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THE SOUTH AFRICAN
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Cape Columbine Lighthouse, Paternoster

Cape Columbine Lighthouse, near Paternoster on South Africa's West Coast, was first lit in 1936. It stands on a rocky headland inside the Cape Columbine Nature Reserve, marking one of the country's most treacherous stretches of coastline. The lighthouse rises 15 metres, with its light reaching 30 nautical miles out to sea. It remains fully operational, guiding vessels and offering visitors panoramic views of the Atlantic Ocean and rugged shoreline.

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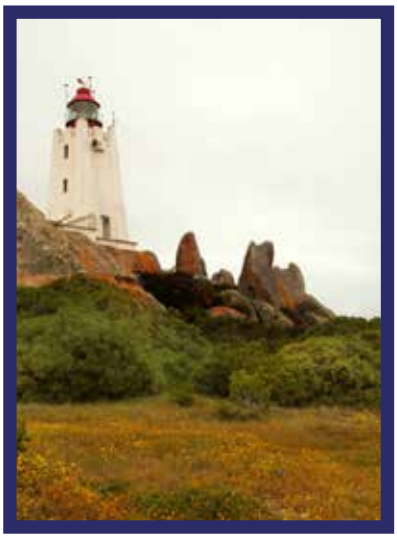
Our Front Cover for this Issue...

Cape Columbine Lighthouse, Paternoster

The Cape St. Blaize Lighthouse, built in 1864, stands atop the cliffs of Mossel Bay, guiding ships along South Africa's southern coast. Its white tower, still operational today, offers panoramic views of the Indian Ocean. The lighthouse remains a historic maritime beacon and popular tourist stop, with a scenic trail nearby that leads to the St. Blaize Cave.



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Guided by Data, Grounded in Values: Dentistry in the Age of NHI and AI

SADJ JULY 2025, Vol. 80 No.6 P287-P292

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

Why This Moment Matters

At no time in our profession's history has the ground shifted so decisively beneath us. The National Health Insurance Act of 2023 ushers in a new era in South African healthcare: one where access becomes a universal promise rather than a privilege. It positions dentistry, long sidelined in public health discourse, at the centre of a collective reimagining of care delivery.

Simultaneously, artificial intelligence (AI) is emerging from the realm of speculative fiction and into the dental operatory. AI promises precision diagnostics, streamlined workflows, and predictive insights. Deep learning systems now rival human experts in interpreting panoramic radiographs and caries detection, doing it in seconds what once took minutes. Yet in this dawning age of algorithms, human judgment still reigns supreme, if we know how to wield both tool and wisdom.

South African oral health is wrestling with a legacy stained by systemic neglect, inequity, and structural fractures while simultaneously being invited to leap into universal coverage and digital advancement. It is a rare convergence: policy, technology, ethics, and equity intersect in our profession's most visible moment.

But here's the catch: these forces can either converge into synergy or collide into dissonance. NHI's universal promise may feel like liberation, but without thoughtful calibration, standardised benefit designs could narrow clinical discretion. AI's interpretive warp may feel like a shortcut but without transparency, it risks protocolizing nuance and masking bias.

The golden thread then, is this: in the tension between systems and judgment, equity and efficiency, we must be deliberate. We ask whether we can architect a future where policy supports clinical conscience and technology enhances, rather than erodes, patient humanity?

This is the moment to define how dentistry will behave clinically, ethically, pedagogically, and professionally, in the age of the act and the algorithm.

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Artificial intelligence in dentistry is no longer a futuristic curiosity. It is in our clinics, our radiographic suites, and even in our patients' pockets. From automated charting and AI-assisted caries detection to predictive analytics for periodontal disease progression, the technology promises an intoxicating combination of speed, accuracy, and efficiency. A 2023 systematic review found that deep convolutional neural networks could detect dental caries on bitewing radiographs with accuracy rates comparable to or exceeding experienced clinicians.[1]

For the overstretched practitioner in a high-volume public clinic, the benefits seem irresistible. AI could flag pathologies in seconds, standardise treatment planning, and even suggest cost-effective care options. In theory, this frees clinicians to focus on the human aspects of care like communication, trust-building, and shared decision-making.

But algorithms are not neutral. They inherit the biases embedded in their training data, and in dentistry, this data often comes from well-resourced clinical settings in the Global North. Such models may not account for the oral disease patterns, socio-economic realities, or resource constraints common in South African practice. The result? A diagnostic output that is statistically sophisticated but contextually naive.

The more insidious risk is over-reliance. As protocols increasingly integrate AI outputs into mandatory treatment pathways, particularly under the cost-containment pressures of a universal health insurance model, there is a danger that the clinician becomes a validator rather than a thinker. The "human in the loop" risks becoming "the human rubber stamp."

If the algorithm is the scalpel, we must still be the surgeon. Clinical judgment, cultural sensitivity, and ethical reasoning cannot be delegated to lines of code. The challenge and opportunity before us is to ensure that AI amplifies our judgment rather than replaces it, and that the datasets we train on reflect the realities of our patients, not just those of patients thousands of kilometers away.

The NHI Act and the Shaping of Clinical Autonomy

The National Health Insurance (NHI) framework in South Africa aspires to create an equitable, universal healthcare system that closes the gap between the privileged few and the underserved majority. Its vision is undeniably noble. Yet for dental professionals, the NHI's operational realities will shape not only the economics of practice, but also the very boundaries of clinical decision-making.

Under the NHI, standardised treatment protocols will likely become the default, with the dual aim of containing costs and ensuring uniformity of care across diverse settings. These protocols, while valuable for promoting consistency, can also narrow the clinician's scope for tailoring treatment to individual needs. The inclusion of AI-driven decision support in such systems may further embed this standardization, locking practitioners into algorithmically guided pathways.

For the public sector dentist, this could mean reduced variability in care quality between urban and rural clinics. However, it could also mean that treatment plans are increasingly dictated by cost-effectiveness algorithms rather than nuanced clinical judgment. In private practice, particularly for practitioners contracted to the NHI, reimbursement models and case authorisation processes may subtly encourage the selection of cheaper interventions over those that are clinically superior but financially less viable within the scheme's constraints.

Clinical autonomy is not an abstract privilege. It is the safeguard that ensures a dentist can recommend the treatment that best serves the patient's health, even if it is not the least expensive or most convenient. The integration of AI within NHI frameworks will demand that dental professionals become advocates for the preservation of that autonomy, articulating the difference between efficiency and quality, between standardisation and stagnation.

The real measure of the NHI's success will not be in how much it can save, but in whether it can deliver equitable, evidence-based care without eroding the professional discretion that lies at the heart of ethical dentistry.

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This marriage of technology and policy could redefine dentistry in South Africa. Imagine a rural community dental clinic where AI-powered diagnostics flag carious lesions, assess periodontal status, and even suggest the optimal restorative material. The clinician, under the NHI's reimbursement constraints, might then face a silent tension: proceed with the AI-recommended cost-efficient option, or advocate for a more durable, albeit more expensive, alternative that the system might not cover. In theory, AI could elevate the baseline standard of care nationwide. In practice, it risks institutionalising a lowest-common-denominator approach if the algorithms are tuned more for cost control than for clinical excellence.

Ethically, this convergence forces us to confront the question: who holds the final authority in patient care? If AI algorithms are trained on datasets that reflect historic inequities or exclude certain population profiles, their guidance may unwittingly perpetuate disparities. Under the NHI, where these algorithms could be embedded as decision-support defaults, such biases risk becoming codified into national healthcare delivery.

There is also the matter of trust. Patients may assume that every recommendation, whether human or algorithmic, is grounded in their best interest. Dentists will need to develop the skill and courage to explain, and if necessary, challenge algorithmic recommendations when they do not align with the patient's unique context. This is not simply a clinical responsibility; it is an ethical imperative.

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compromises judgment, and accessibility that trades away quality, could leave us with a system that meets targets yet fails patients. The task for the profession will be to harness these forces in a way that expands, rather than contracts, the scope of ethical and patient-centred dentistry.

Navigating the Future: Preparing Dentists for a New Clinical Reality

Dentistry is entering a new era in which neither clinical skill nor business acumen alone will be enough. The next generation of dentists will need to navigate an environment where patient needs, technological capabilities, and systemic constraints are in constant negotiation. Preparing for this reality requires more than updating clinical syllabi; it demands a reimagining of what it means to be a competent and ethical practitioner in the 21st century.

Undergraduate and postgraduate education must adapt to this shifting landscape. Students must be trained not only to use AI-driven diagnostic tools, but to critically appraise their outputs. They must understand how reimbursement systems like the NHI influence treatment planning, and how to advocate for patient-centred care within these structures. This is not about producing graduates who can follow a flowchart; it is about producing clinicians who can recognise when the flowchart serves the patient and when it doesn't.

Beyond technical competence, there is a need to cultivate ethical resilience. This means giving future dentists the frameworks and language to challenge cost-driven care when it undermines patient welfare, to articulate the long-term value of preventive interventions, and to resist the quiet erosion of professional autonomy. It also means preparing them to engage in interdisciplinary conversations, where dental priorities are sometimes overshadowed by broader health system demands.

The profession has faced crossroads before in times when new technologies or policy changes threatened to narrow our role to technicians rather than healthcare leaders. Each time, our survival and relevance have depended on our ability to adapt without surrendering the core values of care, integrity, and patient advocacy. This new intersection of AI and NHI is no different. If we can prepare our current and future practitioners to navigate this complexity, we can ensure that dentistry in South Africa does not merely endure the coming transformation, but actively shapes it. The goal is not just to survive within the system, but to lead within it, confidently, ethically, and with an unwavering commitment to the people behind the policies and algorithms.

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The convergence of algorithms and acts will redefine dentistry's landscape, but it will not decide its soul. That choice remains ours. AI will continue to sharpen its predictions, and national health policies will continue to shape access and funding. Yet no software, no statute, can replicate the deeply human act of sitting across from a patient, hearing their concerns, and tailoring a plan that honours both their needs and their dignity.

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Dentistry has always been about more than teeth; it is about the health, confidence, and quality of life of those we serve. The market may dictate costs, algorithms may suggest pathways, but it is the clinician's voice anchored in evidence, ethics, and empathy, that should chart the course. The future will remember not only how we adapted to these changes, but how steadfastly we held to the values that make dentistry a profession and not just a service.

The compass is still in our hands. The question is: will we let others set our direction, or will we navigate with purpose?

Further reading:

Schwendicke F, Rossi JG, Göstemeyer G, Elhennawy K, Cantu-Aguilar GP, Gaudin R, Chaurasia A, Gehrung S, Krois J. Cost-effectiveness of artificial intelligence for proximal caries detection. Journal of Dental Research. 2021;100(4):369–376.

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CPD questionnaire on page 336

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.

Continuing to Elevate the Standard: SADA Congress 2025 and the Ongoing Development of Oral Healthcare Practitioners

SADJ JULY 2025, Vol. 80 No.6 P293-294

Mr KC Makhubele – CEO, South African Dental Association

Each year, the South African Dental Association (SADA) renews its commitment to advancing the profession and elevating oral healthcare in South Africa. The *2025 SADA Dental and Oral Health Congress & Exhibition*, held in Durban, delivered emphatically on that promise. With *836 attendees*, including *536 delegates, 216 exhibitors, and 40 speakers*, it stood as a national beacon of professional development, networking, and inspiration.

This year's Congress theme aligned with – *"Reimagining the Future of Oral Health"* – was more than a title. It was a call to action, one which every contributor, partner, and delegate answered with purpose and passion.

A Scientific Programme Rooted in Excellence

The *SADA Scientific Advisory Committee* must be commended for assembling a robust and dynamic educational programme. From cutting-edge clinical updates to ethics, technology integration, and practice sustainability, the CPD-accredited content was carefully curated to address the real-world needs of dental professionals.

The lineup of 40 distinguished local and international speakers reflected SADA's continued commitment to inclusivity, gender balance, and academic excellence. Delegates walked away with practical tools, renewed insight, and a sharpened professional edge.

Workshops, discussion panels, and live demonstrations provided engaging, interactive learning experiences beyond the lecture hall, giving all attendees – from students to specialists – opportunities to grow and collaborate.

A Night to Remember: The 2025 SADA Gala Dinner

Among the standout moments of the Congress was the *SADA Gala Dinner*, held on *26 July 2025* at the Hilton Hotel Ballroom. Masterfully hosted by *Mr KC Makhubele*, the evening was a rich blend of recognition, entertainment, and unity.

Guests were welcomed with live music by *Kirsty on Sax*, followed by opening addresses from the SADA CEO and *SADA President Dr Paul Mathai*. The night honoured

excellence at every level of the profession:

Student Awards 2024
Dr Aiden Schlome – University of Pretoria
Dr Marguerite Brussow – University of the Witwatersrand
Dr Shazeea Rawoot – University of the Western Cape
Dr Charl Marais – University of the Western Cape

Young Publisher Competition Awards
These awards recognise research excellence among professionals under 35:

Undergraduate Research Award
Mrs Bibi Dalvie, Sibiya Bata, and Mr Tshepang Lenkoe

Postgraduate & Non-Degree Research
Dr Steve Swanepoel (Runner-up), Dr Danica Smit (Winner)
The winners received trophies, certificates, and cash prizes, with their work set to be featured in future editions of the

SADJ.
Professional Recognition Awards
The *SADA Meritorious Service Award*, *Service Excellence Award*, and the prestigious *SADA Premier Award* celebrated long-standing dedication and service to the profession:

Meritorious Service Recipients:
Dr Vinay Amaidas
Dr Rhonin Naidoo
Dr Vivesh Rughubar
Dr Barry Beilinsohn

Service Excellence Award:
Dr Arnil Kissoon

SADA Premier Award:
Dr Roux Vermeulen

Distinguished Dental Trade Professional Award:
Mrs Ingrid de Klerk, for over two decades of service with Colgate-Palmolive

The ceremony closed with *Long Service Awards* for Ann Bayman (30 years) and Punkaj Govan (28 years), a *Best Stand Award*, followed by dessert and a vibrant dancefloor hosted by a DJ. The event concluded at midnight – a fitting celebration for a milestone occasion.

Leadership in Action
The presence of *SADA Board Members* throughout the Congress – particularly *Chairperson Dr Francois Meyer* and *President Dr Paul Mathai* – was a visible and meaningful demonstration of leadership and solidarity. Their adaptability as the Congress programme evolved, and their direct engagement with stakeholders, exhibitors, and delegates, reaffirmed SADA's values in practice.
Their support was pivotal in fostering the professional tone and high standards observed throughout the event.

Looking Forward
As we reflect on the 2025 Congress, we are both humbled and energised. Challenges – such as those presented by logistical constraints and coordination with SADTO – were met head-on with resilience and professionalism. The results speak for themselves: a well-executed, future-focused gathering that reinforced the essential role of continued learning in our field.

We will release a detailed Congress report in due course, including attendance breakdowns, feedback, and strategic insights.

A Profession Reimagined
SADA's mission remains clear: to *advance the dental profession* through visionary leadership, collaborative growth, and excellence in education. The 2025 Congress demonstrated that we are not just keeping pace with change – we are helping to shape it.

Here's to 2026 – and to continuing the journey of lifelong learning, together.

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Obturation Quality after Pulpectomy Treatment in Primary Molars using Different Preparation Techniques

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I Middleton[1], M Vorster[2], PJ van der Vyver[3]

INTRODUCTION

Pulpectomy is the preferred treatment option to preserve primary teeth with pulpal necrosis or irreversible pulpitis.[1] Primary teeth guide the eruption of permanent teeth and act as natural space maintainers in the dental arch.[2] Primary teeth also aid in chewing, prevent speech problems and aberrant tongue movement, improve aesthetics, and prevent psychological effects due to premature tooth loss. The retention of primary teeth is therefore of paramount importance.[3] Pulpectomy treatment in primary molars is challenging due to complex internal anatomy and morphology, and due to the process of physiological root resorption.[4] The outcome and overall success of pulpectomies are often considered unpredictable and depend on various treatment- and patient-related factors.[5] Dental practitioners might therefore refrain from performing these treatments despite the importance of preserving primary teeth.

The objective of pulpectomy treatment is to completely remove residual necrotic material, vital tissues, debris, and infected dentine from the root canal system and replace this with inert obturation material.[6] During the pulpectomy procedure, dental practitioners have to create space for instrumentation, attain an ideal shape for irrigation and obturation while retaining the integrity of the root and preserving dentine.[7] For pediatric patients, root canal preparation is usually performed using manual stainless steel (ss) K-files, and to a lesser degree, rotary nickel-titanium (NiTi) files.

The use of manual ss K-files has been the "gold standard" for preparing root canals during pulpectomy treatment in children.[8,9] However, preparation with hand instruments is time consuming and iatrogenic, procedural accidents such as canal transportation, ledging, zipping, and apical blockage often occur due to the inflexibility of ss K-files.[10] To overcome these challenges, much attention has been given to other options such as NiTi rotary and reciprocating instruments for treating primary teeth. The advantages of NiTi instruments include increased flexibility, super elasticity, a significant reduction in preparation times, and better anatomically shaped root canals.[11]

In pulpectomy treatment, high quality obturation often determines the long-term success of the procedure. As the aim of pulpectomy is to fill the root canal with inert obturation material, high quality obturation implies optimal filling without under filling or overfilling.[12] The ideal obturation material for primary teeth should have the same resorption rate as that of the original root, be anti-bacterial, be harmless to the permanent tooth germ and surrounding tissues, and also resorb if extruded through the apex.[13] In this study, the authors wanted to evaluate the shaping ability of different instrumentation types with a high degree of reliability. Vitapex (Neo Dental Chemical Products Co., Ltd, Tokyo, Japan), a premixed calcium hydroxide and iodoform paste, was chosen as the obturation material.[13]

In pediatric patients, pulpectomy treatment is often avoided due to the complexity of the procedure and the need for longer chair times when using manual instruments. In a previous study, the authors compared the preparation times when using ss K-files (ISO size 20-35), the rotary ProTaper Gold SX file (Dentsply Sirona, Ballaigues, Switzerland), and the reciprocating WaveOne Gold Medium file (Dentsply Sirona) and found that manual preparation was much slower than when using rotary or reciprocating files. In this study, the authors compared the obturation quality with Vitapex as obturation material, between different canal shaping instruments. Canal shaping was done with manual ss K-files (ISO size 20-35), the rotary ProTaper Gold SX file, and the reciprocating WaveOne Gold Medium file.

The objective of this study was to evaluate and compare the obturation quality of the canals after canal preparation using the three different file systems to give recommendations on which file system resulted in the best obturation quality.

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METHODS

The study was approved by the Research Ethics Committee, Faculty Health Sciences, University of Pretoria in June 2019 (Reference nr: 272/2019) and in accordance with the Helsinki Declaration of 1975, as revised in 2000. The teeth used for the study were teeth extracted from human patients as part of a comprehensive treatment plan for each individual patient and not for the purpose of this study. Parents gave informed consent for the extractions.

In this ex-vivo, randomised comparative cross-sectional study, 60, extracted, human, primary mandibular second molars were selected, of which the mesiobuccal canals were prepared. The inclusion criteria were root canals clearly visible on pre-preparation digital radiographs, roots that were intact and measured 8 mm or more from the cemento-enamel junction, and an apical foramen size of no bigger than 0.3 mm.[10] Teeth with sclerosed mesiobuccal canals or canals that had been previously accessed endodontically were excluded.[10]

Sixty root canals were randomly divided into three instrumentation groups (K-file, ProTaper Gold SX, and the WaveOne Gold Medium groups) using Research Randomizer software (n = 20).

The teeth were coded and placed in a simulated jaw to replicate the clinical setting. Before access cavity and canal preparations, periapical pre-operative radiographs were taken. Coronal access was prepared using a high-speed hand piece and a diamond fissure bur. An Endo-Z bur (Dentsply Sirona) was used to ensure straight-line access to all root canals. The teeth were then removed from the simulated jaw and a size 10 ss K-file was used to locate the mesiobuccal canals and negotiate to patency. One mm was subtracted from the length of the canal measured to the major apical terminus under 10 times magnification using a dental operating microscope (Zumax Medical Co, Ltd, Suzhou, China) to determine working length.[14] The teeth were placed back into the simulated jaw and an initial size 10 ss K-file was moved in and out of the root canal with amplitudes of 1–2 mm up to working length for all 60 root canals to create an initial, manually reproducible micro glide path. A size 15 ss K-file was used in a similar manner once the size 10 ss K-file moved more freely up to working length. A final reproducible glide path was confirmed when the size 15 ss K-file could reach full working length, pulled back 4 mm and pushed back with light finger pressure without any interference or blockages.[14] After the glide path was confirmed, preparation of root canals was performed using one of three different instrumentation types.

K-file group: Root canal preparation was done by the conventional step-back method using pre-curved ss K-files from size 20 to 35 up to working length with the quarter-turn-pull technique (n = 20).

ProTaper Gold SX group: Root canal preparation was done using the ProTaper Gold SX file with rotation up to working length according to manufacturer's instructions (n = 20).

WaveOne Gold Medium group: Root canals were enlarged using the WaveOne Gold Medium file with reciprocation up to working length according to the manufacturer's instructions (n = 20).

The 40 mesiobuccal canals that were prepared using the rotary and reciprocating files, were all prepared using a 16:1 speed reducing hand piece (X-Smart Endo motor, Dentsply Sirona). Throughout the instrumentation process, each canal was irrigated with 5 ml of 3% sodium hypochlorite solution, and RC Prep (Premier, Pennsylvania, USA) was used as a lubricant. The flutes of the files were cleaned of debris after each insertion. The rotary and reciprocating files were used only once to prepare the canal before being discarded.

After final irrigation, the canals were dried with matching paper points. After canal preparation, a bubble of red wax was placed around the apex of each root to create a halo space around the apex, preventing unnecessary extrusion of the obturation material through the apex. The roots were then mounted in plaster moulds to obturate the prepared canals.[15] Obturation was done with Vitapex according to the manufacturer's instructions. A post-operative digital radiograph was taken to evaluate obturation quality. An adjusted scoring system was used to evaluate the obturation quality for each canal based on previous methods described in literature.[16-18] Two evaluators blinded to the groups assessed the presence of voids and extent of fill based on the following criteria to limit bias and ensure reliability of results.

