THE SOUTH AFRICAN DENTAL JOURNAL

SADJ

OCTOBER 2020
Volume 75 Number 9

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

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THE SOUTH AFRICAN DENTAL ASSOCIATION

Hesy-Ra ...the first dentist
Hesy-Ra is recognised as the first known dental surgeon. An Egyptian who lived in about 2650 BC, he practised dentistry and medicine.

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CONTENTS

Our Front Cover for this Issue...

The theme for the Front Cover of the South African Dental Journal this year provides for some historical figures, some characters illuminating dental history and some important achievements in South African Dental history. The cover for October looks at an Egyptian recognised as the first dentist.
Read more on page 473.


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Hesy-Ra ...the first dentist
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CONTENTS

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Hesy-Ra …the first dentist

In about 2650 BC, a particular title was bestowed on a high Egyptian official… it reads: *Wer-ibeh-senjw*. Intriguingly, there are alternate translations of the award. *Wer* implies "Great one". *Ibeh* may be "dentition" but could also be "ivory". *Senjw* is a plural form meaning "arrows", or "cutters", or "physicians". So *Wer-ibeh-senjw* could translate to "Great one of the ivory cutters" or to "Great one of the dentists".

The official is known as Hesy-Ra and his tomb was discovered by Auguste Mariette, a French archaeologist, in 1861, and excavated later by Egyptologist James Quibell. The tomb contained the clues as to which profession the official followed. The walls, 42 metres long, were covered with paintings and objects of daily life… and most relevant were six wooden panels some of which depicted Hesy-Ra in his practice of medicine and dentistry.

Healthcare was taking root in Egypt at that time, illustrated by collections of texts known as the medical papyri and Hesy-Ra is the first recorded physician and known dentist in history. He evidently was a man of considerable talent for he held several titles, amongst these being:

Confidant of the King: *Rekh-neswt*

Great one of the ten of Upper Egypt: *Wer-medi-shemaw*

Chief of the scribes: *Medjeh-seschjw*

Magician of Mehit: *Hem-heka-Mehit*

The First Dentist was recognised by society as he was one of the few officials who was permitted to link his name to that of the Sun God, Ra. Those holding that privilege could not use the sun disk hieroglyph as that option was restricted only to the King, Djoser of the Old Kingdom.

Sections of the wooden panels discovered in the tomb of Hesy-Ra excavated by British archaeologist James Edward Quibel in 1910-1912. **Images Sourced:** Djehouty, CC BY-SA 4.0

Dentistry can claim that right from the start, ability and commitment and enterprise are characteristics of those in the profession. Dentistry may have taken some four and a half thousand years to reach the expertise of today… the Egyptian Connection provided the firm foundation!

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Upholding parameters of care in a service-provision constrained time period

SADJ October 2020, Vol. 75 No. 9 p474

LM Sykes

Advances in technology necessitate constant changes in all aspects of medical education and patient care. This requires educators and clinicians to merge traditional practices with new innovations, materials and techniques. We are also aware that rapid and dramatic changes are taking place in the world with respect to urbanisation and migration, science and technology and the future of the earth.

Many traditional and dependable diagnostic devices or treatment modalities, such as the familiar stethoscope, are dying after serving us well for years, and will likely be replaced with a handheld ultra-sonic device. With these rapid advances, and the momentum of the Fourth Industrial revolution, the curricula, teaching, learning spaces. examination methodologies, and clinical practices also need to transform. "There is a demand for us to try and solve many of the crucial healthcare challenges through translational research that transverses various disciplines. This will entail integration of Big Data platforms for collection and interpretation of information, as well as practical skills training using state of the art technology".[1] To this end the profession needs to remain current, and to adapt to the changing world.

In the past, clinicians and educators have generally had the luxury of time, allowing them to make considered and cautious decisions before changing their routine management protocols or embarking on new ventures. The unforeseen COVID-19 pandemic led to widespread disruption in all aspects of medicine and dentistry and necessitated immediate and often drastic changes.

During the last few months we have had to work through a number "teething problems" (excuse the dental analogy) of teaching and service provision under new, uncertain, unexplored and often stressful conditions. Many patients have had to forego routine medical care, visits to doctors and clinics had to be restricted and practitioners have had to make difficult decisions when prioritising needs. It also forced doctors to consider a number of legal and ethical issues and to question their own moral ethos, especially if patients had to be refused treatment. They were faced with the unique situation of having to provide high quality services in a new and often compromised environment or manner. These demands can be paraphrased well by the parameters set out by Knoernschild[2] in a position paper on care in prosthodontics. He stated that clinicians must at all times still assess and assure the quality of the care; assist patients and colleagues in clinical decision making; provide education to individuals and in groups via alternative channels; reduce their risks of legal liability as a result of negligent care; help guide the allocation of health resources and identify clinical situations that need to be prioritised or referred to specialist facilities.

At the same time the final decisions must be objective, based on existing scientific evidence, be representative of a professional consensus, and formulated to provide structural flexibility, in order to achieve the desired outcomes.

The education system has also had to adapt. Traditional lectures, ward rounds, and clinical sessions have been replaced with online teaching and learning platforms. Many felt that these changes would compromise the standards of education, and would then impact negatively on future patient care. However, the situation proved to be the exact opposite as it opened up an expansive new world. Teachers had to once again become students and learn how to present their lecture material in different and innovative ways. These included amongst others, use of a variety of internet teaching platforms and chat rooms, development of virtual patients and case scenarios, and even exploration of 3-D technology to fabricate anatomical models that students could use to acquire the manual dexterity and skills needed for the real-life situations. However, perhaps the greatest positive spin off to come from this situation was the explosion of research and publications that the pandemic generated.

Furthermore, this universal crisis seems to have brought people from across the globe together in their pursuit of a vaccine and/or treatment. We can only hope that this unified spirit of collaboration and camaraderie will persist for many years to come, regardless of whatever "new normal" conditions we find ourselves living in.

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Reference

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Submitting and tracking SADJ manuscripts to be facilitated by manuscript management systems

- A professional development bulletin

SADJ October 2020, Vol. 75 No. 9 p475 - p477

N Metsing
SADA - Head: Professional Development

The South African Dental Journal (SADJ) keeps you abreast of the latest developments in dentistry, and is the only Department of Higher Education and Training accredited scientific dental journal in South Africa for publication of scientific papers, clinical articles, current dento-political information and opinion, and trade information. Members are also able to attain their CDP points by completing the online questionnaires.

All SADJ online CPD Questionnaires are valid for a two-year period from the date of online publication. If you are not able to load the questionnaire to your courses it may be as a result of expiry.

The SADJ is published 10 times per annum between the months of February and December, that are available electronically. Hard copies are available at a single copy purchase price of R100.00 and postage included is R100 (both VAT inclusive). **We would like to emphasize that the sale for SADJ is not limited to SADA members, it is for everyone.**

The editorial and professional development team was hard at work to improve manuscript submission, review and general management processes all the way to publication. The whole process is now digitized from beginning to end!

We have gone into a partnership with The Academy of Science of South Africa (ASSAf) to ensure that we make the processes and access much easier for the authors, reviewers and readers.

What are the benefits for users of the journal?

While we used manual processes for only a few months prior to publishing the inaugural issue, and thus quantification of before-and-after improvements is not feasible or practical, the benefits of using an online system to manage manuscripts and peer reviews were immediately apparent to us, as the journal moved to more automated processes. In particular, eight features of such a system have been key to helping us manage the journal's processes, particularly with respect to peer review:

- Authors are now able to load their manuscripts online 24/7 at their own convenience.
- Automated tracking of manuscripts through the peer review workflow.
- Selecting and allocating appropriate peer reviewers.
- Assigning alternative reviewers.
- Sending letters and reminder notifications.
- Facilitating the blinded review process.
- Monitoring and evaluating journal processes.
- Ability to analyse the vital statistics of out process.

THE ACADEMY OF SCIENCE OF SOUTH AFRICA (ASSAf)

The Academy of Science of South Africa (ASSAf) was inaugurated in May 1996 by the former President of South Africa and patron of the Academy, Nelson Mandela. It was formed in response to the need for an academy of science congruent with the dawn of democracy in South Africa - activist in its mission of using science for the benefit of society.

The mandate of the Academy encompasses all fields of scientific enquiry and it includes the full diversity of South Africa's distinguished scientists. The Parliament of South Africa passed the Academy of Science of South Africa Act (Act 67 of 2001), as amended, which came into operation in May 2002.

ASSAF is the official national Academy of Science of South Africa and represents the country in the international community of science academies. Since its inception, ASSAf has grown from a small, emergent organisation to a well-established academy.

Vision

The Academy of Science of South Africa (ASSAf) aspires to be the apex organisation for science and scholarship in South Africa, recognised and connected both nationally and internationally. Through its Membership which represents the collective voice of the most active scholars in all fields of scholarly enquiry, ASSAf aims to generate evidence-based solutions to national problems.

Mission

The benefits that the Academy aspires to bring to South Africa (and the wider world) are the sustainable provision of a professionally managed organisation that can mobilise the best intellect, expertise and experience.

These are used to investigate and provide evidence-based solutions to national problems; inspiration and example in science and technology, applied for the benefit of society; international connectedness at the highest level of knowledge and insight; and facilitation of public understanding of the nature, scope and value of the scientific and technological enterprise.

Relevance

The strategic priorities of the Academy are closely matched to those of the nation. The priorities focus particularly on the need for the greatly enhanced availability of high-level human capital and an increased use of the country's best intellectual expertise in generating evidence-based science advice in support of policy development.

The Academy is aligned to national policy as dictated in the White Paper on Science and Technology and the National Research and Development Strategy. It also seeks, through its studies and convening activities, to address the triple challenges of the reduction of poverty, unemployment and inequality, as enunciated in the National Development Plan (NDP).

Selected benefits

SADJ has been accepted along with eminent DHET accredited journals on the Khulisa Journals platform, hosted by the Academic of Science Africa (ASSAf).

The Public Knowledge Project (PKP) Open Journal Systems (OJS) open source software is used to host the journal. It is the preferred platform for South African academic journals and used by more than 10,000 scholarly journals worldwide. OJS is a comprehensive tool for managing the entire submission and editorial workflow up to the publishing of articles and issues. The automated workflow streamlines the process, and Authors can at any stage check the status of their submitted articles.

All content submitted are managed online, and all email and other communication are captured and stored within the system, for convenient referencing should there be a need in future. Should there be a change in Editor or members of the Editorial Board, the transition will be seamless since all activities and communication are captured by the system.

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profiles, and digital preservation through Portico, are all automated.

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http://dx.doi.org/10.17159/2519-0105/2020/v75no9a1

Contamination of used toothbrushes and their decontamination with disinfecting agents

SADJ October 2020, Vol. 75 No. 9 p478 - p484

TRMD Ralephenya[1], J Molepo[2], M Molaudzi[3], A Volchansky[4], SL Shangase[5]

ABSTRACT

Aim

To evaluate microbial contamination of toothbrushes and the efficacy of different oral disinfectant agents in their decontamination.

Methods

The heads of 98 used toothbrushes derived from patients who needed oral hygiene treatment were included in the study. In the laboratory, microorganisms on toothbrush heads were identified using standard microbiological methods. Toothbrush heads with microorganisms were then randomly divided into four groups of 19 and disinfected with Brushtox, Andolex C, Listerine® and water (control), followed by microbiological analysis.

Results

Seventy eight percent of toothbrushes were contaminated with different microorganisms. Coagulase-negative staphylococci (CoNS) were found in a high number of toothbrushes (49%), followed by *Pseudomonas* spp (37%), *Staphylococcus aureus* (32%), *Streptococcus mutans* (14%), coliforms (9%) and *Candida albicans* (3%). Decontamination of toothbrushes with Andolex C and Listerine® reduced the number of contaminated toothbrushes by 74% each, Brushtox by 90% and water by 0.0%.

Conclusion

Toothbrushes were contaminated with various types of microorganisms, but predominantly with CoNS. Although Brushtox is a toothbrush spray, soaking toothbrushes in this solution was the most effective method, reducing the number of disinfected toothbrushes by 90%. Oral health practitioners should raise awareness to their patients regarding the need to disinfect toothbrushes.

Keywords

Toothbrush, microorganisms, contamination, oral disinfectant agents.

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4. **Alfred Volchansky:** Co-author - 10%
5. **Sindisiwe L Shangase:** Co-author - 10%

INTRODUCTION

Toothbrushes are the most commonly used oral hygiene tools to remove plaque and maintain good oral health.[1,2] Oral disinfectant agents could be utilized to supplement or even supplant patient-dependent mechanical plaque control and thus reduce or prevent oral disease.[3] Micro-organisms from the oral cavity such as *Streptococcus, Staphylococcus*, and *Lactobacilli* could contaminate them during brushing.[4]

These micro-organisms may cause oral, respiratory, gastrointestinal, cardiovascular and renal diseases.[5,6,7] Organisms associated with periodontal diseases[8,9] and opportunistic pathogens such as Candida albicans[10] have also been implicated in toothbrush contamination. The possibility of infection/re-infection with resultant disease manifestation, because of the contamination of toothbrushes by microorganisms is a cause for concern.

Storage of toothbrushes in bathrooms is a common practice worldwide including South Africa, and plays a role in their contamination. Bathrooms often have attached toilets, thus increasing the chances of toothbrush contamination by enteric bacteria such as *Escherichia coli*.[4] In an attempt to limit the contamination, toothbrushes in some households are stored in covers. However, such practice facilitates retention of moisture

thus prolonging drying time, which may lead to proliferation of opportunistic microorganisms such as *Pseudomonas aeruginosa*.[11]

The American Dental Association (ADA) recommends replacement of toothbrushes every three to four months of use to maintain the effectiveness of the brushes in removing dental plaque biofilm.[12] Most oral health practitioners have adopted this and recommend it to their patients. However, in developing countries where resources are limited, the majority of people may find it costly, and therefore impractical to replace toothbrushes every three to four months.

Whilst regular toothbrush change may enhance removal of dental plaque biofilm, it does not completely address the problem of contamination, as new toothbrushes were found to harbor significantly more *Streptococcus mutans* than worn toothbrushes.[13] It is of even greater concern that new unused toothbrushes from different manufacturers may present with bacterial contamination before oral contact.[5,14]

Previous studies have investigated and reported microbial contamination of toothbrushes after use.[15,16,17,18,19,20] Contaminated toothbrushes may lead to oral and systemic diseases, such as gastrointestinal, cardiovascular, respiratory, renal problems and septicaemia.[21] There is an important need to disinfect toothbrushes to prevent these diseases, especially in children, the elderly and immunosuppressed individuals including those undergoing organ transplants or chemotherapy.[19]

Various methods have been evaluated for the disinfection of toothbrushes including antiseptic rinses or sprays, coating toothbrush bristles with toothpaste or gel with antimicrobial effect.[9,22,23,24,15] There are only a few studies on toothbrush disinfection using Brushtox and Listerine® mouth rinse and no documented studies on the use of Andolex mouth rinse as a toothbrush disinfectant.

