regulatory health authority of the Department of Health of the province. This study was conducted at the Dental Department of King Dinuzulu Hospital Complex, Springfield, Durban.

The sample size was based on the association between satisfaction scores on the one hand and sociodemographic and clinical factors on the other. For the detection of small, medium and large effect sizes (f=0.10, 0.25 or 0.40, respectively) with 80% power at the 5% significance level, sample sizes of 1096, 180 or 76 are required.[16] Although at least a medium effect size would be ideal, the actual sample size of 157 was thus slightly smaller than desired, but it was found not possible to increase this number of participants.
Assessment of each patient was carried out by the same clinician to ensure standardisation and consistency of observations. The following demographic data were recorded:

- Age
- Gender
- Place of residence
- Mode of transport to the clinic
- Cost to get to the clinic
- Time taken to get to the clinic
- Ease or difficulty in getting to the clinic
- Medication
- Educational level
- Ability to write and read
- Wearing dentures at night
- Cleaning dentures
- Use of fixative
- Relationship with the dentist
- Attitude towards losing their teeth
- Attitude toward wearing dentures

The patient satisfaction dimensions measured were:

- Pain – upper
- Pain – lower
- Comfort – upper
- Comfort – lower
- Appearance – upper
- Appearance – lower
- Function – upper
- Function – lower
- Stability – upper
- Stability – lower
- Speech quality
- Cleaning difficulty – upper
- Cleaning difficulty – lower
- Overall satisfaction – upper
- Overall satisfaction – lower

The full questionnaires used are available from the authors.

A Visual Analogue Scale and the McGill Pain Questionnaire[17,18] were modified to assess denture comfort and patient satisfaction. The two pain scores were reverse scored so that all 15 satisfaction scores ranged from 0 (low satisfaction) to 100 (high satisfaction). The patients were given an information letter explaining the study, or it was read out to those patients only available telephonically, and they were asked to give their consent. A translator was used as necessary and, to prevent bias, the questionnaire was applied by a single administrator. If the patients were unable to attend the clinic, then telephonic contact was made and instead of a visual analogue scale, the patients were asked to score according to the expression "on a scale of 1 to 100". Patients who were able to attend the clinic were also asked to score according to this expression to provide some correlation between the two methods.

Because the fabrication of the dentures was carried out by six different clinicians based at the hospital, patient records were obtained and the procedures used as well as the number of visits were noted.

A clinical evaluation of the dentures was not carried out, because there is consensus in the literature that there is little or no correlation between such a normative assessment of complete dentures and patient satisfaction.[9,19-23]

Statistical analysis

The relationship between pairs of satisfaction scores was assessed by Spearman's rank correlation coefficient since the data did not meet the assumptions of Pearson's correlation coefficient. The strength of the associations was measured by interpreting the absolute value of the correlation coefficient. The following scale of interpretation was used:[24]

0.50 and above	large effect
0.3 to 0.49	moderate effect
Below 0.3	small effect

The relationships between patient satisfaction and sociodemographic and clinical variables were assessed by the Wilcoxon rank sum test (or the Kruskal-Wallis test for more than two categories). The following scale of interpretation was used:[24]

0.80 and above	large effect
0.50 to 0.79	moderate effect
0.20 to 0.49	small effect
below 0.20	near zero effect

The $\chi 2$ test was used to assess the relationships between procedures and the number of post-insertion visits. Fisher's exact test was used for 2 x 2 tables or where the

https://doi.org/10.17159/sadj.v78i09.16651

Table 1. Statistically significant associations between some demographic variables and satisfaction scores

Demographic variable	Satisfaction variable
Mode of transport	Pain
Travel time (categorised as 0-30min, 31-60min and >61min)	Pain, comfort, appearance and function
Cost of travel to the clinic (median R30; range R0-R200)	Pain, cleaning and overall satisfaction for the lower denture
Accessibility to clinic: Easy	None
Accessibility: Difficult or impossible without help	Pain, comfort, function
Wearing maxillary denture at night (23% of patients)	Lower scores for most variables
Wearing mandibular denture at night (15% of patients)	Lower scores for most variables
Using fixative in maxillary denture (5% of patients)	Lower scores for stability, speech and overall satisfaction for that denture
Using fixative in maxillary denture (8% of patients)	Lower scores for comfort, function, stability, speech and overall satisfaction for that denture

requirements for the X^2 test could not be met. The strength of the associations was measured by Cramer's V and the phi coefficient respectively. The following scale of interpretation was used:[24]

0.50 and above	high/strong association
0.30 to 0.49	moderate association
0.10 to 0.29	weak association
below 0.10	little, if any, association

Data analysis was carried out using SAS (version 9.4 for Windows). The 5% significance level was used.

RESULTS

Because there were no baseline data, the end-point satisfaction scores for the various dimensions were compared and not the percentage difference/gain/loss in satisfaction. A total of 157 patients who received complete dentures completed the VAS survey, 62% on paper and 38% telephonically. For those who completed the scores on paper, there were no differences between where they placed their mark and when subsequently asked to score verbally on a scale of "one to a hundred", thus validating the telephonically derived scores.

Associations between demographic variables and satisfaction scores

The mean age of the patients was 71 years with a range of 60 to 91. The proportion of female patients (66%) was almost twice that of male patients (34%). Only 7% of the patients had matriculated from school, 5% had a diploma, and 11% were illiterate. Sixty-nine percent of the participants were on medication for hypertension and 48% for diabetes. There were no meaningful associations between any of the satisfaction scores and age, gender, education and medication.

In terms of their attitude toward wearing dentures, 75% were upset at having lost their teeth, and 64% reported that they had not minded wearing dentures. There were no significant or meaningful relationships to any of the satisfaction scores.

The statistical analysis did reveal some associations between some of the satisfaction scores and some of the demographic variables (Table 1) but the effect sizes were small or very small and so it is unlikely that any of these variables influenced satisfaction.

Relationship with the dentist

This was marked on a 5-point scale where 1 = poor and 5 = excellent. Patients generally had a good relationship with the dentist who made their dentures, with 87% rating a 4 or 5. No patients rated 1, 7 rated 2, and 14 rated 3. For associations, categories 1-3 were combined, because of the small group sizes (13%). Many of the scores were significantly lower in the few patients whose relationship with the dentist was reported as poor, but there were only two medium effect sizes (comfort and function of the upper denture), the rest being small.

Procedures used

The procedures used for fabricating dentures and the percentages are shown in Table 2.

Table 2. Procedures used in denture fabrication

		N	%
Procedures used	Primary impression	157	100.0
	Secondary impression	119	75.8
	Record blocks trimmed	135	86.0
	Records blocks not trimmed but marked	22	14.0
	Jaw registration other	9	5.7
Number of clinic visits	4	32	20.4
	5	53	33.8
	6	50	31.9
	7	16	10.2
	8	4	2.6
	9	2	1.3
Number of try-ins	0	1	0.6
	1	116	73.9
	2	38	24.2
	3	2	1.3
Post-insertion visits	0	46	29.3
	1	62	39.5
	2	41	26.1
	3	6	3.8
	4	1	0.6
	5	1	0.6

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16651

For analysis, because of small group sizes it was necessary to make groupings as follows:
Number of clinic visits: 7 or more visits were grouped.
Number of try-ins: 2 and 3 were grouped, and 0 was omitted.
Number of post-insertion visits: 2 or more visits were grouped.

The only statistically significant difference to emerge was, not surprisingly, between whether or not a secondary impression was made and the number of clinic visits. Associations were then sought to enquire if any of the procedure variables were associated with any of the satisfaction scores. Statistically significant differences were found only for secondary impressions (appearance, stability of the mandibular denture, speech and cleaning) and jaw registrations when the record lock was not trimmed (appearance of the maxillary denture). In all cases the effect sizes were small.

Overall patient satisfaction scores

Correlations coefficients were calculated between the patient satisfaction variables, and several large effect sizes were found, all at $p < 0.0001$ (Table 3).

Table 3. Statistically significant satisfaction variable correlates with large effect sizes

SATISFACTION CATEGORY	CORRELATES	r
Comfort lower	Pain lower	0.62
Appearance lower	Appearance upper	0.75
Function upper	Comfort upper	0.72
Function lower	Comfort lower	0.81
Stability upper	Comfort upper Function upper	0.61 0.61
Stability lower	Comfort lower Function lower	0.64 0.63
Cleaning lower	Cleaning upper	0.80
Overall satisfaction upper	Comfort upper Function upper Stability upper	0.75 0.79 0.61
Overall satisfaction lower	Comfort lower Function lower Stability lower	0.84 0.87 0.71

DISCUSSION

Patient satisfaction

Patient satisfaction is the ultimate goal in dental treatment. Conventional complete dentures are the only practical treatment option for most edentulous patients. However, a patient's satisfaction with denture use hinges on a variety of factors such as aesthetics, speech, retention, comfort and function, as well as dentist-patient communication.[14,25]

Visual analogue scales (VAS) were used for assessing patient satisfaction, and these have been validated in several studies. The results showed that the correlations observed were all entirely logical; for example, discomfort was correlated with pain, stability with comfort and function and overall satisfaction with comfort, function and stability.

In a questionnaire-based study, Marinus (1990)[26] stressed the mutual benefits of the patient-dentist relationship concerning satisfaction, attitude and expectations from their new dentures. Santos et al (2015)[27] found that the establishment of a friendly and respectful relationship between patients and dentists during denture-making may result in higher satisfaction. The participants in this study reported an overwhelmingly good relationship with their dentist, with 87% scoring 4 or 5 on a 5-point poor-to-excellent scale. The patients' satisfaction scores affected most variables except stability of the mandibular denture, but with small effect sizes. Moderate effect sizes were, however, noted for comfort ($r = 0.53$) and for function ($r = 0.50$) of the maxillary denture. These results would generally imply and confirm that the psycho-social element in the making of complete dentures is an important one.

The satisfaction variable correlates were all logical, and overall patient satisfaction was high, with a mean score for all scores of 75 (SD 17). The overall satisfaction score with the maxillary denture was 75 and 68 with the mandibular denture. It was clear, therefore, that these patients were able to adapt well to their dentures and all were using them satisfactorily for at least a year post-insertion. Although patients were able to function well with their dentures, a limitation of the procedures was that it appears that nutrition counselling was not a routine. It has been shown that this is necessary as the mere presence of a prosthesis does not necessarily change food choices without targeted interventions to improve dietary habits.[28,29]

Patient demographics

The age and gender distribution was not dissimilar to those reported elsewhere, as was the fact that there was no association between these and satisfaction scores,[13,22,25,30-32] although there have been associations shown of a higher satisfaction score for aesthetics in women denture wearers.[27,33,34]

Many medications and combinations of medication can contribute to adverse intra-oral conditions such as depleted and poor saliva (which contributes to difficulty with denture wearing), but there were no significant associations between any of the satisfaction scores and medication. It is unclear why this should be the case among these participants, and it may reflect their adaptability.

Although there were some associations between some of the satisfaction scores and some of the demographic variables, the effect sizes were small or very small and so it is unlikely that any of these variables influenced satisfaction. This may have been a measure of the fact that in this sample only moderate or large effects would be significant, but other studies have not reported consistent associations and most relied purely on probability values without calculating effect sizes.

It was interesting to note that the most common method of cleaning their dentures was soaking in water alone, although this was mostly after either brushing with soap or toothpaste. This has not been reported in the literature. An advantage of following up patients and recalling them is that aspects such as denture cleaning can be reinforced, as some reported using bleach (which adversely affects the appearance), and abrasives such as the use of bicarbonate of soda and coarse salt. Although no clinical examinations were performed, it is important to emphasise appropriate cleaning methods because of the well-known association with denture stomatitis.

https://doi.org/10.17159/sadj.v78i09.16651

It was also of some concern to find a relatively large number of patients who slept with their dentures at night (23% and 15% wore maxillary and mandibular dentures, respectively). A recent systematic review[35] reported mean values of nocturnal denture wearing varying from 11% to 31%. The concern is mainly with the association between nocturnal denture wearing and candidiasis[36] as well as a possible association with sleep disorders. The clinical advice is always for patients to leave their dentures out at night, especially those with denture stomatitis. There were some associations: scores for pain, comfort, function and speech were significantly higher for those who wore their dentures at night, compared with those who did not but so were the scores for overall satisfaction, which is not logical, and perhaps explains why the effect sizes were small.

Only 5% and 8% of the patients reported that they used a fixative for their maxillary and mandibular dentures respectively. No prevalence studies on the use of fixatives could be found. Although the effect sizes were small, it was logical to observe higher scores for the stability, overall satisfaction and speech for those using fixatives in the maxillary denture and comfort, function, stability, overall satisfaction and speech for the mandibular denture. It has been suggested that denture fixatives may improve the dietary behaviour of complete denture wearers[37] and, for patients who can afford these, this could be encouraged if they have difficulty wearing complete dentures which are technically correct.

Procedures used during the making of complete dentures

The literature has been equivocal about the link between certain procedures used in the construction of complete dentures and subsequent patient satisfaction. Several recent systematic reviews (eg Sanjeevan et al (2021)[38] have shown similar outcomes using abbreviated techniques when compared with conventional multivisit techniques and some studies have found some links such as between fewer post-delivery adjustments and higher patient satisfaction scores (eg Gaspar et al 2013).[6]

In this study, it was not possible to infer that those who had more than one try-in were correlated with the procedures used, due to the low numbers. It was also not possible to determine the reasons for the variety in post-insertion visits (40% had one visit, but 29% did not return at all). It would appear that, in keeping with the literature on abbreviated or "simplified" techniques, the procedures used did not influence patient satisfaction in the participants of this study.

Limitations

The sample size was a limitation of this study as only small effect sizes could be detected. The influence of previous denture wearing was also not determined and this could have had a bearing on patient adaptability and therefore of satisfaction. Nevertheless, the information gave valuable insight into the multiple aspects that can affect patient satisfaction, as well as the need for follow-up in terms of oral hygiene and nutrition advice.

CONCLUSION

Within the limitations of this study, and despite the great variety among the participants, their overall satisfaction scores with their complete dentures were such that, in comparison with other international studies, they had adapted well to denture-wearing.

Although there were several associations between satisfaction scores and some characteristics of the participants, the low sample size precluded definitive correlations. Patient satisfaction and patient adaptability are subject to a multitude of factors, and just how patients cope, and what factors assist this process, remains unknown.

The provision of this mucosa-borne complete denture service in a public sector hospital has provided these patients with improved function as they were able to adapt well to their dentures. However, denture hygiene and nutritional counselling should become a routine part of all removable prosthodontic service provision. It is therefore recommended that national and provincial health departments provide sufficient funds so that edentulous patients may have the health benefits of being able to chew and therefore improve their nutritional status and, at the same time, improve their appearance.

REFERENCES

1. Feine JS, Carlsson GE, Awad MA, Chehade A, Duncan WJ, Gizani S, et al. The McGill Consensus Statement on Overdentures. Int J Prosthodont 2002; 15: 413-4
2. Thomason JM, Kelly SA, Bendkowski A, Ellis JS. Two implant retained overdentures – a review of the literature supporting the McGill and York consensus statements. J Dent 2012; 40: 22-34. doi: 10.1016/j.jdent.2011.08.017
2. Owen CP. Standards of care: good or evil? Int J Prosthodont. 2008; 22: 328-330
3. Fitzpatrick B. Standard of care for the edentulous mandible: a systematic review. J Prosthet Dent. 2006; 95(1): 71-8. doi: 10.1016/j.prosdent.2005.11.007
4. Carlsson GE. Critical review of some dogmas in prosthodontics. J Prosthodont Res. 2009; 53(1): 3-10. doi: 10.1016/j.jpor.2008.08.003
5. Gaspar MG, Dos Santos MBF, Dos Santos JFF, Marchini L. Correlation of previous experience, patient expectation and the number of post-delivery adjustments of complete dentures with patient satisfaction in a Brazilian population. J Oral Rehab. 2013; 40: 590-594. doi: 10.1111/joor.12070
6. Omar R, Al-Tarakemah Y, Akbar J, Al-Awadhi S, Behbehani Y, Lamontagne P Influence of procedural variations during the laboratory phase of complete denture fabrication on patient satisfaction and denture quality. J Dent 2013; 41: 852-860. doi: 10.1016/j.jdent.2013.07.013
7. Fenlon MR, Sherriff M, Newton JT. The influence of personality on patients' satisfaction with existing and new complete dentures. J Dent 2007; 35(9): 744-8. doi: 10.1016/j.jdent.2007.06.003
8. Van Waas MAJ. The influence of clinical variables on patients' satisfaction with complete dentures. J Prosthet Dent 1990; 63: 307-310. doi: 10.1016/0022-3913(90)90202-n
9. Garrett NR, Kapur KK. Effects of improvements of poorly fitting dentures and new dentures on patient satisfaction. J Prosthet Dent 1996; 76(4): 403-413. doi: 10.1016/s0022-3913(96)90546-6
10. Brunello D L, Mandikos MN. Construction faults, age, gender, and relative medical health: Factors associated with complaints in complete denture patients. J Prosthet Dent 1998; 79(5): 545-554. doi: 10.1016/s0022-3913(98)70176-3
11. Fenlon MR, Sherriff M, Walter JD. An investigation of factors influencing patients' use of new complete dentures using structural equation modelling techniques. Community Dent Oral Epidemiol 2000; 28(2): 133-140. doi: 10.1034/j.1600-0528.2000.028002133.x
12. Bilhan H, Geckili O, Ergin S, Erdogan O, Ates G. Evaluation of satisfaction and complications in patients with existing complete dentures. J Oral Sci. 2013; 55(1): 29-37. doi: 10.2334/josnusd.55.29
13. Chen JH, Huang HL, Lin YC, Chou TM, Ebinger J, Lee HE. Dentist-Patient Communication and Denture Quality Associated with Complete Denture Satisfaction Among Taiwanese Elderly Wearers. Int J Prosthodont. 2015; 28(5): 531-7. doi: 10.11607/ijp.4223
14 Kimoto S, Kimoto K, Kitamura A, Saita M, Iijima M, Kawai Y. Effect of dentist's clinical experience on treatment satisfaction of a complete denture. J Oral Rehabil. 2013; 40: 940-947. doi: 10.1111/joor.12108
15. Faul F, Erdfelder E, Lang A.-G, Buchner A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007; 39(2): 175-91. doi: 10.3758/bf03193146
16. Melzack R. The McGill Pain Questionnaire: major properties and scoring methods. Pain. 1975; 1(3): 277-299. doi: 10.1016/0304-3959(75)90044-5
17. Ohnhaus EE, Adler R. Methodological problems in the measurement of pain: a comparison between the verbal rating scale and the visual analogue scale. Pain. 1975; 1(4): 379-384. doi: 10.1016/0304-3959(75)90075-5
18. Langer A, Michman J, Seifert I. Factors influencing satisfaction with complete dentures in geriatric patients. J Prosthet Dent 1961; 11: 1019-1031
19. Berg E. The influence of some anamnestic, demographic and clinical variables on patient acceptance of new complete dentures. Acta Odontol Scand 1984; 42: 119-273. doi: 10.3109/00016358409035249
20. Heyink J, Heezen J, Schaub R. Dentist and patient appraisal of complete dentures in a Dutch elderly population community. Dent Oral Epidemiol 1986; 14: 323-6. doi: 10.1111/j.1600-0528.1986.tb01083.x
22. Awad MA and Feine JS. Measuring patient satisfaction with mandibular prostheses. Community Dent Oral Epidemiol. 1998; 26(6): 400-5. doi: 10.1111/j.1600-0528.1998.tb01978.x
23. Fenlon MR, Sherriff M, Walter JD. Agreement between clinical measures of quality and patients' rating of fit of existing and new complete dentures. J Dent. 2002; 30(4): 135-9. doi: 10.1016/s0300-5712(02)00016-7
24. Cohen J. Statistical power and analysis for the behavioral sciences (2nd ed.), 1988; Hillsdale, NJ, Lawrence Erlbaum Associates, Inc.
25. Al-Omiri MK, Sghaireen MG, Al-Qudah AA, Hammad OA, Lynch CD ynch E. Relationship between impacts of removable prosthodontic rehabilitation on daily living, satisfaction and personality profiles. J Dent. 2014; 42(3): 366-72. doi: 10.1016/j.jdent.2013.12.010

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16651

26. Van Waas MA. The influence of psychologic factors on patient satisfaction with complete dentures. J Prosthet Dent. 1990; 63(5): 545-548. doi: 10.1016/0022-3913(90)90073-I
27. Santos BF, dos Santos MB, Santos JF, Marchini L. Patients' evaluation of complete denture therapy and their association with related variables: A pilot study. J Prosthodont. 2015; 24(5): 351-357. doi: 10.1111/jopr.12286
28. Bradbury J, Thomason JM, Jepson NJ, Walls AW, Allen PF, Moynihan PJ. Nutrition counseling increases fruit and vegetable intake in the edentulous. J Dent Res. 2006; 85(5): 463-468. doi: 10.1177/154405910608500513
29. Hamdan NM, Gray-Donald K, Awad MA, Johnson-Down L, Wollin S, Feine JS. Do implant overdentures improve dietary intake? A randomized clinical trial. J Dent Res. 2013; 92(12 Suppl): 146S-53S. doi: 10.1177/0022034513504948
30. Charles C, Gafni A, Whelan T. Decision-making in the physician-patient encounter: Revisiting the shared treatment decision-making model. Soc Sci Med 1999; 49: 651-661. doi: 10.1016/s0277-9536(99)00145-8
31. Al Quran F, Clifford T, Cooper C, Lamey PJ. Influence of psychological factors on the acceptance of complete dentures. Gerodontology. 2001; 18: 35-40. doi: 10.1111/j.1741-2358.2001.00035.x
32. Celebic A, Knezovic-Zlataric D, Papic M, Carek V, Baucic I, Stipetic J. Factors Related to Patient Satisfaction with Complete Denture Therapy. J Gerontol A Biol Sci Med Sci. 2003; 58(10): M948-53. doi: 10.1093/gerona/58.10.m948
33. de Lima EA, dos Santos MB, Marchini L. Patients expectations of and satisfaction with implant-supported fixed partial dentures and single crowns. Int J Prosthodont. 2012; 25: 484-490
34. da Cunha MC, Santos JF, Santos MB, Marchini L. Patients expectations before and satisfaction after full arch fixed implant–prosthesis rehabilitation. J Oral Implantol. 2015; 41(3): 235-239. doi: 10.1563/AAID-JOI-D-12-00134
35. Emami E, Nguyen HP, Rompré P, Lavigne GJ, Huynh NT. The effect of nocturnal wear of dentures on the sleep quality: a systematic review and meta-analysis. Sleep Breath. 2017; 21(1): 9-18. doi: 10.1007/s11325-016-1369-1
36. Compagnoni MA, Souza RF, Marra J, Pero AC, Barbosa DB. Relationship between Candida and nocturnal denture wear: quantitative study. J Oral Rehabil. 2007; 34(8): 600-605. doi: 10.1111/j.1365-2842.2007.01754.x
37. Bartlett DW, Maggio B, Targett D, Fenlon MR, Thomas J. A preliminary investigation into the use of denture adhesives combined with dietary advice to improve diets in complete denture wearers. J Dent. 2013; 41(2): 143-7. doi: 10.1016/j.jdent.2012.10.012
38. Sanjeevan V, Rajagopal P, Venkitachalam R, Aras M. Efficiency of simplified versus traditional denture fabrication methods: A systematic review and meta-analysis. J Prosthet Dent. 2021; 126(3): 377-385. doi: 10.1016/j.prosdent.2020.07.003.

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16955

Essential non-clinical skills and training required by dentists in South Africa

SADJ October 2023, Vol. 78 No.9 p443-448

MO Tukuru[1], L Snyman[2], TC Postma[3], SE van der Berg-Cloete[4]

INTRODUCTION

Dentists possess clinical experience garnered within supervised clinical settings, primarily aimed at diagnosing, treating and preventing oral cavity related diseases.[1] Undergraduate dentistry training mostly focuses on the scientific underpinnings of this discipline and building clinical experience, not allowing adequate time for additional coursework.[1] According to Haslach et al.[2], dentists choose dental careers because they want to help and work with people, as well as desire job and financial security. The current economic downturn has led to a revenue plunge for many independent dental practices, attributed partially to less per capita patient expenditure.[3] In response, patients have increasingly embraced preventative measures over more costly procedures, seeking to minimise expenses.[4] The global financial crisis further underscores the value of leadership development, given its potential impact on the efficacy of clinic leaders.[5]

The movement towards outcomes-based medical education was prompted by the escalating demand for heightened accountability across all facets of modern medical professions.[6] Healthcare professionals have to respond to societal needs and healthcare education should align with these requirements. Education in the healthcare sector must embrace a "begin with the end in mind" approach, focusing on equipping graduates with the skills needed to meet the requirements of those they serve and achieve desired healthcare outcomes.[6]

Authors' information
1. Michelle Olubunmi Tukuru, BDS, PG Dip Dent (Practice Management), MSc Dent (Gen), Department of Dental Management Sciences, School of Dentistry, Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa.
ORCID 0000-0002-9116-25281
2. Lorraine Snyman, BChD, PG Dip Dent (Clinical Dentistry), PG Dip Dent (Practice Management), PGCHE, MBL, Department of Dental Management Sciences, School of Dentistry, Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa.ORCID 0000-0002-1080-20881
3. Thomas C Postma, BChD, MChD (Com Dent), DHSM, PhD, Department of Dental Management Sciences, School of Dentistry, Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa.
ORCID 0000-0002-2885-621X1
4. Sophy E van der Berg-Cloete, BChD, PG Dip Dent (Community Dentistry), MBA, DHSM, PhD, Department of Dental Management Sciences, School of Dentistry, Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa.
ORCID 0000-0001-7560-10951

Corresponding author
Name: Sophy E van der Berg-Cloete
Tel: +27 82 427 0792
Email: Sophy.vanderBerg-Cloete@up.ac.za

Author's contribution
1. Michelle Olubunmi Tukuru 100%
2. Dr L Snyman 100%
3. Prof TC Postma 100%
4. Prof SE van der Berg-Cloete 100%

Additionally, new dentists must perform a variety of administrative tasks, such as bookkeeping, financial forecasting, retirement planning, human resources, understanding insurance policies, purchasing equipment, keeping track of inventories and advertising. Dentists must be proficient in these areas to lead and manage a successful enterprise. Success in a private practice depends on excellent business and communication skills and self-discipline – aspects that often receive secondary attention in dental education.[1]

Leadership stands as a pivotal skill requisite for transforming the dental profession, spearheading innovation and navigating novel challenges. Recently, the number of leadership development programmes for dental practitioners has proliferated, attesting to a growing interest in developing this essential skill.[7] The need for effective leadership across all aspects of dentistry such as dental education, dental public health and clinical practice has also been recognised in the literature.[8]

Similarly, Patel et al.[9] reported that practitioners in private practice also advocate for fostering leadership abilities in dental students as there is lack of these qualities in practice. Given South Africa's (SA's) healthcare challenges, acquiring leadership skills may enhance healthcare outcomes by fostering collaborative efforts among healthcare professionals.[10] Viable dental practice also linked to the delivery of high quality care.[11] Dental practices operate as complex entities, often comprising a dynamic mix of dental experts and team members working together to provide high quality dental care. Inevitably, dentists must assume a leadership role even though they do not have the requisite skills.[12] Universities face the difficult task of nurturing graduates who are able to run a dental practice. The Medical Leadership Competency Framework (MLCF) stands as a prominent model emphasising leadership training.[13] The MLCF describes the leadership competencies healthcare professionals must cultivate to actively engage in planning, delivering and transforming patient services. Dental Practice Management is included in the undergraduate curricula of some South African dental schools. It is designed to develop and improve communication, leadership, management and marketing skills.[14] However, these non-clinical skills should holistically be integrated into dental curricula, in addition to their clinical abilities.[15] In 2016, Van der Berg-Cloete et al.[16] described students' viewpoints on the need for leadership and management training and the most essential non-clinical skills. However, key stakeholders' opinions on the need for management and leadership training and essential non-clinical skills in dentistry have not been investigated in the South African context. In this study, we assessed key stakeholders' perceptions on essential non-clinical skills for dentists in SA and how these skills can best be taught.

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16955

METHODS

The University X Research Ethics committee approved the study (352/2016).

Study design

This was a qualitative study. Senior managers (SMs) and recently qualified dentists, who are referred to as young dentists (YDs) in this study, were purposively sampled. Fifteen SMs were identified through referrals by oral health professionals, academics at the University X and internet searches. Dental professionals were registered with reputable public and private oral health organisations, including the Dental Professionals Association, SA Dental Association, SA Military Health Services, group practices (Intercare and Medicare), Public Health Services (National Department of Health and regional Tshwane district) and five private dentists. SMs represented the views of key oral health experts and professionals in SA because of their experience and position in the oral health field. YDs were sampled from the Young Dentists Council.