Presence of voids:

Score 1: Entire canal perfectly filled, well adapted to the root canal with no voids
Score 2: Imperfectly-condensed root canal filling with irregularities of less than 0.25 mm
Score 3: Imperfectly-condensed root canal filling with irregularities of 0.25–1 mm
Score 4: Poorly-condensed root canal filling with irregularities of more than 1 mm

Extent of fill:

Grade A: Less than half of the root canal length was filled
Grade B: More than half the root canal length was filled but not optimal
Grade C: Optimal filling (canal filled to within 0–1 mm from the apex)
Grade D: Overfilling of the root canal to an acceptable standard (< 1 mm through the apex)
Grade D+: Extreme overfill, not acceptable (> 1 mm through the apex)

The presence of voids (Score 1–4) and the extent of fill (Grade A–D+) were combined to grade obturation quality (Table 1). Each tooth was graded as "good", "average", "poor" or "failed" (Figure 1).

STATISTICAL ANALYSIS

The analysis was descriptive and inferential, and all analyses were performed using SAS (SAS Institute Inc, Cary, NC, USA), Release 9.4. The obturation outcomes ("good", "average", "poor" or "failed") were compared between the three instrumentation groups using the Fisher Exact test.

RESULTS

The obturation outcomes observed across the three instrumentation groups differed significantly ($p = 0.016$). This was followed up by pair wise comparisons for each obturation outcome.

The proportion of "good" obturation outcomes observed with the ProTaper Gold SX group (65%) was significantly

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Table 1: Scoring criteria for obturation quality in pulpectomy of primary molars

Obturation quality score	Presence of voids (1–4) + extent of fill (A–D+)
Good	1C, 2C, 1D, 2D
Average	3C, 4C, 3D
Poor	1B, 2B, 3B, 4D
Failed	1A to 4A, 1D+ to 4D+, 4B

Figure 1 A-D: Obturation quality score: Good (A), Average (B), Poor (C) and Failed (D).

higher than observed in the K-file group (25%, p = 0.025) but was similar to the proportion of "good" outcomes observed in the WaveOne Gold Medium group (55%, p = 0.748). The proportion of "average" obturation outcomes was similar across the three groups (Table 2). The proportion of "poor" obturation outcomes was significantly higher in the K-file group (40%) than that observed in the ProTaper Gold SX group (5%; p = 0.020). No other significant differences were observed (Table 2).

DISCUSSION

In this study, obturation quality was assessed. Three different preparation instrumentations were used to prepare root canals during pulpectomy treatment. The authors found that manual preparation resulted in more "poor" obturation outcomes than the outcomes observed using rotary files. These findings are similar to the results of several other studies.[3,9,19,20] No significant differences in obturation quality were observed when comparing rotating or reciprocating files in the preparation of primary teeth.

Obturation quality is a key factor that influences the long term success of a pulpectomy.[21] The quality depends on effective mechanical cleaning and shaping of the root canal. During canal preparation, it is essential to remove micro-organisms, debris and residual pulp while preserving the original shape of the canal.[22-24] The prognosis of a pulpectomy also depends on the length of the root canal filling [12,24,25] and the presence and size or absence of obturation material voids.[17,20] The presence of voids can lead to leakage and the possibility of retained micro-organisms leading to reoccurring abscess formation and periapical disease after treatment.[17,26] Under instrumentation or extreme overfilling of root canals have also been proven to cause treatment failure.[3,22] Whereas optimally

Table 2: Obturation quality observed following root canal preparation using three different instrumentation types

Obturation quality	Frequency (%)		
	K-file group	ProTaper Gold SX group	WaveOne Gold Medium group
Good	5 (25)[a]	13 (65)[b]	11 (55)[b]
Average	4 (20)[a]	2 (10)[b]	0[b]
Poor	8 (40)[a]	1 (5)[b]	3 (15)[b]
Failed	3 (15)	4 (20)*	6 (30)
Total	20 (100)	20 (100)	20 (100)

Mean values with different superscript numbers were statistically different at p value <0.05

*2 of these failed cases were lateral perforations caused by the preparation technique.

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filled or slightly overfilled root canals have been proven successful when obturating with a resorbable paste, such as Vitapex.[13,27]

Ultimately, endodontic obturation aims to create a bacteria-tight seal from the coronal opening of the canal to the apical termination.[12] Endodontic failures usually occur when bacteria persist in the root canal, filling is inadequate due to poorly shaped/cleaned root canals, materials overflow through the apex, poor coronal seal, unprepared canals, and procedural errors.[23] Overfilling of root canals is a common finding, especially when root resorption has already started to take place. Excessive overfilling of root canals can lead to the irritation of the surrounding periapical tissues and cause deflection of the permanent successor. Deflection of the permanent successor defeats the purpose of a pulpectomy, which is to maintain function and space, by not extracting the primary tooth, and allowing normal growth and physiological root resorption.[13]

Different techniques have been proposed for mechanical preparation of root canals, although manual filing is still considered the "gold standard." Manual filing using ss K-files however has limitations, as these files are more rigid causing aberrations, irregularities, and ledges in the root canal making optimal obturation difficult.[28] The findings of this present study are in agreement with many other studies[10,11,20,28], as the authors also found that manual ss K-files resulted in inferior obturation quality than that observed with other instrumentation groups. These include rotary and reciprocating files. To improve obturation quality, dental practitioners may prefer to prepare canals with rotary or reciprocating file systems.

NiTi rotary files create a predetermined conical shaped canal. These files are specifically designed to be super flexible to closely follow the original canal shape, resulting in uniform and predictable obturation.[29] Several studies have concluded that NiTi rotary files create a smooth, predetermined, funnel-like shape without the risk of ledge formation and canal transportation.[5,30,31] The use of NiTi rotary files, designed for permanent teeth, in primary teeth raises concerns because primary teeth have narrower, curved roots, and ribbon-shaped canals increasing the risk of lateral perforation.[32] Subsequently NiTi rotary files should be designed specifically for primary teeth to prevent lateral perforations.[32] In the present study, two lateral perforations were observed, both caused by the ProTaper Gold SX file. These lateral perforations might be explained by the larger taper of the ProTaper Gold SX file, ranging from 3.5%–19%. This file has the largest taper of all the files in the ProTaper Gold system with cross-sectional diameters of 0.50, 0.70, 0.90, and 1.10 mm at D6, D7, D8, and D9 respectively and a tip size of 0.19mm.[33] Many practitioners already have endodontic armamentarium including the ProTaper Gold system which they use for pulpectomies in primary teeth to prevent additional expenses. In our study, the ProTaper Gold SX resulted in the best obturation quality with the most "good" outcomes.

Obturation quality is apparently affected by the taper and metallurgy of instruments which affects shaping and cleaning.[34] The three instruments tested in our study, included the ProTaper Gold SX, WaveOne Gold Medium, and manual ss K-files, which differed in both metallurgy and taper. Several studies have been done in primary teeth comparing manual and rotary preparation techniques to determine which technique results in the best obturation quality [3,4,20,28], but little scientific evidence is available comparing obturation quality between manual, rotary files, and reciprocating files in primary molars. Hence, these three groups were investigated in our study.

In 2014, Katge, Patil, Poojari, Pimpale, Shitoot, Rusawat [35] also investigated canal preparation using three different file systems but they only evaluated preparation times and cleaning efficacy, but not obturation quality. This is the only study, to the researchers' knowledge, that was done where a reciprocating file system was compared to manual ss K-files and a rotary file system. One case report done in 2011 concluded that the ProTaper Universal SX file (Dentsply Sirona) produced adequate chemo-mechanical preparation of canals and satisfactory obturation after shaping and disinfection.[36] The authors of the current study also tested the WaveOne Gold file system, which has a parallelogram-shaped cross-sectional diameter which limits the engagement of the file and dentine to only one or two points of contact at any given stage of canal preparation. This improves the safety of the file with less taper-lock and screw-in effect. The file's cross-sectional design also allows for more debris extrusion during canal preparation. The file is designed with a progressively decreasing percentage taper from D14–D16 to preserve dentine.[33] The WaveOne Gold file engages at a counter-clockwise angle of 150° and a clockwise disengaging angle of 30°. After three cutting cycles the file rotates one complete circle. This unique movement, according to Ruddle [33] is a major advantage due to the safety of the file when compared to continuous rotating files. The file advances more readily to the desired working length without excessive inward pressure and debris extrusion from the canal. There are four WaveOne Gold files in different sizes and lengths: small (20/07), primary (25/07), Medium (35/06), and large (45/05). According to the manufacturer, the primary (25/07) file is suitable for shaping most root canals in permanent teeth but will not be suitable for primary teeth due to the increased taper of primary canals. In this study, the Medium (35/06) file was used due to its tip size corresponding to that of the prescribed manual ss K-file size of 35.[5]

Obturation quality was assessed by using post-operative radiographs, which are two-dimensional images of three-dimensional objects. This was done in a simulated setting, and the findings of this study may differ in a clinical setting. Obturation quality is likely to be affected by a wide range of factors that were beyond the scope of this study.

Rotary and reciprocating file systems perform better than manual instrumentation in terms of obturation quality and even results in faster preparation times,[37,38] but results suggest that there is a need to create a dedicated file for pulpectomy in primary teeth. Further studies should be done thickness and cleaning efficiency as the authors of this study only evaluated the obturation quality. The file should have a smaller taper to prevent lateral perforations. More research should also be done on other file systems already used by practitioners for permanent teeth, to recommend suitable file options for pulpectomy in primary teeth.

CONCLUSIONS

Based on the results of this study, the authors conclude the following:

1. The rotary ProTaper Gold SX file showed superior obturation quality followed by the reciprocating WaveOne

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Gold Medium file and then conventional ss K-files.
2. The K-file group resulted in the most "poor" and "average" outcomes.
3. There was no significant difference in "failed" outcomes between all three groups.
4. Although further clinical studies are recommended, we conclude that both ProTaper Gold SX and WaveOne Gold Medium files might be viable instrumentation options for pulpectomy treatment in primary molars, although remaining dentine and root thickness should be carefully evaluated to avoid perforations or over instrumentation.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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CPD questionnaire on page 336

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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Final-year dental students' perceptions of verbal feedback in the clinical setting

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ABSTRACT

Verbal feedback has been shown to improve student learning and performance, increase professional collaborative dialogue and communication, and develop student identity and self-worth.

Purpose

To explore final year dental students' perceptions of verbal feedback practices within the clinical setting.

Methods:

A cross-sectional, exploratory descriptive quantitative study with additional open-ended, qualitative responses was employed in a cohort of 71 final-year dental students. The questionnaire investigated four main constructs i.e. the nature of feedback, the value of feedback, the clinical environment and supervisor-specific factors which impact on verbal feedback practices.

Results:

Data was analysed using both quantitative and qualitative approaches. Thematic analysis of the open-ended written responses was conducted. The findings indicated that students are aware of the multiple benefits of verbal feedback for the improvement of both their theoretical knowledge and clinical skills, but they felt that not enough time is devoted to verbal feedback practices following their clinical sessions. The importance of mutual respect, professionalism and autonomy of thought were emphasised as key variables which underpin successful verbal feedback.

Conclusion

This study highlighted the importance of raising awareness within the faculty regarding the various forms of feedback and the need for effective action plans to improve student learning and performance.

Key words

Formative assessment, feedback, clinical assessment, clinical teaching, clinical environment

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Conflict of interest

None to declare (financial, personal or professional).

INTRODUCTION

Assessment drives student learning (Wass, van der Vleuten, Shatzer & Jones, 2001; Downing & Yudkowsky, 2009) and for dental students, verbal feedback from clinical supervisors regarding knowledge and clinical skills should form a large part of the formative assessment (Boud, 1990; Black & Wiliam, 1998; Downing & Yudkowsky, 2009; Schuwirth & van der Vleuten, 2014). Formative assessment, or assessment 'for learning', should take on a strong focus in education as it is vital for student learning (Boud, 1990; Black & Wiliam, 1998; Downing & Yudkowsky, 2009; Schuwirth & van der Vleuten, 2014), especially in the clinical context where clinical skills are acquired (Rolfe & Sanson-Fisher, 2002; Taylor, Grey & Satterthwaite, 2013). These clinical skills will ultimately have an impact on patient management.

Students should receive constant and meaningful advice and feedback from supervisors in a supportive and educationally conducive learning environment, to promote active engagement, student interest and active learning during the execution of clinical tasks (Rolfe & Sanson-Fisher, 2002; Taylor *et al*., 2013). This facilitates a deeper approach to learning (Rushton, 2005) and simultaneously promotes reflective practices among students with regards to self-appraisal (Mubuuke, Louw & van Schalkwyk, 2017). Feedback is therefore essential for dental students following the treatment of their patients in the clinical area as it gives students the chance to compare differences and similarities between their actual performances and the target performance (Boud & Molloy, 2013; Musick, 2014). It allows them to identify their strengths and weaknesses in terms of their performance and with respect to meeting the learning objectives successfully. It also gives clinical teachers a better indication of which aspects of the content need more attention in terms of learning and teaching activities, which may need more explicit direction and which may possibly require more emphasis in terms of those sections which are felt to be less understood by students (Boud, 1990; Black & Wiliam, 1998).

The dental degree programme is a five-year course. At the Dental Faculty of ***, students typically enter the clinical area in the middle of their third year, when they start to treat patients.

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This continues until the end of their final year. Students have therefore been exposed to verbal feedback on their clinical performance since their third year of study. Final year dental students typically attend ten clinical sessions per week. This offers clinical supervisors ample opportunity to provide feedback regarding student performance, improvement and progression in terms of their clinical skills, knowledge acquisition and application in a practical sense.

High quality feedback is vital for work-based learning in health professions education, as the nature of the student-teacher interaction has a direct effect on student performance levels and learning outcomes (Holmboe, Sherbino, Long, Swing, & Frank, 2010; Morris & Blaney, 2010; Boud & Molloy, 2012) and therefore directly impacts on patient outcomes. The inability of students to be able to improve their clinical competency and learn from their mistakes would have negative consequences for dental care delivery to patients.

High quality feedback is, per definition, as much about effective delivery from the supervisor as it is about the interpretation and value of the feedback when it is received by the student (Boud, 1990). Verbal feedback should result in active student involvement, which aims to facilitate the development of a suitable and practical plan of performance enhancement (Sadler, 1989; Hattie & Timperley, 2007; Molloy & Boud, 2013) by narrowing the chasm that exists between what students know and what is expected of them in terms of knowledge and skills (Sadler, 1989; Hattie & Timperley, 2007; Kaufman, 2003; Molloy & Boud, 2013). The action plan is a crucial component of delivering high quality feedback, which maximises the educational impact of the feedback received (Ende, Pomerantz & Erickson, 1995; Blatt, Confessore, Kallenberg & Greenberg, 2008; Hamburger *et al.*, 2011; Pelgrim, Kramer, Mokkink & van der Vleuten, 2012) and should be constructed via the conversational duality and active collaborative dialogue between student and educator (Johnson *et al*., 2016). It should also improve aspects such as critical reflective thought, reasoning and problem-solving skills of students (McDade, 1995; Popil, 2011). The quality of the student-educator relationship can therefore have a noticeable effect on stimulating student emotions (Molloy & Boud, 2013) by either improving or limiting the potential for learning (Hattie & Timperley, 2007; Carless, 2013).

It is well accepted that feedback should be given as timeously as possible (Lara, Mogensen, & Markuns, 2016), soon after the learning event and based on first-hand observations between the student and educator in a detailed, specific and clearly understandable manner for the student (Johnson *et al*., 2016). It should be directed to actions and behaviours which can be changed and not towards personal attributes of the student (Ende, 1983; Kluger & DeNisi, 1996; Lara *et al*., 2016). Feedback should aim to be transparent and predictable in nature, which reduces student anxiety associated with the evaluation and assessment process by allowing students to be able to readily identify what is expected from the feedback encounter (Rudolph, Simon, Raemer, & Eppich, 2008).

Face-to-face verbal feedback is not always beneficial for students or their learning and poor quality feedback may cause harm to students personally and not improve their performance (Litzelman, Stratos, Marriott, Lazaridis, & Skeff, 1998; Veloski, Boex, Grasberger, Evans & Wolfson, 2006; Hattie & Timperley, 2007; Sargeant, Mann, Sinclair, van der Vleuten & Metsemakers, 2007; Ivers *et al.*, 2012). Several reasons have been put forth to explain this, including poor credibility of the educator; lack of relevance of the feedback given (Bing-You, Paterson & Levine, 1997; Lockyer, Violato & Fidler, 2003; Johnson *et al*., 2016); poor comprehension of the feedback content (Bing-You *et al*., 1997; Sargeant, Mann & Ferrier, 2005; Johnson *et al*., 2016); and feelings of being unfairly treated, judged or victimised on the student's part (Hewson & Little, 1998; Sargeant *et al*., 2005; Sargeant *et al*., 2008; Moss, Derman & Clement, 2012).

The readiness of students to receive, accept and utilise feedback to effect the necessary changes in their behaviour to improve their clinical performance (Deci & Ryan, 2000), is affected by their perception of feedback and how they are able to engage with the process (Holmboe *et al.*, 2010; Morris & Blaney, 2010; Boud & Molloy, 2012). This is concurrently dependent on a multitude of factors which include the learning environment (Carless, 2013), and the nature and value of feedback (Johnson *et al*., 2016). Issues such as the supervisor's role, behaviour (Carless, 2013) and credibility (Bing-You *et al*., 1997; Johnson *et al*., 2016), the content that is included in the feedback (Sargeant *et al*., 2005; Johnson *et al*., 2016) and how the content is relayed (Valcke, 2001; Lara *et al*., 2016), are similarly important during feedback.

The limiting nature of the dental clinical area is not always a suitable environment in which high quality feedback can take place. This could affect how feedback is perceived, accepted and used by students to learn and grow– personally and professionally. Resource and time constraints limit the opportunities for practicing effective formative assessment and feedback (Yorke, 2003; Gibbs, 2006; Price, Handley, Millar, & O'Donovan, 2010). At present, this is very applicable to the South African and *** contexts in particular and the delivery of goal-directed and impact-driven, high quality verbal feedback should therefore be prioritised as it remains a cornerstone of learning and teaching and quality assurance.

In order to make meaningful changes, it is important to determine the aspects of verbal feedback which are perceived by final year dental students as being valuable influences and determinants of their clinical performance and progress following a clinical session, and what their perceptions are of the clinical environment and the clinical supervisors who provide them with feedback. This would highlight strengths, weaknesses and inadequacies and help with the development of a successful feedback implementation plan which could promote student learning and considerably improve performance. This feedback plan could further develop the working relationship between the student and educator, improve clinical teaching and ultimately raise the standards of dental care delivery for patients.

The aim of the study was thus to examine the perceptions of final-year dental students as to the quality of feedback provided to them after their clinical sessions with respect to four main constructs, namely:

i. the nature of feedback,
ii. the value of feedback,
iii. the clinical environment in which feedback takes place, and
iv. the influence of supervisor-specific factors on how feedback is received by students.

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METHODS

A cross-sectional, exploratory descriptive quantitative study was employed in a cohort of final year dental students at *** Dental Faculty. A structured questionnaire was used which included additional open-ended questions to record qualitative responses for each of the four constructs being investigated.

The design of the questionnaire was broadly based on validated survey instruments (Stalmeijer, Dolmans, Wolfhagen, Muijtjens & Scherpbier, 2010; Johnson *et al*., 2016) but a more context-specific and detailed instrument was constructed for use in this study. The four main constructs in the questionnaire were formulated by synthesising a variety of appropriate research articles relating to feedback (Nicol & Macfarlane-Dick, 2006; Hattie & Timperley, 2007; Cantillon & Sargeant, 2008; Stalmeijer *et al*., 2010; Ansary *et al*., 2011; Boud & Molloy, 2013; van de Ridder, McGaghie, Stokking & Ten Cate, 2015; Johnson *et al*., 2016.). Under each construct, a series of specific statements (or items) were populated from the above readings. Questions based on the researcher's experience with students were also included. These represented additional broad categories within the pre-defined constructs.

A Likert scale questionnaire was used, whereby a series of pertinent statements (or items) relating to the specific study objectives, were posed to students for their response (Rowe & Wood, 2008; Losby & Wetmore, 2012; Artino, La Rochelle, Dezee, & Gehlbach, 2014). This instrument employed a four-point itemised rating scale (Maclellan, 2001) to measure students' responses (Artino *et al*., 2014). The four labels included 'strongly agree', 'agree', 'disagree' and 'strongly disagree', with the exclusion of a fifth rating label of 'not sure' or 'sometimes' with the explicit intention of eliciting more specific responses from the participants.

The questionnaire was piloted amongst a group of eight fourth-year dental students to examine its degree of acceptance in terms of comprehension, clarity, length and time taken to complete the questionnaire. The pilot study also provided a better indication of the type and detail of written responses to be expected from students and identify where changes should be made to the original questionnaire format and/ or statements to improve its rigor. After considering the results from the pilot study, minor changes were made to the questionnaire before sending the final version for professional formatting.

Target population

Convenience sampling of the entire final year class of 78 dental students was done.

Data collection and management

Hard copies of the questionnaire were distributed to the final year dental class. The purpose of the questionnaire and the mechanism of the instrument was explained to the class who were provided with an information sheet. Informed consent forms were completed by the students. Students were instructed to deposit their anonymously completed questionnaires and consent forms into two separate sealed boxes. To limit the extent to which students might feel coerced or pressured into completing the questionnaire, the researcher did not remain in the room while the questionnaires were being completed, but was available to clarify questions if the need arose. An appointed research assistant remained in the room and ensured that the completed questionnaires and consent forms were collected separately.

The Student Feedback Unit at the Centre for Teaching and Learning at *** formatted the questionnaire and captured the data, thereby ensuring better control of the correctness and accuracy of the data capturing. Quantitative data was captured on an Excel spreadsheet. The responses from the open-ended (qualitative) questions were captured in a Word document.

Data analysis

For quantitative data, statistical analysis was conducted by a bio-statistician using IBM SPSS version 25 (IBM, 2017) to analyse the data. Sample responses to the individual items were described using frequency tables. Scores were created by averaging the responses to the items in each scale. Missing values were very few, but they were dealt with by assigning the sample mean to the missing value for that item prior to calculating the scores.

