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Port Shepstone Lighthouse

Port Shepstone Lighthouse stands at the mouth of the uMzimkhulu River on KwaZulu Natal's South Coast. The 8 metre cast iron tower has a black and white checker pattern. It was commissioned in March 1905 and later moved from Scottburgh. The light flashes every 6 seconds from a 24 metre focal plane, visible to about 26 nautical miles. Port Shepstone Lighthouse was declared a national monument in 1995 and remains active.

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Our Front Cover for this Issue...

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Participation, Professionalism, and the Quiet Work of Growing Knowledge

SADJ NOVEMBER 2025, Vol. 80 No.10 P519-P520

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

As 2025 draws to a close, the South African Dental Journal stands at a moment of both gratitude and reflection. This has been a year marked by remarkable engagement from across the profession: clinicians submitting clinical techniques and case series; academics forwarding original research; postgraduate students venturing into their first publications; and reviewers, our unsung custodians of rigour, giving their time generously to appraise, challenge, refine, and strengthen the manuscripts entrusted to us.

In the past twelve months, the SADJ has received more submissions than in any recent year. This is a milestone worth celebrating. It signals not only increased scholarly productivity, but a profession willing to invest in its collective intellectual capital. In a time where the pressures on clinical dentistry are substantial, and academic workloads continue to swell, participation in the scholarly process is no small act, it is a demonstration of commitment to the discipline, to the evidence base that underpins practice, and to the future practitioners who rely on accurate, credible, ethically reviewed information.

Yet more submissions also mean more work. Turnaround times have lengthened, not because of inefficiency or neglect, but because rigour takes time. The peer review process, double-blinded, methodologically attentive, ethically anchored, remains the backbone of the SADJ's identity. We do not compromise on that. Each submission, whether a simple technique note or a major original investigation, receives the same quality-assurance scrutiny; each is read critically, reviewed independently, and judged against the standards expected of reputable international journals as we continue to grow and develop our journals profile and standing.

This is a promise we renew every year.

As many readers will have noticed, turnaround times for manuscript decisions have lengthened this year. This is not due to reduced efficiency, but rather to a significant rise in the number of submissions and, in some cases, delayed or declined reviews from external experts. High-quality peer review is the backbone of scholarly publishing, but it is also increasingly difficult to secure promptly, particularly in a profession where academic, clinical, and supervisory workloads continue to escalate. When reviewers withdraw, delay, or decline to complete a report, the editorial office must restart the process, sometimes multiple times, to uphold the standards expected of a credible scientific journal. These realities inevitably influence timelines, and we appreciate the patience of authors who await decisions under such circumstances. We acknowledge the inconvenience and are addressing these as we grow and develop.

As journals grow in stature, so too do the expectations placed upon them. With an expanding readership and a more diverse pool of submissions, the SADJ continues to refine its editorial processes and strengthen the calibre of its peer review. This includes identifying and inviting reviewers with deeper expertise, ensuring methodological scrutiny is more robust, and offering authors clearer, more constructive, and higher-quality feedback across clinical, scientific, and educational domains. We have already seen a noticeable improvement in the depth and quality of reviewer reports, reflecting a deliberate effort to provide authors with richer critique and to elevate the standard of work suitable for publication. Such growth is intentional. Improving reviewer expertise not only enhances the scientific validity of the articles we publish, but also supports the professional development of our authors by giving them access to meaningful guidance that strengthens their scholarship. A rising journal must lift the standards of everyone involved, authors, reviewers, and editors alike, and we remain committed to that upward trajectory.

In rare circumstances, extended reviewer delays can compromise the integrity of the editorial process. When reviewers do not complete reports despite accepting the invitation, or when repeated attempts to secure expertise are unsuccessful, manuscripts may face rejection, not because of their quality, but because the journal cannot ethically or indefinitely sustain a stalled process. These decisions are never taken lightly. They reflect the reality that timely evaluation is part of maintaining a functioning scholarly platform. We take these rare occurrences seriously and will always try to find a resolution for such works. Authors can assist greatly by ensuring their manuscripts are carefully prepared and by suggesting qualified reviewers, while reviewers support the profession by honouring deadlines or declining promptly when they are unable to assist. A well-functioning peer review ecosystem depends on this mutual respect.

But honest reflection requires us also to acknowledge the pressures within the system. The majority of reviewers serve voluntarily. Many are already stretched by teaching, clinical service, and postgraduate supervision. Their work, painstaking, thoughtful, and often invisible, deserves the strongest appreciation. To each reviewer, advertiser, contributor, and supporting institution: thank you. The SADJ endures because you believe in the value of scholarly participation.

Participation as Professional Citizenship

Publishing is not merely an academic exercise; it is an act of professional citizenship. It signals a willingness to test ideas against evidence, to contribute to collective learning, to invite critique, and to accept refinement. It strengthens not only the profession's knowledge frontier, but its culture of honesty, accountability, and transparency.

- A profession that publishes grows.
- A profession that reviews grows wisely.
- A profession that participates grows together.

But there is another dimension we must speak to honestly. Every editor, in every journal in the world, encounters a particular category of submission: the manuscript accompanied by the expectation of special treatment. Occasionally, we receive firm demands for expedited review because the author is perceived as an influential or authoritative figure. It might happen that we are told that their contribution is "urgent," or that the review process "should not apply" because the author is distinguished, or visible, or has served in certain academic roles.

Let us address this respectfully and directly:

All authors are equal at the point of submission.

Titles, positions, and profiles do not and cannot determine editorial decisions. Academic rank does not exempt any manuscript from methodological scrutiny, ethical evaluation, or critical peer review. The SADJ's responsibility is to the profession as a whole, and to the scientific record, not to the preferences or expectations of any individual, however esteemed.

Indeed, the true hallmark of academic maturity is the willingness to submit one's work, no matter one's rank to the same standards that govern everyone else. Leadership in dentistry is not demonstrated by bypassing the system, but by modelling respect for it. And to be clear: every submission is valued, whether from a first-time postgraduate student or a longstanding academic. But value does not mean exemption; it means engagement. It means leaning into the process that strengthens the work, even when it is uncomfortable.

If anything, senior figures should exemplify humility in scholarship. They set the tone for the next generation. When seasoned academics work respectfully and patiently within the editorial process, they teach juniors that rigour is a virtue, not an inconvenience.

Safeguarding a Credible and Proudly African Journal

As we grow, it becomes even more important that our processes remain transparent, fair, defensible, and insulated from influence, formal or informal. Our standards are aligned with those expected of scholarly journals globally. We continue to uphold and develop:

- Double-blinded peer review
- Ethics compliance checks
- Methodological soundness assessments
- Plagiarism and originality verification

Editorial independence from institutional or personal pressure These are not bureaucratic hurdles; they are the architecture of trust. They are what make the SADJ a credible platform worthy of national and international readership. Maintaining these standards during a period of high submission volume is demanding, but it is necessary. Quality must never become the casualty of quantity.

A Final Reflection for 2025

As we close the year, we extend deep gratitude to:

- our authors, for generating and sharing the knowledge that nourishes the profession;
- our reviewers, for their meticulous work and intellectual generosity;
- our advertisers and partners, whose support sustains the infrastructure of publication;
- our readers, who continue to engage, critique, and apply what is published.

To our editorial and production teams: thank you for your unwavering commitment, meticulous attention to detail, and the countless hours spent ensuring each issue meets the standards expected of a national scientific journal. Your expertise, patience, and professionalism are the quiet engine behind every published page.

To SADA as an organisation: thank you for your steadfast support, strategic guidance, and continued investment in the SADJ's mission. Your partnership strengthens our ability to serve the profession, uphold scientific integrity, and sustain a journal that reflects the best of South African dentistry.

In a profession where clinical demands can overshadow scholarly life, participation in academic publishing becomes a quiet act of stewardship. You help grow the knowledge frontier. You strengthen the discipline's integrity. You shape dentistry's future.

Let us carry this spirit into 2026: collaborative, thoughtful, committed to excellence, and grounded in the shared belief that publishing, done well, is one of the most powerful ways we contribute to the health of the profession.

The SADJ remains your journal.

- A place for evidence.
- A home for scholarship.
- A platform for growth.
- And above all, a collective endeavour, stronger because of your participation.

The Unseen Pain in the Dental Surgery: Why Our Profession's Mental Health Can No Longer Be Ignored

SADJ NOVEMBER 2025, Vol. 80 No.10 P521

Mr KC Makhubele – CEO, South African Dental Association

If you were to walk into any dental practice in South Africa, you would see the same picture: a team of professionals, masked and gloved, projecting an image of calm competence. We are problem-solvers. We are healers. We are, by the very nature of our work, expected to be pillars of strength for our patients and our teams.

But beneath the surface of this clinical composure, a silent epidemic is brewing. I'm not talking about caries or periodontal disease. I'm talking about the profound strain on our collective mental health and well-being.

Internationally, our colleagues are sounding the alarm. The British Dental Association reports stress levels among dentists that are staggeringly high. The American Dental Association has launched extensive campaigns on dentist well-being, openly discussing burnout, depression, and the troubling prevalence of substance abuse as a coping mechanism. They have recognised that the very environment of our work – long hours in a confined space, performing precision tasks on anxious patients, under immense time pressure – is a perfect catalyst for chronic stress.

But here in South Africa, we face these universal professional pressures while navigating a uniquely challenging landscape. The stressors we carry are not just confined to the surgery; they are woven into the fabric of our daily lives.

The South African Burden: A Heavy Weight to Carry

Think about the weight you are carrying right now. It's more than just the responsibility for a patient's oral health.

- **The Economic Vice:** We are running small businesses in a stagnant economy. The rising costs of materials, loadshedding's relentless drain on generators and inverters, and the pressure to keep services affordable for a struggling patient base create a constant, low-grade hum of financial anxiety.
- **The Shadow of Crime:** It's the hyper-vigilance leaving the practice after a late appointment. It's the investment in security systems that feels more like a tax on doing business. This ever-present threat erodes our sense of safety and peace.
- **Complex Patient Needs:** We often see the sharp end of South Africa's socio-economic divide. Patients present with advanced conditions borne from a lack of access, forcing us into complex, often heart-wrenching clinical and ethical decisions daily.
- **Political and Systemic Uncertainty:** The constant churn of news, the uncertainty around NHI, and the fragility of our public infrastructure contribute to a pervasive sense of instability. It's exhausting.

When you combine the innate pressures of dentistry with this South African context, it's no wonder that many of us are feeling drained, irritable, disconnected, or simply… tired. Burnout isn't a personal failing; it's a logical response to an overloaded system. And the historical stigma within our profession – the "just get on with it" mentality – is a dangerous barrier to healing.

Breaking the Stigma: It's a Sign of Strength, Not Weakness

As healthcare professionals, we are brilliant at diagnosing and treating problems in others, but we often neglect our own. We fear that acknowledging struggle is a sign of incompetence or weakness. I am here to tell you, as your CEO, that the opposite is true. Recognising your own distress and taking steps to address it is the ultimate sign of professional strength and personal courage.

Seeking help is not an admission of defeat. It is a strategic, proactive step to preserve your most valuable clinical asset: your own mind.

What SADA is Doing: A Hand Reaching Out

SADA has heard your concerns, and we are moving beyond mere awareness to concrete action. Our commitment to your well-being is now a central pillar of our strategy.

A Call to Action: For Ourselves and For Each Other

My message to you today is simple, yet urgent: **Your well-being is non-negotiable.**

I urge you to look out for one another. Check in on your colleagues. If you notice someone struggling, reach out. That simple act of human connection can be a lifeline.

We chose this profession to care for others. Let's extend that same compassion to ourselves and to our colleagues. By prioritising our mental health, we are not just saving ourselves; we are safeguarding the future of a resilient, compassionate, and sustainable dental profession in South Africa.

Yours in solidarity,

Chief Executive Officer
South African Dental Association

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Morphometric Analysis of the Supraorbital Foramen in the South African Population

SADJ NOVEMBER 2025, Vol. 80 No.10 P522-P527
Kajal Ramkissoon[1], Akaashni Bhika[2], Muhammad Bobat[3], Risimati Ephraim Rikhotso[4]

ABSTRACT

Introduction

The supraorbital notch (SON) or supraorbital foramen (SOF) houses the supraorbital neurovascular bundle which supplies the scalp, skin and muscles of the upper eyelid. Surgeons operating in the region may be cautious about performing surgical procedures in this region due to the increased risk of injury.

Aim

To assess the morphological characteristics of the supraorbital foramen in the South African population

Methods

108 dry skulls were examined, to determine the following morphometric data: width of SON/SOF and position of SON/SOF relative to the nasal midline and frontozygomatic suture. Left and right sides were compared and differences between the sexes was considered.

Results

The SON (44%) was the most commonly identified passageway, followed by the SOF (27%), absent SON/SOF (19%), double foramen (5%), co-occurrence (4%), and double notch (1%) respectively. This study localised the SON/SOF approximately 26.87 mm ± 4.21 from the nasal midline to SON/SOF in females, and 28.20 mm ± 3.68 in males. When using the frontozygomatic suture as a reference point, SON/SOF lies 28.42 mm ± 3.00 medially in females and 29.83 mm ± 2.80 in males. Positional distances were significantly greater in males than females. No significant differences were observed between the left and right sides. The width of SON was approximately 4.16 mm ± 1.81, and the diameter of SOF was approximately 2.60 mm ± 1.14.

Conclusion

Accurate anatomical knowledge of the neurovascular architecture and foramina localisation can help avoid iatrogenic injury.

Keywords

Anatomy, Morphology, South Africa, Supraorbital notch, Supraorbital foramen.

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Authors' Contributions:

1. K Ramkissoon – study design, data collection, data analysis, data interpretation and drafting of the manuscript
2. A Bhika, MA Bobat, RE Rikhotso – study conception & supervision of the entire work

INTRODUCTION

The supraorbital foramen (SOF) is an elongated bony aperture above the orbit and below the forehead. When the passage is encircled by bone, it is referred to as the supraorbital foramen, however, when partly enclosed in bone, it is called the supraorbital notch (SON)[1]. The supraorbital foramen or supraorbital notch is located along the supraorbital margin on the frontal bone[2]. The terminal point houses the supraorbital nerve, artery and vein. This nerve forms the largest branch of the frontal nerve, extending from the ophthalmic division of the trigeminal nerve (Cranial Nerve V). The supraorbital nerve is bounded by the orbital roof and levator palpebrae muscle[3]. The nerve subdivides into two branches: a medial (superficial) branch which journeys through the frontal foramen or notch, providing sensation to the medial part of the upper eyelid, medial forehead, and bridge of the nose; and a thicker lateral (deep) branch which usually exits through the SON/SOF providing sensory innervation to the skin of the forehead (extending from the parietal to the temporal regions[4]. The supraorbital artery forms a branch of the ophthalmic artery, originating from the internal carotid artery. After passing through SON/SOF, it separates into the superficial and deep branches that supply muscles and skin of the forehead, scalp and upper eyelid. The supraorbital vein joins the supratrochlear vein at the medial angle of the eye to form the angular vein which continues through the face as the facial vein[5].

Comprehensive knowledge of the regional anatomy of the supraorbital nerve, vessels, and exit passageway is crucial in combination with modern diagnostic and therapeutic methods and surgical procedures in the supraorbital region[4]. This includes procedures such as corneal neurotization, anterior orbital approach, supraorbital injections, treatment of migraine headaches, fronto-glabellar reconstruction flap, upper eyelid surgeries (e.g., blepharoplasty), and any

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procedure requiring incisions in the forehead endoscopic facial therapies[4].

Surgeons operating in the region may be cautious to perform surgical procedures in this region due to the increased risk of injury to the supraorbital nerve and causing loss of sensation[2]. Effective and precise analgesia can only be achieved with a thorough understanding of the position of the nerve and its point of exit. Excessive retraction and dissection near the neurovascular bundle can result in scarring, leading to painful neuralgias. Clinicians need to be cognizant of the anatomical position and dimensions of the SON/SOF when diagnosing and treating conditions in the region, such as supraorbital neuralgia[2].

Previous studies have indicated variation in the location and morphology of the SON/SOF amongst different population groups such as Nigerians, Sri Lankans, Koreans, Caucasians, and South Indians[1,2,4,5,6]. In addition, these characteristics may differ between populations and within inhabitants of the same geographical location[6]. No studies have been conducted in the South African population. Understanding the specific morphometric traits of the South African population can provide data that accurately reflects the unique characteristics of this group, leading to more precise clinical assessments and interventions.

AIM AND OBJECTIVES

Aim

To assess the morphological characteristics of the supraorbital foramen in the South African population.

Objectives

1. To determine the existence of various morphologies of the supraorbital notch/foramen across the population and sexes of interest.
2. To determine the width of the supraorbital notch and/or diameter of the supraorbital foramen on human skulls.
3. To determine the distance from the nasal midpoint to the midpoint of the supraorbital notch or foramen.
4. To determine the distance from the midpoint of the supraorbital notch/foramen to the frontozygomatic point.

MATERIALS AND METHOD

The study population included 108 dry skulls from The Raymond A. Dart Collection of Modern Cadaveric Human Skeletons of the School of Anatomical Sciences at the University of the Witwatersrand[7]. In this study, the dry skull was defined as a skull including cranial bones & facial bones, without the mandible and calvaria. Only specimens of known population affinity, age and sex were included.

The crania of the study were used in compliance with the South African National Health Act 61 of 2004. An ethics clearance waiver issued to the School of Anatomical Sciences, University of the Witwatersrand was obtained W-CBP-220504-01. The age, population affinity and sex of the skulls were recorded. The study included 54 male and 54 female skulls. The age of the crania ranged from 20 years to 90 years, with a median age of 50 years old.The required sample size was calculated and required 104 macerated skulls.

Measurements

Digital vernier calipers (Guanglu ISO9001:2000 (China) were used to conduct the relevant osteometric measurements (Figure 1):

- Demographic data including: age, sex, and population affinity was captured.
- Width of the SON or diameter of SOF.
- Distance from the frontozygomatic point to the midpoint of the SON/SOF.
- Distance from the midpoint of the SON/SOF to the nasal midline.

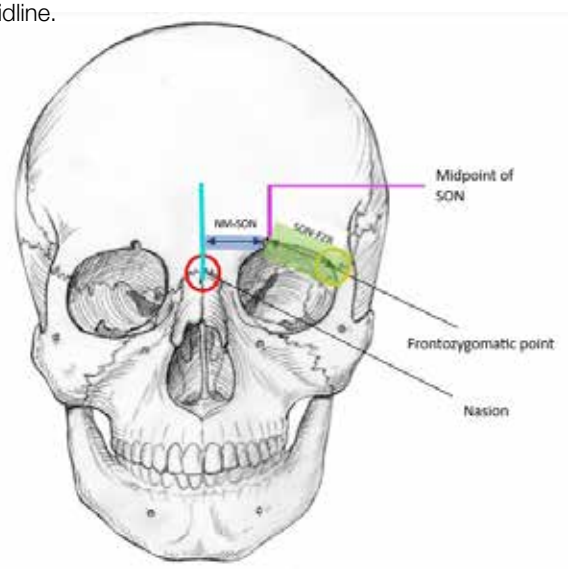

Figure 1: Osteometric measurements. NM-SON: Nasal Midline-Supraorbital Notch; SON-FZR: Supraorbital notch-Frontozygomatic point. Adapted from Ashwini *et al*[6]

Table 1

Landmark/Measurement	Abbreviation	Description
Nasion	n	A bony depression at the midpoint where the two nasal bones and the frontal bone intersect.
Frontozygomatic point	FZR	The most medial and anterior point of the frontozygomatic suture in the plane of the lateral orbital rim.
Nasal midline	NM	
Straight line from the nasion extending superiorly		
Nasal midline-supraorbital notch	NM-SON	Straight line measurement from the nasal midline to the midpoint of the supraorbital notch.
Supraorbital notch-frontozygomatic point	SON-FZR	Straight line measurement from the midpoint of the supraorbital notch to the most medial and anterior point of the frontozygomatic suture.
Midpoint of supraorbital notch		Determined as half the width of the supraorbital notch

The researcher (1st observer) measured the entire sample population. Measurements were repeated in triplicate and the mean was recorded (intra-observer reliability). A second observer (supervisor) conducted independent measurements on one-third of the sample (interobserver measurements) using the same calipers and method as the 1st observer. A single set of instruments was used to ensure reliability. Intraclass Correlation Coefficient (ICC) was used to quantify the agreement between observers' measurements (interobserver reliability).

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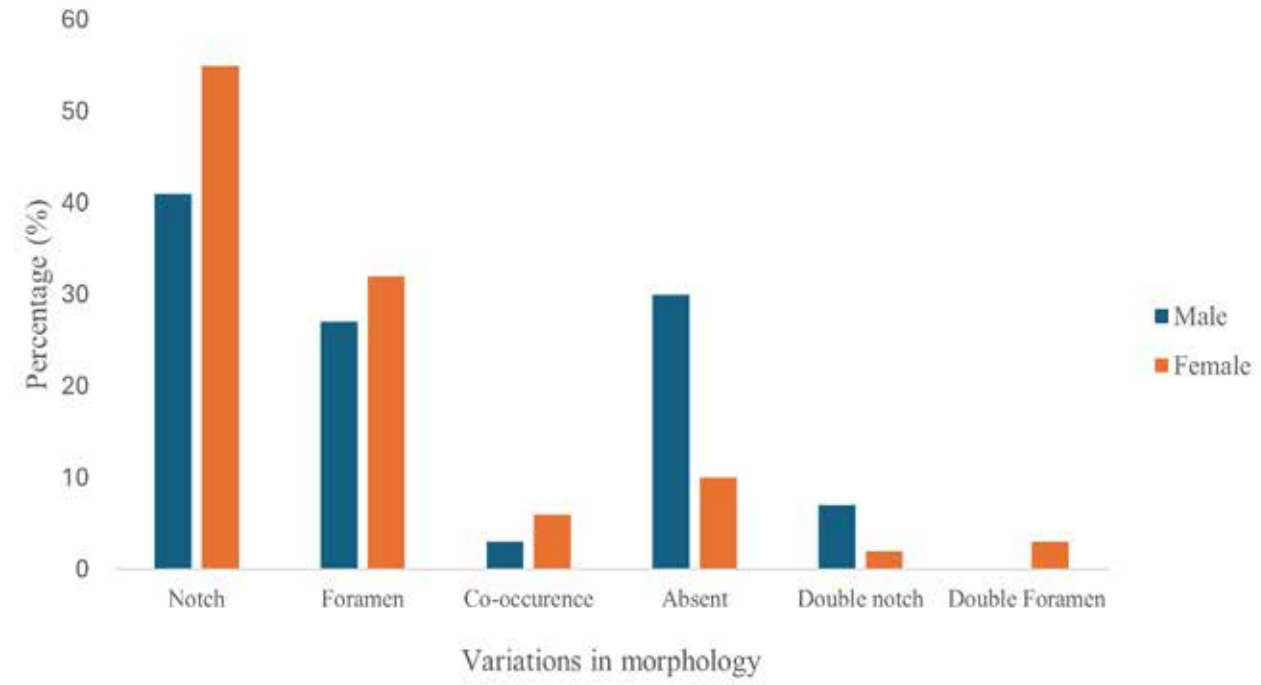

Figure 2: Frequency distribution amongst sexes in the South African population.

Data analysis:

Data was captured on Microsoft Excel 2021 (Microsoft Corporation). Data was then exported to Statistical Package for Social Service (SPSS) (Version 28). Descriptive statistics of the data was utilised to determine the minimum, maximum, mean and standard deviation of the groups under analysis. Thereafter, a Shapiro-Wilk test was used to test for the normality distribution of the data. A t-test was used to analyse differences observed in the measurements between the right and left sides of the skull and the differences observed between sexes where the data was normally distributed.

A Mann-Whitney U test was used if data was non-parametric. The significance level was set at $p \leq 0.05$.

RESULTS

The study population consisted of 108 specimens, 54 males and 54 females. The age of the crania ranged from 20 years to 90 years, with a median age of 50 years old.

The reliabilities for each measurement were above 0.8, indicating good reliability.

Different morphologies including the supraorbital notch (SON), supraorbital foramen (SOF), absent SON/SOF, double foramen, co-occurrence, and double notch were identified in our sample population (Figure 2). When comparing the frequency in the distribution of morphologies in a South African population SON (44%) was the most commonly identified passageway, followed by the SOF (27%), absent SON/SOF (19%), double foramen (5%), co-occurrence (4%), and double notch (1%) respectively (Figure 3).