Hence, the aim of this study was to evaluate the microbial contamination of toothbrushes and the efficacy of Andolex C, Listerine® and Brushtox in disinfecting the contaminated toothbrushes as a strategy to prevent oral diseases in a South African population.

MATERIALS AND METHODS

Study population

Patients of both genders attending the Wits Oral Health Centre for oral hygiene treatment were recruited to participate in the study. Patients were informed about the study at a screening appointment. At this visit, they were given both a written and an oral explanation of the background of the study, its objectives, and their involvement.

Signed consent forms were obtained from all patients who agreed to participate in the study and they were asked to bring the toothbrush that they have been using in the past three months. Patients that were included had to be a minimum of 18 years of age, not having systemic diseases such as diabetes mellitus and hypertension which was considered as healthy, not having used antibiotics, antifungal agents and mouth rinses within the 30-day period prior to data and toothbrush collection and not having had any form of periodontal therapy in the past 3 months. Medical history of the participants was obtained from the participants themselves to rule out systemic diseases. The study was approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg (M120290).

Methodology

A total of 98 used manual toothbrush heads were included in this study. Used toothbrushes of different designs were collected from patients and immediately placed into sterile pouches and labelled. Convenience sampling method was used to collect toothbrushes. The toothbrushes were not exposed to each other during the time of collection. All toothbrushes were processed within 24 hours of collection. The handle of the used toothbrush was aseptically cut off using a rotary saw and retained in the bag to avoid contamination.[25]

Each toothbrush head was soaked for 5 hours in a separate tube containing 15 ml of sterile tryptone soya broth (TSB) medium. Following soaking, the contents were vortexed for 60 seconds and hundred microlitres of the resulting suspension was plated onto MacConkey agar, *Mitis salivarius Bacitracin* (MSB) agar and Sabouraud's Dextrose agar (SDA) to select for enterobacteria, mutans streptococci, and yeasts, respectively. All plates were incubated aerobically at 370C for 48 hours except for MSB agar, which was incubated for 48 hours under CO_2 conditions in a candle jar.

After incubation, the colour and morphology of colonies were recorded, and Gram's staining was performed on a representative of each colony morphotype. Coagulase and catalase tests were performed to confirm and differentiate Staphylococci. Colonies from SDA were identified by wet mount and ID32C test following the manufacturer's instructions (bioMérieux, Marcy-L'Etoile, France).

Streptococcus mutans was identified morphologically from MSB agar as convex, pale blue colonies with granular frosted glass appearance. Gram-negative bacilli were subcultured on MacConkey agar and tested for oxidase (Pro-Lab Diagnostics, Basingstoke, UK).

Gram-negative, non-lactose-fermenting, oxidase-positive colonies isolated on MacConkey agar were considered to be *Pseudomonas* spp, while Gram-negative, lactose-fermenting, oxidase negative colonies isolated on MacConkey agar were considered to be coliforms. For every test conducted, positive and negative controls were included to ensure accuracy and validity of results.

In the decontamination procedure, the toothbrush heads that showed growth were randomly divided into four groups of 19 and immersed overnight in 15ml each of the following oral disinfectant agents: Andolex C (Chlorhexidine gluconate 0.12%; iNova Pharmaceuticals (Pty) Ltd, Bedfordview, South Africa), Brushtox (Chlorhexidine gluconate 0.2%; Dentox Ltd., Warwick, England), Listerine® (with 26.98% alcohol; Johnson & Johnson, New Jersey, USA), and sterile distilled water (control).

Toothbrush heads were then rinsed with sterile distilled water to wash off excess oral disinfectant agents, placed in 15ml of sterile TSB medium for 5 hours and the resulting suspension cultured on the same media as above. Standard microbiological methods were repeated as above to identify the different organisms.

Statistical analysis

Disinfection data was analysed using the Kruskal-Wallis ANOVA test. All statistical significance was calculated at the 5% significance level.

RESULTS

Our data showed that microorganisms were present on 76 (78%) of the 98 tested toothbrushes. No growth was observed in the remaining 22 toothbrushes. Coagulase-negative *staphylococci* (CoNS) were found in a high number of toothbrushes (n=37; 49%), followed by *Pseudomonas* spp (n=28; 37%), *Staphylococcus aureus* (n=24; 32%), *Streptococcus mutans* (n=11; 14%), Coliforms (n=7; 9%) and *Candida albicans* (n=2; 3%) (Figure 1).

After using the various oral disinfectant agents, Andolex C and Listerine® reduced the number of contaminated toothbrushes by 74% (n=14) and Brushtox by 90% (n=17). Water could not disinfect any of the contaminated toothbrushes (Figure 2).

Statistical analysis

There was no statistically significant difference when Brushtox was compared with Listerine® and Andolex C in the disinfection of toothbrushes (p=0.4048). Statistically significant differences were observed in disinfection efficacy between Brushtox, Listerine® and Andolex C when compared to sterile distilled water ($p < 0.00001$).

DISCUSSION

Toothbrushes are the most common tools used to improve the oral health of an individual. The ADA recom mends that toothbrushes be replaced every three to four months of use to maintain the effectiveness of the brushes in removing dental plaque biofilm.[12] Evidence that used toothbrushes retain oral microorganisms has been previously demonstrated from countries other than South Africa.

Toothbrushes are the most common tools used to improve the oral health of an individual. The ADA recommends that toothbrushes be replaced every three to four months of use to maintain the effectiveness of the brushes in removing dental plaque biofilm.[12]

Evidence that used toothbrushes retain oral microorganisms has been previously demonstrated from countries other than South Africa[3,18,25], however, there is very little public awareness that toothbrushes can be contaminated with use.

Although various methods have been evaluated for the disinfection of toothbrushes,[9,15,22,23,24] the use of Andolex C, Brushtox and Listerine® as oral disinfectant agents has not been widely studied.

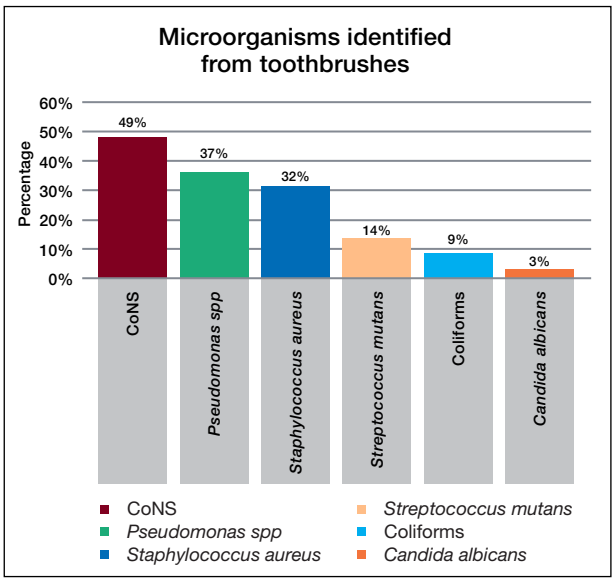

Figure 1. Microorganisms identified from toothbrushes (N=76).

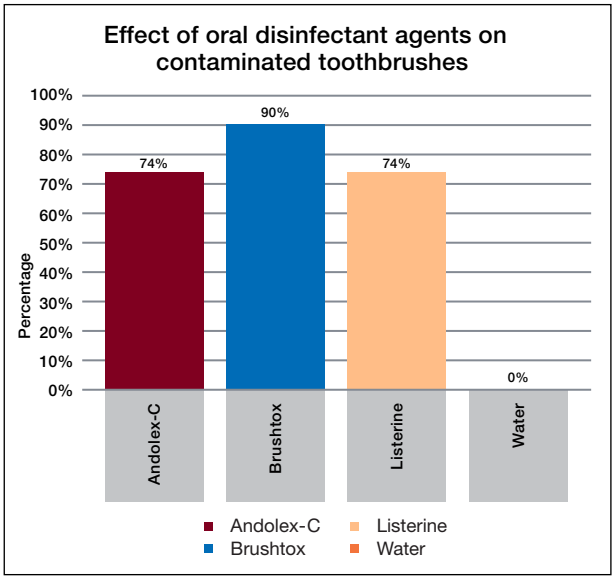

Figure 2. Effect of oral disinfectant agents on contaminated toothbrushes.

Hence, the aim of this study was to evaluate the microbial contamination of toothbrushes and the efficacy of Andolex C, Brushtox and Listerine® in disinfecting the contaminated toothbrushes as a strategy to prevent oral diseases in a South African population.

In the current study, 76 (79%) of tested toothbrushes showed microbial contamination. The microorganisms isolated were coagulase-negative staphylococci (CoNS), *Pseudomonas* spp, *Staphylococcus aureus*, *Streptococcus mutans*, coliforms and *Candida albicans*. These results confirm that toothbrushes may play a major role in the retention of organisms which may pose a health risk in susceptible individuals.

These toothbrushes were collected from patients seeking oral treatment from infections which could have been caused by these contaminated toothbrushes.

The absence of growth in 22 toothbrushes from this study could have been due to participants submitting new, purchased toothbrushes instead of the ones they used at home or they could have disinfected the toothbrushes before submission. In addition, the media used for culture were specific for growth of enterobacteria, mutans streptococci, and yeasts, therefore these 22 toothbrushes could be having other pathogens not tested in this study.

The results of our study are in concordance with those of previous studies. Mehta et al.[11] and Ferreira et al.[26] reported that 70% of the toothbrushes were heavily contaminated with different pathogenic microorganisms after use. Pesevska et al.[17] and Rodrigues et al.[19] evaluated microbial contamination of toothbrushes used by Dentistry students and microbial growth was observed in 100% and 91% of toothbrushes respectively, thus increasing the risk of oral diseases in this healthy population. These investigators reported that contamination of toothbrushes occurs often, even in individuals who should know the ideal conditions for the storage of toothbrushes.

In this study, coagulase-negative staphylococci (CoNS) were the most predominant organisms found in the highest number of toothbrushes (49%). In contrast, Ferreira et al.[26] found CoNS to be the least isolated organisms (10%) in toothbrushes of healthy individuals whilst Saini and Kulkarni[27] isolated CoNS from 36% of toothbrushes obtained from a similar population.

CoNS are normal inhabitants of human skin and mucous membranes[27] and their predominant occurrence in toothbrushes in the current study may be due to handling and rinsing of the toothbrushes after use[27]. However, the pathogenic potential of the predominant CoNS cannot be ignored as these microorganisms have been implicated in various infections including endocarditis, bacteraemia, surgical site and urinary tract infections[28]. In addition, CoNS have been reported to be multidrug resistant, which could lead to difficulty in treating infections caused by these organisms[29].

Pseudomonas spp. was found in 37% of toothbrushes and was the second most isolated organism. Osho et al.[30] found *Pseudomonas* in 40% of toothbrushes collected from healthy patients and concluded that toothbrushes can serve as fomites in various homes especially if they are not properly used and taken care of. On the contrary, Pesevska et al.[17] reported *Pseudomonas* in 15% of toothbrushes from healthy students and indicated that toothbrushes can be carriers of microorganisms, increasing the risk of diseases in healthy people.

Another study found *Pseudomonas* in 83% of toothbrushes from healthy individuals and those with oral infections.[31] *Pseudomonas* spp causes various infections including respiratory system infections, soft tissue infections, bacteraemia, and a variety of systemic infections, particularly in immunocompromised patients. These micro-organisms can survive in water therefore their presence in toothbrushes may be due to incorrect storing of the toothbrushes, where the aerosols from the toilet could easily reach them.[32]

In this study, *Staphylococcus aureus* (*S. aureus*) was isolated in 32% of toothbrushes. Contrary to this finding, Abd-ulnabi[31] reported *S. aureus* in 21% of toothbrushes from individuals with oral infections but not from healthy individuals and concluded that toothbrushes may be a source of opportunistic pathogens such as *S. aureus* due to their incorrect storage. Similarly Osho et al.[30] found *S. aureus* in 20% of toothbrushes of the same brand and type used by different individuals.

S. aureus was the most predominant isolated organism in 60% of toothbrushes used twice per day by students.[34] *S. aureus* was found in the lowest number (10%) of toothbrushes collected from students in a study by Osungunna and Oyajoju.[34] This microorganism has been implicated in life threatening diseases including infective endocarditis and bacteraemia and can influence the occurrence of oral diseases such as dental caries and gingivitis.[10,15] In addition, *S. aureus* has been reported to develop resistance to several antibiotics including methicillin (MRSA), penicillin and cephalosporins.[36] In cases where toothbrushes are shared, MRSA can be transmitted from the infected individuals to the uninfected, thus requiring that the toothbrushes be disinfected regularly.

Streptococcus mutans (*S. mutans*) was isolated in 14% of tested toothbrushes. These results differ from those of a study by Rodrigues et al.[19] where *S. mutans* was detected in 47% of toothbrushes, highlighting the ability of this organism to form biofilms and binding to the material of the toothbrushes. Saini and Kulkarni[27] reported *S. mutans* in 36% of toothbrushes from healthy individuals and concluded that toothbrushes are considered a potential biohazard for reintroduction of microorganisms in the oral cavity. Efstratiou et al.[36] found that immediately after brushing, 30% of toothbrushes were contaminated with *S. mutans*.

The presence of *S. mutans* in toothbrushes in the current study is not surprising as they are part of the oral normal flora. The growth of these bacteria on toothbrushes may be due to improper rinsing of toothbrushes after use. *S. mutans* is currently considered to be the major cause of dental caries[37] due to its exceptional aciduric and acidogenic properties and the use of a contaminated toothbrush may lead to re-infection with this organism, escalating dental caries problem.

Coliforms, which are organisms not normally associated with oral flora were isolated in 9% of tested toothbrushes. Similarly, Osho et al.[30] reported *Escherichia coli* (*E. coli*) in 10% of tested toothbrushes from different individuals. In contrast, Samuel et al.[33] reported *E. coli* in 20% of toothbrushes from students whilst Sammons et al.[24] showed that 28% of toothbrushes from healthy volunteers were contaminated with *E. coli*.