All 39 registered YDs were invited to participate in the study; of these, 11 consented to participate. The YDs graduated between 2002 and 2015 were younger than 35

Table 1: Senior managers' list of non-clinical skills to teach dental students as depicted by the domains of the Medical Leadership Competency Framework (MLCF)

	Personal qualities		Working with others			Managing services			Improving services		Providing strategic direction
	A3: Self develop-ment	A4: Acting with integrity	A1/B2: Building and main-taining relation-ships	B0: Building networks	B1: Develop networks	C0: General manage-ment skills	C2: Managing resources	C3: Managing people	D2: Critical evaluation	D3/E1: Encour-aging innovation	E1: Identify contexts for change
SM01						1. Practice manage-ment	4. Financial mana-gement		2. Critical thinking		3. Policy perspective
SM02				2. Interpersonal relationships		1. Manage-ment					
SM03		2. Profes-sionalism 3. Ethics		1. Commu-nication 4. Interpersonal relationships							
SM04	4. Knowledge			1. Leadership 2. Commu-nication		3. Manage-ment					
SM05				1. Commu-nication		4. Practice manage-ment	3. Marke-ting 2. Finance				
SM06						1. Business	2. Finance 3. Marke-ting	4. HR			
SM07				1. Commu-nication		2. Business	3. Finance 4. Marketing				
SM08				3. Commu-nication		2. Business	1. Finance 4. Marketing				
SM09		2. Personal behaviour 4. Profes-sionalism									
SM10	4. CPE			1. Interpersonal skills		2. Business skills	3. Marketing				
SM11						2. Business Management	1. Finance	3. Customer service		4. Entrepre-neurial skills	
SM12		4. Ethics				1. Practice management 2. Coding	3. Finance				
SM13				2. Leadership		1. Practice management 3. Business		4. Human resources			
SM14			2. Respect for persons	4. Phone etiquette	3. Working with colleagues		1. Finance				

https://doi.org/10.17159/sadj.v78i09.16955

years old and from the public (n = 5) and private (n = 6) sectors. Four of SA's nine provinces – Gauteng, KwaZulu-Natal, Mpumalanga and Western Cape – were represented. Participants were invited by telephone call or email. The study's title, purpose and expectations were all described. Only those interested in participating signed an informed consent form.

2.2 Data collection

Data were collected during semi-structured, one-on-one or telephonic interviews.[17] Open-ended questions were posed to SMs and YDs: What are your opinions about dentistry in SA? What are the important non-clinical skills to teach students? Do you believe there is a need for leadership and management training in dentistry in SA? The YDs were also asked whether their dental education equipped them with necessary non-clinical skills to operate an efficient dental practice.

2.3 Data analysis

To maintain anonymity, codes were assigned to each participant, namely SM01–SM14 (SMs) and YD01–YD11 (YDs). During the interviews, responses to the questions were audio-recorded verbatim, transcribed and then thematically analysed. Non-clinical skills were interpreted using the MLCF.[13,16] We further calculated the frequency of responses to support the weight of each theme.

RESULTS

3.1 Non-clinical skills in dentistry

The SM and YD responses to the question on the four non-clinical skills required by dental students are summarised in Table 1 and 2. According to the adapted MLCF, their answers were categorised as shown below.

Fourteen SMs revealed 54 non-clinical skills. Of the 54 skills, 61.1% were within Domain C (managing services) (57.4%) and Domain D (improving services) (3.7%). Other skills fell within Domain A (personal qualities) (16.6%) and Domain B (working with others) (22.2%) (Table 1).

SMs rated critical non-clinical skills as follows: financial management (16.6%), business skills (11.1%), marketing skills (9.2%), communication (9.2%), practice management (7.4%), interpersonal relationship skills (5.5%), ethics (5.5%), professionalism (3.7%), leadership skills (3.7%), general management (3.7%), human resource management (3.7%) and others (3.6%) (Table 1). Working with others, respect, telephone etiquette, critical thinking, dental coding, entrepreneurship, knowledge, personal behaviour, continuous education and policy perspective skills were among the skills in the Others category.

The YDs identified four non-clinical domains and listed 43 skills as essential non-clinical skills to train dental students. Skills fell within Domain B (the ability to work with others) (37%) and Domain A (personal qualities) (19%), Domain C (managing services) (42%) and the least in Domain D (improving services) (2%).

During the interview, when asked to rate non-clinical skills, YDs reported communication (16%), ethics and morality (16%), leadership (14%), teamwork (7%), general practice management (7%), business skills (5%) and others (2%). Others included business ownership, administration, human resources, financial management, labour legislation, time management and standard operating procedures.

Participants stated the following:

"Big gap for advocacy for dentistry to be prioritised in health agenda. Therefore, we need leaders in dentistry who will collaborate dentistry with private stakeholders and boost the economy" (SM03)

"It is needed because it's important to be taught leadership to learn how to lead the team, then management to help to manage the business" (SM08)

"There is a high need. Challenges are being faced which requires a different approach in terms of management and leadership training" (YD03)

3.2 Delivery of management training in the South African context

Based on SM's responses, three broad themes emerged related to management training: (1) undergraduate level only, (2) undergraduate level with a postgraduate follow up, and (3) postgraduate level only.

Regarding theme one, four SMs agreed that management training should be taught at the undergraduate level. Although there is a lack of undergraduate training, there is a strong expectation that students should be taught management abilities as part of their undergraduate education. SM03 opined that management training should be delivered via short courses offered by business schools. Management training should include supply chain management, financial management, risk management and human resource management courses.

"The best time is in the final years where 4th/5th year students should be exposed to full functional setups, to be taught management skills" (SM08)

"It is best acquired in undergraduate study; should significantly include non-clinical skills mentioned above with equal focus on clinical skills" (SM01)
"While in undergraduate level, presented by professional associations…" (SM10)

Five YDs agreed that the optimum period to teach managerial skills to dental professionals was during their undergraduate years.

"This should be part of the dental educational system from day one and I don't think it's professional for doctors or other dentists to teach management unless they are qualified in that regard. Someone with experience of management at the corporate level to be involved and not just for a year or two but training should be from the beginning" (YD10)

"As an undergraduate course at least by third year" (YD08)
"Professionals should come train at the undergraduate level in the universities" (YD05)

"Definitely in undergraduate like in 4th year perhaps in the form of research before graduation" (YD04)

Regarding the second theme, six SMs agreed that management skills should be taught at the undergraduate level with a postgraduate level follow-up. Dentists who have their own practices will be more cognisant of their specific issues and will likely benefit from further postgraduate management training. Management training could take the

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16955

Table 2. Young dentists' list of non-clinical skills to teach dental students as depicted by the domains of the Medical Leadership Competency Framework (MLCF)

	Personal qualities			Working with others		Managing services			Improving services
	A1: Self awareness	A2: Self manage-ment	A4: Acting with integrity	B0: Building networks	B3: Working in teams	C0: General manage-ment skills	C2: Managing resources	C3: Managing people	D3/E1: Encoura-ging innovation
YD01	3. Morals	2. Ethics	1. Communi-cation 4. Leadership						
YD02		3. Stress manage-ment		1. Communi-cation		4. Standard operating procedures		2. Staff manage-ment	
YD03			2. Ethics	3. Communi-cation		1. Business			4. Entrepre-neurship
YD04			4. Ethics		3. Team-work	1. Practice manage-ment	2. Dental finance		
YD05			4. Ethics	2. Leadership	3. Teamwork	1. Business 5. Manage-ment			
YD06				1. Communi-cation 3. Leadership			2. Time manage-ment		
YD07				1. Leadership		2. Manage-ment			
YD08			1. Ethics	2. Leadership	3.Teamwork		4. Financial manage-ment		
YD09			1. Ethics	2. Leadership 3. Communi-cation		4. Admin and scheduling 5. Manage-ment			
YD10				2. Written Communi-cation 3. Verbal communi-cation	4. Practice manage-ment	1. Taxes			
YD11						1. Practice manage-ment 2. Medical aid		3. Human resources 4. Labour laws	

form of continuous professional development (CPD) forums or presentations made by professional bodies.

"Introducing it as a course in the undergraduate level either within a year or as a six-month module and then continuous training in the postgraduate level" (SM13)

"Should be included in the undergraduate curriculum from a management company to be included as a module. Then follow up in the postgraduate level" (SM04)

"The days of someone standing in front and lecturing to practitioners/individuals are numbered. Most would prefer to educate themselves with online possibilities, which they can do after hours (less travelling). Female dentists for fear of personal safety will not travel to CPD meetings in the evenings. So this will allow all interested dental professionals to learn from the online materials in the safety of their homes" (SM12)

Five YDs agreed that managerial training should be delivered at all educational levels, from the undergraduate to the postgraduate phases. Management is a valuable skill that should be developed from early on in their career.

"Good to be delivered at all levels. High school, undergraduate and postgraduate levels. Not as a separate course but incorporated into the clinical courses" (YD01)
"Yes, sufficient lectures were given, however not appreciated because as a student I was more focused on the clinical aspect. So regardless of how well the university prepares the students with non-clinical skills it cannot be sufficient. In the postgraduate phase the professionals will need to appreciate the knowledge and skills learnt by adding more to them through extra training" (YD09)

Regarding theme three, four SMs agreed that the delivery of managerial training could best be delivered in the postgraduate training only.

"CPD courses at the postgraduate level will yield better responses" (SM06)

https://doi.org/10.17159/sadj.v78i09.16955

"Through postgraduate training but not long term like going back to school but rather short courses like CPD courses or online courses" (SM11)

" Through postgraduate courses more than the undergraduate level" (SM05)

Only one YD (YD02) agreed with this theme. "It should be practical based. Otherwise, the knowledge would be lost. Through internship training in the dental setting" (YD02)

3.3 Delivery of leadership training in the South African context

Six SMs felt that leadership skills ought to be taught primarily at the undergraduate phase.

"Very big challenge in the South African context. Many dentists gravitate towards private practice in an isolated environment not conducive for leadership development. Leadership is acquired over time primarily through mentorship and not just formal training. Deliberate mentorship: deliberate efforts to mentor students in universities by giving them responsibilities that nurture leadership" (SM01)

"Through the use of professional experts coming in to teach the students at the undergraduate level" (SM07)

"It's a skill that is taught through mentorship best in the undergraduate level" (SM08)

SM14 felt strongly that leadership is learnt by imitating and cannot necessarily be taught. Universities should be responsible for unpacking values, such as respect and equity, which South Africa holds as a nation.

Four YDs agreed that leadership skills should be taught at the undergraduate phase.

"Also in undergraduate level like management, leadership should be taught not only in the fourth year but throughout the dental study. It can be acquired but leadership training should be started very early in undergraduate level" (YD04)

"Through business leaders as experts coming to teach in a university classroom. Learning from a mentorship role programme in undergrad" (YD07)

"Leadership is best developed from a childhood stage where the mind starts to form. One should learn that other people matter as much as you do. Schools need to be improved and it needs to be introduced earlier where we learn how to be leaders in different ways at different times" (YD10)

Two SMs felt that leadership training should best be taught through the undergraduate phase into the postgraduate phase. One SM acknowledged that management and leadership are quite similar, and both should be taught in a formal environment, such as in an undergraduate institution. One SM believed that delivering leadership development at the undergraduate level would be very helpful in fostering information gained by coaching, mentoring and educating dentistry students as they progressed through their studies. Six YDs supported that leadership training should be offered from the undergraduate phase through to the postgraduate phase.

"Very early in undergraduate level such as in the 1st year and at the postgraduate level through the universities" (YD06)

"There should be greater motivation for leadership within the dental practice. It can be introduced as a major component of dental study and CPD courses for postgraduates" (YD02)

"Undergraduate level. Also, during postgraduate level, and then continuous learning" (YD03)

"Undergraduate basic knowledge with postgraduate more in-depth courses" (YD09)

Six SMs agreed that only postgraduate-level leadership training should be provided to dental students.

"In the postgraduate level because, as students, we focus on clinical skills and may end up not needing it after qualification" (SM04)

"Through congresses and learning from outside of South Africa by inviting someone to come in and interact with dentists, doctors and businesspeople, so the variety will help nurture ideas. Also networking sessions to meet like-minded people not necessarily in the same line of industry to stimulate one's thinking" (SM11)

Lastly, only one YD (YD05) felt that leadership skills should be taught to dentists at the postgraduate phase only.

DISCUSSION

In this study, we asked SMs and YDs what they felt were the most important non-clinical skills needed by dentists in SA, and when these skills should be taught at SA universities. Participants expressed varying insights about when best to teach management and leadership skills, but all participants agreed that there is a dire need for management and leadership training.

Participants in this study highlighted the dire need for non-clinical skills, management and leadership training for dentists. Dentists inevitably end up leading their team[18], and they will likely encounter management and leadership challenges due to not having these skills after graduation. These skills are needed to support change and innovation while empowering dental professionals to navigate these challenges.[19] Various studies have demonstrated that practicing dentists agree that curricula should include dental practice management courses.[20] Graduates of dental schools all over the world have adequate clinical skills, but they only start engaging with non-clinical work when they open practices. Studies have revealed that many people lack these soft skills.[21]

In dental settings, non-clinical activities include self-management abilities, service management, professionalism, communication and teamwork.[13] These skills are essential for dentists if they are to meet societal needs and maintain autonomy.[22] In our study, most participants confirmed that they lacked sufficient undergraduate training in non-clinical skills to prepare them for their hybrid roles as clinicians and managers. SMs identified four vital non-clinical skills, namely financial management, business skills, communication/marketing and practice management, that should be taught to undergraduate students. These skills fall within Domain B and C of the MLCF, where Domain B encompasses working with others and Domain C includes managerial services.

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16955

These suggest that experienced SMs recognised the importance of these skill sets, particularly financial management. In contrast, YDs identified communication, leadership skills and ethics, practice management skills and business skills as the most vital non-clinical skills to teach dentists. These findings can be attributed to the fact that most of the YDs were just eight years out of school, and their main areas of interest were clinical care and related skills such as communication, leadership and ethics. This suggests that these YDs still need to learn the necessary skills to function satisfactorily at the next stage of the MLCF for managing services.

In our study, we included two groups of participants, namely SMs and YDs. These groups responded differently, likely reflecting recent changes in dental education. For example, SMs reported a lack of appreciable management training during their undergraduate studies to sufficiently prepare them for clinical practice. In contrast, YDs did receive some form of dental practice management training as part of their undergraduate curriculum but still felt unprepared for leadership roles. Dental professionals can be trained in leadership knowledge and skills,[23] yet not all dental schools have incorporated the necessary leadership skills in their curricula.[12, 24, 25] Previous studies have confirmed that it is possible to include management and leadership training at the undergraduate level.[26-28] Such training would have remarkable benefits. Aside from improving dentists' ability to lead a dental team, such training might help educators to quickly recognise future leaders. The students would develop their own aspirations and grow into an awareness of their innate leadership abilities.[19] Our findings confirm that leadership training should be facilitated from the undergraduate phase through to the postgraduate phase, which is in line with previous studies.[9, 29] For leadership training to be successful, students should be accepting and willing to participate in training.[30, 31] Unfortunately, undergraduate curricula are often overloaded and there is not enough time for undergraduates to see the relevance of leadership training.[32] Consequently, postgraduate students may find leadership and management training to be more applicable. Kabir et al.[28] further reported that health professionals do not always attend postgraduate courses due to lack of time, support or opportunity. They seem to prefer focusing on their clinical work, and leaving the management and leadership tasks to support staff.[28] Ultimately, our results, and those of previous studies,[9, 29] support the inclusion of management and leadership training at all levels of training. The MLCF proposes that basic leadership skills such as personal qualities and working with others be included in undergraduate curricula. These skills include self-development, self-awareness, acting with integrity, communication, teamwork and the ability to build and maintain relationships. Undergraduate dental students should at the very least be introduced to managerial tasks. These skills should be expanded at the postgraduate level to include general management skills, improving services, evaluating impact and providing strategic direction. Most participants agreed that training should commence at the undergraduate level with follow-up postgraduate courses.

LIMITATIONS OF THE STUDY

The generalisability of the study may be affected due to the small sample size. It could, however, be argued that the key stakeholders who were consulted in this study were fairly representative of the incumbent organisational leadership in dentistry in SA. Young dentists also originated from multiple training institutions to give a perspective of their recent education.

CONCLUSION

Since dentists serve in a hybrid role as clinicians and managers who need to able to provide quality dental care and establish a profitable business, stakeholders in this study identified non-clinical skills that might be relevant to clinical treatment and practice management. To allow dentists in training to realise their leadership potential, participants unanimously agreed that management and leadership skills need to be introduced earlier in the curriculum and followed up at the postgraduate level.

ACKNOWLEDGEMENT:

We would like to acknowledge Dr Chery I Tosh (Science Editor, Faculty of Health Sciences, University of Pretoria) for her help with the editing of the manuscript.

Conflicts of interest

The authors have no conflicts of interest to disclose.

REFERENCES

1. Barber M, Wiesen R, Arnold S, et al. Perceptions of business skill development by graduates of the University of Michigan Dental School. J Dent Educ 2011; 75(4): 505-17
2. Haslach SD, Aytepe Z, Kokkari A, et al. Country and gender differences in the motivation of dental students – An international comparison. Eur J Dent Educ 2018; 22(4): e724-e729
3. Manski RJ, Moeller JF, Chen H, et al. Dental usage under changing economic conditions. J Public Health Dent 2014; 74(1): 1-12
4. McClure CB, Sæmundsson SR. Effects of a national economic crisis on dental habits and checkup behaviors – a prospective cohort study. Community Dent Oral Epidemiol 2014; 42(2): 106-12
5. Marks A, Mertz E. Leadership development: A critical need in the dental safety net. San Francisco: University of California. Center for the Health Professions at UCSF. 2012
6. Frank JR, Snell L, Englander R, Holmboe ES, Icbme Collaborators. Implementing competency-based medical education: Moving forward. Med Teach 2017; 39(6): 568-73
7. Kalenderian E, Taichman RS, Skoulas A, et al. Developing the next generation of leaders in oral health. J Dent Educ 2013; 77(11): 1508-14
8. Wali O. Leadership skills in dental curriculum – a review. J Evol Med Dent Sci 2018; 7(42): 4584-88
9. Patel R, Eaton KA, Garcia A, et al. Factors influencing dental practitioner performance: A summary of recent literature review. Oral Health Dent Manag 2011; 10(3): 119-30
10. Ireri S, Walshe K, Benson L, Mwanthi MA. A qualitative and quantitative study of medical leadership and management: experiences, competencies, and development needs of doctor managers in the United Kingdom. J Manag Marketing Healthc 2011; 4(1): 16-29
11. Levin RP. Business innovation in the dental practice. J Am Dent Assoc 2013; 144(2): 203-4
12. Seaman CL Leadership in dentistry: An empirical phenomenological study of practicing general dentists in South Central Idaho. University of Phoenix: 2008
13. Clark J, Armit K. Leadership competency for doctors: a framework. Leadersh Health Serv 2010; 23(2): 115-29
14. Van der Berg-Cloete SE, Snyman L, Postma TC, White JG. Dental students' perceptions of practice management and their career aspirations. Afr J Health Prof Educ 2015; 7(2): 194-8
15. Busari JO. Management and leadership development in healthcare and the challenges facing physician managers in clinical practice. Int J Clin Leadersh 2012; 17(4): 211-6
16. Van der Berg-Cloete SE, Snyman L, Postma TC, White JG. South African dental students' perceptions of most important nonclinical skills according to medical leadership competency framework. J Dent Educ 2016; 80(11): 1357-67
17. Gill P, Stewart K, Treasure E, Chadwick B. Methods of data collection in qualitative research: interviews and focus groups. Br Dent J 2008; 204(6): 291-5
18. Hebbal M, Ankola A, Murugaboopathy V, et al. Do Dentists Require Leadership Qualities? Can Med Edu J 2012; 3(1): e80
19. Morison S, McMullan C. Preparing for the future: challenges and opportunities for management and leadership skills. Br Dent J 2013; 214(1): E2-E2
20. Clark J, Armit K. Attainment of competency in management and leadership: no longer an optional extra for doctors. Clin Govern Int J 2008; 13(1): 35-42
21. Frymier AB, Shulman GM. "What's in it for me?" Increasing content relevance to enhance students' motivation. Commun Educ 1995; 44(1):40-50
22. Craven SH. Dentists as clinician managers: Leadership influences on dental team empowerment and engagement (Doctoral dissertation) Walden University, 2017
23. Miller DL, Umble KE, Frederick SL, Dinkin DR. Linking learning methods to outcomes in public health leadership development. Leadersh Health Serv 2007; 20(2): 97-123
24. Willeford R. 10 steps to a financially healthy practice, Part 1. Dent Econ 2006; 96(6): 22-6
25. Harkins D, Butz D, Taheri P. A new prescription for healthcare leadership. J Trauma Nurs 2006; 13(3): 126-30
26. Klaber RE, Roueché A, Hodgkinson R, Cass HD. A structured approach to planning a workbased leadership development programme for doctors in training. Int J Clin Leadersh 2008; 16(3): 121-9
27. Coltart CE, Cheung R, Ardolino A, et al. Leadership development for early career doctors. The Lancet 2012; 379(9828): 1847-9
28. Kabir C, Potty A, Sharma R. Current opportunities for the development of leadership skills for doctors. Int J Clin Leadersh 2008; 16(3): 115-9
29. Gallagher J, Wilson NH. The future dental work-force? BDJ 2009; 206(4): 195-9
30. Taichman RS, Parkinson JW, Nelson BA, et al. Leadership training for oral health professionals: a call to action. J Dent Educ 2012; 76(2): 185-91
31. Parsell G, Bligh J. Encouraging educational leadership. Med Educ (Oxford. Print) 2000; 34(3): 199-200
32. White JG, Kruger C, Snyman WD. Development and implementation of communication skills in dentistry: an example from South Africa. Eur J Dent Educ 2008; 12(1): 29-34
33. White JG. Interacting forces influencing private dental practice in South Africa: implications for dental education. SADJ 2008; 63(2): 80-5
34. Karimbux NY. Teaching dental practice management in a time of change. J Dent Educ 2015; 79(5): 463-4
35. Manogue M, McLoughlin J, Christersson C, et al. Curriculum structure, content, learning and assessment in European undergraduate dental education-update 2010. Eur J Dent Educ 2011; 15(3): 133-41

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16861

Root and canal morphology of the mandibular first molar: A micro-computed tomography-focused observation of literature with illustrative cases.

Part 1: External root morphology

SADJ October 2023, Vol. 78 No.9 p449-456

CH Jonker[1], PJ van der Vyver[2], AC Oettlé[3]

ABSTRACT

The mandibular first molar often requires endodontic intervention, which can be challenging and complex with several variants in the number of canals and roots. Usually, these teeth have a single mesial and distal root, but variants and anomalies have been noted. The incidence of the number of roots can differ between populations. For instance, up to a third of East Asians present with a third root, while the global prevalence is 8.9%. One- and four-rooted first molar teeth are seldom encountered. Over the years different methods have been used to study root and canal morphology, but micro-computed tomography (micro-CT) has provided a non-invasive method to study root and canal morphology in high definition. This paper is the first of two giving an overview of available literature on various aspects of the external and internal root and canal morphology of the mandibular first permanent molar. The aim is to provide an overview of relevant aspects of the external root morphology of the mandibular first molar in different populations. The content is supported by illustrative micro-CT images and a report on clinical cases where anomalies have been treated.

Authors' information:
1. Dr Casper H Jonker, *BChD, Dip Odont* (Endo), *MSc* (Endo), *PGCert* (ClinEd), *AFHEA*, PhD student in Anatomy (University of Pretoria), Faculty of Health, Peninsula Dental School, University of Plymouth Ground, Truro Dental Education Facility, Knowledge Spa, Royal Cornwall Hospital, Truro, UK.
ORCID: 0000-0002-9110-5208
2. Prof Peet J van der Vyver, *BChD, PG Dip Dent* (Endo), *PG Dip Dent* (Aesthet Dent), *MSc*, *PhD*, Department of Odontology, School of Dentistry, School of Health Sciences, University of Pretoria, Pretoria 0031, South Africa
ORCID: 0000-0003-1951-6042
3. Prof Anna C Oettlé, *MBBCh, DTE, MSc, PhD*, Department of Anatomy and Histology, School of Medicine, Sefako Makgatho Health Sciences University, Pretoria, South Africa.. ORCID: 0000-0002-9389-057X

Corresponding author
Name: Dr CH Jonker
Email: casper.jonker@plymouth.ac.uk
Tel: +44 1872 258104

Author's contribution
1. Casper H Jonker: Principal author, manuscript layout and write-up – 60%
2. Peet J van der Vyver: Treated patients and clinical images, manuscript layout and proofreading – 25%
3. Anna C Oettlé: Proofreading and layout – 15%

Acknowledgements
The corresponding author would like to extend his gratitude to Dr Charlotte Theye for technical support in preparation of the manuscript. The corresponding author would like to extend his gratitude to Dr Guy Lambourn, colleague and consultant in Prosthodontics, School of Dentistry, University of Plymouth, for his support and encouragement.

Keywords
Micro-CT, number of roots, radix entomolaris, radix paramolaris

INTRODUCTION

Root canal treatment involves the removal of irreversibly inflamed or infected tissues from a root canal system.[1,2] The endodontic treatment of molars can be particularly challenging due to their root and root canal complexity.[2] Variants in roots or canals can easily be overlooked during clinical investigation and if they remain undiscovered could compromise the treatment outcome. These undiscovered roots potentially harbour infected or inflamed root canals, which can cause re-infection and ultimate treatment failure.[2-4]

The mandibular first molars are often neglected in the early years, placing them at risk of early carious pulpal involvement leading to root canal treatment.[5] They often require endodontic intervention, which can be challenging and complex with several variants in the number of canals and roots.[2,6,7] In most populations the mandibular first molars have one mesial (M) and one distal (D) root with either three or four canals.[7-9] The incidence of the number of roots and root canals can differ between populations.[10-13] An additional root can be present on either the buccal or lingual surface. A radix entomolaris (RE) is an extra root on the disto-lingual side (DL); where an additional root is present on the mesiobuccal side it is referred to as a radix paramolaris (RP).[14,15]

Micro-computed tomography (micro-CT) is a non-invasive method to study root and canal morphology in high definition.[16] Although micro-CT was not originally intended for use in dentistry, Nielsen et al.[16] first used it to describe the root and root canal morphology of a maxillary first molar. Since then it has been used regularly for morphological studies and reporting on complex detail in human dentition; it has therefore been proposed as the most suitable method to describe complexities and fine morphological detail in dental studies.[7,16-19] In combination with suitable software (for example Avizo), all the components of a tooth can be viewed in different colours and isolated from each other in a segmentation process called the watershed.[20,21] Images can also be magnified and rotated for complete observation.

Figure 1 depicts examples of three-rooted mandibular first molars (RE) viewed through micro-CT and Avizo software,

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16861

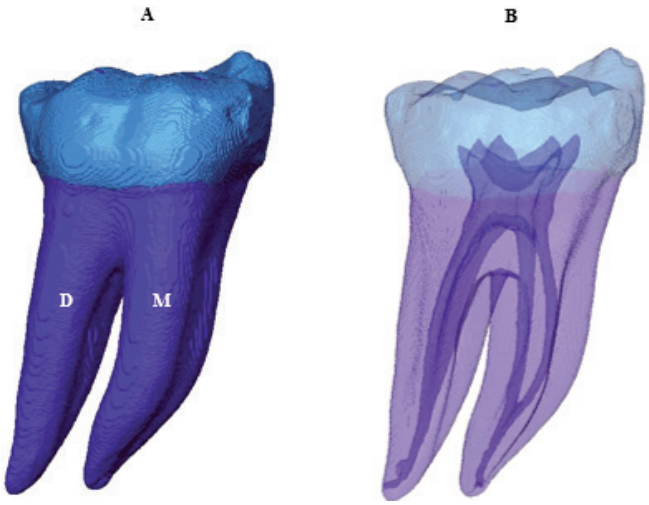


Figure 1: Micro-CT illustrations of a typical two-rooted mandibular first molar; (A) Viewed from mesio-buccal displaying one M and one D root; (B) Adjusted transparency with increased radiolucency illustrating the relationship between the external and internal root and canal morphology. This micro- CT image

while Figure 2 illustrates two clinical cases of South African patients.

The aim of this paper is to provide an overview of available literature on root morphology of the mandibular first molar supported by illustrative images in micro-CT and clinical cases. Authors report on different methods and populations that are included in the review, but this paper focuses on the use of micro-CT.

Number of roots

The consensus is that the mandibular first molar has two roots[7] and the prevalence can range between 73.5%[12] and 100%.[9] 10% nitric acid, and 99% methyl salicylate. India ink was coronally injected into the pulp chamber and withdrawn apically by suction. The teeth were viewed under a magnifying lens and the numbers of root canals and their configurations, lateral canals, intercanal communications, and multiple apical foramina were recorded, along with the number of roots and their morphology. Student's t test for independent samples was used to assess significant differences in the root canal system. All specimens were tworooted with one mesial and one distal root. Root fusion was more frequent in the second than in the first molar: 3.2% versus 0.4%. Vertucci type IV canal configuration was most frequently recorded in the mesial root of the first (44.6% Figure 1 illustrates the root and canal morphology of a typical mandibular first molar with a single M and D root using micro-CT and Avizo software.