Qualitative data analysis took place with the active assistance from the survey specialist consulted with, in order to improve the trustworthiness of the interpretations made. A combined, adaptable and flexible approach of both deductive and inductive analysis was employed for the open-ended questions, using the six-phase method of thematic analysis by Braun & Clarke (2006). Data was collated as relevant to each verbal code in an inductive manner and open-coding of as many individual perspectives, attitudes, emotions, experiences and incidents as possible was done (Gale, Heath, Cameron, Rashid & Redwood, 2013), whereby descriptive phrases could be coded for, which are strongly linked to the data obtained from the study (Braun & Clarke, 2006). Codes were then collated into categories as determined deductively by the questionnaire, but also inductively as new categories emerged within each of the four constructs in an iterative manner (Auerbach & Silverstein, 2003).

Ethical considerations

Approval for the study was obtained from *** Ethics Committee (Reference number: S18/02/026) as well as from the Registrar's Office of *** (Reference number: UWCRP120318CP).

Study participants were provided with a comprehensive information sheet attached to the questionnaire, as well as detailed informed consent forms with explicit details of the benefits and reasons for participating in the study. Participation in the study was voluntary without any consequences for non-participation.

All data was stored in securely-locked cabinets and/ or password-protected computers for the duration of the project. Electronic files of quantitative data will be kept for five years, then destroyed. As all questionnaires were completed anonymously by students, no identifying information (such as names, ages, contact details or student numbers) were stored with the data and hence no de-identification methods were required.

Results

A total of 71 students out of a class of 78 participated in the study. Seven students were not present in the class on the day that the questionnaire was administered.

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Table I: Frequency Table for the nature of feedback provided by clinical supervisors.

Item on Questionnaire	Strongly agree		Agree		Disagree		Strongly disagree	
	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %
1. I usually do not receive feedback from my supervisor after my clinical session.	18	25.4%	40	56.3%	12	16.9%	1	1.4%
2. Feedback gives me an opportunity to interact with my supervisor in a positive way.	24	33.8%	42	59.2%	5	7.0%	0	0.0%
3. The feedback I receive is usually based on my past performance and not on current performance.	13	18.3%	16	22.5%	37	52.1&	5	7.0%
4. Feedback from my supervisor has a negative effect on my emotional state.	10	14.3%	19	27.1%	31	44.3%	10	14.3%
5. I want feedback after my clinical session.		80.0%	13	18.6%	1	1.4%	0	0.0%
6. Not enough time is devoted to feedback after my clinical session.	24	33.8%	33	46.5%	13	18.3%	1	1.4%

Frequency tables were constructed on their original scales for the items under the four proposed constructs. The total count and percentage of responses for each item/ question/ statement is indicated within the specific construct based on the four-point Likert scale. These tables refer to the first objective of the study, which is to examine what the students' perceptions of verbal feedback practices are in terms of the four main constructs.

The findings of the open-ended questions are presented under each of the four main proposed constructs as detailed in the questionnaire. This includes a summary of the main categories identified after coding the written responses with the number and percentage of respondents in the identified categories. A table depicts the data for each construct. Additionally, under each category, students' written responses have been included to better clarify and give meaning to the data in support of the main identified categories, where the number and category correspond to that in the respective tables.

Nature of feedback

From Table I, 81.7% (n=18+40) of students agreed that they do not usually receive feedback after their clinical session (item 1); while all but one student (98.6%) agreed that they wanted feedback (item 5). In fact, 80% strongly agreed that they wanted feedback (item 5). Approximately 80% (n=24+33) of students who felt that not enough time is devoted to feedback after their clinical session (item 6), while 93% (n=24+42) agreed that feedback creates an opportunity to positively interact with their supervisor (item 2). It was encouraging to see that majority of students (58.6%) disagreed that feedback affects their emotional state negatively (item 4), and 59.1% (n=37+5) disagreed with the statement that feedback is based more on their past performances (item 3).

The categories in Table II were created after coding the written responses to the open-ended question on the questionnaire, which asked students to '*Describe in your*

Table II: Open-ended responses for the nature of feedback, as relating to the above question.

	CATEGORIES	NUMBER (n=71)	%
1	Feedback should focus on both positive and negative aspects	51	71.8
2	Feedback should be based on current student performance	45	63.4
3	Feedback should be done immediately after the clinical session	37	52.1
4	Feedback should include an improvement plan	33	46.5
5	Feedback should be a motivation/ reason for the clinical mark	27	38.0
6	Discussion/ communication is needed and is important	24	33.8
7	Should only involve the student and supervisor/ one-on-one basis	23	32.4
8	Feedback must be given professionally/ non-confrontationally/ fairly	17	23.9
9	Too much negative feedback is given	14	19.7
10	Not enough feedback is given and more time is needed for feedback	13	18.3
11	Verbal feedback can have an emotional strain on students	9	12.7
12	Supervisors should listen more during feedback	8	11.3

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own words what you consider to be optimal feedback, including how feedback is offered, who offers it, and when.' It is important to note that not all students provided responses for this section of the questionnaire.

A selection of individual student responses in the form of direct quotations, within the main identified categories are listed below.

1. Feedback should focus on both positive and negative aspects of student performance:
   "Optimal fe edback would consist of the positive and negative parts of my clinical session…, whereby I can assess… the positive and negative aspects of my session with my supervisor."

2. Feedback should be based on current student performance:
   "Supervisors need to consciously put effort into evaluating clinical performance of a student on the day and not just evaluating a student based on their past or their perceptions."

3. Feedback should be done immediately after the clinical session:
   "Feedback should be given post-session; enough time should be made available for that… and this should be done after *every session."*

4. Feedback should include an improvement plan:
   "…I would like to know: Basically, if you, as the supervisor, were also my employer at the time, would you be willing to allow me to work on your patients and if not, why not and how could I improve?"

5. Feedback should be a motivation / reason for the clinical mark:
   "Some supervisors may need to motivate their choice of clinical mark better, as it does appear as if some of them are giving the same marks routinely without correlating the mark with the verbal feedback (e.g. the verbal feedback may be positive for the session but the clinical mark does not reflect this)."

6. Discussion / communication is needed and is important:
   "I enjoy it when supervisors ask me to reflect on my own performance, as it opens the discussion to healthy debates."

7. Too much negative feedback is given:
   "Having feedback about just the negative things from supervisors doesn't do anyone good, because we tend to end up doubting our every move / decision in the clinics because we are being constantly told that we suck."

Value of feedback

All but five students (93%) agreed that feedback is valuable for them in developing their skills (item 7), with a combined 80.3% (n=45+12) agreeing that this feedback is useful for them (item 9). Roughly 50% disagreed that the verbal feedback received is usually clear and specific (item 10). With regards to the identification of student strengths and weaknesses (items 12 and 13, respectively), the data

Table III: Frequency Table for the value of feedback, as reported by students

Item on Questionnaire	Strongly agree		Agree		Disagree		Strongly disagree	
	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %
7. Feedback from my supervisor is not valuable in developing my skills.	2	2.8%	3	4.2%	31	43.7%	35	49.3%
8. Feedback from my supervisor helps me to identify where I need to improve.	42	59.2%	26	36.6%	2	2.8%	1	1.4%
9. The verbal feedback I receive is usually not helpful to me.	6	8.5%	8	11.3%	45	63.4%	12	16.9%
10. The verbal feedback I receive is usually clear and specific.	2	2.8%	31	43.7%	32	45.1%	6	8.5%
11. My supervisor does not usually ask me to reflect on my own performance after the session.	16	22.9%	38	54.3%	14	20.0%	2	2.9%
12. My supervisor identifies my strengths during feedback.	2	2.8%	20	28.2%	34	47.9%	15	21.1%
13. My supervisor identifies my weaknesses during feedback.	12	16.9%	48	67.6%	8	11.3%	3	4.2%
14. My supervisor helps me to develop an action plan for improving my performance.	1	1.4%	15	21.2%	37	52.1%	18	25.4%
15. I consider this action plan to be the most important part of receiving feedback.	21	29.6%	43	60.6%	6	8.5%	1	1.4%
16. My supervisor rarely helps me to set goals for future clinical sessions.	25	35.2%	35	49.3%	11	15.5%	0	0.0%
17. The feedback provided promotes critical thinking and problem-solving after my clinical session.	11	15.7%	35	50.0%	22	31.4%	2	2.9%

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18. I find it difficult to use the criticism from feedback in a constructive way to improve my performance.	5	7.1%	9	12.9%	41	58.6%	15	21.4%
19. I usually don't want to be asked my opinion about my own performance after a clinical session.	7	9.9%	20	28.2%	28	39.4%	16	22.5%
20. The feedback I receive is not usually an accurate reflection of my performance during a clinical session.	11	15.5%	32	45.1%	25	35.2%	3	4.2%
21. It is equally important to receive feedback about both my theoretical knowledge and clinical performance after my clinical session.	27	38.6%	35	50.0%	7	10.0%	1	1.4%
22. I do not always receive verbal feedback about my theoretical knowledge after my clinical session.	23	32.4%	42	59.2%	6	8.5%	0	0.0%

suggests that clinical teachers are more inclined to identify student weaknesses, as agreed by 84.5% (n=12+48) of students, than they are to identify their strengths, as only agreed by 31% (n=2+20) of students.

Items 15, 16, 17, 19 and 20 relate to student performance and improvement. Although a combined 90.2% (n=21+43) of students agreed that an action plan is an important part of receiving feedback and for future improvement (item 15), only 22.5% (n=1+15) agreed that their supervisors help them to develop such a plan (item 14). A total of 84.5% (n=25+35) of students agreed that supervisors rarely assist them in setting goals for future clinical sessions (item 16), while only 14 students (20%) agreed that they experience difficulty in using verbal feedback in a constructive way to improve their performance (item 18). Majority of students (61.9%) agreed that they would have appreciated being asked their opinions about their own performance (item 19).

With respect to the value of feedback for student learning, approximately two thirds (65.7%) of students agreed that feedback promotes critical thinking and problem-solving (item 17). An overwhelming 88.6% (n=27+35) agreed that it was equally important to receive feedback regarding their knowledge and skills (item 21), but again only 6 students (8.5%) agreed to receiving verbal feedback about their theoretical knowledge after a clinical session (item 22). Reflective practice has well accepted benefits for learning, but 77.2% (n=16+38) of students agreed that supervisors do not usually ask them to reflect on their own performance after a clinical session (item 11).

Table IV is a summary of the main categories identified after coding the students' written responses to the statement *'Describe in your own words what you consider to be valuable and useful feedback',* as posed in the student questionnaire.

Table IV: Open-ended responses of students' opinions of what valuable feedback is.

	CATEGORIES	NUMBER (n=71)	%
1	Feedback identifies areas of improvement	60	84.5
2	Feedback provides constructive advice on how to improve	59	83.1
3	Feedback should identify both strengths and weaknesses	41	57.8
4	Feedback increases student encouragement/ motivation/ self-confidence	31	43.7
5	Feedback improves learning, understanding and knowledge	29	40.9
6	Feedback improves clinical skills/ being a better clinician/ clinical progress	20	28.2
7	Feedback/ advice on future patient treatment/ management	17	23.9
8	Feedback promotes professionalism/ prepares students for the real world	11	15.5
9	Feedback is important for an action plan/ goal setting/ provides solutions	11	15.5
10	Feedback allows students to learn from mistakes (clinically)	10	14.1
11	Feedback facilitates the reproduction of good work	9	12.7
12	Feedback builds relationships (between student and supervisor)	6	8.5

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Illustrative quotes taken from the qualitative data set and which motivated the creation of the above listed categories include the following:

1. Feedback identifies areas of improvement:
   "If a student is really struggling, feedback must always be given so that they know where they are going wrong and where they must improve."

2. Feedback provides constructive advice on how to improve:
   "It's feedback that shows you how you can improve or change certain things so that you don't encounter the same problem in future…"

3. Feedback should identify both strengths and weaknesses:
   "Valuable and useful feedback for me would be a supervisor helping me identify my strengths and weaknesses and giving me constructive advice on how to overcome my weaknesses or problem areas I may have in clinics, and filling in the gaps in my knowledge."

4. Feedback increases student encouragement/ motivation/ self-confidence:
   "Valuable feedback can be motivational for students… Useful feedback is when a lecturer motivates the students on how they can improve their work in future."
   "It is nice to hear that you are doing right or where you are performing good – it boosts confidence, which is needed to continue performing good."

5. Feedback improves learning, understanding and knowledge:
   "Useful feedback helps me learn new things (techniques, management of cases). Optimal feedback must be given just to make a student learn more…"

6. Feedback improves clinical skills/ being a better clinician / clinical progress:
   "Valuable feedback is feedback that will mould you into becoming a better dentist with the right clinical ability. Useful feedback would be feedback that would improve my clinical skills as a clinician."

The clinical environment

Although 52.1% of students agreed with item 23, that the clinical environment is not best suited to receiving verbal feedback, roughly 80% (n=22+34) agreed that they can actively learn within this environment (item 24) and 50.7% disagreed that receiving feedback in the clinical environment makes them feel uncomfortable (item 25). Considering item 27, 26.8% of students strongly agreed and 49.3% agreed that their privacy and confidentiality is not fully respected within the clinical setting.

Table V: Frequency Table for the role of the clinical environment in feedback practices.

Item on Questionnaire	Strongly agree		Agree		Disagree		Strongly disagree	
	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %
The clinical environment is not conducive (best suited) to receive meaningful feedback.	9	12.7%	37	52.1%	23	32.4%	2	2.8%
The clinical environment is one in which I can actively learn through communication with my supervisor.	22	31.4%	34	48.6%	12	17.1%	2	2.9%
Receiving feedback in the clinical area makes me feel uncomfortable.	7	9.9%	22	31.0%	36	50.7%	6	8.5%
My privacy and confidentiality is not fully respected during feedback within the clinical areas	19	26.8%	35	49.3%	15	21.1%	2	2.8%

Table VI: Open-ended responses of important aspects regarding the clinical environment.

	CATEGORIES	NUMBER (n=71)	%
1	Receiving feedback in the presence of patients is uncomfortable	42	59.2
2	Privacy / confidentiality is important (one-on-one) and/ or lacking	42	59.2
3	Receiving feedback in the presence of supervisors is uncomfortable	31	43.7
4	Receiving feedback in the presence of students is uncomfortable	31	43.7
5	Limited time is available for feedback in the clinical area	16	22.5
6	Feedback administration in the clinic results in embarrassment/ stress/ anxiety for students	15	21.1
7	Receiving feedback in the clinical area is inherently uncomfortable	13	18.3
8	Respect/ dignity is important (mutual) in the clinical area	12	16.9
9	Professionalism during feedback is important in the clinical area	8	11.3
10	Feedback administration affects the relationship between student and patient	8	11.3
11	Patient's feel uncomfortable when feedback is offered in the clinical area	7	9.9

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The question posed to the students in the questionnaire under the construct of the clinical environment was *'Describe in your own words what you consider to be important aspects (positive and/ or negative) of the environment in which verbal feedback is given to you (i.e. the clinical area).'*

1. Receiving feedback in the presence of patients is uncomfortable:
   "Feedback should be given to each student away from their patients, as the fear of judgement/ disappointment has an emotional impact on the student."

2. Privacy / confidentiality is important (one-on-one) and/ or lacking:
   "Privacy and respect is important. It is much nicer when the supervisor gives you feedback in your cubicle compared to outside your cubicle..."
   "…sometimes confidentiality is not maintained as other students hear this and more importantly, other supervisors hear this..."

3. Receiving feedback in the presence of supervisors is uncomfortable:
   "Supervisors often engage in discussion with other supervisors about students during feedback. In essence, your performance is no longer between your supervisor and yourself."
   "Everyone hears the feedback that you receive during your session and some supervisors may use this against you at your next session."

4. Receiving feedback in the presence of students is uncomfortable:
   "I think that any feedback is best given in private rather than at the back of the clinical area, where other students can hear everything. It makes me a little bit uncomfortable."

5. Limited time is available for feedback in the clinical area:
   "There aren't enough supervisors, therefore sometimes there isn't enough time for decent feedback or the supervisors are too rushed to give meaningful feedback."

6. Feedback administration in the clinic results in embarrassment/ stress/ anxiety for students:
   "I think that if you had a bad session, then getting feedback in the clinical area may cause more stress and anxiety."

Supervisor-specific factors on feedback

A combined 70% (n=15+34) of students agreed that supervisors do not always provide feedback in a respectful manner to them (item 28). Linked to this, items 29 and 38 highlighted that a large proportion of students agreed that their supervisor's attitude towards them affected their performance positively.

Respectively, 56.3% and 57.7% of students strongly agreed that the mood (item 31) and tone (item 32) of their supervisor affected how they perceive and value the feedback given

Table VII: Frequency Table for supervisor-specific factors which pertain to verbal feedback.

Item on Questionnaire	Strongly agree		Agree		Disagree		Strongly disagree	
	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %
27. My supervisor does not always provide feedback to me in a respectful manner.	15	21.4%	34	48.6%	20	28.6%	1	1.4%
28. My supervisor's attitude towards me during feedback affects my future performance in a positive way.	8	11.4%	38	54.3%	20	28.6%	4	5.7%
29. The relationship between me and my supervisor affects how I perceive feedback given to me.	20	28.6%	38	54.3%	12	17.1%	0	0.0%
30. The mood of my supervisor affects how I perceive the feedback given.	40	56.3%	27	38.0%	4	5.6%	0	0.0%
31. The tone that my supervisor uses in delivering feedback has a direct influence on how I value the feedback.	41	57.7%	27	38.0%	3	4.2%	0	0.0%
32. I feel that supervisors are negatively biased towards me in a personal way when delivering verbal feedback.	18	25.4%	19	26.8%	28	39.4%	6	8.5%
33. I find it difficult to approach my supervisors during the clinical session to ask for advice.	11	15.7%	28	40.0%	25	35.7%	6	8.5%
34. My supervisor usually acts in a professional manner when delivering feedback to me.	1	1.4%	48	67.6%	19	26.8%	3	4.2%
35. I often feel victimised or belittled by my supervisor during feedback.	10	14.1%	25	35.2%	29	40.8%	7	9.9%
36. I feel there is little consistency in feedback between different supervisors.	38	53.5%	28	39.4%	5	7.0%	0	0.0%
37. My supervisor's attitude towards me affects me during feedback and affects my future performance in a negative way.	18	25.4%	23	32.4%	29	40.8%	1	1.4%

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to them. This further translates into 82.9% (n=20+38) of students who agreed that the relationship between them and their supervisor affects their perception of verbal feedback (item 30). A combined 52.2% (n=18+19) of students agreed that supervisors were negatively biased towards them when giving them verbal feedback (item 33), while a combined 49.3% (n=10+25) agreed that they often feel victimised or belittled by their supervisor during feedback (item 36). Majority of students (55.7%) felt that their supervisors are difficult to approach during a clinical session (item 34), despite 69% agreeing that supervisors act in a professional manner when delivering feedback to them (item 35). The results indicate that 53.5% of students strongly agreed and 39.4% agreed that there is little consistency between supervisors (item 37).

Within this construct, eighteen categories were identified after coding students written responses to the open-ended question posed on the questionnaire, namely '*Describe in your own words what your personal experiences are with your supervisor(s) when they give you verbal feedback in the clinical area – both good and bad.*'

1. Experiences of belittling/ demeaning/ criticism/ victimisation/ rudeness:
   "A lot of supervisors have a habit of belittling you in front of your patients and you end up feeling embarrassed and the patient loses trust and confidence in you, thereby losing confidence and self-esteem in yourself. Feedback should always be given in a positive manner, never belittling a student and making them feel useless. It should be motivational."
   "I feel if I question supervisors (during feedback), then I would be victimised or disliked and could affect my future marks."

2. Professionalism and respect are important for feedback:
   "The way in which the feedback is given should be respectful and kind. Supervisors never know what is going on in a student's life or day."

3. Negative biases/ judgements from supervisors during feedback:
   "Feedback and marks are often given based on who the supervisor is and whether the student is well liked, not on the quality of the work that is produced."

4. Tone of the supervisor is important during feedback:
   "Feedback should be carried out in a positive tone and encouraging manner. Feedback should in no way be directed at clashing personalities or done in a degrading manner for the whole world to hear."
   "It (optimal feedback) does not depend so much on what they (supervisors) say, but how they say it."

5. Supervisor's mood is important and affects feedback:
   "I also feel that the supervisor's mood impacts their judgement and attitude towards you. Also, I have seen others supervisors discuss us in the clinic in a condescending way. If supervisors are allowed to be moody, so should we. Supervisors come with all their moods and problems but we, as students, are not allowed to have a bad day."

6. Supervisors develop pre-conceived impressions of students:
   "Sometimes supervisors have a pre-conceived idea of your work…and this affects how they speak to me and whether they are prepared to help me improve during feedback."

7. Supervisors discuss students amongst themselves:
   "…instead of discussing it (feedback) with the student, they (supervisor) discuss issues with other staff members in front of the students. This is belittling and affects us negatively."

8. Supervisor attitude (positive / negative) affects feedback experience:

Table VIII: Open-ended responses of supervisor-specific factors which students rated as being important to them.

	CATEGORIES	NUMBER (n=71)	%
1	Experiences of belittling/ demeaning/ criticism/ victimisation/ rudeness	41	57.8
2	Professionalism and respect are important for feedback	36	50.7
3	Negative biases/ judgements from supervisors during feedback	35	49.3
4	Tone of the supervisor is important during feedback	29	40.9
5	Supervisor's mood is important and affects feedback	21	29.6
6	Supervisors develop pre-conceived impressions of students	16	22.5
7	Supervisors discuss students amongst themselves	15	21.1
8	Supervisor attitude (positive/ negative) affects feedback experience	15	21.1
9	Supervisors become defensive/ assert their power and/ or authority	11	15.5
10	Supervisor approachability/ ability to listen is important for feedback	10	14.1
11	Fairness/ patience/ transparency/ objectivity is important	9	12.7
12	Lack of consistency in feedback between supervisors	8	11.3
13	Feedback results in stress/ anxiety/ depression	8	11.3
14	Supervisors are too rushed/ should be more eager to teach	8	11.3
15	Supervisors must not make feedback personal	6	8.5

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"There's a supervisor who always gives me negative remarks and attitude during feedback – it affects my clinical performance negatively and I end up hating that clinic or session."