A study by Ferreira et al.[26] found that 80% of toothbrushes from healthy individuals were contaminated with *E. coli*. These investigators found that 90% of the toothbrushes were stored in bathrooms which could have accounted for the high contamination with these faecal bacteria.

Coliforms are normally found in the gastrointestinal tract and therefore in faecal matter. Aerosols released after flushing the toilet can deliver faecal matter up to 20 feet in the air, reaching toothbrushes that have been stored on bathroom counters.[38] The presence of coliforms in toothbrushes in the current study shows faecal contamination. In addition, these bacteria may have entered the toothbrushes through the rinsing water as coliforms can be found in water.[39] In addition to gastrointestinal tract infections, coliforms have been shown to cause respiratory tract infections.[38,40]

Candida albicans (*C. albicans*) was isolated in a low number of toothbrushes (3%) in agreement with a study by Pesevska et al.[17] where *C. albicans* was reported in 5% of toothbrushes. In contrast, in an *in vitro* study, Nascimento et al.[19] reported *C. albicans* in 37.3% of toothbrushes after treatment with water, showing that rinsing toothbrushes with water does not disinfect the toothbrushes. Wetzel et al.[10] reported that toothbrushes made with different anchoring techniques could retain *C. albicans*. Another study reported that contamination of toothbrushes with Candida was significantly higher in the samples of diseased individuals compared to healthy individuals.[41] C. albicans may colonize the mucosal surfaces including periodontal tissues, especially in immunocompromised individuals and patients with extended antibiotic treatment.[42] The source of the *C. albicans* in the current study could have most likely been the oral cavity where it is a normal flora.

Although *C. albicans* was isolated in low numbers in this study, its presence is significant as infection with *C. albicans* has been shown to be an important cause of mortality and morbidity in patients with AIDS, bone marrow transplantation and aggressive anti-neoplastic therapy.[43]

The presence of the microorganisms in the toothbrushes in this study highlights the need to control the microbial contamination of toothbrushes in order to prevent reinfection of the mouth and dissemination of microorganism to other parts of the body.

In our study, overnight immersion of contaminated toothbrushes in Brushtox (CHX gluconate 0.2%) was found to be highly effective in disinfecting 90% of the toothbrushes. These results are in agreement with those of an *in vitro* study by Neal et al.[44] where Brushtox showed 100% efficacy against bacteria and fungi on toothbrushes. Macari et al.[45] corroborated these findings, with Brushtox reported as the best disinfectant for prevention of cariogenic biofilm formation on 84.4% of children's toothbrushes. These results are in contrast with those of a previous clinical study where Brushtox was less effective than 0.12% chlorhexidine in removing *S. mutans* biofilms from toothbrush bristles.[46]

Brushtox Antiseptic Toothbrush Cleanser (Dentox Limited, Warwick, England) is a chemical solution that was developed for toothbrush disinfection. Brushtox consists of activated ethanol solution (35-40%), 4.5% biocides and a mixture of para-hydroxybenzoate, and is highly effective against a wide range of bacteria, fungi and viruses.[47] The results of our study agree with this as Brushtox decontaminated 90% of the toothbrushes contaminated with bacteria and fungi.

Andolex mouth rinse (0.12% chlorhexidine) was found to be less effective than Brushtox in the current study. When reviewing the literature, no documented studies on the use of Andolex mouth rinse as a toothbrush disinfectant could be found. However, a study by Rodrigues et al.[19] reported a significant decrease (91%) in toothbrushes contaminated with Streptococci, *Streptococcus mutans*, Staphylococci, Enterobacteria and yeast, when they were sprayed with 0.12% chlorhexidine solution three times a day after every brushing.[20]

According to Komiyama et al.[48] 0.12% chlorhexidine was the most effective disinfectant when toothbrushes contaminated in vitro with standardized suspensions of *S. mutans, Streptococcus pyogenes, S. aureus* or *C. albicans* were tested. Nelson-Filho et al.[22] used 0.12% chlorhexidine gluconate for disinfection of children's toothbrushes and reported total elimination of *S. mutans* after 20 hours. A study by Nascimento et al.[49] found 0.12% chlorhexidine gluconate to be more effective in reducing bacterial colonization on toothbrushes after storage in closed containers. Andolex contains Benzydamine HCL and chlorhexidine gluconate, which kills or inhibits the growth of bacteria, viruses and fungi.[50]

Our study showed Listerine® to be as effective as Andolex (0.12% chlorhexidine gluconate), but less effective than Brushtox in disinfecting toothbrushes. In contrast, Basman et al.[51] reported Listerine® to be more effective than 0.12% chlorhexidine gluconate in disinfecting toothbrushes. Konidala et al.[52] reported 100% efficacy of Listerine® in disinfection of children's toothbrushes. According to Belanger-Giguere et al.[54] using Listerine® for 20 minutes to disinfect toothbrushes contaminated *in vitro* with S. mutans showed lower effectiveness than mouthwashes with chlorhexidine.

Mehta et al.[12] showed that overnight immersion of toothbrushes in Listerine® was less effective than Brushtox in decontaminating toothbrushes. In contrast, Merchan et al.[54] evaluated the in vitro effectiveness of 0.12% chlorhexidine gluconate and Listerine® in toothbrush disinfection and found Listerine® less effective than 0.12% chlorhexidine gluconate. Beneduce et al.[55] showed that treating toothbrush heads with Listerine® for 7 min was less effective than hydrogen peroxide in reducing the numbers of both aerobic and anaerobic bacteria.

Essential oil derivates, including Listerine® are reliable antiseptic and disinfecting agents with no secondary effects on host's oral cavity.[6,49] Listerine® is composed of menthol, ethanol, thymol, eucalyptol (essential oils) and methyl salicylate as active agents.[52] Listerine® inhibits enzymatic activity of bacteria, disrupts their cell walls, thereby preventing their aggregation and slowing down their multiplication.[56]

Sterile distilled water did not decontaminate any of the toothbrushes and a statistically significant difference was observed when compared with using Brushtox, Listerine® and Andolex C ($p<0.00001$). This is in agree-

ment with a study by Nelson Filho et al.[46] where microbial contamination was detected in 100% of tooth brushes sprayed with sterile water. Macari et al.[45] reported that rinsing toothbrushes with sterile water resulted in continued high levels of contamination and biofilm. In another study, uncountable colonies of bacteria were observed after treating toothbrushes with water.[57] Our study show that the use of water to decontaminate toothbrushes after regular use is ineffective as also reported by other studies.[52,53,58].

The inability to use molecular methods to detect non-cultivable microorganisms remains a limitation of this study. The possibility that the 22 toothbrushes without growth may have been newly purchased by patients or disinfected before they were collected for the study can not be overruled as limitations. It is recommended that sensitive and specific molecular assays be employed to detect, in particular, non-cultivable microorganisms.

CONCLUSION

Toothbrushes in this study were contaminated with various types of microorganisms, with CoNS predominating. Brushtox was the best disinfectant, reducing the number of contaminating microorganisms on disinfected toothbrushes by 90% after overnight immersion.

Oral health practitioners should raise awareness to their patients regarding the need to disinfect toothbrushes and that water alone does not disinfect the toothbrushes. The use of Brushtox as a soaking medium should be encouraged for disinfection of toothbrushes between uses.

Acknowledgements

Wright Millners for providing Oral B toothbrushes which were handed out to patients as a replacement of their used toothbrush. Ivodent for providing Brushtox.

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http://dx.doi.org/10.17159/2519-0105/2020/v75no9a2

Schwannoma of the infratemporal fossa - A rare case report

SADJ October 2020, Vol. 75 No. 9 p485 - p487

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ABSTRACT

Schwannoma is a benign nerve sheath tumour that originates from schwann cells of the peripheral nerve. In spite of constituting 25-40% of head and neck tumours its intraoral presentation is rare which accounts for only 1%.

The purpose of this case report is to highlight the rarity of this lesion, to emphasize the significance of an accurate diagnosis and to include tumours of nerve sheath origin in the differential diagnosis of facial asymmetry.

Keywords
Schwannoma, nerve sheath, head and neck region.

INTRODUCTION

Schwann cells intimately ensheath all neurons of both myelinated and non-myelinated nerves in the peripheral nervous system.[1] Schwannomas occurring in the head and neck region constitute 25–45% of head and neck tumours.[2]

The present case of schwannoma is limited to the infratemporal fossa, which is a rare location, arising from the extradural division of the trigeminal nerve. Trigeminal schwannomas account for about 0.2% of all intracranial, tumours and 0.8% and 8% of intracranial schwannomas.[3] Surgically a zygomatico-temporal approach was planned to provide access to such a cryptic anatomical region whilst ensuring a satisfactory cosmetic result.

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3. **Pooja Prasad:** Lead the writing of the case report, approved the final draft - 20%
4. **Mugdha S Raut:** Lead the writing of the case report, approved the final draft - 20%
5. **Rajiv S Desai:** Examined the patient; conceiving the idea for the case report, approved the final draft - 20%

CASE REPORT

An 18-year-old female reported with a main complaint of a gradually increasing painless swelling on right side of the face of 4 months duration. It extended from right ala of nose to preauricular notch, anteroposteriorly, and from right maxillary buccal vestibule to right infraorbital region, superioinferiorly (Fig. 1).

Intraorally, the right maxillary buccal vestibule was obliterated. The swelling was firm on palpation and the patient presented with difficulty in opening of mouth. There were no neurological signs on the right side of the face.

Figure 1. Extra-oral swelling extended from right ala of nose to preauricular notch, anteroposteriorly, and superioinferiorly from right maxillary buccal vestibule to right infraorbital region.

T2 weighted MRI demonstrated a large well defined, heterogeneously enhanced mass measuring 5x4.4x4.2 cm in right infratemporal fossa. The posterior wall of the right maxillary antrum was bowed anteriorly and the floor of the orbit was attenuated by the mass (Fig. 2A). The lesion showed extension into the right cavernous sinus. Widening of foramen rotundum was noted.

Based on the clinical and radiological findings, a provisional diagnosis of a benign soft tissue neoplasm in the right infratemporal fossa was made. An intraoral incision biopsy was performed under local anaesthesia from right maxillary molar region. Histopathologically, connective tissue was shown to be composed of numerous spindle cells arranged in fascicles and in a palisading pattern depicting hypercellular Antoni A arrangement.

The spindle cells were characterized by flattened elongated and tapered nuclei. Presence of chronic inflammatory infiltrate was seen; neural bundles were also evident in a few areas of the stroma consistent with a diagnosis of spindle cell neoplasm (Fig. 2B). Immunohistochemical analysis showed S100 positivity (Fig. 2C). Based on the clinicopathological and immunohistological features, a final diagnosis of the spindle cell lesion Schwannoma was established.

The tumour resection was planned through zygomaticotemporal approach with osteotomy of zygomatic complex bony structure for access to infra temporal space and maxilla (Fig. 2D) for ensuring a satisfactory cosmetic result. The whole zygomatic complex bony structure was retracted laterally to expose the tumour in the infra temporal fossa. The tumour was enucleated as a single mass. After excision the tumour, a rigid fixation of osteotomised bony complex back in premarked position was done with miniplates. Healing was uneventful. A 5-year follow-up showed no sign of recurrence.

DISCUSSION

Schwannoma (neurilemmoma) is a rare, benign, encapsulated perineural tumour of neuroectodermal origin that is derived from the Schwann cells of the neural sheath. Earlier, Verocay[4] referred to it as a "neuronoma." Later, Stout used the term, "neurilemmoma," believing that this tumour originated from the Schwann cells.[4]

Twenty-five to forty-eight percent of all cases of schwannomas occur in the head and neck region.[5-7] It is more common between 30 and 50 years of life.[8] William et al.[9] showed that in 83% of the cases studied by them, schwannomas presented in males, while for Lucas, there was a greater predilection for females which is in accordance to our case and for Hatziotis[9] and Asprides, Enzinger and Weiss,[9] there was an equal distribution.[4,9] Within the head and neck region, the tongue, palate, cervical and pharyngeal regions are frequently involved, but a lesion in the infratemporal fossa is relatively rare.[8,10,11]

Clinically Schwannoma presents with symptoms related to the nerve involved maybe associated with pain along with other symptoms such as hearing loss, hoarseness and dysphagia, depending on the site of involvement. However, lack of symptoms is common when the lesion originates from the trigeminal nerve and is located in the infratemporal fossa which is in accordance to our case report.[11]

Trigeminal schwannomas account for about 0.2% of all intra cranial tumors, and 0.8% and 8% of intracranial schwannomas.[3] In the present case, the tumour showed evidence of originating from the second division of the fifth cranial nerve near the foramen rotundum. They can originate from any section of the fifth cranial nerve, from the root to the distal extracranial branches, but the majority develops at the Gasserian ganglion, usually growing in the middle cranium.[3] In our case, though intracranial extension into the right cavernous sinus was seen, during surgery the duramater was found to be intact. It was concluded that the tumour primarily originated within infratemporal fossa.

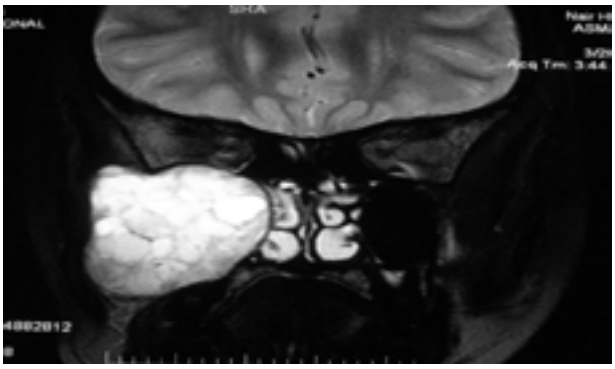

Figure 2A. T2 weighted MRI demonstrated a low-density mass in the right infratemporal fossa and bowing in of the right maxillary sinus.

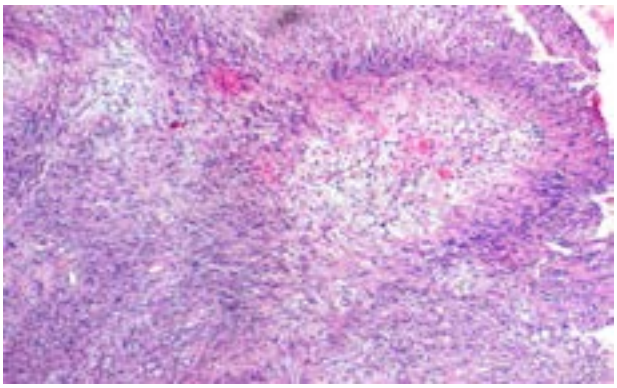

Figure 2B. Photomicrograph demonstrates cellular neoplastic connective tissue arranged in short fascicles, composed of cells with aligned long nuclei and few spindle cells randomly arranged within a loose stroma (H&E 100x).

