RESEARCH

436  Clinical evaluation of the loop-design fibre-reinforced composite and the band-and-loop space maintainers

442  Debris contamination of endodontic hand files in dental practice

447  An in vitro examination on the effectiveness of commercial toothpastes in the prevention of tooth decay, using eggshell as a substitute for human tooth material

Ardipithecus ramidus: “Ardi” (ground floor) lived between 4.4 and 4.2 million years ago. Many fossils have been found in Ethiopia. They had canines somewhat smaller than other known apes and the upper canine was diamond shaped, similar to Australopithecus. They represent the earliest stages of human evolution. The dentition points to an omnivorous/frugivorous diet.

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A song of note.

SADJ August 2018, Vol 73 no 7 p432

WG Evans

How marvellous to be woken in the morning with bird song, and the first to greet the sun in Johannesburg is the Cape Robin (Cossypha caffra) with its lilting whistle, perhaps not as versatile as the Chorister (Cossypha dichroa), nor indeed the Whitethroated Robin (Cossypha humeralis), but nevertheless a welcome melody at the break of day. Endeavours to reproduce the whistle of the Cape Robin result in a mixed reaction, it is quite possible to discern incredulity in the quizical gaze the bird directs at this impertinent and inept mimic, and then the feeble attempt to match the genius of birdsong is tossed aside with an outpouring of magnificnt calls.

I am sure that has been the experience of all fortunate enough to reside in leafy gardens in Johannesburg!

Why is it that the human larynx, capable of such versatile accomplishments as the top C, the marvellous contralto, the rumble of the lower bass, the wondrous tenors, the capacity to shout from hilltop to hilltop, ranging to the merest whisper, how then that the birds outdo us in ability to sing?

In a word, it is the SYRINX (Greek for Pan pipes), birds have this vocal organ located at the base of the trachea, just above the bronchial openings. That immediately offers an advantage for the bird may use one, the other, or both bronchi. The openings may be unilaterally controlled and altered and some birds are so expert that they can in this way produce two notes at the same time! A trick called lateralisation. But the main anatomical feature contributing to song are the membranes surrounding the syrinx. The bird uses these flexible membranes in a manner similar to the human vocal chords. The tensions and shape of the membranes are altered by a series of associated muscles. In the true artists of bird song there may be five to nine sets of muscles controlling the membranes. At the other end of the scale, ostriches and vultures have no syringeal muscles at all. They have no need to exchange vocal information about food sources, hence their limited production of sound, lacking a syrinx altogether, vultures hiss.

Pursuing the analogy further, humans produce sounds of varying amplitude and frequencies in the larynx by vibrations of the vocal chords. The sounds are modulated above by the pharynx and by changing configurations of the mouth and lips. In birds the cavities above the syrinx are no less effective in final modulation, movements of the neck, the tongue, the beaks and the trachea all contribute to the eventual note. The vocal chords are relatively paltry when compared with the more extensive—and more variable- avian membrana tymbaniformis.

Observe that no mention has yet been made of the teeth, which in humans play an influential role in articulation. Try the S sound without teeth, as we all have seen, or more accurately, heard! But birds have no teeth, and how did that happen, recognising that their ancestors, the Dinosaurs, or, as opinion has been expressed, the Archosaurs, most certainly had teeth, some terribly impressive!

Accepting that avian song is not limited by a lack of a dentition, explore now why indeed teeth have been lost. A postulate has been that the presence of a heavy dentition in the head of a flying creature may have caused unwieldy aerodynamics. Not so, more recent opinion holds, it is because birds tend to swallow their food whole, and the anatomy of the hyoid structures has been adapted to accommodate the demands of ingesting larger items. Or, if you can swallow large items there is no need to reduce the bolus by chewing! The hyoid apparatus in mammals is attached to the skull, in birds it is not, allowing greater flexibility of the structures, and an enlarged glottis to accommodate a whole meal. No need for teeth, and the song has not been affected, not with nine sets of syringeal muscles to ensure wonderful vibrations of the air coming through two bronchi!

Humans have limited pharyngeal openings, and they have teeth. And there certainly have been times when those teeth have contributed directly to songs, but songs of agony, especially when a root canal is infected and swollen and, sore, very sore! Recent issues of the Journal have included papers on Endodontics and this issue actually carries two articles dealing with different aspects of the discipline. It is indicative of the advances made in this demanding treatment modality that explicit research is being carried out and that there is genuine excitement at the enhanced opportunities to resolve challenging problems. The papers present an unusual divergence, for most positive clinical excellence is evident, vide the new material Biodentine and the efficacy of treatment of a double rooted canine, whilst a very practical problem is unveiled in the inefficiency of much of the commonly practised cleansing of endodontic files. How punctilious is the discipline in meticulously investigating every aspect, positive or critical. That that example is carried through in all aspects of Dentistry will have been evidenced by the papers presented at the 2018 Congress of the Dental Association of South Africa. Progress can be made only if the errors as well as the successes are recognised. We can then, despite the limitations of our vocal chords, sing the praises of our profession!

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No.1 DENTIST RECOMMENDED BRAND FOR SENSITIVE TEETH⁶
Women in Dentistry – realities, challenges and opportunities

South Africa commemorates Women's Month in August as a tribute to the more than 20 000 women who marched to the Union Buildings on 9 August 1956 in protest against the extension of Pass Laws to women. The Government of South Africa declared August as Women's Month and 9 August is celebrated annually as Women's Day. This was a case of women being the heroines of their own story – stepping out of their comfort zones, taking risks, but effecting positive change. Accordingly, this Guest Editorial hopes to bring in focus the Women in Dentistry.

It is a fact that women dentists tend to juggle more in life than do their male colleagues. Let’s stop to think about that. Not only do these ladies have to handle the responsibilities of being somebody’s doctor, they are quite likely managing the formidable contexts and responsibilities of being somebody’s wife or significant other, life partner, housekeeper, cook, family caretaker, social secretary, and/or general runner-of-things. If they are one of the legions of women dentists with children, they are also handling the superhuman demands of being somebody’s mother. Talk about “Mission Impossible!”

So, what’s the difference between the experiences of men and women in dentistry? From my own personal perspective: from early childhood, boys were raised and trained to focus on financial or professional success. As girls, we were socialised differently, more around relationships and nurturing. Just look at our previous social roles and experiences — supportive sister, doting daughter, loving wife, adoring mom, true friend ... fixing problems and running rings around home, workplace, and community to keep everyone happy. Even though this makes the world a nicer place to live in, it is perceived differently in the how-to-manage-a-dental-staff department. Although hardwiring might separate the girls from the boys, staff members and patients, as well as colleagues, often perceive similar personality traits differently, making bias a reality. It is acknowledged that socio-cultural influences do play a role. However, as women, we not only have the greater number of challenges, but must possess a greater range of skills to meet these challenges.

Putting courtship, marriage, and family aside, let’s focus on our professional role ... the challenges of being somebody's boss, of minding professional matters, of liaising with other colleagues around governance as well as multi-disciplinary matters:

I look back at the time when I studied and I am amazed at how few of us there were — ten percent of the graduating class were women. Today, our profession and society have come a long way with many changes. The rise in the number of women in the profession has brought, and continues to bring many positive changes, slowly, but surely. Certainly, challenges do remain for women dentists, such as addressing the lack of representation in leadership roles and education, improving ergonomics and closing the wage gap. As women become more engaged and integrated into the profession, culture and sensitivity will improve.

It remains an issue of concern that, whilst women are now represent more than 50 percent in the graduating classes at dental schools, they are still not equally represented in the number of continuing education speakers, in the number of professors teaching at dental schools or being offered tenured positions, and in leadership roles in organized Dentistry. Indeed, it is not just Dentistry where this situation obtains.

We can no longer submit to our own or imposed stiletto ceilings and remain apathetic or on the periphery asking “why me?” It is time for “TRY ME!”

Change is happening and we cannot afford to find ourselves left out. In his book “Thanks for being late: An Optimist’s Guide to Thriving in the Age of Accelerations”, Thomas L Friedman argues that we are living through the greatest inflection points in history, paving the way for Reformation. The three largest forces on the planet – technology, globalisation and climate change - are all accelerating at once. As a result, so many aspects of societies, workplaces and geopolitics are being reshaped and therefore need to be reimagined. When the pace of change accelerates in so many realms all at the same time, as we are now experiencing, it is easy to be overwhelmed by it all and to feel uncertain and uncomfortable. But, fact is, we are in that state of acceleration and the recommended option is to pause and reflect, rather than to panic and withdraw. It is not a luxury or a distraction – it is a way to increase the odds that you will better understand, and
engage productively with, the world around you.

In our current professional climate, we have so many challenges and disencouraging experiences. Enough to deter our enthusiasm! However, we have to remain focused on living on purpose. To this end, the words of Marie Curie never rang more true or felt more relevant to me: “Life is not easy for any of us. But what of that? We must have perseverance and above all, confidence in ourselves. We must believe that we are gifted for something and that this thing, at whatever cost, must be attained. Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, to embrace change, so that we may know who we are, where we are going, and fear less.”

When you work in alignment with who you are and your gifts, it is not work. A job is a vocation only if someone calls you to do it for them rather than for yourself. And so, our work can be a calling only if it is reimagined as a mission of service to something beyond merely our own interests.

Thinking of work mainly as a means of self-fulfillment and self-realization slowly crushes a person – Timothy Keller.

Make every effort to discover your authentic flow and you will find yourself energized to effortlessly attract opportunities from both expected and unexpected sources.

It is time to approach change and productivity like welcome friends rather than scary intruders. All the scares and scars of gender bias or “missions impossible”, should never make us bitter or jaded but must become badges reflecting our tenacity that we can wear proudly.

To the younger women joining the profession, remember that if you have personal transformation in mind, you will never be disappointed. Prepare to be a life-long learner. Learning is as important as breathing. In the words of Alvin Toffler: “The illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn and re-learn.” Unlearn and transform those unproductive mindsets and re-learn what is futuristic. The power of our values and beliefs advise and shape the form of our organizational structures, systems and strategies.

Always think positively – optimists live longer than pessimists. When you encounter an obstacle, go over it, under it, around it, or through it. Being rolled over by it is not an option. Turn it into a stepping stone. Don’t only think “survive”…… think “sur-thrive”!

NOTICE OF 19th ANNUAL GENERAL MEETING (AGM) OF The South African Dental Association NPC (“SADA”)

Notice is hereby given that the 19th Annual General Meeting (AGM) of the South African Dental Association (SADA) will be held at

the SADA Head Office, 31 Princess of Wales Terrace, Parktown, Johannesburg on Thursday 14 March 2019 at 18:00

followed by snacks and refreshments.

The Agenda for the meeting will be posted on the SADA website.

SADA is your Association and your voice counts.

KC Makhubele
Chief Executive Officer
Clinical evaluation of the loop-design fibre-reinforced composite and the band-and-loop space maintainers.

SADJ August 2018, Vol 73 no 7 p436 - p441
N Potgieter¹, PD Brandt², N Mohamed³

ABSTRACT

Purpose: The fibre-reinforced composite space maintainer (FRCSM) has been suggested as an alternative to the band-and-loop space maintainer (BLSM). The aim of this in-vivo study was to evaluate the clinical performance and the reasons for failure of the two types of fixed space maintainers over a six-month period.

Methods: Twenty patients, ranging from 4-9 years old, were selected for this study. They were randomly divided into two groups (n=10) according to the type of space maintainer that was placed. The patients were recalled on a monthly basis for clinical evaluation over a period of six months. The two-sample t-test and the non-parametric Wilcoxon rank sum test were used for statistical analysis.

Results: Both groups of space maintainers had a 50% failure rate. The main reason for BLSM failure was bending of the wire with impingement on the soft tissue. The FRCSM failed due to debonding and fracture of the fibre loop. There was no statistically significant difference between the failure rates (P=0.53).

Conclusion: The clinical performances of both space maintainers were disappointing. Only 50% of fixed space maintainers were still clinically acceptable according to the strict evaluation criteria used. Further research is recommended on the loop-design FRCSM.

Key words: Space maintenance, Band-and-loop space maintainer, Fibre-reinforced composite space maintainer

INTRODUCTION

Loss of space due to drifting after early loss of deciduous teeth is one of the leading causes of malocclusion in paediatric patients in the deciduous- or transitional-dentition stages.¹ An effective space-maintaining appliance could, therefore, reduce the incidence of occlusal discrepancies.²

Stainless steel band-and-loop maintainers (BLSMs) are widely used as fixed appliances to maintain space after the early loss of a single deciduous tooth and should remain in place until the permanent tooth erupts.³ Common reasons for the failure of BLSMs are fracturing and bending of the loop or loosening of the band under occlusal forces.⁴,⁵ The average “survival time” of a BLSM has been reported as approximately 13 months.⁶ A long-term study by Sasa et al.⁷ revealed the success rates of BLSMs to approximate only 10 percent. Thus, alternatives to the BLSM are being investigated.

Fibre-reinforced composite material is known for its flexural and physical strength.³,⁸ Consequently, the fibre-reinforced composite space maintainer (FRCSM) has been suggested as an alternative to the conventional stainless steel BLSM.³,⁹,¹⁰

A mean survival time of five months for FRCSMs has been reported¹¹ and success rates over a six-month period were found to range from 27.5% to 67%.¹ These are relatively low survival times and further research on the FRCSM placement technique has been recommended.⁴ Kulkarni et al.³ and Yeluri et al.⁹ tested the loop-design FRCSM in vitro and concluded that it might be considered an alternative to BLSMs.

This study presents a novel placement technique of the loop-design FRCSM. The study aimed to investigate and compare the in vivo failure rates, as well as the reasons for failure, of the loop-design FRCSM and the metal BLSM over a six-month period.

ACRONYMS

BLSM: band-and-loop space maintainer
FRCSM: fibre-reinforced composite space maintainer

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MATERIALS AND METHODS
Twenty patients, ranging from 4-9 years old, were selected for this study, determined by strict criteria. Patients were included provided they presented with; premature loss of a deciduous first molar (> one year before the expected exfoliation time); anchor teeth (second deciduous molars) with intact, undamaged buccal and lingual surfaces to bond to; and anchor teeth with more than half of the root length present. Patients were excluded from the study if they presented with; teeth with compromised structure in the intended bonding area (i.e. demineralized enamel, caries, fractures, iatrogenic damage or existing restorations); occlusal discrepancies (i.e. a cross-bite, an open bite, or a deep bite); or the inability to return for monthly follow-up appointments.

The space maintainers were allocated alternately to patients in the order in which they were accepted for the study. The sample was therefore randomly divided into two groups (n=10) according to the type of space maintainer that was placed. The patients were recalled on a monthly basis for clinical evaluation for six months.