DISCUSSION

The most pertinent results will be discussed under each of the proposed four constructs namely, the nature of feedback, the value of feedback, the effect of supervisor-specific factors on feedback and the influence of the clinical environment on student perceptions of verbal feedback practices.

Nature of feedback

As noted in Table II, students are aware of what constitutes good verbal feedback and actively seek it from their supervisors. Feedback should include a practical action/ performance improvement plan (Sadler, 1989; Hattie & Timperley, 2007; Molloy & Boud, 2013) and must be both detailed and specific (Johnson *et al.,* 2016). From the qualitative written responses in Table 2, students are clearly focussed on the manner in which verbal feedback is delivered to them.

Considering the nature of verbal feedback practices within the context of this study, several key issues have been highlighted. Majority of students (± 80%) felt that they did not receive enough feedback after their clinical sessions and also felt that not enough time is made available for effective feedback (Table I). Similar findings were reported by Price *et al.* (2010). This might be as much a reflection of resource constraints in higher education and healthcare professions as reported by Yorke (2003) and Gibbs (2006), as it is about the crammed nature of the dental programme itself and the limiting nature of the clinical dental environment.

It is evident that students are acutely aware of the importance and lack of privacy, the lack of confidentiality and the fact that there are too few supervisors and insufficient time within the clinical setting. There are certain additional key factors which supervisors need to pay explicit attention to. This includes respect and professionalism. Carless (2013) reported that fostering a learning environment of respect, trust and support is vital for the project of learning, by ensuring the psychological safety of students. Based on the findings of the present study, the spin-off of receiving verbal feedback in the clinical setting undoubtedly has effects on both students and their patients, which makes both parties feel uncomfortable, embarrassed, anxious and affects their inter-personal and professional working relationship. As a result of this, many students in this study recommended that verbal feedback be given to them in private on a one-to-one basis, after the patient has been dismissed.

Despite the numerous negative implications of receiving verbal feedback in the clinical area in front of a patient, many students did mention several positive effects this has on them. These included getting immediate feedback from supervisors with active demonstrations of tasks in a bid to promote practical learning and teaching, while receiving constructive feedback on their clinical performance. High quality feedback is essential for work-based learning (Holmboe *et al*., 2010; Morris & Blaney, 2010; Boud & Molloy, 2012) and impacts directly on patient management.

Value of feedback

It is evident that students within this study cohort are distinctly aware of the numerous benefits of verbal feedback, with approximately 90% of the students stating that receiving feedback is valuable for the development of their skills (Table III). A similar proportion felt that feedback should be given on both their knowledge and clinical skills, so that they can actively learn and improve from the feedback session. This aspect of self-improvement featured very highly within the open-ended written responses.

Other benefits of feedback include improved encouragement and motivation (Ten Cate, Kusurkar & Williams, 2011; Ten Cate, 2013), building their own self-confidence (Johnson *et al*., 2016) and improving the relationship between students and their supervisors (Murray, 1997; Carless, 2013) through active discussion, communication and debate (Johnson *et al*., 2016). The fact that 61.9% of students (Table III) would like to be asked their opinions about their own performance after a clinical session, indicates that students welcome engaging in dialogue and actively seek it from their supervisors. Once again, in this study, the issue of professionalism was identified as a key emergent category within this construct.

It is of concern that 84.5% of students stated that supervisors rarely assist them in setting goals for future clinical session (Table III), but encouraging that only 14 students (20%) experienced difficulty in using verbal feedback to improve their performance (Table III). Unfortunately, with regards to the action plan, 77.5% of students reported that supervisors did not help them to develop an effective action plan, while roughly 90% were of the opinion that this action plan is the most important aspect of the feedback process (Table III). The value of the improvement plan was again highlighted in the study from the open-ended written responses, where 15.5% of students commented that such a plan is an important part of receiving feedback (Table IV).

Despite 77.2% of students (Table III) mentioning that their supervisors do not ask them to reflect on their own work after a clinical session, some students did identify reflective practice as one of the benefits of receiving verbal feedback in their written responses.

The clinical environment

The dental clinical workplace is a very dynamic space and therefore closely associated with how the nature of feedback practices could be perceived by students. Even though more than half of the students in this study indicated that this environment is not ideally suited to receiving verbal feedback, 80% still felt that actively learning could take place (Table V). The learning environment must be educationally conducive to promote active engagement and active learning with clinical tasks. This might explain why close to 60% of students in this study did not feel uncomfortable receiving feedback in the clinical setting. However, a similar proportion did feel uncomfortable when feedback was provided in the presence of their patients (Table VI).

The influence of supervisor-specific factors on feedback

When looking at the data (both quantitative and qualitative) within the supervisor-specific construct, one cannot but notice that dental students have highlighted several shortcomings within the faculty's verbal feedback practices. Due to these perceptions and student experiences, many students reported emotions of increased stress and anxiety associated with the feedback process. Not only do students become defensive, but this study also confirmed findings

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from other studies that students perceived supervisors to become defensive as well during verbal feedback (Ende *et al*., 1995; Hewson & Little, 1998; Blatt *et al*., 2008; Kogan *et al*., 2012).

An overwhelming 70% of students (Table VII) responded that supervisors do not always provide feedback in a respectful manner, with the majority commenting that their supervisor's mood and tone affects how they perceive feedback. In this study, six students (8.5%) mentioned in their open-ended written responses, that some supervisors make feedback personal (Table VIII). The notion that effective communication and collaboration is essential for optimal feedback has been reported by Johnson *et al*. (2016), which cultivates respect for each other's perceptions and opinions. The need for mutual respect was confirmed across all the constructs of this study.

Similarly, it is of concern that a combined 52.2% of students felt a negative bias from supervisors towards them during feedback (Table VII), and 49.3% experienced negative emotions of belittling, victimisation and/ or rudeness (Table VIII). This might explain why the majority of students (55.7%) felt that their supervisors are difficult to approach during a clinical session (Table VII). The fact that 82.9% of students responded that the relationship between them and their supervisor played a role in how they perceived verbal feedback (Table VII) implies that improving this relationship could translate into more positive student perceptions of feedback.

SUMMARY OF FINDINGS

Considering this study in its entirety and taking the data across all four constructs into account, there are numerous over-arching themes which can be identified and which bear valuable contextual relevance for feedback practices within the faculty. These include:

- The lack of time and necessity for additional time for effective verbal feedback
- The importance of professionalism during feedback,
- The fact that supervisors need to listen more to students,
- The awareness of supervisors regarding students' emotional needs (stress, anxiety),
- The importance of effective communication, dialogue and debate.
- The effect of feedback practices on the relationship between student and supervisor, and vice-versa.

CONCLUSION

The findings of this study suggest that the above listed over-arching themes could be a good starting point for the faculty to develop an acceptable and effective feedback policy for students. It would seem as though all these themes relate directly to issues which educators have control over and can change. Having this valuable knowledge and insight into students' perceptions of feedback, would enable clinical supervisors to have a better understanding as to where strengths and weaknesses lie when delivering feedback to students in the clinical area and to be more aware of issues which affect how students receive, regard and apply any feedback given to them. In this way, the educational vision and mission can be strengthened, by improving the inter-professional relationship between student and supervisor through better communication, collaboration and meaningful interaction while fostering intentions of self-regulated and self-directed student learning and performance improvement.

While recognising the primary goal of being patient-centred in every clinical interaction, a recommendation arising from the study is that educators should also remain student-centred in their approach to teaching, which includes engaging with students positively during verbal feedback, as feedback represents a crucial opportunity to enhance student learning. Losing sight of the effects of what educators' actions and behaviours could potentially be having on students, would simply detract from the perceived and intended benefits and advantages of feedback.

Given the information-rich data generated from the open-ended questions in this study, it seems that by attending to the interpersonal actions and behaviours of supervisors, much could be achieved and improved upon, with the effect of reducing the negative impact of the clinical environment on verbal feedback practices.

Being able to improve on the faculty's feedback practices and reinforce those which are already aligned with high quality education (of which there are many), poses exciting opportunities for growth and development in terms of staff development. Paying attention to what dental students are saying about their experiences with verbal feedback in the clinical setting not only shows respect for their opinions and fosters greater inclusivity, but also reinforces that the faculty and university are progressive and forward thinking.

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CPD questionnaire on page 336

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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Efficacy of GapSeal® in Preventing Microleakage at the Dental Implant Abutment Interface

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ABSTRACT

Introduction

Dental implants have proven to be a success, however the microleakage at the implant-abutment interface is still a major concern. Suggested measures to decrease microleakage include the application of silicone sealing gels, such as GapSeal®.

Aims and objectives

To test the ability of GapSeal, in preventing microleakage at the implant-abutment interface of internal hexagon design dental implants, under dynamic loading.

Design

In-vitro experimental study.

Methods

30 dental implants were equally divided into 2 groups: one group had GapSeal (GS) added and the other group had none (GN). The implants were connected to their adjacent abutments and microbiological analysis was done by immersing the implant assembly in Streptococcus *sanguinis* inoculated BHI suspension. The implants were subjected to dynamic forces of 80 N at 1 Hz for 200,000 cycles in a chewing simulator. They were then dismantled and samples from the implants' interiors were obtained and cultured on agar plates incubated for 24 hours. Finally, colony forming units were recorded.

Results

Significant difference (Levene's test of variances p=0.006) in the number of CFU/ml in GS group compared to GN group, with the mean CFU/ml of GS group (10.21) being less than the GN group (87.79).

Conclusions

Application of GapSeal to the implants interiors was effective in reducing microleakage at the implant abutment interface, under dynamic loading. However, it did not completely prevent it.

Keywords

GapSeal, Implant Abutment Interface, Microleakage, Dynamic Loading, Chewing Simulator

Abbreviations

IAI: Implant Abutment Interface
BHI: Brain Heart Infusion
CFU: Colony Forming Units

INTRODUCTION

With success rates higher than 90%, dental implants are one of the best rehabilitation methods in modern dentistry.[1] Nevertheless, microleakage that occurs at the microgap in the implant abutment interface (IAI) is still a concerning factor for implants' success.[2] Dental implant systems generally consist of two main components: a fixture inserted surgically into the alveolar bone and a transmucosal abutment,[3] which inevitably creates a microgap between the implant fixture and abutment.[4,5] Chewing causes a pumping action that allows the influx of fluids and bacteria into the microgap,[6] even in clinically healthy conditions.[7] The interior well of the implant becomes a reservoir for microorganisms and their metabolic products which affect the periodontal tissues directly and are capable of migrating in a bidirectional manner.[5] Tissues adjacent to the IAI can subsequently present with a marked infiltration of inflammatory substances regardless of the accumulation of plaque present.[8]

Microleakage can interfere with osseointegration in the healing phase of the surgical intervention, and it can result in an inflammatory reaction and a host response in the peri-implant soft tissues which can lead to bone loss and peri-implantitis.[5,8,9] Microleakage can also cause abutment screw loosening as a consequence of the lubricous environment created by the microbial activities.[10]

The type of implant abutment connection used plays a crucial part in microleakage.[8] Internal hexagon connections showed less microleakage in comparison with external connections,[8] however microleakage still occurred regardless of the implant abutment connection used.[11] Numerous studies showed that microbial leakage cannot be completely prevented even in contemporary implant system designs.[12,13]

Studies deduced that masticatory loads can cause an increase in microgap size due to micromovements in the prosthetic components,[14] and cause a so-called pumping

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effect,[6,14] which increases the susceptibility of the implant systems to microleakage.[15,16] Dynamic loading also causes deterioration of the IAI over time.[15] Therefore, it is proposed that testing microleakage under dynamic loading be a standard step in all future in-vitro studies conducted.[16]

There has been an increased interest in testing the use of sealing materials at the IAI to reduce or perhaps even prevent microbial leakage at the IAI. Studies tested the use of different sealing materials including chlorhexidine gel,[18,19] Atridox[19] and GapSeal.[19-23] GapSeal® (Hager & Werken, Duisburg, Germany) is a sealing gel added on a highly viscous silicone matrix with 5% weight of thymol,[24] and showed promising results in reducing microleakage and decreasing microgap size.[19-23] However, not enough studies were conducted testing the effectiveness of GapSeal under dynamic forces, in internal hexagon connections, thus this study was conducted.

MATERIALS AND METHODS

Closing Torque Procedure

A total of 30 dental implants (SEVEN MIS design, internal hexagon, standard platform) (MIS Implants Technologies Ltd, Haifa, Israel) and their corresponding abutments were utilized in this study, after consultation with the statistician and considering the cost effectiveness. Each dental implant was stabilized and held upright with autopolymerizing resin, prepared according to the manufacturer's instructions, in custom-made, polytetrafluoroethylene (PTFE) test chambers. This was done to create a compartment for the bacterial solution and to standardize the volume used for each implant assembly. The resin also helped in mimicking the intraoral environment in which some forces transported to the IAI would be absorbed by the bone.[25] The dental implants and their respective abutments were then put in sterilization pouches, assigned codes and sent for gas sterilization.

The dental assemblies were divided into two groups of 15 implants each: Group GS had GapSeal applied to the internal aspect of the implant fixture prior to abutment connection while group GN implants had none applied. The GapSeal was added to the maximum capacity of the internal aspect of the implant fixture according to the manufacturer's instructions to prevent air entrapment. GapSeal was applied using an applicator provided by the manufacturer and sterilized before every use. Subsequently, each implant was carefully connected to its corresponding abutment using a sterile torque wrench, at 30 Ncm according to the manufacturer's guidelines. All dental assemblies were handled by one operator, in sterile conditions in a laminar flow chamber.

Bacterial Culture Preparation

Streptococcus *sanguinis,* a gram positive, facultative anaerobic bacterium is amongst the primary colonizers in the oral cavity. It attaches directly to oral surfaces and even more to titanium than other bacteria.[26] It has a relatively small size, 0.5-1.0µm,[27] and is capable of adhering to implant titanium surfaces, irreversibly,[28] as well as facilitating the adherence of secondary microbial colonizers.[29] S. *sanguinis* was cultured using the direct colony suspension method. The bacterial inoculum was then extracted from the incubated culture and diluted in 2 ml of PBS and adjusted to 0.5 McFarland standard (~1.5x 10^8 CFU/ml), using DensiCHEK. The 2 ml of inoculated PBS was then added to 2 ml of sterile BHI and mixed well using a vortex mixer for 5 seconds. This was the final inoculated BHI solution used for testing the microbial leakage.

Dynamic Loading

All implant assemblies from each group were then placed in the custom-made PTFE chambers and mounted in the chewing simulator. 2 ml of the inoculated BHI was transferred to the chamber of 28 of these assemblies, using a sterile pipette. This volume of solution was adequate to guarantee that the IAI was fully immersed, but not the screw opening. This was to ensure that if leakage occurred, it would be due to leakage through the IAI and not from the screw opening. 1 implant assembly from Group GS and 1 from Group GN had 2 ml of sterilized BHI solution added to their test chambers instead of the inoculated BHI. This served as a negative control that ensured any microleakage into the implant was from the inoculum and not a result of external contamination.

The chewing simulator (CS-4, SD Mechatronik, Germany) housed two implants at the same time (Figure 4-5). A cyclic fatigue load of 80 N was applied for a total of 200,000 cycles at 1 Hz to each implant assembly with a sterile round stainless-steel stylus in the axial direction. 200,000 cycles were completed in around the 24 hour time frame which took into consideration the S. *sanguinis* livelihood. The chewing simulator operated via a computer program, therefore it calibrated automatically once the parameters mentioned above were input. The chewing simulator and its components were disinfected before and after every complete set of cycles.

Measuring Bacterial Colonies

After the completion of the chewing cycle, the assemblies were removed from the test chambers using sterile pliers, sprayed with 70% alcohol and positioned vertically for 10 minutes until the alcohol evaporated. The assemblies were carefully disconnected in a disinfected laminar flow chamber, using a sterile torque wrench. A sample for testing bacterial contamination from the inside of each implant was taken using sterile paper points. The paper points were then immersed in 1000 µl of sterile BHI in sterilized eppendorf tubes, labelled with the implant code, and placed in an incubator at 37 °C for 20 minutes.

Serial dilution was performed for each sample. 200 µl was pipetted from the eppendorf tube and transferred to the wells in row A of the first three columns in the 96-well plate. Afterwards, 100 µl of PBS was added to the wells from row B of the first column to row H of the third column, using a multichannel pipette. The solution was then diluted by two-folds by adding 100 µl from the wells in row A to the wells in row B and so forth up to the wells in row H.

10 µl was then transferred from the wells E1, E2 and E3, using a single channel pipette, spread on 3 individual labelled agar plates using a sterile hockey stick and then incubated at 37°C for 24 hours. After the complete incubation period, the CFU in the plates were measured by means of a colony counter (Gerber, Switzerland) and recorded. Individual colonies on the agar plates were tested for gram positive cocci to ensure S. *sanguinis* growth. The usually accepted range of CFU per plate is 30 to 300, where any number of colonies above 300 is considered too numerous to count and any less than 30 too few to count. However, in this study any CFU less than 30 were recorded.

Data Collection and Analysis

Each sample was coded to permit blind analysis. The data was collected by the same investigator, recorded in Microsoft

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Excel© spreadsheets (Microsoft Corporation, USA) and processed using various statistical analysis techniques. IBM SPSS Statistics Version 20 for Windows (SPSS©, Inc. Chicago, IL, USA) and Microsoft Excel 2010 (Microsoft Corporation, USA) were used for all the statistical analysis. Descriptive analysis, Levene's test for equality of variances and an independent t test were performed for analysis and a value of $P < 0.05$ considered statistically significant.

RESULTS

Evidence of bacterial leakage was observed in most GS group samples, with the exception of 2 samples (Table I), and in all connections of group GN (Table II).

No bacterial growth was observed in the negative control of the GS group (Table I) or in the negative control of the GN group (Table II).

Code	Sample	CFU/ml
2534	1 2 3	6 3 10
4747	1 2 3	8 8 4
6248	1 2 3	3 9 5
6128	1 2 3	23 20 25
3224	1 2 3	7 8 8
5643	1 2 3	0 0 0
1478	1 2 3	8 15 6
4307	1 2 3	0 0 0
7045	1 2 3	12 18 15
3312	1 2 3	4 4 9
8417	1 2 3	13 16 20
2536	1 2 3	8 8 15
9058	1 2 3	17 28 35
6608	1 2 3	9 15 7
1112 Control	1 2 3	0 0 0

Table I: GS group CFU/ml

Code	Sample	CFU/ml
3874	1 2 3	65 50 60
3821	1 2 3	43 62 74
1313	1 2 3	57 81 88
2837	1 2 3	47 73 99
7148	1 2 3	60 85 62
1474	1 2 3	72 70 82
9827	1 2 3	44 53 55
5219	1 2 3	165 200 150
2730	1 2 3	140 166 135
5623	1 2 3	87 74 102
1824	1 2 3	99 78 86
2364	1 2 3	67 74 88
6252	1 2 3	122 105 125
5937	1 2 3	75 88 79
1984 Control	1 2 3	0 0 0

Table II: GN group CFU/ml

For the description of data, mean values and standard deviations were calculated, shown in Table III.

The data for both groups was subjected to statistical analysis using the Levene's test for equality of variances for comparison where a value of 5% ($P \leq 0.05$) was considered significant. The test resulted in a significant value of 0.006. Results of the test are shown in Table IV.

The data obtained from both groups was compared by using an independent t-test. The results are shown in Table V.

A comparison of the mean counts of S. *sanguinis* detected in the internal well of the implants in both groups is shown in Figure 4.

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	N	Mean	STD. Variation	Variance	Minimum	Maximum	Range
Overall mean	28	49.00	46.52	2163.84	0.00	171.67	171.67
GS	14	10.21	7.70	59.28	0.00	26.67	26.67
GN	14	87.79	34.57	1194.76	50.67	171.67	121.00

Table III: The descriptive analysis for S. sanguinis CFU/ml in GS and GN groups

	F	Sig.
Equal variances assumed	8.911	0.006
Equal variances not assumed		

Table IV: Levene's test for equality of variances.

Independent Samples Test	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Equal variances assumed	8.196	26	0.000	77.57	9.46	58.12	97.03
Equal variances not assumed	8.196	14.287	0.000	77.57	9.46	57.31	97.83

Table V: Independent t-test.

	Mean	Std. Deviation	Std. Error Mean
GN	87.79	34.57	9.24
GS	10.21	7.70	2.06

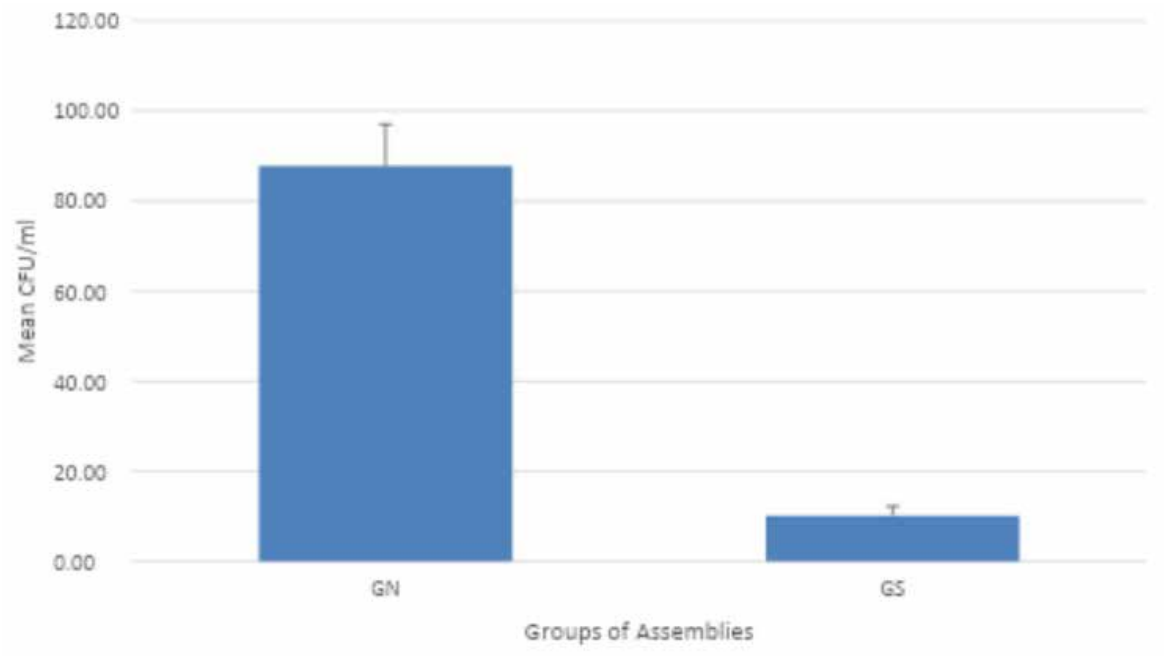

Figure 4: Graph illustrating the mean S. sanguinis CFU/ml in GS and GN groups.