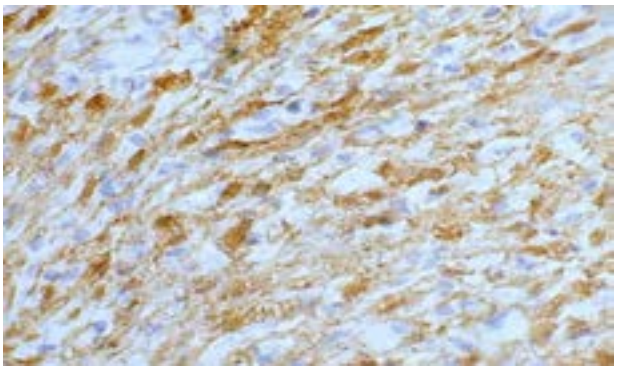

Figure 2C. The tumour cells showed positive immunohistochemical reactivity for S100 protein.

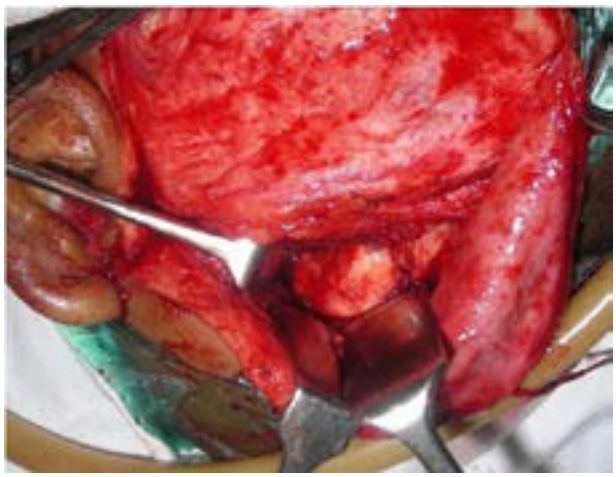

Figure 2D. Intra operative picture showing exposure of the tumour through temporal approach with osteotomy of zygomatic complex bony structure for access to infratemporal space and maxilla.

The infratemporal region is the irregular retromaxillary space, inaccessible by virtue of its relatively concealed location, and is remote for clinical examination.[12] Tumours in this clinically silent area always pose a problem in diagnosis and management. They cannot be seen clinically while they are still confined within the boundaries of the fossa, and localizing signs and symptoms usually do not become apparent until the tumour reaches a significant size.[11] In the present case, the patient was asymptomatic, radiographs showed erosion of the bony walls of infratemporal fossa, thinning of floor of orbit and extension into the sphenoid sinus.

CONCLUSION

Though rare, the treatment of infratemporal schwannomas provide a great surgical challenge. The low incidence of schwannomas often leads to the omission of the tumour in the differential diagnosis of soft tissue tumours of the oral cavity. We have presented a unique case of a schwannoma of the infratemporal fossa to stress its rarity and importance of ruling out neurogenic tumours in differential diagnosis of facial asymmetry without paraesthesia.

Declaration

The authors of this manuscript declare no conflict of interests.

Ethics statement

Ethics approval is obtained. All details of the patient have been anonymized.

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http://dx.doi.org/10.17159/2519-0105/2020/v75no9a3

Granulomatosis with polyangiitis - An oral medicine case book

SADJ October 2020, Vol. 75 No. 9 p488 - p492

I Snyman[1], L Robinson[2], AW van Zyl[3], WFP van Heerden[4]

CASE REPORT

A 33-year-old female patient presented at a private specialist practice (Periodontics and Oral Medicine) with a main complaint of sore and bleeding gums, fever, headaches and sinus pain. The gingiva became irritated, red and swollen five weeks prior to the first consultation in July 2018.

She was referred by her dentist one month after prescribing two consecutive courses of antibiotics and providing oral hygiene instructions to the patient, with no significant improvement. The first prescription was for Augmentin 375 mg t.d.s. for 5 days and the second prescription two weeks later was for Amoxycillin 250 mg t.d.s. and Metronidazole 200mg t.d.s. for 5 days. The patient was also using a chlorhexidine mouth rinse.

The patient's medical history included the following:

- Caesarian section 8-months prior to consultation.
- Quit smoking (5-10 cigarettes/day) before conceiving in 2017.
- Plantar psoriasis of the left foot, diagnosed after clinical examination by a Rheumatologist.
- Childhood allergic rhinitis (hay fever).
- No known allergies.

On examination, the gingiva appeared erythematous and swollen with a "strawberry appearance". Both the buccal and lingual gingiva in the upper and lower jaws were affected (Figures 1 & 2). The affected areas of the gingiva were firm, tender and exhibited spontaneous bleeding at times. At this stage, the differential diagnosis included granulomatosis with polyangiitis, pyostomatitis vegetans or a leukemic infiltrate.

Figure 1. Initial clinical presentation of the right mandibular buccal gingiva.

Figure 2. Initial clinical presentation of the mandibular lingual gingiva.

DIAGNOSIS AND MANAGEMENT

An incisional biopsy was performed with a scalpel (15C blade) under local anaesthesia of the affected gingiva, lingual to the left mandibular first molar, for histological examination. Sutures were placed (chromic gut 4/0), post-operative instructions were given and healing was uneventful.

Macroscopic examination revealed a specimen consisting of a scalloped fragment of mucosa with a granular surface, measuring 29 x 8 x 3 mm. Histological evaluation showed a tissue fragment surfaced by acanthotic, hyperparakeratotic stratified squamous epithelium exhi-

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4. **Willie FP van Heerden:** Histological diagnosis and review - 15%

biting pseudoepitheliomatous hyperplasia and moderate-to-severe inflammatory exocytosis (Figure 3). The underlying lamina propria contained large areas of suppuration with microabscess formation. Numerous poorly formed granulomas composed of lymphocytes and histiocytes were noted, with eosinophils and plasma cells present throughout the adjacent stroma. Prominent multinucleated giant cells, varying in size and shape and containing 5 to 15 nuclei, were present throughout the lesion (Figure 4). There were abundant capillaries involved by a leukocytoclastic vasculitis with associated erythrocyte extravasation and fibrin deposition. There was no evidence of epithelial dysplasia or malignancy in the sections examined. Periodic acid-Schiff (PAS), Warthin-Starry and Ziehl-Neelsen histochemical stains failed to highlight any fungal elements, bacilli/spirochetes or acid-fast bacilli respectively. These histological features were in keeping with granulomatosis with polyangiitis.

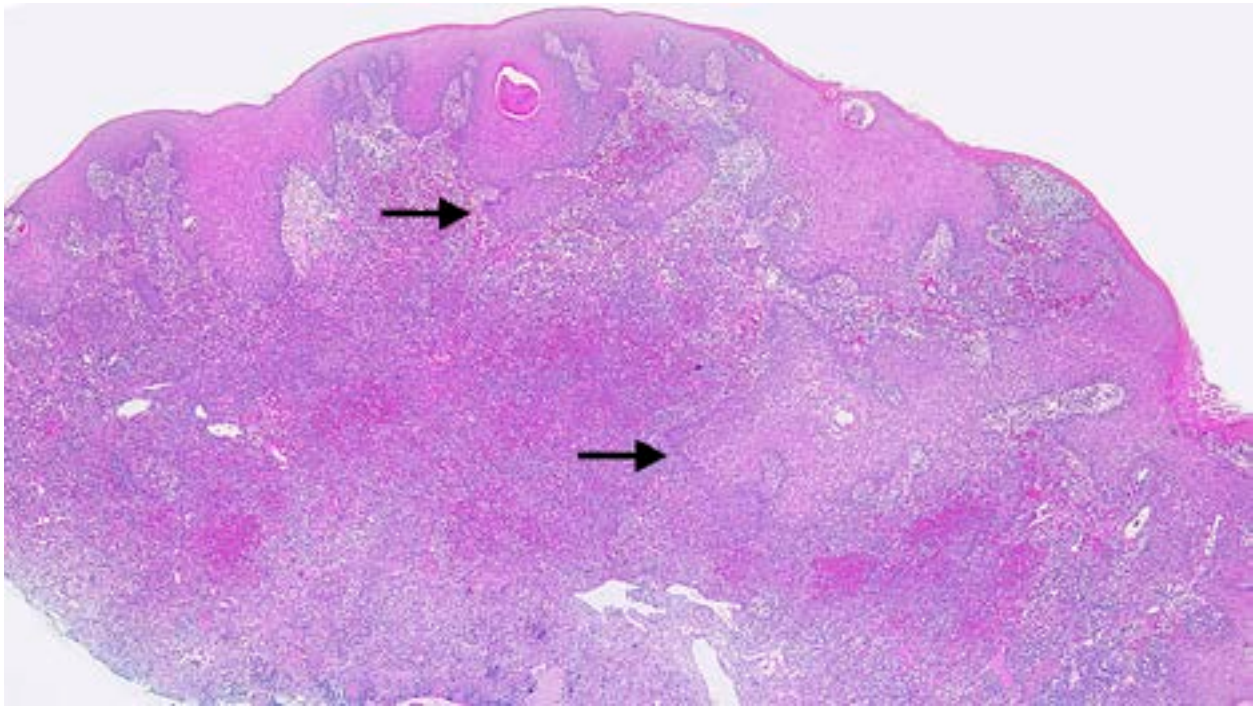

Figure 3. A low-power H&E-stained section showing a tissue fragment surfaced by stratified squamous epithelium exhibiting pseudoepitheliomatous hyperplasia (arrows) (original magnification x 4).

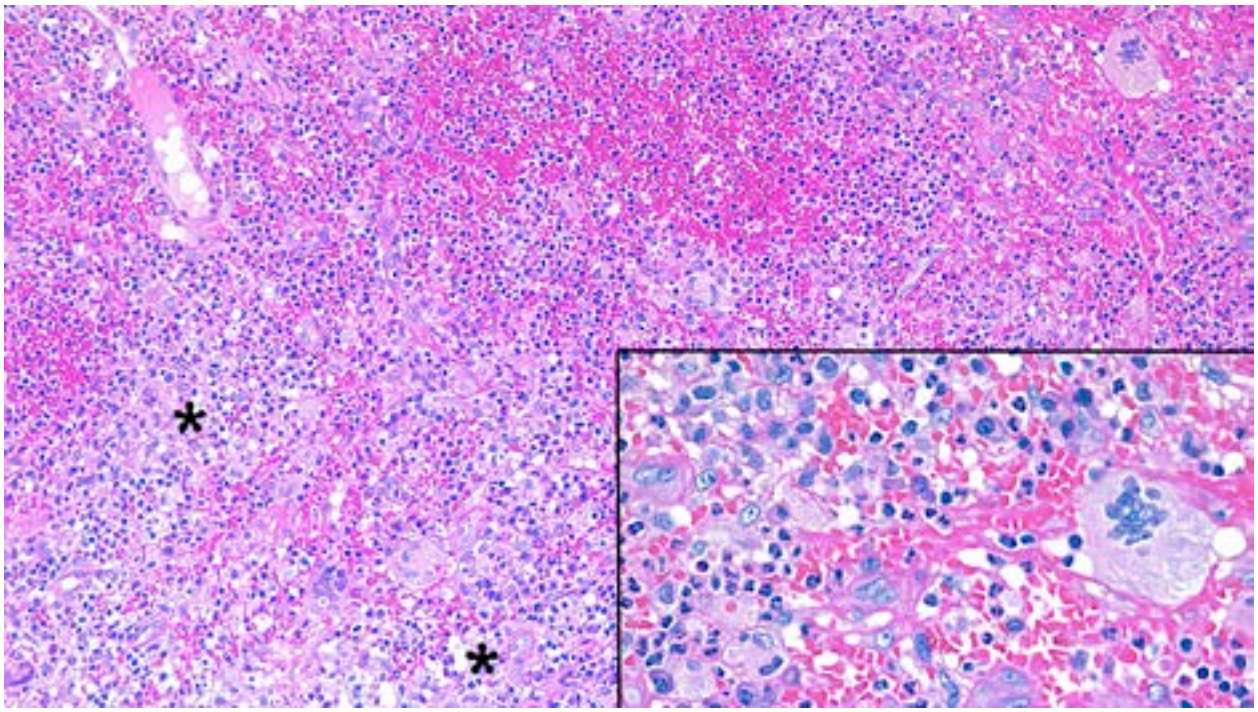

Figure 4. H&E-stained section showing poorly formed granulomas (asterisk) with adjacent mixed inflammation including giant cells, microabscesses and extravasated erythrocytes (original magnification x 20). **Insert**: Higher magnification emphasising the cellular components (original magnification x 40).

The patient was referred to a Rheumatologist for a comprehensive systemic evaluation. Multiple blood tests were ordered and the results recorded in Table 1. The patient met the American College of Rheumatology criteria according to the 1990 classification for granulomatosis with polyangiitis:[1]

1. Oral inflammation.
2. Abnormal urinary sediment.
3. Granulomatous inflammation upon biopsy.

The clinical, histological and laboratory findings confirmed a final diagnosis of granulomatosis with polyangiitis.

Table 1. Blood tests performed with results.

Test	Result
Full blood count (FBC)	Normal
Platelet count	Slightly elevated
Electrolytes and eGFR	Normal
S-Total bilirubin	Normal
S–gamma GT	Slightly elevated
S–ALT	Normal
S–AST	Normal
C–Reactive protein	Elevated
S-ACE	Decreased
S-TSH	Normal
Prothrombin Time	Normal
International normalised ratio (INR)	Normal
Erythrocyte sedimentation rate (ESR)	Normal
C3 and C4	Normal
ANA/ENA screen	Negative
MPO-ANCA (p-ANCA)	Negative
PR3-ANCA (c-ANCA)	Positive
Cytomegalovirus	Negative
Epstein-Barr virus	Negative
Treponema Pallidum (RPR)	Negative

Initial treatment, starting in July 2018, consisted of systemic prednisone (5mg/day) and azathioprine (50mg/day). After six months, the response to treatment was excellent, however it was not possible to wean the patient off prednisone. Azathioprine was ceased and Methotrexate (20mg/week) initiated in January 2019. A renal biopsy in June 2019 showed mild mesangial proliferative glomerulonephritis. During a follow-up visit in December 2019, no gingival lesions were noted (Figures 5 and 6). The urine protein/creatinine ratio was normal and the psoriatic skin lesion on the left foot improved. Her respiratory examination was clear and she had no active joint disease. She was still very sensitive to prednisone withdrawal and her treatment was adjusted as follows:

- Systemic prednisone 2,5 mg on alternate days.
- Methotrexate 20 mg weekly.
- Folate 5 mg weekly.
- Caltrate Plus 1 tablet daily.
- Cardiac Aspirin 1 tablet on alternate days.