Figure 3 (a): image depicts SON

Figure 3(b): image depicts absent SON/SOF

Figure 3(c): Image depicts SOF

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Figure 3(d): Image depicts double foramen

Figure 3(e): Image depicts cooccurrence

Figure 3(f): Image depicts double notch

Figure 3: Images depict the different morphologies seen: (a) supraorbital notch (SON), (b) absent SON/SOF; (c) SOF; (d) double foramen; (e) co-occurrence; (f) double notch

This study determined the dimensions of SON/SOF in South African females and males; and compared the left and right sides and differences between sexes. No significant differences in dimensions between left and right sides in males and females was exhibited (Tables 1-4).

TABLE II: POSITION OF SON/SOF IN FEMALES

	Width of SON/ Diameter of SOF (mm)	
	Right side	Left side
Min	1.10	0.71
Max	9.80	8.25
Mean	3.88	3.40
Median	3.35	3.04
Standard deviation	2.19	1.49
P-value	0.46	

TABLE III: POSITION OF SON/SOF IN FEMALES

	Distance to nasal midline (NM-SOF) (NM-SON) (mm)		Distance to (SOF-FZR) (SON-FZR) (mm)	
	Right side	Left side	Right side	Left side
Min	17.96	18.26	21.87	21.79
Max	34.83	40.52	35.67	35.02
Mean	26.53	27.18	28.72	29.01
Median	26.48	27.02	28.10	28.09
Standard deviation	3.74	4.11	2.72	3.24
P-value	0.10	0.28		

TABLE IV: WIDTH OF SON/SOF SEEN IN MALES

Width of SON/ Diameter of SOF (mm)		
	Right side	Left side
Min	0.69	0.97
Max	9.60	6.31
Mean	3.47	3.36
Median	3.39	3.19
Standard deviation	1.74	1.50
P-value	0.78	

TABLE V: POSITION OF SON/SOF IN MALES

	Distance to nasal midline (NM-SOF) (NM-SON) (mm)		Distance to frontozygomatic point (SOF-FZR) (SON-FZR) (mm)	
	Right side	Left side	Right side	Left side
Min	17.30	20.13	23.08	23.97
Max	35.67	33.84	35.23	40.36
Median	28.62	28.29	29.58	29.81
Standard deviation	4.07	3.24	2.55	3.04
P-value	0.63	0.58		

In this study, dimensions and relative position of SON/SOF were compared between South African males and females.

In reference to dimensions, statistical analysis revealed no significant differences between males and females (p = 0.46).

TABLE VI: WIDTH OF SON/SOF SEEN IN THE FEMALE & MALE SAMPLE

	Width of SON/ Diameter of SOF (mm)	
	Females	Males
Min	0.71	0.69
Max	9.80	9.06
Mean	3.60	3.42
Median	3.09	3.32
Standard deviation	1.87	1.62
P-value	0.46	

This study measured the length between the SON/SOF and two anatomical points: the nasal midline and the frontozygomatic point. Statistical analysis revealed that males displayed significantly larger SON/SOF-NM distances than females (p = 0.008). The distance from SON/SOF to the frontozygomatic point ranged from 21.79 mm – 35.67 mm (mean: 28.42 mm ± 3.00) in females. The corresponding distance in males ranged from 23.08 mm – 40.36 mm (mean: 29.83 mm ± 2.80) and was statistically greater than the distance from SON/SOF to the frontozygomatic point in females (p = 0.002).

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TABLE VII: SOF/SON POSITION IN MALES VS FEMALES

	Distance to nasal midline (NM-SOF) (NM-SON) (mm)		Distance to frontozygomatic point (SOF-FZR) (SON-FZR) (mm)	
	Females	Males	Females	Males
Min	17.96	17.30	21.79	23.08
Max	40.52	35.67	35.67	40.36
Median	26.87	28.41	28.10	29.83
Mean	26.87	28.20	28.42	29.63
P-value	0.008	0.002*		

* p-value p≤0.05

DISCUSSION

The study sought to determine the existence of various morphologies of the SON/SOF along with the dimensions of the SON/SOF and position relative to the nasal midline and frontozygomatic point, in the South African population. This was done using osteometric measurements taken with a digital vernier caliper.

Numerous studies exist, reporting on the relative position and size of the SON/SOF. In general, most studies found the notch to be more prevalent[6,8]. The presence of a foramen rather than a notch suggests that the supraorbital neurovascular bundle is in a relatively stable position and thereby at greater risk during surgical dissection, as it is more likely to be stretched during retraction. Therefore, extra care must be exercised during the reflection of flaps, where the supraorbital foramen is present[9]. According to Tomaszewska *et al*[10], the frequency of SON is greater in warmer climate regions than in cold regions. The study identified a high frequency of SOF (35.4%) in cold climates and a low frequency of SOF (18.8%) in warm conditions. The frequency of SON was greater in warm climates (59%) and lowest in cold climates (44%). This would provide a larger exit route for the supraorbital vessels and may be due to thermoregulatory processes. The supraorbital vein is more exposed and therefore susceptible to heat loss when passing through the SON10. The warm climatic conditions could be a possible factor in the greater frequency of SON than other exit passageways in our study.

Without the SON/SOF, the supraorbital vasculature is more susceptible to injury due to the sharp supraorbital margin[9]. According to Tezer *et al*[11], the foramen and absent SON/SOF cannot be palpated, however, the notch can be palpated during physical examination. In our study, 19% of cases identified an absence of SON/SOF, in the South African population. The risk of neurovascular damage is thus greater in subperiosteal interventions, such as endoscopic facelifts and migraine surgeries, when there is an absence of SON/SOF[11].

Very few studies have reported the incidence of double notches. Hong *et al*[12] conducted a study using 3D CT images and identified 0.8% double notches on the right side and 0.4% on the left side. In this study, only 3.7% of double notches were found on the right side in females, which is considerably higher than the study conducted by Hong *et al*[12]. There were no double foramen identified in males, which is similar to the study conducted by Hong *et al*[13]. Knowledge of the presence of accessory foramina is important to surgeons as additional nerve bundles may emerge from these openings. The occurrence of accessory supraorbital nerves may render anaesthetic blocks unsuccessful[13].

The size of the SON/SOF in this study is smaller in diameter than in other studies[5,6]. The difference in our findings might be due to population affinity differences between the studied population15. No significant differences were found between the left and right sides, in our study.

This indicates that our study had a greater SON-NM / SOF-NM distance than other studies[6,8]. In addition, Ilayperuma *et al*[6] described sex differences in the position of SON/SOF, in agreement with our study. The study emphasized the importance of applying anatomical variation data to each subject within a population[6]. Males displayed a significantly greater SON-NM / SOF-NM distance than females, in our study. On average, female individuals are smaller in cranial size and overall more gracile in comparison to males. Del Bove *et al*[15] explained that the glabellar region, nasal region and supraorbital torus are sexually dimorphic[15]. This may explain the greater SON-NM / SOF-NM distance in males than females.

Ashwini *et al*[5] reported a mean of 29.34 mm ± 0.32 on the right, and 28.7 mm ± 0.29 on the left side. Voljevica *et al*[9] found a mean of 28.30 mm ± 2.56 in males and 27.16 mm ± 2.74 in females. These findings indicate that the data does not deviate markedly from previous studies. Ashwini *et al*[5] suggested SON-FZR / SOF-FZR to be a more reliable parameter, as it can be accurately located on the skin. The frontozygomatic suture can be palpated on the skin at a notch along the lateral orbital margin, along the plane of the end of the palpebral fissure[5].

In our study, the distances of SON-NM / SOF-NM and SON-FZR / SOF-FZR were significantly larger in males than females. Similar findings of shorter distance in females than males have been previously reported by Agthong *et al*[16], whereby NM-SOF was smaller on the left side in females. Thus, our findings suggest that sex should be considered when locating SON/SOF, as the distance to midline may be greater in males than in females[16]. The shape of the human cranium and distribution of the supraorbital structures may be influenced by genetic and environmental factors[14].

Palamenghi et al[17] explored the potential of cranial non-metric traits, such as SON/SOF. The study determined that SON/SOF was not sufficiently unique to be regarded as individualizing. Whilst our study did identify significant positional differences of SON/SOF, between males and females, a larger sample size is required to evaluate the accuracy of this tool, as a sex estimator[18]. When this data is available, the morphological features and positional data may be used for sex estimation, or to narrow down potential matches and strengthen tentative or presumptive identifications, in conjunction with other methods.

Based on the findings, it is recommended that surgeons operating in the supraorbital region consider the following guidelines:

1. Pre-operative examination must include palpation in the supraorbital region to identify SON/SOF, as the SON is a palpable structure.
   a. If SON is palpated–maintain a 2mm safety zone around the area.
   b. If no SON is palpated and there is a risk of injury to structures based on the procedure performed – consider using adjunct tools (CT/CBCT/MRI imaging) as appropriate.

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   c. If no obvious SON/SOF is identified ensure informed consent and comprehensive counselling of the patient regarding greater risk of injury to structures in the region is obtained.
2. Reference points measured (i.e., nasal midline and frontozygomatic point) can aid intraoperative orientation as well as planning surgical incision placement and needle insertion for nerve blocks.
3. Consider location variations of SON/SOF amongst sexes.
4. If an unsuccessful or incomplete nerve block is encountered, one should consider the possibility of accessory foramina or the absence of foramen or notch.
5. Careful dissection techniques and possible use of magnifying aids/loupes/nerve stimulators to aid in dissection, and prevent injury.

South Africa has a highly diverse population, comprising of different ethnic and genetic backgrounds. Morphometric studies provide insight into craniofacial variations, specific to this population, and can assist in surgical planning and improve treatment outcomes. Accurate anatomical knowledge of the neurovascular architecture and foramina localisation in the supraorbital region can help avoid iatrogenic injury during the administration of local anaesthetic, retraction of musculocutaneous scalp flaps or surgical dissection of the supraorbital region.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare. All co-authors have seen and agree with the contents of the manuscript and there is no financial interest to report.

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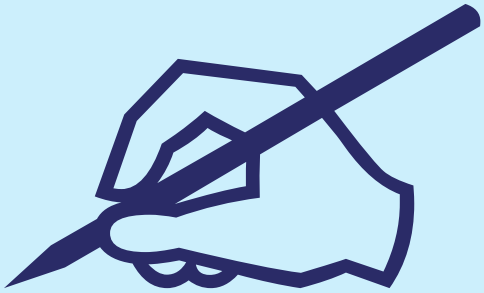
CPD questionnaire on page 570

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



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Periodontal status in adolescents with Type 1 Diabetes mellitus in a South African study population

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Keywords
Adolescents, Periodontitis, Type I Diabetes, Prevalence, Periodontal disease, Metabolic control.

Background
Periodontal disease (PD) can be considered a comorbidity of diabetes mellitus[1]. The relationship between Type I Diabetes mellitus (T1DM) and periodontal disease (PD) has been less extensively studied compared to Type II Diabetes Mellitus (T2DM). According to the International Diabetic Federation , the number of children and adolescents with type 1 diabetes in 2021 was 1.2 million people with 184,100 newly diagnosed cases each year[2]. This study investigated the periodontal status of adolescents with type 1 Diabetes in a South African population.

Aim
This study investigated the prevalence of periodontal disease in adolescents with Type 1 diabetes mellitus in a South African population.

Method
A cross-sectional study was conducted on 58 adolescent patients diagnosed with T1DM. Periodontal parameters were evaluated to establish the periodontal status of these individuals. PD was diagnosed according to the American Academy of Periodontology and the European Federation of Periodontology 2017 classification[3,4].

Results
Findings of the 58 T1DM adolescents, showed 44 patients (75.86%) had gingivitis, 6 (10.34%) had periodontitis, and 8 (13.79%) adolescents showed a healthy periodontal status. When relating the individuals' diabetic control to their periodontal status; 7 of the 8 patients with clinical periodontal health, 40 of the 44 gingivitis patients, and 4 of the 6 periodontitis patients found uncontrolled diabetes; No statistically significant association between periodontal status and metabolic control, p=0.231 was found

Conclusion
Despite a higher prevalence of periodontal disease compared to periodontal health among adolescents in the study, a correlation between periodontal diagnosis and metabolic control in adolescents with T1DM was not discernible which may be ascribed to limitations in the sample size. Therefore, future research endeavours should consider employing larger sample sizes to better elucidate potential relationships.

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1. INTRODUCTION

PD is prevalent worldwide[5]. Reports indicate that a substantial portion of the global population, approximately 90%, have gingivitis, while around 14% suffer from periodontitis[6,7]. Gingivitis affects only gingival connective tissues, periodontitis is characterised by collagen and connective tissue loss as well as bone loss and results in compromised tooth structure, function, and stability. Periodontitis[8] is prevalent among individuals diagnosed with T1DM and may exacerbate glycaemic control [8–10]. T1DM, a subtype of DM, is characterised by absolute insulin deficiency[11,12] and predominantly affects children and adolescents.

Recent research recognises PD as a comorbid condition to DM, owing to dysbiotic changes in the periodontal microbiome triggering an inflammatory response shared by both conditions[1]. Moreover, there is evidence suggesting improved diabetic control with reduced circulating pro-inflammatory mediators and improved lipid profiles observed,

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following periodontal therapy[15]. The association between PD and DM in adults has been well-established[16]. T1DM, in younger population groups, such as adolescents, are limited [17]. The study investigated the periodontal status of T1DM adolescents in a South African population.

2. METHODS

2.1 Study Hypothesis

This study investigated the prevalence of periodontal disease in adolescents with Type 1 diabetes mellitus in a South African population

2.2 Study population:

A total of 58 adolescents (between the ages of 12 to 18 years) with T1DM were examined and assessed for PD at the Tygerberg Oral Health Center (Faculty of Dentistry). Patients included in the study had been diagnosed with diabetes at least 12 months prior.

Adolescent patients diagnosed with T2DM, taking medications that are implicated in drug-influenced gingival enlargement (phenytoin, nifedipine and cyclosporine) or those with other known chronic and or immunosuppressive systemic diseases, human immunodeficiency virus (HIV) and haematological deficiencies were excluded from the study.

2.3 Data collection:

A convenience sampling method was used to source patients from the Tygerberg Adult Endocrinology outpatient clinic between January- November 2019. At this clinic, patients were monitored for their metabolic disease control.

A structured interview was conducted, and patient records were accessed for diabetes-related data such as, HbA1c level and patient demographics. Patients were then referred to the Tygerberg Oral Health Centre for further clinical examination.

At the Tygerberg Oral Health Centre, periodontal disease-related parameters were recorded by carrying out a periodontal examinations by a single examiner (MA) using a Williams probe recorded on a periodontal chart. An orthopantomogram and periapical radiographs were used to assess alveolar bone levels[20]. The patient's periodontal status was diagnosed as Clinical health, Gingivitis or Periodontitis according to the EFP/AAP Periodontal classification (2017)[21,22].

2.4 Study permissions:

Ethical approval was granted by the relevant Research Ethics committees (Biomedical Research and Ethics_Committee (BMREC), the Health Research Ethic Committee (HREC) of the University of the Western Cape and the Stellenbosch University Health Research Ethics Committee (SU HREC)). All necessary permissions and consent were obtained.

2.5 Data analysis:

The diabetic control of these adolescent patients was compared to their periodontal disease. The data was analyzed using STATA (Stata Corp. 2017. Stata Statistical Software: Release[15]. College Station, TX: Stata Corp LLC). Descriptive statistics represented by frequencies and percentages for categorical data and mean (standard deviation) or median (Interquartile Ranges) for continuous data, depending on the distribution of data. For categorical data, a Chi square test was utilized. For continuous data, a t-test was utilized to demonstrate contrast between two groups else an ANOVA was utilized for group sizes greater than[2]. In the event that the data did not fulfill the assumptions for the above stated tests, a non-parametric equivalent was used. Level of significance was established at a p-value of less than 0.05[4].

3. Results

The sample of 58 participants, with a mean age of 15. 4 years, comprised more females than males (37 versus 21). The majority of the participants presented with gingivitis (75.86%), followed by periodontitis (10.34%) and periodontal health (13.79%), respectively. Fifty-one of the participants (87.92%) had uncontrolled diabetes with HbA1c levels ≥ 7%, with an average of 9.24% (SD = 2.05).

Table 1: Basic sample demographic table

		Healthy	Gingivitis	Periodontitis	Total	p-value
Total (N)		8 (13,8)	44 (75,9)	6 (10,3)	58	
AGE, mean (SD)		14.9 (2.6)	14.5 (1.8)	16.3 (2.6)	14.8 (2.1)	0.14
HbA1c-cat	Controlled	3 (38%)	10 (23%)	2 (33%)	15 (26%)	0.52
	Uncontrolled	5 (63%)	34 (77%)	4 (67%)	43 (74%)	
Sex	Male	2 (25%)	18 (41%)	1 (17%)	21 (36%)	0.47
	Female	6 (75%)	26 (59%)	5 (83%)	37 (64%)	

Table 2: Clinical Periodontal Parameters:

Clinical Parameters	Level	Healthy N=8	Gingivitis N= 44	Periodontitis N= 6	Total N= 58	p-value
PROBING POCKET DEPTHS	0-3mm	8 (100%)	40 (91%)	0 (0%)	48 (83%)	<0.001
	4 mm	0 (0%)	4 (9%)	6 (100%)	10 (17%)	
RADIOGRAPHIC BONE LOSS	No bone loss	8 (100%)	44 (100%)	0 (0%)	52 (90%)	<0.001
	Radiographic bone loss	0 (0%)	0 (0%)	6 (100%)	6 (10%)	
BLEEDING, median (IQR)		7.9 (7.3, 8.9)	53.0 (27.4, 64.8)	70.8 (32.3, 81.5)	47.4 (19.2, 65.7)	<0.001
Periodontitis Stage, Grade and extent	Stage I, Grade B, localized Stage I, Grade B, localized Stage II, Grade C, generalized	n/a	n/a	3 2 1		

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Table 3: Correlation between PD and Metabolic Control

Healthy (baseline)	OR (95% Confidence Interval)	p-value
Gingivitis: HbA1c-cat Uncontrolled	0.713 (-0.88 to 2.31)	0,381
Periodontitis: HbA1c-cat Uncontrolled	0.182 (-2.04 to 2.4)	0,872

Most of the patients, 43 (74%) had uncontrolled diabetes with HbA1c ≥ 7% (Table 1), which echoed through periodontal health, gingivitis and periodontitis, but this was not found to be statistically significant. It is no more likely that you are an uncontrolled DM patient than a controlled DM if you have periodontitis or gingivitis compared to healthy gingiva or gingivitis compared to healthy gingiva. (Table 3).

4. DISCUSSION

Diabetes mellitus and periodontitis are prevalent conditions impacting a significant portion of the population. Over 1.2 million children and adolescents are diagnosed with type 1 diabetes (IDF, 2021). Among adolescents, gingivitis is the most common form of periodontal disease, while periodontitis shows a lower prevalence of approximately 1.7%, as reported in a recent systematic review. Studies across various regions indicate differing prevalence rates, though gingivitis consistently appears more frequently than periodontitis[24–28]. Data aggregation could be explained by the relatively recently revised classification system for periodontitis, which unified previous subtypes into a single condition. Additionally, variations in socioeconomic status may potentially impact the distribution of disease, where a higher socioeconomic status is sometimes reported to be associated with better access to medication, dental care, and health information disease[29].

Age and HbA1c are recognised risk factors of periodontitis[4,30]. This study examined the relationship between HbA1c levels and periodontal status. Most participants with gingivitis and periodontitis, in this study, had uncontrolled diabetes (HbA1c > 7%), though no statistically significant association was found. The limited number of periodontitis cases may be attributed to sample size constraints. Notably, a Brazilian study of 168 young adults with type 1 diabetes reported gingivitis and periodontitis rates of 20.8% and 5.9%, respectively[31]. Similarly, an Italian study involving 120 patients found a predominance of gingivitis[32]. Considering that this study focussed on a limited age group, particularly under-reported in current literature, it resulted in a reduced sample size and restricted the conclusions.

The severity of periodontitis in this diabetic population (Table 2) was assessed, with most cases (n=5) showing localized disease and only one case presenting generalised disease (>30% involvement). Five of the six patients with periodontitis were classified as Stage I (early/mild), characterised by pocket depths ≥4 mm and bone loss under 15%. Three patients demonstrated a slow progression rate (Grade A), while two exhibited a moderate progression rate (Grade B). Due to HbA1c levels exceeding 7%, these patients were classified as Grade B (n=1) or Grade C (n=2). Although greater disease severity might be expected, considering the early onset of disease, these adolescents may still be in the initial stages of disease progression[4, 33]. Systemic diseases can exacerbate periodontal disease by altering the inflammatory response due to focal irritants and infections[34].

The study found no association between periodontal disease and glucose metabolic control, indicating that type 1 diabetic patients with controlled or uncontrolled HbA1c levels were equally likely to present with periodontal health or disease.
This study faced several limitations. Firstly, the cross-sectional study design restricted the researcher to include only participants who presented at a single point in time, potentially excluding those who did not present during that specific period. Secondly, the sample size was limited, affecting the generalisability of the findings. Additionally, the participants were sourced from a tertiary hospital, which resulted in a sample predominantly composed of patients with poorly controlled Type 1 Diabetes Mellitus (T1DM).

Recommendations

Continuous efforts should be made to enhance access to diabetes education programs that incorporate lifestyle modifications, blood glucose self-monitoring, and insulin management. It is also crucial to consider periodontitis as a potential comorbidity in diabetic patients. Broad patient education on oral hygiene and regular dental check-ups are recommended.

Further research should explore the relationship between periodontal disease and metabolic control in adolescents with insulin-dependent diabetes mellitus. Future studies should include a larger sample size, consider socioeconomic factors, and assess a broader range of periodontal parameters, including the gingival index, plaque index, calculus index, tooth decay, and number of missing teeth.

5. CONCLUSION

For adolescents with Type 1 diabetes mellitus, gingivitis was the most prevalent condition, followed by periodontal health, with periodontitis being the least prevalent. Additionally, most of the sample exhibited poorly controlled Type 1 diabetes mellitus. Budget constraints prevented concurrent testing of metabolic control. Future studies should involve larger sample sizes that are longitudinal over time, as this would provide insight of disease progression in such populations.

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CPD questionnaire on page 570

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

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Patients' Understanding of Information Provided During Consent Process for Fixed Prosthodontic Treatment: A Mixed Methods Study at Dental Facilities in Kampala

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ABSTRACT

Introduction

Obtaining valid informed consent requires that patients understand treatment information. This is crucial for irreversible procedures, like fixed prosthodontic treatment, where dentists are required to communicate highly technical information to patients with different literacy levels and treatment expectations. Failure of patients to understand some aspects of the treatment may result in dissatisfaction and complaints. There is limited data about dental patients' understanding of treatment information in Uganda.

Aim and objectives: This study explored patients' understanding of information provided for fixed prosthodontic treatment at two dental care facilities in Kampala, Uganda.

Design

Parallel-convergent mixed methods

Methods

A survey was carried out on 216 patients and 19 in-depth interviews at two dental facilities. The patients had received information from their dentists about the fixed prosthodontic treatment they were to undergo. Quantitative data were collected using a pretested semi-structured interviewer-administered questionnaire. The questionnaire consisted of 5 items on a 4-point Likert scale and a checklist of 19 items to collect data on patients' subjective and objective understanding of the information provided, respectively. An interview guide facilitated the interviews. Quantitative data were analysed using descriptive statistics and Chi-square statistics. Total scores were computed for the assessment of objective understanding and categorized as adequate, moderate, or inadequate understanding, on attaining 80-100%, 50-79% or less than 50% of the maximum possible score. Qualitative data were analysed using thematic analysis.

Results

Over three quarters (> 85.0%) of the patients reported to have received the information during a verbal discussion with their dentist at prior appointment. Several participants reported that they were not informed about the possible risks (48.4%) or alternative treatments (22.2%). More than two-thirds felt that they had understood well (subjective understanding) many aspects of the treatment information, but only 13.4% of them had an adequate objective understanding. Treatment procedures and alternative treatment options were the most difficult to understand. There was no significant association between subjective and objective understanding.

Conclusions

Most participants did not adequately understand the information. Results indicate the need to develop interventions to enhance patient understanding of information provided during the consent process and measures for objective assessment of' understanding.

Keywords

fixed prosthodontic treatment, informed consent, information, understanding.