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DISCUSSION

The present in-vitro experimental study was conducted to investigate the efficacy of GapSeal® in preventing microleakage at the implant abutment interface of internal hexagonal connection dental implants after exposure to dynamic loading. According to the results, it was determined that GapSeal® was successful in reducing microleakage significantly. The results showed that the mean CFU detected in the case group (GS) was 10.21, which was significantly less (p=0.006), than in the control group (GN) with a mean CFU of 87.79.

Microleakage is stated to be dependent on multiple factors, including the geometry of the implant abutment connection and the final closing torque.[29] Studies showed that in comparison to the external hexagon design, the internal connection designs produced superior sealing abilities at the IAI, with the Morse taper connection showing the least CFU within the implants. Nevertheless, none of the implant abutment connection designs was able to fully prevent microleakage.[8,11,13] Internal hexagon connection dental implants were used to test the microleakage in the current study. They were connected at a torque of 30 Ncm in accordance with the manufacturer's guidelines, since studies showed that to acquire the best seal in the IAI, the manufacturer's torque recommendations should be followed strictly.[8,30]

Studies showed that another factor affecting microleakage is the micromovement caused by dynamic loading which leads to a pumping effect and increased flow of fluids and bacteria into the implant.[6,14] Increased microleakage under dynamic loading is stated to also be due to deterioration in the IAI and deformations to the threaded portion which may aid in loosening of the screw.[15] Sahin and Ayyildiz (2014) established a two-way relationship between microleakage at the IAI and screw loosening, in which microleakage can cause screw loosening which increases the microgap which in turn increases microbial leakage.[10] Mao et al. (2023) upon conducting a systematic review and meta analysis on in-vitro studies testing microleakage, concluded that testing bacterial leakage under dynamic loading should be a set standard in future studies.[16] Steinebrunner et al. (2005) showed an implant-abutment connection mechanically failed at 172,800 cycles (120 N) of dynamic loading.[25] The present study provided dynamic loading in a chewing simulator for 200,000 cycles with a magnitude of 80 N, considered within the physiologic ranges and in line with previous studies that employed dynamic conditions with magnitudes ranging from 15 N to 160 N and cycles between 200,000 to 1,200,000.[31]

Different studies investigated microleakage with several methodologies.[8,16] Studies investigated leakage either from the external environment to the internal part of the implant (inward method),[21-23,31] or from the inner parts of the implants to the outside environment (outward method).[32-34] The freehand inoculation of bacterial broth into the implant in the outward method, in addition to the lack of determination of the implant's internal volume could generate false-positive results.[12,35] Moreover, higher precision from the operator is required to avoid possible contact with the borders of the implant, enabling the passage of bacteria into the external environment.[35] When considering microleakage testing at the IAI with the inward testing procedure, the total immersion of implant assemblies in the testing liquid could lead to false-positive results owing to the potential penetration of the fluid through the abutment screw interface.[35] In addition, assembling and disassembling the implant abutment complex in a sterile environment, and extracting a sample from inside the implant without cross contamination from the exterior aspect is considered a methodological challenge.[12] This study tested microleakage using the inward method, and assembled and disassembled the implant systems in a laminar flow chamber for sterile conditions. Also, the exact volume of bacterial solution added was measured and was adequate to cover the IAI without submerging the abutment screw interface to avoid false positives. 1 implant from each group (GS and GN) was tested with sterile BHI to check for external contamination issues, and the results showed no bacterial growth in either implant after dynamic loading.

Numerous qualitative and/or quantitative microleakage testing methods were tried, including turbidity analysis, checkerboard DNA-DNA hybridization, radiotracer technique, and microbial counting.[8] This study used CFU counting since Do Nascimeto et al. (2012) concluded that the accuracy of conventional culture counting methods gave comparable results as that of DNA checkerboard hybridization testing methods.[36]

Various methods of reducing microleakage were proposed, including the application of sealing materials,[19,20] decontaminating the internal wall of the implant and using memory shape alloys.[37] Gutta percha showed no success in prevention of microleakage,[38] and silicone gel sheets were tested in-vivo and resulted in reduced microleakage after 90 days.[39] Chlorhexidine gel was studied in-vitro[18] and in-vivo[40] and contradicting results were found. Ozdiler et al. (2018) performed a study on microleakage in internal conical connections under dynamic loading. 50 N force was applied for 500,000 cycles and the results deduced that the use of sealants such as chlorhexidine gel and silicone material decreased bacterial leakage at the IAI significantly, with no significant difference between the 2 materials.[31] Yu et al. (2020) tested a silicone sealing gel in 3 different implant systems under dynamic loading of 20 N to 200 N, using the outward method with toluidine blue dye. They concluded that the gel enhanced the immediate fastening and anti-loosening performances of implant connections, and reduced the IAI microleakage and abutment screw thread abrasion.[41]

Nayak et al. (2014) compared the effect of GapSeal® and O-Ring in microleakage using the inward method with Enterococcus bacteria, and concluded that GapSeal® application significantly reduced microbial leakage.[20] However, their study was performed in static conditions which could lead to an underestimation of microleakage. Mohammadi et al. (2019) compared the use of Atridox, chlorhexidine and GapSeal® in preventing microleakage using the outward method with A. actinomycetemcomitans. They concluded that GapSeal® did not have an antimicrobial effect and was not successful in preventing microleakage, rather delaying it.[19] Their study was performed under static conditions and only recorded turbidity but did not count colonies which gave more of a qualitative result. Smojver et al. (2022) compared GapSeal, Flow.sil, and Oxysafe gel in preventing microleakage in conical and straight internal abutment connections. They tested the implants in a suspension of Candida albicans and Staphylococcus aureus using the inward method and colony counting. They found that only GapSeal®was successful in significantly reducing microleakage, however their study was also conducted under static conditions.[22]

Mostofi et al. (2019) studied the effect of GapSeal®on microleakage in internal hexagon connection implants,[21] and

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Zarbakhsh et al. (2018) in external hexagon implants,[31] with similar methodologies. They both tested microleakage under dynamic loading using the inward method with methylene blue dye, as well as measuring the microgap size using scanning electron microscopy. Both studies concluded that GapSeal® does not provide a complete seal but significantly decreases microleakage and number of gaps.[21,23] However, studies that utilized bacteria to measure microleakage showed more consistent results with reality compared to methylene blue dyes.[21] In addition, methylene blue dye leakage was reported qualitatively.[21,23]

In the present study, GapSeal® was tested under dynamic loading to mimic the chewing action, and only two implants from the GS group showed no colony forming units (Table I). This means that GapSeal® did not provide a complete seal against microleakage. It did nonetheless significantly reduce microleakage through the IAI, which is in line with previous studies. One of the limitations of this study was not measuring the microgap size, so no correlation between the microgap size and microleakage could be deduced. Also, this study tested GapSeal® in a 24 hour period only, therefore additional studies for testing it in a longer time frame are needed since it is a silicone gel that breaks down with time. This will add clinical significance to the mentioned findings. The GapSeal manufacturer recommends the material be replaced every 5 years,[24] so it is crucial to conduct in-vivo studies regarding its biological effects and longevity.

CONCLUSION

Considering the limitations found in the present study, the results showed that microbial leakage persistently occurred at the IAI in the internal hexagon implants after being exposed to dynamic loading, even with the application of GapSeal. However, the application of GapSeal was successful in significantly reducing the microleakage of S. *sanguinis* in-vitro through the IAI, under dynamic loading. Testing GapSeal's sealing longevity, in addition to whether the reduction in microleakage was due to GapSeal decreasing the size of the microgap or due to the antibacterial effect were not in the scope of this study and further research is required to investigate them.

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Antimicrobial Resistance and the Dentist: A review of literature

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The practice of medicine was revolutionised by the discovery of penicillin by Alexander Fleming in 1928, and by 1945 antibiotics were readily available as a therapeutic agent. Since then antibiotics have become the most commonly used medication to treat and prevent bacterial infections. The use of antibiotics has prevented many deaths, transformed healthcare and allowed the public health sector to better manage communicable diseases.

As early as 1947 Hoffman emphasised the ease of use of penicillin, with little regard for correct diagnosis and dosage; and thus, overlooking general principles of medicine, surgery and dentistry in the management of disease. As antibiotic prescribing has increased and the overuse and misuse of antibiotics has increased, so too has the ability of bacteria to adapt as a protective mechanism, thereby rendering the antibiotic ineffective. Since the introduction of penicillin there has been an increase in antibiotic prescribing among both medical and dental practitioners. Excessive and incorrect use of antibiotics encourages bacterial resistance which leads to complex treatment strategies for infectious diseases and possible failure of treatment. In addition, the increased antimicrobial resistance rates place a burden on healthcare costs and thus, antimicrobial resistance is evident globally as a major public health concern.

Aim of Review
To offer an overview of existing literature on antimicrobial resistance, antibiotic prescribing and antimicrobial stewardship in dentistry.

Key words
antimicrobial resistance, antibiotic prescribing, dentistry

ANTIMICROBIAL RESISTANCE
What is Antimicrobial Resistance?
The phenomenon of antimicrobial resistance (AMR) occurs when microorganisms (which include bacteria, viruses, fungi, and parasites) are able to adapt and grow in the presence of medication/s that previously affected them.[1] Antimicrobial resistance is an inherent characteristic of microorganisms, however the occurrence of AMR in healthcare has been intensified by the misuse and inappropriate use of antimicrobial medication, such as antibiotics. Subsequently, a reduction in the effectiveness of an antibiotic against an infectious strain at minimum inhibitory concentration is seen. The lowest concentration at which an antibiotic is effective to inhibit bacterial growth is the minimum inhibitory concentration, which highlights this important concept when confronted with therapeutic failure.[2,3]Although the drivers of AMR are varied, inappropriate antibiotic prescribing by healthcare professionals are highlighted as a serious contributor to AMR.[3]

Dental outpatient antibiotic prescriptions and hospital inpatient prescriptions account for the most commonly prescribed medications; with dentists accountable for an approximate 10% of all antibiotics prescribed globally.[4,5]

Antibiotic prescribing in Dentistry
The management of pain and swelling by correct diagnosis and eradication of oral infection falls within the ambit of the dental practitioner. This management involves correct diagnosis, treatment of disease and if required prescribing of antibiotics and analgesics.[6,7,8] The prescribing of antibiotics when managing dento-alveolar infections should only be considered when there is indication of an increased risk of systemic involvement.[9,10,11]

Dental practitioners often deem the prescribing of antibiotics fitting to relieve pain symptoms, in the treatment of acute infections and also to prevent infections when patients receive dental treatment.[12]

The treatment of dental pain without the presence of infection has been extensively reported in literature.[13,14] The prescribing of antibiotics during dental treatment should be limited, as most dental infections respond well to clinical operative intervention. The supplementary use of antibiotics is only required in a limited number of situations.[15,16,17,18,19]

Prescribing trends in Dentistry
Antibiotic prescribing in dentistry has either prophylactic or therapeutic benefit. The prophylactic antibiotic treatment regime can be either primary (to prevent surgical site infections) or secondary (to prevent an infection elsewhere in the body, e.g. infective endocarditis in high risk cardiac patients). Therapeutic antibiotics is used to manage odontogenic and non-odontogenic infections which are either primary or adjunctive. Primary therapeutic antibiotic treatment is the standard practice when there is an infection, however this is rarely used in dentistry. Adjunctive antibiotic treatment together with clinical (operative and surgical) interventions is most commonly used in dentistry.[8,15,20]

The decision to prescribe antibiotics should be based on

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the following factors: clinical indications for an antibiotic regimen, the oral health status of the patient, medical history and current medication information. This information will be useful in making an informed evidence-based decision and therefore preventing the misuse of antibiotics. In clinical dentistry, antibiotics are only indicated in the event of systemic involvement or during treatment measures in which the patient's immune system is unable to fight infection. In most clinical situations where antibiotics are required, a short effective course of a narrow-spectrum antibiotic is advocated.[4,8,21,22] The practice of routinely using antibiotics as an aide to treating dental infections or in combination with dental surgical procedures was formed before the current crisis period of antimicrobial resistance; and thus, contributes to the global concern surrounding AMR.[16]

The prescribing of antibiotics is common in both general and specialist dental practices, with the foremost prescribed antibiotic by dental practitioners is amoxicillin, and the combination of amoxicillin and clavulanic acid is the second most prescribed antibiotic. Although azithromycin has a greater risk of being associated with AMR, it ranks third in the prescribing order.[24] Dental practitioners appear to favour a broad-spectrum amoxicillin, whereas the narrow-spectrum antimicrobial agents such as penicillin V are less likely to be prescribed.[8] This development is of concern as narrow spectrum antimicrobial agents do not easily lead to resistant bacteria. Antibiotic resistant bacteria are of concern in healthcare as these infections can result in greater adverse clinical consequences and death.[8,25,26] A scoping review by Stein et al. (2018) demonstrated that antibiotics were routinely prescribed prophylactically to healthy patients when undergoing invasive clinical treatment, such as implant placement, root canal treatment and surgical removal of teeth. The majority of dental conditions for which antibiotics are recommended by dental practitioners, should in fact be treated by clinical intervention procedures in order to relieve or remove the inflammation and/or infection associated with the dental condition.[8,27]

The guidelines and criteria for antibiotic prescribing in dentistry is explicitly stated in various guidelines published globally.[28,29,30,31] Examples of these guidelines include the American Dental Association guidelines in USA, NICE (National Institute for Health and Care Excellence UK) in the United Kingdom, Scottish Dental Clinical Effectiveness Program in Scotland and UK and the Afssaps (French Agency for the Safety of Health Products) recommendations for good practice of antibiotics in oral practice amongst others and dental practitioners are encouraged to adhere to these guidelines.[17,18,25,30,32] Antibiotics should be prescribed at the required dosage and length of time to obtain minimum inhibitory concentrations in order to avoid the development of resistant strains.[2,7]

Factors influencing antibiotic prescribing among dentists

Various factors influence dental practitioners when it comes to determining the prescribing of antibiotics, and this can differ amongst practitioners.[18]

Factors include: patients' incapability or reluctance to accept invasive clinical treatment; failure of previous clinical treatment procedure; shortage of treatment time to complete the clinical procedure, and requests for antibiotics by patients.[27] Additional clinical factors reported by Sheikh Rezaei et al. 2022, include the total number of teeth being extracted, where multiple extractions warrant antibiotic prescription. Sheikh Rezaei et al. 2022, also reported a greater number of antibiotic prescriptions were provided to younger patients; where this could be due to more complex extractions, compared to older patients with periodontally compromised teeth.[33] Additional factors that drive antibiotic prescribing amongst dental practitioners include concern that the lack of prescribing antibiotics which may be required later, and would be perceived as failure. The possibility of missing an infection also drives antibiotic prescribing amongst dental practitioners. Thus, prescribing antibiotics "just in case".[34] A study by Rodríguez-Fernández et al. 2022 revealed that practicing in private practice compared to public health clinics as well as years of experience influenced prescription rates. Dental practitioners with greater years of experience were more likely to incorrectly prescribe antibiotics; as were those in private practice. The greater the time since date of qualification of dental practitioners, there was an increased degree of inappropriate antibiotic prescribing.[21] Dentists may also base decisions to prescribe antibiotics on influence of peers and colleagues, and often mention requests from non-dental healthcare practitioners (such as orthopaedic and cardiac specialists) as a reason when deciding to prescribe.[35] Al Marah et al. (2022) found that dentists in academia adhered to guidelines and correctly prescribed antibiotics, compared to their peers in the clinical sector. This could be attributed to academics being aware of latest developments and updates surrounding antimicrobial resistance (AMR) and antimicrobial stewardship (AMS), as this would be incorporated in dental curricula.[36] The slow uptake of reform or new and updated guidelines as well as lack of knowledge by dental practitioners has also been identified as contributor to antibiotic prescribing habits and AMR.[8]

Also included amongst the non-clinical factors surrounding dentists' antibiotic prescribing patterns are: the pressure of the patient and patient preference; and also, the fear of loss of the patient if antibiotics are not prescribed.[8,37] In addition, often the general public are under the impression that antibiotics are required to treat pain and to avoid invasive treatment such extraction.[14] Access to primary dental care, after hours emergency appointments and concern about inflicting pain on loyal patients can also influence whether a dentist will prescribe antibiotics or not.[18] Inconsistent scientific guidelines, the absence of clinical evidence, fear of malpractice lawsuits and lack of knowledge on consequences of needless antibiotic prescribing further increases inappropriate antibiotic prescribing.[32]

Prescribing guidelines

In clinical dentistry, antibiotics are only indicated in the event of systemic involvement or during treatment measures in which the patient's immune system is unable to fight infection. In most clinical situations where antibiotics are required, a short effective course of a narrow-spectrum antibiotic is advocated.[4,8,21,22] The practice of routinely using antibiotics as an aide to treating dental infections or in combination with dental surgical procedures was formed before the current crisis period of antimicrobial resistance; and thus, contributes to the global concern surrounding AMR.[16]

Guidelines are widely available to assist dental practitioners to make evidence-based decisions when it comes to prescribing antibiotics; and most guidelines advise against antibiotic use for the treatment of dento-alveolar infections,

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when there is no evidence of spreading infection and systemic symptoms. Regardless of the availability of these guidelines globally, evidence still exists of routine antibiotic prescribing for acute dental conditions without the clinical indicators to justify the decision.[15,19,27]

In 2019, due to the increased rate of AMR worldwide, the World Health Organization (WHO) created a classification of antibiotics in order to promote antimicrobial stewardship and decrease AMR. The Essential Medicines List: Access, Watch and Reserve (AWaRe) classification is available for hospital and outpatient prescribing and includes antibiotic guidelines for dentistry. The Access collection of antibiotics contains narrow-spectrum antibiotics and which has a lower chance of developing resistance. The Watch collection of antibiotics comprises of a broader spectrum of antibiotics. This group has a higher resistance potential. The Reserve collection of antibiotics comprises of the last recourse antibiotics for targeted use in drug resistant infections.[38] By using the AWaRe classification, using the WATCH group of antibiotics should be done with caution in dentistry.[23]

Antibiotic stewardship

Currently, research and development of new antibiotics is limited, and this highlights the need to promote appropriate and judicious use of existing antibiotics. It is also necessary to safeguard the efficacy of current antibiotics to allow future use.[17,39]

Antibiotic stewardship is a coordinated approach to optimize antimicrobial prescribing by selecting the correct drug, at the appropriate dose, for the correct time period, and aims to achieve the best clinical outcomes for patients while minimizing the development of antibiotic resistance.[40]

The key feature of antimicrobial stewardship is to measure the prescribing of antibiotics, improve rational antibiotic prescribing and use by patients, decrease antibiotic resistance, reduce health complications of needless and incorrect antibiotic use and thus improve patients' health status. It also aims to ensure that the correct drug, dosage and dosage time is chosen when an antibiotic is prescribed. Antimicrobial stewardship provides a plan to encourage justifiable antibiotic use.[41,42]

It therefore describes an integrated and interdisciplinary approach to decrease antibiotic prescription rates. Antibiotic stewardship takes on an all-encompassing purpose and consists of various methods and practices. These include: education (to encourage the appropriate selection, dosage and time period of antibiotics), enhanced surveillance systems (of antibiotic prescribing and use), audit and feedback, implementation of prescribing guidelines and policies.[17,43,44]

CONCLUSION

Antimicrobial resistance represents a critical global public health crisis, with healthcare practitioners, including dentists, playing a pivotal role in its propagation. The widespread and inappropriate prescribing of antibiotics has contributed significantly to this crisis, with dentists accounting for approximately 10% of antibiotic prescriptions worldwide. Although antibiotic prescribing practices in dentistry are influenced by various factors, both clinical and non-clinical; it is valuable for the dentist to prioritise sound diagnostic principles and evidence based best practice, in addition to adhering to established prescribing guidelines. This highlights the ethical responsibility for dentists to practice judicious prescribing by adhering to antimicrobial stewardship principles in an effort to mitigate the escalating threat of antimicrobial resistance.

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An Ectopic Tooth in the Coronoid Process: a rare case report

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A 46-year-old male patient presented to the outpatient department of a tertiary institution with a main complaint of flaring and progressive shifting of his teeth. His medical history revealed that he was healthy with no history of hospitalization, operations or chronic conditions. His social history confirmed that he consumed alcohol occasionally and did not smoke or use any other illicit substances. Extra-oral examination revealed no abnormalities. Upon intra-oral examination, the patient presented with multiple mobile teeth, missing teeth (16, 17, 26, 38 and 48), sinus tracts buccal to his 15 and 25, and periodontal pockets around all of his remaining dentition ranging between 8mm and 15mm.

RADIOGRAPHIC REPORT

The patient's right and left condylar heads and necks were devoid of pathology and anomalies. The right maxillary sinus had pronounced air cells while the left maxillary sinus presented with slight pneumatization. Both the coronoid notches were devoid of anomalies or pathology. The right coronoid process was devoid of anomalies or pathology however, the left coronoid process presented with an incidental finding of an ectopic tooth (38) embedded within the bone. The inferior alveolar canals were devoid of pathology or anomalies, apart from the appearance of a 9x6mm radiopacity apical to the 45 which may be indicative of idiopathic osteosclerosis or a focal cemento-osseous dysplastic lesion. The alveolar bone had various defects throughout the maxillary and mandibular ridges around all remaining dentition with areas of rarefying osteitis apical to several teeth (indicative of advanced periodontal breakdown).