Figure 5. Clinical appearance of right mandibular buccal gingiva 18 months following initiation of immunosuppressive therapy.

Figure 6. Clinical appearance of left mandibular lingual gingiva 18 months following initiation of immunosuppressive therapy.

DISCUSSION

Since the shift from honorific eponyms to more disease descriptive or aetiology-based nomenclature, Wegener's granulomatosis has been renamed as granulomatosis with polyangiitis (GPA).[2] The disease was first described by Klinger in 1931, and only later by Friedrich Wegener as a separate syndrome.[2,3,4,5] An annual incidence of 5-10 cases per million population has been reported.[6,7] GPA is usually diagnosed in individuals between 45 and 60 years of age, and is very rare in children.[6,8] Males and females are equally affected with the disease being more prevalent amongst caucasian individuals than other population groups.[6,8,7,9]

According to the 2012 International Chapel Hill Consensus Conference on the Nomenclature of Vasculitides, GPA is defined as a systemic necrotising granulomatous inflammatory disease which usually involves the upper and lower respiratory tract, with necrotising vasculitis affecting predominantly small and medium-sized blood vessels.[9,10] The acronym 'ELK' is used to describe clinical involvement of the ear, nose and throat; lungs and kidneys.[11] GPA may only present locoregionally, as a limited form of the disease, or progress to a more widespread systemic form if left untreated.[11] GPA may affect the skin, oral cavity, eyes, nose and paranasal sinuses, ears, upper and lower airway, cardiovascular system, gastrointestinal system, kidneys, central and peripheral nervous system and musculoskeletal system.[7,11]

The precise cause(s) of GPA remain(s) unknown.[12] The disease likely represents a form of T-cell-mediated hypersensitivity response to normal "innocuous" inhaled

microbial or other environmental agents.[12] Environmental factors, such as silica or dust inhalation have been implicated in a minority of patients as a possible trigger.[8] Infectious agents may also play a role through the process of molecular mimicry.[8] The role of genetic factors was also demonstrated in a genome-wide association study.[13] The HLA class II region is the best-established risk gene/locus in GPA, with HLA–DPB1 and HLA–DPA1 variants showing the strongest association signals.[14] B-cells also possibly play a major role in the pathogenesis as they produce anti-neutrophil cytoplasmic antibodies (ANCAs). Anti-proteinase-3 antibodies (PR3-ANCA, previously c-ANCA) are present in up to 95% of cases, and may participate in the disease pathogenesis.[12] GPA, along with microscopic polyangiitis and eosinophilic granulomatosis with polyangiitis (Churg-Strauss) are collectively referred to as ANCA–associated vasculitides.[14] The presence of these antibodies and their titers appear to be related to levels of disease activity. Imbalances in different T-cell subtypes and/or cytokine-chemokine networks can also lead to or at least participate in the failure of tolerance, triggering auto-immunity.[12]

Orofacial manifestations of GPA include labial mucosal nodules, gingival enlargement, granulomatous lesions, oral ulceration, extraction sockets that fail to heal, oro-antral fistulae, temporomandibular joint arthralgia, facial nerve palsy and salivary gland enlargement.[15,16] A chronic destructive process of the nasal cavity may lead to palatal ulcers.[15] Nasal septum collapse may lead to a saddle nose deformity. The most characteristic oral manifestation of GPA is enlarged, red to purple gingiva, with a granular appearance referred to as strawberry gingivitis, because it resembles an over-ripe strawberry.[15] Gingival GPA usually first involves the labial or lingual interdental areas and may progress to involve the entire buccal and/or lingual gingivae.[16] Osteomyelitis and necrosis of the underlying bone may arise with subsequent mobility and tooth loss.[16]

The diagnosis of GPA is based on clinical assessment, serological testing and histological findings.[11] The American College of Rheumatology proposed four diagnostic criteria, with a minimum of two required for a diagnosis of GPA (Table 2).[1] The presence of any 2 or more criteria yields a sensitivity of 88.2% and a specificity of 92.0%.[1] Histologically, GPA appears as a pattern of mixed inflammation, vasculitis, necrosis and poorly formed granulomas. All stages of vasculitis may be present, ranging from acute to granulomatous to healed. Extravasated erythrocytes and fibrin thrombi are often seen in association with damaged blood vessels. The adjacent connective tissue contains a variable mixture of histiocytes, lymphocytes, eosinophils and multinucleated giant cells. Areas of geographic coagulative necrosis may be present, with a prominent rim of palisaded epithelioid histiocytes. Giant cells may also be present around the necrotic areas. Special histochemical stains are negative for organisms, and no foreign material can be detected.[8,13,17]

Table 2. Criteria for the classification of granulomatosis with polyangiitis.[1]

Criteria	Description
Nasal or oral inflammation	Development of painful or painless oral ulcers or purulent or bloody nasal discharge
Abnormal chest radiograph	Chest radiograph showing the presence of nodules, fixed infiltrates, or cavities
Urinary sediment	Microhematuria (>5 red blood cells per high power field) or red cell casts in urine sediment
Granulomatous inflammation on biopsy	Histologic changes showing granulomatous inflammation within the wall of an artery or in the perivascular or extravascular area (artery or arteriole)

Since the introduction of immunosuppressive therapy, the prognosis of GPA has greatly improved from a mean survival time of 5 months to a 10-year survival rate of approximately 80%.[8,16] A diagnosis of GPA always necessitates treatment and is mainly guided by disease activity and severity.[16] Therapy may include the use of corticosteroids, cyclophosphamide, methotrexate, azathioprine, leflunomide, co-trimoxazole, mycophenolate, cyclosporine and rituximab.[16] A combination of azathioprine and low-dose prednisone is mainly used as maintenance therapy.[18] Relapse might occur in 50% of patients following remission, due to discontinuation of therapy, rapid tapering of corticosteroids or persistent positive-ANCA during the remission period.[16] It should be emphasised that the management of GPA requires a multidisciplinary approach that may involve the dentist, oral medicine specialist, oral pathologist, maxillofacial surgeon, rheumatologist, pulmonologist, nephrologist and/or internal medicine specialist.[7]

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Do the CPD questionnaire on page 518

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

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http://dx.doi.org/10.17159/2519-0105/2020/v75no9a4

Root canal preparation with reciprocating instruments
- A literature review and clinical application

SADJ October 2020, Vol. 75 No. 9 p493 - p504

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INTRODUCTION

It is well described that the presence of microbial flora in the pulp space of the tooth, and the inability of the immune system to remove these pathogens, are the major sources of peri-apical and radicular inflammation.[1] Eradication of these pathogens from the pulp and root canal space by means of cleaning, shaping, disinfecting and complete obturation is necessary to safeguard the health of the periodontal tissues from endodontic infection and subsequent breakdown.[2,3]

The basic objectives of cleaning and shaping of root canals include: (1) removal of all infected soft and hard tissues; (2) creating space for delivery of disinfectants and medicaments to the apical part of the canal; (3) facilitating three dimensional obturation and (4) preservation of radicular structures.[4]

Even modern endodontic file systems leave untouched areas on the root canal walls after preparation and show compaction of hard tissue debris.[5] This debris consists of pulp tissue remnants, bacteria and dentine chips of which most is found in the apical part of the prepared root canal system.[6] Aiming for a centred preparation that corresponds to the original canal anatomy accompanied by the lowest amount of canal transportation, especially in middle and apical parts of curved canals, will result in the most favourable post instrumented canal shape. The four optimal canal shaping objectives are: (1) to have a tapered funnel from orifice to apex, (2) maintenance of original anatomical canal pathway, (3) apical foramen position should remain constant and (4) leaving the apical opening as small as possible.[2,7]

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1. **Peet J van der Vyver:** Contribute to the data analysis, scientific writing and proofreading of the manuscript - 35%
2. **Martin Vorster:** Contribute to the scientific writing and proofreading of the manuscript - 20%
3. **Zunaid I Vally:** Contribute to the scientific writing and proofreading of the manuscript - 15%

Importance of attaining and maintaining apical patency

Negotiating the canal to the apical terminus is the first significant step in setting up a glide path. Typically utilizing a very thin K-File and passing it through the apical extent of the root canal for 1 mm, will achieve patency.[8] This assists in accurate electronic measurement of the root canal length.[9] A strong tendency for debris to be compacted at the apex of the canal can lead to: apical blockage of the canal, loss of working length, risk of extruding bacterial infused debris into periodontium, preventing natural flow of enlarging instruments along the canal - predisposing to apical ledging and incomplete disinfection of the apical portion of the canal.[10,11]

Regular recapitulation of the canal during preparation with a thin K-File (size 08 or 10), maintaining patency throughout, drastically improves disinfection of the apical portion of the canal.[10,12]

Glide path preparation

Glide path is defined as a smooth reproducible pathway from the canal orifice to the apical portal of exit.[13] This will allow any shaping file system to easily pass along this route. As a rule no rotary or reciprocating system ought to be used before the canal has been negotiated and a reproducible glide path has been established by hand files.[14,15]

Many procedural errors can be reduced by preparing a proper glide path.[16] Pre-flaring of the coronal part of the canal will reduce instrument torque while preparing the apical portion, thereby reducing the risk of instrument fracture.[17] Torsional stresses on shaping instruments may also be reduced after effective glide path establishment.[18]

Occurrence of canal transportation, ledging and perforations are reduced, with improved centered preparations and more favourable amounts of dentine removal.[19] Initial preparation of a glide path shows quicker preparation

times and lower fatigue fracture risk of reciprocating instruments.[20,21] Glide path preparation can be done with stainless steel K-Files, either by hand or in a reciprocating hand piece. Alternatively, newer rotary or reciprocating NiTi systems can be used in dedicated endodontic motors.[16]

This "glide path" will guide the non-cutting tips of the rotary/reciprocating NiTi files to working length.[16] It is recommended that the glide path size should be one size larger than the tip size of the first shaping file to be introduced.[17]

Glide path preparation using reciprocation

1. Reciprocation with hand stainless steel K-Files

Utilizing a stainless steel (SS) hand file inserted into a dedicated reciprocating hand piece can reduce fatigue and operating times with lower risk of instrument failure compared to NiTi rotary glide path files.[22]

Ti-Max Ti35L (NSK, Kanuma, Japan) and the M4 Safety Reciprocating Hand Piece (SybronEndo, Orange, CA, USA) (Figure 1) are some of the hand pieces that are available with 90° and 30° reciprocation angles respectively.[23] However, loss of physical perception on the file increases the risk of iatrogenic errors with this technique.[16,24]

Excess dentine removal, apical transportation and debris extrusions are reported with the use of larger files (greater than size 15), undue apical forces during canal instrumentation and over preparation of canals.[22,25]

Figure 1. M4 Safety Reciprocating Hand Piece (SybronEndo).

2. Dedicated reciprocation glide path systems

The three systems mentioned below all cut in a counter clockwise (CCW) direction and operate with a 150° CCW and 30° clockwise (CW) angle of rotation.[23]

a). WaveOne Gold Glider (Dentsply Sirona, Ballaigues, Switzerland) (Figure 2)

The WaveOne Gold Glider was introduced into the market in 2017. Utilizing proprietary post-manufacturing thermal treatments that modifies the transition between austenite and martensite to produce a distinctive gold coloured alloy (Gold Wire) that exhibits superior flexibility and cyclic fatigue resistance compared to M-Wire and conventional NiTi alloys.[26,27]

It is a single file system that has an ISO 15 tip size that is variable tapered from 2% at D0 to 6% at D16. Designed with a parallelogram shaped cross section and a semi-active tip.

Figure 2. WaveOne Gold Glider (Dentsply Sirona).

b). EdgeOne Fire GlidePath (EdgeEndo Albuquerque, New Mexico, USA) (Figure 3)

EdgeOne Fire GlidePath file is also a single file system to be used in reciprocation motion. Made from the same trademarked "FireWire" as EdgeGlide Path files, they are also designed similarly to the WaveOne Gold Glider with a parallelogram cross-section but with an ISO tip size of 19. The file is recommended for use prior to final shaping with the EdgeOne Fire shaping system.[28]

According to the manufacturer, FireWire NiTi yields performance-enhancing durability providing flexibility of up to 90° curves and will expedite endodontic treatment.[29]

Figure 3. EdgeOne Fire GlidePath (EdgeEndo).

c). One File G Reciprocating Glide Path File (Pac-Dent, Brea, CA, USA) (Figure 4)

One File G Reciprocating Files are reciprocating endodontic files manufactured from heat-treated NiTi. The One File G Reciprocating Glide Path file has an ISO 15 tip with a 2% taper. The file has a square-shaped cross section and is used prior to shaping with the One File G Reciprocating Shaping System (Pac-Dent).[30]

Figure 4. One File G Reciprocating Glide Path File (Pac-Dent).

d). R-Pilot (VDW, Munich, Germany) (Figure 5)

The R-Pilot instrument is a glide path instrument manufactured from M-Wire and is used in reciprocating motion to prepare the root canal system before the shaping with a rotary or a reciprocating instrument. The R-Pilot instrument has a constant taper of 4%, an ISO tip size of 12,5 and an S-shaped cross section. It is a single-use instrument designed for use in no more than one molar.

The R-Pilot instrument can be used only in a reciprocating motion with a designated drive system using that uses the original Reciproc (VDW) settings. Failure to do so, according to the manufacturers can lead to instrument fracture and misuse. The instrument is not recommended for use in canals with abrupt apical curvatures in the apical region.

Figure 5. R-Pilot (VDW).

Rotation vs. reciprocation for root canal preparation

Introduction of NiTi endodontic instrumentation, paved the way for many machine assisted rotary systems to be developed which allowed for more efficient root canal preparation.[31,32] Recently, asymmetrical rotary systems have been added: Revo-S (MicroMega, Besancon, France), ProTaper Next and TruNatomy (Dentsply Sirona) as well as systems with variable cross section designs like OneShape (MicroMega).