Variants are single-rooted, three-rooted and four-rooted teeth. In a recent meta-analysis of available literature, a group of authors determined that, globally, the prevalence of two-rooted first molars was 90.2% and 8.9% for three-rooted teeth. They also did a geographic analysis of the prevalence of three-rooted first molars and found that the distribution was 12.2% in Asia, 3.2% in Africa and 3.2% in Europe.[22] Only a few studies on African subjects could be found in the literature reviewed. Subjects from Uganda, Tanzania and Kenya all had two roots,[9,23,24] 10% nitric acid, and 99% methyl salicylate. India ink was coronally injected into the pulp chamber and withdrawn apically by suction. The teeth were viewed under a magnifying lens and the numbers of root canals and their configurations, lateral canals, intercanal communications, and multiple apical foramina were recorded, along with the number of roots and their morphology. Student's t test for independent samples was used to assess significant differences in the root canal system. All specimens were tworooted with one mesial and one distal root. Root fusion was more frequent in the second than in the first molar: 3.2% versus 0.4%. Vertucci type IV canal configuration was most frequently recorded in the mesial root of the first (44.6%[23,24]University of Nairobi\nResults: The mesial root of mandibular first molars had two canals in 96.3% of the teeth in both males and females and type IV canal configuration was most prevalent in the mesial root. The distal root of the mandibular first molar had one canal in 57.7% of the teeth in males and females. There were significant gender variations in the number of canals and canal configurations in the distal root. Two canals were more prevalent in females (53.6% while in Egypt, 99.5% of teeth were two-rooted and 0.5% were three-rooted.[25] In a South African study investigating a mixed population, the authors reported an incidence of two roots in 98.7%, 1% of three-rooted first molars, 0.3% for single-rooted teeth and no teeth with four roots.[8]

There are several papers available on the number of roots in different populations and most used cone-beam computed tomography (CBCT), but few authors reported on root numbers in their micro-CT investigations. In a Chinese population where 122 first molars were observed using this technology, Gu et al.[26] found 1.6% of teeth were single-rooted, 66.4% were two-rooted and approximately 32% were three-rooted. A prevalence of approximately 2.6% with a third root was reported in a Brazilian population also using micro-CT.[27] An overview of investigations that reported on the number of roots in different populations is given in Table I.

Radix entemolaris (RE) and radix paramolaris (RP)

Several studies report different prevalence of RE and RP. The differences in prevalence noted could be ascribed to variations between populations. A number of investigators used CBCT and other techniques used include *in vivo* radiographic observations[61,62] or *in vitro* observations of extracted teeth.[29,42,54] Examining literature from different studies using different modalities, a group of authors in 2012 calculated an average of 14.4% of RE.[63] A population-specific report published in 2022 found an average prevalence of RE of 5.6% on 23 nations from five continents using CBCT. The findings ranged from 0.9% in Venezuela to 22.4% in China.[64] On the other hand, a literature review and meta-analysis in the same year (2022) of 72 available studies on 33 populations worldwide focusing on CBCT as the main methodology determined that the RE was present on average in 12.3% of teeth, ranging between 0% and 29% in 72 studies originating from 33 populations. On average, RP was present in 0.1% of teeth ranging between 0% and 2%.[65] There was also a rare clinical case of a first molar that had both RE and RP.[66]

In Africa there were a few reports on RE or RP. In Ugandan, Tanzanian and Kenyan population groups no teeth had RE or RP.[9,23,24]10% nitric acid, and 99% methyl salicylate. India ink was coronally injected into the pulp chamber and withdrawn apically by suction. The teeth were viewed under a magnifying lens and the numbers of root canals and their configurations, lateral canals, intercanal communications, and multiple apical foramina were recorded, along with the number of roots and their morphology. Student's t test for independent samples was used to assess significant differences in the root canal system. All specimens were tworooted with one mesial and one distal root. Root fusion was more frequent in the second than in the first molar: 3.2% versus 0.4%. Vertucci type IV canal configuration was most frequently recorded in the mesial root of the first (44.6% In a Senegalese

https://doi.org/10.17159/sadj.v78i09.16861

Table I: Summary of the number of roots in mandibular first molars identified in different populations.

Country	One root (%)	Two roots (%)	Three roots (%)	Four roots (%)	Number of teeth	Author and date
Belgium	0.7	96.5	2.8	-	145	Torres et al. 2015[28]
Burma	-	89.9	10.1	-	139	Gulabivala et al. 2001[29]
Brazil	3.0	97.0	-	-	234	Silva et al. 2013[30]
Brazil	1.0	94.9	4.1	-	600	Mantovani et al. 2022[31]
Chile	-	93.8	6.2	-	146	Torres et al. 2015[28]
Chile	0.2	99.8	-	-	510	Abarca et al. 2020[32]
China	0.7	73.5	25.8	-	558	Wang et al. 2010[12]
China	-	77.5	22.3	0.2	910	Zhang et al. 2015[33]
China	1.6	66.4	32.0	-	122	Gu et al. 2010[26]
China	-	74.1	25.9	-	466	Martins et al. 2018[34]
Egypt	-	99.5	0.5	-	218	Sharaan and Elrawdy 2017[25]
France	1.5	90.0	7.7	0.8	130	Monsarat et al. 2016[35]
Greece	0.2	96.4	3.3	-	478	Kantilieraki et al. 2019[36]
India	-	94.6	5.3	-	150	Chourasia et al. 2012[13]
India	0.7	93.6	5.7	-	299	Felsypremila et al. 2015[37]
Iran	-	98.6	1.4	-	209	Shahi et al. 2008[38]
Iran	-	96.7	3.3	-	150	Akhlaghi et al. 2017[39]
Iran	1.2	96.8	2.0	-	154	Madani et al. 2017[40]
Italy	-	100	-	-	117	Plotino et al. 2013[41]
Japan	-	68.4	31.6	-	38	Peiris et al. 2008[42]
Jordan	-	96.0	4.0	-	330	Al-Qudah and Awawdeh 2009[10]
Korea	0.7	73.5	25.8	-	1952	Kim et al. 2013[43]
Korea	0.3	77.4	22.3	-	666	Park et al. 2013[44]
Malaysia	0.4	88.1	11.4	-	301	Deng et al. 2018[45]
Palestine	-	96.3	3.7	-	322	Mukhaimer and Azizi 2014[46]
Portugal	0.7	97.3	2.0	-	709	Martins et al. 2016[47]
Portugal	0.7	97.1	2.2	-	450	Martins et al. 2017[48]
Portugal	0.6	96.8	2.6	-	220	Martins et al. 2018[34]
Saudi Arabia	-	97.1	2.9	-	174	Mashyakhy et al. 2019[49]
South Africa	0.3	98.7	1.0	-	371	Tredoux et al. 2021[8]
Spain	1.7	94.2	4.1	-	121	Pérez-Heredia et al. 2017[50]
Sri Lanka	-	97.0	3.0	-	100	Peiris et al. 2007[51]
Sri Lanka	-	95.8	4.1	-	529	Peiris et al. 2015[52]
Sri Lanka	-	94.4	5.6	-	295	Peiris et al. 2008[42]
Tanzania	-	100	-	-	146	Madjapa and Minja 2018[24]
Taiwan	-	74.7	25.3	-	237	Huang et al. 2010[53]
Thailand	0.6	85.6	9.4	0.6	118	Gulabivala et al. 2002[54]
Turkey	-	97.6	2.4	-	533	Miloglu et al. 2013[55]
Turkey	0.3	99.2	0.5	-	966	Nur et al. 2014[56]
Turkey	1.8	95.9	2.1	0.2	823	Demirbuga et al. 2013[57]
Uganda	-	100	-	-	224	Rwenyonyi et al. 2009[9]
UAE	-	96.0	4.0	-	807	Al Shehadat et al. 2019[58]
Vietnam	-	87.7	12.3	-	166	Pham et al. 2019[59]
Yemen	-	96.8	3.2	-	500	Senan et al. 2020[60]

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16861

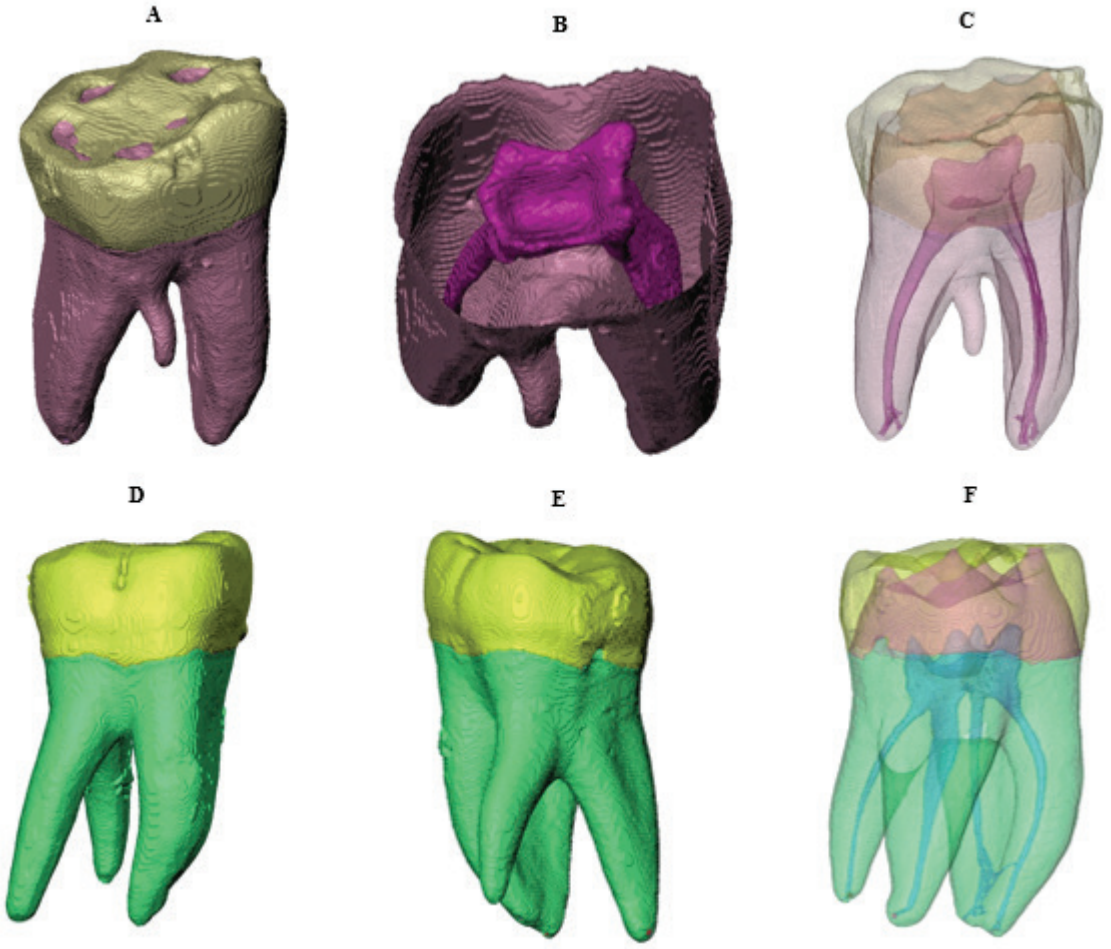


Figure 2: Micro-CT illustrations of mandibular first molars with additional DL roots and classified as RE; (A) Micro-CT view of a mandibular first molar with an additional DL root (RE); (B) No root canal system was noted in the additional DL root; (C) Adjusted transparency displaying the relationship between roots and root canals with no root canal present in the DL root; (D) Buccal view of a mandibular first molar that presents with RE; (E) DL view of the RE displaying three separate roots; (F) Transparent view allowing visualisation of the pulp-root interface.

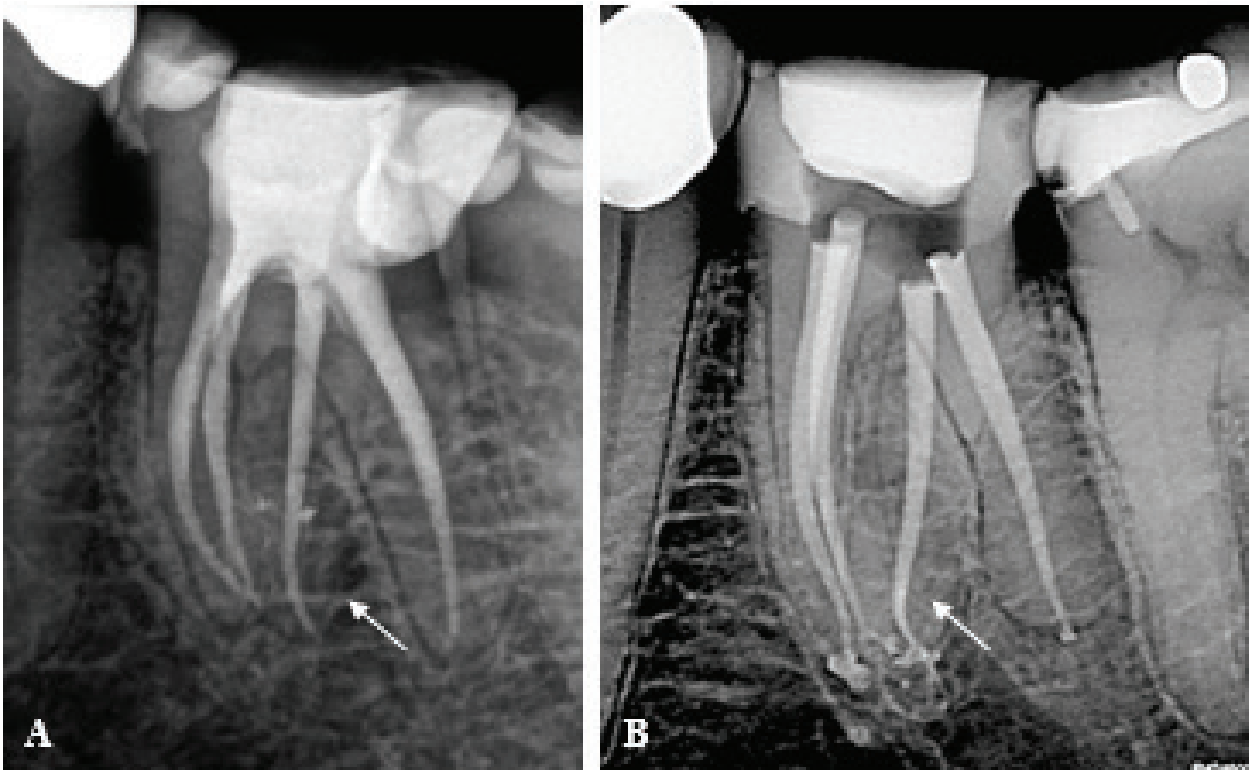


Figure 3: Completed endodontic treatment on mandibular first molars with RE; (A) Periapical radiograph of left mandibular first molar that presented with RE. Note the additional DL root and root canal system (arrow); (B) Periapical radiograph of right mandibular first molar that presented with RE. Note the additional DL root and root canal system (arrow).

https://doi.org/10.17159/sadj.v78i09.16861

population a prevalence of 3.1% was noted.[67]West Africa, revealed 15 teeth with three roots (3.12% In Egypt, a prevalence of approximately 0.7% was noted in individuals of African descent,[68] while a relatively high prevalence of 10.8% was noted in Syrian individuals.[64] In South Africa a prevalence of 1% and 5.2% respectively has been reported in mixed populations from Pretoria and Durban.[8,64]

A limited number of authors reported the presence of RE or RP when using micro-CT investigations. A prevalence of approximately

Table II: Summary of prevalence of RE or RP as reported by authors in different population groups.

Region/country	Number of teeth	Prevalence (%) RP	Prevalence (%) RE	Author and date
Africa	68	-	-	Shaw 1931[70]
Belgium	250	-	3.2	Martins et al. 2022[64]
Brazil (Africans)	106	-	2.8	Ferraz and Pecora 1992[71]
Brazil (Japanese)	105	-	11.4	Ferraz and Pecora 1992[71]
Brazil (Caucasian)	117	-	4.2	Ferraz and Pecora 1992[71]
Brazil	232	-	5.2	Da Costa Rochai et al. 1996[72]
Burma	139	-	10.1	Gulabivala et al. 2001[29]
Canada (Baffin Inuit)	69	-	21.7	Corzon 1974[73]
Canada (Keewatin Inuit)	98	-	27.0	Curzon and Curzon 1971[74]
Canada (Alberta Native American/Mongloid)	250	-	16.0	Somogyi-Csizmazia and Simons 1971[75]
China	122	-	32.0	Gu et al. 2010[26]
China	232	-	29.7	Zhang et al. 2011[76]
China	1020	-	27.1	Yang et al. 2010[77]
China	558	-	25.8	Wang et al. 2010[12]
China	910	-	22.1	Zhang et al. 2015[33]
Costa Rica	250	-	2.4	Martins et al. 2022[64]
Egypt	218	-	0.5	Sharaan and Elrawd 2017[25]
Egyptian Africans	457	-	0.7	Younes et al. 1990[68]
England (Caucasians)	390	-	3.4	Curzon 1973[78]
France	250	-	3.2	Martins et al. 2022[64]
Georgia	247	-	6.9	Beshkenadze and Chipashvili 2015[79]
Germany	1024	-	0.7	Schäfer, Breuer and Janzen 2009[80]
Greece	478	-	3.3	Kantilieraki et al. 2019[36]
Guam	400	-	13.0	Hochstetter 1975[81]
Iceland	250	-	4.0	Martins et al. 2022[64]
India	1000	-	13.3	Chandra et al. 2011[62]
India	150	-	5.3	Chourasia et al. 2012[13]
India	1100	-	1.0	Bansal and Ajwani 2010[82]
India	299	0.7	5.0	Felsypremila et al. 2015[37]
India	1054	-	4.6	Garg et al. 2010[61]
Iran	250	1.2	-	Kuzekanani and Najafipour 2018[83]
Iran	386	-	3.1	Rahimi et al. 2017[84]
Israel	1229	0.6	2.0	Shemesh et al. 2015[85]
Italy	250	-	12.4	Martins et al. 2022[64]
Japan (Caucasians)	198	-	1.0	Onda et al. 1989[86]
Japan (Chinese)	426	-	11.7	Walker 1985[87]
Japan (Chinese)	100	-	15.0	Walker 1988[88but]
Japan	38	-	31.6	Peiris et al. 2008[42]
Jordan	330	-	3.9	Al-Qudah and Awawde 2009[10]
Korea	3088	-	24.5	Song et al. 2010[69]
Korea	1304	-	33.1	Song et al. 2009[89]
Korea	1952	0.1	25.8	Kim et al. 2013[43]
Korea	727	-	22.3	Park et al. 2013[44]
Kuwait	147	-	2.7	Zaatar et al. 1997[90]

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16861

Kuwait	110	-	3.6	Pattanshetti et al. 2008[91]
Malaysia	370	-	21.4	Pan et al. 2019[92]
Mexico	250	-	9.2	Martins et al. 2022[64]
Netherlands	1713	-	1.0	Bolk 1915[15]
New Zealand	250	-	4.4	Martins et al. 2022[64]
Palestine	322	-	3.7	Mukhaimer and Azzizi 2014[46]
Peru	250	-	5.6	Martins et al. 2022[64]
Portugal	450	-	2.2	Martins et al. 2017[48]
Saudi Arabia	251	-	6.0	Al-Nazhan et al. 1999[93]
Senegal	480	-	3.1	Sperber and Moreau 1998[67]
Singapore (Chinese)	304	-	7.9	Loh 1990[94]
South Africa (Khoisan)	23	-	-	Drennan 1929[95]
South Africa (mixed)	369	-	1.0	Tredoux et al. 2021[8]
South Africa (mixed)	250	-	5.2	Martins et al. 2022[96]
Spain	121	-	4.1	Pérez-Heredia et al. 2017[50]
Sri Lanka	100	-	3.0	Peiris et al. 2008[97]
Sri Lanka	295	-	5.6	Peiris et al. 2008[42]
Sudan	100	-	3.0	Ahmed et al. 2007[98]
Syria	250	-	10.8	Martins et al. 2022[96]
Taiwan	521	-	22.1	Huang et al. 2010[53]
Taiwan	332	-	17.8	Tu et al. 2007[99]
Taiwan	337	-	21.7	Huang et al. 2007[100]
Taiwan	832	-	21.5	Yew and Chan 1993[101]an extradistal root. (c
Taiwan	246	-	25.6	Tu et al. 2009[102]
Taiwan	183	-	19.7	Chen et al. 2009[103]
Thailand	364	-	19.2	Reichart and Metah 1981[104]
Thailand	118	-	12.7	Gulabivala et al. 2002[54]
Turkey	966	-	0.5	Nur et al. 2014[56]
Turkey	823	-	2.1	Demirbuga et al. 2013[57]
USA (Hispanics)	156	-	6.4	Steelman 1986[105]
USA (Caucasians)	45	-	2.2	Skidmore and Bjorndal 1971[106]
United Kingdom	119	-	3.4	Taylor 1899[107]
United Kingdom	250	-	3.2	Martins et al. 2022[96]
Yemen	250	-	3.2	Senan et al. 2020[60]

2.6% was noted[27] in a Brazilian population, while the prevalence was approximately 32% in a Chinese study.[26] In another example of an East Asian group, using computer tomography scanning, Song et al. report a relatively high prevalence of 24.5% in a Korean population.[69]

Figure 2 depicts examples of three-rooted mandibular first molars (RE) viewed through micro-CT and Figure 3 illustrates two clinical cases of South African patients who presented with RE.
A summary of other findings in literature can be found in Table II. It is interesting to note that East Asian groups from China, Taiwan, Japan, Korea and Malaysia, as well as Inuit groups, presented with prevalence often greater than 20% and sometimes over 30%, while other populations from Europe and Africa often presented with prevalence below 10% or even below 5%. It was also noted that different populations within a country can present with variants in prevalence – for example, in China it ranged between 22.1% and 32% and in India between 1% and 13.3%.

DISCUSSION

The root morphology of the mandibular first molar is diverse and can differ greatly among populations. A number of factors can influence the incidence, including genetics and geographic distances.[108-110] The differences between individuals or populations are therefore important factors to consider in treatment. Any variations can create difficulties during the diagnostic phase and root or canal morphology that remains undiscovered greatly increases the risk of treatment failure.[2,111]

Authors have used a number of techniques to visualise the morphology of the root canal, such as radiographs,[112] scanning electron microscopy (SEM)67 and magnification.[113] Three-dimensional techniques, for example CBCT109 and micro-CT,[114] have revolutionised the study of root and canal morphology. Micro-CT has become the modality of choice for the investigation of complex root and canal morphology; it can display very fine detail that is easily missed when using other techniques.[114-116]

The typical mandibular first molar contains two roots[7] and the prevalence can range between 73.5% and 100%. The mandibular first molar can also be single-rooted, three-rooted and four-rooted (see Table I). It has also been determined that the global prevalence of two-rooted first molars is 90.2% and 8.9% for three-rooted ones.[22] An awareness of the number of roots is important for

https://doi.org/10.17159/sadj.v78i09.16861

diagnostic purposes and treatment planning. Any additional roots can create challenges for a treating clinician during endodontics and surgical difficulties once a tooth requires extraction.[2,7,96] An additional root, first described by Carabelli,[117] can be a separate morphology or partially fused with other roots.[61] As stated earlier, the additional root can be located DL (RE)[15] or mesio-buccal (RP). These roots are often small and can have a sharp apical hook.[14] They can be challenging to diagnose using traditional radiographs or two-dimensional diagnostic tools.[118]

Geographic distance between populations affects the prevalence of a third root; for example, it is greater in East Asian populations than in European and African groups. The prevalence can be as high as 33.1%, which was noted in a Korean population.[89] In most African populations only two roots were present (Tanzania, Uganda and Kenya) in individuals of African descent.[9,23,24]10% nitric acid, and 99% methyl salicylate. India ink was coronally injected into the pulp chamber and withdrawn apically by suction. The teeth were viewed under a magnifying lens and the numbers of root canals and their configurations, lateral canals, intercanal communications, and multiple apical foramina were recorded, along with the number of roots and their morphology. Student's t test for independent samples was used to assess significant differences in the root canal system. All specimens were tworooted with one mesial and one distal root. Root fusion was more frequent in the second than in the first molar: 3.2% versus 0.4%. Vertucci type IV canal configuration was most frequently recorded in the mesial root of the first (44.6% In a Senegalese population of African descent, a prevalence of 3.2% was noted for three-rooted first molars, which could be ascribed to a larger sample size than in the other African studies mentioned. Smaller sample sizes should be interpreted with care.[115] In South Africa, Tredoux and co-workers[8] found a prevalence of 1% for RE. In another mixed population group from South Africa, but in a different region (Durban, KwaZulu-Natal), a prevalence of 5.2% was noted.[96] In both these South African studies, CBCT was used. In two non-identical worldwide studies on the prevalence of RE in the same year (2022), different prevalences were reported (5.6% and 12.3%). As the prevalence is population-specific, reviews including different populations will report different prevalences. No studies could be found reporting on RE or RP in a South African population group using micro-CT.

In conclusion, the root morphology of the mandibular first molar can show variations between populations. Clinicians should be mindful of root variations or the presence of additional roots, as they can contain additional root canal systems and complicate root canal treatments. Studies focusing on African populations and specifically on South Africa are limited and no micro-CT studies were reported on in the literature researched.

Authors' declaration

The authors declare that there is no financial interest in this paper and that this paper has not been submitted elsewhere for publication. All authors agree with the content of the manuscript.

This manuscript did not receive any funding from funding agencies in the public, commercial or not-for-profit sectors.

Conflict of interest

The authors declare there is no conflict of interest.