ETHICAL CONSIDERATIONS
The study was approved by the Research Committee of the School of Dentistry at the University of Pretoria and the Ethics Committee of the University (ref. nr 523/2015). Written informed consent was obtained from the parent/legal guardian of each child who participated. Participants over the age of seven years also gave their own informed assent.

CLINICAL PROCEDURES
The principal investigator personally selected all participants, placed all space maintainers, and performed all follow-up procedures. The placement techniques used are detailed below.

PLACEMENT OF THE FRCSMS
The FRCSMs in this study differed from the design of the FRCSMs tested in previous clinical studies. To eliminate any restriction of normal physiological tooth movements and growth of the jaws, the teeth adjacent to the edentulous area were purposefully not bonded together when the loop was constructed.

The FRCSMs were placed according to a step-wise clinical procedure. The anchor tooth (second deciduous molar), the edentulous area and the tooth anterior to the edentulous area (deciduous canine) were isolated with rubber dam. A matrix band was applied to the canine and the anchor tooth was prepared by cleaning the surfaces intended for bonding using pumice, water and a rubber polishing cup to remove all plaque and surface accumulations.

As recommended by Zilberman, the bonding surfaces on the second deciduous molars were prepared by etching the enamel for 60 sec with 34 percent phosphoric acid (Scotchbond Universal etchant, 3M ESPE, St. Paul, USA). The everStick instruction manual recommends a 60 sec etch time to maximize bond strength. Bonding agent (Adper Scotchbond 1XT adhesive, 3M ESPE, St. Paul, USA) was applied and light cured according to the manufacturer’s instructions.

The uni-directional glass-fibre bundle (everStick C&B, Stick Tech Ltd., Turku, Finland) was placed in a continuous loop extending from the buccal to the lingual surfaces of the anchor tooth. The full buccal and lingual dimensions of the anchor tooth were used, the bundle being placed in the middle of the occluso-gingival dimension. The glass-fibre bundle was secured in position with a flowable composite (Filtekt Suprême XTE Flowable, 3M ESPE, St. Paul, USA) and light cured on both the buccal and lingual surfaces for an initial 10 sec period. The loop was then manipulated and shaped to the ideal form.

The glass fibre was then moistened with unfilled adhesive resin (Adper Scotchbond 1XT adhesive, 3M ESPE, St Paul, USA), using a bond applicator brush and the entire loop was cured for 40 sec. Flowable composite (3M ESPE) was applied to cover the whole loop and light-cured for 40 sec. An ELiTEDENT® Q-4 LED curing light was used, and the curing tip was kept within one mm of the material to ensure a complete cure. The curing light was regularly tested with a Bluephase® meter to ensure a consistent output of 1000–1100 mW/cm². The FRCSMs were finished and polished using a yellow striped, flame-shaped diamond finishing bur (Dentsply Sirona, Switzerland; ISO 806 314 249 504 012) and the Enhance polishing system (Dentsply Sirona, Milford, USA) (Figure 1a).

The FRCSMs were finished and polished using a yellow striped, flame-shaped diamond finishing bur (Dentsply Sirona, Switzerland; ISO 806 314 249 504 012) and the Enhance polishing system (Dentsply Sirona, Milford, USA) (Figure 1a).

PLACEMENT OF THE BLSMS
The BLSMs were placed according to the standard clinical procedure. An orthodontic band was fitted around the anchor tooth and an impression was taken with the band in place. The band was then transferred to the impression and secured before the impression was sent to the laboratory for pouring of the model and manufacturing of the space maintainer. The BLSMs were cemented with glass ionomer cement (GIC) (Fuji ORTHO, GC America, Illinois, America) according to the manufacturer’s instructions (Figure 1b).

Follow-up and evaluation of space maintainers
Monthly follow-up appointments were scheduled over a six-month period. Parents and patients were, however, instructed to report immediately for an emergency appointment if any problem or failure occurred between these pre-arranged appointments. This ensured that the timing and reasons for any failure of appliances were accurately recorded.

Failure criteria for a space maintainer
Based on previous clinical comparative studies, a space maintainer was classified as having failed when it presented with any of the following:

- Debonding of the fibre-composite or the band-cement interface;
• Debonding of the enamel-composite or the cement-enamel interface;
• Fracture of the fibre/metal frame; or
• Bending of the fibre/metal loop to the extent that the device was in contact with the soft tissue.

**STATISTICAL ANALYSIS**

Frequency tables were used to report on the monthly failures and repairs per group. Contingency tables were drawn up to highlight the distributions of the space maintainers according to the age of the appliance and the reasons for failure. Statistical differences between failure rates of groups were compared and analysed using mean (two sample t-test) and median (non-parametric Wilcoxon rank sum test) values.

**RESULTS**

**Failures and reparability of failed appliances**

During the six-monthly follow-up period, five out of ten (50 percent) of both types of space maintainers failed according to the strict failure criteria.

A comparison of failure rates between the FRCSMs and BLSMs

Table 1 provides a summary of the statistical analysis comparing failure rates of the two groups. The number of days until failure was used as an indication of longevity of the appliance. All space maintainers that survived the six-month period therefore survived 180 days. The difference between the two mean values was 5.1, which was not statistically significant (P=0.525). The difference between the median values was 16, also not statistically significant (P=0.620).

<table>
<thead>
<tr>
<th>Reason for failure</th>
<th>FRCSM (n (%)</th>
<th>BLSM (n %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FRCSM debonding at enamel-composite interface/BLSM debonding at enamel-cement interface</td>
<td>2 (40%)</td>
<td>--</td>
</tr>
<tr>
<td>FRCSM debonding at composite-fibre interface/BLSM debonding at cement-band interface</td>
<td>1 (20%)</td>
<td>--</td>
</tr>
<tr>
<td>Fracture of the fibre/ wire loop</td>
<td>2 (40%)</td>
<td>1 (20%)</td>
</tr>
<tr>
<td>Bending of the fibre/ wire to impinge on soft tissue</td>
<td>--</td>
<td>4 (80%)</td>
</tr>
<tr>
<td>Loss of contact with adjacent tooth</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Total failures</td>
<td>5 (100%)</td>
<td>5 (100%)</td>
</tr>
</tbody>
</table>

**Reasons for failure**

The reasons for failure according to the failure criteria are reported in Table 2 as percentages of the total failures per group.

**DISCUSSION**

When analyzing the results of this study and comparing the data with that of previous studies, the specific anchor teeth should be taken into consideration. Bond strength to deciduous enamel is lower than bond strength to permanent enamel, and FRCSMs placed between deciduous teeth have been reported to have a higher failure rate than those bonded to permanent teeth. Greater success could be therefore be achieved on permanent teeth and this option should be explored in future research.

The study found that the overall failure rates after six months, evaluated according to the strict failure criteria, were 50 percent for both the BLSMs and the FRCSMs. These failure rates were similar to those of two previous comparative clinical studies conducted in India for the BLSMs, but differed markedly for the FRCSMs. Previous studies, conducted over six months, reported overall failure rates of 63.3% and 56.7% for the BLSMs, and 36.7% and 33.3% for the FRCSMs respectively.

The reparability of the space maintainers should be considered when comparing failure rates. Three of the five failures reported for the FRCSMs were reparable chairside, whereas none of the five failed BLSMs were reparable chairside and had to be removed and refabricated in the dental laboratory. Hence the FRCSMs proved to be more economical by saving time, additional laboratory costs and additional patient visits during the repair/ refabrication process.

Breakdown of the enamel-composite interface (Figure 2a) accounted for 40% of the FRCSM device failures. This finding is consistent with those of previous studies and is attributed to a relatively weak bond between composites and the aprismatic enamel of deciduous teeth. Kirziolu and Erturk reported failure rates of 32%, within just one month when fibres had been placed without rubber dam protection and emphasized the importance of moisture control during placement to ensure good bond strength.

Debonding of the fibre-composite interface accounted for 20% of the FRCSM device failures reported. Previous authors have also reported debonding of the fibre-composite interface as a reason for FRCSM failure, attributing respectively 4.2% and 13.3% of all recorded FRCSM failures to this cause. The debonding might be the result of strain placed on the fibre-composite bond during finishing, occlusal contact with the fibre strut, and wearing of the composite layer by the forces of mastication. Differences in bonding agents, placement techniques, types of composite and operator skill might all have contributed to the variation in these results, as FRCSM-related techniques are not yet standardized.

Fracturing of the fibre frame accounted for 20% of the FRCSM failures. Previous studies had attributed 6.7% and 16.7% of device failures to such fracturing. Fibre frames are thought to fracture through mechanical stresses arising from the chewing of hard/sticky foods, and/
or the over-eruption of the tooth opposing the edentulous area, which subsequently increases and concentrates masticatory forces on the fibre.\textsuperscript{1,10,11} In the present study, both failed frames broke on the side of the functional cusp, as illustrated in Figure 2b. This finding supports Baroni et al.\textsuperscript{17} conclusions that the mechanical stresses to which the appliance is subjected are more important to its long-term success than is its design. Consequently, the effects of masticatory forces and clearance between the fibre and the opposing tooth, especially when the fibre is bonded to the functional sides, should be taken into consideration during the placement of an FRCSM. Improving the bond strength on the functional side of a deciduous abutment tooth through, for example, adding mechanical retention by embedding the fibre and composite into a prepared groove could be advantageous and merits further exploration.

Interestingly, both FRCSM devices that fractured in this study retained contact with their non-abutment teeth (Figure 2b). Thus, although the devices were reported as failures according to the failure criteria, clinically they still fulfilled their space-maintaining purpose. The unlikely success of these two “broken” fibres could indicate the possibility of placing half a loop, bonded to the non-functional side of the abutment tooth, so that the loop seems to function on the functional cusp side. Indeed, Kirzioglu and Ertürk\textsuperscript{4} have previously suggested using a single fibre bonded to the non-functional side of both teeth. Whilst it might prove challenging to place half a loop without bonding it to the anterior tooth, this approach could be investigated further.

Bending of the fibre to impinge on soft tissue was not reported in this study as a reason for any FRCSM failures. In fact, no other clinical FRCSM studies have reported fibre bending as a reason for device failure.\textsuperscript{1,4,11}

BLSM failure rates are in accordance with the results of a study\textsuperscript{19} that reported a 63.3\% failure over a six-month period. In previous studies, cement loss was found to be the main reason (i.e. 46.7\%\textsuperscript{10} and 60\%\textsuperscript{11}) for failures of fixed space maintainers. In the present study, only one band was found to be de-cemented. The reasons for these disparate outcomes might include cement type, band fit and moisture control. Croll\textsuperscript{19} suggested using zinc phosphate or polyacrylate cement to secure bands. However, GIC, which enables bonding to metal and enamel with the additional advantage of fluoride release, is now more widely accepted.\textsuperscript{8} The cement chosen for this study was a GIC that is specifically indicated for the cementation of orthodontic devices. Some of the studies reviewed did not indicate the type of cement used.\textsuperscript{1} Therefore, it is possible that the use of more moisture-sensitive cements, or cements that are not indicated for orthodontic band cementation, could have contributed to the high de-cementation rates reported by other research,\textsuperscript{1,10} although the results may also have been significantly influenced by operator skills and placement techniques.

The main reason for failure (80\%) in this study was bending of the loop to impinge on soft tissue as illustrated in Figure 3. Distortion of the loop has been reported in two previous studies as a failure in, respectively, 3.3\%\textsuperscript{10} and 9\%\textsuperscript{11} of cases. Intermittent functional loading on the space maintainer causes high compressive stresses on the tooth supporting the cantilever extension.\textsuperscript{9} Losing contact with the non-attached abutment tooth has been suggested as the major factor leading to bending of a loop with subsequent submerging of the wire beneath the gingiva.\textsuperscript{18,20} Previous BLSM studies did not limit placement to deciduous molars and included those placed on permanent teeth. Therefore the loop extended further, giving the cantilever wire a larger contact surface in comparison with the situation in this study, where all the wires extended to a deciduous canine with a smaller contact area. The absence of a rest could have contributed to the instability of the loop.

Second, the thickness of the wire used for construction of BLSMs was not specified in previous studies comparing BLSMs with FRCSMs.\textsuperscript{1,10} For this study a 0.8mm diameter stainless steel round wire was used, as described by Kara et al.\textsuperscript{20} The findings from the current study may indicate that this wire thickness is inadequate for BLSMs without an occlusal rest. Although wire thickness is specified for active orthodontic devices, no specification could be found specifically for BLSMs. Further research could recommend a suitable wire thickness specifically for BLSMs with and without occlusal rests.

Sasa et al.\textsuperscript{7} also suggested that children fiddling with devices could be a possible reason for distortion of the wires. During the current study, one child admitted to playing with the wire because it felt ‘funny’ in his mouth. Previous authors\textsuperscript{7,10} did not record bending of a wire separately as a reason for failure; consequently, it might have been recorded under the formation of soft tissue lesions or as unspecified reasons. These considerations might explain why bending of the wire has not been recorded as a main reason for failure in previous studies.\textsuperscript{7,10}
The present study attributed only one (20%) failure to a loop fracture. Previous BLSM studies have reported 6.7%,10 and 9%2 failure rates over six months. Another study with a 40-month follow-up period reported a higher incidence of 22.2%,2 which indicates that the incidence of fracture might increase with time. Fracture of the metal loop is commonly attributed to poor-quality construction. Factors that might have an influence during construction include an incomplete solder joint, overheating of the wire, over-thinning of the joint or thinning of the wire during polishing.3,10,21

Reasons for BLSM failure not found in this study but reported elsewhere include slippage of the band gingivally,10 split bands and unspecified causes.3 It is important to note that all BLSM cases that failed in this study were not reparable chairside.

In addition to failures, this study delivered coincidental clinical findings. It became evident that FRCSMs were more appealing to the parents of the patients. Six of the parents (30%) immediately commented that, although they would adhere to the allocation process, they preferred an FRCSM for its aesthetics and the need for only one appointment for its placement.

Four participants in this study presented with two missing first deciduous molars. Two received FRCSM and two, BLSM. All four commented that they preferred the FRCSM. Their preference might have been due to the FRCSM’s superior aesthetics, the ease of its placement, and/or comfort.10,11,22,23 However, when patients were asked to elaborate, it emerged that the main reason for their preference was the discomfort experienced during BLSM band fitting and impression taking. This finding is in agreement with results reported by Garg et al.,10 who used the Wong-Baker Face Pain Rating Scale to identify patient preference during a split-mouth study comparing the FRCSM with the BLSM. They confirmed that the FRCSM was the patients’ preferred device.