A cone beam computed tomographic (CBCT) image of the left coronoid process was taken, revealing the ectopic 38 embedded within the left coronoid process. A 3-dimensional rendering displayed the perforation of the bone by the crown of the ectopic tooth. (Figure 2 and 3)

The ectopic tooth exhibited a radiolucency that appeared to be attached to the cemento-enamel junction. On the sagittal view of the CBCT, the radiolucency measures +/- 7.76mm above the crown of the tooth. This was indicative of a dentigerous cyst or a dilated follicle. (Figure 4)

The patient was educated about the ectopic tooth as well as the possible implications of having the cystic lesion attached to the coronal area of the tooth. Regardless, the patient only requested treatment for his main complaint, a periodontal related issue. The patient was then referred to the Periodontology and Oral Medicine department for follow-up treatment and further management.

DISCUSSION

This paper presents a case of an ectopic tooth in the coronoid process. There are limited reported cases of this condition to date, thus this case report adds further insight to the already limited presentations of this rare form of displaced dentition.[7]

Ectopic teeth refer to teeth that develop in a location, away from their usual anatomical position. This term can apply to deciduous, permanent, and supernumerary teeth that emerge in various sites, such as the maxillary sinus, orbit, palate, mandibular condyle, and coronoid process. While impacted mandibular third molars are relatively common, with a prevalence of 20–30% due to space constraints or obstructions affecting their eruption, ectopic mandibular third molars are rare, with limited documented cases.[1] Thus, the etiology, clinical manifestations, and appropriate management of ectopic mandibular third molars are not well-established. Ectopic third mandibular molars were found in older individuals, with a predilection for females in contrast to impacted mandibular third molars that are commonly found in the younger population.[1]

The presentation of ectopic teeth may present with a myriad of clinical signs and symptoms (such as pain, swelling, or infection), although many cases are asymptomatic and discovered incidentally through radiographic imaging. The use of radiographic tools (such as the panoramic radiograph and CBCT scans) play a crucial role in diagnosis, helping to determine the appropriate treatment approaches.[1]

The etiology of ectopic dentition has not yet been completely understood, however theories have been put forward to explain these rare conditions. For a rare conditions such as trauma, deviant position of tooth germ, aberrant eruption patterns, or displacement by pathological lesions such as cysts or tumours in the jaw. [2,3]

Wu *et al.* included a classification for ectopic third molars in their comprehensive analysis of ectopic third molars. The images below describe a classification in which 4 lines (a, b, c and d) are created to form four levels (I-IV) as well as a yellow area that should be considered to be a 'normal region' in which any third molar in contact would be regarded as an impaction rather than ectopic.[1]

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Figure 1: Panoramic Radiographic view of the patient

Figure 2: A lateral view of a CBCT reconstruction of the ectopic tooth in the left coronoid process

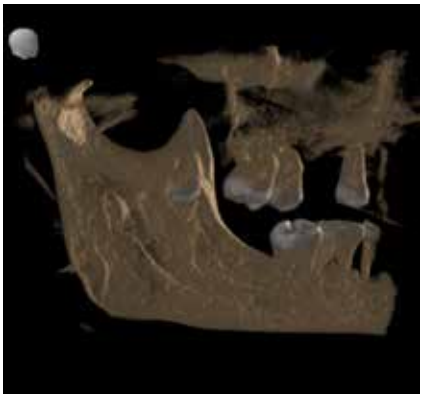

Figure 3: A Medial view of a CBCT reconstruction of the ectopic tooth in the left coronoid process

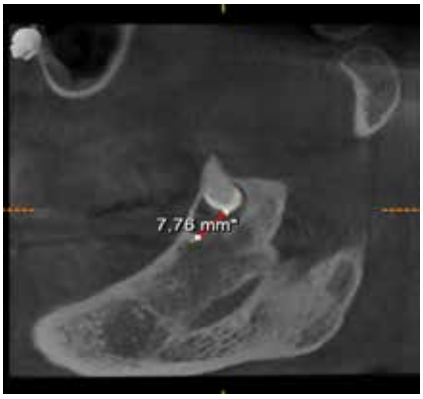

Figure 4: CBCT lateral view of the left coronoid process

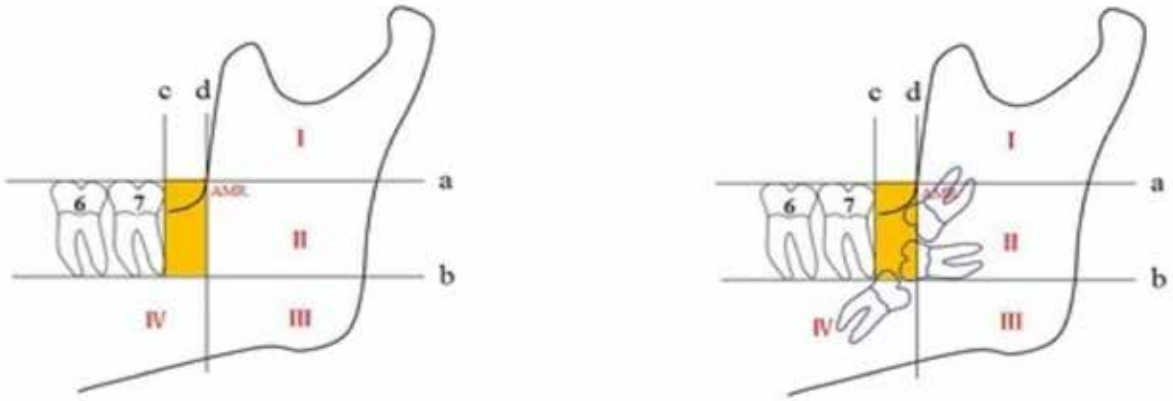

Figure 5: An illustration of the classification used for ectopic teeth adapted from Wu et al. (2017)

Most reported ectopic mandibular third molars were found to be located unilaterally and bilaterally in extreme rare cases. Furthermore, ectopic teeth were found more common in Level I and II followed by level III and IV which align with previous reported cases of ectopic mandibular molars.[1]

Treatment and management of ectopic third molars require meticulous preoperative planning and usually involve surgical removal. Although two-dimensional diagnostic imaging, such as panoramic radiograph and lateral jaw projections, were mainly used, Ghaminia *et al*. suggested in their study that three-dimensional imaging techniques would significantly contribute to appropriate risk assessment and subsequently allow improved surgical planning.[9]

Three-dimensional imaging techniques allow for easier identification and surroundings of the tooth's position, associated pathologies, surrounding neurovascular structures.[1]

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Apaydin & Salahattin highlighted several factors when considering the management of ectopic third molars such as signs, symptoms and associated pathologies. Pathology in the mandibular ramus and condyle areas may lead to several complications (such as condylar resorption, fractures and osteolysis). The choice of surgical approach depends on surgeon preference and tooth position. However, it is widely accepted to utilise a more conservative technique (intra-oral approach to prevent scarring). Intra-oral approaches may incorporate the use of an endoscope to achieve a better field of vision. An extra-oral approach through the submandibular and retromandibular routes were most commonly used when encountering a molar in the condylar or subcondylar region. Apaydin & Salahattin stated that despite common complications such as scarring and damage to surrounding nerve structures, complications were rare.[1]

CONCLUSION

This case report represents an ectopic tooth (38) in the coronoid process, a rare presentation of an ectopic tooth. Furthermore, association of a dilated follicle or dentigerous cyst is represented in the pantomogram and CBCT imaging. This case report highlights the importance off basic radiographic examinations for all patients (within sound clinical justification) as this may reveal certain conditions or anomalies that may otherwise be harmful towards patients' wellbeing.

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

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

1. PREVENTING WHITE SPOT LESIONS AROUND ORTHODONTIC BRACKETS: EFFICACY OF PRE-REACTED GLASS-IONOMER BARRIER COAT VERSUS SILVER DIAMINE FLUORIDE

White spot lesions (WSLs) around orthodontic brackets are areas of enamel demineralization caused by acid produced by bacteria in dental plaque, especially when oral hygiene is poor during fixed orthodontic treatment. These lesions can appear as early as 4 weeks after bracket placement and commonly form on the buccal surfaces near the gingival margin, particularly around the lateral incisors and canines. Males tend to be affected more than females.

Orthodontists have long attempted, with limited success, to decrease demineralization. The preventive effects of dentifrices and/or home use of fluoride solutions, for example, have been established. However, patient compliance with the traditional preventive measures is problematic. It has been shown that 52.5% of the patients did not utilize fluoride solutions at home[1]

Remineralizing therapy has recently gained popularity, and many studies suggest that they are as effective as traditional restorative approaches.[1] More recently, bioactive substances with the power of remineralization at the deep area of the body of the lesion have been utilized. These include Silver Diamine Fluoride (SDF) and a surface reaction-type pre-reacted glass ionomer (S-PRG) fillers containing dental materials. PRG filler is an effective additive due to its capacity to liberate and replenish fluoride ions. It releases additional active ions when exposed to water or acidic solutions. These ions can modulate acidic environments, turning the surrounding environment into reduced coating material (PRG Barrier) to reduce dentin hypersensitivity and prevent cavities on smooth surface areas.[1]

Elshenaway and colleagues (2025)[1] reported on an in-vitro study that sought to compare the preventive potential of silver diamine fluoride (SDF) versus PRG barrier coat on the development of White spot lesions (WSLs) around orthodontic brackets regarding surface elemental analysis and microhardness. In addition, the effect of these materials on the shear bond strength of orthodontic brackets was evaluated. The first null hypothesis was that surface elemental analysis and microhardness will not change significantly after tested materials were applied. The second null hypothesis was that the applied, tested materials will not interfere with the shear bond strength (SBS) shear bond strength (SBS) of orthodontic brackets to the enamel.

Materials and methods

The materials that were used in this study are shown below.

This study was conducted as an in vitro experimental study using a split-tooth design. The specimens were designed to be surface characterized twice (before bonding and after bracket removal) by SEM, EDX, and microhardness. In addition, the effect of the tested materials on brackets' shear bond strength (SBS) was studied.

The estimated sample size of 21 samples per group was found to be the minimum needed. 105 extracted human permanent maxillary first premolars were chosen as the sample based on the specified inclusion and exclusion criteria. Teeth were examined under a stereomicroscope using 10x magnification. Sound completely formed maxillary first premolars typically removed for orthodontic

Material	Composition
Artificial saliva	(Na-3PO4 (3.90 mM), NaCl (4.29 mM), KCl (17.98 mM), CaCl2 (1.10 mM), MgCl2 (0.08 mM), H2SO4 (0.50 mM), NaHCO3 (3.27 mM)4
38% SDF solution	Silver particles and 38% (44,800 ppm) fluoride ion, which at pH 10 is 25% silver, 8% ammonia, 5% fluoride, and 62% water.
PRG Barrier Coat	Base: S-PRG filler based on fluoroboroaluminosilicate glass, Distilled water, Methacrylic acid monomer, and others Active: Phosphonic acid monomer, Methacrylic acid monomer, Bis-MPEPP, Carboxylic acid monomer, TEGDMA, Polymerization initiator, and others
Ortho Solo Primer	Highly filled light-cure adhesive, Bis-GMA resin
Grengloo (Two-way color change adhesive)	Uncured methacrylate ester monomers (20–38%), inert mineral fillers, fumed silica, activators, and preservative
Demineralizing solution	50 mMol acetic acid derivation, 2.25 mMol CaCl2 2H2O, 1.35 mMKH2PO4; 130 mm KCl 4
Remineralizing solution	(1.5 mMol Calcium Chloride-0.9 mMol Sodium Phosphate-150 mMol Potassium Chloride)

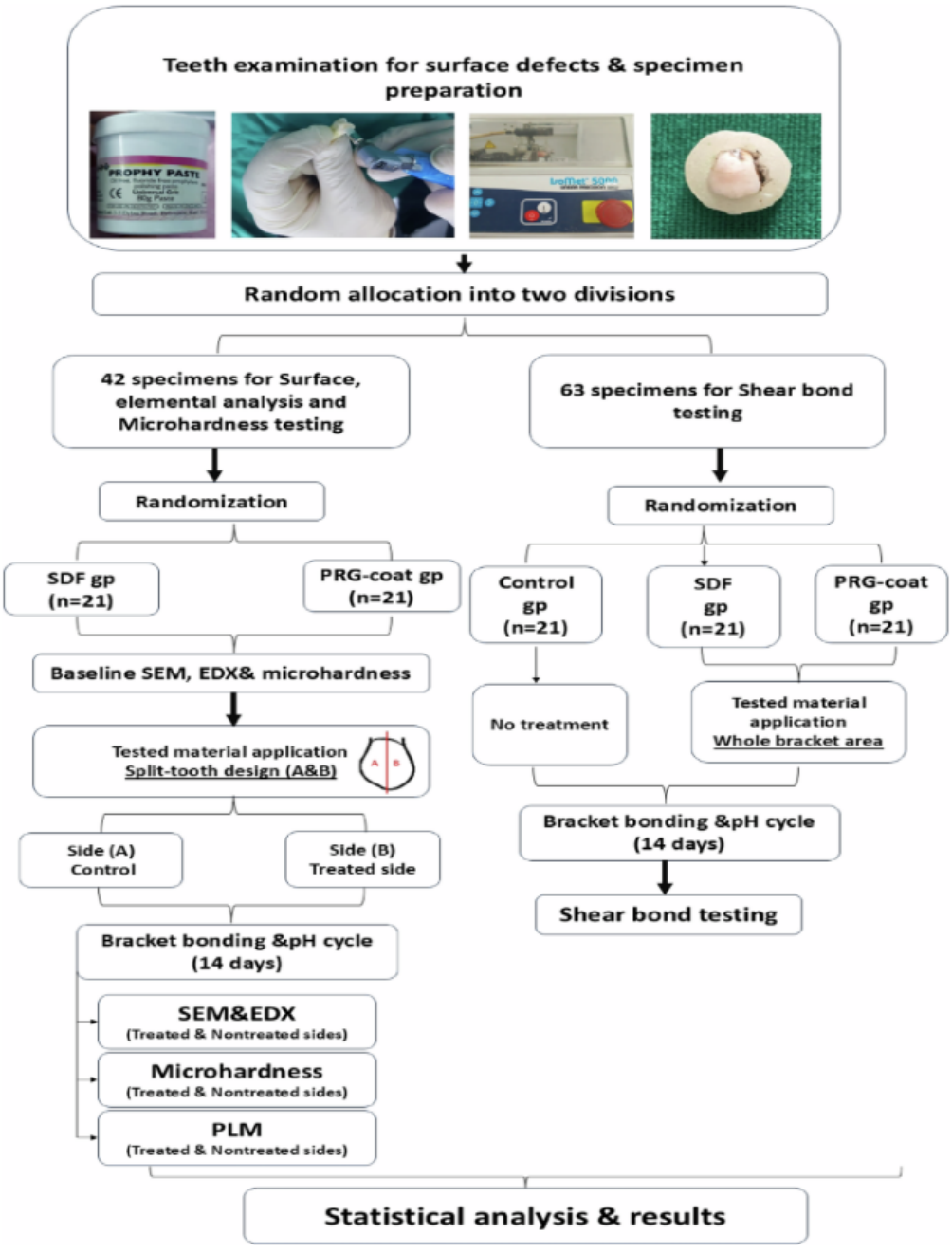
treatment were the inclusion criterion. The following teeth met the exclusion criteria: those with evident buccal flaws, microcracks, erosions, caries, or restorations.

After extraction, a hand scaler was used to remove calculus and soft deposits from the teeth. The teeth were carefully washed with distilled water after being cleaned with fluoride- and oil-free pumice (Prophy paste). Teeth crowns were separated at CEJ using a diamond saw. Each tooth's coronal portion was subsequently embedded in self-cured acrylic resin blocks with buccal surfaces facing upward. The teeth were housed in laboratory-prepared artificial saliva in an incubator at 37 ° C, which was changed daily until the experiment was finalized. Fig 1 provides details of the methodology in a table format.

For elemental analysis and microhardness, the buccal surfaces of 21 specimens from each group were divided vertically into two halves by a permanent marker. The control side (section A) received no treatment in these specimens. The other half was the test side, where the enamel surface would be treated with its respective remineralizing anti-cariogenic agent (section B).

For shear bond testing, three groups ($n = 21$/group) were allocated randomly: the Control group, which received no treatment before Athe whole bracket area; and the PRG-coat group, which received a PRG-barrier coat over the entire bracket area.

All groups' samples underwent remineralization/demineralization pH cycles for 14 days. Each cycle consisted of four phases: a demineralizing phase lasting 120 minutes, a washing phase lasting 30 seconds, a remineralizing phase lasting 60 minutes, and a final washing for 30 seconds. The specimens were subjected to the remineralizing solution for a 6-hour "night" period. The pH of both solutions was measured using a pH meter.



Surface characterization

Specimens designated for surface evaluation by SEM, microhardness, and *Polarized light microscopic examination* (PLM) were assessed as follows:

- **Scanning electron microscopy (SEM) and quantitative elemental analysis (weight %) by EDX spectrometry**

Sample surfaces on sections A and B were examined using **SEM attached** with EDX Unit SEM. *For SEM evaluation*, the samples were carefully dried and gold-plated. Then, the samples were fixed to investigate the enamel surface. In addition, Both Calcium (Ca) and Phosphorus (P) content at the enamel surface of each specimen were analyzed quantitively as weight percentage using EDX. This step was done for all specimens at baseline and after bracket removal for non-treated (section A) and treated sides (section B).

- **Microhardness**

Microhardness was measured using a Digital Vickers Microhardness testing machine using 300 gm force for 10 seconds with a Vickers' diamond indenter and 10X objective length. Three indentations were made on the surface of each specimen, and the average was calculated. This step was done for all specimens at line baseline and after bracket removal (for treated and non-treated sides).

- **Polarized light microscopic examination (PLM)**

Each tooth was sectioned vertically in a buccolingual direction utilizing a diamond saw to split up section A from section B. Each half could be analyzed individually under PLM. The images were captured using a PLM built-in camera via image software LAS EZ version 3.0.0.

- **Shear bond strength (SBS) evaluation**

A universal testing machine (INSTRON 3365) was used to measure SBS. The debonding force was measured in Newtons (N) and then divided by bracket base area (10.25 mm^2) to calculate SBS in MPa.

To ensure consistency in data collection, each examiner independently assessed the same samples under standardized conditions. The degree of agreement between examiners was evaluated using Cohen's kappa (κ) test, yielding a kappa value of 0.9, which reflects excellent agreement.

Results

To better understand the alterations occurring after treatment application, the researchers captured an SEM image of a typical, intact enamel surface (Baseline) before treatment. The normal enamel surface appeared smooth in architecture with a layer of a prismatic enamel covering its external surface. Side A of both SDF and PRG groups (untreated side) depicted the typical etching pattern irregular with uneven depressions and type-I pattern which include removal of the rod body and maintenance of rod boundary and interrod area. However, side B of SDF (treated side) showed enamel remineralization that covered almost the whole enamel surface with many large calcium crystals combined. Tiny pores between the calcium crystallites were also depicted in small areas. Moreover, side B of PRG (treated side) revealed enamel remineralization, which covered almost the enamel surface with many large calcium deposits coalesced with small porosities between the calcium crystallites.

The data obtained from EDX spectrometry was Ca and P weight %, so the researchers calculated Ca/P ratios for each group based on their content. Paired T-test results of both groups showed significant differences between Ca/P ratios at baseline and non-treated sides ($P=0.000$*). In addition, the treated side of both groups showed significantly higher Ca/P ratios than those of non-treated sides ($P=0.000$*). Regarding the SDF group, the Ca/P ratio of the treated side did not differ significantly from the baseline ratio ($T=1.6$, $P=0.121$). For the PRG-coat group, the Ca/P ratio of the treated side showed a significantly lower Ca/P ratio than baseline ratios ($T=3.4$, $P=0.003$*). Notably, non-significant differences were found in the mean difference of Ca/P ratios between treated and baseline groups according to T-test outcomes ($T=0.99$, $P=0.32$).

Baseline hardness for both groups was significantly higher than the treated sides, which was significantly higher than the non-treated sides ($P=0.000$*) and ($P=0.000$*) in accordance with the Paired T-test. In comparing SDF with PRG-coat groups, the T-test showed non-significant differences in mean differences between treated and baseline values ($T=0.32$, $P=0.74$).

Mean Shear bond strength (SBS) values showed a non-significant difference between the groups ($F=2.51$, $P=0.089$), with the SDF group showing slightly higher values followed by PRG-coat groups than the control group.

Polarized light microscope (PLM) for Baseline normal enamel showed a standard prismatic surface enamel layer with almost typical homogenous subsurface enamel reflecting normal mineralization and birefringence of enamel. However, side A of SDF (untreated side) and side A of PRG (untreated side) showed surface demineralization with a positive birefringent demineralized enamel band extending beneath an intact surface layer.

The treated side of SDF showed widely distributed areas of remineralized enamel, small, demineralized regions, and an evident remineralized surface enamel layer. The treated side of PRG showed alternative areas of remineralized enamel together with small, demineralized areas and elimination of demineralization with the appearance of a surface remineralized layer.

Conclusion

The researchers found that applying either SDF varnish or PRG-barrier coat before bonding orthodontic brackets could effectively prevent the development of WSL and achieve surface enamel protection. In addition, the two applied varnishes showed slightly higher shear bond strength of orthodontic brackets compared to the control group, with the SDF slightly higher than PRG.

Implications for practice

These findings indicate that incorporating these protective agents in orthodontic practice may enhance enamel preservation without compromising bracket adhesion.

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2. THE ROLE OF VITAMIN D DEFICIENCY IN THE DEVELOPMENT AND SEVERITY OF ORAL LICHEN PLANUS: A CASE-CONTROL STUDY

Lichen planus (OLP) is a chronic inflammatory, autoimmune ailment, primarily affecting the skin, oral and genital mucosa, and with a potential for undergoing malignant alterations. Oral involvement is a common occurrence, and in 15–35% of cases, oral mucosa may be the only affected site of the disease. Oral lichen planus (OLP) represents the mucosal counterpart of the cutaneous LP and typically presents with episodes of exacerbation and remission. OLP has an age and gender predilection, primarily affecting females over 40 years of age[1].

Recent studies have reported that the malignant transformation rate of OLP ranges from 0.44% to 2.28% [1] . However, there is an increased risk of malignant potential in cases of erosive and/or atrophic lesions, tongue lesions, greater intake of alcohol/tobacco, and an accompanying hepatitis C virus infection.