REFERENCES

1. Wu MK, Wesselink PR, Walton, RE. Apical terminus location of root canal treatment procedures. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2000; 89: 99-103. DOI: 10.1016/S1079-2104(00)80023-2
2. Vertucci FJ. Root canal morphology and its relationship to endodontic procedures. Endod Topics. 2005; 10: 3-29. DOI: 10.1111/j.1601-1546.2005.00129.x
3. Versiani MA, Ordinola-Zapata R. Root canal anatomy: Implications in biofilm disinfection. In: The root canal biofilm, 1st ed. Heidelberg: Springer, 2015: 155-87
4. Versiani MA, De-Deus G, Vera J, et al. Mapping of the irrigated areas of the root canal space using micro-computed tomography. Clin Oral Invest. 2015; 19: 859-66. DOI: 10.1007/s00784-014-1311-5
5. Gutmann JL, Fan B. Tooth morphology, isolation, and access. Cohen's pathways of the pulp, 11th ed. St. Louis: Elsevier, 2016: 130-208
6. Versiani MA, Ordinola-Zapata R, Keles A, et al. Middle mesial canals in mandibular first molars: A Micro-CT study in different populations. Arch Oral Biol. 2016; 61: 130-37. DOI: 10.1016/j.archoralbio.2015.10.020
7. Versiani MA, Sousa-Neto MD, Basrani B. The root canal dentition in permanent dentition, 1st ed. Heidelberg: Springer, 2018: 89-240
8. Tredoux S, Warren N, Buchanan GD. Root and canal configurations of mandibular first molars in a South African subpopulation. J Oral Sci. 2021; 63: 252-56
9. Rwenyonyi CM, Kutesa A, Muwazi LM, Buwembo W. Root and canal morphology of mandibular first and second permanent molar teeth in a Ugandan population. Odontology. 2009; 97: 92-6
10. Al-Qudah AA, Awawdeh LA. Root and canal morphology of mandibular first and second molar teeth in a Jordanian population. Int Endod J. 2009; 42: 775-84. DOI:10.1111/j.1365-2591.2009.01578.x
11. Chen G, Yao H, Tong C. Investigation of the root canal configuration of mandibular first molars in a Taiwan Chinese population. Int Endod J. 2009; 42: 1044-49. DOI:10.1111/j.1365-2591.2009.01619.x
12. Wang Y, Zheng Q, Zhou X, et al. Evaluation of the root and canal morphology of mandibular first permanent molars in a Western Chinese population by cone-beam computed tomography. J Endod. 2010; 36: 1786-89. DOI: 10.1016/j.joen.2010.08.016
13. Chourasia HR, Meshram GK, Warhadpande M, Dakshindas D. Root canal morphology of mandibular first permanent molars in an Indian population. Int J Dent. 2012; 2012: 1-6
14. Calberson FL, De Moor RJ, Deroose CA. The radix entomolaris and paramolaris: Clinical approach in endodontics. J Endod, 2007; 33: 58-63
15. Bolk L. Bemerkungen über wurzelvariationen am menschlichen unteren molaren. Z Morphol Anthropol, 1915; 17: 605-10
16. Nielsen RB, Alyassin AM, Peters DD, Carnes DL, Lancaster J. Microcomputed tomography: An advanced system for detailed endodontic research. J Endod. 1995; 21: 561-68
17. Grande NM, Plotino G, Gambarini G, et al. Present and future in the use of Micro-CT scanner 3D analysis for the study of dental and root canal morphology. Ann 1st Super Sanita. 2012; 48: 26-34
18. Briseño-Marroquín B, Paqué F, Maier K, Willershausen B, Wolf TG. Root canal morphology and configuration of 179 maxillary first molars by means of micro-computed tomography: An ex vivo study. J Endod. 2015; 41: 2008-13
19. Ahmed HMA, Ibrahim N, Mohamad NS, et al. Application of a new system for classifying root and canal anatomy in studies involving micro-computed tomography and cone beam computed tomography: Explanation and elaboration. Int Endod J. 2021; 54: 1056-82
20. Meyer F, Beucher S. Morphological segmentation. J Vis Commun Image Represent, 1990; 1: 21-46
21. Westenberger P. Avizo – Three-dimensional visualization framework. In: Proceedings of the Geoinformatics 2008 – Data to Knowledge, USGS, 2008, 13-4
22. Tomaszewska IM, Jarzebska A, Skinningsrud B, Pekala PA, Wronski S, Iwanaga J. An original Micro-CT study and meta-analysis of the internal and external anatomy of maxillary molars – implications for endodontic treatment: Morphology of maxillary molars. Clin Anat. 2018; 31: 838-53. DOI: 10.1002/ca.23201
23. Muriithi NJ, Maina SW, Okoth J, Gathece LW. Internal root morphology in mandibular first permanent molars in a Kenyan population. East Afr Med J. 2012; 89: 166-71
24. Madjapa HS, Minja IK. Root canal morphology of native Tanzanian permanent mandibular molar teeth. Pan Afr Med J. 2018; 31: 1-6. DOI: 10.11604/pamj.2018.31.24.14416
25. Sharaan M, Elrawdy A. An evaluation of mandibular molars root canal morphology using cone-beam computed tomography in an Egyptian subpopulation. Tanta Dent J. 2017; 14: 220-4. DOI: 10.4103/tdj.tdj_50_17
26. Gu Y, Lu Q, Wang H, Ding Y, Wang P, Ni L. Root canal morphology of permanent three-rooted mandibular first molars – Part I: Pulp floor and root canal system. J Endod. 2010; 36: 990-4, DOI :10.1016/j.joen.2010.02.030
27. Rodrigues CT, Oliveira-Santos C, Bernardineli N, et al. Prevalence and morphometric analysis of three-rooted mandibular first molars in a Brazilian subpopulation. J Appl Oral Sci. 2016; 24: 535-42. DOI: 10.1590/1678-775720150511
28. Torres A, Jacobs R, Lambrechts P, et al. Characterization of mandibular molar root and canal morphology using cone beam computed tomography and its variability in Belgian and Chilean population samples. Imaging Sci Dent. 2015; 45: 95-101
29. Gulabivala K, Aung TH, Alavi A, Ng Y. Root and canal morphology of Burmese mandibular molars. Int Endod J. 2001; 34: 359-70. DOI: 10.1046/j.1365-2591.2001.00399.x
30. Silva EJNL, Nejaim Y, Silva AV, Haiter-Neto F, Cohenca N. Evaluation of root canal configuration of mandibular molars in a Brazilian population by using cone-beam computed tomography: An in vivo study. J Endod. 2013; 39: 849-52. DOI: 10.1016/j.joen.2013.04.030
31. De Oliveira Mantovani V, Gabriel AE, De Silva RG, Savioli RN, Sousa-Neto MD, Cruz-Filho AM. Analysis of the mandibular molar root canal morphology. Study by computed tomography. Braz Dent J. 2022; 33: 1-8
32. Abarca J, Duran M, Parra D, Steinfort K, Zaror C, Monardes H. Root morphology of mandibular molars: A cone-beam computed tomography study. Folia Morphol. 2020; 79: 327-32
33. Zhang X, Xiong S, Ma Y, et al. A cone-beam computed tomographic study on mandibular first molars in a Chinese subpopulation. PLoS ONE. 2015; 10, e0134919. DOI: 10.1371/journal.pone.0134919
34. Martins JNR, Gu Y, Marques D, Francisco H, Caramês J. Differences on the root and root canal morphologies between Asian and White ethnic groups analyzed by cone-beam computed tomography. J Endod, 2018; 44: 1096-104. DOI: 10.1016/j.joen.2018.04.001
35. Monsarrat P, Arcaute B, Peters OA, et al. Interrelationships in the variability of root canal anatomy among the permanent teeth: A full-mouth approach by cone-beam CT. PLoS ONE. 2016; 11: e0165329. DOI: 10.1371/journal.pone.0165329
36. Kantilieraki E, Delantoni A, Angelopoulos C, Beltes P. Evaluation of root and root canal morphology of mandibular first and second molars in a Greek population: A CBCT study. Eur Endod J. 2019; 4: 62-8
37. Felsypremila G, Vinothkumar TS, Kandaswamy D. Anatomic Symmetry of root and root canal morphology of posterior teeth in an Indian subpopulation using cone-beam computed tomography: A retrospective study. Eur J Dent. 2015; 09: 500-7. DOI: 10.4103/1305-7456.172623
38. Shahi S, Yavari HR, Rahimi S, Torkamani R. Root canal morphology of human mandibular first permanent molars in an Iranian population. J Dent Res Dent Clin Dent Prospects. 2008; 2: 20-3. DOI: 10.5681/joddd.2008.004
39. Akhlaghi NM, Khalilak Z, Vatanpour M, et al. Root canal anatomy and morphology of mandibular first molars in a selected Iranian population: An in vitro study. Iran Endod J. 2017; 12: 87-91
40. Madani ZS, Mehraban N, Moudi E, Bijani A. Root and canal morphology of mandibular molars in a selected Iranian population using cone-beam computed tomography. Iran Endod J. 2017; 12: 143-8
41. Plotino G, Tocci L, Grande NM, et al. Symmetry of root and root canal morphology of maxillary and mandibular molars in a White population: A cone-beam computed tomography study in vivo. J Endod. 2013; 39: 1545-8. DOI: 10.1016/j.joen.2013.09.012

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16861

42. Peiris R. Root and canal morphology of human permanent teeth in a Sri Lankan and Japanese population. Anthropol Sci. 2008; 116: 123-33. DOI: 10.1537/ase.070723
43. Kim SY, Kim BS, Woo J, Kim Y. Morphology of mandibular first molars analyzed by cone-beam computed tomography in a Korean population: Variations in the number of roots and canals. J Endod. 2013; 39: 1516-21. DOI: 10.1016/j.joen.2013.08.015
44. Park JB, Kim N, Park S, Kim Y, Ko Y. Evaluation of root anatomy of permanent mandibular premolars and molars in a Korean population with cone-beam computed tomography. Eur J Dent. 2013; 7: 94-101
45. Deng PU, Halim MS, Sam'an Malik Masudi SA, Shehadat BA. Cone-beam computed tomography analysis on root and canal morphology of mandibular first permanent molars among a multiracial East Coast Malaysian population. Eur J Dent. 2018; 12: 410-6
46. Mukhaimer R, Azizi Z. Incidence of radix entomolaris in mandibular first molars in a Palestinian population: A clinical investigation. Int Sch Res Notices. 2014; 2014: 1-5
47. Martins JN, Mata A, Marques D, Caramês J. Prevalence of root fusions and main root canal merging in human upper and lower molars: A cone-beam computed tomography in vivo study. J Endod. 2016; 42: 900-8
48. Martins JNR, Marques D, Mata A, Caramês J. Root and root canal morphology of the permanent dentition in a Caucasian population: A cone-beam computed tomography study. Int Endod J. 2017; 50: 1013-26. DOI: 10.1111/iej.12724
49. Mashyakhy M, Chourasia HR, Halboub E, Almashraqi AA, Khubrani Y, Gambarini G. Anatomical variations and bilateral symmetry of roots and root canal system of mandibular first permanent molars in a Saudi Arabian population utilizing cone-beam computed tomography. Saudi Dent J. 2019; 31: 481-6. DOI: 10.1016/j.sdentj.2019.04.001
50. Pérez-Heredia M, Ferrer-Luque CM, Bravo M, Castelo-Baz P, Ruíz-Piñón M, Baca P. Cone-beam computed tomographic study of root anatomy and canal configuration of molars in a Spanish population. J Endod. 2017; 43: 1511-6. DOI: 10.1016/j.joen.2017.03.026
51. Peiris R, Takahashi M, Sasaki K, Kanazawa E. Root and canal morphology of permanent mandibular molars in a Sri Lankan population. Odontology. 2007; 95: 16-23. DOI: 10.1007/s10266-007-0074-8
52. Peiris R, Malwatte U, Abayakoon J, Wettasinghe A. Variations in the root form and root canal morphology of permanent mandibular first molars in a Sri Lankan population. Anat Res Int. 2015; 2015: 1-7. DOI: 10.1155/2015/803671
53. Huang RY, Cheng WC, Chen CJ, et al. Three-dimensional analysis of the root morphology of mandibular first molars with distolingual roots. Int Endod J. 2010; 43: 478-84. DOI: 10.1111/j.1365-2591.2010.01702.x
54. Gulabivala K, Opasanon A, Ng YL, Alavi A. Root and canal morphology of Thai mandibular molars. Int Endod J. 2002; 35: 56-62. DOI: 10.1046/j.1365-2591.2002.00452.x
55. Miloglu O, Arslan H, Barutcigil C, Cantekin K. Evaluating root and canal configuration of mandibular first molars with cone beam computed tomography in a Turkish population. J Dent Sci. 2013; 8: 80-6. DOI: 10.1016/j.jds.2012.09.002
56. Nur BG, Ok E, Altunsoy M, Aglarci OS, Colak M, Gungor, E. Evaluation of the root and canal morphology of mandibular permanent molars in a south-eastern Turkish population using cone-beam computed tomography. Eur J Dent. 2014; 08: 154-9. DOI: 10.4103/1305-7456.130584
57. Demirbuga S, Sekerci A, Dincer A, Cayabatmaz M, Zorba Y. Use of cone-beam computed tomography to evaluate root and canal morphology of mandibular first and second molars in Turkish individuals. Med Oral Patol Oral Cir Bucal. 2013; 18: e737-e744
58. Al Shehadat S, Waheb S, Al Bayatti SW, Kheder W, Khalaf K, Murray CA. Cone-beam computed tomography analysis of root and root canal morphology of first permanent lower molars in a Middle East subpopulation. J Int Soc Prev Community Dent. 2019; 9: 458-63
59. Pham K, Le AL. Evaluation of roots and canal systems of mandibular first molars in a Vietnamese subpopulation using cone-beam computed tomography. J Int Soc Prev Community Dent. 2019; 9: 356-62. DOI: 10.4103/jispcd.JISPCD_52_19
60. Senan EM, Madfa AA, Alhadainy HA. Root and canal configuration of mandibular first molars in a Yemeni population: A cone-beam computed tomography. Eur Endod J. 2020; 5: 10-7
61. Garg AK, Tewari RK, Kumar A, Hashmi SH, Agrawal N, Mishra SK. Prevalence of three-rooted mandibular permanent first molars among the Indian population. J Endod. 2010; 36: 1302-6. DOI: 10.1016/j.joen.2010.04.019
62. Chandra SS, Chandra S, Shankar P, Indira R. Prevalence of radix entomolaris in mandibular permanent first molars: A study in a South Indian population. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2011; 112: e77-e82. DOI: 10.1016/j.tripleo.2011.02.016
63. Abella F, Patel S, Durán-Sindreu F, Mercadé M, Roig M. Mandibular First molars with disto-lingual roots: Review and clinical management: Mandibular first molars with disto-lingual roots. In Endod J. 2012; 45: 963-78. DOI: 10.1111/j.1365-2591.2012.02075.x
64. Martins JN, Nole C, Ounsi HF, et al. Worldwide assessment of the mandibular first molar second distal root and root canal: A cross-sectional study with meta-analysis. J Endod. 2022; 48: 223-33
65. Aung NM, Myint KK. Three-rooted permanent mandibular first molars: A meta-analysis of prevalence. Int J Dent. 2022; 2022: 1-30
66. Gladwin L, Patel JA. Rare finding of a radix entomolaris and radix paramolaris in a lower first mandibular molar requiring endodontic treatment: A case report. Dent Update. 2022; 49: 515-8
67. Sperber GH, Moreau JL. Study of the number of roots and canals in Senegalese first permanent mandibular molars. Int Endod J. 1998; 31: 117-22
68. Younes SA, Al-Shammery AR, El-Angbawi MF. Three-rooted permanent mandibular first molars of Asian and Black groups in the Middle East. Oral Surg Oral Med Oral Pathol. 1990; 69: 102-5. DOI: 10.1016/0030-4220(90)90276-X
69. Song JS, Choi HJ, Jung IY, Jung HS, Kim SO. The prevalence and morphologic classification of distolingual roots in the mandibular molars in a Korean population. J Endod. 2010; 36: 653-7. DOI: 10.1016/j.joen.2009.10.007
70. Shaw JCM. The teeth, the bony palate and the mandible in Bantu races of South Africa, 1st ed. London: Bale, Sons & Danielsson, 1931: 32-8
71. Ferraz JAB, Pecora JD. Three-rooted mandibular molars in patients of Mongolian, Caucasian and Negro origin. Braz Dent J. 1992; 3: 113-7
72. Da Costa Rocha LF, Manoel DSN, Sandra RF, Wanderly FD, Pécora JD. External and internal anatomy of mandibular molars. Braz Dent J. 1996; 7: 33-40
73. Corzon MEJ. Miscegenation and the prevalence of three-rooted mandibular first molars in the Baffin Eskimo. Community Dent Oral Epidemiol. 1974; 2: 130-1. DOI: 10.1111/j.1600-0528.1974.tb01669.x-i1
74. Curzon ME, Curzon JA. Three-rooted mandibular molars in the Keewatin Eskimo. J Can Dent Assoc (Tor). 1971; 37: 71-2
75. Somogyi-Csizmazia W, Simons AJ. Three-rooted mandibular first permanent molars in Alberta Indian children. J Can Dent Assoc (Tor). 1971; 37: 105-6
76. Zhang R, Yang H, Yu X, Wang H, Hu T, Dummer PMH. Use of CBCT to identify the morphology of maxillary permanent molar teeth in a Chinese subpopulation. Int Endod J. 2011; 44: 162-9. DOI: 10.1111/j.1365-2591.2010.01826.x
77. Yang Y, Zhang LD, Ge J, Zhu Y. Prevalence of 3-rooted first permanent molars among a Shanghai Chinese population. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010; 110: e98-e101. DOI: 10.1016/j.tripleo.2010.05.068
78. Curzon MEJ. Three-rooted mandibular permanent molars in English Caucasians. J Dent Res. 1973; 52: 181. DOI: 10.1177/00220345730520011901
79. Beshkenadze E, Chipashvili N. Anatomo-morphological features of the root canal system in Georgian population – cone-beam computed tomography study. Georgian Med News. 2015; 247: 7-14
80. Schäfer E, Breuer D, Janzen S. The prevalence of three-rooted mandibular permanent first molars in a German population. J Endod. 2009; 35: 202-5. DOI: 10.1016/j.joen.2008.11.010
81. Hochstetter RL. Incidence of trifurcated mandibular first permanent molars in the population of Guam. J Dent Res. 1975; 54: 1097. DOI: 10.1177/00220345750540052401
82. Bansal R, Ajwani P. Prevalence and morphological study of three-rooted mandibular first molar [radix molar] in an Indian population. Int J Hum Anat. 2010; 2: 1-8
83. Kuzekanani M, Najafipour R. Prevalence and distribution of radix paramolaris in the mandibular first and second molars of an Iranian population. J Int Soc Prev Community Dent. 2018; 8: 240-4
84. Rahimi S, Mokhtari H, Ranjkesh B, et al. Prevalence of extra roots in permanent mandibular first molars in an Iranian population: A CBCT analysis. Iran Endod J. 2017; 12: 70-3
85. Shemesh A, Levin A, Katzenell V, et al. Prevalence of 3- and 4-rooted first and second mandibular molars in the Israeli population. J Endod. 2015; 41: 338-42. DOI: 10.1016/j.joen.2014.11.006
86. Onda S, Minemura R, Masaki T, Funatsu S. Shape and number of the roots of the permanent molar teeth. Bull Tokyo Dent Coll. 1989; 30: 221-31
87. Walker RT. Three-rooted lower first permanent molars in Hong Kong Chinese. Br Dent J. 1985; 159: 298-9
88. Walker RT. Root form and canal anatomy of mandibular first molars in a Southern Chinese population. Dent Traumatol. 1988; 4: 19-22. DOI: 10.1111/j.1600-9657.1988.tb00287.x
89. Song JS, Kim SO, Choi BJ, Choi HJ, Son HK, Lee JH. Incidence and relationship of an additional root in the mandibular first permanent molar and primary molars. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2009; 107: e56-e60. DOI: 10.1016/j.tripleo.2008.09.004
90. Zaatar EI, Al-Kandari AM, Alhomaidah S, Yasin IMA. Frequency of endodontic treatment in Kuwait: Radiographic evaluation of 846 endodontically treated teeth. J Endod. 1997; 23: 453-6. DOI: 10.1016/S0099-2399(97)80302-0
91. Pattanshetti N, Gaidhane M, Kandari AMA. Root and canal morphology of the mesiobuccal and distal roots of permanent first molars in a Kuwait population – a clinical study. Int Endod J. 2008; 41: 755-62. DOI: 10.1111/j.1365-2591.2008.01427.x
92. Pan JYY, Parolia A, Chuah SR, Bhatia S, Mutalik S, Pau A. Root canal morphology of permanent teeth in a Malaysian subpopulation using cone-beam computed tomography. BMC Oral Health. 2019; 19: 1-15. DOI: 10.1186/s12903-019-0710-z
93. Al-Nazhan S. Incidence of four canals in root-canal-treated mandibular first molars in a Saudi Arabian sub-population: Root canal morphology. Int Endod J. 1999; 32: 49-52. DOI: 10.1046/j.1365-2591.1999.00188.x
94. Loh HS. Incidence and features of three-rooted permanent mandibular molars. Aust Dent J. 1990; 35: 434-7. DOI: 10.1111/j.1834-7819.1990.tb05426.x
95. Drennan MR. The dentition of the Bushmen tribe. Ann S Afr Museum. 1929; 24: 61-87
96. Martins JN, Nole C, Ounsi HF, et al. Worldwide assessment of the mandibular first molar second distal root and root canal: A cross-sectional study with meta-analysis. J Endod. 2022; 48: 223-33
97. Peiris HRD, Pitakotuwage TN, Takahashi M, Sasaki K, Kanazawa E. Root canal morphology of mandibular permanent molars at different ages. Int Endod J. 2008; 41: 828-35. DOI: 10.1111/j.1365-2591.2008.01428.x
98. Ahmed HA, Abu-bakr NH, Yahia N, Ibrahim YE. Root and canal morphology of permanent mandibular molars in a Sudanese population. Int Endod J. 2007; 40: 766-71. DOI: 10.1111/j.1365-2591.2007.01283.x
99. Tu MG, Tsai CC, Jou MJ, et al. Prevalence of three-rooted mandibular first molars among Taiwanese individuals. J Endod. 2007; 33: 1163-6. DOI: 10.1016/j.joen.2007.07.020
100. Huang RY, Lin CD, Lee MS, et al. Mandibular disto-lingual root: A consideration in periodontal therapy. J Periodontol. 2007; 78: 1485-90. DOI: 10.1902/jop.2007.060419
101. Yew S, Chan KA. Retrospective Study of endodontically treated mandibular first molars in a Chinese population. J Endod. 1993; 19: 471-3. DOI: 10.1016/S0099-2399(06)80536-4
102. Tu MG, Huang HL, Hsue SS, et al. Detection of permanent three-rooted mandibular first molars by cone-beam computed tomography imaging in Taiwanese individuals. J Endod. 2009; 35: 503-7. DOI: 10.1016/j.joen.2008.12.013
103. Chen YC, Lee YY, Pai SF, Yang SF. The morphologic characteristics of the distolingual roots of mandibular first molars in a Taiwanese population. J Endod. 2009; 35: 643-5. DOI: 10.1016/j.joen.2009.01.020
104. Reichart PA, Metah D. Three-rooted permanent mandibular first molars in the Thai. Community Dent Oral Epidemiol. 1981; 9: 191-2. DOI: 10.1111/j.1600-0528.1981.tb01053.x
105. Steelman R. Incidence of an accessory distal root on mandibular first permanent molars in Hispanic children. ASDC J Dent Child. 1986; 53: 122-3
106. Skidmore AE, Bjorndal AM. Root canal morphology of the human mandibular first molar. Oral Surg Oral Med Oral Pathol. 1971; 32: 778-84. DOI: 10.1016/0030-4220(71)90304-5
107. Taylor AE. Variations in the human tooth-form as met with in isolated teeth. J Hum Anat Physio. 1899; 33: 268-72
108. Kuzekanani M, Najafipour R. Prevalence and distribution of radix paramolaris in the mandibular first and second molars of an Iranian population. J Int Soc Prev Community Dent. 2018; 8: 240-4
109. Buchanan GD, Gamieldien MY, Tredoux S, Vally ZI. Root and canal configurations of maxillary premolars in a South African subpopulation using cone-beam computed tomography and two classification systems. J Oral Sci. 2020; 62: 93-7. DOI: 10.2334/josnusd.19-0160
110. Cleghorn BM, Christie WH, Dong CCS. Root and root canal morphology of the human permanent maxillary first molar: A literature review. J Endod. 2006; 32: 813-21
111. Cantatore G, Berutti E, Castellucci A. Missed anatomy: Frequency and clinical impact. Endod Topics. 2006; 15: 3-31
112. Castellucci A. Access cavity and endodontic anatomy. Endodont. 2004; 1: 245-329
113. Chavda SM, Garg SA. Advanced methods for identification of middle mesial canal in mandibular molars: An in vitro study. Endodontology. 2016; 28: 92-6
114. Ahmed HMA. A critical analysis of laboratory and clinical research methods to study root and canal anatomy. Int Endod J. 2022; 55: 229-80
115. Ordinola-Zapata R, Martins JN, Plascencia H, Versiani MA, Bramante CM. The MB3 canal in maxillary molars: A Micro-CT study. Clin Oral Investig. 2020; 24: 4109-121
116. Ahmed HMA, Versiani MA, De-Deus G, Dummer PMH. A new system for classifying root and root canal morphology. Int Endod J. 2017; 50: 761-70
117. Carabelli G. Systematisches handbuch der zahnheilkunde, 2nd ed. Georg OLMS: Verlag, 1844. ISBN 3-487-41399-X
118. De Moor RJG, Deroose CAJG, Calberson FLG. The radix entomolaris in mandibular first molars: An endodontic challenge. Int Endod J. 2004; 37: 789-99. DOI: 10.1111/j.1365-2591.2004.00870.x

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.15726

Impact of surface treatments on the sorption and solubility of a heat-cured denture base material

SADJ October 2023, Vol. 78 No.9 p457-464

RG Barnard[1], PC Clarke-Farr[2], Abduraghman Latief[3]

ABSTRACT

Introduction

Removable dentures fabricated from polymethylmethacrylate material are the most common prostheses used to treat edentulism worldwide.

Aims and Objectives

This research aimed to compare the sorption and solubility characteristics of a mechanically polished heat-cured acrylic denture material and a light-cured varnished material against non-treated material, all of which were soaked in distilled water.

Methods

A total of 45 specimens were prepared and tested according to the ISO Standard 20795-1: 2013 (E) to test for sorption and solubility. The data were analysed through one-way analysis of variance (ANOVA) and Tukey-Kramer multiple comparison test.

RESULTS AND CONCLUSIONS

The results indicated that both surface treatments were successful in reducing either the sorption or solubility level recorded by the specimens. The control group recorded mean sorption and solubility values which were both within the parameters set out by ISO 20795-1: 2013 (E) for a type-one polymer. Mechanical polishing was identified as the surface treatment that resulted in the largest reduction of solubility, with the lowest sorption values being recorded after the application of the light-cure varnish to the heat-cure denture base material. When mechanical polishing is compared to Optiglaze™ light-cured varnish, the results indicate that mechanical polishing may be a more effective surface treatment option.

Authors Contributors:
Name: Rian George Barnard
Affiliation: Department of Dental Sciences, Cape Peninsula University of Technology
email: rian.barnard55@gmail.com
ORCID iD: 0000-0002-0824-8292
Name: Peter Christopher Clarke-Farr
Affiliation: Department of Ophthalmic Sciences, Cape Peninsula University of Technology
email: clarkefarrp@cput.ac.za
ORCID iD: 0000-0003-3801-6692
Name: Abduraghman Latief
Affiliation: Department of Dental Sciences, Cape Peninsula University of Technology
email: latiefa@cput.ac.za
ORCID iD: 000-0001-8637-4131

Corresponding author:
Name: Rian George Barnard
Email: rian.barnard55@gmail.com

Author Contributions
R.G.B. conducted research for this manuscript as part of a Master's degree study under the supervision of P.C.C-F. and A.L. The manuscript was written by R.G.B. (65%) and P.C.C-F (25%) with technical expertise and review from A.L (10%).

Acknowledgments
We acknowledge and thank the Oral Health Centre of the University of the Western Cape and their staff for their assistance and use of their facilities and equipment during the conduct of this research. We also acknowledge the South African Department of Higher Education and Training as well as the Cape Peninsula University of Technology for providing the funding for this research in the form of the Nurturing Emerging Scholars Programme (NESP) Scholarship, dated 10 May 2021.

Declaration of Interest
The authors have no competing interests. Furthermore, the authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Keywords
Heat-cured, Light-cured Varnish, Solubility, Sorption, Surface Treatment, Polymethylmethacrylate

Introduction

Removable dentures, whether complete or partial, are still the most prevalent dental prostheses worldwide. In recent times, there has been an increase in the demand for fixed prostheses due to their apparent advantages over removable prostheses, in terms of comfort, aesthetics and preserving underlying alveolar bone. This trend is however not as marked among those with lower socio-economic means or individuals in the older age groups due to the costs entailed.[1,2] Sorption and solubility have been identified as two major drawbacks of denture base materials and their detrimental effects are well documented.[3–7] Literature pertaining to the mixing ratios, polymerisation cycles and thickness of the denture bases are factors identified as external variables that may negatively influence the rate of sorption and solubility experienced by denture base materials.[8] Measures to reduce the amount of sorption and solubility in denture base materials include various surface treatment procedures which may be applied in order to mitigate these effects.

Surface treatments are applied to improve the properties and characteristics of the material, for physical, mechanical, chemical or aesthetic purposes.[9,10] However, as a result of continued use, masticatory erosion may result in the degradation of the polished surface over time. This degradation is associated with the increase in the surface roughness of the denture and may result in an increase in the sorption and solubility of the denture base material. As an alternative to mechanical polishing, a review of existing scientific literature has established that there are very few published studies investigating the effects that the application of a light-cured varnish to heat-cured PMMA

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.15726

Table I: Sorption of samples in µg/mm³

	Mean	Median	Std Dev.	Std Error	Min.	Max.	Range
Group A	22.3690	22.1536	0.8619	0.2225	21.2659	24.5340	3.2681
Group B	21.8613	21.9569	0.2676	0.0691	21.4994	22.3403	0.8409
Group C	21.3713	21.3372	0.2873	0.0742	20.8905	21.9269	1.0364

Table II: Solubility of samples in µg/mm³

	Mean	Median	Std Dev.	Std Error	Min.	Max.	Range
Group A	0.1843	0.1866	0.1367	0.0353	-0.189	0.4321	0.6212
Group B	0.1593	0.1600	0.0457	0.0118	0.0683	0.2315	0.1632
Group C	0.2406	0.2492	0.1080	0.0279	0.0223	0.4191	0.3968

denture base material have on the material's sorption and solubility characteristics. Although there are studies that have reported the effect of mechanical polishing on the sorption and solubility of denture base materials [9,11–14], establishing a standard has proved to be challenging due to inconsistencies across the board, as very few documented studies have precisely followed ISO regulations. This research therefore aimed to determine the sorption and solubility characteristics of mechanically polished heat-cured dental acrylic material and light-cure varnished material soaked in distilled water and to evaluate which surface treatment resulted in the least sorption and solubility when compared to untreated acrylic material.