ProTaper Next is made from M-Wire and has a off-centre rectangular cross section that moves in an asymmetrical fashion.[33] This "swaggering" action in the canal leaves more space to auger debris coronally and lowers apical debris extrusion with higher cutting efficiency and less dentine crack formation compared to conventional rotary systems.[34-36] Less dentine engagement due to fewer contact points at any given time, lowers generated forces on the root canal walls and might attribute to higher fracture resistance of the instrument.[37]

The new TruNatomy system features slimmer files with a unique off-centered cross sectional design. Designers claim that the files are three times more flexible than ProTaper Next, due to post-grinding thermal treatments, that operates at higher speeds of 500 rpm. As a single-file system, they also allow for more conservative, minimal invasive canal preparation, without straight-line ccess to the canal.[38,39]

Even though NiTi reciprocating instrumentation has only recently been introduced, reciprocating motion with SS files has been utilized widely in the progress of mechanical root canal preparation systems.[40] Early hand pieces like Giromatic (MicroMega) from the 1960's with 90° reciprocation, prepared canals comparable to the manual technique,[41] but the risk of iatrogenic errors increased.[42,43]

Many of these drawbacks was attributed to the mechanical rigidity of SS instruments.[44] Modern trends advocate the use of SS files in reciprocation hand pieces only with initial canal negotiation and glide path management. The M4 Safety hand piece (SybronEndo) features a chuck that engages a normal hand file to assist with this.[22]

Yared[47] (2008) first introduced single-file NiTi reciprocation. He experimented with a F2 ProTaper Universal (Dentsply Sirona) rotary file in a 16:1 reduction contra-angle motor that allows for reciprocation. Set at 4/10ths of a circle CW followed by 2/10ths CCW the instrument would require five cycles to complete a full 360° rotation.

In this way he completed single file shaping of a root canal (after traditional canal negotiation and glide path preparation). A technique that lowered cost, used less instruments, eliminated cross-contamination, and lead to faster treatments.[45-47] This also improved safety whereby the instrument is not exceeding its elastic limits and causes less instrument fatigue.[48] Reciprocation seems to employ the "balanced-forced" concept advocated by Roane.[49]

Different types of reciprocatory movements include:[40]

i. Vertical (in-out) only reciprocation like Racer (Cardex, Austria) and Self-Adjusting file (ReDent Nova, Israel).[50]
ii. Complete reciprocation - horizontal. With no completion of any rotations and no vertical movements. Giromatic (MicroMega), M4 Safety hand piece (SybronEndo).[22]
iii. Complete reciprocation with vertical oscillations. Canal-Finder (Fa. Societe Endo Technique, Marseille, France) introduced by Lévy.[51]
iv. Partial reciprocation. Complete rotations completed, dependent on unequal angles of reciprocation. WaveOne Gold (Dentsply Sirona) and Edge One Fire (EdgeEndo).
v. Hybrid reciprocation. TF Adaptive System (SybronEndo) that can interrupt continuous rotation (CR) (600° CW cutting motion) with 50° CCW movement if undue torsional stresses is detected.[52]

The majority of endodontic treatments can now be completed utilizing only a single-file, even in teeth with multiple canals (post glide path preparation).

Cyclic fatigue and torsional resistance

The biggest drawback of using a rotary instrument in a root canal is the high incidence of file fractures.[53] CR could be one of the main contributing factors.[31] As previously mentioned these files are subject to cyclic fatigue and torsional forces.[54-56]

Reciprocation, firstly reduces the number of rotations the file makes in a curved canal, reducing the amount of bending (compression and tension) forces it subjected to, lowering the risk of cyclic fatigue fracture.[57] Secondly it reduces the amount of torsional forces placed on the instrument by counter rotating the file before the metal reaches its elastic limit while binding into the dentine, thereby decreasing the risk of torsional fracture.[47,58]

The metal's elastic limit of each individual system dictate the cutting speed and angle of reciprocation. As an example Reciproc (VDW, Munich, Germany) uses 150°/30° at 300 rpm and WaveOne (Dentsply Sirona) with M-Wire uses 170°/50° at 350 rpm.[59]

CR system files show a higher risk of instrument fracture when compared to systems utilizing reciprocation.[60,61] De-Deus confirmed in 2010 the extended lifespan and reduced cyclic fatigue of the ProTaper Universal F2 file (used by Yared[47] in 2008) in reciprocation movement compared to CR.[62]

Kim et al.[59] compared two reciprocating file systems to the ProTaper Universal F2 file in CR and found them to have improved mechanical properties with increased fatigue and torsional resistance. Greater torsional and cyclic fatigue resistance with reciprocation is confirmed in a number of other studies.[63-65]

Importantly, many other factors influence the cyclic fatigue and torsional resistance of these instruments. Metallurgic properties differ between Reciproc (VDW) M-Wire and heat treated Reciproc Blue, rendering the M-Wire counterpart more torque resistant.[66] WaveOne Gold Primary (Gold Wire) (Dentsply Sirona) exhibited greater cyclic fatigue than the M-Wire counterparts Reciproc R25 and WaveOne primary.[67] WaveOne Gold also shows higher torsional resistance and flexibility compared to Reciproc (VDW) and Twisted File (Axis/Sybron Endo).[68]

A higher angle of reciprocation (increasing the angle of progression for every reciprocating cycle) is directly associated with reduced cyclic fatigue resistance.[62]

Cross sectional design features like diameter and shape also seems to play a role, but some studies suggest otherwise.[69-71] Hülsmann et al.[72] recently concluded in a critical appraisal on cyclic fatigue, that there are extensive differences in both static and dynamic tests. These studies are difficult to compare and some cases contradictory.

Dynamic fatigue testing is closer to clinical situations and usually show higher resistance figures. Seeing that temperature plays a significant role in study outcomes, many room temperature studies are however rendered inaccurate. All taken into account, including the move to new single-use instruments, cyclic fatigue should not be a major factor in clinical situations any more.

Maintaining original canal anatomy

The interaction of three main instrument factors can have an effect on the preservation of the original canal anatomy: the cross section design of the file, kinematics and the alloy of the NiTi instrument.[53] Although still controversial, the establishment of a glide path prior to final shaping does show to better maintain original anatomy.[19,23]

The effectiveness of the shaping system can be evaluated by assessing the centering ability and the amount of canal transportation, both mid root and apically.[19] WaveOne Gold (Gold-Wire, in reciprocation) combined with the ProGlider (M-Wire in CR) (Dentsply Sirona) showed the best canal shaping ability with most conservative removal of dentine, when compared to M-Wire instruments, ProTaper Next and OneShape (MicroMega) in CR.[73]

Early comparisons of reciprocating and CR instruments by You et al.[74] showed no increased transportation values, even in the apical portion of curved canals. Paqué et al.[75] revealed similar results, with no statistical difference in shaping outcomes between single file ProTaper Universal F2 and full sequence CR ProFile instruments (Dentsply Sirona).

Franco et al.[76] concluded with better centered preparations on simulated canals using reciprocation. Canal modifications were reduced with WaveOne primary reciprocating file compared to the ProTaper Universal system.[77]

On the other hand a study by Saleh et al.[78] showed better anatomy preservation and less dentine removal by OneShape (CR) than the WaveOne or Reciproc systems in S-shaped canals.[78]

Newer studies on WaveOne Gold compared to OneShape showed no statistical significance at any level for canal transportation and centering ratio.[79] Bürklein et al.[80] concluded that Gold and Blue heat treated files were not associated with an improved shaping ability. Reciprocation has been shown to adequately shape and preserve the anatomy of root canals, although no system is yet able to completely prepare all the dentine, eliminate all micro-organisms or remove all obturation material from the root canal system.[53]

Debris removal

Cleaning effectiveness is accessed by the histological evaluation of the amount of debris compaction or remaining smear layer in the root canal after instrumentation.[81,82] Usually inaccessible area's like isthmus, fins and the apical third are more prone to impaction of debris.[83] Although some studies indicate more debris accumulation with reciprocating technique,[84] compared to multiple consecutive CR files, overall cleaning effectiveness has been shown to be equal or comparable[81,85] and, in some, better[86] than traditional rotary systems.

It has been suggested that file design is more responsible for effective cleaning than the kinematics of a system.[86]

Apical debris extrusion

As already discussed, apical extrusion of debris can cause negative outcomes and post-operative flair ups.[87] De Deus et al.[88] reported positive results, showing no difference in debris extrusion between the original ProTaper Universal F2 in reciprocation and full sequence ProTaper Universal rotary systems.

Unfortunately many conflicting results exist in the literature, and may well be clarified by the difference in study designs,[53] and other physiological factors like the absence of periodontal tissue back pressure in *ex vivo* studies.[89] Bürklein et al.[46] described higher extrusion of debris from WaveOne and especially Reciproc compared to full rotary systems ProTaper Universal and Mtwo (VDW). This was backed up by two other studies.[90,91] Opposing results demonstrating lower amounts of extrusions created by reciprocating movements compared to other systems is also present.[92-94] Some studies even show no difference between the two.[95]

A recent systematic review on the incidence of postoperative pain (usually the main symptom of apical extrusions) after root canal treatment with either reciprocating or rotary systems, concluded that rotary systems showed a negative impact on postoperative pain, and even more so after 48 hours.[96]

Independent of the system used, apical debris extrusions is possible by incorporating additional irrigation protocols to conventional procedures. These include passive ultrasonic irrigation and negative pressure irrigation systems which will reduce apical extrusions.[97,98]

Reduction of intracanal bacteria

Reducing the bacterial load inside the root canal remains the cornerstone for a successful endodontic treatment outcome.[1] Mechanical disruption of the bio-film is required to adequately remove and destroy the micro-organisms.[99]

Reduction of the bacterial load were found to be similar in both reciprocating and rotary systems. Studies by Machado et al.[100], Nabeshima et al.[101] and a systematic review by Siddique and Nivedhitha[102] confirmed these findings.

Dentinal cracks

It is well described that endodontic treatment can have a negative impact on root dentine.[103] Most shaping systems will in some way cause defects or micro cracks in the root dentine, which could further extend and lead to complete root fractures or endodontic failure due to bacterial invasion.[104,105]

An initial pilot study on cadavers could not show a relationship between different shaping techniques and the incidence of micro cracks.[106] Further investigations ultimately showed a clear relationship between both reciprocating and rotary systems predisposing to higher incidences of dentinal defects.[107,108]

One study showed that reciprocating files, Reciproc and Self-Adjusting File (ReDent-Nova, Israel) actually cause less cracks than the rotary ProTaper Universal and One-Shape files.[109] Another by Deus et al.[110] observed no association between these cracks and shaping with Reciproc, WaveOne and BioRaCe (FKG Dentaire) systems.

Ultimately it seems that reciprocating files could be more favourable, with lower incidence of dentinal defects and cracks.[53]

Efficiency and shaping times

Having faster treatment times, allow for shorter and more economical treatments. Additionally it allows more time for important irrigation protocols.[53] Some evidence suggest that shaping times are reduced with single-file reciprocation systems, compared to full rotary systems,[45,75,86] while some show no significant difference.[111]

Reciprocating root canal shaping systems

After glide path enlargement, final shaping of the root canal can be completed. As mentioned before, Yared[47] was the first to propose that reciprocating single-file systems are safe, cost effective and efficient.[45,47,48]

Reciprocating instruments has been shown to cause less transportation with better centered preparations compared to continuous rotary systems, keeping in mind that other factors like design features and metallurgic properties of the instrument could attribute to these results.[77,112]

Unequal CCW movement and CW movements ensures that elastic limit of instrument is not exceeded, more effective coronal advancement of debris and better progression with less apical pressure is promoted compared to equal CCW/CW movements.[113]

Although no instrumentation system can render the canal free of bacteria, reciprocation systems seem to perform equally to rotary systems in reducing bacterial load in the canal.[114]

All these systems advocate single-use with already pointed out benefits.[47] Three reciprocating shaping file system analogues, operated by the same endodontic motor with identical settings will be reflected upon.

a). WaveOne Gold (Dentsply Sirona)

WaveOne Gold is a reciprocating root canal shaping system with a unique alternating offset parallelogram-shaped cross-section design with two 85° cutting edges that reportedly limits the engagement between the file and dentine to only one or two points of contact at any given cross-section. This reduces taper-lock and the screw-effect, improves safety, increases cutting efficiency, and provides more chip space to auger debris coronally.[67,68,80,115]

WaveOne Gold is manufactured from Gold-Wire, a new super-metal that is said to render this system 80% more flexible, 50% more resistant to cyclic fatigue, and 23% more efficient than its predecessor, WaveOne (Dentsply Sirona), manufactured from M-Wire.[113,116] WaveOne Gold cuts in a CCW direction in reciprocating angle of 150° with a 30° CW disengaging angle at 300 rpm.[117]

In a CBCT study comparing the shaping ability of 2Shape (MicroMega), WaveOne Gold, and ProTaper Gold, WaveOne Gold preparations resulted in better maintenance of original canal anatomy and removed less excess dentine than its rotary multiple file counterpart ProTaper Gold, made from the same heat treated Gold wire.[118]

Differences of nanoscale surface profiles, after preparing four curved root canals, between WaveOne, WaveOne Gold, Reciproc and Reciproc Blue instruments were described by AlRahabi and Atta.[119] This study revealed WaveOne and WaveOne Gold as having the highest level of surface distortion, possibly due to different manufacturing processes. Feghali et al.[120] showed by means of scanning electron microscopy that WaveOne Gold file produced less debris and smear layer in the apical third of root canals compared its Reciproc Blue counterpart.

While evaluating structural and torsional properties of WaveOne and WaveOne Gold files, Paula Ribeiro et al.[115] showed that WaveOne files exhibit higher torsional resistance than WaveOne Gold, probably due to geometric and metallurgic differences. While WaveOne Gold has higher angular deflection values due to the superior flexibility of Gold wire properties.

In a comparative study to evaluate the appearance of dentinal defects in root canal walls after machine driven instrumentation with WaveOne Gold and ProTaper Universal systems, the WaveOne Gold group showed less dentinal cracks (up to 30%) in the apical and coronal thirds compared to the ProTaper system.[121]

In a 2017 study by Asiye et al.[122] they evaluated the amount of apical extrusions post root canal preparation and found that WaveOne Gold and Twisted File Adaptive (TFA, SybronEndo) produced less apical extrusions than the ProTaper Next system. The study further indicated reduced shaping times for TFA and WaveOne Gold compared to ProTaper Next.

In another 2018 study, comparing canal shaping ability of the Primary WaveOne Gold instrument - preceded by

different glide path techniques. No difference in canal transportation values, or canal centering ability was noted after canal preparation, irrespective of preceding glide path and system used, or no glide path at all.[123]

The system is available in four files with different tip sizes (**Figures 6-9**) and come in 21mm, 25mm, and 31mm lengths. These tips are ogival, roundly tapered (pointed arch) shape that is semi-active that is able to better follow the secured glide path. A variable and reducing taper design from D1 to D16 will result in a more conservatively shaped canal.