OLP lesions characteristically manifest as bilaterally symmetrical reticular lesions on the buccal mucosa, tongue, and gingiva, although, involvement of the palatal mucosa, lips, and floor of the mouth is infrequently seen.

OLP may manifest a plethora of clinical forms, and range from reticular, erosive, atrophic, plaque-like, papular, and bullous lesions. Generally, reticular lesions are the commonest, and the bullous/papular forms are the rarest oral presentations. The most common reticular form of OLP is asymptomatic, whereas, the atrophic, erosive, and bullous forms usually cause pain, burning sensations, difficulty in mastication and speech, and deteriorated oral hygiene. These forms are also associated with negative psychosocial outcomes due to the chronic, uncertain clinical patterns and potential for malignant transformation, thus affecting the patient's quality of life[1].

Despite breakthrough research and substantial knowledge advancements, the etiopathogenesis of OLP is still ambiguous, and OLP is regarded as a chronic T-cell-mediated disorder of unknown etiology. However, a plethora of multifactorial predisposing factors, such as autoimmunity, microorganisms, infective agents, drugs and dental materials, nutritional deficiencies, psychological stress, and genetic predisposition may also have a role to play.

Treatment strategies are focused on precluding the excruciating symptoms, hastening the remission of erosive lesions, enhancing the asymptomatic periods, diminishing the malignant transformation risk, and maintaining good oral hygiene and dental status. Several pharmacological and non-pharmacological treatment regimens have been advocated for the management of OLP. The pharmacological therapeutic modalities used in the treatment of OLP include corticosteroids (topical, intralesional, and systemic steroids), Immunosuppressants (tacrolimus, azathioprine, cyclosporin, and mycophenolate mofetil,), immunomodulators (levamisole and thalidomide), and retinoids. Various non-pharmacological regimens, such as Light amplification by stimulated emission of radiation (LASER) therapy, photodynamic therapy, and Psoralen plus ultraviolet-A radiation (PUVA) therapy are also used in OLP treatment[1].

In recent years, the relationship between vitamin D (VD) and immunologically mediated diseases has drawn increasing attention. VD, a fat-soluble vitamin, exerts its action through VD receptors (VDR), which are abundantly present on T-lymphocytes. There is emerging evidence about the role of active VD (25-hydroxy VD3) in the control of immune reactions. To date, the responsibility of serum vitamin D level (SVDL) as a possible risk element in the OLP development and its advancement into oral squamous cell carcinoma is unclear.

Furthermore, a recent meta-analysis revealed that OLP participants experience a greater incidence of stress, anxiety, and depression. Shalaby et al (2025) [2] reported on a study that sought to compare SVDL between OLP patients and healthy controls as well as between OLP subtypes representing different severities of the condition. In addition, the current study compared SVDL in OLP lesions that showed signs of dysplasia in histopathologic examination (Dysplastic) and those with no signs of dysplasia (non-dysplastic) to ascertain whether VD deficiency ought to be regarded as a contributing factor for the onset, progression, to more severe forms, or probably malignant transformation of OLP. Additionally, psychological assessment utilizing the Depression Anxiety and Stress Scale (DASS-21 scale), and socioeconomic status using Kuppuswamy's scale was performed.

Methodology

This was an Observational case-control study that followed the STROBE guidelines. Seventy participants were assigned into two groups. Thirty-five patients in Group A had a clinical picture that matches the clinical diagnosis of OLP and histological findings that confirm the diagnosis, mainly liquefaction degeneration of the basal cells and a band-like area of lymphocytic infiltration limited to the upper part of connective tissue, without exclusion of dysplasia. Clinically, patients were classified into three main types: reticular (including papular or plaque type), atrophic, and bullous erosive ulcerative OLP. Histologically, any signs of epithelial dysplasia were recorded, so lesions were further divided into dysplastic and non-dysplastic OLP. Group B included 35 healthy volunteers which were matched by sex, age, and dietary habits (whether they were vegetarian or non-vegetarians).

Exclusion criteria involved were Patients receiving any medication including corticosteroids for the management of OLP or any other condition for the past 6 months; Individuals who have been using multivitamins, different types of VD supplements, or medications that might alter VD measures; Patients with oral lichenoid lesions including lesions caused by contact with amalgam, reaction to drug or in the setting of graft versus host disease; Patients who smoke and/or use smokeless tobacco because additional keratotic lesions caused by tobacco products could mislead the examiners; Pregnant females or individuals with any systemic medical condition; and when VD ≥ 100 ng/ml as it is considered VD toxicity.

To gather information, each participant filled out a structured questionnaire. Age, sex, country, early living circumstances

(rural or urban), systemic medical conditions, history of drug intake, consumption of VD supplements, dietary habits, psychological assessment applying the DASS-21 scale, and socioeconomic status using Kuppuswamy's scale were among the details it contained. Also, investigators collected 5 ml of peripheral venous blood from all participants. For the quantification of VD3, the enzyme-linked immunosorbent assay (ELISA) was employed to analyze all samples concurrently in accordance with the manufacturer's instructions. A competitive ELISA-based technique was performed to measure the level of 25-OH VD3/D2 in blood samples.

According to the Society of Clinical Endocrinology, the blood level of 25(OH)D above 20 ng/ml is considered sufficient to prevent rickets and osteomalacia in children and adults respectively, with normal being between 30 and 100 ng/ml, deficiency between 12 and 19 ng/ml and serious deficiency < 11 ng/ml. In the present study, SVDL ≤ 20 ng/ml were assigned to the VD deficiency set, while levels ranging between 20 and 100 ng/ml were classified as VD sufficiency, while levels ≥ 100 ng/ml were considered VD toxicity.

Results: The present study included 70 Egyptian participants involving 35 OLP participants and 35 healthy volunteers. According to Kuppuswamy's socioeconomic status scale, there was a statistically significant difference between OLP and the healthy controls ($P = 0.028$); while, no significant difference was noted among different types of OLP cases ($P = 0.895$). It was found that the majority of the OLP group (45.7%) was of middle level compared to the control group (28.6%) while the majority of control group was of upper middle level (57.1%). Regarding results of the DASS-21 scale, a statistically significant greater number of patients having depression, anxiety and stress in OLP group than in control group ($P = 0.004$, 0.036, and 0.05, respectively). Moreover, there were statistically significant differences in number of patients having depression, anxiety and stress between the three types of OLP ($P = 0.05$, 0.021 and 0.011 respectively). It was noticed that severe depression occurred in 50% of erosive OLP and 50% of atrophic OLP compared to none of those with reticular type. Similarly, severe anxiety and stress occurred in 100% of participants with erosive OLP, while none of those with atrophic or reticular lesions had severe anxiety or stress.

Regarding SVDL, the mean value ± SD in OLP was 16.7 ± 5.02 ng/ml while in controls was 29 ± 8.73 ng/ml. Statistically significant greater values of SVDL were found in the healthy controls than the OLP group ($P \leq 0.001$, effect size = 0.818, and CI of -14.8 to -8.00). There was a statistically significant difference between reticular and atrophic forms of OLP ($P = 0.012$), as well as reticular and erosive types ($P = 0.029$), while there was no statistically significant difference between atrophic and erosive types of OLP ($P = 0.344$). Similarly, by comparing each type of OLP and controls, there were statistically significant differences between each type and controls ($P = 0.012$, ≤ 0.001, and ≤0.001) for reticular, atrophic, and erosive types, respectively. Although lower SVDL was detected in patients with dysplastic lesions (14 ± 4.32) than non-dysplastic lesions (17 ± 5.09), the difference was not statistically significant ($P = 0.187$).

When the two study groups were compared in terms of VD deficiency or sufficiency, there was a statistically significant difference between the two study groups ($P \leq 0.001$). Furthermore, it was clear that VD deficiency was more pronounced in erosive and atrophic types than reticular types, with a statistically significant difference that reflects the effect of VD deficiency on the severity of the condition ($P \leq 0.001$).

Statistical analysis was performed between some risk factors for OLP and VD deficiency and it was noticed that only two factors namely, depression and sun exposure significantly affected the number of patients having VD deficiency.
Also, there was a statistically significant direct relation between the progress of the reticular type into more severe forms, namely atrophic and erosive ($P = 0.022$ and 0.004, respectively).

A univariable binary logistic regression analysis was done for determining the risk of OLP from VD deficiency. It revealed that VD deficiency significantly contributed to the development of OLP ($p < 0.001$), with about 26 times increased likelihood of OLP among patients having VD deficiency (OR = 26.156, 95%CI = 7.083–96.593, B coefficient = 3.264, SE = 0.667). This was followed by multivariable analysis to determine the risk of OLP from VD deficiency after controlling for confounding factors which are: age, sex, socioeconomic level, diet habits, duration of sun exposure, and presence of moderate to severe depression, anxiety and stress. The results showed that VD deficiency still significantly contributing to OLP development with an increased risk to about 34 times (AOR = 34.161) after controlling confounders. The multivariable model displayed an accuracy of 85.7% and explained 62.5% of variations in the OLP disease. Higher SVDL significantly reduced the risk of having OLP (OR = 0.5, 95%CI = 0.33–0.76, $p = 0.001$).

Higher SVDLs was significantly associated with lower risk of dysplasia ($p = 0.041$). Likewise, more sun exposure was significantly associated with reduced dysplasia ($p = 0.045$). Socio-economic status, depression, age, sex and diet didn't show significant associations in this multivariable regression analysis.

Conclusion

The present study corroborates the evidence from previous reports that VD deficiency is a potential risk factor affecting the initiation of OLP and validates its association with more severe forms of the disease, including the incidence of epithelial dysplasia.

Implications for practice

Checking patients VD level who present with signes and symptoms of OLP could reduce the severity and duration of the symptomatic episodes of the condition.

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The association between feedback delivery and student self-regulation

SADJ JULY 2025, Vol. 80 No.6 P330-P335

TC Postma[1], LM Sykes[2]

ABSTRACT

Purpose

This paper examined the association between the mode of feedback delivery and the student's ability to self-regulate learning.

Methods

A Prisma 2020 scoping review was conducted by entering "Ethics" and "Feedback" as the only two key words in the Medline (Web of Science), Pubmed and PsycINFO databases. No limitations were placed on the search to maximise the identification of ethical considerations that influence feedback. Duplicates, non-sensical publications and non-English articles were systematically removed. The remaining publication titles were screened for appropriateness and relevance. The search strategy required there to be some form of connotation to 1) feedback delivery 2) ethical considerations and 3) the impact on students' self-regulation in any teaching context. Articles were qualitatively analysed. Apposite quotations were recorded, and emerging themes were grouped under teacher and student-related factors.

Results: "Ethical" feedback delivery was linked to academic success and promoted the development of self-regulation amongst learners. Conversely an "unethical" mode of feedback delivery was linked to poor performance and a lack of growth. Respect, being autonomy supportive and the maintenance of confidentiality during feedback delivery could be linked to psychological safety, which encourages learning. The opposite behaviour created fear which is not conducive to learning, particularly amongst students with low self-esteem and self-regulating capabilities.

Conclusion: The associations drawn in this study may serve a s a conceptual model for staff development to provide constructive feedback with an ethical basis to induce self-regulation amongst students.

Keywords

Ethics, feedback, self-regulation, psychological safety.

INTRODUCTION

The provision of feedback is critical to close learning gaps in dental education. Feedback is effective when given correctly.[1] Empirical evidence exits that good feedback improves self-regulation.[2] Unfortunately feedback is not always constructive.

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Feedback on the self is, in particular, discouraged as it negatively affects self-efficacy belief, motivation and learning.[1, 3] It can hence be argued that feedback on the self is unethical as it harms the student's self-esteem and may be counter productive in the learning process.

Undergraduate dental education can be a challenging endeavour for learners, with one of their main stressors being their interaction with teachers.[4] A sense of psychological safety is necessary to enhance personal and professional development.[1] Psychological safety is important for learning.[5] Thus, disparaging behaviour by the teachers that denigrates this could be considered academically and ethically unacceptable, especially in terms of their commitment towards beneficence and doing good.[3]

Feedback is often that interface between the teacher and the student and can either enrich or be detrimental to learning, depending on the mode of delivery.[1] The efficacy of feedback however does not only depend on the teacher's ability to appropriately convey their message, but also on the student's ability to self-reflect and then adapt accordingly.[3] Zimmermann believes that students regulate their learning through self-efficacy belief and motivation which elicits a goal orientation along with a distinct outcome expectation. Self-regulated learners exercise self-control and metacognitive monitoring to successfully complete a task. Thereafter, they are able to reflect on their performance, take responsibility for their own failures, and implement constructive changes.[6] It can be argued that because of the default power relationship that exists between a teacher and a student, the incorrect delivery of feedback maybe intentionally or unintentionally unethical as it works against the notion of contributing to the greater good.[7]

A need therefore exists to explore the relationship of ethics and feedback in education. This paper aimed to investigate the factors that inform on the ethical basis of clinical teaching. Understanding their relationship and how feedback delivery impacts on learning, may allow for improvements in the approach to feedback delivery in the clinical training environment. The establishment of a model may also systematically inform staff training through the conception of a standard against which staff can be evaluated.

MATERIALS AND METHODS

A PRISMA 2020 scoping review[8] was conducted to identify the ethical considerations that interface with feedback delivery, and then to synthesise these into a proposed model for staff development. "Ethics" and "Feedback" were entered as the only two key words in the Medline (Web of Science (WoS)), Pubmed and PsycINFO databases. No limitations were placed on the search to maximise the identification of ethical considerations that influence feedback. Identified citations were downloaded and organised in a Microsoft Excel dataset. The citation titles were alphabetically sorted, duplicates, non-sensical publications and non-English articles were systematically filtered out through a manual process.

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The remaining publication titles were screened for appropriateness by the primary researcher (TCP) and later verified by the co-author (LMS). The only inclusion criterion at this stage was a clear connection to feedback delivery. The elimination process continued after reading the abstracts of the initially included titles. At this point the search strategy required a connotation to 1) feedback delivery 2) ethical considerations and 3) the impact on students' self-regulation in any teaching context.

The remaining articles were qualitatively analysed and focal ethical principles and considerations were identified and thematically grouped.[9] Ethical observations related to teacher behaviour were deductively analysed using the basic ethical principles (beneficence, non-maleficence, respect, integrity, tolerance, veracity, and confidentiality) as a point of reference, and at the same time allowing for the open-ended addition of related themes. Reference to students' self-regulation were deductively organised against the components of Zimmermann's model of self-regulated learning (e.g., self-esteem, self-efficacy belief, motivation, goal setting, outcome expectation, self-observation, self-control, self-monitoring, self-evaluation, self-reflection, attribution and adaptation), [6] similarly allowing for the open-ended (inductive) addition of related concepts and themes.

Emerging themes were used to synthesise a proposed model that demonstrates how the ethical basis of clinical teaching, combined with student characteristics could affect learning outcomes.

RESULTS

A total of 5351 documents were identified of which 1236 were from Medline (WoS), 3278 from Pubmed and 837 from PsycINFO (dated 3 June 2023). This was followed by the removal of one non-sensical document, 1256 duplicates and the remaining 56 non-English articles (Figure 1).

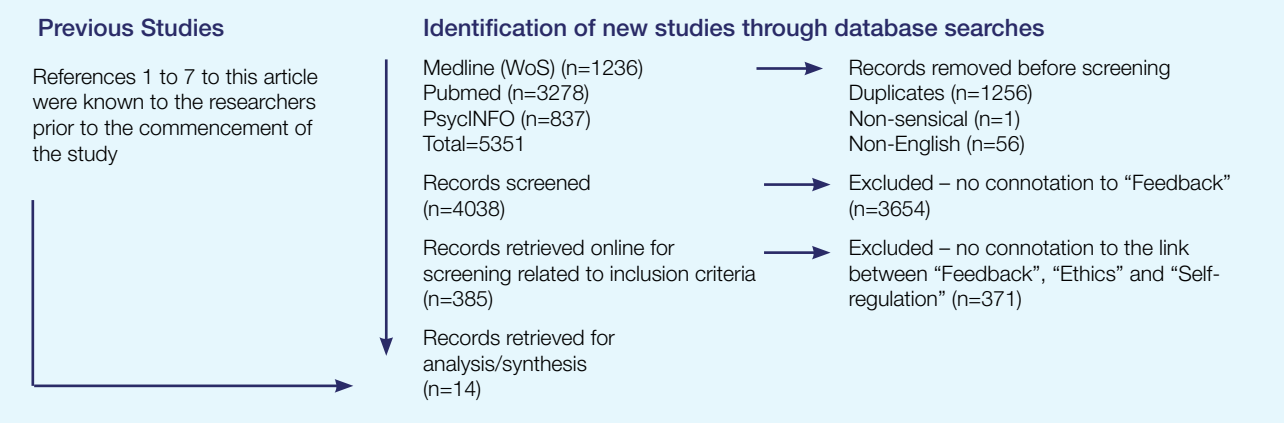

FIGURE 1: PRISMA 2020 flow diagram[8]

The number of remaining titles with a connotation to feedback delivery and self-regulation totalled 385 of which 14 were kept (Table 1) for analysis after reading the abstracts and the articles.

Table 1: Articles included in the analysis and synthesis

1.	Fullerton PD, Sarkar M, Haque S, McKenzie W. Culture and understanding the role of feedback for health professions students: realist synthesis protocol. BMJ open. 2022;12(2):e049462. [10]
2.	Irlenbusch B, Rilke RM, Walkowitz G. Designing feedback in voluntary contribution games: the role of transparency. *Exp Econ*. 2019;22:552-76.[11]
3.	Emke AR, Cheng S, Dufault C, Cianciolo AT, Musick D, Richards B, *et al*. Developing professionalism via multisource feedback in team-based learning. *Teach Learn Med.* 2015;27(4):362-5.[12]
4.	Johnson CE, Keating JL, Farlie MK, Kent F, Leech M, Molloy EK. Educators' behaviours during feedback in authentic clinical practise settings: an observational study and systematic analysis. *BMC Med Educ*. 2019;19(1):1-1[13]
5.	Eva KW, Regehr G. Effective feedback for maintenance of competence: from data delivery to trusting dialogues.[14]
6.	Herrmann-Werner A, Loda T, Erschens R, Schneider P, Junne F, Gilligan C, Teufel M, Zipfel S, Keifenheim KE. Face yourself! -learning progress and shame in different approaches of video feedback: a comparative study.[15]
7.	Fourie MM, Thomas KG, Amodio DM, Warton CM, Meintjes EM. Neural correlates of experienced moral emotion: an fMRI investigation of emotion in response to prejudice feedback. [16]
8.	Rösler IK, van Nunspeet F, Ellemers N. Falling on deaf ears: The effects of sender identity and feedback dimension on how people process and respond to negative feedback – An ERP study.[17]
9.	Larson EL, Patel SJ, Evans D, Saiman L. Feedback as a strategy to change behaviour: the devil is in the details. Journal of evaluation in clinical practise. 2013;19(2):230-4.[18]
10.	Henry D, Vesel T, Boscardin C, van Schaik S. Motivation for feedback-seeking among pediatric residents: a mixed methods study. [19]
11.	Gong Z, Van Swol L, Xu Z, Yin K, Zhang N, Gul Gilal F, Li X. High-power distance is not always bad: ethical leadership results in feedback Seeking. [20]
12.	Moss SE, Song M, Hannah ST, Wang Z, Sumanth JJ. The duty to improve oneself: How duty orientation mediates the relationship between ethical leadership and followers' feedback-seeking and feedback-avoiding behavior.[21]
13.	Johnson CE, Keating JL, Farlie MK, Kent F, Leech M, Molloy EK. Educators' behaviours during feedback in authentic clinical practise settings: an observational study and systematic analysis. *BMC Med Educ*. 2019;19(1):1-1. [22]
14.	Harrison CJ, Könings KD, Dannefer EF, Schuwirth LW, Wass V, van der Vleuten CP. Factors influencing students' receptivity to formative feedback emerging from different assessment cultures.[23]

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Table 2 displays the main emerging quotations, and Table 3 the teacher- and student-related themes. The emerging quotations highlights potential connections between ethical behaviour of the feedback provider as well as the self-regulation impacts the feedback has on the receiver.