Similar to the experience of other researchers,10 impression taking for BLSMs proved challenging with some children. One patient cried during the taking of an impression, while another could not tolerate the impression material in the maxilla because of a gag reflex. In the latter case, it was decided to fit an FRCSM instead.

The greater the time lapse between the extraction and placement of a space maintainer the greater is the incidence of space loss.24 Indeed, in this study, it proved convenient to place FRCSMs in theatre directly after an extraction. Bleeding was controlled and the rubber dam was positioned, enabling the FRCSM to be placed immediately. Follow-up visits indicated normal healing of the extraction socket. (See Figure 4.)

Placement of FRCSMs proved to be technique sensitive. Manipulation of the fibres to form a uniform loop was a challenge. As a result, not all fibres had a perfect loop shape (as illustrated in Figure 5a). However, this did not prove to affect the FRCSM failure rate in this small sample, as even the non-uniform fibre loop was intact after six months.

During the study, it became evident that the composite covering the fibre would chip off over time (Figure 5b). Although this was not reported as an FRCSM failure in this study, it has previously been reported as a type of device failure.1 Chipping of the composite could influence plaque retention, patient comfort, device strength, and device longevity. Repairs can of course be effected chairside with flowable composite.

Considering all the findings from this study, both the BLSM and FRCSM have obvious limitations- and the search for a more economic, aesthetic and effective fixed space maintainer may still be warranted.

CONCLUSIONS

Based on the results of this study, the following conclusions can be made:

1. No statistically significant differences were found between the failure rates of the BLSM and the loop-design FRCSM when placed on deciduous molars.
2. A 0.8mm diameter stainless steel round wire for construction of the BLSM is not efficient.
3. The effectiveness of the loop-design FRCSM is limited by bond strength and further research on the technique is recommended.

Acknowledgements

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References

2009;76:204-8.
Debris contamination of endodontic hand files in dental practice.

ABSTRACT
Introduction: The risk of cross-contamination validates the need to assess how adequately dental instruments can be cleaned and sterilised.

Aims and Objectives: This study aimed to evaluate residual debris contamination of endodontic hand files collected from private practice following routine reprocessing procedures.

Design: A cross-sectional observational study was conducted.

Methods: Clinically used and reprocessed endodontic hand files were collected from 27 dental practices. Information regarding the routine decontamination procedures of each practice was also submitted. The endodontic files were assessed by two previously calibrated examiners using a stereomicroscope and were scored for the presence or absence of remnant debris using a modified scoring system. Statistical evaluation of the data estimated the frequency and proportions of debris in each scoring position. Cohen’s Kappa statistic assessed inter-examiner agreement and groups were compared using Fisher’s Exact test.

Results: In total, 401 endodontic hand files were examined. Debris was found on 94% of files. Inter-examiner agreement was fair to moderate over the entire dataset. Group B was found to contain significantly less debris than the other groups

Conclusion: Routine decontamination methods used in general dental practice do not effectively remove debris from endodontic hand files.

Key words: Cross-contamination, debris, decontamination, endodontics

INTRODUCTION
Endodontic hand files are instruments used to prepare the root canals of teeth. Historically, the re-use of these instruments, after cleaning and sterilisation, to treat multiple patients has been regarded as safe clinical practice. Although some regions, such as the United Kingdom, have made the single-use of endodontic files obligatory, economic pressures in many countries may dictate a high rate of the re-use of these instruments.

Contaminated dental instruments must be both cleaned and sterilised prior to re-use. This is necessary to prevent cross infection between patients and to avoid introducing additional foreign microorganisms into the root canal system, which potentially may compromise treatment outcomes.

The risk of transmission of both infectious diseases as well as of prion disease validates the need to assess the cleanliness of all dental instruments, including endodontic hand files, prior to reuse. The presence of biological debris, such as blood, dentin, dental pulp tissue and microorganisms on endodontic files may hinder the sterilisation of these instruments. Evidence contrary to this possibility, does however, exist. A 2004 study showed no bacterial growth after steam sterilisation, irrespective of the cleaning method used.

Previous studies have demonstrated the inadequacy of routine decontamination procedures in rendering dental instruments free of biological debris. However, these studies were conducted elsewhere and no information regarding the cleaning of endodontic files in South Africa could be found. A cleaning protocol for endodontic files was developed by an Australian research group in 2004 that consistently resulted in rotary nickel-titanium endodontic files which were completely free of biological debris. Whilst complete decontamination of endodontic files was shown to be possible under the conditions of that study, it is questionable whether this reflects the situation found in everyday clinical practice.

The present study aimed to determine the extent of residual debris contamination of endodontic hand files following the application of routine reprocessing procedures in private general dental practice in Pretoria, South Africa. Details regarding the decontamination methods used by the participants were also recorded.
METHOD AND MATERIALS

Ethical clearance was obtained from the Ethics Committee of the Faculty of Health Sciences, University of Pretoria, prior to the commencement of the investigation. A cross-sectional, observational study was designed and conducted.

Twenty-seven general dental practices in Pretoria, South Africa, were contacted and invited to participate on a voluntary basis. Convenience sampling had been used to select practices known to provide endodontic services. Each participant was requested to submit 15 endodontic hand files which had undergone the decontamination processes following clinical use which was routinely used by their practice. Hand files of the K-type and Hedstrom files were included. Barbed broaches, rotary files and other hand instruments (e.g. finger spreaders) were excluded. The decontamination methods employed by each practice were also recorded. The number of previous uses of each file was not recorded. An independent moderator assigned the group of files from each practice (n=27) a unique randomised identifier to de-identify the samples from each participant. A calibration group, comprising 15 stainless steel hand files (M-Access, Dentsply Maillefer, Bailiegues, Switzerland), taken directly from the manufacturers’ packaging, was included to facilitate calibration of the two examiners and for direct comparison with the collected files of each group.

Assessing the files

Two independent examiners assessed each file under light microscopy at 40X magnification using a stereomicroscope (Olympus, SZ-CTV, Japan). An endodontic ruler was mounted alongside the endodontic file. Each quarter of the cutting blade of the sample was allocated a number: position: 1, 2, 3, and 4, consecutively from the tip of the file to the end of the file’s cutting blade (Figure 1). Each possible scoring position on a file was scored based on the presence or absence of debris – a score of 1 denoted the presence of debris and a score of 0 denoted its absence. A novel scoring system, based on an earlier study by Smith et al.,

but modified for use in the present study, was devised (Table 1). Following microscopic evaluation, the scores of the examiners were combined to provide a single reading per scoring position. If a discrepancy in scoring arose between examiners, a score of 1 (positive score) was assigned to that scoring position. This was done to eliminate the possibility of half scores (i.e. 0.5) as a score of 0.5 was considered to represent the presence rather than the absence of debris. The data was captured in Microsoft Excel 2016.

Frequency and distribution of debris in each group at each scoring position was determined. Cohen’s Kappa statistic assessed inter-rater agreement. Groups were compared with each other using Fisher’s Exact test. All statistical analyses were performed using the SAS software suite, Release 9.4 (SAS Institute Inc., North Carolina, USA).

RESULTS

A total of 401 endodontic hand files were analysed in this study. Seventeen participants provided the requested number of files, five provided more and five provided fewer. The calibration group consisted of 15 individual endodontic files removed directly from the manufacturer’s packaging.

Twenty-four of the 401 files were found to be completely free of debris following routine reprocessing (6% of the total number of files). The rest of the files (94%) all displayed some debris contamination.

Seven of the 27 groups contained some individual files that scored zero in all four positions by both examiners.

Table 1: Overview of the modified scoring system, based on Smith et al.12

<table>
<thead>
<tr>
<th>Position</th>
<th>Description</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>the most apical quarter of the blade</td>
<td>D₃ to D₄</td>
</tr>
<tr>
<td>2</td>
<td>the middle quarter nearest to the tip of the file</td>
<td>D₄ to D₅</td>
</tr>
<tr>
<td>3</td>
<td>the middle quarter closest to the handle of the file</td>
<td>D₅ to D₁₂</td>
</tr>
<tr>
<td>4</td>
<td>the quarter closest to the handle of the file</td>
<td>D₁₂ to D₁₆</td>
</tr>
</tbody>
</table>

Table 2: Cleaning method by group

<table>
<thead>
<tr>
<th>Practice</th>
<th>Cleaning Method</th>
<th>Clean files (Total files)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Washer disinfector</td>
<td>0 (16)</td>
</tr>
<tr>
<td>B</td>
<td>Manual cleaning and ultrasonication</td>
<td>11 (15)</td>
</tr>
<tr>
<td>C</td>
<td>Manual cleaning gauze or sponge soaked in alcohol</td>
<td>0 (15)</td>
</tr>
<tr>
<td>D</td>
<td>Manual cleaning, ultrasonication and washer disinfector</td>
<td>0 (15)</td>
</tr>
<tr>
<td>E</td>
<td>Manual cleaning, ultrasonication and washer disinfector</td>
<td>0 (18)</td>
</tr>
<tr>
<td>F</td>
<td>Manual cleaning with brushes/detergent only</td>
<td>0 (14)</td>
</tr>
<tr>
<td>G</td>
<td>Manual cleaning with brushes/detergent only</td>
<td>0 (15)</td>
</tr>
<tr>
<td>H</td>
<td>Manual cleaning with brushes/detergent only</td>
<td>0 (15)</td>
</tr>
<tr>
<td>I</td>
<td>Manual cleaning and ultrasonication</td>
<td>0 (17)</td>
</tr>
<tr>
<td>J</td>
<td>Manual cleaning gauze or sponge soaked in alcohol</td>
<td>0 (15)</td>
</tr>
<tr>
<td>K</td>
<td>Manual cleaning and ultrasonication</td>
<td>0 (15)</td>
</tr>
<tr>
<td>L</td>
<td>Manual cleaning with brushes/detergent only</td>
<td>1 (16)</td>
</tr>
<tr>
<td>M</td>
<td>Manual cleaning and ultrasonication</td>
<td>1 (18)</td>
</tr>
<tr>
<td>N</td>
<td>Manual cleaning with brushes/detergent only</td>
<td>0 (15)</td>
</tr>
<tr>
<td>O</td>
<td>Washer disinfector</td>
<td>0 (14)</td>
</tr>
<tr>
<td>P</td>
<td>Washer disinfector</td>
<td>0 (15)</td>
</tr>
<tr>
<td>Q</td>
<td>Manual cleaning with brushes/detergent and washer disinfector</td>
<td>0 (15)</td>
</tr>
<tr>
<td>R</td>
<td>No answer</td>
<td>0 (15)</td>
</tr>
<tr>
<td>S</td>
<td>Manual cleaning and ultrasonication</td>
<td>3 (15)</td>
</tr>
<tr>
<td>T</td>
<td>Manual cleaning with brushes/detergent only</td>
<td>0 (13)</td>
</tr>
<tr>
<td>U</td>
<td>Washer disinfector</td>
<td>0 (15)</td>
</tr>
<tr>
<td>V</td>
<td>Manual cleaning and ultrasonication</td>
<td>4 (15)</td>
</tr>
<tr>
<td>W</td>
<td>Manual cleaning and ultrasonication</td>
<td>3 (15)</td>
</tr>
<tr>
<td>X</td>
<td>No answer</td>
<td>1 (15)</td>
</tr>
<tr>
<td>Y</td>
<td>Manual cleaning and ultrasonication</td>
<td>0 (15)</td>
</tr>
<tr>
<td>Z</td>
<td>Manual cleaning with brushes/detergent only</td>
<td>0 (15)</td>
</tr>
<tr>
<td>AA</td>
<td>Manual cleaning with brushes/detergent only</td>
<td>0 (15)</td>
</tr>
</tbody>
</table>
(i.e. completely clean files). These groups and the cleaning methods they employed are displayed in bold in Table 2. Of the seven participants that produced “clean” (debris-free) files, five reported using the same method of cleaning: namely a combination of manual and ultrasonic cleaning.

Group B was an outlier and displayed the greatest number of completely clean files of all groups (n = 11/15). When compared with the remaining groups using Fisher’s Exact test, group B contained significantly more clean files than group V, which contained the second highest number of “clean” files (n = 4/15). By extension, group B was significantly less debris-contaminated than all other groups in the dataset.

Table 3 represents the distribution of debris as a percentage found in each assigned scoring position. Inter-examiner agreement was found to be fair in scoring position 2 and moderate over the other scoring positions, as assessed using a simple Kappa test (0.41, 0.39, 0.41, and 0.52 for positions 1 to 4, respectively).

Table 3: Distribution of debris by scoring position

<table>
<thead>
<tr>
<th>Position</th>
<th>Percentage (%)</th>
<th>Confidence interval (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>68.1</td>
<td>63.4 – 72.4</td>
</tr>
<tr>
<td>2</td>
<td>67.1</td>
<td>62.3 – 71.5</td>
</tr>
<tr>
<td>3</td>
<td>76.6</td>
<td>72.2 – 80.4</td>
</tr>
<tr>
<td>4</td>
<td>74.1</td>
<td>69.6 – 77.1</td>
</tr>
</tbody>
</table>

Table 2 provides a graphical representation of the total number of clean and debris-contaminated scoring positions per group.

**DISCUSSION**

The present study found 94% of endodontic files to be debris-contaminated following routine reprocessing. This finding is in agreement with other studies which found 98% and 96% of the samples analysed to remain contaminated with debris. Some authors have also found in their studies that a significant portion of evaluated endodontic files display visual evidence of debris contamination following routine decontamination procedures. Two of these investigations assessed more than 20 dental practices and included over 200 files. The present study revealed a variation in residual debris contamination of endodontic files between groups. This is likely the result of the differences between practices in the methods employed for endodontic file decontamination. There is no standardised cleaning method for reprocessing endodontic files in South Africa, as evidenced in Table 2. This is in agreement with the findings of previous research which found the cleaning procedures of dental instruments from different practices to be inconsistent and poorly controlled.

In this study, it was demonstrated that the files with the least amount of debris contamination were collected from practices where a combination of manual and ultrasonic cleaning methods were used for reprocessing. This is in agreement with previous research which recommended the use of manual cleaning and pre-soaking of endodontic files in an enzymatic agent prior to ultrasonification.

This must however be interpreted with caution, despite the finding that Group B contained statistically more clean files than any other group. The cleaning method used by this practice (Group B), namely manual cleaning with ultrasonication, was also used by several other practices, which produced no clean files. It therefore appears that correlations cannot be drawn between cleaning method and file cleanliness, given this particular dataset.

The number of uses of endodontic files was not recorded in this particular study and it is unknown whether a correlation exists between the level of debris contamination and the number of uses/sterilisation cycles of files. Investigation of this aspect may enhance future studies.