- Primary (Red) – ISO 25 tip 7% Taper (D1-D3) – Used in 80% of cases from Orifice to Apex (Figure 6).

Figure 6. WaveOne Gold Primary File (25/07).

- Small (Yellow) - ISO 20 tip 7% Taper (D1-D3) - Used as bridging file when Primary file does not seem to progress passively (**Figure 7**).

Figure 7. WaveOne Gold Small File (20/07).

- Medium (Green) ISO 35 tip 6% Taper (D1-D3) - When Primary did not cut sufficient dentine or the apex is larger than ISO size 25 (**Figure 8**).

Figure 8. WaveOne Gold Medium File (35/06).

- Large (White) ISO 45 tip 5% Taper (D1-D3) - When the apex is larger than ISO 35 and not sufficient cutting was done with Medium file (**Figure 9**).[117]

Figure 9. WaveOne Gold Large File (45/05).

Distinctively these files exhibit less memory effect than M-Wire or conventional NiTi and is super elastic. This allows for a certain amount of pre-curving of the instrument before canal penetration (and it will retain its shape) and naturally follows the canal shape better.[116]

b). EdgeOne Fire (EdgeEndo) Shaping Files

EdgeEndo is one of the largest suppliers of endodontic NiTi file systems.[124] EdgeOne Fire is a reciprocating shaping system manufactured from trademarked FireWire and is available in 21mm, 25mm, and 31mm lengths with Primary (Red) - ISO 25 tip 6% Taper (D1-D3), Small (Yellow) - ISO 20 tip 6% Taper (D1-D3), Medium (Green) ISO 35 tip 4.5% Taper (D1-D3) and Large (White) ISO 45 tip 3% Taper (D1-D3) (**Figure 10**).

These files are to be used in the same way as WaveOne Gold, with similar reciprocating angles and 300rpm.[125] This familiar sequence, according to EdgeEndo, will ensure the switch to EdgeOne Fire will be seamless.[28]

The manufacturers claim that the heat-treated FireWire NiTi construction of EdgeOne Fire tests at five times the cyclic fatigue resistance compared to WaveOne Gold-Wire,[28] Gambarini et al.[125] tested the cyclic fatigue resistance at two times in a severe 90° canal. The manufacturer claims that EdgeEndo files can be used in place of competitors like WaveOne Gold, at half the cost.

EdgeOne Fire has a similar cross-sectional design, three dimensional characteristics and tip sizes as the WaveOne Gold system.[125] FireWire exhibits the same metallurgic CME, showing no “bounce-back” to retain apical anatomy.[126]

After testing cyclic fatigue by number of cycles to fracture of three different NiTi rotary files at different temperatures, EdgeFile out performed Vortex Blue (Dentsply Sirona) and ESX (Brasseler, USA), at all tested temperatures. While all systems showed a decrease in resistance with rising temperatures.[127]

Figure 10. EdgeOne Fire (EdgeEndo), Small (Yellow 20/06), Primary (Red 25/06), Medium (Green 35/045) and Large (White 45/03) .

c). One File G Reciprocating Shaping File (Pac-Dent)

One File G Reciprocating Shaping Files (Pac-Dent) is a system that shapes canals in a reciprocating motion and is compatible with the same motor, hand piece, and settings as WaveOne Gold instruments.

According to the manufacturer, One File G Reciprocating Shaping Files are made using proprietary heat-treated NiTi Wire, which increase its cyclic fatigue resistance and imparts a unique shape memory to the files.

Figure 11. One File G Reciprocating Shaping File (Pac-Dent), (Yellow) (ISO 20/07), Primary (Red) (ISO 25/07), Medium (Green) (ISO 35/06), and Large (White) (ISO 45/05).

The file has a parallelogram cross section, and recommended for use after the One File G Glide Path File. They are available in the same sizes, lengths and tapers as the other two systems: Small (Yellow) ISO 20 tip 7% Taper, Primary (Red) ISO 25 tip 7% Taper, Medium (Green) ISO 35 tip 6% Taper, and Large (White) ISO 45 tip 5% Taper (**Figure 11**).[30]

d). Reciproc Blue (VDW)

Reciproc Blue (**Fig. 12**), based on its predecessor Reciproc, was recently launched by VDW (Munich, Germany). Blue NiTi is a newly developed alloy that is obtained through a proprietary-specific oxide surface layer thermo- mechanical manufacturing process.

Like M-Wire and Gold, Blue NiTi is thermally treated NiTi designed to improve the mechanical properties of endodontic instruments such as fatigue resistance, flexibility, cutting efficiency, and canal centering ability.[128,129]

Thermal treatment modifications, in addition to the reciprocating motion, have already been shown to extend the life span of a NiTi instrument and its resistance to fatigue in comparison with continuous rotation movement.[130,131]

Reciproc Blue has an S-shaped cross-section and is available in sizes 25 (with a taper of 8%), 40 (with a taper of 6%) and 50 with a taper of 5% (**Figure 12**).

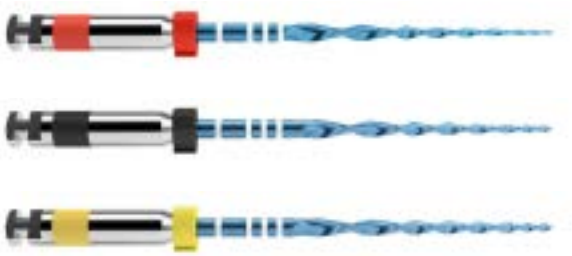

Figure 12. Reciproc Blue (VDW)– 25 (red), 40 (black) and 50 (yellow).

Instruments are used in an unequal forward and reverse reciprocating cutting motion at 10 cycles of reciprocation per second. Manufacturer recommend cutting in amplitudes of no more than 3-4 mm per cutting cycle with an in- and out movement.[132]

A recent study compared the bending resistance and cyclic fatigue of conventional Reciproc files to Reciproc Blue.[133] The study concluded that the Blue thermally treated NiTi files showed overall improved performan-

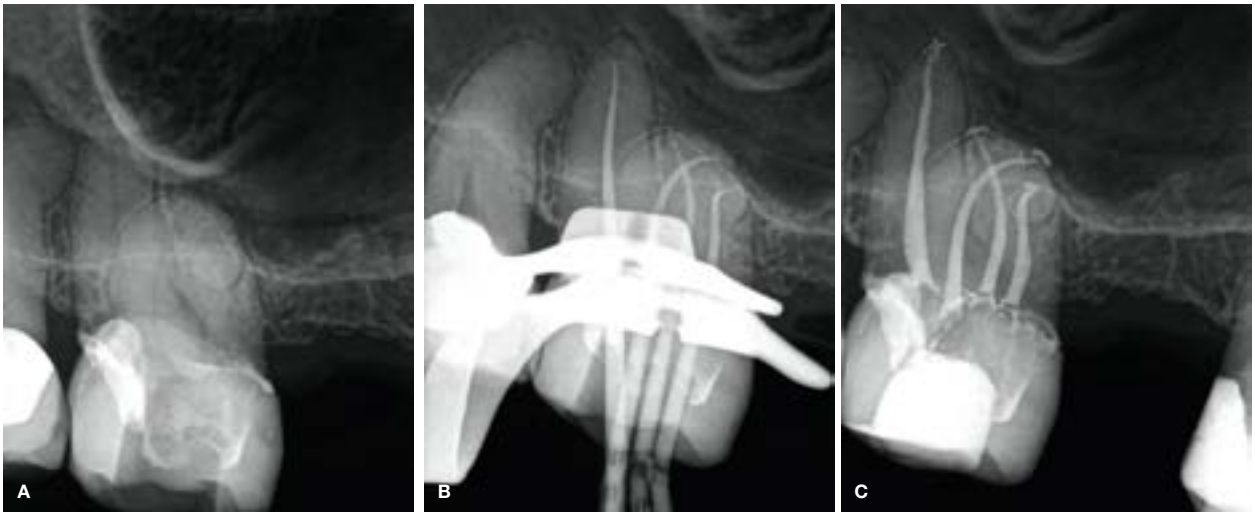

Figure 13. (A) Preoperative periapical radiograph revealed very narrow and calcified root canal systems. (B) Cone-fit radiograph to confirm the fit of the four size 20/07 gutta-percha points; (C) Final result after root canal obturation.

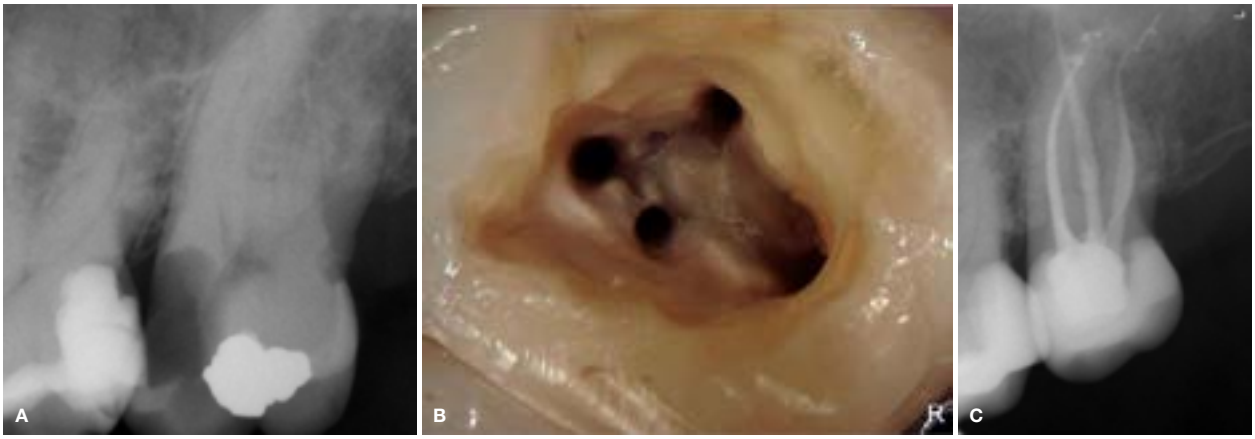

Figure 14. (A) Preoperative periapical radiograph of the left maxillary second molar. (B) Magnified view of the pulp chamber showing the four root canal systems that were located. (C) Final result after root canal obturation.

ces when they were compared to conventional M-Wire super-elastic NiTi. Reciproc Blue demonstrated improved flexibility, fatigue resistance and reduced microhardness while at the same maintaining similar characteristics of the surface.

CASE REPORT 1

The patient, a 62 year old female presented with a history of an unsuccessful attempted emergency root canal treatment on her maxillary right first molar. A preoperative periapical radiograph (Figure 13A) and CBCT scan revealed very narrow and calcified root canal systems.

After canal location and negotiation with size 08 K-Files and C+ Files, the glide paths were enlarged using a WaveOne Gold Glider (Dentsply Sirona). The four root canals systems were prepared with the Small WaveOne Gold (20/07) (Dentsply Sirona) instrument.

Figure 13B illustrates the cone-fit radiograph to confirm the fit of the four size 20/07 gutta-percha points. The final result after root canal obturation is shown in Figure 13C.

CASE REPORT 2

The patient, a 58 year old male presented with irreversible pulpitis as a result of extensive decay on the mesial aspect of his left maxillary second molar. After caries removal the pulp was exposed and four root canal systems were detected.

After glide path enlargement with the EdgeOne Fire GlidePath (EdgeEndo) all four root canal systems were prepared with the Primary EdgeOne Fire (EdgeEndo) file. Figure 14B illustrates the intra pulpal view after root canal preparation, and Figure 14C the final result after obturation.

CASE REPORT 3

The patient, a 32 year old male presented with a non-vital maxillary left first premolar (Figure 15A). After glide

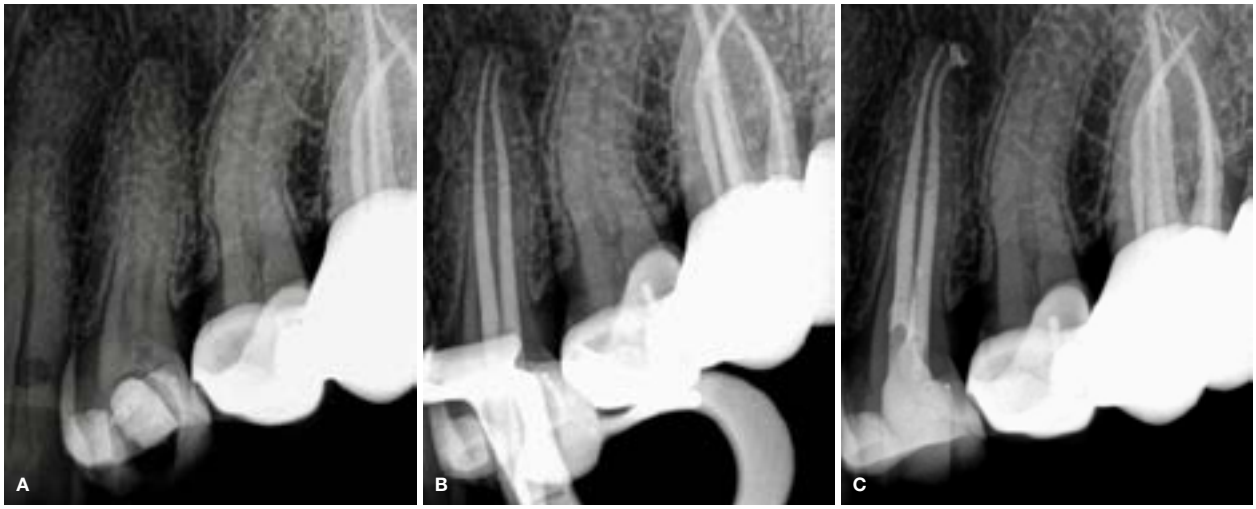

Figure 15. (A) Preoperative periapical radiograph of the maxillary left first premolar. (B) Cone-fit radiograph to confirm the fit of the two gutta-percha points. (C) Final result after root canal obturation.