Materials and Methods

A total of 45 specimens were prepared according to the ISO Standard 20795-1: 2013 (E) to test for sorption and solubility of a Type One, Class One denture base material. The specimens were required to have a thickness of 0.5 (± 0.05) mm and a diameter of 50 (± 0.1) mm. The total sample population consisted of three groups, comprising 15 specimens each: No surface treatment (Group A, Control), mechanically polished (Vertex, High Gloss polishing Paste, Vertex-Dental B.V, Zeist, NL) (Group B) and those that were treated with a light cure varnish (GC, Optiglaze, GC N.V. Europe, Belgium) (Group C). Vertex™ Rapid Simplified (Vertex-Dental B.V, Zeist, NL) heat-cured denture base material was the material of choice for this study. After fabrication, the specimens were all placed in individual air-tight bags, and stored in a portable cold storage unit (Snomaster, Classic Series CL60, Snomaster, Texas, USA) at a constant temperature of 7°C. A stainless-steel mould and cover were custom made to conform with ISO 20795-1: 2013 (E). The mould and cover were invested in a two-part denture flask with type two dental gypsum (Interdent, Alabaster, Interdent d.o.o,, Celje, SI) mixed according to the manufacturer's recommendation. One half of the flask contained the mould and the other half the cover. The laboratory environment was controlled at 23 (± 2) °C and at a relative humidity of 50 (± 10) °C. To produce the most accurate results possible and strictly to follow ISO protocols, the researcher used the same mould for the fabrication of all 45 specimens. A calibrated Denver Instruments S-403SN (Denver Instrument Inc., New York, USA) balance scale accurate to 1 mg and Biohit Proline Pipette (100-1000µl) (Biohit Oyj, Helsinki, FI) were used to measure the liquid-to-powder ratio of 1 ml: 2.3g recommended for Vertex™ Rapid Simplified (Vertex-Dental B.V, Zeist, NL) heat-cured denture base material. A polythene sheet from Metrodent™ (Metrodent Limited, West Yorkshire, UK) was placed over the mixed material to create a buffer between the material and the stainless-steel cover of the mould. The flasks were closed and placed in a pneumatic press (Dentalfarm SRL, Turin, IT). Pressure of two bars was applied and maintained until no loss in pressure was observed, after which the flask was removed and placed in its respective clamp. The flask was immersed in a curing bath (Eurocem, Water Polymeriser, Eurocem, Milan, IT) containing water heated to 100°C and cured for 20 minutes as recommended by the manufacturer. Following this, the flask was removed and allowed to bench cool until it reached the ambient temperature. Once all the specimens were fabricated, they were selected at random from the portable cold storage unit to receive their allocated surface treatment.

Table III: Wsl results for Tukey-Kramer multiple comparison test

Group	Mean	Different from Groups
No Surface Treatment, Distilled Water (A)	0.1843	None
Mechanical Polishing, Distilled Water (B)	0.1593	None
Light-Cured Varnish, Distilled Water (C)	0.2406	None

Table IV: Wsp results for Tukey-Kramer multiple comparison test

Group	Mean	Different from Groups
No Surface Treatment, Distilled Water (A)	22.3690	B and C
Mechanical Polishing, Distilled Water (B)	21.8613	A
Light-Cured Varnish, Distilled Water (C)	21.3713	A

https://doi.org/10.17159/sadj.v78i09.15726

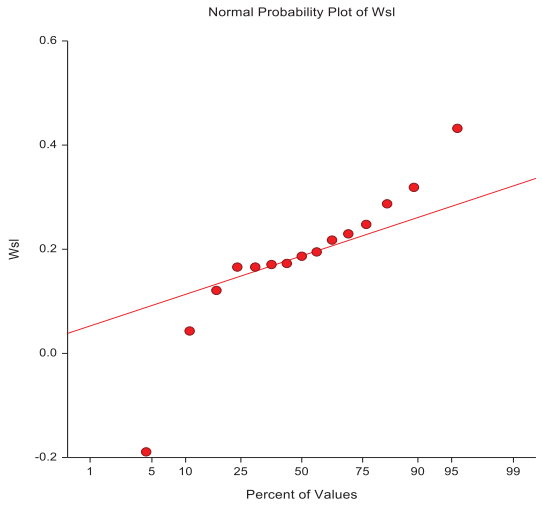


Figure 1a. Plot graph indicating the individual Wsl values recorded for Group A.

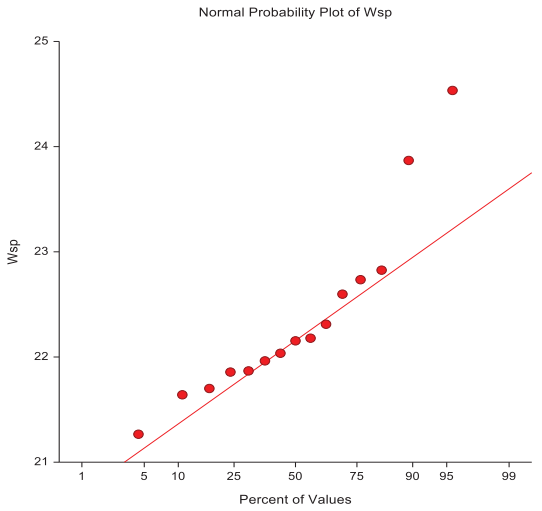


Figure 1b. Plot graph indicating the individual Wsp values recorded for Group A.

Surface Treatments

All the specimens were ground with wet pumice (Interdent, Pumice, Interdent d.o.o,, Celje, SI) and a wet muslin wheel for one minute per surface at a circumferential speed of 650 ± 350 meters per minute as specified by ISO 20795-1:2013(E). The mechanically polished (Group B) specimens were polished for two minutes per surface using an unstitched muslin wheel and Vertex™ High Gloss Polishing Paste (Vertex-Dental B.V, Zeist, NL). After polishing, the specimens were visually inspected to ensure they complied with ISO requirements, presenting a smooth surface with a high gloss. The application surface of the specimens in Group C was wiped with Vertex™ Rapid Simplified monomer (Vertex-Dental B.V, Zeist, NL), to remove any smear layer from the surface. A thin layer of Optiglaze™ (GC N.V. Europe, Belgium) protective coating agent was applied, after which it was cured in a light-curing unit (Max Stir, MS Multiact, Max Stir srl, Cavriago, IT) for 40 seconds on each side. Once the respective surface treatment procedures were complete, the specimens were marked using a black waterproof marker.

Sorption and solubility

The sorption and solubility of the samples were based upon measurement of the uptake and release of a solute under controlled conditions. The guidelines established by the ISO 20795-1 (2013) document to test for sorption and solubility were followed precisely. The specimens were placed in a desiccator containing freshly dried silica gel, which was stored in an incubator for 23 (± 1) hours at 37 (± 1) °C. Once the time had elapsed, the specimens were removed from the desiccator and placed in a second desiccator containing freshly dried silica gel for 60 (± 10) minutes at 23 (± 2) °C. Once the specimens reached a conditioned mass, the volume of each specimen was calculated. The racks containing the specimens were then submerged in a glass bowl filled with grade two distilled water. The bowl was sealed with plastic wrap and placed in an incubator kept at a constant of 37 (± 1) °C for seven days (± 2 hours). After the time had elapsed, the specimens were individually removed, dried and weighed. The specimens were reconditioned for a final time until a constant mass was reached. Using the recorded variables, and formulae provided by ISO 20795-1:2013(E), the sorption and solubility of the specimens were calculated according to the following formulae:

Water sorption (Wsp) was calculated in µg/mm³ using the formula recommended by ISO 20795-1:2013(E):

$$Wsp = \frac{m_{-2} - m3}{V}$$

Water solubility (Wsl) was calculated in µg/mm³ using the formula recommended by ISO 20795-1:2013(E):

$$Wsl = \frac{m_{-1} - m3}{V}$$

V = Volume,
m1 = Conditioned mass of the specimen
m2 = Increase in mass due to sorption
m3 = Loss in mass of the specimen due to solubility

A Mettler AE 240 (Mettler Toledo, Ohio, USA) analytical balance scale mounted on a granite top was used to provide readings accurate to 0,1mg and indicating up to five decimal places. The weighing plate of the scale was situated in a glass enclosure with sliding doors to prevent any external variables such as moisture in the air from affecting the weight reading of the specimen. To calculate the volume of the specimens, the thickness readings were measured by means of a Toolquip & Allied Digital Outside Micrometer 0-25mm (Toolquip and Allied Ltd, Johannesburg, ZA) accurate to three decimal places, and the diameter readings with a Mitutoyo CD-15 DCX Digital Calliper (Mitutoyo Corporation, Kanagawa, JP) indicating up to 2 decimal places. All the instruments were calibrated by the internationally accredited "Lasec Group" prior to the commencement of the study.

Data analysis

Determination of any statistically significant differences between the means of the sorption and solubility characteristics of the surface-treated specimens was conducted by one-way analysis of variance (ANOVA). A p-value of 0.05 was considered to be statistically significant and values less than 0.05 were used to

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.15726

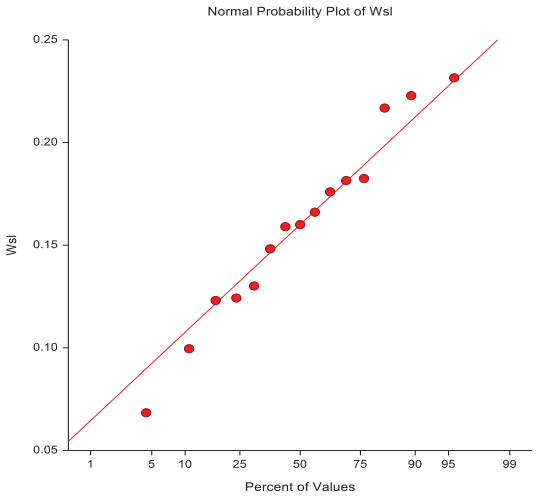


Figure 2a: Plot graph indicating the individual Wsl values recorded for Group B.

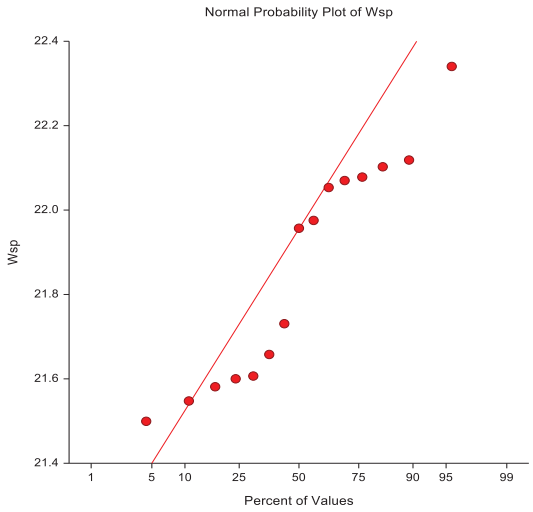


Figure 2b: Plot graphs indicating the individual Wsp values recorded for Group B.

conclude that a significant difference existed between the variables. The Tukey-Kramer multiple comparison test was further used to establish significant differences among the means of the different sample groups.

RESULTS

All analyses were performed using the NCSS (2019) Statistical Software package. The first analysis was a one-way analysis of variance on the Wsl and Wsp variables to test whether the within sample variances were equal and if the data showed a normal distribution. For Wsl a p-value of 0.102597 was recorded, indicating that no significant difference existed between the different treatment groups($p > 0.05$). For Wsp a p-value of 0.000056 was recorded, indicating that a significant difference was found between the treatment groups ($p < 0.05$).

Sorption and solubility of the unpolished acrylic control group (Group A)

Group A, the control group was used to record baseline sorption and solubility values to assess the effectiveness of surface treatments on reducing the levels of sorption and solubility observed in Vertex™ Rapid Simplified denture base material (Fig.1a & Fig.1b). The specimens in sample group A obtained a mean sorption value of 22.3690 µg/mm^3 (Table I) and a mean solubility value of 0.1843 µg/mm^3 (Table II), which are both within the parameters set out by ISO 20795-1: 2013 (E) for a type-one polymer. The ISO 20795-1: 2013 (E) states that the sorption and solubility of type-one polymers should not exceed 32 µg/mm^3 and 1,6 µg/mm^3 respectively, in order to be deemed viable for clinical use. A single specimen in the group recorded a negative solubility value of -0.1891 µg/mm^3 (Fig.1a) which indicated that it was not able to expel all the moisture it adsorbed during the saturation process. It was decided to keep this value in the recorded data as it is believed that the variance is not of such an extent as to affect the conclusions drawn from the study.

Sorption and solubility of mechanically polished specimens (Group B)

The specimens in sample group B (Fig.2a & Fig.2b) obtained a mean sorption value of 21.8613 µg/mm^3 (Table I) and a mean solubility value of 0.1593 µg/mm^3 (Table II), which are both within the parameters set out by ISO 20795-1: 2013 (E) for a type-one polymer. The Tukey-Kramer Multiple Comparison Test indicated that the lower sorption values were statistically significant in comparison to Group A. Even though mechanical polishing reduced the solubility values, it was not deemed statistically significant (Table III and Table IV).

Sorption and solubility of light-cured varnished acrylic soaked in distilled water (Group C)

The specimens in this group (Fig.3a & Fig.3b) obtained a mean sorption value of 21.3713 µg/mm^3 (Table I) and a mean solubility value of 0.2406 µg/mm^3 (Table II) which are both within the parameters set out by ISO 20795-1: 2013 (E) for a type-one polymer. The mean sorption value was lower and the mean solubility value was higher for this group than for Group A. The Tukey-Kramer Multiple Comparison Test indicated that the lower sorption values recorded by the specimens that were treated with the light-cured varnish soaked in distilled water were statistically significant. Even though the light-cured varnish increased the solubility values observed in Vertex™ Rapid Simplified denture base material, this was deemed not to be of statistical significance (Table III and Table IV).

Overall it was found that for sorption, sample Group C recorded the lowest mean value (21.3713 µg/mm^3), followed by Group B (21.8613µg/mm^3) and Group A (22.3690 µg/mm^3), whereas for solubility, sample Group B recorded the lowest mean value (0.1593 µg/mm^3), followed by Group A (0.1843µg/mm^3) and Group C (0.2406 µg/mm^3). Both groups B and C exhibited significantly lower Wsp values than the control group.

DISCUSSION

For this study, the objective of the control group was to record baseline sorption and solubility values to assess the effectiveness of surface treatments on reducing the levels of sorption and solubility observed in Vertex™ Rapid Simplified denture base material. A single specimen in the group recorded a negative solubility value of -0.1891 µg/mm^3 which indicated that it was not able to expel all the moisture it adsorbed during the saturation process. Negative solubility values were also recorded by Tuna et al.[5], who suggested that the material or content within the material was responsible for bonding with the water

https://doi.org/10.17159/sadj.v78i09.15726

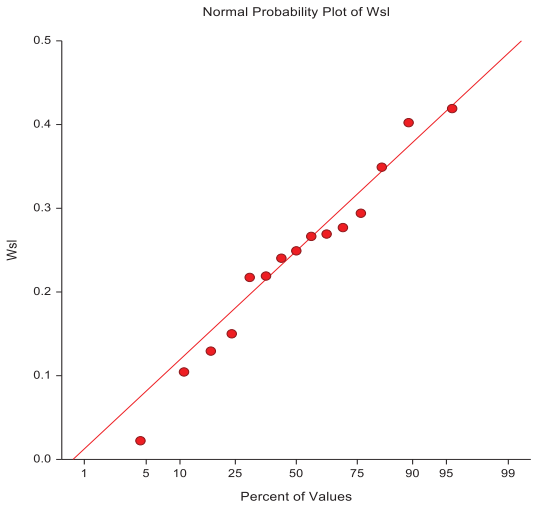


Figure 3a. Plot graph indicating the individual Wsl values recorded for Group C.

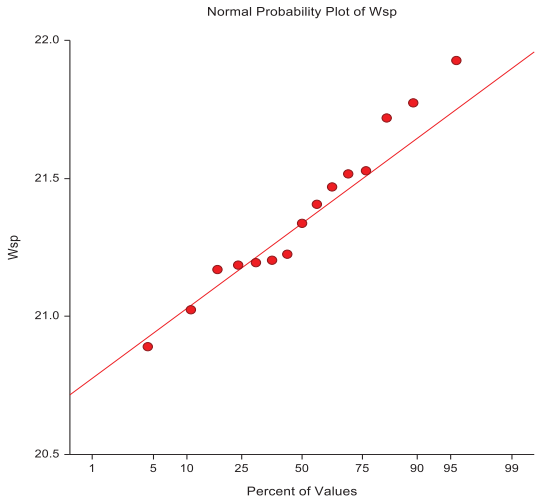


Figure 3b. Plot graph indicating the individual Wsp values recorded for Group C

molecules chemically. Due to the sensitivity of the scale, the possibility exists that this negative value was a result of human error. The sorption values recorded for this sample group were similar to those recorded by Engelbrecht [14], who also used an unpolished sample group soaked in distilled water fabricated from Vertex™ Rapid Simplified denture base material. The author recorded a mean sorption value of 23 µg/mm^3 for the sample group that received no surface treatment, soaked in distilled water.[14] The solubility value recorded was however considerably higher, with a mean value of 1.1 µg/mm^3. It is possible that the higher solubility value recorded is because of the thicker specimens and a different fabrication method from that used by this author.[14]

For sample group B, these specimens obtained lower mean sorption and solubility values than the control group, with only the reduction in sorption being deemed statistically significantly. These findings are also in line with those of Engelbrecht [14] and Al-Muthaffar [13], who found that surface treatment in the form of mechanical polishing was successful in reducing the mean sorption and solubility values experienced by heat-cured denture base material. Al-Muthaffar[13] tested the effect of a conventional polishing procedure on the sorption of heat- and cold-cured denture base material and found that the conventional polishing procedure significantly reduced the amount of sorption experienced by the materials. Engelbrecht[14] recorded similar results, with the conventional polishing procedure reducing both mean sorption and solubility values of the heat-cured denture base material, although only the reduction in sorption was deemed significant. It is noteworthy that the mechanical polishing of denture base material is associated with high levels of friction which may generate a considerable amount of heat within the material. As the heat generated is of a greater temperature than the flashpoint of methyl methacrylate monomer, it has been thought that the heat generated during the mechanical polishing procedure may serve to reduce the amount of residual monomer within the specimen, resulting in lower solubility levels.

Al-Muthaffar[13] explains that the increase in temperature during the polishing procedure may also exceed the glass transition temperature of the material, resulting in the smearing of the material's surface. The smeared surface is thought to decrease the surface polarity of the material, and effectively reduces the concentration of polar sites for water molecules to form hydrogen bonds with. As the resin's polarity is one of the main factors governing the uptake of water into the structure of denture base acrylics, the reduction in the concentration of polar sites on denture base acrylics may reduce the rate of sorption observed in the material.[15] It is therefore possible that the generation of heat and the smearing of the specimens' surface during the polishing procedure contribute to the positive effect that mechanical polishing has on the sorption and solubility of heat-cured denture base material. The extent of this is however unknown and more tests would need to be conducted to determine the exact effects that the heat generated during the polishing procedure has on the sorption and solubility of the material. There is also the possibility that the surface roughness of denture base materials may affect their sorption and solubility. Rough surfaces essentially have a larger surface area, which increases the contact interface between the water molecules and the surface of the denture base. The phenomenon is also explicable in terms of contact angle hysteresis. A study published by Rahal et al.[11] investigated the influence of chemical and mechanical polishing on the water sorption and solubility of denture base acrylic resins. The authors noted that reducing the surface roughness of the material not only results in a smaller surface area but may also affect the hydrophilic nature of the material.[11] Monse 'ne 'go et al.[16] suggest that water droplets form lower contact angles with rougher surfaces. Surfaces that produce lower contact angles are of a more hydrophilic nature, increasing the material's affinity to water.

With respect to the third aspect of the study, the specimens in sample group C obtained a mean sorption value that was lower and a mean solubility value that was higher than the mean values recorded for the control group, with only the lower sorption values being statistically significant. These findings indicate that the application of Optiglaze™ light-cured varnish increased the observed levels of solubility. The increase in solubility may perhaps be attributed to the composition of this specific light-cured varnish. The application of Optiglaze™ had a positive result on the sorption of Vertex™ Rapid Simplified denture base material soaked in distilled water. A possible explanation for this occurrence may be that the application of Optiglaze™ alters the polarity of the specimen's surface. As explained

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.15726

by Malacarne et al.[15], the resin's polarity is one of the main factors governing the uptake of water into the structure of denture base acrylics, and a reduction in the concentration of polar sites may reduce the rate of sorption observed. A comprehensive review of the literature[4,17], together with the product information stated by GC America[18], indicates that Optiglaze™ may act as a surface sealer, sealing microscopic cracks, pores and irregularities on the surface of the specimens. It has also been suggested that water molecules are adsorbed to the surface of the material and are further absorbed into the body of the denture base through porosity and intermolecular spaces via diffusion.[4,19] If the quantity of irregularities on the surface is reduced by the application of Optiglaze™, this may inhibit the uptake of water into the body of the material.

CONCLUSION

This study has established that the mechanical polishing of prostheses fabricated from Vertex™ Rapid Simplified heat-cured acrylic will reduce their sorption and solubility, but only the reduction in sorption can be expected to be statistically significant. The application of Optiglaze™ light-cured varnish to prostheses fabricated from Vertex™ Rapid Simplified heat-cured acrylic also significantly reduces the sorption of the material but will result in higher solubility values. When mechanical polishing is compared to Optiglaze™ light-cured varnish as a surface treatment, the sorption and solubility results indicate that mechanical polishing may be a more effective surface treatment option. However, Optiglaze™ light-cured varnish may be considered as an alternative surface treatment to mechanical polishing or used in conjunction with it as the sorption and solubility levels recorded were within the thresholds stipulated by ISO.

Limitations of the study

This study has identified some limitations: a test for statistical power was not conducted to determine the sample size, but rather the sample size was chosen in order to substantially exceed any previously published study of a similar nature. Secondly, while light-cured varnishes with different compositions may exhibit different sorption and solubility properties, this study, only investigated the effect of one light-cured varnish. In addition, the dimensions of the specimens recommended by ISO significantly differ to that of a removable prosthesis fabricated from heat-cured acrylic, thus the possibility exists that the results of this study may not accurately represent the sorption and solubility of complete dental prostheses fabricated from heat-cure acrylic. Concerning the solutes leaching from denture base materials during function, the exact substances leaching from the specimens are unknown so it is unknown whether the variables in this study would reduce the cytotoxicity of heat-cured acrylic material. Finally, the sorption and solubility of the study specimens were determined after being soaked for seven days, as recommended by ISO. It is therefore unclear what the long-term effects of surface treatments on the sorption and solubility of heat-cured acrylic materials would be.

REFERENCES

1. Zitzmann NU, Hagmann E, Weiger R. What is the prevalence of various types of prosthetic dental restorations in Europe? Clin Oral Implants Res. 2007;18(3):20–33.
2. Radnai M, Saini R, Gorzo I. Removable partial denture with bar or plate: How should we decide? Int J Exp Dent Sci. 2013;2(2):104–9.
3. Miettinen VM, Vallittu PK, Docent DT. Water sorption and solubility of glass fiber-reinforced denture polymethyl methacrylate resin. J Prosthet Dent. 1996;77(5):531–4.
4. Ferracane JL. Hygroscopic and hydrolytic effects in dental polymer networks. Dent Mater. 2006;22(3):211–22.
5. Tuna SH, Keyf F, Gumus HO, Uzun C. The evaluation of water sorption/solubility on various acrylic resins. Eur J Dent. 2008;2(3):191–7.
6. Kalachandra S, Turner DT. Water sorption of polymethacrylate networks: Bis-GMA/TEGDM copolymers. J Biomed Mater Res. 1987;21(3):329–38.
7. Figuerôa RMS, Conterno B, Arrais CAG, Sugio CYC, Urban VM, Neppelenbroek KH. Porosity, water sorption and solubility of denture base acrylic resins polymerized conventionally or in microwave. J Appl Oral Sci. 2018;26:1–7.
8. Barnard RG, Clarke-Farr PC, Latief A. Factors Affecting Sorption and Solubility of Denture Base Acrylic Materials: A Review. Ann Dent Univ Malaya. 2022;29:1–8.
9. Al-Rifaiy MQ. The effect of mechanical and chemical polishing techniques on the surface roughness of denture base acrylic resins. Saudi Dent J. 2010;22(1):13–7.
10. Ulusoy M, Ulusoy N, Aydin AK. An evaluation of polishing techniques on surface roughness of acrylic resins. J Prosthet Dent. 1986;56(1):107–12.
11. Rahal JS, Mesquita MF, Henriques GEP, Nóbilo MAA. Influence of chemical and mechanical polishing on water sorption and solubility of denture base acrylic resins. Braz Dent J. 2004;15(3):225–30.
12. Al-Kheraif AAA. The effect of mechanical and chemical polishing techniques on the surface roughness of heat-polymerized and visible light-polymerized acrylic denture base resins. Saudi Dent J. 2014;26(2):56–62.
13. Al-Muthaffar AMR. Effect of conventional polishing procedure in water sorption of cold and heat cured acrylic denture base material. Med J Babylon. 2016;13(2):481–8.
14. Engelbrecht M. Factors influencing sorption, solubility and cytotoxicity of a heat cured denture base polymer (masters's thesis). University of the Western Cape; 2010.
15. Malacarne J, Carvalho RM, de Goes MF, Svizero N, Pashley DH, Tay FR, et al. Water sorption/solubility of dental adhesive resins. Dent Mater. 2006;22(10):973–80.
16. Monse 'ne 'go P, Baszkin A, de Lourdes Costa M, Lejoyeux J. Complete denture retention. Part II: Wettability studies on various acrylic resin denture base materials. J Prosthet Dent. 1989;62(3):308–12.
17. Anusavice KJ, Phillips RW, Shen C, Rawls HR. Phillips' Science of Dental Materials. 12th ed. Amsterdam: Elsevier; 2012. 93–110, 231–252 and 474–491 p.
18. GC America. OPTIGLAZE™ - Glossy, Protective Coating Agent [Internet]. GC America. 2020 [cited 2020 Aug 17]. Available from: http://www.gcamerica.com/lab/products/OPTIGLAZE/
19. Sakaguchi RL, Powers JM. Craig's Restorative Dental Materials. 13th ed. Philadelphia: Elsevier Mosby; 2012. 33–83 p.

CPD questionnaire on page ???

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.

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.17387

A simplified and evidence-informed approach to designing removable partial dentures.

Part 2. The biomechanical basis of support

SADJ October 2023, Vol. 78 No.9 p463-466

C Peter Owen[1]

SUMMARY

For many decades the literature has regularly reported that there is a discrepancy between what is taught in dental school and what is practised, especially in the field of removable partial dentures. Not only that, but for more than 60 years reports from around the world have shown that, usually, the majority of clinicians abdicate their responsibility to design a removable partial denture (RPD) and instead leave this to the dental technician, who has no knowledge of the clinical condition of the patient and works only from a cast. Most patients around the world who require RPDs to improve aesthetics and chewing can only afford a removable prosthesis simply because the majority are poor. But RPDs can improve these aspects and contribute to an improved quality of life.

The purpose of this series of articles is to derive the basic, evidence-informed principles of partial denture design and to suggest a simplified explanation and application of those principles in the hope that clinicians will increasingly take responsibility for the design of partial dentures. Part 1 summarised studies revealing what can only be described as the malpractice of abdication of responsibility for design by clinicians, and then explained the evidence-informed basic principles of design; Part 2 will look at the biomechanical basis of those principles in terms of support; Part 3 will do the same for the biomechanical basis of retention; Part 4 will provide a simple seven-step approach to design, applied to an example of an acrylic resin-based and a metal framework-based denture for the same partially edentulous arch; and Part 5 will provide examples of designs for RPDs that have been successfully worn by patients, for each of the Kennedy Classifications of partially dentate arches. Much of this is referenced from an electronic book on the Fundamental of removable partial dentures.[1]

Author's information
1. CP Owen, Professor Emeritus, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa
ORCID: 0000-0002-9565-801

Corresponding author
Name: Prof CP Owen
Tel: +27 83 679 2205
Email: peter.owen@wits.ac.za

Conflict of interest
None

Keywords
Removable partial denture, design, support, retention, acrylic-based, framework-based

Running title
A simplified approach to designing RPDs

THE BIOMECHANICAL BASIS OF SUPPORT IN RPDS

Mucosa versus teeth

Residual ridge mucosa varies in thickness but is mostly spongy and responds characteristically to pressure. This response is visco-elastic and the original studies on this response were carried out a long time ago in the 1970s.[2] A sudden load induces an immediate displacement and then a slower continued displacement. Removal of the load induces an immediate recovery but then a very delayed recovery (Figure 1).

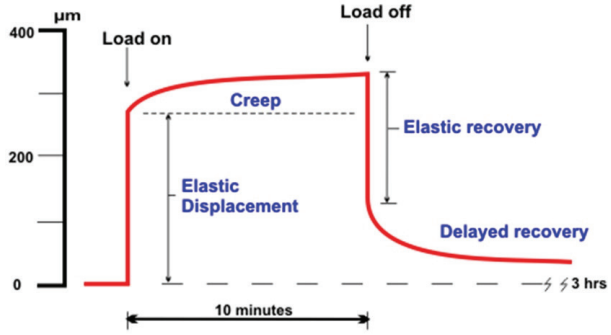


Figure 1: Displacement of mucosa under constant load for 10 minutes (redrawn after[2]).

More importantly, under functional conditions in the mouth, loading varies with each chew and, with successive chews, there is a progressive displacement, but also a progressive failure to recover, so that equilibrium at a displaced position relative to the starting position is reached. This progressive failure to recover becomes longer with age, mostly because of a decrease in mucosa thickness with age.