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2. Sudeshni Naidoo: design of the work, review and editing (12%)
3. John Barugahare: conceptualization, review and editing (12%)
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5. Charles Mugisha Rwenyonyi: design of the work, review and editing (12%)

INTRODUCTION

Informed consent obtained from patients undergoing clinical procedures is important not only for ethical and legal reasons but also for the quality of care.[1] Key to the success of the

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consent process is the ability of a patient to understand the information provided and be able to make autonomous and informed decisions.[2-5] This is particularly important for irreversible procedures such as fixed prosthodontics. In addition, patients often have high or unrealistic expectations of the outcomes, and failure to understand the treatment as well as the limitations may result in dissatisfaction.[2] This could trigger legal action.[2] Patient understanding of treatment information allows cooperation, improves trust, strengthens the dentist-patient relationship, satisfaction, and reduces the likelihood of misconceptions concerning treatment, and litigations.[2, 6]

The importance of ensuring that patients understand the information provided has been emphasized in various ethical codes.[7, 8] For instance, in Uganda, Article 10 of the Patient's Charter states that "information shall be communicated to the patient at the earliest possible stage in a manner that he/she is expected to understand in order to make a free informed, and independent choice".[9] This Charter serves as a key guideline in Uganda's healthcare system, emphasizing patient rights and the responsibility of healthcare providers to ensure effective communication.

While it is critical for patients to understand the information provided during the informed consent process, available literature from medical specialties reports several shortcomings in practice, including difficulties in patient recall, poor understanding or knowledge, and misconceptions of treatment information.[5,10-12] However, there is limited data on patients' understanding of the information provided during consent for dental care, and the scenario is the same in Uganda. This is particularly of concern for complex procedures such as fixed prosthodontic treatment (FPT), in which dentists must communicate highly technical and specialised information to patients with varying literacy levels and socio-cultural backgrounds.[2] There is also a need for an objective assessment of dental patients' understanding of treatment information before consent.

Therefore, this study aimed to explore patients' understanding of the information provided during the informed consent process for FPT among patients attending two dental care facilities within Kampala. It was hypothesized that, despite patients receiving information, they did not adequately understand the treatment information provided during the consent process.

MATERIAL AND METHODS

Study design and approach

The study employed a parallel, convergent mixed-methods design that included a survey and in-depth interviews. Both quantitative and qualitative methods were used to gain in-depth knowledge of how well patients understood the information provided during the consent process. The qualitative approaches clarified areas of inadequate understanding in the collected interviews and enabled understanding of the complex issues related to the communication of information, and patient's understanding. The study was approved by the Makerere University School of Medicine Research Ethics Committee (Mak-SOMREC-2022-418) and the Uganda National Council of Science and Technology (HS2914ES). Written informed consent was obtained from all participants before enrolment. The ethical considerations followed the guidelines of the Declaration of Helsinki.

Study setting

This study was conducted at two dental care facilities in Kampala, Uganda, between September 2023 and March 2024. The two hospitals were the Mulago and Makerere University Dental Hospitals (MUK-DH). Mulago is a national referral hospital (MNRH) that registers approximately 30 patients for fixed prosthodontics monthly. MUK-DH is a teaching and oral health service delivery facility for Makerere University that registers approximately 40 patients for fixed prosthodontic treatment monthly

Study population, sample size determination, and sampling procedure

The study was conducted among patients aged ≥ 18 years who had treatment plans involving FPT, had received information concerning their treatment from their dentists, and agreed to participate. Patients with a background in dental education, those on treatment for mental health issues, or those unable to speak English or Luganda were excluded.

The sample size was calculated using a statistical formula with a finite population correction:[13] $n = \frac{n_0 N}{n_0 + (N-1)}$, where n = sample size; no = (Z2PQ)/d2; N is population size; Z is 1.96, P is the proportion (considering an arbitrary value of 50% as no previous study in Africa); $Q = 1 - P$, d = 5%. Given that approximately 420 (N) patients sought FPT at the two hospitals over six months, the estimated sample size was 200, which was increased by 10% to 220 to account for missing data.

Proportional allocation was used to ensure adequate representation of each facility. Consecutive sampling was used to select participants at the dental facilities. For qualitative data, nineteen participants were purposively selected based on data saturation.

Data collection and quality control

Four research assistants (dentists) collected quantitative data using an interviewer-administered questionnaire (Supplementary file 1) in either English or Luganda. The questionnaire comprised three parts. Part I solicited socio-demographic information and service-related factors. Part II comprised five items on the subjective understanding of the information on a four-point Likert scale assessing patients' understanding of dental problems, proposed treatment procedures, benefits, probable risks, and alternative treatments. The Likert scale had the following alternatives: (1) "patient did not understand the item at all," (2) "somewhat understood," (3) "understood well," and (4) "understood very well." If participants believed they were not informed about a certain item, they were prompted to select not informed = 0. Part III contained a checklist of 19 items for the assessment of objective understanding of the information, including 5 items for the procedure, 6 regarded benefits, 6 probable risks, and 2 items concerning alternative treatments. The responses were "Disagree" (1), "Unsure/ I do not know" (2), and "Agree" (3). The questionnaire was developed based on the validated Quality of Informed Consent Tool for assessment of both subjective and objective understanding in research settings.[14] The checklist was developed based on literature regarding consent information for FPT and was reviewed by 3 dentists. The questionnaire was piloted among 15 patients to assess its clarity and reliability, achieving a Cronbach's alpha of 0.776. Data from the pilot study were included in the main survey.

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In-depth interviews (IDIs) were conducted by the principal investigator and a trained research assistant among 19 patients. The IDIs were conducted in either English or Luganda, using an interview guide (Supplementary file 2), and lasted 15-25 minutes. The interview guide included items to explore patients' views about: the information provided and their understanding of the information provided, decision-making, and suggestions to improve patients' understanding. The interviews were audio-recorded and supplemented with notes.

The study teams were trained before data collection, and daily checks were conducted to ensure the accuracy and completeness of the data. The trustworthiness of qualitative findings was demonstrated through the concepts of credibility, transferability, dependability, and confirmability. Credibility was enhanced through data triangulation, while the dependability of findings is illustrated through the well-documented methods. Study findings are derived from the data.

Data analysis

Quantitative data were analysed using STATA version 14.0 and summarized using descriptive statistics. Responses for the assessment of objective understanding were recorded as follows: correct=2, unsure/I do not know=1, and incorrect=0. Total scores were computed for each domain and categorized as: "adequate understanding" if 80-100% of the maximum possible score was attained, "moderate understanding" for 50-79%, and "inadequate understanding" for less than 50%. This categorization of scores was adapted from a systematic review of the comprehension of informed consent for surgery and clinical research.[15] Chi-square ($\chi 2$) statistic was used to determine the relationship between patients' subjective and objective understanding. Statistical significance was set at $P < 0.05$.

For qualitative data, audio recordings were transcribed verbatim. Three transcripts were translated from Luganda into English and verified for their accuracy. Thematic analysis was conducted using both inductive and deductive approaches using NVivo version 12. The PI and a social scientist with expertise in qualitative methods analysed the data following the six steps for thematic analysis.

RESULTS

Results for the quantitative data

Socio-demographic characteristics of the study participants

More than half (55.4%) were female, and the median age (interquartile range) was 27 (23, 36) years. Almost all (94.4%) were literate and had completed secondary education (Table I).

Table I: Frequency distribution of participants according to socio-demographic characteristics (n=216)

Characteristic	Categories	Frequency n(%)
Facility	Facility 1	65(30.1)
	Facility 2	151(69.9)
Sex	Female	119(55.1)
	Male	97(44.9)
Age category (in Years)	18-29	124(57.4)
	30-35	72(33.3)
	36-65	20(9.6)
Highest level of Education	None	4(1.9)
	Primary	8(3.7)
	Secondary	62(28.7)
	Tertiary	142(65.7)
Ability to read and write	Yes	211(97.7)
Marital Status	Single	134(62.0)
	Married	75(34.7)
	Widowed/Separated/Divorced	7(3.3)
Religion	Catholic	76(35.2)
	Protestant	67(31.0)
	Muslim	26(12.0)
	Other	47(21.8)
Occupation	Unemployed	12(5.6)
	Studying	86(39.8)
	Business/self-employed	59(27.3)
	Civil/ public service /formal employment	48(22.2)
	Farming or other	11(5.1)
Given an opportunity to ask questions	Yes	186(86.1)
	No	30(13.9)

n-number, %-percentage

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Service-related factors

More than three-quarters (>83.0%) of the patients needed a crown, and this was their first time to have such treatment. Majority (85.2%) noted that information had been provided by the dentist who would be treating, while for the rest it was from another dentist in the same practice. Almost all (96.3%) patients reported to have received the information at a prior appointment or before the start of the procedure, while for 3.7% of them, information was provided as the procedure was being conducted. All patients reported having received information in an verbal discussion, and videos or dental models were utilised among 4.6 % and 9.3% of them, respectively.

Information provided and assessment of patient's subjective (perceived) understanding of information provided

Almost half (48.4%) reported that they had not received information about risks. More than two-thirds reported to have understood either well or very well the information regarding their dental problem, the proposed treatment procedure, and its benefits, whereas less than a third (31.4%) felt they understood information regarding the possible risks. Notably, about 15 to 20% of them felt they did not understand or somewhat understood the information provided regarding procedures, alternative treatment, or risks (Table II).

Objective understanding of the information provided

Overall, approximately 13.4% of the participants had an adequate objective understanding of the information provided regarding FPT (Table III). Most items assessing participants' understanding of treatment procedures (P1, P2, P3, P4) were answered correctly, with more than two-thirds (68.1%) having an adequate understanding. Conversely, less than one-third of the participants had an adequate understanding of the risks, alternative treatment options, and benefits,

Table II: Frequency distribution of participants according to the subjective (perceived) understanding of the information provided (n=216)

Characteristic	Not informed	I didn't understand this at all	Somewhat	Well	I understood this very well
The problem/diagnosis	2(0.9)	2(0.9)	19(8.8)	96(44.4)	97(44.91)
The treatment/procedures you will undergo	24(11.1)	7(3.2)	34(15.8)	80(37.0)	71(32.9)
The alternative treatment(s) to the chosen option	48(22.2)	6(2.8)	27(12.5)	68(31.5)	67(31.0)
The benefits of the treatment	7(3.3)	2(0.9)	22(10.2)	88(40.7)	97(44.9)
The risks of undertaking the treatment	104(48.2)	14(6.5)	28(12.9)	41(19.0)	29(13.4)
Overall, how well did you understand the information provided?	2(0.9)	1(0.5)	27(12.5)	101(46.8)	85(39.3)

Table III: Frequency distribution of participants' responses according to objective assessment of understanding (n=216)

Domain	Item	Participant responses			Understanding		
		Agree	Unsure	Disagree	Adequate†	Moderate†	Inadequate†
		n(%)	n(%)	n(%)	n(%)	n(%)	n(%)
Treatment procedures	**P1**: The dentist will numb my teeth and gums on the affected side by giving medicine in an injection in my mouth	182(84.6)*	30(14.0)	3(1.4)	147(68.1)	66(30.5)	3(1.4)
	P2: Part of the tooth and or filling will be cut to prepare for the crown/ bridge	154(71.6)*	56(26.1)	5(2.3)			
	P3: They will use some material to take measurements/ impressions of the teeth and mouth	158(73.5)*	54(25.1)	3(1.4)			
	P4: The treatment may take 2 or more appointments to be completed	168(78.2)*	42(19.5)	5(2.3)			
	P5: The crown or bridge can easily be removed in case there is a need for adjustment.	106(49.3)	76(35.4)	33(15.3)*			

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Benefits of the treatment	**B1:** The prosthesis will improve my appearance or speech	159(74.0)*	47(21.9)	9(4.2)	67(31.0)	142(65.7)	7(3.3)
	B2: The crown/bridge will improve my chewing ability	175(81.4)*	38(17.7)	2(0.9)			
	B3: The crown or bridge will function as comfortably as your tooth	163(75.8)*	38(17.7)	14(6.5)			
	B4: The crown/bridge will be fixed onto your teeth/tooth; you will not need to remove it from time to time	125(58.1)*	57(26.5)	33(15.4)			
	B5: This treatment is permanent, and I don't need any home care.	105(48.8)	81(37.7)	29(13.5)*			
	B6: The artificial tooth is quite tough and may be used to open packaging, open bottles, or crack hard foods.	49(22.8)	64(29.8)	102(47.4) *			
Probable risks	**R1:** You may experience slight pain or sensitivity in the prepared tooth/teeth if they are not root canal treated.	126(58.6)*	82(38.1)	7(3.3)	51(23.6)	139(64.4)	26(12.0)
	R2: The dental crown or bridge may chip or fracture.	89(41.4)*	104(48.4)	22(10.2)			
	R3: The underlying tooth/ teeth may require root canal treatment before or after the procedure.	136(63.3) *	69(32.1)	10(4.7)			
	R4: The underlying tooth may develop tooth decay.	62(28.8) *	119(55.4)	34(15.8)			
	R5: Over time, the gums around the crowned tooth / teeth may shift, exposing the margins	43(20.0)*	141(65.6)	31(14.4)			
	R6: Sometimes the crown may become loose over time	76(35.4) *	109(50.7)	30(13.9)			
Alternative treatment options	**A1:** Having this treatment is the only option for managing this problem	93(43.3)	48(22.3)	74(34.4)*	58(26.9)	103(47.7)	55(25.4)
	A2: Can replace the tooth or teeth with a removable option/ denture	117(54.4)*	70(32.6)	28(13.0)			
Overall objective understanding	29(13.4)	185(85.7)	2(0.9)				

*Denotes the correct response, †Adequate, moderate, and inadequate levels of understanding were considered if the participant had correctly answered and obtained ≥80%, 79 to 50%, and <50% of the maximum possible score for a specific domain of information.

23.6%, 26.8%, and 31.0%, respectively (Table III).

Association of subjective and objective understanding of information among participants

There was no significant association between the different levels of subjective understanding and overall objective understanding among the participants (P=0.064, χ^2 test).

Qualitative Results

The participants had a mean age (SD) of 30.3(11.9) years. Most (17/19) participants had attained formal education up to secondary school. Six had formal jobs or personal businesses, two were farmers, and 11 were students (nine pursuing a diploma or bachelor's degree, one a postgraduate degree, and one secondary school education).

Three key themes emerged from the qualitative data: 1) patients' perceptions of the information received, 2) patient awareness of the treatments, and 3) suggestions on how to improve patients' understanding of information.

Theme 1: Patient perceptions of the information received

The majority (n=16, 84%) of the participants reported that they felt they had received adequate information about their management to make informed decisions. However, two university students felt that they needed more information and searched on the internet, as one participant stated:

> *'Yes, I did. I went back and saw some videos [..]. I did some search and I went to Google, I read about it. I saw the different types [fixed prostheses]; I saw the metallic and their disadvantages.' (IDI 7)*

However, on exploring the information received for each specific domain, less than half (n=9, 47.4%) indicated that they had no recollection of being told about the details of the procedures or possible risks. A few participants (n=3, 15.7%) reported knowing only one benefit of the treatment, which

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directly resolved their chief complaints. For instance, patients who wanted to restore or replace a missing anterior tooth to enhance their appearance claimed that the only benefits of the bridge or crown they knew of were to improve their esthetics.

Participants felt that the main importance of the information provided was to educate and guide them to make informed treatment decisions about their treatment, as well as to allay their worries arising from certain misconceptions, as expressed by the quotes.

'It [information] is important because it helps to make a rational decision […]. People fear these procedures. They say, how do you go for a root canal treatment? It is very risky, a challenge can come, and you can get an accident […], so when you are given all the information, it helps you make a rational decision.' (IDI 7)

'It is important because first of all I make a choice that is informed, that suits me because the dentist might do something that is general, but I have my [personal] fears, so if I am given a variety of options, I go with something that I am comfortable with and that suits me'. (IDI 17)

Theme 2: Participants' awareness about the fixed prosthodontic treatment they were to undergo.

Most participants (n=13, 68.4 %) indicated that the information provided was easy to understand according to them. However, some participants reported that they did not understand some of the information and had to trust the dentist to make correct decisions. A female with a tertiary education level indicated that she could not understand the information but trusted the dentist to do the right thing.

Information that was difficult to understand included treatment procedures and alternative treatments, especially when technical terms were used in the discussion, as expressed in the participant quote below.

'The treatment type and procedure need to be explained in detail because some of the medical terms are not friendly […]. The other two treatments were not clear because they told me three treatments, but I didn't understand well the other two'. (IDI 14)

Overall, the majority (n=16, 84%) described explicitly their problem and knew at least one reason for the treatment and benefits of the FPT. Only one participant was aware of two or more of the possible risks. Several participants had no information on the details of the procedure or risks.

'No, I am not sure of what exactly will be done. I am neither sure of what I will go through nor the number of appointments'. (IDI- 1)

It is worth noting that one participant did not know the reason for the treatment they had agreed to undergo.

'I don't even know the reason why I need a crown. I haven't got the information why they are putting a crown […]. Although I agreed, but I don't know why the tooth needs a crown'. (IDI 8)

Theme 3: Suggestions for improving communication and patients' understanding

More than a third (n=7, 37%) suggested that the use of visual aids may improve patients' understanding of the information. Visual aids such as videos, pictures, or models should be used during discussions or shared on social media to improve the patients' understanding. Other suggestions included the use of simplified language during the discussion, allowing the patient sufficient time to make decisions that may involve another appointment, providing information at several appointments, encouraging patients to ask questions, using local languages, and providing a more detailed explanation of the treatments.

'I think in clinics, having visual aids will be one of the easiest ways to communicate to patients. For the pamphlets, people don't read them'. (IDI 17)

'I think in this era of communication, online and social media are the best ways of communication. With a particular patient, you can share pictures, for example, Dr. X shared with me. Or send a link of a procedure, and the person sees what is going to happen to them. Well, if they haven't understood the verbal information, they can see the video of the process, so that they know how it's going to be'. (IDI 7)

'Maybe by simplifying some of the terms and the language used. Simplify the way they communicate to make it understandable to everyone'. (IDI 9)

DISCUSSION

The study findings indicated that the majority of patients did not have an adequate understanding of the FPT they were to undergo on the objective assessment. These findings are consistent with those from several studies conducted in clinical settings, which showed that most patients did not have an adequate understanding of information.[5, 15-17] For example, a systematic review of articles on understanding informed consent for surgery found that 6 out of the 21 (29%) studies reported that participants had inadequate understanding of the information provided during the consent process.[15] In contrast, Sahai et al reported that most (> 90%) of participants had an adequate understanding of the information provided in a leaflet or video before laparoscopic surgery in the United Kingdom.[18] The difference in results may stem from the present study used mainly verbal discussions to convey information for a complex treatment, fixed prosthodontic treatment, and the variability of the information provided by the different dentists, while Sahai et al utilised other methods like information leaflets, consent forms, and videos to deliver information.[18]

The study's findings, that few participants had an adequate understanding, raise various concerns; about the effectiveness of methods used for communication of treatment information, whether patients in the present study were in a position to make informed decisions, and provide valid informed consent, as the four criteria of information disclosure, competence, understanding, and voluntariness must be met. As suggested by several authors, it is proposed to incorporate the use of adjunct educational materials, either delivered in written form or visual tools, for improvements in patients' understanding of consent information and the delivery of standardised information.[5, 10]

Furthermore, the qualitative results revealed that difficulties in understanding information were partly due to the use of medical terms. Goltileb et al observed similar findings and noted that the use of medical phrases during doctor-patient discussions may lead to confusion among patients.[25] Thus, it is proposed that simplified language should be used during

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the consent process, as well as adding communication courses to dentists' training to promote the development of requisite knowledge, skills, and expertise.[22, 27, 28]

In addition, several participants in both study arms noted that they had not received any information about the risks or treatment procedures. The results are comparable to findings by Brezis et al., who observed that half and two-thirds of the patients who underwent invasive procedures did not recall receiving explanations about risks or alternative treatment options, respectively.[29] Despite these findings, various ethical codes, including the local guidelines of Uganda, stipulate that dentists must provide patients with adequate and balanced information, including probable risks, to enable patients to make informed decisions regarding the proposed treatment.[4, 8, 9] In addition, most procedures are complicated, and the attendant risks or benefits are unknown to patients.[21] Thus, dentists are required to disclose to patients the material risks associated with the proposed procedures, defined as those risks that are most relevant to the patient, that are the most common, and the most serious.[4] Without providing such information, a dentist breaches their duty, resulting in potential negligence.[1]

Furthermore, the study findings revealed no significant association between subjective and objective understanding, which may imply that participants who thought they had understood the information actually did not. This discrepancy between patients' subjective perception of understanding and their actual comprehension indicates possible biases in self-reports by patients and the need to provide comprehensive treatment information. This also indicates a challenge to practitioners, as they may proceed with treatment on the assumption that whenever patients answer affirmatively to a general question on whether they have understood such information, then they have indeed understood. Since obtaining valid informed consent is a stringent moral and legal obligation of practitioners, and the burden of proof of understanding usually lies on practitioners,[4] there is a need to close this gap. It is necessary to devise strategies to enhance the delivery of information and patient understanding and develop metrics for assessing patient understanding, such as asking questions at the end of the informed consent process, as suggested by study participants.

The findings revealed that the overall objective understanding of information was as low as 13% in a predominantly literate study sample. Thus, it could be worse among semi-literate and illiterate patients as several studies have noted that information recall and patient understanding are affected by literacy level.[28, 30] This emphasizes the critical need for future research to diverse interventions for communicating complex information, such as the use of visual aids, leaflets, and measures for communicating complex concepts in digestible chunks[22-24] to improve patients' understanding of the information provided during the informed consent process for dental care. In addition, there is a need to develop innovative methods for objective assessment.

Limitations of the study include: 1) the study findings may not be generalized to all patients in Uganda as participants were recruited from two dental facilities in urban area, and 2) the lack of documentation concerning what was discussed during the informed consent process for the participants and relying on patients' recall as a reporting tool could have influenced the responses with recall bias. (3) There may have been variability in the information provided during the consent process.

CONCLUSION

Most patients who received FPT at the two dental care facilities did not adequately understand the treatment they were to undertake. Based on the data, it is suggested to devise measures for the objective assessment of patient understanding before obtaining consent or starting treatment. In addition, to develop interventions such as visual tools or consent forms to improve patient understanding of information deemed difficult to understand. To improve the generalizability of study findings, similar studies should be conducted with larger sample sizes and across multiple regions, including rural and urban areas.

Conflicts of interest

The authors have no conflicts of interest to declare.

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A Comparative Analysis of Traditional Dental Screening versus Smart Phone Screening

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ABSTRACT

Teledentistry has emerged as a promising solution to address oral health disparities, particularly in resource-limited settings like rural South Africa, where low dentist-to-population ratios and high costs restrict access to dental care. The present study evaluated the reliability and accuracy of smartphone-based, remote dental screening compared to traditional chairside clinical examination screening. A cross-sectional study was conducted with 145 participants (≥18 years) attending the Tygerberg Oral Health Centre. Standardized intraoral photographs were captured using an Apple iPhone XS and uploaded securely to the Vula App for remote assessment. Diagnostic tools, including the International Caries Detection and Assessment System (ICDAS) and the Decayed, Missing, and Filled Teeth (DMFT) index, were employed to ensure consistency.

The results showed an "Almost Perfect Agreement" between clinical and photographic examinations, with Cohen Kappa coefficients ranging from 0.84 to 0.95 and strong Pearson correlations (>0.90). No statistically significant differences were observed, confirming teledentistry's reliability as a diagnostic tool.

Teledentistry offers a secure, and cost-effective method to improve access to dental care, particularly for underserved populations. By overcoming geographical and economic barriers, it aligns with public health goals, including South Africa's National Health Insurance (NHI) scheme, to improve equity and quality in healthcare delivery.

Key words

Teledentistry, Remote Dental Screening, Oral Health Equity, Digital Health, National Health Insurance (NHI), Diagnostic Reliability

INTRODUCTION

The COVID-19 pandemic fundamentally altered global health practices, necessitating innovations to adapt to safer working environments. In dentistry, the high risk of virus transmission—whether airborne, contact-based, or from contaminated surfaces—emphasizes the need for safer practices, such as the use of teledentistry.[1]

Teledentistry emerged as a key innovation during the pandemic, leveraging technology to bridge gaps between patients and healthcare professionals. Its use has increased, particularly in South Africa, where online platforms have become vital for pre-screening and consultations.[2] Teledentistry's potential extends beyond the pandemic, offering significant benefits in remote areas where access to dental care is limited .[3] It is particularly promising in the context of South Africa's upcoming National Health Insurance (NHI), which aims to provide equitable healthcare to all citizens.[4,5]

Oral diseases, including dental caries, are among the most common and preventable non-communicable diseases, affecting billions worldwide and significantly impacting quality of life.[6] Teledentistry offers a solution by facilitating remote dental consultations, thus improving access to care and potentially reducing the economic burden of oral diseases on society.[7]

Literature Review

Telehealth involves the exchange of clinical information or access to care via information technology. The global increase in internet access and smartphone use has significantly increased communication among healthcare practitioners.[8] Teledentistry, a subset of telehealth, uses telecommunications to facilitate dental consultations and treatment planning by exchanging clinical information and images over remote distances. Mobile health (mHealth), part of digital health, provides healthcare through smartphones, tablets, and wearables, with smartphones being the most frequently used device.[9]

Oral Disease Burden in South Africa

Teledentistry has significant potential to address oral health inequalities, especially in low- and middle-income countries, which face a disproportionate burden of disease. For instance, Africa, with 10% of the global population and only 3% of the health workforce, bears about a quarter of the world's disease burden.[10] In South Africa, where the Department of Health recommends a dental practitioner-to-patient ratio of 1:60,000[11], the actual ratio is far below this, leading to untreated oral diseases and delayed diagnoses.[12] Teledentistry can bridge this gap by enabling early detection of conditions like carious lesions, reducing disease burdens and improving care access. It facilitates the remote exchange of clinical information and images for consultation and treatment planning, making the process more accessible and less stressful.[13] In underserved areas, teledentistry encourages professional consultations over ineffective home remedies, promoting better oral health outcomes.