Despite the high level of debris contamination following routine decontamination procedures, as found in both the present and previous studies, the success rate of endodontic treatment remains high. Low endodontic treatment failure rates may be due to the sterilisation processes which endodontic files undergo rather than the efficiency of debris removal prior to sterilisation.

There is no consensus regarding the potential detrimental effects caused by debris found on dental instruments. Disagreement exists on whether or not residual debris on clinically used endodontic files can be sterilised. There is evidence in support of both these possibilities that residual debris may lead to failure of the sterilisation process. Despite this ongoing debate surrounding the ability to sterilise residual debris, the American Dental Association (ADA) continues to advise the removal of bioburden from dental instruments, including endodontic files, prior to sterilisation.

Dead cells and foreign particles can trigger inflammation, even if they are sterile. It is possible to transfer sterile...
debris from endodontic files between patients when files are clinically reused.\(^2\) Whether or not this debris will lead to a clinically significant inflammatory response and/or failure of endodontic treatment requires further investigation. The presence of debris on endodontic files has however not been linked to the spread of infectious disease.\(^2\)

In 2004, Parashos, Linsuwanont and Messer recommended a cleaning protocol which rendered rotary endodontic files 100% clean of biological debris.\(^5\) This protocol included manual cleaning in consisting of ten vigorous strokes a scouring sponge soaked in 0.2% chlorhexidine, pre-soaking for 30 minutes in an enzymatic agent, followed by 15 minutes of ultrasonic cleaning prior to sterilisation. If endodontic files are to be reused and re-processed between cases it may be prudent to implement this protocol, as it has been proven to be effective.

It has been suggested that time constraints of a busy dental practice may contribute to a reduction in the quality of cleaning of dental instruments.\(^2\) Furthermore, it has been postulated that inconsistencies in infection control in less developed countries may be the result of these procedures being performed by inadequately trained staff members.\(^2\)

Regardless of the reasons for a lack of proper decontamination of dental instruments, it is the ethical responsibility of dental practitioners and auxiliary dental staff to remain up to date with currently prescribed infection control and decontamination guidelines to minimise the potential risk of spreading disease during dental treatment.\(^2\)

The relative risk of the spread of prion disease and the inability to adequately clean endodontic files led to the UK moving toward a single-use policy regarding these procedures.\(^3\) Whether or not this debris will lead to a clinically significant inflammatory response and/or failure of endodontic files, Part I: The effect of bioburden on endodontic files, Part II: The risk of bioburden on endodontic files could be found in South Africa.\(^2\) The results of this study could prompt guidelines to be established regarding the use and reprocessing of endodontic files.

Manufacturers of endodontic instruments currently provide endodontic hand files packaged specifically for single-use,\(^2\) with some citing as a reason the inability to adequately clean debris from these instruments.\(^2\)

**CONCLUSION**

The present study demonstrates the inadequacy of decontamination methods routinely employed in general dental practice for the removal of debris from endodontic hand files. Ninety-four percent of files in this study still contained debris following reprocessing. The highest possible standards of infection control should be maintained by employing proven methods of instrument reprocessing if endodontic files are to be re-used. If the available cleaning methods prove too difficult or unreliable to implement in clinical practice, dental practitioners may consider abandoning the reuse of endodontic files and adopting the alternative of single-use. Guidelines regarding endodontic file reprocessing should be established for South Africa.

**Acknowledgements:** The authors thank Prof. H.S. Schoeman for providing statistical support.

**References**

**An in vitro examination on the effectiveness of commercial toothpastes in the prevention of tooth decay, using eggshell as a substitute for human tooth material.**

**ABSTRACT**

**Background:** Despite improvements in oral health status, dental caries remains a public concern. This study examines the effectiveness of commercial toothpastes in the prevention of tooth decay, using eggshell powder as a substitute for human tooth material.

**Methods:** Colgate, Aquafresh, Colgate Sensitive, Sensodyne, and Oralwise were tested. An enamel model was simulated by adding eggshell powder to beakers containing dissolved toothpastes. The contents were agitated for eight hours at 800rpm, filtered and oven dried. Scanning Electron Microscope (SEM) and Energy Dispersive Spectroscopy (EDX) were used to characterise the surface morphology and the calcium and phosphate composition of the toothpastes pre- and post-agitation with eggshell powder. Gas-displacement and pressure sensor tests evaluated the rate of reaction between the substitute “tooth enamel” and acids.

**Results:** EDX analysis confirmed the presence of calcium phosphate ions, while SEM revealed the formation of an enamel-like layer after agitation. Pressure sensor tests confirmed Colgate Sensitive as most effective in protection against acid attacks, with Oralwise least effective.

**Conclusions:** Eggshell can be used as a substitute for the human tooth in an in vitro experiment. All the tested brands of toothpaste effectively reduced the acid reaction, which would contribute to the prevention of tooth decay.

**INTRODUCTION**

Dental caries, also known as tooth decay, is a common bacterial disease characterised by demineralisation and destruction of hard tissues, usually by the production of acid by bacterial fermentation of undisturbed food debris which has accumulated on the tooth surface. Despite the global improvement in oral health status, Inetianbor et al. point out that dental caries remains one of the most chronic and prevalent infectious diseases in the world. Although dental caries has multifactorial causes, the dietary lifestyles of the individual as well as sub-optimal oral hygiene habits help facilitate the onset of this disease. For instance, it has been reported that the consumption of sweets with high concentrations of glucose, saccharine, or fructose, especially if taken in processed juices, and over a prolonged period play an important role in caries development in children. Dental caries occurs as a result of the metabolism of bacteria lodging in plaque attached to the tooth, and hence toothpaste and tooth brushing should help reduce the adherence of these microorganisms within the plaque biofilm in the mouth. This is supported by some clinical studies which have shown that regular tooth brushing with well-formulated fluoride toothpaste can reduce the incidence of dental caries. Significantly, the dental health organisation in Nigeria has advocated preventive and prophylactic measures in the management of dental caries through regular hygiene and dietary modifications. The increased availability and consumption of soft drinks, fruit juices, and sports drinks, however, make it difficult for individuals to alter their dietary habits. As such, promoting good oral habits through regular brushing with the use of toothpaste may become the most viable option for the oral prophylactic measures in the management of dental caries through regular hygiene and dietary modifications. The increased availability and consumption of soft drinks, fruit juices, and sports drinks, however, make it difficult for individuals to alter their dietary habits. As such, promoting good oral habits through regular brushing with the use of toothpaste may become the most viable option for the oral
Health care provider in the management of dental caries. Brushing of teeth using toothpaste is recognised as the most commonly practiced form of oral hygiene in most countries. Toothpaste serves as an abrasive which helps in removing dental plaque and food particles from the teeth, as well as assisting in suppressing halitosis and releasing active ingredients, mainly fluoride. Goldman, Yee (15) Strong arguments have been presented that toothpaste is the only realistic fluoride strategy in many low-income countries where lack of infrastructure renders fluoridation of water or salt not feasible. In recent years, the oral health care market has witnessed a boom of different brands of toothpaste, with some claiming to be more effective in protection against acid attack and the prevention of dental caries. But just how effective they actually are remains a question since the continued prevalence of dental caries is still a public health concern. Thus, it is desirable to evaluate the claims that these commercial toothpastes completely prevent the acid attacks that result in caries.

Previous studies suggested that bovine and enamel models be used when examining the effectiveness of commercial toothpaste against acidic attacks. Also considered as the sole test model was the dissolution of hydroxyapatite (HA). It is generally well known that tooth enamel consists mostly of calcium hydroxyapatite with a molecular formula of Ca$_{10}$(PO$_4$)$_6$(OH)$_2$. Although hydroxyapatite is a hard and resistant compound, acid (H$^+$) that is produced, especially after a high-sugar meal, attacks the apatite causing the enamel to dissolve. In this in vitro study, eggshells were used as a substitute for human teeth in the examination of factors associated with tooth decay. Eggshells are natural structures composed of both inorganic and organic components such as – 97% of calcium carbonates in the form of calcite; 1% magnesium carbonate; 1% apatite [Ca$_5$(PO$_4$)$_3$OH]; and ~ 5% of organic matter. Owing to this unique chemical composition, eggshells have been used either directly or indirectly as a bone substitute in maxillo-facial surgery and as a source of hydroxyapatite in bone regeneration.

To our knowledge, there is limited research on the use of eggshells in examining the effectiveness of commercial toothpaste in the prevention of dental caries. This in vitro study was therefore designed to test that premise. It also aimed to evaluate whether commercial toothpaste can slow down the rate of reaction between dental enamel and acids.

**MATERIALS AND METHODS**

Five different brands of toothpaste were bought from a popular shopping mall located in Durban (South Africa). These toothpastes included: Sensodyne, Colgate Sensitive toothpaste, Aquafresh, Oral-wise and Colgate. The composition, active ingredients and manufacturers of the toothpaste are shown in Table 1. The listed brands of toothpaste were selected on the criteria that they: (1) contained no whitening or herbal formulation that may react with acids and: (2) did contain fluoride in their formulations.

**Table 1: Brand, composition, and manufacturer of toothpastes**

<table>
<thead>
<tr>
<th>Products</th>
<th>Composition as indicated in the labeling</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colgate</td>
<td>Sodium mono-orthophosphates, Calcium carbonates, Aqua, Sorbitol, Sodium lauryl sulphate, Aroma, Cellulose gum, Sodium bicarbonate, Tetrasodium pyrophosphate, Benzyl alcohol, Sodium saccharine, Sodium hydroxide, limonene.</td>
<td>Colgate-Palmomive Co.</td>
</tr>
<tr>
<td>Oralwise</td>
<td>Sorbitol, Hydrated silica, Deionized water, Propylene, Glycol, Sodium lauryl sulphate, Essence, Cellulose gum, Carrageenan, Sodium saccharin, Sodium benzoate, Tetrasodium pyrophosphate, Sodium fluoride, Titanium dioxide.</td>
<td>Shoprite Checkers (Pty) Ltd.</td>
</tr>
<tr>
<td>Colgate Sensitive</td>
<td>Aqua, Glycerin, Hydrated silica, Sorbitol, Potassium nitrate, PEG-12, Tetrapotassium pyrophosphate, Sodium lauryl sulphate, Zinc citrate, PVM/MA copolymer, Aroma, Potassium hydroxide, Xanthan gum, Cellulose gum, Cocamidopropyl betaine, Sodium fluoride, Sodium saccharin, Eugenol, and Limonene.</td>
<td>Colgate-Palmomive Co.</td>
</tr>
<tr>
<td>Sensodyne</td>
<td>Aqua, Sorbitol, Hydrated silica, Glycerin, Potassium Nitrate, Cocamidopropyl betaine, Aroma, Xanthan gum, Titanium dioxide, Sodium fluoride, Sodium saccharin, Sodium hydroxide, Sucralose, and Limonene.</td>
<td>GlaxoSmithKline</td>
</tr>
<tr>
<td>Aquafresh</td>
<td>Aqua, Hydrated silica, Sorbitol, Glycerin, Sodium lauryl sulphate, Xanthan gum, Aroma, Titanium dioxide, PEG-6/PEG-8, Sodium fluoride, Sodium saccharin, Carrageenan, and Limonene.</td>
<td>GlaxoSmithKline</td>
</tr>
</tbody>
</table>

**Preparation of the eggshell powder**

Eggshells collected from food outlets were washed to remove impurities, disinfected by immersion in a diluted solution of household sodium hypochlorite for six hours and then vacuum dried for ± 6-9 minutes at 250°C. Thereafter, 20g of the eggshell was placed in a 250ml stainless jar (inner diameter of 100 mm), together with 10 stainless steel balls of 10mm diameter and dry-milled in a planetary ball mill (Retsch® PM 100) at 400 rpm for 20 minutes. The collected powder was then sieved to a particle size of ≤ 25µm using a mechanical sieving machine (Retsch AS 200, Germany).

**Simulating tooth using eggshell powder**

Three grams of each brand of the toothpastes listed in Table 1 were dissolved in a beaker containing 100 cm$^3$ deionised water by constant agitation using a magnetic stirrer at 800 rpm for 20 minutes. One gram of the prepared eggshell powder was added to the beaker containing the dissolved toothpaste and the contents agitated for eight hours at a speed of 800 rpm. The mixtures were then filtered and subsequently oven dried at 60 degrees for three hours. Six sample groups were used in this experiment, five containing eggshell powder and dissolved toothpaste (test groups), while the sixth, eggshell powder dissolved in 100 cm$^3$ deionised water, was used as the control group. Energy dispersive x-ray spectroscopy in conjunction with a scanning electron microscope (Field Emission-Carl Zeiss), operating at controlled atmospheric conditions at 20 kV, were used to determine the elemental composition.
of the samples and to examine the surface morphology. Prior to SEM observation, the surface was coated with a thin, electric conductive gold film to prevent a build-up of electrostatic charge. As a proxy measure, samples of pre and post agitation of eggshell powder with toothpaste were characterised to establish the formation of a calcium hydroxyapatite layer.

Methods of evaluating the effectiveness of the toothpaste in prevention of tooth decay
The effectiveness of the commercial toothpaste against acid attack was evaluated using 2 M hydrochloric acid. This was prepared by diluting 9.6 mL of acid with deionised water in a 500 mL volumetric flask.

Gas displacement test
A gas-displacement test was used to quantify and measure the rate of reaction by observing the displacement of gas formed during the experiment. This entailed using a cylindrical tube of two cm inner diameter and of 60 cm in height as the gas displacement test set-up. As illustrated in Figure 1, a 250 mL Schott bottle, sealed using an airtight stopper, was used for the experiment. A tube was firmly attached through the stopper and connected to a cylindrical tube placed in a reservoir of deionised water. With the aid of a vacuum pump, water from the reservoir was drawn into the cylindrical tube. Prior to the gas displacement test, the initial height of the water in the cylindrical tube was marked using a permanent marker. 0.5g from each samples were placed in the Schott bottle, while 50mL of the prepared 2 M HCl was used as the acid reactant. After 20 minutes, the volume of gas displaced was measured again as the final height of displacement. The amount of gas formed was calculated using equation 1 below.

\[ V = \pi r^2 h \] equation 1

Where “V” is the volume of the cylinder, “r” is a constant, approximated as 3.142, “r” the radius of the cylinder and “h” is the displaced height of the cylinder.

Pressure sensor test
A gas pressure sensor was used to monitor pressure changes (kPa) against time (s) during the reaction of the toothpastes samples with 2 M HCl acid. As shown in Figure 2, an Erlenmeyer flask (250 mL) served as the reaction container during the pressure test, with 0.5g of each sample being placed sequentially in the flask, while 25mL of the prepared 2 M HCl was used as the acid reactant. A stopper fitted with plastic tubing was inserted into the flask to provide an airtight container. The tubing lead to a gas pressure sensor (Order Code GPS-BTA). With the aid of an interface system (Vernier LabPro) attached to a computer, the pressure readings were collected and analysed using LoggerPro 3 software.