So residual ridge mucosa, as many a complete denture wearer will tell you, is not great for support. In a partial dentition, the use of only the mucosa for support means that it is not only residual ridge mucosa that is used but, of course, also the gingival margins around any teeth that the denture base contacts. Covering gingival margins is not a good idea. And because the denture contacts the teeth and teeth have slopes, there is an added danger of applying a force to the teeth every time the denture is pressed down by the opposing teeth during function and parafunction. So, with mucosa-borne partial dentures two of the worst consequences will be gingival pathosis (hence the term "gum stripper" for these dentures) and tooth movement (Figures 2 and 3).

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.17387

Figure 2 (left): The partial denture was originally festooned around the teeth, and must have contacted them. Occlusal pressure on the denture has produced an intermittent vector of force which has acted as an orthodontic appliance and pushed the teeth away.
Figure 3 (above): The gingival margins have obviously been adversely affected by a "gum-stripper" type of denture base.

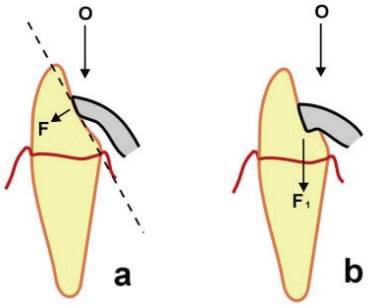


Figure 4a: Without a rest seat the occlusal force O produces a force vector F in an unfavourable direction; b: the rest seat now allows a force vector F_1 to be in an axial direction.

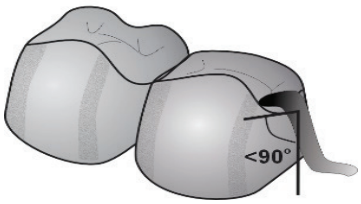


Figure 5: The rest seat should be less than 90° to the path of insertion.

The only conclusion that can be made is that relying on mucosa alone for support is simply unacceptable. The solution, of course, is to make use of the remaining teeth. The attachment mechanism of tooth to alveolar bone is designed to withstand surprisingly large forces. It does this optimally when the force is directed along the long axis of the tooth, as the force is then evenly distributed by the periodontium. This would seem to be blindingly obvious and, as was shown in Part 1, was first suggested in 1817![3] Yet, many RPDs are still made without tooth support[4,5] or without tooth preparation for rests.[6] (Table 1, Part 1 of this series[7].)

Principles of rest seats

To distribute forces axially, rests should be prepared on the occlusal surface of posterior teeth or on the cingulum area of anterior teeth. The size and shape of the rest seats will vary, depending on a number of factors:

1. The principle governing all rest seats is that the occlusal force should be directed axially (Figure 4). This determines the angle of the rest seat: it should be less than 90° to the path of insertion (Figure 5).

2. The material used for the RPD determines the shape of the posterior rest seat: an acrylic-based RPD must use wrought wires for a posterior rest and that requires that the rest preparation conforms to the shape of the wrought wire (half-round wire is used) (Figure 6); but for framework-based dentures, whether cast, milled, sintered or printed, the cast rest can conform more to the anatomy of the tooth's rest seat preparation (Figure 7).

3. Anterior rest seats rely on the shape of the cingulum irrespective of the material: either acrylic or metal will conform to the preparation (Figure 8).

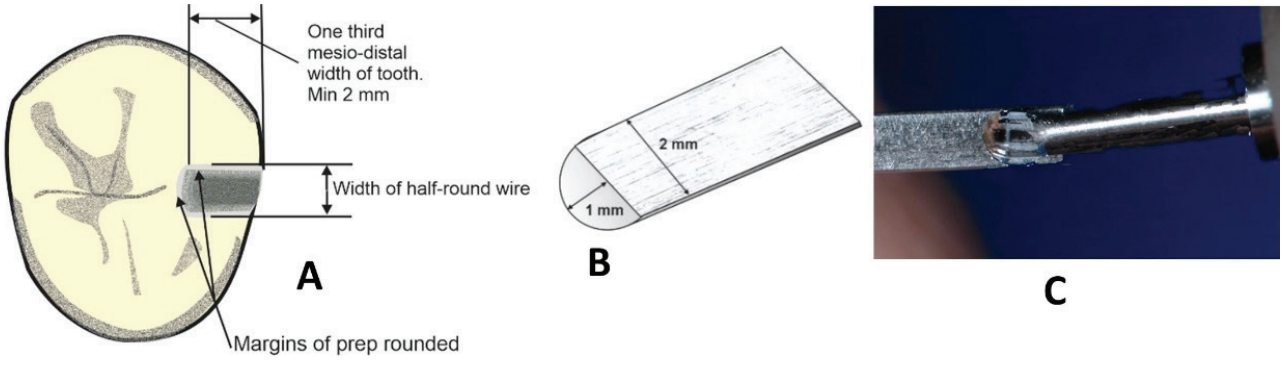
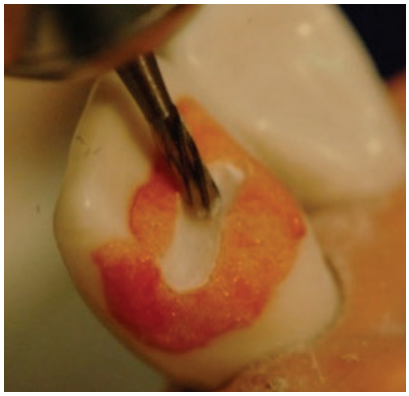


Figure 6A: The dimensions of a posterior rest seat for a half-round wire rest. B: the recommended size of the half-round wire. C: choose a bur slightly smaller than the width of the wire, ie a .018 round bur.

https://doi.org/10.17159/sadj.v78i09.17387



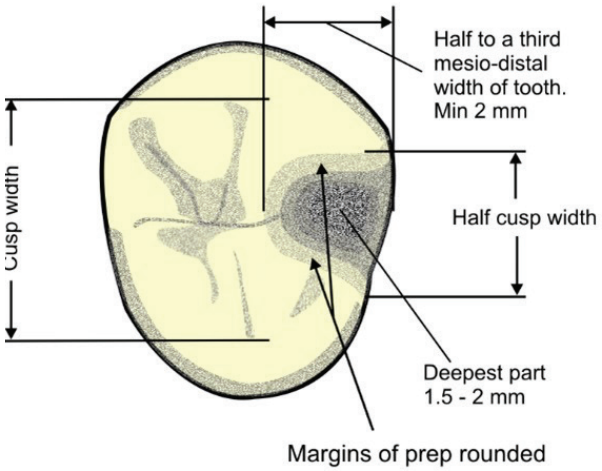


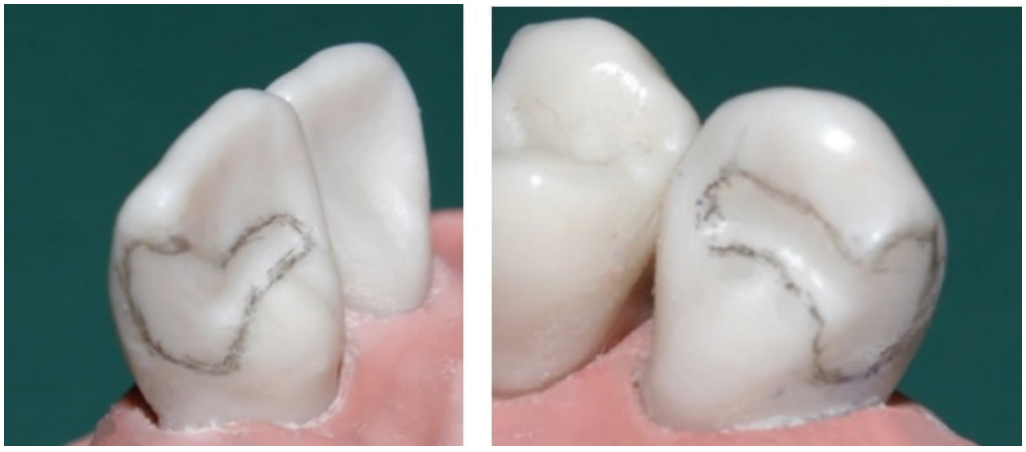
Figure 7 (above): Demonstrating the preparation of a cingulum rest on typodont tooth. A round-ended straight fissure bur is recommended.
Figure 8 (right): The dimensions of a posterior rest seat for a cast rest. The seat should be spoon-shaped.

4. If the tooth to receive a rest is adjacent to an edentulous space, then it should also have a guide plane and so the rest should be continuous with the guide plane: this applies to both anterior and posterior teeth (Figure 9).
5. All preparation margins must be rounded, with no sharp edges. This is particularly important for frameworks to be cast, as the refractory model has a large grain size and any sharp edges will not be reproduced, with the result that the framework will not seat properly (Figure 10).

Preparation

It should be self-evident (but appears not to be) that the RPD design must be decided based on the primary diagnostic models prior to the preparation in the mouth and the final impression, whether that is analogue or digital. All preparations should ideally be kept in enamel but, on occasion, the palatal cingulum area of anterior teeth may require the placement of a restoration first.

Figure 9: Cingulum rests should be continuous with the guide plane as illustrated on these typodont teeth.



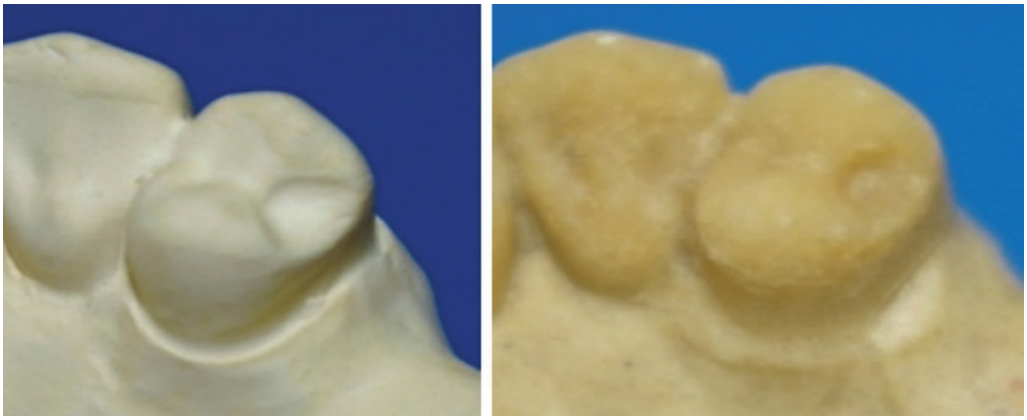


Figure 10 :The difference between a smooth gypsum cast on the left and the refractory cast on the right.

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.17387

Position

The position of rest seats is determined by the design principles and will be covered in Part 4 of this series. The only contentious issue seems to be in the case of distal extension dentures, where laboratory studies have not been shown to have any credibility from a clinical point of view.

Guidelines for rests

1. The angle of the rest seat should be less than 90° to the path of insertion.
2. An occlusal rest for acrylic-based RPDs should be shaped to accommodate half-round wire.
3. An occlusal rest for framework-based RPDs should be spoon-shaped.
4. A cingulum rest must conform to the shape of the cingulum.
5. All rest preparations should have smooth, rounded edges.
6. All rests should ideally be in enamel: if not, a restoration may be required.
7. If the tooth is adjacent to an edentulous space the rest should be continuous with the prepared guide plane.
8. At least three rests are required, as widely spaced as possible.
9. Each edentulous space being replaced should have a rest on either side; if a distal extension, one of the rests will be on the abutment.

Summary

Support is essential to resist occlusally directed forces and should not only be provided by mucosa. Tooth support is ideal, but there are situations were a combination of both tooth and mucosal support is necessary. All rest seats should be prepared to best direct the forces axially and so that there is no interference with the occlusion. Occasionally an opposing tooth may require adjustment, but the patient should be informed of this in advance, lest they believe you are making their mouth fit your denture, which will hardly engender confidence.

The next part will deal with how the denture resists the opposite force, that of removal away from the teeth, ie the biomechanical basis of retention.

REFERENCES

1. Owen CP. Fundamental of removable partial dentures. 5th Ed. Electronic book, available at https://www.appropriatech.com Accessed 5 September 2023
2. Wills DJ, Manderson RD. Biomechanical aspects of the support of partial dentures. J Dent. 1977;5(4):310-8. doi: 10.1016/0300-5712(77)90123-3
3. Walisezewski MP. Turning points in removable partial denture Philosophy. J Prosthodont. 2010;19:571-9
4. Pun DK, Waliszewski MP, Waliszewski KJ, Berzins D. Survey of partial removable dental prosthesis (partial RDP) types in a distinct patient population. J Prosthet Dent. 2011;106(1):48-56. doi: 10.1016/S0022-3913(11)60093-0
5. Daya R, Owen CP. Conformity of removable partial denture designs from three laboratories to a set of design principles. SADJ 2022;77(8):459-64 doi: 10.17159/2519-0105/2022/v77no8a1
6. Farias-Neto A, da Silva RSG, da Cunha Diniz A, Batista AUD, Carreiro AdeFP. Ethics in the provision of removable partial dentures. Braz J Oral Sci. 2012;11(1):19-24
7. Owen CP. A simplified approach to designing removable partial dentures. Part 1. Evidence-informed design principles. SADJ 2023

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16766

Unpacking the NHI Bill recently passed by parliament in May 2023: Implications for oral health

SADJ October 2023, Vol. 78 No.9 p467-468

Y Malele-Kolisa[1]

"The Portfolio Committee on Health, having considered the subject of the National Health Insurance Bill [B11–2019] (National Assembly – sec 76)], referred to it and classified by the Joint Tagging Mechanism as a section 76 Bill, reports the Bill with amendments [B11B–2019]. " (pg.91).

The journey to enacting a policy is a lengthy but worthy process. It was first the green paper in 2012, then the white paper NHI discussions in 2015, then NHI policy in 2017 and incorporated universal health coverage concepts. From 2019 it was passed into an NHI Bill, went for public comment and was debated at length, with, understandably, many concerns. The Bill must be approved by parliament – by both the national assembly (NA) and the nation council of provinces (NCOP) – before being sent to the president to sign into law – NHI Act of 2023 [or 2024]. The Covid-19 pandemic delayed the process but also brought concerns from the already sceptical public about the intended reform.

Throughout the process, stakeholder engagement was paramount as it changed the form and structure of the intended reform. Even after the Bill is passed, stakeholder engagement is still paramount in shaping the final enactment and the implementation processes.

The process is on track as, according to the white paper, it was going to be phased in over a period of 14 years from 2012 to 2026. Now the details are important – the real work in operationalising the activities from now to 2026 must be clear. The reasons behind the reform are not in dispute. The discourse and discordance are around the nuts and bolts for full implementation processes by both proponents and adversaries. The governance is a source concern where the minister will appoint a board and the board will run this, as is customary of all state-owned entities (SOEs). Slight changes have been made to the proposed Act where the minister will no longer appoint the board on his or her own but must do so in or after consultation with the cabinet and with the cabinet's approval.

Another great concern for the working public is possible funding. The current response to funding is the Finance Minister and the Treasury have at their disposal various mechanisms to raise taxes. These are:

- Raise taxes, most notably personal tax
- Company tax
- Payroll tax expense appropriate at the time

Currently the equitable share from Treasury is allocated to provinces to fund health care and this filters down to hospital and districts. Now, with the proposed Act, the equitable share will go to the NHI Fund to accredited hospitals in all categories (provincial, regional, district public or private), as well as the district health management office, then to the contracting units for primary health care (CUPs). The provincial governments as they are currently will become agents.

- NHI Fund will buy and pay for services [including oral health care] based on own pricing and reimbursement through the CUPs in districts and provinces.
- The CUPs will purchase and pay for health from all forms of clinics, ward-based outreach teams, contracted general practitioners, community health centres and district hospitals.
- The Fund will also buy and pay for services from accredited private hospitals, regional hospitals, district hospitals, specialised hospitals and emergency services.

The proposed Act needs to be clear on:

- The role of the provinces.
- The role and functioning of the CUPs in relation to the functions of the board.

Oral health should be part of the panel of multidisciplinary experts in:

- Benefits Advisory Committee (BAC) – formulary, benefits package, complementary list
- Budget
- Health Care Benefits Pricing Committee – pricing health care
- Stakeholder advisory committee
- Office of Health Standards ComplianceOffice of Health Products Procurement
- District Health Management Offices (DHMO)Contracting Units for Primary Health Care (CUPs)
- Oversee transition until legislation enactment

The oral health care implementation plans now supported by legislation should be specific on the role of dental practitioners in the public and private sectors. The accreditation, licencing, contracting guidelines and plans should be finalised for private dental practitioners and entities. For the public

Author's information
1. Yolanda Malele-Kolisa, Head: Department of Community Dentistry, University of the Witwatersrand, Johannesburg, South Africa24358 ORCID: 0000-0003-3368-9193

Corresponding author
Name: Prof Y Malele-Kolisa
Email: yolanda.kolisa@wits.ac.za

Author's contribution
Concept, design, intellectual content, literature search, data analysis, statistical analysis, manuscript preparation, manuscript editing and review

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.16766

sector practitioners, it will be business as usual from the practitioner point of view; however, management should oversee accreditation of institutions to be CUP registered. Researchers, opinion makers and many stakeholders often cite the impending NHI's universal health coverage as impetus for research, human resource for health realignment and programme initiation. The opponents warn of the huge task ahead. Indeed, in my opinion, the initial four important facets of NHI still needs to occur. The total overhaul of the facilities cannot be downplayed and the reengineered PHC are necessary to provide the nest for the UHC/NHI to germinate, cocoon and blossom. Radical change in management and the transformation of service delivery are imperative.

The gap, I believe, is the "mandatoriness" of the membership. It is not clear how this will be enforced. This should be a relief for those not in favour as it will be business as usual for them if they don't enlist.

The medical aid system will still be important but will be "changed" to top-up schemes which will cover whatever is not covered by the NHI. This will be the bulk of services which are excluded in the basic package of oral health service. Currently, the basic PHC package may include emergency consultations, extractions, basic restorations, preventive services and basic acrylic dentures. Communities, should they wish, will continue to insure themselves for complementary services not provided by the NHI Fund outside the basic PHC package.

The reform has the potential to alleviate the problems as initially underscored. There are lessons to be considered from other settings and these can't be ignored lest they end up being just stories instead of lessons.

This article is the opinion of the author, Prof Y Malele-Kolisa, Head of Clinical Department of Community Dentistry at the Wits Oral Health Centre/School of Oral Health Sciences

REFERENCE

1. Report of the Portfolio Committee on Health on the National Health Insurance Bill [B11 – 2019] (National Assembly – sec 76)], dated 26 May 2023 https://www.parliament.gov.za/storage/app/media/Bills/2019/B11_2019_National_Health_Insurance_Bill/ATC-73-2023-05-26-ENG.pdf

Online CPD in 6 Easy Steps

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

What's new for the clinician – summaries of recently published papers (October 2023)

SADJ October 2023, Vol. 78 No.9 p469-472

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

1. The impact of electronic and conventional cigarettes on periodontal health – a systematic review and meta-analysis

According to the World Health Organization (WHO), tobacco kills more than 8 million people each year, including 1.3 million non-smokers who are exposed to second-hand smoke. Around 80% of the world's 1.3 billion tobacco users live in low- and middle-income countries. In 2020, 22.3% of the world's population used tobacco: 36.7% of men and 7.8% of women.

Regular smoking can cause various pathologies such as cancer, cardiovascular disease, respiratory disorders and periodontitis and is the single most preventable cause of death worldwide[1]. Triggers for many pathologies include more than 90 proven carcinogenic and toxic cigarette substances, some resulting from the burn process. These include polycyclic hydrocarbons, nitrosamines and aldehydes[1]. Electronic nicotine delivery systems (ENDS) (eg electronic cigarettes, vaporisers, vape pens, shisha pens and e-pipes) are said to prevent the formation of unwanted products by bypassing the combustion process.

The tobacco industry and related industries market and promote ENDS as "safer" alternatives to traditional cigarettes, and many users consider them to be significantly "less harmful" than tobacco products, particularly cigarettes[1]. Consequently, their use – especially among younger and first-time smokers – has grown exponentially over the past few years.

Since the oral cavity, the first upper respiratory tract station, is the primary exposed region when smoke is introduced, the influence on oral health, more especially on periodontal health, is significant. Current studies have proven that smoking and vaping are risk factors (ENDS: odds ratio = 2.3, 95% confidence interval (CI) = 1.52 to 3.59; conventional cigarettes: odds ratio = 2.2, 95% CI = 1.76 to 2.68) for periodontal disease.[1] Thiem and colleagues (2023)[1] from Germany reported on a systematic review with meta-analysis that sought to determine whether and to what extent the consumption of ENDS bears advantages and disadvantages on periodontal health (bleeding on probing (BoP), plaque index (PI), probing depth (PD), attachment loss (AL), marginal bone loss (MBL), tooth loss, molecular inflammation markers, salivary flow rate) compared to conventional cigarette smoke and non-smokers.

METHODOLOGY

This meta-analysis was performed based on the recommendations and principles of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Statement (PRISMA). The focused PI(CO) question addressed was as follows: "To what extent does oral health differ between e-cigarette users, cigarette smokers or non-smokers?"

- "Population": e-cigarette users, smokers and non-smokers
- "Intervention": clinical inspection of the oral mucosa, radiographic imaging and histological assessment
- "Comparison": e-cigarette users, smokers and non-smokers
- "Outcome": bleeding on probing (BoP), plaque index (PI), probing depth, attachment loss, marginal bone loss (MBL), tooth loss, molecular inflammation markers and salivary flow rate

A search strategy with mesh terms was developed and adjusted for different electronic databases including MEDLINE (OVID), Embase (OVID; 2006–04/2022), Web of Science, CENTRAL (The Cochrane Library, 2022) and ClinicalTrials.gov. Articles in German and English were screened.

The inclusion criteria were as follows: (a) studies published between January 2006 and April 2022, (b) all studies that compare the clinical effect of e-cigarettes to conventional cigarettes on oral health, namely periodontal health. The primary examination parameter was bleeding on probing (BoP). Secondary examination parameters included plaque index (PI), probing depth (PD), attachment loss (AL), marginal bone loss (MBL), tooth loss, molecular inflammation markers and salivary flow rate. No selection based on other clinical, histologic or radiographic examination methods as well as age, gender or social origin was conducted. Studies that did not compare inhalation products were excluded, as were studies without a control group other than e-cigarette users (healthy non-smokers or cigarette smokers).

The following items were extracted from publications that met the inclusion criteria: author, year, country, study design, sample size, measures of exposure (smoking status), measures of outcome (BoP, PI, PD, AL, MBL, tooth loss, molecular inflammation markers, salivary flow rate), results, conclusions, conflict of interest and source of funding.

To avoid bias in study selection, abstract screening was performed by two independent reviewers. Discrepancies were discussed afterward and evaluated by a third independent reviewer.

Specific exclusion criteria were established during the literature search to guarantee the review's validity to exclude irrelevant data. Studies were individually pooled, and an effect measure was determined for each. The effect measure of individual studies was then formulated at the review level

www.sada.co.za / SADJ Vol. 78 No.9

as the overall effect of the intervention. The means and standard deviations calculated in the individual studies were used to merge different scales or rankings. Instead of providing the standardised mean difference as an effect size, the authors converted it to the odds ratio and their respective 95% confidence intervals (CIs). Heterogeneity was tested using Cochran's Q test and quantified using the I-square test (level of inconsistency) and Tau^2 (estimate of between-study variance). The risk of bias in cohort studies was assessed using a modified version of the Newcastle-Ottawa scale (NOS). According to the description, however, the scale refers to cohort and case-control studies. Nevertheless, other observational studies, such as cross-sectional, were assigned to the two subgroups and assessed. To assess the selected studies' quality of evidence and the quality classification for validity control, the GRADE (Grading of Recommendations Assessment, Development and Evaluation) approach, which focuses on evaluating the study design, was performed.

Meta-regressions were used to test the influence of different moderators (age, duration of exposure, frequency of exposure, time of cessation and dropout rates) on pooled estimates. Heterogeneity (I^2) and the amount of heterogeneity accounted for each variable (R^2) were calculated. A funnel plot was established to detect publication bias.

RESULTS

From a total of 923 publications identified, 16 studies were included in the review. Since all studies were non-randomised, they were classified as evidence grade III or IIa according to the Cochrane GRADE tool.

Pooled outcomes for meta-analysis

- **Evaluation of bleeding on probing:** E-cigarette versus cigarette users

The pooled results showed that the odds of a positive BoP were 0.33-fold lower in e-cigarette users than in cigarette smokers ($p=0.03$) Furthermore, it was checked whether publication bias was present. Based on the funnel plot publication bias was excluded.

Meta-regression revealed that the age of cigarette smokers did not affect the pooled effect size ($\beta = -0.02$; $p=0.79$). Therefore, a higher age does not increase the odds ratio, indicating equal chances of positive and negative BoP among e-cigarette users and cigarette smokers. Likewise, there was no effect of the duration of use of conventional cigarettes ($\beta = -0.03$; $p=0.64$) or e-cigarettes on the pooled effect size ($\beta = -0.04$, $p=0.83$). Moreover, neither daily e-cigarette use ($\beta = -0.04$; $p=0.09$) nor everyday use of cigarettes ($\beta = -0.22$, $p=0.04$) affected the pooled effect size. The chance of bleeding (positive BoP) is equal between e-cigarette smokers and smokers in the case of increased consumption. The remaining influencing variables and moderator variables were not significant.

- **Evaluation of bleeding on probing:** E-cigarette users versus non-smokers

When comparing e-cigarette users and non-smokers, significant heterogeneity between studies was evident ($Q(6)=120.3$; $p<0.0001$), leading to the application of the random effects model with $I^2=95\%$ and $\tau^2=12.8$. The pooled odds ratio indicated that e-cigarette users have a significantly lower chance for positive BoP than non-smokers ($p<0.01$). When assessing for publication bias, effect sizes were distributed asymmetrically in the funnel plot, suggesting publication bias.

To counteract the publication bias, the trim-and-fill method was applied to estimate the number of additional studies required to minimise the effect of bias and to achieve a symmetric distribution. The following forest plot is augmented with studies according to the above methodology. As a result, significant heterogeneity occurred ($Q(6)=71.07$; $p<0.001$). To quantify the heterogeneity, $I^2=96\%$ and $\tau^2=21.87$ were calculated, indicating the presence of considerable heterogeneity. The random effects model yielded a pooled effect size of 0.01, resulting in a 0.01-fold decreased chance of a positive BoP result in e-cigarette users compared with non-smokers ($p<0.01$)

No pooled effect analyses for the other variables were attempted due to the lack of studies or heterogeneity between the studies.

CONCLUSION

Based on the present results, it can be summarised that e-cigarette use might be considered a healthier alternative to cigarette smoking concerning periodontal health. Even so, harmful effects of electronic nicotine delivery systems (ENDS) usage on periodontal health were seen as well. Due to the lack of standardisation among studies and randomised controlled trials, more research is required to conclusively pronounce on this controversial product.

IMPLICATIONS FOR PRACTICE

The harmful effects of e-cigarettes appear to be less obvious when compared to conventional smoking but clinicians need to continue their efforts to educate their patients on the harmful effects of nicotine containing products.

REFERENCE

1. Thiem DG, Donkiewicz P, Rejaey R, Wiesmann-Imilowski N, Deschner J, Al-Nawas B, Kämmerer PW. The impact of electronic and conventional cigarettes on periodontal health – a systematic review and meta-analysis. Clinical oral investigations. 2023 Sep;27(9):4911-28

2. Immediate versus conventional loading of mandibular implant-retained overdentures: a 3-year follow-up of a randomised controlled trial

In edentulous patients, the use of conventional dentures has offered the benefit of providing improvement in function and aesthetics. More recently, the introduction of implant-supported overdentures has become a better treatment option for edentulous patients. In fact, the implant-supported overdenture is considered as the first choice of standard care for edentulous patients because it offers a higher retention and stability provided by the attachment mechanism, opposing successful conventional maxillary dentures.[1] The robust evidence in literature currently leads many clinicians to recommend treatment of completely edentulous individuals with implant mandibular overdentures (IMO) retained by 2 implants using a conventional loading (CL), regardless of implant diameter, due to the cost-benefit effective nature of this treatment and the rapid increase in patient satisfaction[1]. However, patients who have undergone CL treatment have reported discomfort and trauma while using conventional complete dentures during the 3-month waiting period before occlusal loading. The instability and lack of retention of the provisional dentures have resulted in inadequate function, adding to the patient's overall discomfort[1]. Studies have demonstrated that immediate

loading (IL) is able to improve oral health-related quality of life (OHRQoL) faster than CL and that satisfaction with IMO generally increases progressively from the first months to the second year, along with comfort, aesthetics and the ability to masticate and speak.