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Remote Dental Screening as a Tool in the NHI

Remote dental screening involves sharing photographs, radiographs, and clinical data between clinicians for diagnosis. This can be done through "store and forward" methods or in real-time via telephone or video calls. Intraoral photographs have proven to be valuable and reliable aids in diagnosing oral pathology.[14] The benefits of remote dental screening include reducing the transmission of communicable diseases, providing access to dental care in underserved areas, and allowing isolated patients to receive care. Additionally, clinicians in remote areas can consult specialists for advice on certain procedures, enhancing the quality of care.[15]

South Africa's National Health Insurance (NHI) system aims to provide high-quality healthcare to all citizens, especially those who are vulnerable and socio-economically disadvantaged. The NHI is based on principles of access, social solidarity, effectiveness, equity, affordability, and efficiency, with objectives to enhance healthcare services, pool risks and funds, procure services efficiently, and strengthen the public sector.[16,17] For the NHI to succeed, South Africa requires coherent systems that support the growth of e-health services, including remote monitoring tools, mHealth, and portal technology.[18] These technologies can streamline processes, increase efficiency, reduce waiting times, and enhance patient care by enabling healthcare workers to monitor and engage with patients remotely.[4]

Teledentistry and the COVID-19 Pandemic

The COVID-19 pandemic emphasized the importance of minimizing close contact between individuals.[19] Teledentistry aligns with social distancing rules by offering remote triaging and screening of patients. During the pandemic, suspected carriers were identified through teledentistry and advised to isolate, reducing exposure risks for healthy patients and healthcare staff while still providing emergency care.[20]

Mobile Applications and Their Utilization in Healthcare

Mobile applications are increasingly used by medical and dental practitioners to exchange sensitive patient information. However, platforms like WhatsApp, though popular, are not compliant with privacy regulations such as the Protection of Personal Information Act (POPIA), the General Data Protection Regulation (GDPR), and the Health Insurance Portability and Accountability Act (HIPAA).[21] The Vula App, developed in South Africa in offers a compliant alternative for secure communication and patient referrals. It is endorsed by the South African government and is the official referral app in the Western Cape Province.[22] The Vula App facilitates rapid patient evaluations, remote patient management, and secure data exchanges, contributing to improved healthcare quality.[23]

Several studies have investigated the diagnostic reliability of teledentistry. A study by Patterson and Botchway compared face-to-face dental screenings with intraoral image-based screenings, finding a diagnostic concordance ranging from 89% to 100%.[24] Similarly, a study by Kopycka-Kedzierawski et al. reported a 95% concordance in diagnosing dental caries in children using these two methods.[25] In the United Kingdom, Boye et al. found diagnostic concordance between visual and image-based screenings ranging from 87.8% to 95.8% in five-year-olds and 58.5% to 71.7% in ten-to-eleven-year-olds.[26] In South Africa, Bissessur and Naidoo reported a 93-98% diagnostic concordance, indicating high reliability in teledentistry.[27]

Legal and Ethical Concerns Associated with Data Sharing in Dentistry

The digitization of healthcare, including dentistry, raises important legal and ethical questions about data storage, sharing, and individual rights. In South Africa, regulatory bodies such as the Health Professions Council of South Africa (HPCSA), South African Health Products Regulatory Authority (SAHPRA), and others oversee the governance of digital health practices .[28] The South African Department of Health, aligning with the World Health Organization's definition of digital health, has yet to establish specific legislation for digital health.[29]

The Protection of Personal Information Act (POPIA), which came into effect on 1 July 2020, aims to protect individuals from data breaches, theft, and discrimination by establishing minimum requirements for processing personal information.[30] Compliance with these regulations is essential for any healthcare app used in teledentistry to ensure the protection and security of sensitive patient data.

AIMS AND OBJECTIVES

The present study determined the diagnostic reliability and accuracy of teledentistry compared to traditional clinical examinations for detecting dental caries. The objectives were to validate teledentistry as a practical, adaptive tool for improving access to oral healthcare and to demonstrate its potential in supporting public health strategies such as South Africa's NHI.

METHODOLOGY

Study Design and Population

A cross-sectional study was conducted with 158 parents or guardians (≥18 years) of children attending the paediatric dental clinic at Tygerberg Oral Health Centre. A purposive sampling technique was used, with a final sample size of 145 participants calculated using a Kappa statistic based on a positivity rating of 0.9.

Inclusion and Exclusion Criteria

Participants included those who provided verbal and written consent for their data and intraoral photographs to be uploaded to the Vula App. Off-site examiners were qualified HPCSA-registered dentists. Exclusion criteria applied to those not meeting these conditions.

Data Collection

Chairside examinations and image acquisition were conducted using an Apple iPhone XS. Intraoral photographs were captured under standardized conditions and securely uploaded to the Vula App for remote assessment. A pilot study with 10 participants refined the methodology.

Standardization and Calibration

Examiners followed WHO Oral Health Survey guidelines, with calibration exercises addressing diagnostic variability. Photographs were taken at specified angles and distances to ensure uniformity.

Data Analysis

The datasets analysed included comparisons between clinical and photographic examinations and assessments of intra- and inter-rater reliability:

- Clinical Examination (Examiner 1) versus Photographic Examination (Examiner 2) - 145 observations
- Clinical Examination (Examiner 1) versus Photographic

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Examination (Examiner 1) - 145 observations
- Photographic Examination (Examiner 1) versus Photographic Examination (Examiner 2) - 145 observations
- Photographic Examination (Examiner 1) versus Photographic Examination (Examiner 1) - 14 observations
- Photographic Examination (Examiner 2) versus Photographic Examination (Examiner 2) - 14 observations

Statistical measures, including p-values, correlation coefficients, and Cohen Kappa coefficients, evaluated inter-rater reliability (agreement between different examiners), intra-rater reliability (consistency of a single examiner), and diagnostic accuracy. These analyses highlighted the reliability and validity of teledentistry as a diagnostic tool for dental screenings.

Utility

Chairside examinations allowed immediate patient interaction but posed exposure risks. Remote screening via the Vula App mitigated these risks and ensured secure data handling, offering a scalable solution for dental assessments in resource-limited settings.

RESULTS

Demographics

152 adults consented to participate in the present study but after excluding seven edentulous participants, the final sample comprised 145 participants, 41 males and 104 females, who were parents or guardians of children receiving dental care at the Tygerberg Oral Health Centre's paediatric dental clinic. The mean age of the participants was 40.23 years.

Table 1 summarizes the key findings of this study, providing a clear and concise overview of the results that are explained in detail in this results section.

Results																		
	Kappa Coefficient	Agreement	DMFT Pearson Correlation	DMFT p(T<=t) two-tail	DMFT Mean Clinical Examination	DMFT Mean Photographic Examination	D Pearson Correlation	D p(T<=t) two-tail	D Mean Clinical Examination	D Mean Photographic Examination	M Pearson Correlation	M p(T<=t) two-tail	M Mean Clinical Examination	M Mean Photographic Examination	F Pearson Correlation	F p(T<=t) two-tail	F Mean Clinical Examination	F Mean Photographic Examination
Clinical Examination (Examiner 1) versus Photographic Examination (Examiner 2)	0.846	Almost perfect agreement	0.98	0.489	12.37	12.99	0.94	0.054	3.85	4.6	1.0	1.000	7.72	7.72	0.93	0.299	0.80	0.59
Clinical Examination (Examiner 1) versus Photographic Examination (Examiner 1)	0.94	Almost perfect agreement	0.99	0.828	12.39	12.58	0.97	0.575	3.82	4.06	1.0	1.000	7.77	7.77	0.78	0.519	0.91	0.76
Photographic Examination (Examiner 1) versus Photographic Examination (Examiner 2)	0.88	Almost perfect agreement	0.99	0.637	12.59	13.0	0.95	0.191	4.10	4.66	1.0	1.000	7.72	7.72	0.95	0.384	0.77	0.59
Photographic Examination (Examiner 1) versus Photographic Examination (Examiner 1)	0.95	Almost perfect agreement	1.0	0.949	12.59	13.0	0.99	0.899	4.10	4.66	1.0	1.000	7.72	7.72	1.0	1.000	0.77	0.59
Photographic Examination (Examiner 2) versus Photographic Examination (Examiner 2)	0.95	Almost perfect agreement	1.0	1.0	14.57	14.57	1.0	0.966	5.07	5.0	0.99	0.918	8.5	8.79	0.85	0.701	1.0	1.29

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Photographic examinations in teledentistry have demonstrated high reliability and accuracy compared to traditional clinical methods, as shown in this study evaluating dental metrics (DMFT, D, M, F). When comparing clinical examinations by Examiner 1 to photographic examinations by Examiner 2, a Kappa coefficient of 0.846 indicated near-perfect agreement, with a strong Pearson correlation for DMFT (0.98). The lack of statistically significant differences, as indicated by p-values, highlights the reliability of photographic methods as an alternative to clinical assessments in remote or resource-limited settings.

Similarly, when clinical examinations by Examiner 1 were compared to photographic examinations conducted by the same examiner, the results showed an even higher Kappa coefficient of 0.94, reinforcing the near-perfect agreement between the two methods. Pearson correlation coefficients were notably high for DMFT (0.99) and perfect for "M" (1.00), with no significant differences observed in p-values. These findings validate the consistency of photographic examinations when utilized by the same examiner across different settings.

The inter-examiner reliability of photographic methods was further supported when comparing Examiner 1 and Examiner 2 using photographic examinations. A Kappa coefficient of 0.88 and a DMFT Pearson correlation of 0.99, with perfect agreement for "M" (1.00), demonstrated strong consistency between the examiners. Again, no significant differences were identified, affirming the robustness of photographic methods regardless of the examiner conducting the assessment.

Intra-rater reliability was assessed through repeated photographic examinations conducted by the same examiners. For Examiner 1, a Kappa coefficient of 0.95 and perfect Pearson correlation for DMFT, "M," and "F" (1.00) indicated exceptional consistency in assessments over time. Examiner 2 also achieved a Kappa coefficient of 0.95, with strong Pearson correlations for DMFT (1.00) and "M" (0.918). The p-values in both cases confirmed no significant differences in repeated assessments, underscoring the dependability of the photographic method.

The high Kappa coefficients (ranging from 0.846 to 0.95) across all datasets demonstrated the reliability of photographic examinations in teledentistry. Pearson correlation coefficients (0.78 to 1.00) further confirm the strong linear relationships across examiners and methods. Importantly, the lack of statistically significant differences in any of the comparisons validates the consistency of this approach, regardless of examiner or repetition. These findings highlight the potential of teledentistry as an effective, scalable, and reliable diagnostic tool, particularly in scenarios where traditional clinical assessments may be impractical. The consistent and comparable performance of photographic examinations underscores their value in modern dental practice and their capacity to expand access to care in underserved or remote areas.

DISCUSSION

Table 1 provides a detailed summary of the study's main findings, which are discussed throughout this section.

The present study evaluated the diagnostic agreement, accuracy, and reliability between traditional clinical dental screening using DMFT (Decayed, Missing, Filled Teeth) scores and teledentistry methods. The sample comprised 145 participants, with the majority being female. This gender distribution might be attributed to the common practice of mothers or grandmothers accompanying children to medical and dental appointments. The study's primary focus was to assess whether teledentistry could be a reliable alternative to conventional dental screening methods, especially in identifying dental caries, tooth loss, and restorations.

Five datasets were analysed in the study, comparing different combinations of clinical and photographic dental examinations. The first three datasets involved 145 observations each, comparing clinical examinations by one examiner against photographic examinations by either the same or a different examiner. The last two datasets involved 14 observations each, comparing repeated photographic examinations by the same examiner to assess reliability. These comparisons aimed to evaluate the consistency and agreement between traditional clinical methods and teledentistry approaches in dental diagnostics.

The Cohen Kappa Statistic was employed to measure the degree of agreement between the different examination methods and examiners. The results revealed high levels of concordance across all datasets, with Kappa coefficients ranging from 0.84 to 0.95. These values indicate a strong agreement, classified as "Almost Perfect Agreement," between the clinical and photographic examination methods. This high level of agreement suggests that teledentistry can be as reliable as traditional dental screening for diagnosing dental conditions.

Specifically, the inter-rater reliability between different examiners (Examiner 1 and Examiner 2) using clinical and photographic methods was high, with a Kappa coefficient of 0.84. This suggests that both examiners were consistent in their evaluations, regardless of whether they used clinical or photographic methods. The reliability was even higher when the same examiner conducted both the clinical and photographic examinations, as seen in the Kappa coefficient of 0.94 for intra-rater reliability. This finding implies that individual examiners maintain a high level of consistency in their assessments over time, further supporting the reliability of teledentistry.

In cases where the same examiner used photographic methods on separate occasions, the Kappa coefficients were slightly higher, around 0.95. This could indicate that within a smaller sample size, the consistency of photographic examinations might be even more pronounced. However, further research with larger samples would be necessary to confirm this observation.

The Pearson correlation coefficients, which measure the linear relationship between two sets of data, were also calculated for the various comparisons. The coefficients exceeded 0.90 for most datasets, indicating a strong correlation between clinical and photographic DMFT scores. This strong correlation further supports the reliability of teledentistry as a diagnostic tool. The study found no statistically significant differences between the clinical and photographic methods, as indicated by p-values greater than 0.05 across all datasets. This lack of statistical significance suggests that both methods are equally reliable for DMFT evaluations.

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The results of this study are particularly relevant in the context of oral healthcare in Africa, where there is a high burden of oral diseases and limited access to dental care. The World Health Organization (WHO) reported that the African region had the highest increase (120%) in caries in permanent teeth between 1990 and 2019. An estimated 480 million people in Africa, or 43.7% of the population, suffered from some form of oral disease in 2019. This burden is disproportionately borne by vulnerable and low-income populations, who often lack access to essential dental services. In South Africa, the prevalence of dental caries is alarmingly high, particularly among children. Kimmie-Dhansay et al. (2022) highlighted the increasing prevalence of dental caries in the country, particularly in underserved populations. South Africa faces significant disparities in access to healthcare, exacerbated by socioeconomic inequalities. Despite being an upper-middle-income country, with a population of 59.62 million, a large proportion of the population relies on public healthcare services, which are often under-resourced and overburdened.

The use of teledentistry presents a promising solution to address these challenges by providing remote access to dental consultations and improving the early detection of dental conditions. The present study findings suggest that teledentistry can serve as a reliable alternative to traditional dental screening methods, particularly in areas with limited access to dental care. By utilizing technology, teledentistry can bridge the gap in healthcare access, allowing for earlier diagnosis and treatment of oral diseases, which is crucial in preventing the progression of dental conditions and reducing the overall burden of oral disease. Moreover, the implementation of teledentistry aligns with the goals of South Africa's upcoming National Health Insurance (NHI) system, which aims to provide equitable access to quality healthcare for all citizens, regardless of their socioeconomic status. Teledentistry could play a vital role in the NHI's success by streamlining dental care delivery, reducing waiting times, and ensuring that dental services reach even the most remote and underserved populations. This aligns with the broader goal of universal health coverage (UHC) and the integration of oral health into primary healthcare.

The present study underscores the potential of teledentistry as a reliable and valid alternative to traditional dental screening methods. The high levels of agreement and strong correlation between clinical and photographic DMFT scores affirm its capability to accurately diagnose dental conditions, particularly in regions with limited access to dental care. In the context of South Africa's ongoing efforts to implement the National Health Insurance (NHI), teledentistry could play a pivotal role in enhancing equitable access to oral healthcare across diverse populations. By integrating technology, this approach has the capacity to transform dental care delivery, improving oral health outcomes while reducing the prevalence and burden of dental diseases in resource-constrained settings.

The findings further establish that standardized photographic methods yield accurate representations of clinical scenarios, validating teledentistry as a robust alternative for remote dental assessments. The study emphasizes the method's accuracy, consistency, and reliability, showcasing its viability for routine dental consultations, particularly in underserved areas. By employing consistent evaluation protocols, teledentistry demonstrates its effectiveness in bridging the gap between traditional care and remote access, highlighting its applicability in public health strategies aimed at improving oral health equity. These results present compelling evidence that teledentistry can serve as a scalable solution for addressing dental care disparities, offering a cost-effective, efficient, and sustainable model for delivering oral health services.

RECOMMENDATIONS

The implementation of teledentistry in South Africa presents a promising opportunity to enhance oral healthcare access, particularly in underserved and remote areas. Key recommendations for successful integration include regulatory measures, technical infrastructure, skill development, socioeconomic considerations, partnerships, funding, and incorporating teledentistry into the National Health Insurance (NHI) system.

Regulatory measures should be promulgated in collaboration with the Health Professions Council of South Africa (HPCSA) to establish legal frameworks, licensure requirements, and standards for teledentistry. Data privacy must be ensured by using secure, encrypted platforms, and quality assurance measures should cover equipment standards, data preservation, and skill training.

With regard to technical infrastructure requirements, it will be essential to begin in areas that have adequate internet access and to forge partnerships with telecommunication providers to expand services to remote regions. Reliable and user-friendly platforms, high-resolution intraoral cameras, and integration with existing electronic health records are critical. Furthermore, enhancement of technical skills is vital, and will require thorough training for dental professionals and educating patients about teledentistry services. In addition, socio-economic factors must be addressed by developing affordable service models, considering government subsidies, and ensuring cultural and linguistic inclusivity.

Collaborations and funding through public-private partnerships, domestic and international sources, and pilot programs will be essential to assess and expand the field and outreach of teledentistry. Teledentistry can be a useful tool for oral disease surveillance, providing early detection and ongoing monitoring. Integrating teledentistry into the NHI system is crucial, and healthcare facilities need to be equipped with necessary tools like smartphones and intraoral mirrors.

CONCLUSION

Teledentistry offers a ground-breaking solution to the most pressing challenges in oral healthcare, including geographic and economic barriers that limit access to care. By enabling remote screenings and consultations, it addresses delays in diagnosis, promotes early intervention, and streamlines treatment planning. The present study highlighted the transformative potential of teledentistry to revolutionize dental care delivery, particularly in underserved and resource-limited areas.

Through its integration into healthcare systems, teledentistry provides a reliable, technology-driven approach to bridging service gaps and enhancing oral health equity. By reducing logistical barriers, it ensures timely access to care, improving diagnosis and treatment outcomes for populations traditionally excluded from regular dental services.

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The findings of the present study reinforce teledentistry's capacity to redefine oral healthcare delivery. By leveraging accessible and adaptable technology, it offers a sustainable pathway to enhance the efficiency and reach of dental care. In underserved areas, teledentistry holds the promise of transforming dental service provision, ensuring that critical oral health needs are met effectively and equitably. This innovative approach not only improves patient outcomes but also addresses systemic barriers, fostering a future where high-quality oral healthcare is universally accessible.

CONFLICT OF INTEREST

The authors declare that the manuscript was created without any commercial or financial associations that may give rise to a conflict of interest.

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CPD questionnaire on page 570

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

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Repair or Replacement of Direct Restorations: Clinical Guidelines

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ABSTRACT

A significant part of general dentistry focuses on the repair or replacement of existing dental restorations to enhance their strength and functionality. In everyday dental practice, defective restorations are among the most common issues faced by professionals Rather than completely replacing damaged restorations, repairing them has become an increasingly popular and effective alternative. When dealing with partially defective restorations, repair instead of full replacement is not only safe but also highly effective. This method often leads to greater retention of the tooth, as only the damaged portion is replaced. However, the repair's success is largely dependent on proper case selection, choosing the right materials, and applying the correct technique. It is also essential to consider factors such as the caries risk level, the type of restoration to be repaired, material selection, and both aesthetic and functional considerations to ensure the longevity of the restoration. This literature review focuses on repair or replacement of direct restorations, its clinical guidelines and minimally invasive approaches.

Key words

Amalgam repair, Repair of composites, GIC, Replacement of restorations, Direct restorations

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INTRODUCTION

Restorative materials commonly used in dental practice include amalgam, direct tooth coloured restorations such as resin-based composites (RBC), compomers, and glass ionomers, as well as indirect restorations like indirect RBC, ceramics, porcelain fused to metal, and gold or other metal castings.[1] A study by Yousef and Khoja (2009) found that composite materials were the most frequently used (71.3%), followed by amalgam (15.3%), and glass ionomers (8.7%), while indirect restorations were the least used restorative materials.[2] When dealing with partially failed restorations, there are two primary treatment options: complete replacement or repair.[3]

In dental practice, placing and replacing restorations are common procedures, with secondary caries being the leading cause for repairs or replacements.[4,5] Minor defects caused by secondary caries, along with stained or degraded edges, can often be resolved through refurbishing or refinishing the restoration. However, for larger defects, a portion of the restoration may need to be removed to access the affected area.[2] This partial removal, done to the full depth of the restoration, allows for a more accurate diagnosis of the lesion's extent, as these defects are often well-defined. If the main part of the restoration remains intact and in good condition, the exploratory cavity preparation can be sealed with an appropriate filling material.[6]

Repair of Restoration

Minimally invasive dentistry emphasizes the importance of restoring rather than replacing dental restorations, which helps to extend their lifespan.[4,7,8] This approach not only minimises the negative effects of invasive procedures on the tooth but also makes treatment less traumatic for both the patient and the tooth, offering significant benefits compared to complete replacement.[9-11]

The essence of minimally invasive treatment is to address dental issues with the least amount of damage to the tooth structure.[12] From a clinical perspective, opting for repair over replacement is a more practical solution, as it preserves the natural tooth structure, reduces the likelihood of complications such as pulp damage, and can lower the overall cost of treatment.[13] When a restoration is deemed clinically unacceptable, it can often be corrected with minimal intervention, typically by adding extra restorative material to the existing restoration.[14] This method tends to be faster, more affordable, and in many cases, may not require local anesthesia, resulting in less stress and discomfort for the patient compared to fully replacing the restoration.[9] It is vital to assess the clinical success of restoration repairs, particularly within the first twelve months following treatment, to ensure longevity and effectiveness.[15]

Repairing a dental restoration always involves adding new restorative material, regardless of whether any preparation

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is done on the restoration or the surrounding tooth structure.[15] Teeth with repaired restorations are less likely to need aggressive procedures like endodontic treatment or extraction, especially when compared to those with fully replaced restorations.[4,7] Kanzow and Wiegand (2020) in their retrospective study stated that repairs are less invasive and can significantly prolong the retention of teeth.[16] Resin-based composite (RBC) is the most commonly chosen material for repairing dental restorations, with various preconditioning techniques applied to ensure proper bonding.[12]

The numerous advantages of opting for repair over replacement of a dental restoration can be summarised as follows:

- No need for local anesthesia, as long as the repair is not extensive[9]
- Shortened treatment times[8,15]
- Lower costs for the patient[13]
- Lower risk of iatrogenic damage to adjacent teeth[13]
- Reduced risk of damaging the dental pulp[13,17]
- Preservation of tooth structure[15]
- Increased longevity of the restoration[5]
- High patient acceptance[18]

Criteria for repair[19]

- Treatment of early secondary caries lesions
- Correction of small marginal openings and cavo-marginal ditching
- Management of localised marginal staining
- Chipping of restoration margins
- Correction of unacceptable aesthetics
- Repair of fractures that do not compromise the integrity of the remaining restoration or tooth structure
- Management of wear

Steps involved in repairing of various restorative materials

Repair protocols for dental restorations depend on factors such as the material used, manufacturer guidelines, the strength of the achieved adhesion, and the location within the oral cavity. [14] Below is an outline of the typical steps involved in repairing different types of dental restorations.