RESULTS
Characterisation of eggshell powder tooth substitute model
Table 2 illustrates the elemental composition of the various toothpastes brands pre and post agitation with eggshell powder. Significant differences in the amounts of calcium and phosphorus content in the brands of toothpaste were observed between pre and post agitation. In particular, excluding Colgate Sensitive brand of toothpastes, there was a noticeable increase in phosphorus content in the toothpaste samples after agitation with eggshell powder. All the brands of toothpaste containing hydrated silica (Table 1) recorded the presence of calcium after agitation.

<table>
<thead>
<tr>
<th>Sample Group</th>
<th>Pre agitation</th>
<th>Post agitation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ca</td>
<td>P</td>
</tr>
<tr>
<td>Colgate</td>
<td>34.04</td>
<td>0.02</td>
</tr>
<tr>
<td>Oralwise</td>
<td>0</td>
<td>0.01</td>
</tr>
<tr>
<td>Colgate sensitive</td>
<td>0</td>
<td>0.53</td>
</tr>
<tr>
<td>Sensodyne</td>
<td>0</td>
<td>0.06</td>
</tr>
<tr>
<td>Aquafresh</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The SEM micrograph shown in Figure 4-7 revealed differences in the surface morphology pre and post agitation with eggshell powder. For the Colgate brand of toothpaste shown in Figure 3, for example, it can be observed that the surface morphology of toothpaste...
became more compact and dense post agitation with eggshell powder (Figure 3B), compared with the brand pre agitation (Figure 3A). Similar patterns and compactness in the toothpaste after agitation were observed for the other brands of toothpaste (Figures 4 to 7).

**Acid resistance properties of commercial toothpastes**

Figure 8 illustrates the results of the gas-displacement test from the various brands of toothpastes after reaction with 2 M HCl acids. In contrast to the control sample (eggshell powder dissolved in water), the various brands of toothpastes generated a lesser volume of gas. The amount of gas produced is in accord with the average mean pressure of gas measured in the gas pressure tests (Figure 9). Overall, it can be gathered that the Aquafresh brand of toothpastes generated the least amount of gas in reaction to the acid when compared with the rest of the brands.

The amount of pressure (kPa) generated during the gas test was plotted against time (seconds) (Figure 10). It may be observed that reaction to acid was low in the various brands of toothpaste after 100 seconds. Thereafter,
increased acid reaction could be observed. After 500 seconds, all the test samples recorded near plateau-like graph lines suggesting no significant changes were occurring in the quanta of gas pressure generated. The Oralwise sample produced the lowest curve (d), while the control had the widest curve(a). Notwithstanding this, Colgate Sensitive brand of toothpaste had the lowest initial rate of acid reaction, while the eggshell powder (control) had the highest initial rate (Figure 11).

DISCUSSION

Despite general improvements in oral health status, dental caries still remains a significant public concern posing a grave challenge for the oral health care provider in mitigation and prevention. Published literature suggests that brushing regularly with well formulated fluoride toothpastes can prevent the onset of this disease.\textsuperscript{9,10,26,27} In the present in vitro study, eggshell powder was used as a substitute for human tooth material to verify the effectiveness of five commercially available toothpastes in the prevention of dental caries. SEM and EDX were used to study the surface morphology and the calcium and phosphate composition of the brands of toothpastes before and after agitation with eggshell powder.

Calcium phosphate is regarded as being fundamental for the formation of teeth.\textsuperscript{25} Based on the EDX elemental analysis (Table 2), calcium phosphate ions were evidently present post agitation with eggshell powder. Notably, the SEM micrographs of the tested brands of toothpastes (Figure 4-7) were able to show net differences pre and post agitation with eggshell powder, which suggests the formation of enamel like hydroxyapatite layer in all brands of toothpastes. In light of the differences in the surface morphology as well as the elemental composition of the tested brands of toothpastes, it can be inferred that eggshell will be suitable as a human tooth substitute for in vitro assessment of erosive attack. This is in agreement with Haghgoo, Mehran (29) that eggshell powder could be used as alternative for hydroxyapatite since it contain calcium, phosphorus and other mineral element.

Furthermore, effectiveness the toothpaste against HCI acid attacks was evaluated using both gas-displacement and pressure sensor tests. The data generated from the gas tests suggest that Aquafresh brand of toothpaste is more likely to produce the less volume of gas when reacted with acids (Figure 8 and 9). However, the volume of gas generated from the test samples is not indicative of the effectiveness of the brands of toothpaste in the prevention of acid attacks. As reported in Figure 11, Colgate Sensitive had the lowest initial rate of acid attack, followed by Sensodyne, hence their ability to prevent acid reaction with the tooth that causes dental caries. Overall, all the tested brands of toothpaste tend to be effective in the prevention of dental caries by reducing the reaction of the tooth enamel to HCI acid exposure.

Importantly, and in respect to time of protection, clear differences in the prevention of acid attacks were observed between the tested brands of toothpastes and control (eggshell powder dissolved in water). From the graphical results shown in Figure 10, as expected, the various brands of toothpastes resulted in less acid reaction than the control. For instance, the tested toothpastes provided greatest protection to the tooth surface in less than 2 minutes (100 seconds) after acid attacks. In contrast, more acidic reaction could be observed for the control sample even after 8-10 minutes (above 500 seconds) exposure to the acids. This suggests that human tooth can react with acid more easily without any protection offered by toothpastes. Hence, it can be gathered that the composition of the tested toothpastes, particularly the fluoride content is responsible for the protection of the tooth against acid attacks. Kallahalli, Sanjay (30) reported that fluorides are abundantly used in many oral health products including toothpastes and mouth rinses as they help in caries prevention by reducing dental caries between 30 and 70% compared with no fluoride therapy. The findings from this study therefore confirmed the effectiveness of fluoride-based toothpastes in the prevention of dental caries.

The protective effect against erosion observed for Colgate Sensitive and Sensodyne, for example, is in line with previous studies. Lombardini, Ceci\textsuperscript{21} reported that Colgate Sensitive Pro Relief was more effective than Sensodyne in the protection of enamel against acid attacks. Kato, Lancia,\textsuperscript{26} who used bovine enamel, observed that Colgate Sensitive and Sensodyne Original had the best protective effect against erosive acids.

Drawing from the above discussion, it is sufficient to say that the eggshells model was successfully used to evaluate the protective effect of commercial toothpaste against acid attacks. This may be important, particularly in the context of oral health care, as eggshells present a suitable, cheaper, and readily available alternative source to the use of bovine and human enamel models in examining the protective effect of commercial toothpaste. The study suggests that gas displacement and the use of a pressure sensor present a new method of evaluating the rate of reaction between enamel and acids.

LIMITATIONS

The gas displacement and pressure tests cannot measure mineral dissolution and surface changes in the eggshell model. Future research could be directed at an examination of the surface of the eggshell model post acid exposure. This would help explain the mechanisms associated with the protective effect of the tested toothpastes by evaluating the mineral dissolution in the eggshell model.

CONCLUSION

Eggshell powder can be used as a substitute for human tooth in an in vitro experiment. Notably, this study conclusively showed that of the test products, Colgate Sensitive is the most effective brand of toothpaste against acid attacks, while Oralwise is the least effective. However, all brands of the tested toothpastes did lower the rate of reaction between HCI acid and eggshell powder tooth substitute, suggesting their ability to protect the tooth from acids that cause dental caries.

Acknowledgment

The authors acknowledge the financial support from the National Research Foundation of South Africa (No. 104824).

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2. Maharani DA, Rahardjo A. Mothers’ dental Health Behaviors
Biodentine: novel endodontic material for single step apexification: A Case report.

ABSTRACT
The management of an immature tooth with pulpal necrosis and periapical pathology poses a great endodontic challenge. Treatment options comprise the conventional apexification procedure with and without apical barriers. The use of an apical barrier in cases with open spces has gained popularity in recent years.

The conventional apexification using calcium hydroxide has certain drawbacks such as the need for long term therapy to enable barrier formation. The recent trend is to form a fragile dentinal bridge as an artificial apical stop. Even though the current gold standard material for the apical stop is Mineral trioxide aggregate (MTA), a large number of novel materials have been studied for this purpose. Biodentine is a new calcium silicate based material, recently introduced as a dentine substitute, applicable whenever original root dentine is damaged. Biodentine was chosen for apxexification because of its superior physical properties including short setting time, solubility, and easy handling characteristics. This case report describes single visit apexification in a maxillary central incisor with a necrotic pulp and an open apex using Biodentine as an apical barrier. The successful clinical outcome in this case is encouraging for the use of Biodentine as an apical plug in single visit apexification procedures.

Key Words: apexification, apical barrier, Biodentine

INTRODUCTION
The completion of root development and closure of the root apex occurs up to three years following eruption of the tooth.1 If, during root formation, the tooth is affected by caries, trauma or other pulpal pathoses, dentin formation is interrupted and root development will cease.2 Consequently, the root canal is wide, with thin and weak walls, and the apex remains open. A further complication is that the dentinal tubules are wide, allowing the penetration of bacteria and irritants.2 These features make root canal instrumentation difficult and prevents achievement of a proper apical stop. In order to permit condensation of root canal filling material and promote apical sealing, it is important to create an artificial barrier or to stimulate closure of apical foramen with calcified tissue. Apexification is defined as 'a method to induce a calcified barrier in a root with an open apex or the continued apical development of an incomplete root in a tooth with a necrotic pulp.3 Whilst several procedures utilizing different materials have been proposed to induce root end barrier formation, calcium hydroxide has gained the widest acceptance.4 Although calcium hydroxide has a predictable outcome in apical barrier formation, the quality of the bridge and the time taken for bridge formation is not so predictable.4,5,6 Considering the various drawbacks associated with calcium hydroxide apexification, the use of the apical plug method seems to be a suitable alternate treatment plan for these cases. Among the alternative materials mentioned, Mineral Trioxide Aggregate (MTA) is currently considered most promising because of its superior biocompatibility and lower cytotoxicity due to its alkaline pH. Moreover, the presence of calcium and phosphate ions result in a capacity to attract blastic cells and hence promote favourable conditions for cementum deposition.7,8 However MTA has certain disadvantages including high solubility, prolonged setting time (approximately 2 hours and 45 minutes) and difficult handling characteristics.8

These disadvantages have necessitated the search for more ideal materials, having adequate biological and mechanical properties. Recently, a new calcium-silicate based material, Biodentine (Septodont, Saint-Maur-des-Fossés, France), has been formulated with the intention of preserving the properties and clinical applications of MTA without its negative characteristics. Biodentine is superior to MTA as its consistency is better suited to clinical use, ensuring better handling and safety, the material does not require a two-step obturation and, as the setting is faster; there is a lower risk of bacterial contamination.9

The aim of the present case report is to report the use of Biodentine in the successful closure of the root apex in a
CASE REPORT

A 28-year old male patient reported to the Department of Conservative Dentistry and Endodontics with the chief complaint of a fractured and discoloured upper left central incisor (Figure 1a). He confirmed a history of trauma 10 years previously. The patient did not recall any history of swelling or pus discharge. The medical and dental histories were uncomplicated. Intraoral examination revealed generalized dental fluorosis with an Ellis’s Class IV fracture and discolouration on tooth no 21. Palpation and percussion test of the involved tooth did not reveal any tenderness. The tooth was not mobile and periodontal probing around the tooth was within physiological limits. Electric pulp testing (Parkell Electronics Division, Farmingdale, NY, USA) and thermal tests (Heat and Cold tests) of the involved tooth gave no response, whereas responses were obtained on the adjacent normal teeth. Detailed radiographic examination of the tooth revealed a wide canal with an open apex and a marked radiolucency periapically (Figure 1b). Evidently, development of the tooth had been interrupted by the trauma suffered years ago. A small healing sinus tract was seen near the position of the apex. Based on the history and the radiographic findings, a provisional diagnosis of chronic periapical abscess was made. The available treatment options were discussed with, and informed consent was obtained from, the patient. Root canal therapy with Biodentine was selected. After rubber dam application under local anaesthesia, the pulp cavity was opened to allow access (Figure 2a). Endodontic working length was established (Figure 2b). Biomechanical preparation was completed using No 80 stainless steel K- file (MANI, INC., Utsunomiya Tochigi, Japan) under copious irrigation with 5.25% NaOCl (Cmident, India). Irrigation was carried out passively with side-vented irrigation needles (R C Twents irrigation needle, Prime Dental Products Pvt. Ltd, Mulund Mumbai), keeping the points 1mm short of the radiographic apex. Calcium hydroxide intracanal medicament (RC Cal, Prime Dental) was placed. The patient was recalled after three weeks and the involved tooth was found to be asymptomatic. The access cavity was reopened, the canal copiously irrigated with 5.25% NaOCl solution and then dried with sterile paper points. Biodentine was mixed according to the manufacturer’s protocol and pellets were placed with a plugger until a thickness of 5 mm had been achieved (Figure 2c). A sterile cotton ball was placed in the canal for 15 minutes and then the root canal was obturated by the thermo plasticized Gutta-percha technique (Obtura - Spartan) (Figure 2d). Non vital bleaching was carried out on two subsequent appointments but no colour change was observed. The access cavity was then sealed with a composite restoration and the discoloured tooth was restored by an all-ceramic crown (Figure 3a). Follow up examinations were carried out at one month, three months, six months and one year after apexification (Figure 3b). During follow up periods the involved tooth was asymptomatic and the post-operative radiographs taken at one year showed remarkable healing of the osseous lesion.