Possebon and colleagues (2023)[1] reported on a trial that sought to evaluate the differences in peri-implant health, marginal bone level (MBL) and implant survival rates, between CL and IL of IMO retained by two unsplinted narrow diameter implants at a follow-up period of 3 years. The secondary objectives were to compare posterior bone resorption of the mandible, functional and patient-centred outcomes and prosthetic maintenance events between the two groups.

METHODOLOGY

The present longitudinal study is a 3-year annual follow-up of IMO wearers who participated in a 3-month randomised controlled trial (RCT) that compared the performance of IL and CL protocols during rehabilitation with two unsplinted narrow diameter implants (Facility-Equator system) used as IMO retainers. The study format for reporting followed the reported Consolidated Standards of Reporting Trials (CONSORT) guidelines for RCT. Each patient who agreed to participate in the study signed a written informed consent form. IMO users were monitored annually over a 3-year period. In relation, the surgical interventions and prosthetic treatment, two dental implants (NDIs – 2.9×10mm) were inserted in the inter foramen region, approximately 5mm anterior to the mental foramina and a minimum inter-implant distance of 20mm using a traditional single-stage surgical protocol. The implant surgery drill sequence followed the protocol recommended by the implant manufacturer and was executed by an experienced surgeon. The bone strength during the preparation of the bone site and the implant placement were based on subjective perception of the surgeon. The insertion torque was recorded and values greater than 30 Ncm were considered adequate for IL. If IL was adopted, the IMO was loaded after surgery by connecting the O-ring cylinder for the Facility Equator attachment intraorally, using self-curing acrylic resin to fit the system to the internal surface of the prosthesis. In the CL group, the intaglio of the mandibular prosthesis was adjusted and rebased with an intermediate liner until the end of the 3-month bone healing period.

For clinical outcomes, the peri-implant health was assessed through clinical examination of the 4 implant faces to monitor the visible plaque index (VPI), peri-implant inflammation (PI), calculus presence (CP), probing depth (PD) and bleeding on probing (BOP). The implant stability analysis was performed by measuring the implant stability coefficient (ISQ) by connecting an A3 type smartpeg directly to the Equator attachment. The measurements were performed in triplicate on all 4 implant faces using an Ostell device. All clinical evaluation has been made by a calibrated operator.

Radiographic evaluation: marginal bone loss and posterior bone resorption

The marginal bone loss (MBL) and the posterior area index (PAI) were analysed using standardised digital panoramic radiographs and all analyses were performed by a single, calibrated examiner. Radiograph calibration involved calculating the Intraclass Correlation Coefficient (ICC) based on two separate analyses at a one-week interval and the outcome was considered acceptable for a correlation index ≥ 0.80. MBL measurements were made at the mesial and distal side of each implant using the linear measurements tools available in the DBSwin 4.5 software package. The external edge of the implant head was used as a reference point during the evaluation, and the implant length was used as reference to correct distortions. The delimitation of reference and experimental areas traced in digital panoramic radiographs was performed using the Photoshop software, and measurements were subsequently performed in the ImageJ software. The PAI was calculated by dividing the experimental area by the reference area, and the average of the PAIs on both sides was reported as the final PAI value.

Functional and patient-centred outcomes

The masticatory performance (MP) test was used to analyse the masticatory function. In this test, patients were instructed to masticate a 3.7g portion of Optocal test food for 40 chewing cycles, counted by a calibrated operator. The triturated test material was subsequently expelled on filter paper, rinsed with water and dried at room temperature for 7 days. The material was then passed through a sieve stack composed of sieves with decreasing opening sizes (5.6mm-0.5mm) mounted on a sieve shaker for 20 min. The material retained in each sieve was weighed and inserted into the Rosin-Rammler equation to calculate the theoretical opening through which 50% of the particles pass (MPX50) and the particle size homogeneity (MPB). The masticatory efficiency (ME) was calculated as the percentage of material weight retained in the 5.6mm and 2.8mm sieves.

The impact of IMO use on OHRQoL was evaluated through the Dental Impact on Daily Living (DIDL) questionnaire. This questionnaire comprises 36 questions divided into 5 domains that map patient satisfaction regarding appearance, pain, oral comfort, general performance and chewing. The final scores for each domain represent the average score of the questions in each domain, and are classified as dissatisfied (< 0), relatively satisfied (0-0.69) or satisfied (0.7-1.0).

Events related to prosthesis maintenance such as pink nylon O-ring exchanges and prosthesis adjustments were also recorded. The following information was also reported: type of complication, number of patients and number of events.

Biological complications such as mucositis or peri-implantitis were diagnosed as reported in the recent World Workshop on the classification of periodontal and peri-implant diseases. The success of the implants was evaluated according to: the absence of clinical implant mobility, the absence of peri-implant continuous radiolucency, the absence of infections, persistent pain and discomfort, and marginal bone loss < 1.5mm. Implant failure was defined by its absence from the mouth or determined when a condition manifests that requires its removal, such as radiolucency around the implant, mobility, suppuration, pain or pathological processes such as osteonecrosis, overloading or advanced peri-implantitits. When implants are still in function in the follow-up, they are categorised into the survival category; survival rates were calculated at 2 and 3 years.

www.sada.co.za / SADJ Vol. 78 No.9

RESULTS

Three losses were registered during initial 1-year follow-up, 2 in the CL group (1 male and 1 female) and 1 male in the IL group. Thus, the remaining sample of the CL group comprised 6 females and 2 males with an average age of 68.9 years and a mean time since mandibular edentulism of 25 years. The IL group comprised 5 females and 3 males with an average age of 70 years and a mean time since mandibular edentulism of 27.4 years. Five implants were lost (3 IL and 2 CL) during the first year resulting in the survival rate of 90% in the CL group and 85% in the IL group. After replacement with new cone morse implants (ø = 3.5 × 9mm, Titamax Cone Morse Implant), no implants were lost between 1 and 3 years. These cone morse narrow diameter implants were not included in the subsequent analysis. In the CL group, 1 patient had mucositis in the right implant; this condition was absent after 3 years of treatment.

The inter-group analysis (IL vs CL) showed differences between the IL and CL groups in the second year, with significantly lower PD ($p < 0.01$), VPI ($p = 0.03$) and MPB ($p < 0.01$). At year 3, only the MBL differed between the groups ($p < 0.01$), as the IL group presented less bone loss in the peri-implant region (Δ = -0.04). For the prosthesis-related complications and maintenance events, no differences were observed between both groups after 2 and 3 years.

The changes over time for the CL group indicated that the average implant stability coefficient (ISQ) in the 3rd year increased significantly compared to the 1st year (+5.47%, $p < 0.01$). The Visible Plaque Index (VPI) doubled between the 2nd and the 3rd year ($p < 0.01$), while the marginal bone loss (MBL) increased slightly (+4.17%, $p < 0.01$). The bone area of the posterior region increased by 5.83% between the 1st and the 2nd year ($p < 0.01$), followed by a minor but significant reduction of 0.79% in the third year ($p < 0.01$). In the CL group, 2 out of 8 individuals (25%) experienced loss of posterior bone area at the end of the 3rd year. There were significant reductions in average triturated particle size (MPX50 -11.25%, $p = 0.04$) between the 1st and the 2nd year, followed by an increase in the 3rd year (MPX50 + 5.19%, $p < 0.01$). The homogeneity of the triturated food particles (MPB) differed significantly at all evaluation periods (1-2 years, $p < 0.01$; 1-3 years, $p < 0.01$; 2-3 years, $p < 0.01$) and a 9.56% increase in heterogeneity was observed between years 2 and 3. The % retention in the 5.6mm sieve (ME5.6) increased significantly ($p < 0.01$) between years 2 and 3 resulting in an overall increase between year 1 and 3 of 3.35% ($p = 0.02$), reflecting a minor decrease in capacity to triturate coarse particles. Conversely, the ME2.8 values showed a minor but significant increase ($p = 0.02$) of 5.10% between 1 and 3 years.

The changes over time for the IL group indicate changes in clinical outcomes over the entire follow-up period, with an increase of 12.20% in ISQ ($p = 0.04$) between the 1st and the 3rd year, alongside a 13.16% increase in the probing depth ($p < 0.01$). In addition, the MBL increased significantly (MBL +16.66%; $p < 0.01$) between the 1st and the 3rd year, and a progressive reduction in the posterior bone area (PAI) between the 1st and 2nd year (PAI -5.26%, $p < 0.01$) and between years 2 and 3 (PAI -0.93%, $p < 0.01$). In the IL group, 5 out of 9 individuals (56%) experienced loss in the posterior bone area at year 3. The average triturated particle size reduced by 6.44% between years 1 and 2 ($p = 0.03$), and subsequently increased by 7.18% between years 2 and 3 ($p = 0.04$). The percentage of particles retained in the 5.6mm sieve reduced by 43.75% between years 2 and 3 ($p = 0.04$), whereas the percentage retained in the 2.8mm sieve reduced by 0.32% between years 1 and 2 ($p < 0.01$).

The only OHRQoL difference between groups occurred in the first year for the pain domain (coefficient: 0.50; 95% confidence interval (CI: 0.12-0 0.87; $p < 0.01$). In the CL group, the score in the oral comfort domain slightly increased between years 1 and 3 (coefficient: 1.21; CI: 0.26-2.17; $p < 0.01$). In the IL group, the pain domain scores reduced by 1.12% between years 1 and 2 (coefficient: 1.83; CI: 0.39-3.27; $p < 0.01$), followed by a slight increase of 2.24% between years 1 and 3 (coefficient: -2.00; CI: -3.78 to -0.21; $p = 0.02$). The oral comfort domain scores increase of 22.97% between years 1 and 2 (coefficient: 2.10; CI: 0.65-3.56; $p < 0.01$), while general performance scores increased by 1.05% (coefficient: 1.45; CI: 0.91-1.99; $p < 0.01$) and reduced by 10.52% between years 1 and 3 (coefficient: -0.23; CI: -0.36 to -0.10; $p < 0.01$). All individuals had a final satisfaction score greater than 0.7, showing everyone was satisfied with their rehabilitation regardless of the loading protocol adopted.

CONCLUSION

Although IL patients experienced the lowest MBL after 3 years, all the outcomes evaluated in this RCT showed that both loading protocols result in predictable medium-term rehabilitation when monitored annually. It can be expected that in the third year of function, IL patients may present more complaints related to general performance even with acceptable masticatory function and self-reported improvements in oral comfort.

IMPLICATIONS FOR PRACTICE

Both loading protocols led to predictable results. This implies that the decision to use CL or IL must be a considered and patient specific decision made between clinician and patient.

REFERENCE

1. Possebon AP, Schuster AJ, Chagas-Júnior OL, Pinto LD, Faot F. Immediate versus conventional loading of mandibular implant-retained overdentures: a 3-year follow-up of a randomized controlled trial. Clinical Oral Investigations. 2023 Aug 23:1-12

The ethical debate between what patients want, need and can afford, and what treatment clinicians think they should receive

SADJ October 2023, Vol. 78 No.9 p473-475

LM Sykes[1], M Vorster[2]

ABSTRACT

Endodontic emergencies are common procedures in dental practice, and need to be addressed as soon as possible. The initial treatment is usually extirpation of the pulp – also known as emergency root canal treatment (ERCT), – followed by complete cleaning, shaping and obturation of the root canal system. Root canal therapy (RCT) needs to be completed with a definitive restoration to increase long-term prognosis of the tooth. Both of these carry additional costs. Patients treated in government facilities often have limited access to follow-up care due to long waiting lists, financial constraints or logistical challenges.

It is also difficult to determine how many patients return for these procedures as some who remain pain-free and asymptomatic may not see the need for any further treatment. Others may experience complications necessitating extraction of the tooth. The prognosis of unrestored extirpated teeth is unpredictable and literature is scant, thus dentists often need to make a judgement call when deciding between trying to save a tooth and recommending an extraction. This paper debates the ethical issue of considering patients' wants and needs, versus what clinicians think they should receive, as well as the issue of paternalism, in relation to the informed consent process.

Introduction

Endodontic emergencies are common in dental practice, and can result from many different conditions of the pulp or peri-radicular tissues.[1] Endodontic emergencies needs to be addressed as soon as possible especially if the patient is in pain or has signs of active infection. Accurate diagnosis and differential diagnosis is essential for proper treatment planning and correct medication.[1] In a study by Farmakis et al. (2016), the authors reported that the highest prevalence of emergencies at their clinic was, in fact, endodontic conditions. Of these almost 48.8% had either reversible pulpitis, irreversible pulpitis and/or acute apical periodontitis, and as such the most frequent treatments performed were pulpectomies and abscess drainage.[2]

Endodontic emergencies may occur prior to endodontic treatment, during active treatment (usually root canal treatment or re-treatment) or at any time after root canal completion.[3,4] The success rates of emergency root canal treatments conducted without completion can vary. While these treatments generally provide relief from pain and infection their long-term effectiveness remains uncertain. Several factors like patient compliance, variation in operator skill, temporisation and state of the tooth, among others, contribute to this uncertainty. The provision of emergency root canal treatment without completion raises concerns. Dentists must carefully consider the need for pain relief as well as ensuring the long-term wellbeing of their patients.

This scenario brings attention to the predicament confronting healthcare professionals especially those working in busy practices and government healthcare facilities that have limited resources. While it is crucial to relieve pain and suffering it is equally vital to educate patients about the importance of completing follow up RCT for the long-term survival of teeth.

This paper will explore the clinical and ethical issues a dentist needs to consider in patients presenting with pain, sepsis, swelling or irreversible pulpitis and requiring emergency pulp extirpation (ERCT).

Considerations

When carrying out an ERCT, the understanding is that the patient will return for completion of the RCT as well as have some form of permanent restoration placed. Both of these carry associated time and costs. However, it is very difficult to determine how many patients do return for the definitive procedures. Once the symptoms have subsided, some may not see the need to have any more work done. Some may not be able to afford the subsequently recommended procedures, while others may only return if the tooth flares up or becomes symptomatic. Following ERCT, a tooth's behaviour and prognosis is unpredictable. Complications may occur at any time, from days to years later. When this happens, some patients may go back to the dentist who saw them initially, while others could seek help elsewhere. Depending on the time lapse and the state of the tooth it may still be possible to complete the RCT and restore it, or it may have broken down to such an extent that an extraction is necessary. Furthermore, some patient may themselves

Authors' information

1. Leanne M Sykes, *BSc*, *BDS*, *MDent*, IRENSA, Dip Forensic Path, Dip ESMEA, *FCD* (Pros), Head of Department of Prosthodontics, University of Pretoria, South Africa. ORCID: 0000-0002-2002-6238
2. Martin Vorster, *BChD*, *PGDipDent* (Endo), *MSc*, *Phd*, Department of Odontology, University of Pretoria, South Africa. ORCID: 0000-0003-4470-1530

Corresponding author

Name: Prof LM Sykes
Email: Leanne.sykes@up.ac.za

Author's contribution

1. LM Sykes, primary author 70%
2. M Vorster 30%

www.sada.co.za / SADJ Vol. 78 No.9

rather opt for an extraction than go through with all the visits needed to save and restore their tooth. Thus, there are a number of clinical, patient-related, clinician-related and ethical factors a dentist needs to consider before embarking on an ERCT in patients who present as emergencies with pain, sepsis, swelling or irreversible pulpitis.

Clinical factors

Following a detailed and specific medical, dental and radiographic evaluation the dentist will have to look at the tooth in question and determine if it is saveable. If not then treatment will include pain relief, control of sepsis and infection, and immediate or delayed extraction. Clinicians should further assess whether in fact it is beneficial in the long term to retain this tooth in question. What is its position in the arch, how many other teeth are present, is it necessary in terms of masticatory function, speech, aesthetics or as an abutment tooth for some other prosthesis, what sort of restoration will be needed after completion of the RCT and if, in fact, endodontics will be possible based on radiographic evaluation of the canal/s. They should also assess the patient's oral hygiene status, number and condition of existing restorations, and treatment needs of the remaining dentition, mouth opening, gag reflexes and if the placement of rubberdam or proper isolation is possible.

Dentist factors

The clinicians faced with a tooth that requires an ERCT must make an honest appraisal of whether they have the skills and armamentarium necessary to complete that particular RCT, and subsequent restoration, or if they will need to refer to a specialist. If the latter, then the patient needs to be made aware of this as it may have time, access and financial implications for them. They also need to weigh up the feasibility of trying to save the tooth in terms of time, cost, pain and discomfort to the patient, versus its anticipated outcomes. A complex, lengthy and costly procedure in a tooth with a poor prognosis is difficult to justify unless that tooth is of crucial importance within the stomatognathic system. The dentist should then explain to the patient the procedures and number of visits that will be required following ERCT, in order to have the RCT completed and a permanent restoration placed. They should provide estimated time and costs involved and caution the patient that there is a possibility of complications, such as root perforation, tooth fracture or subgingival caries resulting in extraction at a later stage. Alternative treatment options should be discussed, including details of the advantages and disadvantages of each. Finally, they should give an unbiased opinion as to which will be the best and most suitable treatment for their situation.

Patient factors and paternalism

The patient, who is now informed and educated, should then be asked what exactly they want. At this stage the clinician needs to give the patient time to communicate, ask questions and deliberate. They should not be tempted to rush through this process or interject with their opinions. It is also important to remember that a patient who is in pain is already in a compromised and vulnerable state, and may need more time and support to help them make a wise decision. Of course, what a patient wants may not be the same as their needs, and may not be possible, desirable or feasible for them in that situation. However, the clinician needs to caution against deciding for the patient based on "their own" opinion of what is best for the patient. It is here where an ethical issue may arise. If after having carried out a similar clinical evaluation and patient assessment to that outlined above, the dentist considers the tooth to be saveable and restorable, but has doubts as to whether the patient will return for the required completion visits, what should they do? One would have to ask, how did they come to this decision? Was it based on a personal judgement call which could have been erroneous or even biased and prejudice?[5] Do they have the right to make assumptions about another person's future behaviour? Are they acting in the patient's best interest or from a self-assigned moral high ground? Should they try to impose their views? Could that be considered paternalistic, and would it be ethically defensible?

Paternalism refers to a situation where "the clinician disregards the patient's opinion and decides on/or refuses treatment unilaterally".[5,6] Soft/weak paternalism generally refers to those situations where the doctor truly believes they are protecting the patient from the consequences of an unwise decision. Other subtle forms may be where they exaggerate the risks and costs of the procedure they don't wish to perform, and downplay these in the treatment they are advocating in order to coerce the patient into accepting their suggestions. They may also purposefully not give the patient too much information, because they have decided that the patient will either not understand it all, does not need to know the details or will not be able to cope with hearing about possible risks or adverse events. Soft paternalism is easier to justify where it is seen to prevent harm, where it will result in perceivable benefits to the patient and where risks to the patient are low.

Hard/strong paternalism is when the practitioner tries to enforce their views based on "differing personal values and goals, fear of litigation, where they feel incompetent to carry out a procedure, or where there is a conflict of interest".[5-7] It is much harder to justify, and more so when the risks to the patient are greater.

DISCUSSION

Given the unpredictable behaviour and unknown prognosis of teeth that have undergone an ERCT without ever having the RCT completed the dentist often needs to make a judgement call when deciding whether to extract or try to save a tooth when patients present with an endodontic emergency. However, before making any final decisions they need to engage with the patients to ensure they provide them with the three core features of informed consent, these being threshold, information and consent elements. In an emergency situation the threshold element of time to consider the options may be limited, but the principles of competence, understanding and voluntariness will still apply. With regard to the information element, the practitioner should not be tempted to make personal judgement calls as to whether the patient deserves to have the tooth saved, and must disclose all the relevant information in an impartial manner. They should also then present the patient with all possible treatment plans but may propose the preferred/most suitable option.

A slightly different situation arises in high patient turnover and resource-limited settings such as government hospitals and rural clinics. Here the numbers of patients who present with emergency endodontic problems often far exceeds the staff or facilities' capabilities of providing timely definitive treatment. Many patients who undergo ERCT procedures find themselves on long waiting lists, and may discover that

by the time they are recalled, the tooth has deteriorated to such an extent that it is no longer possible to save it. The ethical question is now not about refusing treatment for paternalistic reasons, but rather about considering distributive justice. Should limited resources be used to provide a treatment that requires many follow-up visits and costly interventions, which may never materialise. Would it be better to advise the patient to have the tooth extracted and be placed on a waiting list for a partial denture? Not only may this be the more "appropriate" option[8], but they may be treated sooner, in fewer visits, it requires less invasive procedures, is cheaper and may be the ultimate treatment in any event.

However, they still need to respect that fact that an informed patient may want to "take a chance and buy themselves some time", which can vary from a few days to years, by undergoing the ERCT. In this event, they must keep clear records of the conversations and advice given, and the patient's acceptance of the risks.

CONCLUSION

The final decision about any medical or dental treatment must be made by the patient. However, for them to make an informed choice they need to have been guided by the clinician who should have provided them with enough knowledge to ensure they understand the information, proposed plans, consequences of accepting or refusing treatment and all possible alternative options. If they opt to undergo an ERCT, they should also commit to completing the RCT and subsequent restorations, ensure they have the necessary finances and time, and be aware of the limitations and possible complications of these interventions. They must then make the final selection and provide autonomous, voluntary authorisation and signed informed consent.

REFERENCES

1. Abbott PV. Present status and future directions: managing endodontic emergencies. Int Endodontic J. 2022;55(suppl.3):778-803
2. Farmakis ET, Palamidakis FD, Skondra FG, Nikoloudaki G, Pantazis N. (2016) Emergency care provided in a Greek dental school and analysis of the patients' demographic characteristics: a prospective study. International Dental Journal, 66, 280-286
3. Carrotte P. (2004) Endodontics: part 3. Treatment of endodontic emergencies. British Dental Journal, 197, 299-305
4. Azim A, Azim K, Abbott PV. (2017) Prevalence of inter-appointment endodontic flare-ups and host-related factors. Clinical Oral Investigations, 21, 889-894
5. Sykes LM, Van Zyl AM, Harris A. Refusing to treat. Is it legal? Is it justifiable? Is it ethical? SADJ April 2023, Vol 79 No 4:217-219
6. Sykes LM, Evans WG, Cooke HA, Dullabh HD, Herbst D. Informed Consent. Part 16: It's more than a matter of "Been there, done that, got the signature". SADJ 2017
7. Beauchamp T, Childress AF. (2001) Principles of Biomedical Ethics. Ed.Oxford University Press, New York
8. Sykes LM, Kok J, Nethononda PT. Does providing "Compromised treatment" equate to "Compromised care" or could it be considered "Appropriatech"? SADJ July 2023; 78; 5; 321-322

Online CPD in 6 Easy Steps

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

www.sada.co.za / SADJ Vol. 78 No.9
https://doi.org/10.17159/sadj.v78i09.17395

Desmoplastic Fibroma: a benign neoplasm mimicking a malignancy

SADJ October 2023, Vol. 78 No.9 p476-477

L Merbold[1], S Shaik[2]

CASE

A four-year-old African male patient presented to our clinic with a two-month history of a firm, warm lesion involving the right side of his face. The lesion presented as a bleeding papillary mass in the 85/46 region that extended to the floor of the mouth, causing displacement of the tongue (Figure 1A-B). Upon cone-beam computed tomography (CBCT) examination, an expansile homogenous intermediate density lesion was noted with complete destruction of the bucco-lingual cortical bone. Discernible extensions were identified in the anteroposterior plane from the region of the 84 to the posterior mandible involving the right corpus, developing 46, angle and ramus but spared the condyle and coronoid processes. The lesion extended inferiorly below the epiglottis and showed a reduction of the hypopharynx. Marked bucco-lingual expansion with soft tissue swelling was noted (Figure 2A-D). An incisional biopsy was performed under general anaesthesia, and histological examination rendered a diagnosis of desmoplastic fibroma (DF).

Figure 1: (A) Clinical photograph of the patient showing facial swelling and asymmetry on the right. (B) Intra-oral photograph of the patient showing a papillary, expansile lesion in the region of the 46 causing displacement of the tongue.

INTERPRETATION

Aetiology and pathogenesis

Desmoplastic fibroma is a rare benign tumour of connective tissue origin with low to variable cellularity. The tumour is a locally aggressive, invasive, benign neoplasm accounting for less than one percent of bone tumours.[1] The aetiology of DF is still unknown.[2] DF is usually similar to other intra-osseous fibrous lesions that mainly occur in the mandible (69.4%) followed by the femur (15%), pelvis (13%), radius (12%) and tibia (9%).[1,3,4] The lesion commonly presents as a painless swelling that causes facial asymmetry, tooth displacement and mobility.[2]

Clinical presentation

DF generally occurs during the first two decades of life with a mean age of 16 and an equal male-to-female ratio.[1] It has been reported in patients as young as one year old. Clinically, most DFs present as painless, slow-growing swellings.[5] A differential diagnosis of DF is difficult purely based on clinical and radiological examination and, therefore, histopathological examination is required for a definitive diagnosis.[1] Histologically, DF generally resembles a soft tissue desmoid tumour.[5] According to the World Health Organization (WHO), the pathognomonic histological features for DF are the presence of mature fibrous connective tissue, spindle-shaped fibroblasts (that are separated by abundant collagen fibres) and the absence of cellular mitoses or atypia.[6] It is important to distinguish it from other benign spindle cell tumours such as non-ossifying fibroma, myofibroma, odontogenic fibroma, fibrous dysplasia and low-grade fibrosarcoma.[1]

Diagnosis

DF is a very challenging tumour to diagnose due to the slow onset and unremarkable/variable findings. The radiographic features of DF are not very specific.[1] It may present as a uni- or multilocular lesion with well or ill-defined

Authors' information

1. Lené Merbold, BChD, PGDipDent (Radiology), MSc (Maxillofacial Radiology), Department of Oral and Maxillofacial Pathology, School of Dentistry, Faculty of Health Sciences, University of Pretoria, South Africa
   ORCID: 0000-0003-4041-127X
   Email: Lmerbold@gmail.com
2. Shoayeb Shaik, BChD, PDD (MFR), MSc (MFR), Department of Oral and Maxillofacial Pathology, School of Dentistry, Faculty of Health Sciences, University of Pretoria, South Africa.
   ORCID: 0000-0002-4898-3005
   Email: shoayeb.shaik@up.ac.za

https://doi.org/10.17159/sadj.v78i09.17395

borders.[5] Additionally, cortical expansion, perforation or destruction (because of rapid expansion) may cause new bone formation with a "sunburst" appearance. These features may then be mistaken for osteogenic sarcoma or Ewing's sarcoma.[2] It commonly presents with a so-called soap bubble appearance and may be misinterpreted as an ameloblastoma, aneurysmal bone cyst or odontogenic myxoma.[1] Diagnostic imaging is a vital step in assessing bone lesions. Panoramic radiography is usually the first imaging modality, but three-dimensional imaging, like CBCT, CT and MRI, are the imaging modalities of choice if the lesion presents with suspected cortical perforation and extra-osseous growth.[2]

Treatment

Due to the aggressive nature and high recurrence rate, the treatment of choice is complete surgical resection with wide margins or enucleation in selective cases.[4] The recurrence rate is between 40-47% if the lesion is treated via conservative methods such as curettage. Radiation therapy can be used if the lesion is close to vital structures but should be avoided in children due to post-operative complications.[1] Long-term follow-up will be needed for all patients with DF.[4] Bone reconstruction is essential for patients' quality of life.[2]

CONCLUSION

DFs can present very early in life, grow rapidly and have a destructive nature to the extent that they can mimic a malignancy; and thus it is important to manage appropriately. Early diagnosis, comprehensive clinical and radiographic examinations, adequate biopsy site selection, histological evaluation and appropriate treatment can result in a better prognosis and expectation for the patients.[2]

DECLARATIONS

Conflict of interest

The authors declare that they have no conflict of interest.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

Ethics approval

This study was approved by the University of Pretoria Ethics Committee (Reference no: 456/2023). All procedures followed the ethical standards of the Helsinki Declaration of 1975, as revised in 2008.