1. **Surface Preparation:** Start by cleaning all surfaces of the restoration to be repaired using pumice or a polishing paste.[20] Remove any loose or cracked areas from the surface and smooth them out using fine-grit diamond burs.[14,21]

2. **Conditioning:** Different materials require specific physical conditioning methods
   Resin Composite and Amalgam: Use air-borne particle abrasion with alumina or silica-coated alumina particles.[20-24]
   Hybrid Composite Resins and Silicate Ceramics: Use silane coupling agents.[22,25-27]

3. **Adhesion and Polymerization:** Apply adhesive resin to the conditioned substrate and ensure thorough photopolymerization.[22]

4. **Application of Repair Material:** Apply resin composite to the physico-chemically conditioned surfaces and photopolymerize.[17,22]

5. **Finishing and Polishing:** The success of a repaired restoration largely depends on the crucial final step of finishing and polishing.[28] The primary goal of polishing is to smooth the surface of the restoration, reducing plaque deposition and ensuring healthy periodontal maintenance.[18,29] A wide variety of finishing and polishing devices are available, including aluminum oxide-coated abrasives (Sof-Lex), silicone discs, tungsten carbide finishing burs, abrasive-impregnated rubber cups, abrasive strips, diamond rotary instruments, and polishing pastes.[18] Proper finishing and polishing of the repaired area significantly enhance the longevity of the restorations.[30]

6. **Check the occlusion and remove any occlusal interferences present**[17]

Repair of Amalgam

The combination of low cost and lasting durability has made amalgam a staple in general dental practices for many years.[31,32] Repairing amalgam restorations is often more conservative in preserving the tooth structure compared to completely replacing the restoration.[1] In a long-term cohort study on failed amalgam restorations, it was found that repair, rather than replacement, was a successful approach for restorations with marginal defects.[20] Amalgam restorations may become defective due to secondary caries, fracture in the amalgam, fracture in the tooth itself, or marginal defects such as gaps between the restoration and the tooth surface.[9]

Repair of amalgam Restoration with Composite:[17,33]

- Administer local analgesia: As indicated clinically.
- Remove undermined tooth tissue
- Prepare retention features: within the amalgam restoration to provide mechanical retention for the composite material.
- Achieve moisture control by applying rubber dam or using cotton rolls and salivary ejectors.
- Use an intraoral aluminum oxide sandblaster (Microetcher), which is effective at pressures as low as 45psi with 50 microns aluminum oxide abrasives or a diamond bur to prepare the adjacent amalgam and tooth tissue surfaces.
- Provide pulp protection, if necessary
- Etch the tooth surface for 15-30 seconds, wash and dry the preparation
- Apply Adhesive Bonding System to tooth surface
- Apply Alloy-Resin Bonding Agent to restorative surface
- Place Repair Composite, finishing and polishing.

Repair of old amalgam with amalgam:

When repairing amalgam restorations, it is recommended to enhance mechanical retention by roughening the remaining amalgam surface with a diamond bur before applying new amalgam.[34] Amalgam bonding agents are widely used in posterior tooth restorations due to their advantages, such as improved tooth reinforcement, reduced postoperative sensitivity, better marginal adaptation, decreased microleakage, lower risk of secondary caries, and the ability to preserve more tooth structure.[35]

To ensure a strong bond between new and old amalgam restorations, steps to be followed are:[36]

1. Apply pressure vertically to the repair surface
2. Use a condenser smaller than the repair site to maximise pressure.
3. Use an amalgam material with a different composition for the repair to achieve greater strength.
4. Reduce the size of the repair site to improve repair strength.

At the repair/restoration interface, the bonded amalgam technique may sometimes lead to increased microleakage.[35] Hickel et al (2013) in their study have shown that repaired

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and replaced amalgam restorations have similar survival rates after five years. However, after ten years, repaired amalgam restorations tend to perform less effectively.[1] Placing retention grooves in the proximal slot preparation significantly improved fracture strength compared to slots without retention grooves.[36] Additionally, it is important to assess the tightness of the proximal contact points in a reproducible manner. Weak physiological contact points can lead to issues such as food impaction or discomfort.[37]

Repair of composite

Known for their excellent aesthetic appeal and impressive mechanical properties, composite resins have gained widespread acceptance among clinicians for direct restorations.[3,38,39] Over recent decades, composite resins have become the preferred choice for restoring posterior teeth, gradually replacing amalgam as the material of choice.[40,41] A key factor in the success of repairs involving composite resins is the establishment of a strong and durable bond between the new and existing restorative materials.[3] From an economic standpoint, repairing composite restorations is typically more cost-effective than repairing amalgam restorations.[42] Repairing existing composite restorations accounts for nearly half of all dental procedures performed.[43] One of the key advantages of repairing a defective restoration with composite resin is the ability to preserve the intact portion of the direct composite restoration (DCR) that shows no signs of failure, whether clinically or radiographically. This makes it a preferable alternative to full restoration replacement.[44]

For a successful composite repair, achieving strong adhesion between the existing aged restoration and the newly applied composite is crucial. Utilising a separate silane coupling agent remains an important step to enhance the repair potential.[45] The overall success of the composite restoration relies not only on the material used but also on its smooth finish, the quality of polishing agents, and the specific composition of the composite material.[18]

Intraoral Repair Protocol for Chipping or Fracture in Composite restoration[20]

- Use a fluoride-free paste or pumice for cleaning the surface
- Use a fine-grit diamond bur with water cooling and create a bevel for roughening the margins.
- Etching is done by using 37% phosphoric acid for 15-20 seconds, rinse for 60 seconds, and dry.
- Apply a single layer of silane coupling agent and dry gently. Applying silane coupling agents is crucial as it forms chemical bonds between inorganic fillers and organic matrix, enhancing composite adhesion to repaired surfaces. Insufficient or excessive drying can negatively impact this adhesion leading to premature repair failures.
- Apply adhesive resin, air dry, and photo-polymerize.
- Apply resin composite incrementally, photo-polymerize, finish, and polish.

Repair of Glass Ionomer Cement (GIC)

GIC bonds chemically to tooth structure, forming an acid-resistant attachment that enhances caries inhibition. Its fluoride release helps prevent decay, making it a cost-effective and easy-to-use option, especially beneficial for low-income or high-caries-risk populations.[46]

Procedure for repair

With GIC:

Phosphoric acid is the most effective surface conditioning agent for repairing glass ionomer cements, resulting in repairs with higher flexural strength.[47] After conditioning, freshly mixed glass ionomer cement was applied to the treated surface and allowed to set.

With composite:

Repairing Resin modified GIC (RMGIC) with resin composite is generally considered the preferred method. Studies have shown that resin composites bond effectively to RMGIC, with failure primarily occurring cohesively within the RMGIC itself.[48]

Longevity of repaired restorations

Repairing dental restorations can greatly improve their lifespan, with studies showing a reduction in the annual failure rate (AFR) by as much as 50%.[13] Repairs performed on restorations that fail due to caries generally have a better long-term outcome compared to those failing because of fractures.[49] Several studies highlight that repairs are not only straightforward and quick procedures but also improve the clinical properties of defective materials.[50] When it comes to materials, repairing amalgam and composite restorations has been shown to significantly enhance the survival rate of the original structure, with repairs sometimes lasting as long as full replacements.[34] Opting to repair defective composite resins, rather than replacing them entirely, has proven to be a safe and effective method for extending their functionality over time.[50]

Contraindications for repair

- Extensive secondary caries extending beneath the restoration margins.
- Significant structural compromise risking fracture post-repair.
- Aesthetic demands not achievable through repair.

Replacement

The replacement of a restoration involves completely removing the defective or failed material, along with any nearby tooth tissue that is discolored or compromised aesthetically or functionally.[5] This process creates a uniform restoration, which enhances aesthetics and provides a better marginal seal. However, it often comes with downsides, including potential pulp irritation and the unnecessary removal of healthy tooth structure.[43] Additionally, complete restoration replacement can be both costly and time intensive.[20] Considering these factors, replacement should be viewed as a final option, reserved for situations where no other effective treatment alternatives are available.[7,17]

Despite some limitations in the use of amalgam, both composite and amalgam remain the primary materials used for direct restorations, with similar annual failure rates for both.[40] In general dental practice, the most common reasons for replacing restorations are the diagnosis of recurrent or secondary caries, as well as fractures of the restorations.[1,51]

The presence of secondary caries under the restoration likely contributed to the preference for replacement over repair.[12] It is important to note that the term “secondary caries” is often poorly defined, and lesions labeled as such may, in fact, be areas where repair is possible rather than requiring complete replacement. The longstanding belief that microleakage of oral fluids into marginal or interfacial defects leads to secondary caries or pulpal issues has historically supported the practice of replacing restorations rather than opting for repairs.[11]

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Steps to remove amalgam restorations:

Replacement involves completely removing the old amalgam, along with any base or lining materials, which carries the risk of inadvertently removing healthy tooth tissue.[9]

The removal of amalgam should be done as follows: [52]

- A new dental bur is used in the handpiece to ensure easy removal
- High volume suction and a continual addition of water spray are supplied to the site where the amalgam is being extracted
- If possible, the amalgam restoration is sectioned and then scooped out to reduce the release of mercury vapor. Amalgam separators should be used to capture mercury-containing waste dental amalgam from waste water, preventing it from entering sewer systems.

Criteria for replacement[19]

- The restoration exhibits unacceptable qualities, with a high likelihood of further clinically significant deterioration or lesion progression.
- Repair is not a viable option.
- The chances of achieving a favorable clinical outcome are high.

Each time a restoration is replaced[9,53]

- The cavity may expand as more healthy tooth structure is removed, often far from the area where the restoration has failed, which can weaken the tooth.
- It reduces the chances of maintaining pulp vitality.
- The overall cost of treatment is likely to increase.
- There is a higher risk of future failure.

Reasons for restoration failure

To improve patient dental care, it is essential to identify the risk factors that contribute to the failure of restorations.[54,55] The criteria for evaluation included: marginal adaptation, marginal staining, surface staining, postoperative sensitivity, translucency, and fractures.[37,56] Secondary or recurrent caries was the leading cause for the replacement of all types of restorations studied.[13] Other common reasons for replacement included restoration fractures-particularly bulk fractures, discoloration (both bulk and marginal), fractures at the restoration margins, and the presence of degraded margins.[1,15,17,53] Additional factors influencing replacement were the loss of tooth structure due to non-carious lesions, fractures in multi-surface restorations, loss of anatomic form, pain or sensitivity, unacceptable aesthetic appearance, absence of retention form, pulpal disease, debonded restorations, material or aesthetic changes (specifically for amalgam restorations), and complete loss of the restoration (for amalgam only).[19,32,39,41,57]

CONCLUSION

In restorative dentistry, there is a growing consensus that repairing a defective, clinically unacceptable restoration is often a better option than opting for a complete replacement. This approach, which focuses on repair rather than full replacement, is minimally invasive and can significantly prolong the lifespan of the original filling, reducing the risk of pulp-related complications. Repair should be prioritized in cases of limited restoration defects, particularly to conserve tooth structure and manage costs effectively. However, clinical judgment considering long term prognosis, extent of secondary caries and patient specific factors must guide the ultimate decision.

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The Oral Microbiome and Mental Health: An Emerging Paradigm

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ABSTRACT

Recent research highlights the human microbiome as a significant determinant of systemic health. While the gut microbiome has been extensively studied, growing evidence suggests that the oral microbiome is implicated in a range of systemic and neurological disorders. This review examines the emerging relationship between the oral microbiome and mental health, with a focus on mechanisms including inflammation, neurotransmitter modulation and microbial translocation. Dysbiosis within the oral cavity may contribute to neuroinflammatory and neurodegenerative conditions. Understanding these associations provides a foundation for novel therapeutic and preventive strategies that integrate oral health into broader neuropsychiatric care.

INTRODUCTION

The human oral cavity is home to a diverse microbial community, collectively known as the oral microbiome, which is the second largest set of bacteria in the human body and plays a vital role in maintaining oral and systemic health.[1] Over 600 bacterial species, along with fungi, viruses and archaea colonise the oral environment, forming a complex ecosystem.[2] These microorganisms form biofilms on various oral surfaces, contributing to a balanced oral environment that prevents pathogenic invasion.[3] The oral microbiome plays a crucial role in metabolic homeostasis and immune regulation. Commensal bacteria aid in the digestion of dietary carbohydrates, producing short chain fatty acids (SCFAs) that support oral and gut health.[4] Additionally, the microbiome modulates immune responses, preventing excessive inflammation and maintaining mucosal integrity.[5] The balance of this microbiome is crucial, as disruptions can contribute to both local and systemic diseases. Disruptions in this balance, termed dysbiosis can contribute to chronic inflammation and systemic conditions including cardiovascular disease, diabetes and neuropsychiatric disorders.[6]

Bacteria are the most extensively studied components of the oral microbiome. The predominant phyla include Firmicutes, Bacteroidetes, Proteobacteria, Actinobacteria and Spirochaetes.[2] Within these phyla, species such as *Streptococcus*, *Veillonella*, *Fusobacterium*, *Porphyromonas* and *Prevotella* are common inhabitants of the oral cavity, each contributing to ecological balance and immune regulation.[7] While many of these bacteria are commensals, certain pathogenic strains such as *Porphyromonas gingivalis* and *Treponema denticola* are associated with periodontal disease and systemic inflammation.[8] Fungi, particularly *Candida* species are also present in the oral microbiome typically existing in low numbers in healthy individuals. However, in cases of dysbiosis or immunosuppression, *Candida albicans* can overgrow leading to opportunistic infections such as oral thrush.[9] Viruses, including bacteriophages and human viruses like herpes simplex virus (HSV) and Epstein Barr virus (EBV) interact with bacterial populations and contribute to microbial balance or disease progression.[10]

In recent years, research has increasingly highlighted the link between oral microbiome dysbiosis and various mental health disorders, suggesting that microbial imbalances in the oral cavity may influence brain function and behaviour. [11]

Mechanisms Linking Oral Dysbiosis to Mental Health

Neuroinflammation and Cytokine Transport:

Neuroinflammation and cytokine transport is one of the primary mechanisms connecting the oral microbiome to mental health.[12] Periodontal disease, characterised by chronic inflammation due to microbial overgrowth has been associated with increased levels of proinflammatory cytokines such as interleukin 6 (IL-6) and tumor necrosis factor-alpha (TNF-α) which can cross the blood-brain barrier and contribute to neuroinflammatory processes linked to depression and anxiety.[12,13] Furutama (2020) demonstrated that periodontal inflammation increases systemic IL-6 which induces neuroinflammation in the hippocampus.[13] Oral bacteria such as *Porphyromonas gingivalis* and *Fusobacterium nucleatum* have been found in the bloodstream of individuals with systemic inflammatory conditions further supporting the role of oral microbes in influencing overall health including neurological function.[14]

Neurotransmitter modulation:

Neurotransmitter modulation is another critical link between the oral microbiome and mental health. Some bacteria within the oral microbiota are known to influence the production of neurotransmitters including serotonin, dopamine and gamma-aminobutyric acid (GABA) all of which play essential roles in mood regulation and cognitive function.[15] Bacteria from the *Lactobacillus and Bifidobacterium* genera have been shown to enhance GABA production which has calming effects on the nervous system.[15] Conversely, the presence of pathogenic bacteria and the resultant dysbiosis may lead to imbalances in these neurotransmitters, potentially contributing to mood disorders and neuropsychiatric conditions.[16]

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Microbial Translocation:
Pathogens like *Fusobacterium nucleatum* and *P. gingivalis* can breach mucosal barriers, enter the systemic circulation and potentially access the brain, triggering neurodegenerative processes.[17,18]

Hypothalamic Pituitary Adrenal (HPA) Axis Dysregulation:
Chronic oral infections activate the HPA axis, elevating cortisol and disrupting stress regulation pathways implicated in anxiety and depression.[19] This study found that individuals with periodontitis exhibited significantly higher salivary cortisol levels and these levels correlated with measures of stress and depression.[19] The findings suggest that chronic oral infections may activate the HPA axis leading to elevated cortisol and contributing to the pathophysiology of anxiety and depression.[19]

Epidemiological evidence

Epidemiological evidence also supports the connection between oral health and mental well-being.[20,21] Individuals with poor oral hygiene and periodontal disease are at an increased risk of developing depression and cognitive impairment.[22] Additionally, a bidirectional relationship exists between oral health and mental illness; psychiatric disorders often lead to neglect of oral hygiene which exacerbates dysbiosis and inflammation creating a vicious cycle that worsens both oral and mental health outcomes.[23] Thus, understanding the composition and function of the oral microbiome is fundamental to recognising its role in health and disease. As research continues to uncover these interactions between oral microbes and systemic health new therapeutic strategies targeting microbial balance are emerging, highlighting the importance of maintaining oral microbiome stability through proper oral hygiene, dietary interventions and probiotic use.[24]

Oral Dysbiosis in Specific Mental Health Conditions

Oral dysbiosis, an imbalance in the microbial community of the oral cavity has been increasingly linked to various mental health disorders. The disruption of a healthy oral microbiome leads to systemic inflammation, microbial translocation and neurotransmitter imbalances all of which play a role in the pathophysiology of psychiatric conditions. Below, we explore how oral dysbiosis is associated with specific mental health disorders including depression, anxiety, schizophrenia, bipolar disorder and neurodegenerative diseases.

Depression and Oral Dysbiosis

Major depressive disorder (MDD) is a prevalent and debilitating condition marked by persistent low mood, anhedonia and cognitive dysfunction. The pathophysiology of depression includes dysregulated hypothalamic-pituitary-adrenal (HPA) axis activity, proinflammatory cytokine elevation and serotonin (5-HT) imbalance.[25] Increasing evidence suggests that oral dysbiosis may act as both a contributor to and consequence of depression.[26] Disruption of the oral microbial ecosystem particularly an overgrowth of periodontal pathogenic species such as *Porphyromonas gingivalis, Fusobacterium nucleatum* and *Treponema denticola* is associated with elevated levels of interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α) and C-reactive protein (CRP) markers consistently elevated in depressive states.[27] These inflammatory mediators cross the blood-brain barrier and alter neurotransmitter metabolism, including the depletion of tryptophan, a serotonin precursor.[28] Pathogens such as *Porphyromonas gingivalis* and *Fusobacterium nucleatum* can enter systemic circulation triggering systemic inflammation and increasing the risk of depression.[29,30]

Shared biomarkers, IL-6 and TNF-α, may suggest a common inflammatory pathway in periodontitis and depression.[31] The oral microbiome plays a role in modulating neurotransmitters like serotonin, dopamine and GABA levels.[32] Dysbiosis can reduce the production of these neurotransmitters leading to symptoms of depression.[32] Moreover, poor oral health behaviour is common in depressed individuals, including reduced tooth brushing frequency, increased smoking and high carbohydrate intake which promotes microbial dysbiosis and further propagates systemic inflammation.[32] This bi-directional relationship underscores the role of oral health in both the onset and maintenance of depressive disorders.

Anxiety Disorders and the Oral Microbiome

Anxiety disorders including generalised anxiety disorder, panic disorder and social anxiety share features such as heightened stress responsiveness and autonomic nervous system dysregulation. Emerging evidence indicates a crucial role for the microbiota-gut-brain axis in anxiety with oral microbiota increasingly recognised as a contributor to this axis. Gamma aminobutyric acid (GABA), the primary inhibitory neurotransmitter in the brain is produced by certain commensal oral bacteria such as *Streptococcus salivarius* and *Lactobacillus rhamnosus*.[33,34] Dysbiosis characterised by a reduction in GABA producing species may lead to central disinhibition, manifesting as increased anxiety.[35] Additionally, dysbiosis promotes reactive oxygen species (ROS) formation and oxidative stress, which damage neuronal tissues and exacerbate anxiety like behaviors.[35] Chronic oral pain syndromes including burning mouth syndrome and temporomandibular disorders (TMD) are frequently comorbid with anxiety and may be associated with altered oral microbial profiles suggesting a shared pathophysiological substrate involving neuroimmune dysregulation with microbial imbalance.[36]

Schizophrenia is a complex neurodevelopmental disorder characterised by delusions, hallucinations, disorganised thought and cognitive impairment. Individuals with schizophrenia are at increased risk for periodontal disease, dental caries and poor oral hygiene often due to neglect, medication side effects and cognitive impairment. Studies have demonstrated increased *Porphyromonas and Treponema* species among others in patients with schizophrenia contributing to oral and systemic inflammation.[36] These bacteria release endotoxins such as lipopolysaccharides (LPS) which activate toll like receptors (TLRs) on immune cells triggering neuroinflammatory cascades implicated in dopaminergic dysregulation, a central mechanism in schizophrenia.[37] Furthermore, emerging data suggest that oral microbial metabolites including short chain fatty acids (SCFAs) can influence brain function by modulating dopamine synthesis and receptor activity.[37] Antipsychotic medications particularly first generation agents may further alter oral microbial communities via anticholinergic-induced xerostomia and immunomodulatory effects.[38]

Bipolar disorder (BD) is a mood disorder characterised by alternating episodes of mania and depression with a psychosocial impact. The role of systemic inflammation in BD has gained attention with elevated levels of proinflammatory cytokines such as IL-1β and TNF-α

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reported during both manic and depressive phases.[39] Oral dysbiosis may influence circadian rhythm regulation which play a role in mood regulation in bipolar disorder. It has been shown to alter melatonin production and clock gene expression possibly contributing to circadian misalignment in BD.[40] Pharmacologic treatments for BD, including lithium and valproate frequently induce salivary gland hypofunction and xerostomia, reducing the mechanical clearance of pathogens and fostering anaerobic bacterial overgrowth.[41] These medication induced oral changes may potentiate microbial translocation and neuroinflammation, potentially impacting mood regulation. Whether immune dysfunction is a direct cause or a consequence is still an object of intense debate in what concerns the pathophysiology of psychiatric disorders. Nevertheless, interventions that modulate the immune system may be helpful.[39] It has been shown that mild anti-inflammatory effects were described in studies for antidepressants, mood stabilizers and antipsychotics, proposing that by contolling inflammation may relieve psychiatric symptoms. [42]

Neurodegenerative disorders, such as Alzheimer's disease and Parkinson's disease have been linked to microbial imbalances including those in the oral cavity. Alzheimer's disease, the most common cause of dementia is histopathologically defined by amyloid beta plaques and neurofibrillary tangles. A growing body of evidence implicates the oral pathogen *Porphyromonas gingivalis* in AD pathogenesis. Gingipains, cysteine proteases secreted by *P. gingivalis,* have been detected in post mortem brain samples of AD patients suggesting microbial infiltration across a compromised blood-brain barrier[43] These virulence factors promote amyloidogenesis, exacerbate tau hyperphosphorylation and activate microglia thereby perpetuating neuroinflammation.[43] Longitudinal studies have shown that individuals with chronic periodontitis are at significantly increased risk of cognitive decline.[44] In this six month observational cohort study, 60 community-dwelling participants with mild to moderate Alzheimer's disease were assessed for periodontal health and cognitive function. The study found that the presence of periodontitis at baseline was associated with a sixfold increase in the rate of cognitive decline over the follow up period.[44] The presence of bacterial DNA from oral pathogens in the cerebrospinal fluid of Alzheimer's patients suggests direct microbial translocation to the brain.[45] The systemic dissemination of oral pathogens and their endotoxins may serve as persistent neuroinflammatory stimuli hastening the progression of neurodegeneration.

Parkinson's disease is a progressive neurodegenerative disorder marked by bradykinesia, rigidity and tremor associated with loss of dopaminergic neurons in the substantia nigra. Gastrointestinal dysfunction is a prominent non-motor symptom of PD often preceding motor manifestations by years.[46] Although the gut microbiome has received significant attention in PD research, the role of the oral microbiome remains underexplored. Oral dysbiosis, particularly elevated levels of *Aggregatibacter actinomycetemcomitans*, *Prevotella intermedia* and *Campylobacter rectus* may contribute to systemic inflammation and gut barrier dysfunction.[47] These bacteria have been implicated in promoting the misfolding of alpha synuclein, a key protein in PD pathophysiology.[48]Additionally, oral inflammation can influence vagus nerve signaling and modulate enteric nervous system integrity mechanisms believed to be central to PD pathogenesis. Patients with PD frequently exhibit sialorrhea or xerostomia, both of which alter salivary flow and microbial composition. This dysregulation may foster a pro-inflammatory oral environment that facilitates peripheral to central immune activation further accelerating neuronal loss.[49]

The oral brain axis as a potential therapeutic target

Improving oral hygiene may reduce anxiety or depressive symptoms by restoring microbial balance, lowering systemic inflammation and potentially normalising neurotransmitter associated pathways. While direct interventional studies remain limited, observational evidence supports the idea that poor periodontal health correlates with worse mental health outcomes.[21] Regular oral care can reduce the abundance of pathogenic bacteria that promote inflammatory and neurotoxic metabolites, thereby diminishing prodepressive physiological signals. Reduction in pathogenic taxa like *Shuttleworthia* and increases in beneficial microbes such as *Fusobacterium* (associated with healthier mental states) have been observed in individuals without anxiety or depressive symptoms.[20] These findings collectively support the hypothesis that oral hygiene may play a preventive or adjunctive therapeutic role in managing mental health.