DISCUSSION

It is not only the wide-open root apex presented by immature permanent teeth that poses unique challenges during endodontic procedures, but also the fragile weak dentin walls. The conventional apexifcation technique using calcium hydroxide requires at least three to four months and involves multiple appointments. Patient compliance with this protracted treatment protocol may be poor and many fail to return for scheduled appointments. The aim of...
The treatment described in this case report is to create in a single appointment an apical barrier which will prevent the penetration of toxins and bacteria into periapical tissues from the root canal. Technically, this barrier is also necessary to allow the compaction of root filling material.\textsuperscript{11,12} Whilst a higher success rate of apical barrier formation has been reported with the use of calcium hydroxide, long term follow up is essential.\textsuperscript{13} Previous studies have described the disadvantages of calcium hydroxide apicification which include failure to control infection, recurrence of infection and cervical fracture.\textsuperscript{12}

Apexification using MTA provides an alternative treatment option in immature pulpless teeth. The long setting time of ProRoot MTA is a major problem of the material, apart from poor handling characteristics, discoloration potential (Gray MTA), low washout resistance and high material cost.\textsuperscript{14}

Biodentine is a newly introduced (2011) bioactive dentine substitute based on “Active Biosilicate Technology.” It is biocompatible, has mechanical properties similar to dentin, and has good sealing ability on dentinal surfaces.\textsuperscript{15} The detailed composition and the role of each ingredient are summarized in Table 1.\textsuperscript{16}

This case presentation has shown that Biodentine can be used as an effective alternative to MTA, even in the older patient. A study comparing microleakage of glass ionomer cement, MTA, and Biodentine found that the latter exhibits the least microleakage when used as a retro-filling material.\textsuperscript{16} In addition, the material forms a chemico-mechanical bonding with both tooth and composite, which reinforces the thin fragile immature roots.\textsuperscript{17} Its short setting time (9-12 min) is attributed to the smaller particle size, the addition of calcium chloride as accelerator, and reduction in the amount of liquid required for setting. Calcium chloride improves its consistency, making its condensation in the canal more controlled, avoiding need for a matrix, and decreases the chances of the material going beyond the apex, making it safer and easier to handle than MTA.\textsuperscript{18} Its insolubility in saliva and the ability to withstand pressure of 400 gm mm\textsuperscript{-2} within six minutes of setting makes it ideal for single visit apexification, negating the need for a second appointment for obturation.\textsuperscript{19}

About et al. investigated the bio activity of biodentine on dentin. They concluded that biodentine induces dentin regeneration by stimulating pulp progenitor cells.\textsuperscript{20} Studies by Han and Okiji concluded that calcium and silicon uptake by root dentin and the thickness of the hard tissue barrier formed in the case of biodentine are comparable to pro-root MTA.\textsuperscript{21} Due to its superior material properties, Biodentine has a distinct advantage over its closest alternatives in the treatment of teeth with open apex. The material is still under study and several advancements in its clinical applications may be expected in the near future.

**CONCLUDING REMARKS**

Single visit apexification with biocompatible materials such as Biodentine can be considered an effective treatment option for teeth presenting with open apices. Many of the drawbacks of relying on calcium hydroxide and MTA have been overcome by the use of Biodentine, which is accompanied by superior results. The material has great potential in the management of a tooth with an open apex, particularly in its capacity to achieve biomimetic mineralisation. However further research is required to explore the scope of the clinical applications of this material.

**References**


Painful dry socket: an alternative perspective

ABSTRACT
A new and effective way of treating painful dry socket is described.

INTRODUCTION
Painful dry socket is an unwelcome complication following tooth extraction,1 presenting after approximately 3% of routine extractions and may occur in up to 30% of patients following surgical removal of impacted mandibular third molars.2

The most common symptom of painful dry socket is a continuous throbbing pain that radiates to the ear and temple.3 Classically, this starts one to three days post-extraction and may be accompanied by other signs and symptoms such as foul taste and halitosis.4-6 The symptoms can persist for up to 10 days after extraction and may include pain so severe that it is not relieved by even the strongest of analgesic medications.6

The main focus of treatment is the relief of pain, and current therapies are based on the removal of debris from the socket by irrigation, and the use of analgesic medication.4 Intra-socket medicaments may be placed such as antibacterials, topical anaesthetics and obtundents or combinations of all three.4 These medications include zinc oxide and eugenol impregnated cotton pellets,7 lidocaine ointment,8 alvogyl (eugenol, iodoform and butamen),9 dentalone, bismuth subnitrate, iodoform paste (BIPP) on ribbon gauze and metronidazole. Some studies have also reported the use of lasers for the treatment of dry socket.9 Forty-five percent of patients with painful dry socket require multiple postoperative visits, which are time-consuming for the practitioner, and which could have significant consequences for the individual patient as well as societal costs including time off work.6,10

Current perceptions – true or false?
Exposed Bone is Painful
Contrary to what is widely believed, exposed bone is not painful.

According to Hansen and Pindborg, a dry socket that has lost its blood clot, and has exposed alveolar bone, is not always painful. They called a dry socket accompanied by severe pain “alveolitis sicca dolorosa”, or “painful dry socket”. They also described a dry socket that is not painful as “alveolitis simplex”11 and has also been called “clinical socket”.12

That exposed bone is not painful is vividly illustrated in a passage from the book “Oral Surgery” by WH Archer, published in 1968. Archer relates the following tale of a patient who had 22 teeth extracted, and was instructed to keep his mouth clean. Three days later, when the patient returned for a post-operative consultation, his mouth was scrupulously clean, and every socket was devoid of a blood clot, as he had used cotton buds to clean them. The patient reported no pain or discomfort of any kind.13 This is very easy for the reader to verify. Probing a dry socket with a dental probe is painless, unless there is a loose fragment of bone as a result of fracture during the extraction. If pressure is placed on this fragment there may well be pain because of the impact on the underlying tissues. Touching or probing the solid lamina dura of the socket is, however, painless.

In painful dry socket, the pain comes from the socket.
All of the therapies currently in use to treat painful dry socket are designed predominantly to reduce the pain, but an extensive search of the literature on painful dry socket reveals that the literature is devoid of evidence that the origin of the pain is in the socket. All the treatment modalities are designed to treat the pain that is presumed to come from the tooth socket itself, but there is no evidence to show that the pain actually originates in the socket. A most comprehensive and authoritative Cochrane review on dry socket, conducted in 2012, makes no mention of the origin of the pain.14

Where then does the pain of dry socket originate?
This paper describes a radical departure from the current thinking on dry socket, and describes:
1. The origin of the pain,
2. Alternative and highly efficacious treatment, and
3. Simple preventive precautions which may dramatically reduce the incidence of post-operative pain. This is particularly pertinent in patients having third molar removal.

The author holds the opinion that the pain of dry socket comes predominantly from two places:
1. The periodontal ligament of the tooth adjacent to the extraction site, and

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http://dx.doi.org/10.17159/2519-0105/2018/v73no7a5
2. The masseter and at times the temporalis muscles. Consider the following experiences of the author:

**The periodontal ligament**

In every case of painful dry socket, one or both of the teeth adjacent to the extraction site is or are sensitive to percussion.

This may be confirmed by percussing the teeth with the back of a mouth mirror, starting three or four teeth from the socket, and progressively percussing the teeth towards the affected socket. Invariably, the tooth next to the socket is more sensitive to percussion than are the teeth more distant from the socket.

In the case of painful dry socket after removal of mandibular wisdom teeth, the lower second molars are tender.

**The muscles of mastication**

There is tenderness on palpation of the masseter muscles, most commonly at the anterior margin of the masseter where it is attached to the zygoma (Figure 1), but any part of the muscle may be involved.

There may also be tenderness on palpation of the temporalis muscle.

The fact that the masseter and temporalis muscles are painful explains why the most common symptom of dry socket is a continuous throbbing pain that radiates to the ear and temple. Pain originating in the masseter muscle is known to radiate to the ear.

**Why is the periodontal ligament of the adjacent tooth tender to percussion?**

The most likely explanation is that following the extraction of surgical removal of a tooth, there is a certain amount of inflammatory oedema in the surrounding tissues. If this inflammatory oedema also affects the periodontal ligament of the adjacent tooth, then the tooth will be slightly extruded, causing a premature occlusion with the opposing tooth, which in turn will lead to sensitivity to percussion of the extruded tooth. The more trauma during the extraction, the more post-operative oedema can be expected and the greater the chance of painful dry socket developing.

**Why do the muscles become painful?**

The most likely explanation for this appears to be that it results from the premature occlusion and periodontal pain of the extruded tooth.

**TREATMENT**

The treatment of painful dry socket can usually be achieved in a single visit.

If the tooth adjacent to the extraction site is tender to percussion, then a simple bite equilibration results in almost instantaneous relief of the patient’s pain.

There are some caveats however:

1. The tenderness of the involved tooth may prevent the use of articulating paper to pinpoint which part of the tooth should be ground down to relieve the prematurity.
2. Hence the suggestion that any equilibration be carried out on the opposing tooth, as the involved tooth may be painful to work on.

Regarding socket debridement, the author does not carry this out in the rooms. The patient is instead provided with a syringe with a curved nozzle that can easily be inserted into the socket, and is instructed to irrigate the socket after meals.

**PREVENTION**

The main object of prevention is to obviate post-operative pain.

Prior to extracting a tooth, the adjacent teeth should be percussed to ascertain whether they are at all tender to percussion. If they are, then the bite should be equilibrated prior to the extraction. This will minimise the chances of a dry socket becoming painful.

The author has been using this preventive treatment for forty years, and has found that the incidence of post-operative pain following third molar removal has decreased dramatically.

Clot breakdown and the development of dry socket may still occur. The condition is, however, no longer painful.

**DISCUSSION**

The Cochrane Collaboration published a review in 2012 of the local interventions for the management of dry socket. The aim of this systematic review was to analyse the different methods currently used in the management of dry socket. Although dry socket is one of the most studied complications in dentistry, and despite the plethora of different methods used in the management of dry socket pain, a further review concluded in 2015 that there was no evidence to support any of the interventions currently in use. As there have been no recent developments in the management of dry socket since 2015, this conclusion remains valid to this day.

An earlier study had found that the incidence of painful dry socket following single extractions was 5%, whereas the occurrence of the condition following multiple extractions was 2.1%. Statistically, the difference between these proportions is highly significant (P<0.001).

Krogh found that “the more adjacent teeth removed at one operation, the less the danger of (painful) dry socket breaking down.”
socket development”. This is counter-intuitive. It may be expected that the number of painful dry sockets should increase in linear proportion to the number of teeth removed. However, consider the role of the periodontal membrane in influencing pain. If one tooth is removed, unless it is a third molar, there is usually a tooth on either side of it, which means that there are two teeth adjacent to the single extraction socket, either or both of which may experience periodontal inflammation and contribute to pain. If two adjacent teeth are removed, then there is still a tooth on either side of the gap that may become painful. Hence again only two possibly painful teeth but now per two sockets. Effectively the chances of painful dry socket are halved. If three adjacent teeth are extracted, then there are still only two possibly painful teeth, meaning that the potential incidence of painful dry socket per tooth socket is now further reduced. This explains Krogh’s observation that “the more adjacent teeth removed at one operation, the less the danger of dry socket development”.

There are observations relevant to and supportive of these concepts:

- The author has never seen a case of painful dry socket following a full dental clearance, even though clot breakdown most certainly occurs in these cases. He has also been unable to find a single report of this in the literature. This supports the understanding that without teeth adjacent to the extraction site, dry sockets, if they do occur, are not painful.
- Dry socket pain also never occurs when fractured mandibles are immobilised, even when teeth in the fracture line have been extracted or teeth have been lost during the trauma. When a fractured mandible is wired in occlusion, the teeth adjacent to the extracted teeth cannot be extruded by periapical oedema, because they are firmly in occlusion. The author has not found it necessary to debride and pack an extraction socket while the jaws are wired in occlusion.

**CONCLUSION**

The pain of dry socket results from bite prematurities affecting the tooth or teeth next to the socket. These prematurities are the most likely cause of the muscle pain that develops one to three days post-extraction.

The prevention of post-operative pain is accomplished by equilibration of the bite before undertaking the extraction or surgical removal of a tooth. This is only necessary if the tooth adjacent to the extraction socket is tender to percussion before the extraction. If the teeth adjacent to the extraction are not sensitive to percussion before the extraction, the chances of painful dry socket developing are considerably reduced. On the contrary, if the teeth adjacent to the extraction are sensitive to percussion, the chances of post-extraction pain are greatly enhanced.

The recommended treatment of painful dry socket is to equilibrate the bite by removing the premature contacts of the teeth adjacent to the extraction socket, together with ensuring that the socket is kept free of debris.

**Footnote**

The author has practised as a Maxillo-Facial and Oral Surgeon since 1973 and over the years has removed countless impacted wisdom teeth. He has not found it necessary to use Alvogyl or any other socket medication since 1979.

**References**

Maxillofacial radiology case 163

SADJ August 2018, Vol 73 no 7 p459
CJ Nortje

Below are cases of reactive lesions from various patients presenting at the department. What are the most important radiological features and what is your diagnosis?

INTERPRETATION
Figure 1&2 shows an aggressive lesion in a 14 year old male patient. The pantomograph shows the lesion extending from the 36 to the 46. Expansion of the cortex and divergence of the roots is discernible. A histological diagnosis of a Central giant cell granuloma (CGCG) of the bone was made. The original term of CGCG was coined by Jaffe in 1953, when he suggested that this lesion should be distinguished from the Central giant cell tumour (GCT) of bone. Jaffe believed that the CGCG is a reactive lesion, whereas the GCT is a neoplasm. Central giant cell granuloma of the jaws is considered to be a fairly common benign reactive lesion. It is characterized by the presence of numerous multinucleated giant cells. The CGCG most commonly affects young people and over 50% of cases occur in the first two decades of life. The average age of occurrence is 21 years, with a range of 3 to 68 years. Females are affected slightly more than males. The mandible is affected in the majority of cases, with the anterior segments being affected more often than the posterior. Radiographically the lesion is essentially radiolucent, often with a multilocular, soap bubble appearance (Fig.3). A rather marked expansion with thinning of the cortical plates is a characteristic finding (Fig.4). The tumour usually destroys the lamina dura and causes displacement of the teeth (Figs.2&3). It may lie in intimate contact with the teeth, causing very few changes; in other areas it may cause extensive root resorption. This root resorption is usually irregular and leaves a ragged surface in contrast to the smooth resorption seen in association with cysts. According to Langlais et al.(1994), CGCG’s can present with an aggressive or non-aggressive behaviour. The basis for this division consisted of histologic, clinical and radiological factors. The radiological features of the aggressive type include resorption of adjacent root apices, perforation of the expanded cortex and a diameter exceeding 2cm; nonaggressive lesions are characterized by the absence of root resorption, intact cortices and a diameter smaller than 2cm. A peripheral variant of this lesion occurs in the gingiva and produces an epulis-like soft tissue mass in the gingival region. In an edentulous area it may result in a nodule or swelling on the alveolar ridge and may present radiologically with a typical “peripheral cuffing” (red arrows, Fig.5). The CGCG are known to recur, and recurrence is a feature of the aggressive type and may require curettage plus peripheral ostectomy A histological diagnosis of CGCG must always be followed by a workup for the possibility of the presence of a “Brown” tumour of hyperparathyroidism.