REFERENCES

1. Karimi A, Derakhshan S, Khiavi M, Mosavat F, Mirjalili F. (2020). Desmoplastic fibroma of the jaws: a case series and review of literature. Iranian Journal of Pathology, 15(2), 134-143. https://doi.org/10.30699/ijp.2020.103833.2049
2. Motevasseli S, Yousefi Z, Dalili Kajan Z, Modanlou R, Roudbari N. (2022). Periosteal reaction as a crucial radiographic finding for desmoplastic fibroma of the jaw bone in children: A case report. Imaging science in dentistry, 52(3), 319-326. https://doi-org.uplib.idm.oclc.org/10.5624/isd.20220014
3. Stelter GO, Rodrigues WN, Schuch LF, Loureiro FJA, Silveira FM, Martins MAT, Martins MD. (2023). Desmoplastic fibroma of gnathic bones: a systematic review, Oral Surg, Oral Med, Oral Path and Oral Rad, 136(1), 35. https://doi.org/10.1016/j.oooo.2023.03.081
4. Mohammadi F, Shirani G, Derakhshan S, Faghihi T. (2020). Desmoplastic fibroma of the lower jaw in a 2-year-old patient; report of a rare case, 17(3), 231-234. https://doi.org/10.4103/1735-3327.284725
5. Kahraman D, Karakoyunlu B, Karagece, U, Ertas, U, Gunhan O. (2021). Desmoplastic fibroma of the jaw bones: a series of twenty-two cases. Journal of Bone Oncology, 26. https://doi.org/10.1016/j.jbo.2020.100333
6. El-Naggar AK, Chan JKC, Grandis JR, Takata T, Slootweg PJ. World Health Organization classification of head and neck tumours. 4th ed. 2017

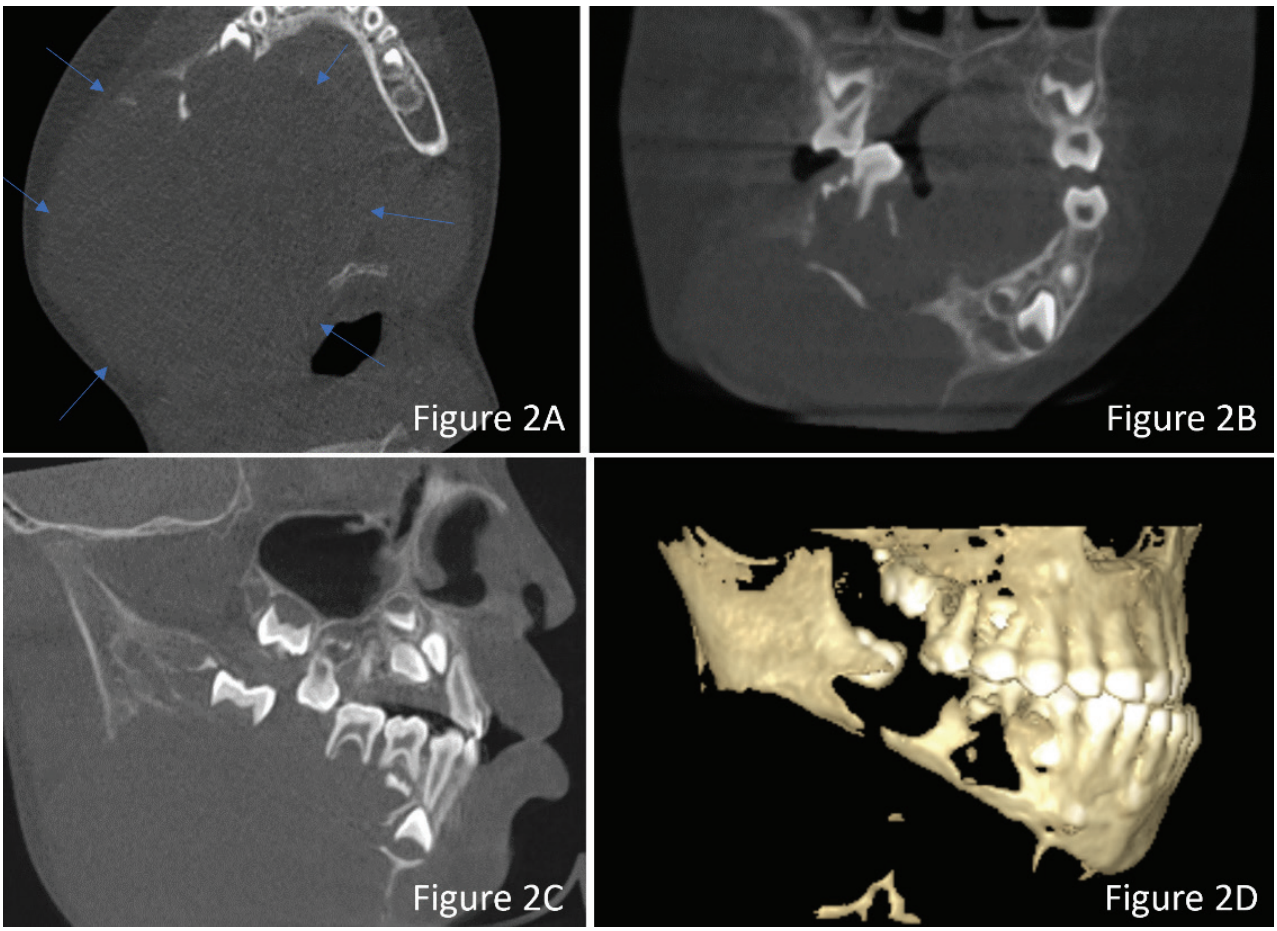


Figure 2: CBCT multiplanar reformatting showing the lesion in the right mandible with expansion, cortical perforation and destruction throughout the entire lesion, extending posteriorly into the corpus, angle and ramus but excluding the condyle and coronoid. (A) Axial view of the lesion with the blue arrows indicating the margins of the lesion. (B) Coronal, (C) sagittal and (D) three-dimensional reconstruction of the lesion indicating the extent of destruction.

www.sada.co.za / SADJ Vol. 78 No.9

CPD questionnaire

A simplified and evidence-informed approach to designing removable partial dentures. Part 2. The biomechanical basis of support

1. **Choose the CORRECT statement. With regard to the response of mucosa overlying an edentulous ridge to a force directed to it:**
   A. It is immediately displaced and then returns after removing the load
   B. It is not fully displaced immediately and takes time to return
   C. It takes time to be displaced, but then returns after removing the load
   D. It is never displaced and therefore has no burden of return

2. **Select the CORRECT option. When mucosa is displaced its recovery is dependent on:**
   A. The underlying periosteum
   B. The size of the removable partial denture
   C. Age
   D. Gender

3. **Which answer is CORRECT. When preparing a rest seat, at what angle should it be to the path of insertion?**
   A. 90°
   B. <90°
   C. >90°
   D. It does not matter

4. **Choose the CORRECT statement. Cingulum rest seats:**
   A. Are not always necessary
   B. Are the same shape whatever the base of denture
   C. Should be kept separate from the guide plane
   D. All of the above statements are correct

Root and canal morphology of the mandibular first molar: a micro-computed tomography-focused observation of literature with illustrative cases: Part 1: External root morphology.

5. **Choose the CORRECT answer. According to the available literature, the mandibular first molar has two roots with a prevalence that can range anything between:**
   A. 60% - 90%
   B. 68% - 95%
   C. 73.5% - 100%
   D. 80% - 89%

6. **Which of the following is CORRECT. In a recent South African study on a mixed population group, the authors determined that mandibular first molars with three roots have a prevalence of**
   A. 1%
   B. 3%
   C. 2.5%
   D. 4%

7. **Select the CORRECT option. In a recent worldwide observation of the radix entemolaris (RE), what was the prevalence reported from Durban, South Africa?**
   A. 2%
   B. 3.5%
   C. 2.5%
   D. 5.2%

8. **Which answer is CORRECT. An additional root present on the mesio-lingual side of a mandibular molar is known as a**
   A. Radix entemolaris (RE)
   B. Radix paramolaris (RP)
   C. Radix mesiolingualis (RML)
   D. Radix distolingualis (RDL)

Knowledge and perception of Oral Health Professionals regarding the National Health Insurance

9. **Select the CORRECT statement. The perceived impact of the NHI on the oral health sector in general.**
   A. Majority of the oral health professionals indicated that funding for oral health will be severely reduced under the NHI
   B. There was an overall negativity about the expected standards and provision and management of oral health under the NH.
   C. Respondents believed that the NHI would have beneficial impact on oral health
   D. All of the above

10. **Which of the following statements is CORRECT. The perceived impact of NHI on the private oral health sector**
    A. Practitioners strongly agreed that NHI would wipe out medical scheme's funds, bankrupt schemes.
    B. The NHI will result in the closure of practices
    C. The funding for oral health will reduce drastically under the NHI
    C. All of the above

11. **Choose the CORRECT answer. The views of the practitioners regarding the fate of NHI?**
    A. Most of the respondents thought that the NHI program was more likely to fail
    B. Majority advocating for the NHI to be amended
    C. The NHI should be excluded from existing medical schemes
    D. The NHI should be privately administered OHPs indicated that NHI was another state-owned enterprise (SOE).

12. **Which percentage is CORRECT. The overall percentage of the practitioners who are knowledgeable about the NHI.**
    A. 75%
    B. 61.3%
    C. 63.7%
    D. 30%

Radiology Corner

13. **Select the CORRECT option. Desmoplastic fibroma is a rare benign tumour**
    A. of connective tissue origin
    B. of adipose tissue origin
    C. of dental hard tissue origin
    D. of osseous origin

14. **Which option is CORRECT. Due to the aggressive nature of DF and its high recurrence rate, the treatment of choice is**
    A. Cystectomy
    B. Complete surgical resection
    C. Marsupialization
    D. Decompression

15. **Select the CORRECT answer. DF may cause new bone formation, giving a so-called**
    A. "fingerprint" appearance
    B. "target" appearance
    C. "tram-track" appearance
    D. "sunburst" appearance

Evidence-based Dentistry

16. **Select the CORRECT answer. When one wishes to check for the presence/absence of publication bias, the most appropriate test to run is**
    A. Meta-regression
    B. GRADE analysis
    C. Heterogeneity (I2) test
    D. Funnel plot test

17. **Which of the following answers is CORRECT. In the Thiem et al systematic review, the pooled results when E-cigarette were compared to conventional cigarette users suggest**
    A. The odds of a positive BoP were 0.53-fold lower in e-cigarette users than in cigarette smokers ($p=0.03$)
    B. The odds of a positive BoP were 0.67-fold lower in e-cigarette users than in cigarette smokers ($p=0.03$)
    C. The odds of a positive BoP were 0.33-fold lower in e-cigarette users than in cigarette smokers ($p=0.03$)
    D. The odds of a positive BoP were 0.13-fold lower in e-cigarette users than in cigarette smokers ($p=0.03$)

18. **Select the CORRECT statement. In the Thiem et al systematic review, the pooled results when E-cigarette were compared to non-smokers suggest**
    A. that e-cigarette users have a significantly lower chance for positive BoP than non-smokers ($p<0.01$).
    B. that e-cigarette users have a significantly higher chance for positive BoP than non-smokers ($p<0.01$).
    C. that e-cigarette users have a equal chance for positive BoP when compared to non-smokers ($p<0.01$).
    D. that e-cigarette users have a significantly lower chance for positive BoP than non-smokers ($p>0.05$).

19. **Choose the CORRECT answer. When the conventional loading (CL) protocol is used, the average time between placement and loading of the implant is**
    A. 1 month
    B. 6 months
    C. 3 months
    D. 12 months

20. **Which of the following statements is CORRECT. The results of the Possebon et al RCT suggest**
    A. Both loading protocols result in predictable medium-term rehabilitation when monitored annually
    B. Only the CL protocol result in predictable medium-term rehabilitation when monitored annually
    C. Only the IL protocol result in predictable medium-term rehabilitation when monitored annually
    D. Both loading protocols result in unpredictable medium-term rehabilitation when monitored annually

The ethical debate between what patients want, need, and can afford, and what treatment clinicians think they should receive.

21. **Select the CORRECT answer. Cost of treatment refers to:**
    A. financial implications
    B. time factors
    C. inconvenience
    D. all of the above
    E. only a) and b) above

22. **Select the CORRECT statement. Paternalism**
    A. refers to situations where a parent decides for their children
    B. refers to a situation where a clinician decides for a patient
    C. is justified if the clinician is more knowledgeable than the patient
    D. is justified in emergencies where a patient arrives without an appointment
    E. relates to all of the above

23. **Which of the following statements is CORRECT. Soft / weak paternalism generally refers to:**
    A. situations where the doctor believes they are protecting the patient from an unwise decision
    B. where the doctor exaggerates the risks and costs of certain procedures
    C. where the doctor does not think the patient will understand all the technical details of a certain treatment
    D. all of the above
    E. only b) and c) above are correct

24. **Choose the CORRECT statement. Hard/ strong paternalism**
    A. is justified if the risks to the patient are great
    B. may arise where a doctor is scared of litigation and wants to avoid doing a certain procedure
    C. is justified if a doctor does not feel competent to carry out a procedure
    D. is justified when treating minors
    E. is justified if the patient is in pain in order to provide immediate pain relief

25. **Which of the following options is CORRECT. The three core features of informed consent are**
    A. threshold, information and consent elements
    B. threshold, information and understanding elements
    C. information, understanding and consent elements
    D. competence, information and consent elements
    E. information, understanding and voluntary elements

www.sada.co.za / SADJ Vol. 78 No.9

Instructions to authors

THE SOUTH AFRICAN DENTAL JOURNAL
SADJ
SADA THE SOUTH AFRICAN DENTAL ASSOCIATION

Thank you for considering the submission of your work to the Journal for possible publication. We welcome papers which may be Original Research, Clinical Review, Case Reports, Clinical Communications, Letters or Notes.

The South African Dental Journal (SADJ) is a peer reviewed, Open Access Journal, published by the South African Dental Association (SADA). The Journal primarily carries research articles which reflect oral and general health issues in Africa but also publishes papers covering the widest consideration of all health sciences. In addition, items of specific relevance to members of the Association find dissemination through the Journal. The Journal is published ten times each year in electronic format. Hard copy is available by arrangement.

We shall be obliged if your submission is prepared respecting all the details listed in these Instructions. This facilitates our process and ensures more rapid responses to you. Please use and submit the Checklist for Authors suplied on page 645 for confirmation. Thank you.

Submission Enquiries

The Editorial Assistant Mr Dumi Ngoepe
Email addresses: sadj@sada.co.za/editor@sada.co.za
For submission instructions kindly refer to the "Submission instructions" page.

Language

All articles must be submitted in English. Spelling should be in accord with the Shorter Oxford English Dictionary.
All articles must be submitted in English. Spelling should be in accord with the Shorter Oxford English Dictionary.

Clinical Research

Articles should adhere to the protocols of the Helsinki Declaration: (https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical research-involving-hu-man-subjects/.

Clinical Trials

Clinical trials should conform to the Consort Statement (Consolidated Statements of Reporting Trials) and Reviews to the PRISMA checklist (Preferred Reporting Items for Systematic Reviews and Meta Analyses) (http://www.equator-network.org).

Authors

Authors should meet the criteria for authorship as in the documents of the International Committee of Medical Journal Editors (ICMJE):

1. Substantial contributions to the conception or design of the work or the acquisition, analysis or interpretation of data for the work, AND
2. Drafting the work or revising it critically for important intellec-tual content, AND
3. Final approval of the version to be published, AND
4. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved (www.icmje.org).
5. The front page of the manuscript should list the title of the article, the author's(s') name(s), and their qualification(s), affiliations and positions held, telephone and fax numbers and address(es), including Email address(es), if available. It is especially important that details of the Corresponding Author should be clearly stated.
6. Please submit on the front page a list of up to eight Keywords.
7. In the case of multiple authors, the role played and the respective contribution made by each should be recorded. For example: "Principal Researcher- 40%, Writing Article- 30%, Tissue Analysis- 20%, Microscopic Examination- 10%", etc.
8. A recent requirement is that authors should be registered with ORCID. This is a number registering you as an Open Researcher and Contributor. Go to the ORCID website home page at https://orcid.org/ and follow the Three Easy Steps indicated in green. Please submit the ORCID number with your author details.

Title

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

Abstract

The abstract shall consist of not more than 200 words.
For research articles, the summary should be structured under the following headings: Introduction, Aims and Objectives, Design, Methods, Results and Conclusions. Do not include references in the Abstract.

Text

- Articles should be clear and concise.
- Text should be typed in Times New Roman font, size 11; double-spaced with a 3 cm. margin on the sides, top and bottom. Each page must be clearly numbered.
- Please include electronic numbering of lines throughout the document.
- Tables should be clearly identified, using Roman numerals ie. Table I, Table II etc.
- Authors are requested to note and adhere to the current style of the Journal particularly with respect to paragraph settings and headings.

Length of the article

In general, papers should be between 4000 and 5000 words, although this is flexible. The Editor reserves the right to edit the length of an article in conjunction with the author(s) and SADJ reserves the right to charge for excess/additional pages. The first four pages of original research papers published in the SADJ will be free of charge after which a charge of R500 per page or part thereof wil l be levied.

Illustrations/graphics/photographs

- Illustrations/graphics/photographs must be appropriate to the content of the manuscript.
- Digital images with a DPI of at least 300 should be supplied. Photocopies and pdf. files of photographs are not acceptable.
- **Please note:** Figures should be included in the text and sent separately in jpg. format.
- The Figure numbers must be in Arabic numerals and clearly identified for each illustration, graphic or photograph. Please remember to record Figure numbers in the text.
- **Permission:** Where any text, tables or illustrations are used

from previously published work, permission must first be obtained from the holder of copyright and a copy of the agreement must be submitted with the article. Suitable acknowledgement must be recorded in the article.

Continuing Professional Development
Please supply 4-5 Multiple-choice Questions (MCQ's) with 4 or 5 options per question related to your article. Questions must have only one correct answer, and indicate this correct answer clearly.

References

- References should be set out in the Vancouver style and only approved abbreviations of journal titles should be used (consult the List of Journals Indexed in Index Medicus for these details at: http://www.nlm.nih.gov/tsd/serials/lji.html).
- References should be inserted seriatim in the text using superscript numbers and should be listed at the end of the article in numerical order.
- A reference in the text should appear as indicated: "...as the results of a previous study showed.23"
- Where there are several papers referenced, the superscript numbers would appear as: "...previous studies have shown. [3,5,7,9-12,14]"
- Do not list the references alphabetically.
- It is the author's responsibility to verify each reference from its original source. Please note that an article may be rejected if the referencing is inaccurate.
- Names and initials of all authors should be given unless there are more than six, in which case the first three names should be given, followed by *et al.,*. First and last page numbers should be given. Where it is applicable the page numbers should be abbreviated by omitting redundant numbers eg. pages 456 to 478 is recorded as 456-78, and 456 to 459 as 456-9, but 398 to 401 is recorded as 398-401.
- Notice that volume numbers are not given in bold, authors are not linked by 'and' or '&', and the year of publication appears after the name of the journal. No item should appear in italics except for foreign terms, eg *in vivo.*

Journal references should appear thus:

Smith NC, Haines A. The role of the dentist in public health promotion. Br Dent J. 1983; 298: 249-51.

Book references should be set out as follows:

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

Weinstein L, Swartz MN. Pathogenic properties of invading microorganisms. In: Sodeman WA, Smith RT, eds. Pathologic Physiology: Mechanisms of Disease. Philadelphia: WB Saunders, 1974: 457-72.

Manuscripts accepted but not yet published may be included as references followed by the words 'in press'.

'Unpublished observations' and 'personal communications' may be cited in the text but not in the reference list.

Declaration

All sources of funding, possible financial interest/s or incentives in products or services mentioned in the article must be disclosed. Authors are kindly requested to read and sign the attached declaration on page 450.

No articles that have been published previously, or that are currently being considered for publication elsewhere, will be accepted. Authors are kindly requested to verify that their article complies with this condition.

Ethics

Where relevant, authors should indicate whether their research has been approved by the Ethics Committee of their Institution or by other research ethics committees.

Conflict of interest

Authors must disclose their involvement with any company either owned by them or from which they have received a grant or remuneration or with which they have an association, and must declare any other personal interest they may have which would constitute a Conflict of Interest. These may include per- sonal relationships, academic competition, or intellectual beliefs. Should there be no applicable Conflicts of Interest this should also be so stated. The statement will be included at the end of the text.

Copyright
The South African Dental Journal is a peer reviewed, Open Access Journal, adhering to the Budapest Open Access Initiative: "By 'open access' to this literature, we mean its free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. The only constraint on reproduction and distribution, and the only role for copyright in this domain, should be to give authors control over the integrity of their work and the right to be properly acknowledged and cited."
https://access.okfn.org/definition/index.html

The Managing Editor reserves the right to decline articles, photographs or illustrations where products or services are mentioned that are not appropriate.

Submission

The paper should be submitted in one file including all Tables and Figures and their accompanying Legends Figures should also be submitted separately file in JPEG. format.

Please submit the paper in electronic format in Word along with separate Figures in JPEG. format to: sadj@sada.co.za and to neil.wood@smu.co.za, accompanied by a covering letter and the Declaration on page 450 signed by the author(s).

Galley proofs

Changes/corrections to the proofs supplied to authors must be returned to the publishers by email or by fax and not over the telephone. Galley proofs must please be returned to the publishers within four days after receipt thereof.

Editorial Policy

Authors may also wish to refer to the Editorial Policy of the SADJ available on the SADA website.

Enquiries
Enquiries regarding Journal matters can be directed to Mr Dumi Ngoepe, Editorial Assistant, at SADA headquarters on: Tel: +27 (0)11 484 5288
Email: sadj@sada.co.za

www.sada.co.za / SADJ Vol. 78 No.9

Submission Instructions

THE SOUTH AFRICAN DENTAL JOURNAL
SADJ
SADA
THE SOUTH AFRICAN DENTAL ASSOCIATION

To submit a new paper to SADJ, do as follows:

1 If this is your first time using this platform, please Register by completing the online form (once off):

Link:
https://journals.assaf.org.za/index.php/sadj/user/register

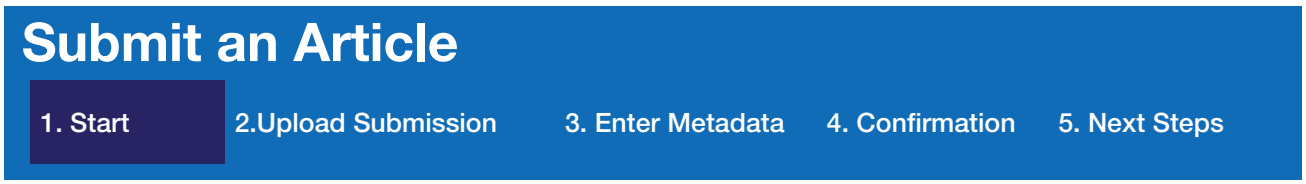
2 Once registered, make sure you are still logged in (Login every time you want to submit a new paper):

Link:
https://journals.assaf.org.za/index.php/sadj/login

3 Click on Make a new submission. on the righthand side of the page. Please ensure that the article is anonymized/No names on the submitted article

4 Familiarize yourself with the Author Guidelines. Then click on Make a new submission.

5 Follow the 5 steps as part of the wizard, until the last screen. You will receive a confirmation email once successfully submitted, and the Journal Manager/Editor will be notified.



If you are struggling on how to load/submit kindly email Dumi Ngoepe at SADA on sadj@sada.co.za for assistance.

NOTE: Incomplete submissions will be returned to the authors and will not be considered for peer-review until complete

Declaration by Author/s

THE SOUTH AFRICAN DENTAL JOURNAL
SADJ
SADA
THE SOUTH AFRICAN DENTAL ASSOCIATION

TITLE

.....

.....

.....

AUTHOR/S

.....

.....

.....

I/We, the undersigned confirm and declare that:

1. This manuscript is my/our original work and I am/we are the owner/s of this manuscript and possess rights of copyright.

2. I/we confirm that this manuscript has not been published previously and it is not currently considered for publication elsewhere. Has this article been submitted to any other journal and if so, has it been rejected?

   YES ☐ NO ☐

3. For no consideration or royalty, I/we hereby assign, transfer and make over to SADA all the rights of copyright, which have or will come into existence in relation to this manuscript.

4. I/we waive in favour of SADA or any successors in title any moral rights which may be vested in me/us.

5. The manuscript does not constitute an infringement of any copyright and I/we indemnify SADA against all loss or damage, from any cause arising which SADA may sustain as a result of having been granted copyrights to the manuscript.

6. The research has been approved by the Ethics Committee of my/our institution/s or the Ethics Commit-tee/s of other accredited research facilities.

7. I/we have disclosed in my/our Acknowledgments all sources of funding, possible financial interest/s or incentives in products or services mentioned in the paper.

.....	.....	.....
Initial(s) and Surname	Signature	Date
.....	.....	.....
Initial(s) and Surname	Signature	Date
.....	.....	.....
Initial(s) and Surname	Signature	Date
.....	.....	.....
Initial(s) and Surname	Signature	Date
.....	.....	.....
Initial(s) and Surname	Signature	Date
.....	.....	.....
Initial(s) and Surname	Signature	Date
.....	.....	.....
Initial(s) and Surname	Signature	Date

www.sada.co.za / SADJ Vol. 78 No.9

Author's Checklist

1. Have you read the Instructions to Authors?
2. Are you submitting electronically?
3. Have you provided all author information including first names, affiliations, qualifications, positions held, Department and Institution, ORCID number, contact details?
4. Is the first author under the age of 35 on submission of the article?
5. Have you provided all details of the Communicating Author?
6. Have you submitted questions for the CPD section? (four or five multiple choice, one correct answer)?
7. Have you submitted details of the contribution of each author... can be percentage or descriptive... or both?
8. Is the first author under the age of 35 on submission of the article?
9. Have you provided all details of the Communicating Author?
10. Have you submitted questions for the CPD section? (four or five multiple choice, one correct answer)?
11. Are the references quoted according to Journal policy, both in the text and in the list of references?
12. Have all authors signed the Letter of Submission?

NOTES

NOTES

NOTES

S2

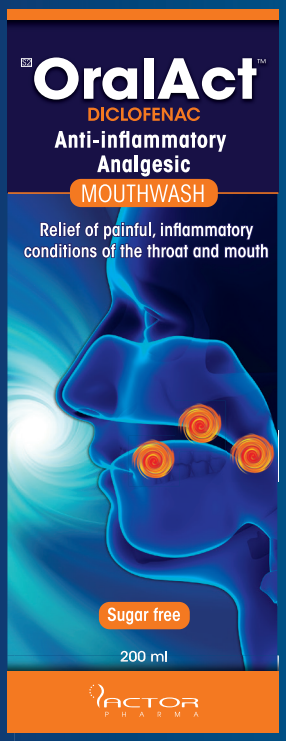
OralAct™

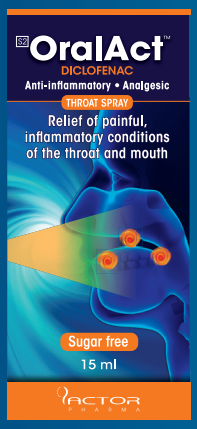
Diclofenac

Anti-inflammatory • Analgesic

THROAT SPRAY • MOUTHWASH

Patented Formula[1]





SA's FIRST DICLOFENAC THROAT SPRAY & MOUTHWASH

Therapeutic indications:

- Symptomatic treatment of localised inflammatory diseases associated with pain of the oropharyngeal cavity
- Treatment of pain and inflammation resulting from minor dental treatment or dental extraction
- Treatment of oral mucositis resulting from radiotherapy treatment in oncology patients (mouthwash only)

SUGAR-FREE, peach and mint flavour.

S2 OralAct™ Throat Spray. Reg No. 48/16.5/0299.
1 spray (corresponding to 0,2 ml) contains 0,3 mg diclofenac free acid.
S2 OralAct™ Mouthwash. Reg No. 48/16.5/0130.
Each 1 ml of solution contains 0,74 mg diclofenac free acid.
For full prescribing information please refer to the individual package inserts approved by the Medicines Regulatory Authority.

Actor Pharma (Pty) Ltd Reg. No. 2008/008787/07
Unit 7, Royal Palm Business Estate
646 Washington Street, Halfway House, Midrand, 1685
Tel: 011 312 3812, Fax: 011 312 7814
ORALA/AD/1.0 03/2023

ACTOR PHARMA

BENEFITS OF JOINING SADA

SADA supports its members throughout their time in the profession - from their time as students in the field, straight through their professional careers, and into retirement.

Our members benefit from the below advantages, amongst others.

Access to local and international networking opportunities, mentoring circles and study groups.

Achieve full CPD requirement through SADA's learning circles.

Full access to SADA online dental resources.

Generate your CPD Report for the HPCSA audit at the click of a button.

Personalised advice on clinical, legal and practice management as well as telephone and email support.

Get preferential rates on Dental Protection (DP) Indemnity Membership.

Access to the only fully accredited scientific dental journal in South Africa, The South African Dental Journal (SADJ), online and in hard copy.

Advertise your employment vacancies and other practice requirements for free on the SADA classifieds.

Receive discounts on SADA branch events and congresses.

Advice on South African health and safety compliance.

Access exclusive online practice related templates and contract examples.

Access independent, unbiased and superior dental mediation services.

Access to the only dental coding book in South Africa.

Eligibility for research grants from the Dental Development Foundation Trust (DDFT).

Full-time academic practitioners are eligible for an IADR membership rebate.

Members in full-time academic employment eligible to publish in the SADJ.

Assistance on medical aid authorisation parameters and risk management.

Access to relevant denta Legal, Clinical and Professional Development bulletins.

Assistance with unresolved medical schemes matters.

Purchase Profitability Assessment tool, D-Calc™ at more than 50% discount as a SADA member.

Benefit from SADA's advocacy in respect of regulatory environment as well as regulatory bodies such as the HPCSA.

Receive regular up-to-date dentistry information and news.

Contribute to and enjoy professional submission in respect to dental policies and funding.

Be part of monitoring and influencing the practice scope of various oral health care practitioners.

SADA
The South African Dental Association **(SADA)** NPC

visit our website at www.sada.co.za for more information.