While the associations between oral health and mental illness are compelling, current evidence is largely correlative and preclinical. Many studies rely on animal models or cross sectional human data. Longitudinal and interventional studies are needed to establish causality, especially concerning oral probiotics' direct effects on neuropsychiatric outcomes. Additionally, confounding variables such as socioeconomic status, diet and medication use complicate interpretation. However, given the mounting evidence linking oral microbiome health to mental well being, it is important to explore interventions aimed at maintaining microbial balance.

Role of probiotics in the oral microbiome

Although much of the evidence regarding probiotics and mental health focuses on the gut microbiome, early findings suggest that oral probiotics may indirectly influence brain health by reducing peripheral inflammation and supporting mucosal integrity.[50] Strategies such as maintaining good oral hygiene, using probiotics and adopting a diet rich in prebiotic fibers may help modulate the oral microbiome and mitigate risks associated with mental health disorders.[50] The effect of *Lactobacillus reuteri* against one of the major cariogenic organism, *Streptococcus mutans* was studied.[51] Yogurt products containing *L. reuteri* showed a significant growth inhibitory effect against *S. mutans*. *L. reuteri* and *L. kefiranofaciens* inhibit cariogenic bacteria like *S.mutans* promote mucosal health and support anti-inflammatory cytokine profiles.[51,52] *L. kefiranofaciens* DD2 from kefir was shown to effectively inhibit *S. mutans* and *S. sobrinus i*n an in-vitro oral environment.[53] The precise mechanisms underlying these interactions needs further research which may pave the way for new and innovative therapeutic approaches that can integrate oral health into a more holistic mental health care regime.

Role of Dentists in maintaining healthy oral microbiome

As frontline healthcare providers, dentists play a crucial role in maintaining not only oral health but also overall systemic

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well-being including mental health. The emerging research on the oral microbiome's impact on neurological and psychiatric disorders suggests that dental professionals should adopt a more holistic approach to patient care. Understanding the connections between oral health, inflammation and mental well-being allows dentists to contribute to both preventive and therapeutic strategies that extend beyond the oral cavity.

Recommendations for Practitioners

Dentists should educate patients on the importance of the oral microbiome, emphasising that the oral cavity hosts a complex microbial ecosystem essential for both oral and systemic health. Patients should understand that maintaining a balanced microbiome not only prevents cavities and gum disease but also helps reduce systemic inflammation linked to mental health outcomes. While good oral hygiene is crucial, excessive use of antimicrobial mouthwashes can disrupt beneficial bacterial communities. Practitioners should therefore encourage effective hygiene practices without over-sterilization and recommend alcohol-free, mild antiseptic rinses that preserve microbial balance rather than eradicating all bacteria.

Promoting the use of probiotics and prebiotics can further support oral and systemic well-being. Products such as probiotic lozenges or mouthwashes containing *Lactobacillus* and *Bifidobacterium* strains may help stabilize the microbiome while a diet rich in prebiotic foods such as fibre rich vegetables, fermented foods and dairy products with active cultures provides a nutritional foundation for beneficial bacteria. Addressing periodontal disease should also be considered a systemic concern given its contribution to systemic inflammation and potential links to neuroinflammation. Personalized management plans for periodontitis should combine mechanical debridement with microbiome supportive therapies.

Clinicians should also remain vigilant in screening for oral systemic health links particularly in patients with mental health disorders such as depression, anxiety or neurodegenerative diseases. These individuals may experience poor oral health due to neglect or medication induced xerostomia and would benefit from tailored oral care strategies including fluoride applications, saliva substitutes and more frequent hygiene visits. Dietary advice should emphasize reducing sugar intake which fuels pathogenic bacteria while encouraging the consumption of anti-inflammatory foods rich in omega 3 fatty acids, polyphenols (such as those found in green tea, berries and dark chocolate) and fibre rich vegetables. Stress management is another important consideration as stress contributes to both periodontal disease and microbiome imbalance; dentists can collaborate with other healthcare professionals to encourage mindfulness practices, exercise and adequate sleep as part of comprehensive care.

As technology advances, personalized oral microbiome testing may allow dentists to integrate microbial profiling into routine care enabling more targeted prevention and treatment strategies.

CONCLUSION

Emerging evidence supports the view that oral health extends beyond the mouth with implications for neurological and psychiatric well-being. Oral dysbiosis may contribute to the pathophysiology of depression, anxiety, schizophrenia, bipolar disorder and neurodegenerative diseases through inflammation, microbial translocation and neurotransmitter modulation. By integrating oral microbiome management into preventive care and interdisciplinary collaboration, dental professionals can contribute meaningfully to public mental health.

By adopting a proactive approach to microbiome health, dental practitioners can move beyond the traditional management of caries and periodontal disease to play a pivotal role in promoting overall systemic health and supporting their patients' mental well-being.

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A Case Report on Electrocautery Gingivectomy for Gingival Enlargement with Nitrous Oxide Sedation to Enhance Patient Comfort

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ABSTRACT

Background

Gingival enlargement characterised by the overgrowth of gingival tissue, can be caused by various factors, including medications, systemic conditions, or poor oral hygiene. Surgical intervention, such as gingivectomy, is required when conservative treatments fail. Electrocautery has become a popular method due to its precision and ability to minimise bleeding. Nitrous oxide sedation can enhance patient comfort, especially in anxious individuals. This report presents a case of gingival enlargement managed with electrocautery gingivectomy under nitrous oxide sedation, resulting in effective treatment and a positive patient experience.

Case Presentation

A 35-year-old Female non-smoker and non-alcoholic with generalised gingival overgrowth due to idiopathic causes sought treatment for aesthetic and functional concerns. The patient, who had a history of dental anxiety, was treated with electrocautery gingivectomy under nitrous oxide sedation. The procedure was successful, with minimal postoperative discomfort and no complications.

Conclusion

Electrocautery gingivectomy combined with nitrous oxide sedation is an effective and well-tolerated treatment for gingival enlargement. This approach improves both the clinical outcomes and patient experience, making it a viable option for those requiring surgical intervention for gingival overgrowth.

INTRODUCTION

Gingival enlargement, or the abnormal enlargement of gingival tissues, can significantly impact both the function and aesthetics .[1] The condition may result from systemic factors, such as use of certain medications (e.g., calcium channel blockers, phenytoin) or diseases like leukemia, or it may be idiopathic in nature.[1,2] In cases where non-surgical interventions like scaling and improved oral hygiene do not yield results , gingivectomy becomes a necessary treatment option.[1,4]

Among the various techniques used to perform gingivectomy, electrocautery offers several advantages, including precise tissue removal, better control over bleeding, and quicker recovery.[5] Furthermore, dental patients often experience anxiety before undergoing surgical procedures. Nitrous oxide sedation is a widely used technique to alleviate anxiety, ensuring that patients remain calm and relaxed during dental treatments.[6,7] This case report discusses the management of gingival enlargement gingival using electrocautery-assisted gingivectomy, combined with nitrous oxide sedation, to optimise both clinical and psychological outcomes.

Case Presentation

A 35-year-old Female non-smoking and non-alcoholic presented with complaints of gingival overgrowth that had progressively worsened over the past year. The gingival enlargement was most noticeable in the anterior maxillary region, affecting her appearance and impeding proper oral hygiene. The patient was suffering from social anxiety due to gummy smile. The Patient had no history of systemic diseases, nor was she on medications known to cause gingival overgrowth, such as phenytoin or calcium channel blockers. Her medical history was otherwise unremarkable, and she denied any known allergies.

The patient expressed significant anxiety about dental procedures, particularly surgery, which had delayed her seeking treatment. Given her concerns, nitrous oxide sedation was planned to reduce her anxiety and ensure a comfortable experience during the procedure.

Clinical Examination

Upon examination, the patient exhibited generalised gingival enlargement, primarily affecting the anterior segments of the maxillary arch.[9] The gingival tissue was erythematous, swollen, and fibrotic, extending over few millimetres of the crowns of the teeth. Probing depths were within normal limits (≥4mm), and there was no evidence of periodontal attachment loss. [10,11] Despite the enlarged gingiva, the patient had no active signs of inflammation, and her oral hygiene was average plaque disposition noticed but hindered by the overgrowth. Periodontal chart, plaque and BOP indexes are prepared before narrative diagnosis. Based on clinical findings, the diagnosis of gingival enlargement Gwas made.[12.13.14.]

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Fig 1: Right side

Fig 2: Left side

Fig 3: Bite showing Probing depth

Fig.5: Digital Treatment stimulation outcome

Treatment Plan

Given the extent of the gingival enlargement and the patient's anxiety, a treatment plan was devised that incorporated both surgical and psychological management.[6,15,16] Electrocautery was chosen as the preferred surgical technique due to its precision and ability to achieve haemostasis, which reduces postoperative complications and recovery time.[17] Nitrous oxide sedation was recommended to alleviate the patient's anxiety, allowing her to remain relaxed and cooperative throughout the procedure.[7] Virtual artificial intelligence (AI) driven try in was done by using digital temple on preparative intraoral photographs. Patient was satisfied with the treatment stimulation outcome. [18,19]

The treatment goals were:

- To remove the excessive gingival tissue and restore a natural gingival contour.
- To minimise patient anxiety and discomfort through nitrous oxide sedation.
- To ensure a smooth and complication-free recovery.

Fig 4: Nitrous oxide sedation machine

Surgical Procedure

Preoperative Preparation: Prior to the surgery, the patient was instructed to use a 0.12% chlorhexidine mouthwash for a week to reduce the bacterial load in the oral cavity. On the day of the procedure, local anesthesia (2% lidocaine with 1:100,000 epinephrine) was administered bilaterally to ensure sufficient numbness. In addition, nitrous oxide sedation was administered at a concentration of 50%, achieving a calm and relaxed state for the patient, while allowing her to remain conscious and responsive during the procedure.[6]

Electrocautery Gingivectomy

Anesthesia and Sedation: After confirming that the patient was adequately anesthetised, nitrous oxide–oxygen inhalation sedation was administered using a standard titration technique. The concentration of nitrous oxide was initially set at **30%** and gradually increased to a maximum of **50%** during the active phase of the procedure to achieve optimal relaxation while maintaining verbal responsiveness. Continuous monitoring of oxygen saturation, pulse, and respiration was performed throughout the surgery. At the conclusion of the procedure, **100% oxygen was administered for 5 minutes** to prevent diffusion hypoxia and to ensure full recovery. The surgical area was isolated using sterile gauze to maintain asepsis, and the patient remained calm and comfortable with no signs of distress throughout the intervention.

Tissue Removal: monopolar Electrocautery was used for gingivectomy. The settings typically range between **6-12 watts** The tissue was excised in layers, starting from the gingival margin and extending down to the base of the hyperplastic

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tissue. The electrocautery unit was set to a low power to prevent unnecessary thermal damage to surrounding tissues, and the removal was done with careful precision to achieve optimal contouring of the gingiva.

Haemostasis: The electrocautery unit provided excellent haemostasis, cauterising blood vessels as tissue was removed. This significantly minimised bleeding during the procedure, reducing the need for other haemostatic interventions.

Postoperative Care: The surgical site was inspected for complications, and none were observed. No sutures were necessary, as the tissue edges approximated well. The patient was given instructions for postoperative care, including guidance on pain management, use of 0.12 % chlorhexidine mouthwash, and oral hygiene practices.

Fig 6: Left side post-operative

Fig 7: Right side post-operative

Fig 8: Bite post-operative

RESULTS

Follow-Up Visits

1 Week Post-Operatively: At the 1-week follow-up, the patient reported mild discomfort, which was easily managed with over-the-counter analgesics. There was minimal swelling, and no signs of infection were present. The gingival tissue was healing well, and the patient was able to maintain better oral hygiene due to the reduction in gingival overgrowth.

2 Weeks Post-Operatively: By the second follow-up, the gingiva had healed significantly. The patient resumed normal eating and oral hygiene practices without difficulty. The surgical site showed minimal erythema, indicating ongoing healing.

1 Month Post-Operatively: At the 1-month follow-up, the gingiva had fully healed, and there was no recurrence of the overgrowth. The patient was very satisfied with both the functional and aesthetic results of the procedure. He reported no pain or discomfort and was able to perform normal daily activities with improved confidence.

DISCUSSION

Gingival enlargement , particularly in its severe form, can create significant functional and aesthetic issues for patients. Surgical intervention, particularly gingivectomy, is often required when conservative treatments such as scaling and improved oral hygiene are insufficient.[21] Electrocautery-assisted gingivectomy provides several benefits, including enhanced precision, better control over bleeding, and a faster recovery period when compared to traditional scalpel methods.[22]

Nitrous oxide sedation is commonly used in dental procedures to alleviate anxiety and improve patient comfort. It allows patients to remain conscious and cooperative while providing significant relaxation.[6,7] The combination of electrocautery and nitrous oxide sedation is ideal for managing anxious patients, as it addresses both their surgical and psychological needs.

In this case, the patient experienced a smooth recovery with minimal discomfort. The combination of these two approaches – electrocautery gingivectomy and nitrous oxide sedation – proved highly effective, both functionally and aesthetically, and contributed to a positive treatment outcome.[22, 23]

CONCLUSION

Electrocautery gingivectomy, when combined with nitrous oxide sedation, offers an effective and patient-friendly solution for managing gingival enlargement . This approach not only ensures precision and reduced postoperative discomfort but also helps address the psychological needs of anxious patients. The success of this case underscores the benefits of using this combined technique in dental surgery, particularly for patients requiring gingivectomy.

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Inversion of a premolar: a case report

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Al Black

ABSTRACT

Objective:

This case report aims to highlight the rare occurrence of an inverted mandibular second premolar (tooth 44) in a 19-year-old Caucasian patient, alongside other dental and medical anomalies. It further explores the diagnostic and management considerations of impacted and inverted teeth, specifically in the context of a sub-Saharan population.

Key words

Inverted premolar, panoramic radiograph, mandible fracture

INTRODUCTION

A 19 year old Caucasian patient presented to the outpatient department of a Tertiary Hospital complaining of a missing front tooth and requesting a crown for his other broken front tooth.

The patient's medical history reveals that he only suffers from acid reflux which he self medicates with antacids. Socially the patient confirms to drink and smoke.
The patient's dental history revealed that he is a regular in patient and was recently brought to the dental hospital due to interpersonal violence trauma which caused him to avulse his 12, damage his 21 and fracturing his mandible. The patient also confirms that he has a history of an orthodontic examination and is awaiting further treatment and that he has had a composite restoration done on his 21 and has a history of a semi rigid splint being placed on his anterior maxillary and mandibular teeth.

A panoramic radiograph was taken as part of the patient's treatment and work up and an incidental finding of an inverted tooth was made. The patient was made aware of this and opted to rather wait for possible orthodontic treatment or to leave the inverted tooth as he is fearful of invasive dental treatment.

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Radiographic interpretation

The panoramic radiograph (Figure 1) displays good diagnostic quality and is suitable for interpretation. On the right condylar head/neck area and articular surface there appears to be no anomalies or pathology, the right maxillary sinus is patent with no anomalies or pathology, the nasal aperture is normal with a slight deviation to the left, the left maxillary sinus is patient and devoid of anomalies or pathology. On the left condylar neck and head area there is increased space between the condylar head and glenoid fossa, the left hand mandible has a subcondylar fracture extending from the ramus to the coronoid notch which appears un-complicated radiographically. The left hand inferior alveolar canal has close approximation of the 37 with slight widening of the right hand inferior alveolar canal. Bilaterally on the angles of the mandible (right and left) there are radiopacities in the soft tissue indicative of calcification of the stylohyoid ligaments.

Upon analysis of dentition the 11 has apical osteitis, the 12 is missing, the 18 is unerupted, the 21 has an incisal and mesial

Figure 1: Panoramic radiograph

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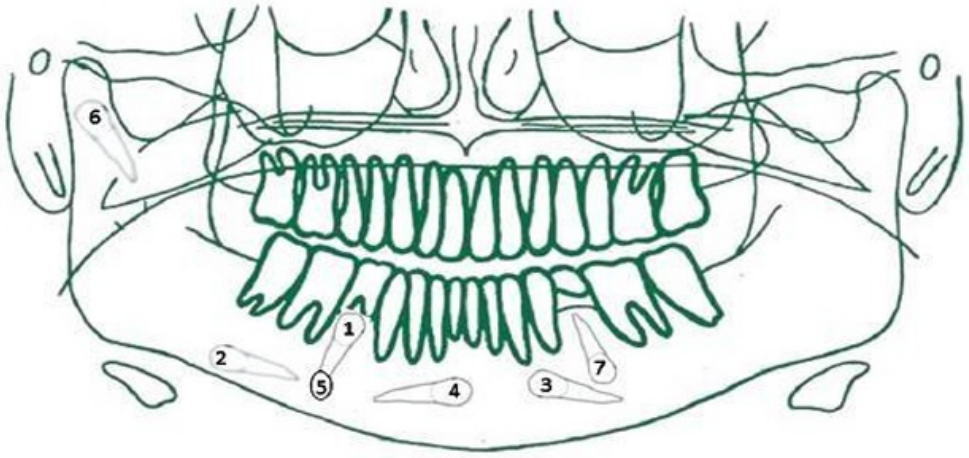

Figure 2: Classification as adapted from Arsyad and Muchlis

class IV composite restoration and the 28 is unerupted. The 38 is missing, the 37 had caries extending to dentine and the 36 is missing. The 44 displays inversion with a radiolucent halo surrounding the coronal area of the tooth attached at the cement-enamel junction. The 46 has taurodontism and the 47 and 48 are missing, all other dentition not mentioned are devoid of anomalies or pathology.

DISCUSSION

In the sub- Saharan population impaction of dentition is seen to be more common in mandibular and maxillary third molars with an equal proclivity towards males and females almost equally. Inversion of a tooth is said to be a tooth that is upside down. [1, 6]Literature pertaining to inverted premolars is very sparse with very few cases reported due to the lack of clinical presentation.[2]

There are various causes that one may look at when determining why teeth may impact namely lack of space, obstruction, infection, displacement and or trauma.[3] Radiographic imaging plays a very important role in determining the location, position and proximity to critical anatomical structures of inverted teeth, techniques that can be used for detecting impacted teeth are intraoral radiographs, orthopantomographs, occlusal radiographs, and in cone beam computerised tomography (CBCT).[4]

Inverted teeth have a tendency to not present with any clinically symptoms but when they do display clinical symptoms its usually a headache, diastema, unrelated late eruption of other dentition, ectopic eruption of other dentition. As far as specific types of dentition that have a preponderance to invert it is usually reserved for incisors, premolars and canines.[5]

The classification for the impacted mandibular second premolar is shown in Figure 2 and Table 1. This is an adaptation from research done by Arsyad and Muchlis.[7]

Management of impacted teeth includes observation, intervention, relocation, and extraction. Occasionally a combination of the above treatment options can be done to better suite the patients needs.[6] Our patient presents with a type 7 according to Arsyad and Muchlis and should be surgically removed but since there are not adverse clinical presentations and the patient is fully aware of the inversion it is best kept at an observational level and only intervention will be done when the patient requests intervention.

CONCLUSION

Inverted teeth are a unique dental anomaly with inverted mandibular premolar teeth being very scarcely documented. This case report serves to add to the already scanty information of inverted mandibular premolar teeth in the Sub-Saharan region.

COMPLIANCE WITH ETHICAL STANDARDS

Funding

This is a case report and no funding was required.

Conflict of interest

All authors declare that they have no conflict of interest.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

There are no patient identifiers in this case report and informed consent was obtained from the patient.

Consent for publication

For this type of study consent for publication is not required.

Availability of data and Materials

All data sets and research materials are available for revision on request.

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Rehabilitation of a severely worn dentition & partially dentate patient with fixed and removable prosthethics: A Case Report

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ABSTRACT

In patients with multiple edentulous areas, evidence of tooth wear and occlusal alterations; a combined crown and bridge and removable partial denture treatment plan may be recommended. This treatment plan involves the placement of both fixed and removable prostheses to restore function and aesthetics. Combined restorative cases typically involve placement of crowns and bridges together with a removable partial denture. Patients often present seeking treatment to restore aesthetics and function, temporomandibular joint (TMJ) discomfort and sensitivity due to tooth wear. During the treatment of such combined cases it will often be necessary to reorganise the occlusion by increasing the occlusal vertical dimension (OVD) prior to the placement of fixed and removable prostheses thus allowing for adequate space to accommodate additional restorative material. In addition, the dental practitioner should always provide accurate and step-wise clinical input and instructions to the dental technician in relation to the removeable partial denture (RPD) design in order to facilitate retention, stability and support.

INTRODUCTION

Tooth wear is described as the irreversible, non-carious loss of tooth structure. A combined fixed and removable treatment plan is an option when there are edentulous spaces in addition to the remaining teeth. The dental practitioner would evaluate the remaining tooth structure for bonding, evidence of tooth wear and the ferrule effect. An additional matter of interest for the dental practitioner is the assessment of the patient's face height and whether the occlusal vertical dimension should be increased.[1]

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The prevalence of tooth wear has shown a marked increase in recent years, and has been attributed to various factors. These are changes in lifestyle with the increased consumption of acidic food and drinks and the increase of gastro-oesophageal reflux disease (GERD) leading to chemical erosion; while mechanical tooth wear is related to bruxism. [3,4] In addition, tooth wear has shown a marked increase with increased patient age. Extensive tooth wear can result in dental pain (due to the exposure of dentinal tubules) and poor masticatory function. Many patients also report a change in aesthetics, which impacts patients on a personal and social level. These factors may have an impact on patient's quality of life. [3,4] Often patients are not cognizant of tooth wear, as it is a gradual process. Quite often patients seek treatment when the tooth wear process has progressed extensively and when symptoms appear; or when aesthetics is compromised. The restoration of functional occlusal relationship and aesthetics will often require a full mouth rehabilitation with an increase in the occlusal vertical dimension.[2,3,4] Localised tooth wear is commonly seen in anterior maxillary teeth. The decision-making process to optimally restore these teeth depend on various factors, such as: the pattern of tooth loss, the occlusal space availability, space that the proposed restorations require, the condition of the remaining tooth structure and the aesthetic concerns of the patient.[5,6]

A systematic review conducted by Kassardjian *et al.,* 2020 examining the restoration of teeth affected by tooth wear, determined that all included studies prescribed an increase in the occlusal vertical dimension, where interocclusal space for restorations are required. This can be achieved by the reorganising of the patient's occlusion.[7]

For patients with severe tooth wear and altered occlusion, increasing the occlusal vertical dimension (OVD) is often essential. This is a key step in planning comprehensive full-mouth rehabilitation. Prior to increasing the OVD, the dental practitioner needs to consider the following: remaining tooth structure, the remaining space for restorations, and the changes in occlusion and aesthetics. Change in OVD is a debated topic amongst dental researchers, as some state that changes to OVD will interfere with the masticatory process and be difficult for a patient to adapt to.[8] Hyperactivity of masticatory muscle, increased bruxism, change in occlusal forces and TMJ dysfunction are considered by some researchers as consequence of increasing the OVD. Contrary to these findings, others have found that those symptoms are temporary and resolve within a period of time.[8] By approximating the difference

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between the ideal tooth height and the loss of clinical crown height, a new OVD can be planned.[9]

CASE REPORT

The patient presented to the Postgraduate Prosthodontics Department for a full mouth rehabilitation, referred from our service rendering clinic at the UWC Oral Health Centre. She presented with severe tooth wear and ill-fitting cobalt-chromium removable partial dentures in the maxilla and mandible. Her occlusion needed to be re-organised due to wear on her natural and acrylic denture teeth. Her incisors and canines revealed minimal space available for adequate crown placement, hence a surgical crown lengthening procedure was indicated and subsequently completed, thus gaining clinical crown height of 1.5 - 2mm. The patients existing lower denture was adjusted and used as a diagnostic denture, in order to evaluate her tolerance to the improved OVD before progressing to the provisional phase with increasing the OVD. The improved OVD was achieved by placing provisional crowns (anterior maxillary and mandibular) and composite restorations on teeth with minimal surface loss, in addition to the newly constructed acrylic removable partial dentures in the maxilla and mandible.

This clinical case involved obtaining increased clinical crown height by a crown lengthening procedure, followed by increasing the OVD by manufacturing provisional crowns and new and improved acrylic partial dentures. After a 6-months period on the provisional prostheses, final prostheses construction was initiated.