References
Respecting Autonomy (Part 2)

AUTONOMY AND OBLIGATION

Respect for autonomy implies acknowledging that autonomous agents are entitled to hold their own viewpoints, are free to make choices, and act voluntarily according to their values, beliefs and preferences. Broadly speaking, autonomy includes (i) independence of thought, inclusive of the ability to “think for oneself”, make decisions, determine preferences and moral assessment for oneself; (ii) autonomy of will or intention which is regarded as the ability of a moral agent to decide on his/hers plans of actions and activities; and (iii) lastly, autonomy of action, which involves doing what the agent thinks and intends or wills to do.

Respecting autonomous agents means acting in a manner that displays a respectful attitude by refraining from interfering in personal affairs, be it what a person thinks, wills, or does. Respecting autonomy means the clinician acknowledges the agency of the patient to exercise the right over all clinical processes undertaken on their person, without undue interference or influence from the attending health care professionals.

As a negative obligation, respect of autonomy requires no external interference or control that would constrain free thought, will and voluntary actions. The question in this regard would be “how far does non-interference extend? Should clinicians in pursuit of this noble virtue still respect the “freedom” of individuals bent at harming themselves, or is there a need to provide some “specifications” or limits on how to respect patient autonomy? As a positive obligation, respect of autonomy encompasses actions and attitudes that encourage autonomous decision-making, and enables the patient’s agency to self-determine. This aspect is symbolised by the Kantian argument that states that we should “…treat others not as means towards some ends, but as ends in themselves.”

Given that persons cannot be prevented from exercising their autonomy, can they be encouraged to make choices? There is no consensus about the nature and extent of this form of encouragement to decision making. Within the clinical environment, patients are subjected to persuasion, inducement and coercion in decision making. It is obligatory to provide persons with all the relevant information, notwithstanding that they might accept or decline to receive or even use the information given. Ultimately it is a violation of the obligation to respect autonomy to compel persons to act on the information provided. In other words, it is a duty to recognise the rights of an autonomous person, as well as to respect their capacity to exercise the right to choose whatever they desire.

CAPACITY, COMPETENCE AND DECISION-MAKING

Can patients revoke the decisions they made previously? Similarly, can patients change or refuse the type of treatment recommended during the course of the delivery of care? These questions centre on the concept of capacity and competence to make rational decisions.

The terms capacity and competence are used interchangeably despite having distinct legal and normative meanings and application. Strictly speaking, capacity refers to the “The ability to understand information relevant to a treatment decision and to appreciate the reasonably foreseeable consequences of a decision or lack of a decision.” Applied to a health care setting, capacity means that a person has an adequate degree of understanding and a reasonable ability for medical decision-making.

Capacity is specific to a specific situation and time. For example, a patient may have reasonable understanding of the patient. For example, veracity, protection of privacy, confidentiality and the need to obtain informed consent prior to intervention, are some applications of the respect for autonomy. The debate over the prima facie status of the principle of autonomy over beneficence, non-maleficence and justice, rages on. There are grounds for this principle to be overridden by competing moral ideologies, such as beneficence and non-maleficence. For instance, public health programmes and policies such as water fluoridation, vaccination, and quarantine, are justified as moral acts aimed at protecting the public while nevertheless infringing on individual autonomy. Similarly, a surgeon who deliberately lies to an anxious 16-year-old patient about their serious health status, is definitely infringing on the patient’s autonomy. However, the principle of beneficence might be invoked to justify the doctor's action if such actions could prevent further harm.

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of dental extraction as compared with marsupialisation of an odontogenic keratocyst. Similarly, and over passage of time, it is possible for patients to develop and achieve a reasonable understanding of more complex medical interventions such as marsupialisation.

It is well-established principle in law and morality that capable patients are able to consent freely for treatment. Informed consent supports and validates the ethical principles of autonomy, beneficence and non-maleficence. First, patients are provided with adequate information to enable free and uncontrolled decision-making. Informed and empowered patients are generally able to judge and determine what is in their best interest or not. In case of incapable patients, the principle of autonomy is inapplicable. However, these patients should be protected from inducing self-harm.

The preferences and desires of patients change over time, meaning that their perception of current treatment might change in future. With passing time, the individual’s cognitive, psychological, intellectual and legal capacities change, similarly his/her expectations, preferences and choices of the treatment(s) will change. This makes judgment of competence difficult in clinical situations. The fundamental question around competence is what standard or criteria should be met in order to declare a patient capable of autonomous decision-making.

CASE 1

A flamboyant, 28 year old movie star, who is accompanied by his fiancé, arrives at your practice requiring your intervention. Following his religious beliefs, he has almost succeeded in pulling out his maxillary central incisors. The primary reason for the consultation is that he is worried about bleeding and pain. Is this behaviour bizarre and indicative of incompetence or incoherence? Are persons with unorthodox beliefs therefore less competent? And how is their autonomy and agency guaranteed or respected by practitioners who might have a different persuasion?

The legal framework, and presumed clinical and moral standpoint, is that an adult patient is competent and should be treated as such until otherwise determined. Paradoxically, one should evaluate the level of incompetence to determine competence. The most consistent feature in measures of competence is the mental faculty, characterised by cognitive capacity and independence of judgment. Therefore ability is tested across a range of standards to express incompetence. Standard questions for evaluation of competence or lack thereof include the following:

1. (In) ability to understand one’s situation (medical problem), its consequences, proposed treatment and alternatives.
2. (In) ability to provide rational reasons pertaining to risk/benefit of proposed treatment for decision to accept or refuse.
3. (In) ability to express and communicate one’s preference or choice.
4. (In) ability to make decision freely and autonomously.

Tests can be designed to corroborate a certain point of view or judgment. Therefore, it is critical to include criteria that are relevant and have been tested in determining competence. Failure to design contextually appropriate tests would serve to validate any normative views of doctors. Such practices compromise the validity of a test and engender normative prejudices.

There is a need for clinicians to test for competence using any standard measure that is empirically sound and normatively appropriate.

CONSENT AND AUTONOMY

What does it mean to give consent? And how is consenting an exercise of the right to autonomous decision-making? According to the Oxford Dictionary consent means “permission for something to happen or agreement to do something”. Seeking informed consent means that the doctor requests authorisation for a medical procedure that the patient fully understands and agrees with. Anything beyond the contracted agreement is a violation of informed consent. For example, a dentist may not unilaterally or intra-operatively undertake further treatment, unless previously agreed with the patient to do so. For clinicians seeking consent means conforming to the legal and ethical obligations of the profession.

Informed consent cannot be equated to shared decision-making, which is often times an informal exchange of information; a casual and asymmetrical communication aimed at getting the patient to choose an intervention among the provided options. Informed consent cannot be reduced to a mere compliance exercise of obtaining authorisation or approval for treatment. Failure to engage patients as equal partners throughout the entire “process” of decision-making is tantamount to medical paternalism.

Hence, it is critical for the health care provider to be aware of several forms of consent. Generally, consent should be expressed explicitly as acceptance or refusal of the suggested intervention over the entire duration of care. However, it is possible for patients or clients to agree or to give general consent for their treatment, implying that any further care would continue without the need to confirm with the patient. In some instances, patients might passively agree or not refuse the treatment suggested; such actions can be construed as tacit consent.

Sometimes a gravely sick patient may receive treatment based on their known history of care and preferences. It is logical and intuitive for doctors to assume that patients would agree to the proposed care based on the medical history, familiarity and trust. Yet, there is a great danger for doctors to impose their wishes and preferences if the patient’s voice is not considered at critical times during treatment. Strictly speaking, consent should be based on what the individual actually chooses or prefers, as opposed to what is presumed to be their choice or preferences. Whether general consent is sufficient or specific or necessary depends entirely on the situation at hand. When undertaking invasive and high-risk interventions, it is advisable to seek specific consent from competent persons than not to seek any authority from patients.

IMPLICATION FOR PROFESSIONALS

Health professionals should make it routine to seek truly informed consent before undertaking any treatment. It is
advisable to follow the process described below as the necessary elements of consent:

1. **Evaluation of Competence**: before any information is disclosed and consent is sought, the practitioner needs to ensure that the patient is competent to engage with the process.

2. **Disclosure**: providing essential and materially critical information to the patient constitutes a major condition for informed consent. How much information is disclosed is dependent on the (i) the standard practiced by the profession; (ii) the standard referenced to a hypothetical reasonable person and (iii) the standard premised on individualism. It is prudent to apply the standard of the reasonable man first before advancing to individualised criteria. There are clinical scenarios wherein intentional non-disclosure may be justified as being beneficial to the patient.

3. **Understanding**: There is no consensus in literature about the nature and degree or level of understanding required for informed consent. Suffice that understanding of pertinent and central facts to the case is sufficient. Complete understanding is not necessary. Clinicians need to enable sufficient processing of information provided to improve comprehension. Information overload and excessive use of unfamiliar medical jargon are among the commonest mistakes that impede understanding.

4. **Voluntariness**: Implies that the patient “should be situated as to be able to exercise free power of choice, without intervention of any element of force, fraud, deceit, duress, over-reaching or other ulterior form of constraint or coercion”. It is often difficult to distinguish between gentle forms of influence and undue and unjustified influence. Generally, practitioners are expected to abstain from any influence that could impact on the free and voluntary decision-making by patients.

5. **Consent**: Clinicians are generally oblivious to the all possibilities associated with the communication by a patient of “informed consent”. Informed refusal should be expected just as much as clinicians would expect a decision in favour of the proposed treatment plan.

**CONCLUSION**

It is a moral and legal obligation for the clinicians to respect the autonomy of the patient and his/her right to decision making. However, and given that autonomy does not supersede other principles, the decision to respect autonomy should be considered alongside other ethical principles and moral theories.

**References**

2. Gillon R. Ethics needs principles—four can encompass the rest—and respect for autonomy should be “first among equals”. Journal of Medical Ethics 2003;29(8):307-12.
1. Toothbrushing techniques: does it change when using a manual or powered toothbrush?


Toothbrushing has become part of the normal daily grooming routine for millions of people around the world. Manual toothbrushes have dominated the market but more recently powered toothbrushes have been introduced with claims that they are superior and more efficient at plaque removal. A recent Cochrane review has shown a statistically significant reduction of gingivitis and plaque score index values with powered compared with manual toothbrushes. An 11% reduction of plaque scores in the short term and 21% reduction in the long term and a 6% and 11% reduction of gingivitis scores respectively were achieved. However, the clinical relevance of these improvements remains unclear.

Video observations of habitual motion habits with manual toothbrushes have shown that many subjects tend to move frequently from the left to the right and spend most of the time brushing the vestibular areas of the dentition. This means that manual tooth brushing is often performed in an unstructured way and many areas are rarely or even never reached. Observational studies on how powered toothbrushes are used have not been published so far. Ganss and colleagues (2018) in Germany reported on a trial that sought to gather observational data on habitual motion patterns with a powered toothbrush. The parameters of interest were brushing duration, type of brushing strokes, area of brushing, brushing events and brushing sequence. Additionally, this study sought to compare the intra-individual motion habits with both a manual and a powered toothbrush in order to investigate whether the motion patterns are independent from the tool used, or whether subjects adapt brushing performance to the type of toothbrush.

MATERIALS AND METHODS

The study was a non-disguised video observation study with healthy volunteers. Inclusion criteria were written informed consent, age ≥18, not involved in dentistry or medicine, in possession of a powered toothbrush and full dentition except for extraction from orthodontic reasons. Exclusion criteria were fixed orthodontic appliances and mental or physical disability with potential to influence oral hygiene performance.

The allocation of toothbrushes (first manual or first powered) was randomised. Sealed, opaque envelopes numbered from 1 to 100 equipped with code 1 (= first manual then powered toothbrush; n = 50) or code 2 (= first powered then manual toothbrush; n = 50) were mixed. Prior to the observational procedures, each subject drew one of these envelopes thus determining the order of toothbrush type.

Subjects were recruited via flyers in local dental practices. The flyers contained information about aim of the study, study procedures and eligibility criteria. One hundred twenty subjects were invited to the study centre. Nine subjects did not meet the inclusion/exclusion criteria, 11 subjects declined to take part and 100 subjects were enrolled.

After informed consent, subjects were asked to brush their teeth in their usual way and were provided with a manual (elmex® InterX toothbrush, short brush head, medium) and a powered (Oral-B Pro 3000 equipped with an Oral-B Precision Clean brush head) toothbrush. Subjects brushed first with either a manual or a powered toothbrush according to the drawn code and secondly with the alternative type of toothbrush. Brushing was performed in front of a mirror without toothpaste to facilitate the analysis of the video recordings. While brushing, each subject was filmed through the mirror without the investigator present and without time restriction. The video films were recorded at 25 frames per second. Between the two brushing performances, a 4-min video clip showing a landscape was presented to distract concentration from tooth brushing. After filming, subjects filled out a short questionnaire regarding age, gender and whether they prefer the manual or powered toothbrush for daily use or are undecided. All communication and technical procedures followed standardised protocols.
For video analysis, the dentition was divided into areas (sextants 1 to 6: two lateral and one anterior sextant in the upper and lower jaw respectively combined with oral, occlusal and vestibular sites). The analysis was done in several passes to code the following parameters according to:-brushing duration (time the toothbrush acts on the teeth, interruptions like rinsing, spitting or breaks excluded), type of brushing strokes (circling, horizontal-linear, vertical-linear, vertical-roll, jiggling (short repetitive horizontal movements), “passive brushing” defined as positioning the brush head on the teeth with less than two movements per second, unspecific brushing movements) and area of brushing. From the latter, brushing events (frequency of alternations between areas) and agreement of the brushing sequence (sequence of sextants in which the toothbrush acts with the manual compared to the powered toothbrush) were determined.

RESULTS
There was no significant impact of gender or order of the type of toothbrush (powered/manual versus manual/powered) for any parameter under study. For daily use, 32 subjects preferred a manual and 42 a powered toothbrush, and 21 were undecided. Preference of the type of toothbrush had no impact on any parameter under study.

The overall brushing duration was significantly longer when powered toothbrushes were used (powered, 145 s (60; 354); manual, 135 s (48; 271); p ≤ 0.001); this was also the case for oral (powered, 40 s (0;113); manual, 29 s (0;149); p ≤ 0.001) and vestibular surfaces (powered, 74 s (1;177); manual, 67 s (11;162); p ≤ 0.001), but not for occlusal surfaces (powered, 31 s (0;122); manual, 31 s (0;117); p> 0.05).

Oral areas were reached much less than vestibular areas regardless of the type of toothbrush (p ≤ 0.001 for both manual and powered toothbrushes). While all subjects reached all vestibular areas with the manual and 96.8% with the powered toothbrush (p>0.05), respective values for oral areas were 44.2 and 58.9% (p ≤ 0.001).