Table 2: Emerging quotations (including philosophical interpretations of the authors)

Emerging quotations *Includes the original authors' philosophical interpretation of the cited literature, literature review, results or discussion sections*	
Article 1:[10]	"Confucius saw learning as a means of social change and to overcome social differences, but also placed much emphasis on personal effort. The Chinese philosophy of education also highlighted a mutually respectful relationship between teacher and learner, with the teacher guiding the learner, rather than pulling the learner along. This parallels the role of guru (teacher) seen in the Indian culture of education—with the guru nurturing the learner."
Article 2:[11]	"Feedback shapes subjects' beliefs"
Article 3:[12]	"A few individuals in the group consistently rated themselves highly while their peers rated them poorly"
Article 4:[13]	Educators commonly provided performance analysis, described how the task should be performed, and were respectful and supportive. Many of the recommended feedback behaviours were rarely seen, such as clarifying the session purpose and expectations, promoting learner involvement, creating an action plan or arranging a subsequent review session
Article 5:[14]	"Dialogue between peers or with a coach in a trusting relationship that aims at building on a physician's strengths more likely to be an effective mechanism for practise change and maintenance of competence." "Cognitive dissonance is the discomfort created by trying to maintain conflicting beliefs at the same time. We are motivated to lessen such discomfort and, in response, tend to alter one of the beliefs. Accepting and incorporating corrective feedback, even in the form of "objective" practise data, requires the acknowledgement that one is performing sub optimally. Such an understanding is, by definition, in conflict with the belief that one is serving one's patients well. Because it is easier to question the data than to question oneself, this pair of conflicting beliefs will often be resolved by discounting the feedback rather than altering one's sense of self as a competent clinician." "Literature on self-efficacy suggests that this discounting may have value. Having a belief that one can accomplish a goal increases the likelihood of accomplishing it. Thus, the drive to sustain a positive self-concept might be important to good performance, and threats to positive self-concept should be defended against."
Article 6:[15]	"Feedback associated with different levels of shame in students with a simple checklist is likely to be perceived as the least embarrassing. Receiving feedback in front of a group of fellow students being perceived as most embarrassing."
Article 7:[16]	"The paradigm induced intense moral-negative emotion (primarily guilt) in 22 low-prejudice individuals through preprogramed feedback indicating implicit prejudice against Black and disabled people. fMRI data indicated that this experience of moral-negative emotion was associated with increased activity in anterior paralimbic structures, …. Of significance was prominent conflict-related activity in the supragenual ACC, which is consistent with theories proposing an association between acute guilt and behavioural inhibition. A significant negative association between self-reported guilt and neural activity in the pregenual ACC suggested a role of self-regulatory processes in response to moral-negative affect. These findings are consistent with the multifaceted self-regulatory functions of moral-negative emotions in social behaviour."
Article 8:[17]	"Subtle cues such as the social group-membership of a sender or the dimension addressed in a feedback message can modulate the cognitive processing of that message. This may explain why people are inclined to disregard negative feedback from outgroup senders."
Article 9:[18]	"Authors developed the 'feedback intervention theory' (FIT), which is based on five assumptions: 1. behaviour is regulated by comparing practise with a goal or standard; 2. the goals or standards are rank ordered by importance; 3. only those gaps between feedback and goals that receive explicit attention will have an impact on behaviour; 4. attention by the learner is normally directed to a moderate level of control hierarchy (from task learning, task motivation and meta-tasks); 5. feedback affects behaviour by changing the locus of control so that the learner feels more 'in charge'. The central explanatory theme to FIT is not how feedback affects one's learning or motivation to perform a task but rather how the feedback focuses one's attention."
Article 10:[19]	"For effective self-directed life-long learning physicians need to engage in feedback-seeking, which means fostering such behaviour during training. Self-determination theory (SDT) posits that intrinsic motivation is fostered when the environment optimizes the individual's experience of autonomy, relatedness, and competence. Educational settings meeting these psychological needs may foster intrinsic motivation in trainees, enhance their desire for feedback, and promote feedback-seeking. Findings suggest that the relationship between motivation and feedback-seeking is complex and cannot be predicted by IMI scores. Career plans and relationships with feedback providers impact feedback-seeking, which can inform educational interventions."
Article 11:[20]	"The results indicate that ethical leadership positively affected nurses' feedback-seeking. Ethical leadership influences feedback seeking through psychological safety. With high power distance, ethical leadership significantly positively influenced psychological safety and then positively affected feedback-seeking behaviour. In sum, in the context of high-power distance, ethical leadership is especially important for psychological safety and feedback-seeking behaviour."
Article 12:[21]	"We tested our hypotheses using a sample of 249 followers across two waves of data collection. Results suggest that ethical leadership and leader competence interact to drive followers' duty orientation, thereby reducing followers' feedback-avoiding behaviours. Further, ethical leadership had a direct positive relationship with followers' feedback-seeking behaviours."
Article 13:[22]	"Autonomy-supporting feedback can still be motivating even when it conveys messages of low competence."
Article 14:[23]	"Students should be enabled to have greater control over assessment and feedback processes, which should be as authentic as possible. Effective long-term mentoring facilitates this process. The trend of curriculum change towards constructivism should be mirrored in the assessment processes in order to enhance receptivity to feedback."

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Source	Teacher-related themes	Student-related themes
Article 1:[10]	Respect	Self-regulated learning as an expectation;
Article 2:[11]	The provision of feedback	Self-regulated learning; Belief
Article 3:[12]	Encouragement of self-evaluation/reflection	Self-regulated learning; self-reflection; self-assessment
Article 4:[13]	Basic ethical behaviour: Respect; Beneficence (supportive / lacked procedure); Autonomy (not autonomy supportive and lack of explanatory rationale)	Learner involvement (autonomous function)
	Basic ethical behaviour: Trust Threats targeting the self-esteem is unacceptable	Self-regulated learning; Self-efficacy; Outcome belief; Self-concept; self-reflection; self-assessment; internal attribution (acknowledgment of suboptimal performance)
Article 6: [15]	Basic ethical behaviour: Confidentiality	Self-regulated learning; Self-esteem (shame/ embarrassment)
Article 7 [16]	Basic ethical behaviour: Tolerance (prejudice)	Self-regulated learning: Self-motivation); Guilt feelings (lack of psychological safety)
Article 8 [17]	Cognitive bias	Self-regulated learning: External attribution; Prejudiced (culturally); Lack of psychological safety
Article 9 [18]	Basic ethical behaviour: Autonomy (allowing autonomy for behaviour change)	Self-regulated learning: Self-efficacy; Outcome belief; Self-motivation; Self-concept; Self-reflection; Self-assessment; Internal attribution (acknowledgment of suboptimal performance)
Article 10:[19]	Autonomy (self-determination theory)	Self-regulated learning: Self-motivation); Self-adaptation/ reflection (Feedback seeking)
Article 11: [20]	Ethical leadership (during power relationship)	Self-regulated learning: Self-esteem (psychological safety); Self-adaptation/ reflection (Feedback seeking)
Article 12: [21]	Ethical leadership	Feedback seeking and avoiding behaviours
Article 13: [22]	Autonomy (autonomy supportive in pointing out gaps)	Self-regulated learning: Self-motivation (even with negative feedback)
Article 14: [23]	Autonomy (student should have greater control); Build knowledge through a constructivist philosophy	Receptivity to feedback (feedback seeking)

DISCUSSION

This study examined the relationship between the ethical behaviour of teachers and the self-regulation ability of students using qualitative data obtained from the scoping review.

The learner's duty

Learners have a moral obligation regulate their own learning Article 1, Table 1).[10]

The teachers' duty

Building trust and respect: Teachers in turn should guide and nurture the student through a respectful relationship (Article 1).[10] Constructive feedback has the potential to instil self-belief in learners (Article 2).[11] The encouragement of self-evaluation and reflection is also likely to develop self-regulation (Article 3).[12] Feedback with an intention to do good and supports the autonomy of the learner is seen to be desirable and effective (Article 4).[13] Building trust between the teacher and learner tends to promote desired self-regulation behaviours such as self-efficacy, self-concept and internal attribution whilst negative remarks aimed at the learner's self-esteem is unacceptable (Article 5).[14] Maintaining confidentiality during feedback delivery is crucial to preserve the learner's self-esteem. For example, giving negative feedback in front of any other person about a person's inability causes extreme embarrassment and harms to the self-esteem (Article 6).[15] Feedback perceived to be prejudicial has a high likelihood to impact on leaner's self esteem eliciting a strong feeling of guilt, which is counterproductive (Article 7).[16] Receiving feedback from somebody who is perceived to be biased (e.g., culturally different) may result in a situation where the feedback is discarded due to a lack of trust (Article 8).[17]

Be autonomy supportive: Allowing students autonomy has a connection with self-regulated learning concepts such as self-efficacy belief, outcome expectation, self-motivation self-concept, self-reflection, self-assessment, internal attribution (acknowledgment of suboptimal performance) (Article 9).[18] Self-determination theory is key to develop feedback-seeking behaviours and to stimulate learners' intrinsic motivation that is needed to drive improvement (Article 10).[19] Feedback given in an ethical way encourages desirable feedback-seeking behaviours because it provides a basis of psychological safety, while the reverse is also true. It provides a basis for self-reflection and positive adaptation (Article 11).[20] Ethical guidance is directly linked with feedback seeking behaviours (Article 12).[21] Feedback that is autonomy supportive can be effective even if the message is that of incompetence (Article 13).[22] Gaps in performance should be highlighted discretely to allow the learner the autonomy to build on existing knowledge (constructivist approach) (Article 14).[23]

Proposed conceptual model

The above-mentioned were used together with the literature known to the authors to synsthesize a model to illustrate the potential impact of a teacher's clinical behaviour on a student's self-regulation and academic success.

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Figure 2 contains a synthesised model of these relationships.

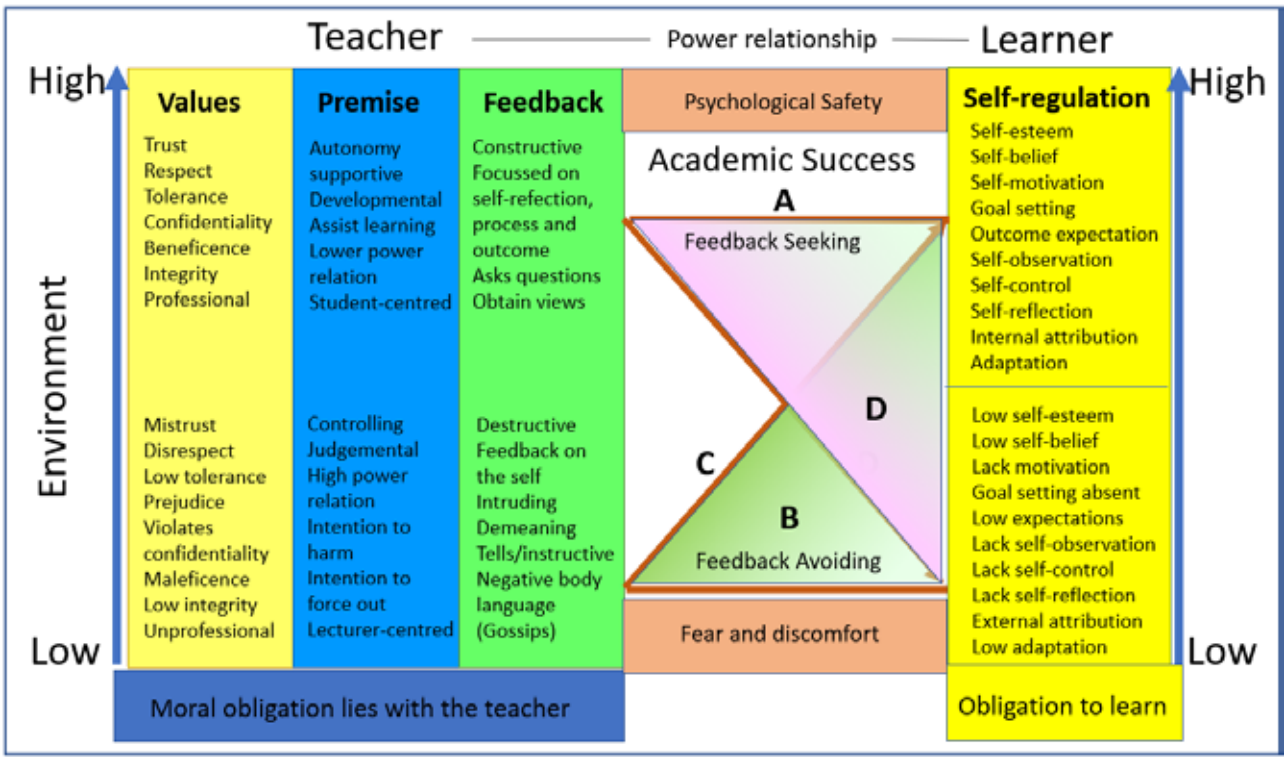

FIGURE 2. Proposed model to illustrate the potential impact of a teacher's clinical behaviour on a student's self-regulation and academic success.

On the left side is the teachers who have an obligation to teach. At the same time, they have a moral duty to do so in a manner that will create an environment of psychological safety for the students.[24] On the right side are the students who have a need and desire to learn, as well as a moral obligation to put in the self-regulation,[10] effort and work required to gain maximum value from the opportunity afforded to them. The results of this review suggest that there may be an association between the manner in which the teachers impart their knowledge and provide feedback (their ethical behaviour) and the effect it has on promoting self-regulation abilities in the students.[10-23]

The lines A and B in the middle demonstrates the general relationships described in the literature. In scenario A there is a combination of ethical teachers who behave with professionalism and are student–centred in their approach. They deliver feedback with the aim of doing good by focussing on the gaps in understanding, allowing the students time and opportunity to self-reflect, and respecting their views whilst giving truthful feedback in a respectful way.[10] The teachers understand that the student is still learning and not yet competent, and thus strive to create a psychologically safe environment. If such educators are linked with learners who already have high levels of self-regulation, and feedback seeking behaviours, it will almost inevitably lead to academic success.

In scenario B the teachers mistrust the student and show little compassion for the fact that they are still new to the study material and will have skills and knowledge gaps. They are often judgmental and prejudicial even before the learning contact starts. They may shame the student in front of others people. This type of behaviour is even more morally reprehensible if they do so when interacting with students who they know have low self-regulation abilities or poor self-esteem. Such students will not perform well academically and avoid feedback because it affects their self-esteem negatively. They thus not only deprive themselves of the much-needed tuition, but may even become depressed and anxious, which further hinders their progress.

In scenario C, the upwards arrow indicates the situation where the teacher behaves as described in scenario B, but the student has high self-regulation ability and ignores the comments of the teacher or puts in more effort to prove them wrong. The student now enters the "Bermuda Triangle". This is risky as it's a large space (illustrated by the pink triangle) and there is no way of telling where they may end up within this triangle. Some may rise up the C arrow and achieve academic success, while others end up anywhere in between the top and bottom limits, achieving varying levels of clinical and academic success.

In scenario D, the downwards arrow represents the situation where the teacher behaves as described in scenario A but the student has low self-regulation and does not perform academically. Once again, few will directly follow the straight line, while most will fall within the green triangle of unknown outcomes.

CONCLUSION

Staff competence should be developed in the field of ethical feedback delivery to enhance student self-regulation and promote learning. Assessment of their skills in feedback delivery could even be used as a measure of their performance as educators. The above-mentioned model may serve as a framework for such development.

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None

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DISCLOSURE

Nothing to disclose

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Online CPD in 6 Easy Steps

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

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CPD questionnaire

Efficacy of GapSeal® in Preventing Microleakage at the Dental Implant Abutment Interface

1. **Select the CORRECT option. Microleakage is dependent on:**
   A. The type of implant abutment connection
   B. The final closing torque
   C. The application of a sealing material
   D. All of the above

2. **Which answer is INCORRECT. All the following statements regarding microleakage are true except:**
   A. It can interfere with osseointegration
   B. There is a two-way relationship between microleakage at the IAI and screw loosening
   C. External hexagon connections are better at curbing microleakage than Morse taper
   D. It increases with an increase in microgap size

Final-year dental students' perceptions of verbal feedback in the clinical setting

3. **Select the CORRECT statement. Which statement about feedback is true?**
   A. Formative assessment is considered to be assessment for learning
   B. Verbal feedback is independent of emotions
   C. Feedback should have a punitive component
   D. Verbal feedback is a natural skill that is instictive to every clinical supervisor

4. **Choose the CORRECT option. One of main goals of feedback is:**
   A. To get students to communicate
   B. To identify student weaknesses after a session
   C. To develop an action plan for improvement
   D. To assist with awarding a student a grade after the clinical session

5. **Which option is CORREC. In this study, it is reported that most students:**
   A. Got sufficient feedback from clinical supervisors
   B. Felt that the feedback they received had a negative effect on their emotional state
   C. Want feedback after clinical sessions
   D. Reported that enough time available to engage in feedback after their clinical sessions

Obturation Quality after Pulpectomy Treatment in Primary Molars using Different Preparation Techniques

6. **Select the CORRECT statement. Which of the following best describes the importance of primary teeth?**
   A. They serve only aesthetic purposes in early childhood
   B. They act as placeholders for permanent teeth and assist in speech development
   C. They do not influence arch space or speech
   D. They are primarily non-functional and expendable

7. **Which answer is CORRECT. What is a major anatomical challenge when performing pulpectomies in primary molars?**
   A. Presence of accessory canals
   B. Thickness of enamel and dentine
   C. Curved, tortuous canals and proximity to developing permanent teeth
   D. Larger pulp chambers compared to permanent teeth

8. **Choose the CORRECT option. Which instrumentation systems were compared in this study?**
   A. Manual files, ultrasonic systems, and lasers
   B. Reciprocating files, rotary files, and lasers
   C. Manual files, rotary files, and reciprocating files
   D. Hand files, sonic irrigation, and thermoplastic obturation

Antimicrobial Resistance and the Dentist: A review of literature

9. **Select the CORRECT statement. Which of the following is true regarding antibiotic use in clinical dentistry?**
   A. Antibiotics are always recommended as the first line of treatment for all dental infections.
   B. The AWaRe classification by the WHO advises the use of broad-spectrum antibiotics for routine dental procedures.
   C. A narrow-spectrum antibiotic is recommended for most clinical situations where antibiotics are required in dentistry.
   D. Guidelines for antibiotic prescribing in dentistry suggest using antibiotics for all dento-alveolar infections regardless of systemic symptoms.

10. **Choose the INCORRECT option. Which of the following is NOT mentioned as a factor influencing antibiotic prescribing by dental practitioners?**
    A. Patient requests for antibiotics
    B. Pressure from non-dental healthcare practitioners
    C. Adherence to updated antimicrobial resistance guidelines
    D. Fear of lawsuits and lack of scientific evidence

11. **Which statement is CORRECT. Which of the following is true regarding the management of dental infections and the use of antibiotics?**
    A. Antibiotics are always necessary to relieve pain during dental treatments.
    B, Antibiotics should only be prescribed for dento-alveolar infections if there is an indication of systemic involvement.
    C. Dental infections always require antibiotics in addition to clinical treatment.
    D. Prescribing antibiotics is the primary method of managing acute dental infections.
    E. All of the above statements are correct

An Ectopic Tooth in the Coronoid Process: a rare case report

12. **Select the CORRECT answer. A radiolucency that appearing to be attached to the cemento-enamel junction of an ectopic tooth is said to be**
    A. Dentigerous cyst or dilated dental follicle
    B. Primodial Odontogenic cyst
    C. Radicular cyst
    D. Odontoma

13. **Which of the following is INCORRECT: The presentation of ectopic teeth may present with a myriad of clinical signs and symptoms.**
    A. Pain, swelling, infection
    B. Nerve damage
    C. Always associated with cystic transformation
    D. Pathological fracture

14. **Select the CORRECT answer. Theories have been put forward to describe why teeth can be impacted:**
    A. Aberrant eruption patterns
    B. Tooth mobility
    C. Atraumatic iatrogenic procedures
    D. Restorations on primary teeth

15. **Which option is CORRECT. According to Wu et al. classification of impacted teeth, impacted teeth are commonly found at which level**
    A. Level I
    B. Level II
    C. Level I and II
    D. Level III and IV

What's new for the clinician – summaries of recently published papers

16. **Select the CORRECT statement: In the Elshenawy et al study, which of the following statements best describe the methodology employed?**
    A. This was an in vivo experimental study using a split-tooth design
    B. This was as an in vitro experimental study using a parallel design
    C. This was as an in vitro experimental study using a split-tooth design
    D. This was as an in vitro case-control study using a split-tooth design

17. **Which statement is CORRECT. In the Elshenawy et al study, which of the following statement best describes the results obtained?**
    A. Baseline hardness for Side A was significantly higher than the non-treated sides (P=0.56)
    B. Baseline hardness for both groups was significantly higher than the treated sides, which was significantly higher than the non-treated sides (P=0.56)
    C. Baseline hardness for both groups was significantly higher than the treated sides, which was significantly higher than the non-treated sides (P= 0.20)
    D. Baseline hardness for both groups was significantly higher than the treated sides, which was significantly higher than the non-treated sides (P=0.000)

18. **Select the INCORRECT presentation. Which of the following is NOT regarded as clinical presentation of Oral Lichen Planus**
    A. Reticular,
    B. Erosive,
    C. Atrophic,
    D. Plaque-like,
    E. Inflamed

19. **Select the INCORRECT treatment. Which of the following treatments are NOT recommended for the treatment of OLP?**
    A. Corticosteroids
    B. Immunosuppressants or immunomodulators
    C. Various non-pharmacological regimens,
    D. LASER therapy
    E. Antibiotics

20. **Choose the CORRECT answer. The results of the OLP study suggest that Vitamen D deficiency is linked to which of the following factor?**
    A. Demographics
    B. Prevalence
    C. Severity
    D. Mortality
    E. Gender

Ethics: The association between ethical feedback delivery and student self-regulation

21. **Select the CORRECT answer. Ethical feedback to students:**
    A. Improves self-regulation
    B. Should be aimed at the self and the task
    C. Should be given immediately
    D. All of the above are correct
    E. Only a) and b) are correct

22. **Which statement is CORRECT. Feedback delivers:**
    A. Can enrich or be detrimental to learning
    B. Relies on power relationships between teacher and learner to be effective
    C. Depends on the learner's ability to self-reflect
    D. Only a) and b) are correct
    E. Only a) and c) are correct

23. **Choose the CORRECT option. In Scenario B of the proposed model:**
    A. The teachers show compassion for the learners
    B. The student may become anxious and depressed due to the mode of feedback given
    C. The teachers are aware that students are still learning and won't know all the material
    D. The teachers avoid giving feedback to students with low self-esteem
    E. The student will strive to learn more due to the mode of feedback given

24. **Choose the CORRECT answer. The literature suggests:**
    A. There is no direct relationship between feedback and performance
    B. Positive feedback will only enhance performance in academically strong learners
    C. Positive feedback can enhance performance in weak learners
    D. Only a) and b) are correct
    E. Only a) and c) are correct

25. **Select the INCORRECT statement. In the article by Eva and Regehr, which statement is false?**
    A. Cognitive dissonance is the discomfort created by trying to maintain conflicting beliefs at the same time
    B. Positive effects of corrective feedback rely on acknowledgement that one is performing sub optimally
    C. Cognitive dissonance is best addressed by discounting the feedback rather than altering one's sense of self
    D. It is easier to question data than to question oneself
    E. Having a belief that one can accomplish a goal increases the likelihood of accomplishing it

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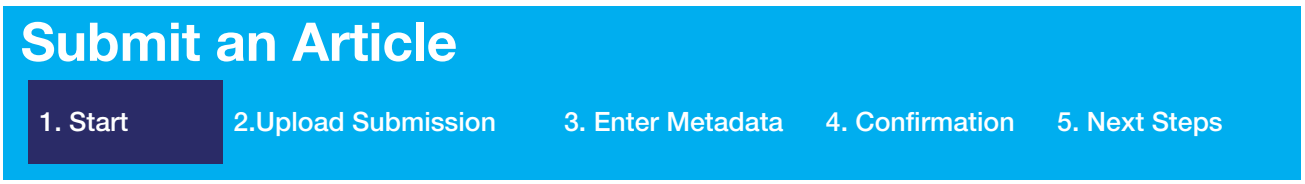

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