For the definitive restorations, the maxillary crowns were constructed first, with palatal milled guide plane surfaces prepared on the abutment teeth, by the dental laboratory which was identified and prescribed in the partial denture design. These preparations on the occlusal and palatal or lingual surfaces will assist in direct occlusal load to the long axis on the abutment teeth, as well as aid in retention of the cobalt-chromium removable partial denture. The dental laboratory (University of the Western Cape – Dental Laboratory) was instructed to incorporate these milled surfaces on the design of the metal ceramic crowns, as per instructions from the partial denture design. The metal ceramic crowns were cemented, with a resin self adhesive cement (Rely X)®. Final impressions for the removable partial dentures were made after cementation on the metal-ceramic crowns. A polyether impression material (Impregum ®) was used. The mandibular teeth were then refined for its definitive metal-ceramic crowns. An impression was made with Impregum™ impression material.

Crowns were cemented with Rely X ®, followed by the final impression for the RPD in the mandible. Imgregum ® impression material was also used for the RPD impression.

The patients occlusion was evaluated, and periodic recall visits set up. On recall the patient reported an improvement in aesthetics, function and comfort with her removable partial dentures.

Summary of treatment steps:

1. OVD assessed based on tooth surface loss.
2. Surgical crown lengthening procedure – lower anterior teeth. This procedure increased the clinical crown height, needed for cementation of the indirect restorations.
3. The patient's occlusion was re-organised by means of using her existing RPD's, adding self-cure resin polyethyl methacrylate (SNAP®) to her dentures occlusal surfaces, to increase her OVD. (Period – 3-6 months use).
4. Teeth were prepared for provisional crowns and interim acrylic RPD's in the maxilla & mandible, at the improved OVD. (Period - 2-4 months use).
5. Proceed with the ceramic & metal-ceramic crowns in the maxilla first, followed by placement of the cobalt-chromium RPD.
6. After delivery of the maxillary crowns & RPD, completion of the mandibular crowns, followed by fittings and placement of the RPD.

Throughout the whole procedure, the patients vertical height was maintained and her occlusion remained stable.

Figure 1: Maxillary Pre-operative partially dentate view

Figure 2: Mandibular pre-operative partially dentate view

Figure 3: Lower partial diagnostic denture used to increase OVD

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Figure 4: Post-operative view with maxillary removable partial denture and anterior all ceramic crowns (12-23), posterior PFM crowns (13, 24 & 25) with palatal milled guide surfaces.

Figure 5: Post-operative view with mandibular removable partial denture

DISCUSSION

With implant supported prosthesis yet to become the first-choice treatment for patients, the combination of a fixed dental prosthesis with removable partial dentures with precision attachments as retentive elements can be considered as the most sophisticated form of care. The combination of fixed prosthesis and removable partial dentures involves full coverage porcelain fused to metal crowns on teeth retaining the RPD with the inclusion of milled guide planes on the lingual/palatal surfaces which serve as a guide plane to enhance the stability and retention of the removable partial denture.[10]

By using a milled guide plane on the palatal area of a partial denture, increased stability and support is afforded to the partial denture. Guide planes are precision milled to the palatal area of the denture in order to ensure a secure and snug fit against the palatal area. By using a guide plane on the palatal surface, it provides a guide for remaining natural teeth, and in this way prevents rotation and movement of the denture during function.[11]

The major and minor connector should cover minimum amount of soft tissue while being in contact with the remaining teeth. The milled palatal and proximal surfaces which are left in the as-cast state, create frictional retention and enhance stability. Axial surfaces, milled to perfection, are only half of the equation. The framework must have maximal possible contact with the milled surfaces so that they function as precision attachments.[12]

Clinicians should bear in mind that errors could occur due to a discrepancy between the milled surface and the cast partial denture due to finishing and polishing. The uncontrolled loss of metal that normally occurs in the fitting phase dramatically alters the fit of the casting to the milled surface. Every effort must be made to leave the internal surface of the casting in the as cast condition in the areas of desired contact with the milled surfaces. The laboratories must neither electro strip these surfaces nor grossly grind them to fit the frame to the master cast. Rather, the fitting of the frame must be first done in the mouth with all restorations present. By integrating the milled guide plane on the palatal aspect of a fixed partial denture, improvement in the stability of an RPD increased its resistance to rotational movements and most importantly eliminated the need for visible anterior clasping, thus achieving the basic principles of retention, stability, and support along with patient compliance.[13]

Figure 6: Pre-operative facial view

Figure 7: Post-operative facial view

CONCLUSION

Combined fixed and removable prosthetic cases allow for a thorough treatment plan that may address various patient concerns. As there is often circumstances in which dental practitioners cannot complete the ideal treatment plan of implant retained prosthesis, combined cases allow patients to benefit from a customised, cost-effective and aesthetic alternative with great success.

No conflict of interest

Informed consent taken was for all images.

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What's new for the clinician – summaries of recently published papers (November 2025)

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

1. EFFICACY OF DIFFERENT THERAPEUTIC OPTIONS FOR PAIN RELIEF AND TREATMENT OF BURNING MOUTH SYNDROME: A SYSTEMATIC REVIEW

Burning Mouth Syndrome (BMS) is a complex chronic pain condition characterised by a persistent burning sensation in the oral mucosa without clinically evident lesions. Its multifactorial and often idiopathic nature makes treatment challenging, necessitating a multifaceted approach. The efficacy of various therapeutic options is supported by evidence of varying quality, with no single universally effective treatment.

Systemic medications form a cornerstone of BMS management. **Clonazepam**, a benzodiazepine, has the strongest evidence for efficacy. The most supported regimen is the topical "swish-and-spit" method, which is believed to counteract central and peripheral neuropathic pathways by modulating oral sensory perceptions. Multiple randomised controlled trials (RCTs) have shown it to be significantly more effective than placebo in reducing pain. Systemic oral clonazepam is also used but carries a higher risk of sedation. *Alpha-lipoic acid (ALA)*, an antioxidant, has been extensively studied with mixed results. Early, smaller RCTs were promising, suggesting it could help repair nerve damage. However, more recent and larger systematic reviews and meta-analyses have concluded that ALA is not significantly more effective than placebo, casting doubt on its utility as a monotherapy.

Antidepressants are commonly employed, particularly low-dose **amitriptyline** or **selective serotonin reuptake inhibitors (SSRIs)**, but robust RCT evidence is lacking. Their use is primarily based on BMS's association with depression and anxiety and their known efficacy in other neuropathic pain conditions. **Gabapentin** and **pregabalin**, first-line treatments for neuropathic pain, are also used off-label for BMS, often showing benefit in refractory cases, though large-scale trials are needed.

Cognitive Behavioural Therapy (CBT) and Psychological Interventions: Given the strong link between BMS, anxiety, depression, and somatisation, psychological interventions are a critical component of treatment. Evidence from several studies demonstrates that CBT can be highly effective in reducing pain intensity and improving coping strategies and quality of life. It helps patients reframe their perception of pain and break the cycle of pain catastrophising. While not a direct pharmacological intervention, CBT is considered a first-line or adjunctive therapy by many specialists.

Non-Pharmacological and Emerging Therapies: Non-invasive brain stimulation techniques, particularly **transcranial magnetic stimulation (TMS)**, have shown promise in small trials. Repetitive TMS can modulate cortical excitability in brain regions involved in pain processing, providing significant relief for some patients. Similarly, *capsaicin* rinses (low-concentration) aim to desensitise oral nociceptors, though the evidence is preliminary and the initial burning sensation can limit tolerability.

In summary, the evidence supports a tiered, personalised approach to BMS management. Topical clonazepam is one of the best-evidenced first-line pharmacological treatments. Psychological interventions, particularly CBT, are equally vital and should be integrated early. For refractory cases, systemic neuropathic pain medications like gabapentin or off-label use of antidepressants may be necessary, despite a weaker direct evidence base. The mixed results for alpha-lipoic acid highlight the need for more rigorous, large-scale trials. Ultimately, managing patient expectations and combining pharmacological agents with psychological support appears to be the most effective strategy for this debilitating condition

Rossetti and colleagues (2025)[1] reported on a systematic review that sought to evaluate the efficacy of the different therapeutic options currently used to treat and relieve the pain of BMS, in order to provide better clinical guidance for the future.

Methodology

This systematic review was conducted in accordance with PRISMA 2020 guidelines. A comprehensive literature search was conducted in February 2025, adhering to PRISMA guidelines, across three databases: PubMed, Google Scholar, and SciELO. The search strategy employed Medical Subject Headings (MeSH) and Boolean operators to maximise sensitivity and relevance.

In Google Scholar, a total of 4,680 records were retrieved. After the removal of duplicates, off-topic studies, studies outside the scope of the review, and those not classified as randomised controlled trials (RCTs), 4,494 articles were excluded. Additionally, four articles in German and 161 without full-text access were excluded. Notably, 21 of the selected articles from Google Scholar were also identified through PubMed. The SciELO search yielded six articles, all of which were excluded due to lack of full-text access. In PubMed, 905 records were identified. After screening, 881 articles were excluded for being duplicates, lacking full-text access, or not meeting the RCT criteria.

Following de-duplication and eligibility screening, a total of 24 full-text RCTs published since 2015 were selected for full-text review. After detailed assessment, three articles were excluded for either not addressing Burning Mouth Syndrome (BMS) or not meeting the inclusion criteria.

Thus, a final total of 21 full-text RCTs, published from 2015 onward, were included in this systematic review.

The search strategy was based on the PICO model (Population, Intervention, Comparison, Outcome), focusing on adult patients diagnosed with Burning Mouth Syndrome (BMS) undergoing therapeutic interventions for symptom relief. Eligibility was determined by predefined inclusion and exclusion criteria, emphasising methodological rigor and relevance to the research question. Data extraction, management, and evaluation were conducted using a systematic and standardised approach to ensure transparency and reproducibility.

A quantitative meta-analysis was deemed unfeasible due to substantial heterogeneity across multiple dimensions: (1) diversity of therapeutic interventions (topical vs. systemic vs. physical therapies); (2) variability in outcome measurement scales (VAS, NRS, categorical scales); (3) different treatment protocols and dosing regimens; (4) heterogeneous follow-up periods (2 weeks to 12 months); and (5) varying definitions of treatment success or "responder" criteria across studies.
The criteria for selecting studies ensured the inclusion of high-quality evidence relevant to the clinical question. Only randomised controlled trials (RCTs) or controlled clinical trials involving adult patients diagnosed with BMS were included. The primary outcome considered was the relief or reduction of oral burning sensation and associated symptoms such as xerostomia and dysgeusia.

For this review, "therapeutic intervention" was defined as any pharmacological (topical or systemic medications), non-pharmacological (physical therapies such as laser therapy, acupuncture), or complementary therapy specifically aimed at reducing oral burning sensation in BMS patients. Studies investigating multitherapy approaches (combination of two or more treatments) were included and analysed separately. Interventions had to be clearly described with sufficient detail regarding dosage, frequency, and duration to allow for replication.

Studies were excluded if they were observational, case reports, reviews, editorials, or involved patients with oral mucosal diseases other than BMS or paediatric populations. Language was restricted to English, Spanish and Portuguese to maintain accessibility for analysis. Studies were also excluded if interventions were: (1) purely diagnostic procedures without therapeutic intent; (2) general oral hygiene measures without specific BMS targeting; (3) interventions for conditions other than primary BMS; or (4) insufficiently described protocols preventing replication.

Trials were analysed independently and objectively, based on the predefined inclusion and exclusion criteria, to decide whether they should be included in the review. After this phase, the selected articles were carefully analysed. A third reviewer was consulted to help reach a final decision in cases of disagreement.

Full texts of all included studies were reviewed, and information was systematically organised in Microsoft Excel. According to the review protocol, key data extracted included: article details (title, year, authors, country), study objectives, patient population, methodology, and results.

Each study's design, purpose, and specific treatment—whether systemic, topical, pharmacological, non-pharmacological, or alternative—were carefully considered, along with the type of Burning Mouth Syndrome reported. Additional data included study participants' characteristics, use of placebo, treatment duration, follow-up periods, number of participants, sex, mean and median age, and diagnostic criteria for BMS.
Symptomatology, adverse effects, and comparisons between treatment strategies were also analysed in detail.
The included RCTs were independently evaluated using the JBI Critical Appraisal Checklist for Randomised Controlled Trials, assessing methodological quality and risk of bias across five domains: (1) Randomisation process; (2) Deviations from intended interventions; (3) Missing outcome data; (4) Outcome measurement; and (5) Selection of reported results.

Results

Due to the heterogeneity in the included studies, no attempt was made to pool the data for a meta-analysis. Fourteen interventions were identified, including alpha-lipoic acid, topical/systemic clonazepam, low-level laser therapy (LLLT), capsaicin, melatonin, gabapentin, and cognitive-behavioural therapy. Topical clonazepam, alpha-lipoic acid, and LLLT consistently demonstrated the most significant symptom improvement with few mild adverse effects.

The overall quality assessment results showed that eleven studies were rated as low risk of bias, eight raised some concerns, and two were considered high risk.

Conclusions

While topical clonazepam, alpha-lipoic acid, and low-level laser therapy (LLLT) emerged as potentially effective options in several RCTs, the overall strength of evidence is limited. These therapies appear promising, but further high-quality, larger randomised trials are needed before firm first-line recommendations can be made.

Implications for practice

This study provides evidence-based guidance for clinicians in selecting effective treatments for BMS, emphasising tailored therapeutic approaches and the potential benefits of topical clonazepam, alpha-lipoic acid, and low-level laser therapy as first-line options.

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2. TREATMENT OF PERI-IMPLANTITIS WITH DIODE LASER OR MUCOSAL FLAP SURGERY: A CLINICAL RANDOMISED CONTROLLED TRIAL

Peri-implantitis affects 9–20 % of implants/implant patients and is currently treated mainly with open-flap surgery to debride and decontaminate the implant surface. Diode lasers (970 nm) can vaporise granulation tissue and kill sub-mucosal bacteria without raising bone temperature if used carefully. If this flapless approach produced healing similar to surgery it would offer a less-invasive first-line option with less morbidity. No previous RCT had tested a 970 nm diode laser used in this way for at least 6 months. This parallel-group equivalence trial therefore compared clinical, radiographic, patient-reported, immunological and microbiological outcomes 6 months after either single diode-laser de-epithelisation/decontamination or conventional mucosal-flap surgery in patients with established peri-implantitis.

Methods

Design: Single-centre, examiner-unblinded, 6-month equivalence RCT (ClinicalTrials.gov NCT04249024, Stockholm regional ethics 2015/822-31/2).

Population: 33 consecutive referrals; 26 patients (29 implants) completed.

Inclusion: ≥ 18 y, ≥ 1 implant with PPD ≥ 6 mm + BOP/SOP and ≥ 2 mm radiographic bone loss after osseointegration. Exclusion: antibiotics, peri-implant therapy, MI, head-neck radiotherapy or i.v. bisphosphonates within 6 months.

Randomisation: Block randomisation (blocks 4/6) stratified by baseline mean PPD (< 4.5, 4.5–6.5, > 6.5 mm); pre-generated list; allocation after baseline examination.

Interventions:

- Laser group (14 patients/17 implants): flapless mechanical debridement (steel curette) if calculus present, then 970 nm diode laser, 1.2 W continuous-wave, 320 µm fibre, saline irrigation; fibre swept pocket-to-apical until entire defect irradiated (mean 314 s, 376 J).
- Surgery group (12 patients/12 implants): local anaesthesia, reversed-bevel incision, full-thickness mucoperiosteal flap, granulation tissue removal, titanium-brush implant surface cleaning, flap closure, 7–12-day suture removal. Both groups received identical oral-hygiene instruction and 0.2 % chlorhexidine rinses until first review.

Outcomes (baseline and 6 m; PROM also immediately and first-week):
Primary outcome measure: equivalence of mean change in PPD and marginal bone level (MBL, periapical radiographs, ImageJ).

Secondary outcome measure: full-mouth and site Plaque/BOP/Suppuration indices; patient VAS (0–100 mm) for pain, discomfort, satisfaction; stimulated saliva and peri-implant crevicular fluid (PICF) calprotectin, IL-1β, MMP-8; qPCR counts of Porphyromonas gingivalis, Tannerella forsythia, Treponema denticola, Fusobacterium nucleatum; post-study care needs.

Statistics: Per-protocol; equivalence zone ± 1 mm for PPD & MBL tested with two-one-sided tests (TOST, 90 % CI); other between-group comparisons by t, Mann–Whitney or χ^2; α = 0.05.

Results

Participants: Groups similar for age, sex, jaw distribution, implant brand; slightly more smokers and deeper baseline defects in surgery arm (non-significant).

Primary outcomes:

- PPD change laser –0.22 ± 0.91 mm vs surgery –0.90 ± 1.84 mm; 90 % CI lower bound –0.29 mm (p = 0.003) but upper bound +1.62 mm crossed +1 mm margin → equivalence rejected.
- MBL change laser –0.06 ± 1.02 mm vs surgery +0.32 ± 1.18 mm; 90 % CI lower –1.11 mm crossed –1 mm margin → equivalence rejected.
  Among the 17 patients whose PPD actually improved (9 surgery, 8 laser) surgery gave significantly greater reduction (–1.81 ± 0.94 mm vs –0.83 ± 0.40 mm, p = 0.016); MBL gains were similar in the smaller subgroup that improved.
- Hence for the **Primary outcomes:** Equivalence (±1 mm) was **not** shown for mean change in probing pocket depth (PPD) or marginal bone level (MBL).
  – PPD: laser –0.22 mm vs surgery –0.90 mm; 90 % CI crossed the equivalence margin.
  – MBL: minimal change in both groups; CI also crossed margin.
- **Clinical benefit:** In the ~60 % of patients whose PPD did improve, surgery gave **twice** the pocket reduction (–1.81 mm vs –0.83 mm, p = 0.016).
- **Patient experience:** Pain/discomfort scores low overall; surgery group had **higher pain and discomfort** during the first week (p ≤ 0.026).
- **Biology:** No meaningful inter-group differences in inflammatory biomarkers or major pathogens; slightly **higher P. gingivalis counts** persisted in the laser group.
- **Post-study care:** Laser patients needed **extra specialist revisits** more often (50 % vs 8 %, p = 0.05); equal numbers (4 per arm) already scheduled for re-treatment.

Conclusions

A single 970 nm diode-laser session (1.2 W cw) produces **less pocket reduction** than conventional flap surgery and **cannot be claimed equivalent** at 6 months. Clinical "success" rates are similar, but surgery wins when measurable gain occurs. Laser treatment is **more comfortable initially** yet may require **more frequent re-care.**

Implications for practice

- Do **not** substitute a single diode-laser decontamination for open-flap surgery when maximal pocket elimination or regenerative access is needed.
- Use the flapless laser as a **staged or palliative option** for high-risk, needle-phobic, or medically complex patients, **provided they accept closer monitoring and possible re-treatment.**
- **Counsel patients**: laser = less pain today, **possibly more visits tomorrow**; surgery = more pain this week, **deeper pocket reduction now**.
- **Larger, longer trials** required to clarify whether lesser early gains translate into higher long-term failure or implant loss.

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Participation of Dental Students in Research – Collaboration or Coercion

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ABSTRACT

This paper interrogates the ethical dimensions of dental student's participation in academic research, challenging the assumption that such participation is inherently collaborative. We draw on theories of captivity, vulnerability, and bounded autonomy to argue that dental students constitute a structurally constrained and relationally dependent population whose agency may be compromised by institutional hierarchies and academic pressures. Notwithstanding that research participation offers cognitive, professional, and pedagogical benefits, the paper contends that these advantages must be weighed against the risks of coercion, undue inducement, and exploitation. Through a layered ethical analysis, the study reframes student participation not merely as a pedagogical tool but as a site of moral tension requiring robust safeguards. In our conclusion, we call for the implementation of transparent recruitment protocols, independent oversight, and the separation of instructional and research roles to uphold the principles of beneficence, non-maleficence, and justice. Ultimately, the paper advocates for a rights-based approach to student research participation, the affirmation of autonomy while acknowledging the structural vulnerabilities embedded in academic institutions.

Keywords

captivity, vulnerability, agency, dental students, research participation

INTRODUCTION

Should dental students be recruited to participate in research initiated by staff or their peers? Does the participation of students in research confer significant advantages to mitigate potentially inherent harm? The review of literature indicates that the number of undergraduate students involved in research has increased significantly in recent times.[1] This phenomenon is attributable in part to the educational value of research programs for undergraduate students and the research value, which incentivizes participation.[2] The inclusion of undergraduate students in research raises specific ethical questions given the inherent characteristics of this population. Moral and ethical debates remain fierce over whether dental students can be deemed easily accessible, vulnerable and captive compared to the general population? In such cases, dental students could suffer undue paternalism from academic staff. A related question could be asked whether dental students must be given preferential protection compared to normal adult subjects involved in research? If so, what should that protection entail? This paper seeks to provide an ethical analysis of the questions raised above.

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The Ethical Argument

This argument is based on several premises about dental students participating in faculty-led research.

Premise 1: Participation of dental students in research is valuable

Critical cross-field outcomes (CCFOs) are generic meta-skills developed by the South African Qualifications Authority (SAQA) to prepare students for lifelong learning. Research has become a critical component of dental education, since it seamlessly encompasses all seven original cross-field outcomes. Hence, the research course is a mandatory module in South African dental schools. The role of research in the cognitive, personal and professional growth of undergraduate students is undeniable.[3] Students who engage in research develop analytical and problem-solving skills, are better organised, and can manage their time and other resources effectively.[3] Research encourages teamwork and collaboration, effective writing and reading as well as communication and dissemination of information using a variety of channels. Students are able through research participation to apply class-room knowledge to answer real-world problems systematically. Students involved in research are motivated to learn, are more active, and are most likely to complete their programs.[4] Hence a strong positive association of research participation with positive student outcomes, including better academic achievement and a stronger ability to synthesize information.[4] Research helps students understand how knowledge is constructed, appreciate the importance of evidence-based reasoning, and the process of formulating informed opinions.[5] Research projects can address complex questions and problems in various fields, providing students with a deeper understanding of the world and their place in it. Research gives students a competitive edge, especially when pursuing postgraduate studies.[5,6] The process of research encourages collaboration with peers, faculty, and professionals, which could result in mentoring opportunities and career advancement.[7,8] Students who participate in research perform well academically and complete their programs in time.[3] Well-conducted research may result in publication, conference presentations, and recognition by the institution and profession, making the student eligible for grants, funding, and scholarships.[9]

On the contrary, dental programs can be rigorous and overwhelming, making it hard for most students to

devote adequate time to clinical and academic activities. Consequently, the participation of students in research could impose additional workload, resulting in poor academic performance, stress, and burnout.[10,11] Overall, the participation of dental students in research provides more advantages than disadvantages. Yet, a delicate balance must be created to ensure that students are supported and not harmed.

Premise 2: Dental students are a captive population

Captivity is a complex phenomenon, often confined to superficial definitions that are limited to being physically constrained to a singular space or choice. According to Rivera, captivity occurs *"when a self-directed creature, capable of independent and intentional actions, is subjected to significant restrictions that diminish its agency and freedom. Captivity is more than mere confinement; it involves a captor exercising control that restricts the captive's options and ability to act autonomously according to the relevant standard of well-being for that kind of being. This captures the essence of captivity as a state of powerlessness over one's choices"*.[12] The broader concept of captivity encompasses psychological, social, legal, and economic factors that individually and collectively limit an individual's autonomy and agency, impacting their well-being and dignity.[12-14]

A captive population refers to individuals who are confined to a specific physical area, which restricts their movement and ability to act and interact freely.[12,15] The captive populations are: (i) often separate and different from the general populations; (ii) are relationally, physically, and organizationally close to the offending institution or individuals (iii) tend to be readily available and easily exploitable because of their unique characteristics; (iv)suffer a degree of control and constraint from authority or institutions; (v) the extent of their dependency on institutions or others tend to limit their autonomy and agency.[12-16]

University students suffer from structural and situational captivity rather than absolute captivity. First, universities are closed systems that impose restrictions on choice and agency given the institutional regulations, academic requirements, and other dependencies. Second, the captor does not always benefit from this relationship, nor does harm always befall the captive. According to the bounded autonomy and competency condition theory, the agency and autonomy of university students are limited, constrained, and shaped by the social, situational, relational, and contextual factors.[17-19] As a result, the autonomy of dental students is comparatively more bounded and constrained than other university students.[17-20] Similarly, the relational and contextual autonomy theories posit that the nature of clinical training, continuous engagement with clinical staff, and dependence on instructors for guidance and mentorship can limit autonomy and agency.

Dental students, as argued above, are physically confined, easily accessible, and likely to endure harm during participation in research.