Of those subjects reaching all 12 areas (vestibular and oral sites of sextants 1 to 6) with the manual brush (n = 42), 33 brushed also completely with the powered brush, eight missed one area and one missed three areas. Of those subjects who brushed incompletely with the manual brush (missing three or more areas; n = 25), 13 improved with the powered device (6 brushed completely, four missed one area and three missed two areas), and 10 performed worse (three missed four to five areas, five missed six areas and one brushed only in one area).

With the manual toothbrush, horizontal and circling movements were most often observed adding up to 88% of the total brushing duration. These types of movements were also frequently shown with the powered toothbrush, whereas the percentage of passive brushing was only 10%. In those subjects spending less than 10% of the brushing duration with passive brushing, there was a significant correlation of the duration of the horizontal and circling brushing strokes for both toothbrush types (horizontal r = 0.43, p ≤ 0.01; circling r = 0.42, p ≤ 0.01), the other types of brushing strokes (vertical linear, vertical roll and jiggling) were much less prevalent and their duration did not correlate significantly for manual and powered toothbrushes.

CONCLUSIONS
These researchers observed brushing duration for powered toothbrushing was sufficient although all the oral surfaces were not cleaned equally well. The intra-individual motion patterns were similar with both the manual and the powered toothbrush, and most subjects did not adapt brushing performance to the type of toothbrush; instead, they tend to persist in their habitual motion patterns. This clearly counteracts the idea of powered devices and may explain the hardly encouraging results with respect to plaque reduction compared with manual brushing.

IMPLICATIONS FOR PRACTICE
These findings indicate that using a powered instead of a manual toothbrush is probably not very promising without proper instruction. Also manual brushing presented in an unsystematic way and was often incomplete. Respective instructions may need to consider that motion patterns among patients seem to be deeply rooted and are potentially difficult to change.

Reference
2. Does a face-bow lead to better occlusion in complete dentures? A randomized controlled trial


A face-bow is used to transfer the relationship of maxillary arch and temporomandibular joint to casts onto which upper and lower teeth can be arranged in a manner that closely mimics the occlusal pattern that exists/existed in the mouth. There are two types of facebows, the kinematic and arbitrary axis facebow. The kinematic facebow records the true centre of the axis along which the condyles rotate during the hinge movement of the mandible. The arbitrary face–bow relates the approximate condylar axis to the maxilla. Use of arbitrary hinge axis is considered sufficiently accurate to create a functional occlusion and prevent occlusal errors particularly when cusped teeth are used in removable complete dentures.

von Stein-Lausnitz and colleagues from Germany (2018) reported on a double-blinded randomized controlled trial that sought to evaluate the impact of an arbitrary face-bow record on the number of laboratory and clinical occlusal contact points after changing the vertical dimension in the articulator by means of casts transferred to the articulator using intraoral pin-supported registration.

The following null hypotheses were stated: If the vertical dimension is changed in the articulator, the use of a face-bow compared to a mean setting has no impact on:

- a. the number of laboratory occlusal contact points
- b. the number of clinical occlusal contact points

MATERIALS AND METHODS

The trial was designed as a randomized controlled, parallel arm, double-blinded trial. Adults patients who met the following inclusion criteria were considered:

1. New complete dentures (CDs) in the upper and lower jaw, worn at least two weeks and at most one month;
2. Absence of temporomandibular disorders,
3. CDs were screened by an experienced prosthodontist for optimal fabrication, i.e., correct occlusal plane, correct vertical and horizontal dimension, equilibration of static occlusal contact points, and canine or unilateral group function for dynamic occlusion.

The fabrication of the CDs was standardised in terms of where and how the dentures were fabricated. All full dentures had an overbite of 2–3mm and an overjet of at most 2–3mm. The occlusal concept depended on individual characteristics of participants. All CDs presented at least one static occlusal contact point per teeth referring to the contact of palatal working cusps in the mandibular centric fossae. Due to the fact that the outcome of the trial defined static occlusion aspects, CDs with different concepts of dynamic occlusion were included. Dynamic occlusion concepts were participant-dependent canine-guided occlusion, unilateral balanced occlusion, or bilateral balanced occlusion.

The number of clinical occlusal contact points was recorded three times in both groups: day 0 (T0) before intervention, days 3 (T1) and 84 (T2) after intervention. Laboratory occlusal contact analyses were performed as follows: the CDs were doubled via the use of silicone forms. Then, two pairs of casts were made from each participant. The casts were mounted into the articulator corresponding to a mean setting and the face-bow setting using the intraoral bite registration mentioned above. Afterwards, the casts were lowered up to the first occlusal contact point and a bite registration was performed.

Participants were randomly allocated into two groups:

- Group 1: a mean setting as given by the Bonwill triangle and the Balkwill angle for the transfer of complete dentures into a semi-adjustable articulator
- Group 2: face-bow-aided transfer into the articulator according to the arbitrary hinge axis

To construct a setting with a change of the vertical dimension, a clinical remount technique using pin-supported registration was performed. The procedure included the following steps:

1. A face-bow registration was performed for all participants by two calibrated secondary operators. They were intensively calibrated for the technique of face-bow registration.
2. An experienced dentist, the main operator, adjusted the pin registration set. He screwed the central stylus up to the minimal required distance needed to eliminate any occlusal guidance. Gothic arch tracing was conducted, and the prostheses were intraorally fixed with a bite registration material at the top of the Gothic arch.
3. In the dental laboratory, remounting of the prostheses into a semi-adjustable articulator was done according to a randomization procedure: CDs from patients of group no. 1 were mounted corresponding to a randomization procedure: CDs from patients of group no. 2 were mounted using the face-bow record.
4. The pin registration set was removed, and CDs were lowered, limited by the first contact points between the upper and lower prostheses. The respective vertical shift was measured by calculating the difference in millimetres after lowering CDs.
5. CDs were adjusted by one dental technician. She was blinded with regards to the mounting procedure. Occlusal adjustment achieved at least one static contact point per posterior tooth.
6. Participants then incorporated their prostheses, while no further chairside adjustment was performed. The maintenance procedure was performed after three days of intervention and as clinically needed.
Thereafter, digital pictures were taken from each silicone bite record by fixing it on a pad with transmitted light. A computer software program converted the thickness of the bite registrations into hard and soft contact points by displaying them in different colours. One operator counted the number of hard and soft contact points and the number of teeth with at least one contact for all bite registrations.

The primary outcome was the group-dependent comparison of the number of laboratory and clinical occlusal contact points after changing the vertical dimension in the articulator.

The secondary outcome was the evaluation of the extent of the vertical shift in relation to the number of laboratory occlusal contact points.

Participants were blinded up to the last follow-up after 84 days. The main operator who performed the intraoral pin registration and the dental technician who adjusted the CDs were blinded; every participant clinically received a face-bow registration. Its use was randomly chosen according to the random list by a second operator in the dental laboratory. Hence, neither the main operator, the participant, nor the dental technician had knowledge of whether the face-bow was used in the laboratory or not.

RESULTS

Thirty-two participants were included in this trial. For analysing clinical contact points, for group 1 (mean setting) data of 16 participants were analysed, in group 2 (face-bow record) data of 15 participants were analysed at T1, data of 14 at T2.

Laboratory occlusal contact points were assessed with doubled casts from each participant. This resulted in the number of 62 pairs of casts. Finally, from each participant a mean value-based as well as a face-bow-associated situation in the articulator were digitally analysable with bite registrations.

Due to the fact of cast duplication, the number of analysed bite registrations was equal in groups 1 and 2 (both n = 31). After removal of the pin registration set and lowering the casts, group 2 (face-bow) presented more occlusal contact points than group 1 (mean setting), but no statistically significant difference was noted. The number of teeth with at least one contact was higher in group 2 (p = 0.027). A detailed analysis for anterior teeth shows that group 2 presented more anterior teeth in contact (p = 0.007). The number of posterior teeth in contact showed no statistical difference (p = 0.428).

Over the time, the number of clinical contact points was shown as not statistically different for either group for anterior and posterior teeth. The number of clinical contact points per tooth decreased from T0 to T1 and increased in the long run to T2. The number of teeth with at least one contact decreased from T0 to T1 and increased over the course of the study. At T2, groups 1 and 2 showed a difference (7.13 and 5.31), which is statistically significant (p = 0.042).

The impact of the extent of the vertical shift during pin-supported registration was evaluated by calculating a coefficient of determination R². The variable of the method of mounting the casts (mean versus face-bow setting) showed no correlation (R² = 0.006).

CONCLUSION

No substantial difference by the use of the arbitrary face-bow compared with a mean setting could be determined, when changing the vertical dimension in the articulator within a remounting procedure of complete dentures.

IMPLICATIONS FOR PRACTICE

The use of face-bows remains controversial. Whilst this trial reported no difference in the groups compared, the small sample size used does not provide sufficient evidence to change current teaching/clinical protocols.

Reference

WHEN LIFE CAN’T WAIT...

I used Myprodol® when I had a tooth extracted and had no pain throughout the healing process. I was able to continue my day as usual.

Myprodol® is my go-to pain relief medication for severe pain, without the severe side effects.

Athma Chetty, 53 years, Procurement Administrator, Gauteng

89% of 196 Myprodol® users in a recent survey agreed that Myprodol® is most effective at relieving pain*2

Myprodol® is indicated for the relief of mild to moderate pain of inflammatory origin with or without fever3,4

GENERAL

Clinical evaluation of the loop-design fibre-reinforced composite and the band-and-loop space maintainers.

1. Identify the CORRECT answer
   One of the main reasons for failure of the loop-design FRCSM was:
   a. Debonding at the enamel-composite interface
   b. Fracture of the fibre loop
   c. Bending of the fibre to impinge on soft tissue
   d. Loss of contact with adjacent tooth

2. Identify the CORRECT answer
   Research has shown that the success rate of band and loop retainers is about:
   a. 15%
   b. 60%
   c. 45%
   d. 10%

3. True or False?
   There were no significant differences between the success rates of the two experimental retainers after 180 days.
   a. True
   b. False

4. Identify the INCORRECT answer
   The debonding of the fibre-reinforced composite may be due to:
   a. the result of strain applied during mastication
   b. differences in bonding agents
   c. thumb sucking by the patient
   d. types of composite
   e. placement techniques

Debris contamination of endodontic hand files in dental practice

5. True or False?
   The United Kingdom has made single-use of endodontic files obligatory.
   a. True
   b. False

6. Identify the CORRECT answer
   Sterilisation of dental instruments may be hindered by which of the following substances?
   a. Blood
   b. Dentin
   c. Pulp tissue
   d. Microorganisms
   e. All of the above

7. True or False
   Group B used manual and ultrasonic cleaning to decontaminate their files. The use of this cleaning method definitively explains why the files in this group were cleaner than the other groups.
   a. True
   b. False

8. Identify the INCORRECT answer.
   Which of the following steps is NOT part of the cleaning protocol for endodontic files suggested by Parashos and colleagues in 2004?
   a. Manual cleaning
   b. Pre-soaking in an enzymatic agent
   c. Ultrasonic cleaning
   d. Sterilisation
   e. Use of a washer disinfectant

An in vitro examination on the effectiveness of commercial toothpastes in the prevention of tooth decay, using eggshell as a substitute for human tooth material.

9. Identify the CORRECT answer
   Two ingredients common to all five test toothpastes are:
   a. Sodium saccharine and sorbitol
   b. Aqua and sodium fluoride
   c. Sorbitol and cellulose gum
   d. Sodium saccharine and cellulose gum
   e. Hydrated silica and sorbitol

10. True or False?
    The study showed that two of the test toothpastes did not offer protection against attack by acids.
    a. True
    b. False

11. Identify the CORRECT answer
    Calcium uptake by the toothpaste was associated with the presence of:
    a. Potassium nitrate
    b. Hydrated silica
    c. Sorbitol
    d. Sodium fluoride
    e. Sodium hydroxide

BIODENTINE: novel endodontic material for single step apexification: A Case report.

12. Identify the CORRECT answer
    The setting time of Mineral Trioxide Aggregate is approximately:
    a. One hour and twenty minutes
    b. Two hours and ten minutes
    c. Forty five minutes
    d. Two hours and forty five minutes
    e. One hour and thirty minutes.

13. Identify the INCORRECT answer
    Biodentine was shown in the study to have the following advantages:
    a. has a short setting time (9-12 min)
    b. exhibits the least microleakage
    c. forms a magnetic -mechanical bonding with both tooth and composite
    d. Expands on setting to an additional 15% of original bulk
    e. has a smaller particle size.
14. True or False?
Researchers have concluded that Biodentine induces dentin regeneration by stimulating pulp progenitor cells.
   a. True
   b. False

Painful dry socket: an alternative perspective
15. The thesis of the paper is that “dry socket pain” emanates from inflammatory changes in the periodontium of the tooth/teeth adjacent to the extraction site.
   a. True
   b. False

Maxillo-facial and Oral Radiography 163
True or False?
16. The original term for Central Giant Cell tumour was coined by Langlais.
   a. True
   b. False

17. Differential diagnosis of CGCG must include Hyperparathyroidism.
   a. True
   b. False

Clinical Windows
True or False?
18. In the Ganss et al trial, more males preferred manual toothbrushes than females.
   a. True
   b. False

19. In the von Stein-Launusiet al trial, for laboratory contact points, group 2 (face-bow) presented significantly more occlusal contact points than group 1 (mean setting) (p < 0.05).
   a. True
   b. False

20. In the von Stein-Launusiet al trial, the number of clinical contact points was shown as not statistically different for either group for anterior and posterior teeth.
   a. True
   b. False

ETHICAL
Respecting Autonomy
21. Identify the INCORRECT statement:
Respecting autonomy includes:
   a. refraining from interfering in personal affairs
   b. acknowledges the agency of the patient to exercise the right over all clinical processes
   c. without undue interference or influence from the attending health care professionals
   d. exercising coercion to direct the patient to the clinically correct decision
   e. a respectful attitude by, be it what a person thinks, wills, or does.

22. Identify the CORRECT statement:
Applying respect for autonomy implies the exercise of:
   a. veracity
   b. protection of privacy
   c. confidentiality
   d. obtain informed consent prior to intervention
   e. all of the above.

23. True or False?
The principle of autonomy applies to all patients including those considered incapable.
   a. True
   b. False

24. True or False?
It is only in the circumstance when a patient has granted general consent for their overall treatment that the clinician may alter the treatment approach without further consultation.
   a. True
   b. False

25. Identify the INCORRECT statement
Steps in determining Informed Consent include:
   a. First finalizing the financial arrangements with the patient.
   b. Evaluation of Competence before discussion of treatment proposals.
   c. Disclosure of pertinent information to the patient.
   d. Understanding of at least the of pertinent and central facts.
   e. Voluntariness: the patient may exercise absolute free power of choice.

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