Premise 3: Dental students are a vulnerable population

Vulnerability is the condition of being susceptible to harm or injury, influenced by both internal and external factors. Luna argues that vulnerability cannot be defined in terms of sufficient or necessary conditions.[15] Such a notion is restrictive, rigid, and limiting in accommodating variation in the nature and levels of vulnerability. Alternatively, Luna proposes a metaphor of layers to represent overlapping conditions, contexts, and situations that give rise to diverse categories of vulnerabilities. This explanation references Goodin, whose framework indicates that *(x) is susceptible to (y) being inflicted by (z); where (y) is some harm, injury, failure, or misuse, and (x) and (z) are some person(s), animal, object, or events.*[16] Applied to dental students, the framework can be written as follows: *(dental students) are susceptible to (harm, injury), being inflicted by (staff, peers, and the institution at large).* The challenge with operationalization of this framework stems from a lack of consensus about (i) the degree of vulnerability among dental students - some students will be more vulnerable than others. Similarly, (ii) some vulnerabilities will be deemed unjust, some bad, and some will be neither. In the context of this argument, it is impossible to develop a comprehensive list of harm or injuries or to list people and events that can cause harm. Suffice to say that *dental students(x) may be susceptible to harm or injuries (y) like coercion, exploitation, violation of privacy, infringement of consent, unfair academic practices, being inflicted directly by (y) academic staff and peers involved in research, or indirectly due to regulations and practices of the university.* There is currently no literature that outlines the specific harms or injuries suffered by dental students involved in research. The factors listed above emanate from literature involving other health professionals, mainly medical and nursing students.[5,21,22]

Premise 4: Dental students have capacity and agency

Senior dental students possess, by virtue of their considerable exposure to clinical practice and research, have the requisite capacity to comprehend and consent to participate in educational research.[23] These students can appraise the risks and potential benefits associated with research involvement. Furthermore, these dental students are well-positioned to discern the probable impact of research participation on their academic prospects.

Dental students should not face risks that exceed those encountered by the general adult population. Yet, it can reasonably be argued that, with their clinical training and experience, this cohort is better positioned than lay participants to provide informed consent.[22] As Angoff has argued, the exclusion of dental students from potentially beneficial research perpetuates an elitist double standard: "One may wonder why it is acceptable to ask masses to accept the risk in the name of science but not the very people whose futures are linked to the successful perpetuation of biomedical research".

In the interest of justice and the equitable distribution of research benefits, it is ethically indefensible to categorically exclude dental students from participating in research. Rather, it is incumbent upon researchers and institutions to implement robust safeguards to protect the health and welfare of these participants while affording them the autonomy and agency to contribute meaningfully to scientific advancement.

Premise 5: Captivity and vulnerability inflict harm and injury on dental students

We argue that despite the potential benefits of research, dental students remain a vulnerable and captive population, which predisposes them to disproportional harm, injury during their participation in research activities.

(a) Imposing institutional structure and hierarchy of dental schools

Dental schools are highly structured and hierarchical

organisations, led by powerful and influential faculty members. Staff members serve as teachers, research supervisors, and mentors with enormous authority over students. This asymmetrical power dynamics makes it difficult for students to decline participating in activities prescribed by staff for fear of academic repercussions. Furthermore, students may be expected to engage fully in the curriculated research modules to meet the program requirements. These mandatory academic activities may limit the student's autonomy and voluntariness, especially when the research is staff-led.

(b) Research experience provides a competitive edge

Research achievements have high equity in academic progression and promotion for staff and students. Participation in research might attract prestigious mentorship, improve recommendations for scholarships, and prospects for future postgraduate tutorship. These academic dependencies, social and professional pressures, increase the likelihood of undue inducement and coercion. Students might feel obligated to participate in research in exchange for these benefits.

Premise 6: Captivity and vulnerability warrant special protection.

Special protection of captive and vulnerable populations is underpinned by the ethical principles of beneficence, non-maleficence, and justice. These principles create a heightened moral obligation for those with authority and power.[21] Additionally, the duty of care should be transformed into specific and actionable activities aimed at protecting "those who cannot protect themselves".[24]

The principle of beneficence invokes a moral obligation to act in the best interest of others by doing good and maximizing benefits.[25] Similarly, the principle of non-maleficence must be upheld to prevent harm to vulnerable populations.[21] Therefore, extra precautions must be taken to protect and not harm those who cannot adequately protect themselves. The risks associated with research must be minimised while the benefits are amplified to justify the conduct of research and involvement of the vulnerable populations. According to the principle of justice, the research burdens and benefits must be distributed fairly and equitably. Therefore, vulnerable groups should not endure disproportionate risks and burdens due to their "convenient availability".[26] Similarly they must not be denied the benefits associated with participation in research.

STRATEGIES TO REDUCE AND PREVENT POTENTIAL HARM TO DENTAL STUDENTS

1. Transparent recruitment protocols

Recruitment must be decoupled from academic performance and supervisory relationships. Staff should not recruit students they teach or assess; where this is unavoidable, an uninvolved staff must be used or the recruitment should occur after the module has completed, to prevent undue influence or perceived coercion. All the materials and communication related to recruitment must be neutral in tone, written in plain language, with emphasis on the voluntary nature of participation. Care should be taken to recruit students through impartial channels and outside teaching environments. Essentially, staff must demonstrate neutrality and decouple research participation from academic credits or performance.

2. Tiered Informed Consent Protocols and oversight by ethics committees

A layered consent process must be developed to allow students to opt out of specific components of research as opposed to providing complete blanket participation. Furthermore, the protocol must clearly state that students can withdraw from study at any time without academic and professional consequences. Ethics committees must only approve research projects that comply with national standards, especially regarding the protection of vulnerable student populations. In addition, oversight and evaluation of research implementation are critical to appraise perception of voluntariness and ethical treatment.

3. Compliance with POPIA

The South African Protection of Personal Information Act (POPIA) emphasises minimization, secure storage, diligent usage, retention and sharing of data. Hence, only necessary data must be collected during research, and clear protocols must be specified about data management during and after research is concluded. Finally, feedback must be provided to research participants as prescribed in the dissemination plan for research findings.

CONCLUSION

While dental students are autonomous, their agency can be constrained by structural vulnerabilities and relational dependencies, hence the need for heightened ethical protection of this cohort as both students and research subjects. Stringent processes must be in place to affirm autonomy, mitigate coercion and ensure justice. Transparent recruitment, tiered consent, and institutional oversight are not merely procedural formalities; they are moral imperatives to protect those who cannot fully protect themselves.

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CPD questionnaire

Morphometric Analysis of the Supraorbital Foramen in the South African Population

1. **Select the CORRECT answer. What structure passes through the supraorbital foramen (SOF) or supraorbital notch (SON)?**
   A. Maxillary nerve
   B. Supraorbital neurovascular bundle
   C. Infraorbital artery
   D. Zygomatic nerve

2. **Which option is CORRECT. In the South African population, what was the most commonly identified morphology of the supraorbital region in this study?**
   A. Double notch
   B. Supraorbital foramen (SOF)
   C. Supraorbital notch (SON)
   D. Absent SON/SOF

3. **Which answer is CORRECT. Which of the following structures is supplied by the supraorbital nerve?**
   A. Lower eyelid and nasal septum
   B. Upper eyelid, forehead, and scalp
   C. Upper eyelid and forehead
   D. Lateral wall of the nasal cavity

4. **Select the CORRECT option. Which of the following factors was suggested to contribute to differences in the occurrence of the supraorbital notch (SON) and foramen (SOF) between warm and cold climates?**
   A. Genetic mutation
   B. Age-related changes
   C. Thermoregulatory processes
   D. Skull shape

Periodontal status in adolescents with Type 1 Diabetes mellitus in a South African study population

5. **Choose the CORRECT answer. Which classification system was used to diagnose periodontal disease in this study?**
   A. WHO Community Periodontal Index (CPI)
   B. American Academy of Periodontology 1999 Classification
   C. British Society of Periodontology Guidelines
   D. 2017 EFP/AAP Classification

6. **Which answer is CORRECT. What was the most prevalent periodontal condition found among the adolescents in the study?**
   A. Clinical periodontal health
   B. Gingivitis
   C. Localized periodontitis
   D. Generalized periodontitis

7. **Select the CORRECT statement. What was the study's conclusion regarding the association between periodontal disease and diabetic metabolic control (HbA1c)?**
   A. A strong positive association was found
   B. A statistically significant negative correlation was found
   C. No statistically significant association was found
   D. All participants with periodontitis had controlled diabetes

8. **Select the CORRECT statement. Which of the following best describes the relationship between Type 1 Diabetes Mellitus (T1DM) and periodontitis as suggested in the literature and the study findings?**
   A. T1DM directly prevents the onset of periodontitis through improved immune function
   B. Periodontitis has no clinical relevance in patients with diabetes
   C. T1DM is associated with an increased risk of periodontitis, though this study found no statistically significant association with metabolic control
   D. Periodontitis is only a concern in Type 2 Diabetes Mellitus, not in T1DM

Patients' Understanding of Information Provided During Consent Process for Fixed Prosthodontic Treatment: A Mixed Methods Study at Dental Facilities in Kampala

9. **Which option is CORRECT. Patients' understanding of treatment information provided during the consent process can be reliably determined by**
   A. Asking a patient, a generic question about whether they understood the information provided.
   B. Use of objective measures, such as test questions about treatment information before obtaining consent.
   C. Patients grasp important aspects of their treatment and there is no need for assessments.
   D. Request the patient re-explain the information provided to the dentist.

10. **Which statement is CORRECT. The information that you provide to a patient about the treatment proposed for them needs to include four of the five elements listed below. Which ONE is the exception?**
    A. Why the treatment is being proposed for them
    B. What the procedure involves and what the effect is likely to be
    C. A detailed review of the relevant evidence base, providing the patient with a list of references to relevant peer-reviewed scientific articles
    D. A balanced explanation of any risks and limitations, as well as any potential benefits of the treatment under consideration
    E. A summary of any alternative treatment options (including that of doing nothing), and how they compare

11. **Which of the following is CORRECT. Which of the following factors may not impact a patient's comprehension of the information provided during the consent process?**
    A. Use medical jargon in explanations by dentists.
    B. Patient's literacy level.
    C. Method used to deliver the consent information
    D. Dentist's qualifications
    E. Allowing enough time for the consent process

The Oral Microbiome and Mental Health: An Emerging Paradigm

12. Select the CORRECT answer. Oral microbiome can modulate neurotransmitters like

A. Serotonin, dopamine, and gamma-aminobutyric acid (GABA),
B. Vitamin B
C. Polyphenols
D. Transforming growth factor beta

13. Which option is CORRECT. How can dentists contribute to patients overall well being

A. Educate Patients on the Importance of the Oral Microbiome
B. Encourage Proper Oral Hygiene Without Over-Sterilization
C. Promote the Use of Probiotics and Prebiotics
D. Personalized Oral Microbiome Testing
E. All of the above

Repair or Replacement of Direct Restorations

14. Which answer is CORRECT. Most commonly used direct restorative material is

A. Amalgam
B. Glass Ionomer Cement
C. Zinc Phosphate Cement
D. Composite

15. Choose the CORRECT option. Which is the most common cause for repair or replacement of restorations?

A. Secondary Caries
B. Fractured restorations
C. Tooth pain
D. Discoloration

16. Select the CORRECT answer. Which is used to prepare the adjacent amalgam and tooth tissue surfaces in amalgam repair?

A. silane coupling agents
B. 37% Phosphoric acid
C. Intraoralaluminum oxide sandblaster
D. All the above

Inversion of a premolar: a case report

17. Select the CORRECT finding. What is the most significant radiographic finding in this patient's panoramic radiograph?

A. Missing third molars
B. Inverted second premolar (44)
C. Impacted third molar
D. Fractured condylar head

18. Choose the CORRECT answer. What is the appropriate initial management for the inverted tooth (44) in this patient?

A. Immediate surgical extraction
B. Orthodontic intervention to reposition the tooth
C. Observation with potential intervention if symptoms develop
D. Root canal therapy

A Case Report on Electrocautery Gingivectomy for Gingival Enlargement with Nitrous Oxide Sedation to Enhance Patient Comfort

19. Select the CORRECT answer. What is a common cause of gingival hyperplasia?

A. Viral infection
B. Medication use and systemic conditions
C. Excessive fluoride intake
D. Trauma from brushing

20. Choose the INCORRECT option. Which of the following is NOT an advantage of electrocautery gingivectomy?

A. Precise tissue removal
B Increased postoperative bleeding
C. Faster recovery
D. Better hemostasis

Ethics: Participation of Dental Students in Research - Collaboration or Coercion

21. Select the CORRECT answer. Which ethical principle is most directly challenged when dental students feel compelled to participate in staff-led research due to hierarchical pressures?

A. Justice
B. Autonomy
C. Beneficence
D. Non-maleficence

22. Which of the following statements is CORRECT. How does the concept of 'bounded autonomy' help explain the ethical tension in dental student research participation?

A. It shows students lack any decision-making capacity.
B. It suggests students are always coerced into participation.
C. It proves students are legally incapable of consent.
D. It highlights how institutional contexts limit student agency.

23. Select the CORRECT statement. What analytical distinction does the paper make between 'captivity' and 'vulnerability' in the context of dental students?

A. Captivity is physical; vulnerability is emotional.
B. Captivity is voluntary; vulnerability is imposed.
C. Captivity applies to staff; vulnerability applies to students.
D. Captivity relates to institutional control; vulnerability to susceptibility to harm.

24. Why might the academic benefits of research participation be considered ethically problematic for dental students?

A. They receive financial compensation for participation.
B. They are not academically qualified to participate.
C. The benefits may unduly influence their decision to participate.
D. They are required to publish their findings.

25. Which strategy best addresses the ethical concern of coercion in student recruitment for research?

A. Mandating participation for all students
B. Recruiting students after module completion through neutral channels
C. Offering extra credit for participation
D. Using staff who teach the module to recruit students

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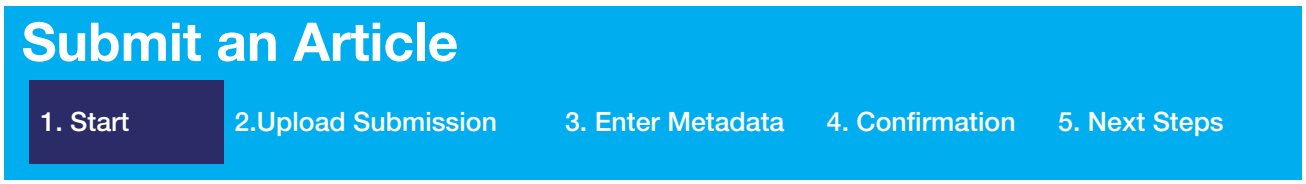

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HEALTH PROFESSIONS COUNCIL OF SOUTH AFRICA – WHO WE ARE AND WHAT WE DO IN OUR REGULATORY MANDATE

The Health Professions Council of South Africa (HPCSA) is a statutory health regulatory body mandated to protect the public and guide the professions by ensuring that healthcare practitioners are fit to practise their profession. Established by Section 2 of the Health Professions Act, 56 of 1974, professionally and ethically the HPCSA operates as a juristic person empowered to perform only those functions defined by legislation. Through this mandate, the Council regulates the scope of practice of health professions, ensures compliance with professional and ethical standards, and provides structured processes for oversight, accountability and disciplinary measures.

Together with the12 Professional Boards under its ambit, the HPCSA is tasked with overseeing the education, training, and registration of health professionals. To protect the public and safeguard the integrity of the professions, Council ensures that practitioners conduct themselves ethically and that complaints are investigated thoroughly, and that disciplinary action is taken when necessary. In fulfilling this broad regulatory responsibility, the Council executes its work through several key divisions, each with a defined role in supporting the overall mandate.

Legal and Regulatory Affairs
The Legal and Regulatory Affairs manages the professional conduct inquiry section which deals with professional conduct inquiries as processed by the committees of preliminary inquiry. The legal advisors appointed within the department act as proforma complainants in the prosecution of complaints referred by the Preliminary Committees of Inquiry (PCI). The Professional Conduct Committee appointed by chairpersons of the boards preside over the prosecution of such complaints. Litigation for and against the Council are also managed by the Department in consultation with the legal advisors.

Road Accident Fund Division
This division was established to render secretariat support to the Road Accident Fund Appeal Tribunal. This function is carried out in terms of regulation 2008 issued by the Minister of Transport which directs the Registrar of the HPCSA to set up tribunals of medical practitioners for the assessment of serious injuries.

The Work of the Inspectorate Office
The Inspectorate Office is central to ensuring compliance with the provisions of the Act, its rules and regulations. It conducts proactive and risk-based inspections, assists the Professional Boards with clinical and professional compliance matters, and monitors adherence to penalties imposed by the Professional Conduct Committee.

A significant focus of this office is the identification and prosecution of unregistered persons masquerading as healthcare professionals. In collaboration with law enforcement agencies, regulatory partners and the public, the Inspectorate exposes and acts against bogus practitioners who pose risks to public health. Strategies employed include proactive inspections, reactive investigations, and the preparation of court dockets for prosecution.

While progress has been made, challenges remain. The widespread presence of unregistered individuals makes detection and tracing difficult, and in some instances registered practitioners have unlawfully engaged unregistered persons as locums. To address this, the Inspectorate continues to emphasise awareness and education campaigns for both practitioners and the public, supported by strengthened collaboration with stakeholders. Members of the public are also encouraged to use the Council's iRegister platform or contact the Call Centre to verify practitioner status.

Investigating Complaints and Maintaining Ethical Standards
A critical part of the HPCSA's regulatory function is handling complaints against practitioners and ensuring adherence to professional and ethical standards. The Complaints Handling and Investigation Division is responsible for receiving, assessing, and investigating allegations of unprofessional conduct.

Complaints undergo a structured process, beginning with verification of practitioner registration and the categorisation of allegations. Where appropriate, matters are resolved through mediation, provided both parties agree to the outcome. Where mediation is unsuccessful, cases proceed to preliminary investigation, during which practitioners are required to respond to allegations within prescribed timeframes.

Matters are then considered by the Preliminary Committee of Inquiry, which determines whether there is evidence of unprofessional conduct. Depending on severity, the Committee may impose a minor penalty or refer the case to a formal inquiry. Where no evidence is found, the matter is closed. This process ensures accountability, protects the public, and preserves trust in the professions.

Ensuring Effective Practitioner Registration
Registration with the HPCSA is both a professional prerequisite and a legal requirement, forming the cornerstone of professional regulation. Practitioners are required to keep their details updated and to maintain good standing through the payment of annual fees. Provisions exist for voluntary erasure from the register and restoration where lapses occur, when practitioners elect not to practise their profession. However, such practitioners will be restored to registers on return, without having to shoulder penalties and/or outstanding fees. There may, however, be conditions to be met for restoration as set by a relevant Professional Board.

The Council manages multiple categories of registration, including student, intern, community service, independent practice, and specialised or temporary categories such as postgraduate, volunteer, and education-related registration. To improve efficiency, the HPCSA has implemented a hybrid registration system through the Enterprise Business System and Oracle Service Cloud. These improvements have reduced turnaround times significantly, with graduate registrations decreasing from three months to 3.5 days, and individual practitioner registrations reduced to an average of 3.5 working days.

Since March 2017, annual registration renewals have been conducted online, further streamlining the process. Future enhancements aim to integrate all applications into the Oracle Service Cloud, which will also enable the collection of employment data to strengthen workforce planning.

Dr Magome Masike

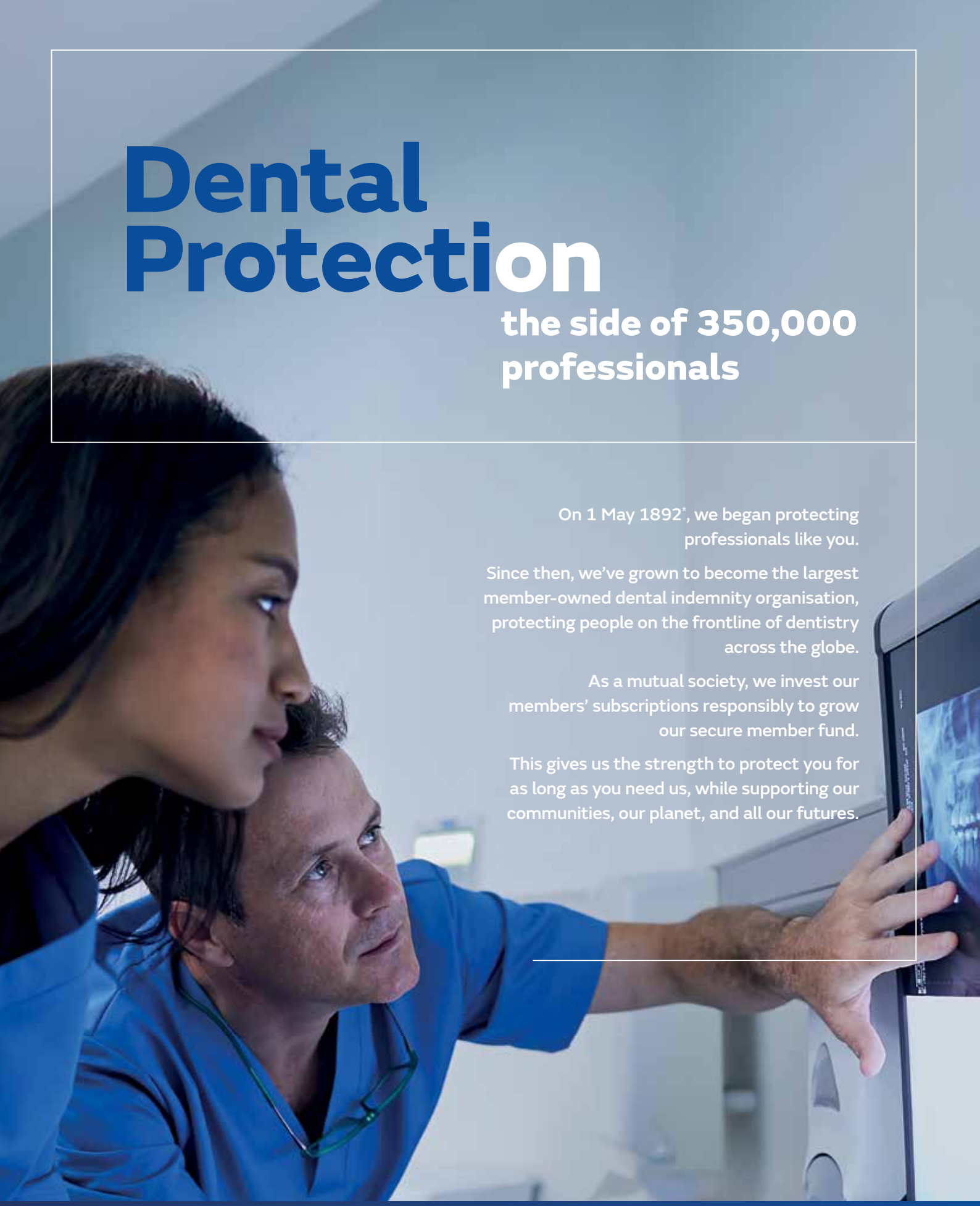
Professional Practice and Ethical Guidance
The Professional Practice Division plays an important role in guiding practitioners on ethical and professional standards. It supports the development of policies, issues directives, and provides advisory support to practitioners and Professional Boards. Its work covers areas such as scope of practice, continuing professional development (CPD), and the curation and review of ethical guidelines.

Recent achievements include attaining a 70% compliance rate in CPD across the professions, reviewing sixteen ethical guidelines, and introducing three new ones. The division has also engaged practitioners through workshops across the country, ensuring that professional and ethical issues remain a shared priority across the sector.

Education and Training Oversight
The Education and Training Division ensures that the education of healthcare professionals meets the highest standards by accrediting training programmes, conducting site visits, and evaluating clinical training facilities. The division also oversees the registration process for foreign-qualified practitioners, ensuring that only suitably trained professionals enter the system. Working closely with the Professional Boards and the ETQA Committee of Council, the division supports the facilitation of Board examinations. During the reporting period, 183 Board examinations were conducted, with 1 806 candidates participating. Of these, 1 316 passed and 490 did not meet the required standard. While notable progress has been achieved, challenges remain, including delays in curriculum reviews and complexities in the administration of Board examinations.

Conclusion
Through its regulatory mandate, the HPCSA continues to play a critical role in safeguarding the public and guiding the health professions in South Africa. Each division, from inspections and registrations to complaints handling, professional practice, and education oversight, contributes to ensuring that practitioners meet the highest professional and ethical standards. While challenges persist, the Council remains committed to strengthening its systems, enhancing stakeholder collaboration, and continuously improving regulatory processes in pursuit of a safer and more accountable health system.

HPCSA
Health Professions Council of South Africa



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