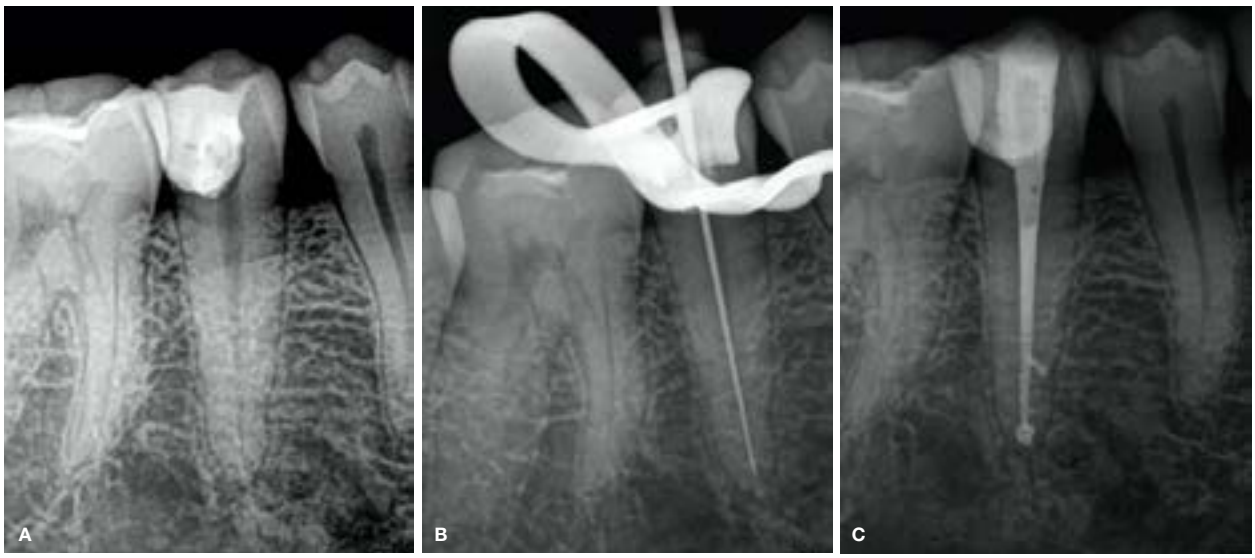

Figure 16. (A) Preoperative periapical radiograph of the mandibular right second premolar after a previous an emergency root canal treatment. (B) Length determination radiograph. (C) Final result after root canal obturation and core build up.

path enlargement with the One File G Glide Path file instrument (Pac-Dent) both root canal systems were prepared with the One File G Primary (25/07) instrument 9 (Pac-Dent). **Figure 15B** illustrates the cone-fit radiograph to confirm the fit of the two gutta-percha points and the final result after root canal obturation is shown in **Figure 15C**.

CASE REPORT 4

The patient, a 41 year old male presented with a history of an emergency root canal treatment on his mandibular right second premolar (**Figure 16A**). Length determination was done using an electronic apex locator and confirmed radiographically (**Figure 16B**).

Glide path preparation was completed using the R-Pilot file (VDW) and root canal preparation was completed using the Reciproc Blue (VDW). **Figure 16C** illustrates the final result after root canal obturation and core build up.

CONCLUSION

Reciprocation increases treatment safety, without compromising cutting efficiency or shaping ability, respecting the anatomical pathway of the root canal. Reciprocating movement extends the life span and increases fracture resistance of instruments, with equally effective debris removal and bacterial load reduction, when compared to continuous rotation.[57,86,130]

Reciprocation systems allow for single-file root canal shaping and single-use instruments that make it highly unlikely that these instruments will be used above their thresholds.[15] There is however still some contradicting evidence on the amount of apical extrusions, shaping times and the contribution of reciprocation to the development of dentinal defects and cracks.

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http://dx.doi.org/10.17159/2519-0105/2019/v75no9a5

What's new for the clinician?
- Excerpts from and summaries of recently published papers

SADJ October 2020, Vol. 75 No. 9 p505 - p510

Compiled and edited by V Yengopal

1. Prosthetic outcomes and clinical performance of CAD-CAM monolithic zirconia versus porcelain-fused-to-metal implant crowns in the molar region

S Mühlemann, T Lakha, RE Jung, CH Hämmerle, GI Benic. Prosthetic outcomes and clinical performance of CAD-CAM monolithic zirconia versus porcelain-fused-to-metal implant crowns in the molar region: 1-year results of a RCT. Clinical Oral Implants Research. 2020; Jun 19.

INTRODUCTION

Prosthetic outcomes and clinical performance of CAD-CAM monolithic zirconia versus porcelain-fused-to-metal implant crowns in the molar region.

Different restoration materials are available for the fabrication of implant-supported single crowns. Porcelain-fused-to-metal (PFM) implant crowns are considered the gold standard presenting an estimated 5-year survival rate of 98.3%[1] However, fracture of the ceramic veneering is reported as the most frequent technical complication and this then leaves the metal exposed which is a problem aesthetically.

Ceramic materials for the fabrication of implant crowns has largely replaced PFM crowns as a treatment option but implant-supported all-ceramic crowns are known to exhibit a relatively high rate of technical complications. Both these crowns are made in dental laboratories. However, advances in dentistry has allowed for chairside construction of crown using CAD/CAM technology which has shown significant savings in costs and chairside time.

Monolithic zirconia restorations, manufactured exclusively by the CAD/CAM technology, have considerable advantages: they exhibit high flexural strength, require more conservative dental preparation, minimize wear on the antagonists, exhibit satisfactory aesthetics, require less laboratory time and fewer dental sessions, and as monolithic, they lack the unwanted complication of chipping.[1]

Their main disadvantage until a few years ago was their low aesthetic performance due to the inability to achieve satisfactory transparency. However, recent modifications in composition, structure, and fabrication methods have led to monolithic zirconia ceramics of superior translucency.

Mühlemann and colleagues (2020)[1] reported on a randomized controlled trial that sought to test whether CAD-CAM monolithic zirconia implant crowns show less technical complications as compared to PFM implant crowns in the molar region. The study hypothesis was that CAD-CAM monolithic zirconia implant crowns present a lower technical complication rate.

MATERIALS AND METHODS

This was a randomized controlled clinical trial with two parallel study groups involving seventy-six partially edentulous patients in need of a single implant-supported crown in at least one maxillary or mandibular molar site.

The subjects had to fulfill the following inclusion criteria: 18–80 years of age; In need of a single implant crown in the maxillary or mandibular molar region; Implant position allowing a screw-retention of the crown; Presence of an antagonist. Patients were excluded if they were pregnant; had a history of known or suspected non-compliance, drug or alcohol abuse; had a full-mouth plaque score (FMPS) >30%; smoked more than 15 cigarettes per day or had a history of temporomandibular disorders.

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Implant surgery among included patients were performed according to standard protocols and following the implant manufacturer's instructions for the placement of the implants. All sites received titanium–zirconium narrow diameter implants (Straumann® Standard Plus SLActive RN, Roxolid, 3.3 mm diameter).

Three to 6 months after implant placement, the implant impression was taken. At this time point, patients were randomly allocated to one of the treatment modalities according to a computer-generated randomization list. The test group received a monolithic zirconia crown (Lava Plus, 3M) bonded to a titanium base abutment (Straumann® RN Variobase with 1 mm mucosal height). Patients in the control group received PFM crown consisting of a gold abutment (Straumann® RN synOcta cast gold abutment) with castable high noble gold alloy and feldspathic veneering ceramic.

An intraoral scanner was used to take an impression of the quadrant with the implant and the scan body, of the opposing quadrant, and of the bite in maximal intercuspation. All crowns were fabricated by one experienced master dental technician. In the test group, Mono-ZrO2 crowns were fabricated using a laboratory-based CAD and an industrial CAM process. In case of a conventional impression, models were poured in dental stone. After at least 24 hr, a laboratory scanner was used for model scanning and further processing in the same CAD-CAM workflow.

In the control group, either the milled digital model or the conventional model was used for the fabrication of the PFM crown.

At a try-in appointment, all implant crowns were evaluated and if needed chairside adjustments were performed. Thereafter, the laboratory finalization of the Mono-ZrO2 crowns included polishing and staining procedures. The submucosal part of the crown was left unstained to keep a highly polished zirconia surface in contact with the peri-implant mucosa. The titanium base abutment was abraded applying air-borne particles of 50 µm aluminium oxide (Rocatec) from a distance of 1 cm for 15 s using 2.8 bar blast pressure The abutment and the crown were cleaned with ethanol and the bonding surfaces were treated with a primer. Subsequently, the crown was luted onto the abutment using a chemically curing composite cement (Multilink Hybrid Abutment). The laboratory finalization in the PFM crowns included veneering, glazing, and polishing procedures.

Each implant crown was screw-retained with the implant specific torque of 35 Ncm. The screw access hole was filled with Teflon tape and sealed with a composite filling (Filtek).

All patients were recalled for the baseline examination 1–2 weeks after crown insertion (BL) and 1 year later (1y-FU). For standardization purposes, two calibrated operators performed all clinical examinations. Prosthetic parameters were evaluated using modified USPHS (United States Public Health Service) criteria which included items such as patient satisfaction, ceramic fracture, abutment fracture, marginal fit, anatomical form, proximal contact, colour match and occlusal wear. All implant crowns were checked for further technical complications: abutment screw loosening, fracture of the abutment screw, fracture of the implant, and loss of the occlusal composite filling. Specifically, the Mono-ZrO2 crowns were controlled whether debonding of the crown from the abutment was detectable.

The total technical complication rate on the prosthetic level (primary outcome) included fracture of the veneering ceramic, fracture of the crown, fracture of the abutment, fracture of the abutment screw, loosening of the abutment screw, loss of the occlusal filling, and decementation.

Periodontal parameters were assessed at six sites around each study implant and the mesial and distal dentition. These included probing pocket depth (PPD), bleeding on probing score (BOP), plaque control record (PCR). The width of the keratinized mucosa (KM) was assessed at the mid buccal aspect of the study implant and the teeth mesially and distally. MBL changes were calculated from baseline to one year follow-up (BL to FU-1Y).

RESULTS

In total, 76 patients were included in this study. Of these, 39 patients (mean age 57.7 years; 17 females and 22 males) were in the Mono-ZrO2 group and 37 patients (mean age 56.4 years; 17 females and 20 males) in the PFM group.

At 1 year, 74 of the 76 patients attended the follow-up examination. No adverse events were recorded. One crown in each treatment group was lost due to loss of the implant. In the Mono-ZrO2 group, one implant fractured after 11 months, whereas in the PFM group one implant was lost without any signs of inflammation after 3 months. These failures yielded an implant/crown survival rate of 97.4% and 97.3%, respectively.

At the 1y-FU, in 4 PFM crowns a fracture of the veneering ceramic was detected (11.1%), whereas none of the Mono-ZrO2 crowns showed a ceramic fracture. All fractures in the PFM crowns were polishable. No further technical complications were observed. The difference in the total technical complication rate between the treatment groups was statistically significant ($p = .024$).

Patient satisfaction was high in both groups with no significant difference between treatment groups at BL ($p = .7$) and at the 1y-FU ($p = .26$). In the Mono-ZrO2 group, the anatomical form and the colour match as compared to the neighbouring dentition were significantly better rated for PFM crowns ($p = .005$ and $p = .0035$).

After 1 year, in 3 Mono-ZrO2 crown the mesial contact point was lost, whereas in one PFM crown the distal contact point was lost. In the same time period, the occlusal contact was lost in 4 Mono-ZrO2 crowns and in 6 PFM crowns. After 1 year of clinical service, significantly more occlusal wear was detected in the PFM crowns as compared to the Mono-ZrO2 crowns ($p = .02$).

No statistically significant difference was calculated for plaque control record (PCR) and bleeding on probing (BOP) between the Mono-ZrO2 group and the PFM group neither at baseline (BL) nor at one year follow-up (1y-FU). The mean change of probing pocket depth (PPD) and MBL after one year was not statistically different between treatment groups.

CONCLUSIONS

The researchers concluded that the short-term results of the present randomized controlled clinical trial suggest that monolithic zirconia crowns are a valuable alternative to PFM crowns for restoring single implants in the molar region.

Implications of practice

The clinical results of the present study showed that the use of monolithic zirconia for implant crowns in the posterior area eliminated the risk for ceramic fractures and consequently positively influenced the total technical complication rate after 1 year.

Reference

1. Mühlemann S, Lakha T, Jung RE, Hämmerle CH, Benic GI. Prosthetic outcomes and clinical performance of CAD-CAM monolithic zirconia versus porcelain-fused-to-metal implant crowns in the molar region: 1-year results of a RCT. Clinical Oral Implants Research. 2020; Jun 19.

2. The effect of using a mobile application to improve oral hygiene among adolescents receiving fixed orthodontic treatment: A RCT

JF Scheerman, B van Meijel, P van Empelen, et al. The effect of using a mobile application ("WhiteTeeth") on improving oral hygiene: A randomized controlled trial. International Journal of Dental Hygiene. 2020; 18: 73-83

INTRODUCTION

Oral hygiene is an important factor controlled by the patient during orthodontic treatment, which can affect the quality and timing of the therapy. Previous studies have demonstrated a rapid decline in oral hygiene compliance after the initial bonding, and the appliance favours plaque accumulation and represents an obstruction to the hygiene procedures.[1]

Failure to practise good oral hygiene results in prolonged accumulation of biofilm (dental plaque), which potentially increases levels of cariogenic bacteria such as *Streptococcus mutans*. These produce acids that cause enamel demineralization.[1] As a result, many patients with fixed appliances have dental caries, specifically white-spot lesions, which can lead to aesthetic problems that potentially cancel out the beneficial effect of the orthodontic treatment.

To prevent the development and the progression of dental caries, orthodontic healthcare providers recommend their patients to adhere to a good oral hygiene regimen involving the use of fluoride-containing mouth rinses, toothpastes and varnishes.[1] However, adherence to these recommendations is low, and oral hygiene in adolescent orthodontic patients is often inadequate.[1] This indicates a need for interventions to improve oral health behaviour and oral hygiene in this special-risk population.

The high use and various features of mobile phones make them suitable for the delivery of health promotion programmes. As portable devices tend to be switched on and to remain with the owner throughout the day, they provide opportunities to bringing behavioural programmes into important real-life contexts involving people's decisions about their health and the barriers they encounter to behaviour change.[1] Currently there are over 500 apps on orthodontics across Android and Apple operating systems. Most of them have very simple functions and do little more than provide basic dental information. Despite the high number of orthodontic apps now available, very few apps have been evaluated for their effectiveness.

Scheerman and colleagues (2020)[1] from Netherlands developed the WhiteTeeth app, a mobile-delivered oral health promotion program for adolescents with fixed orthodontic appliances. This app provides oral health education and an automatic coaching programme intended to help users maintain good oral health behaviour and oral hygiene. Sheerman et al (2020)[1] reported on a randomized controlled trial that sought to evaluate the app's effectiveness on dental plaque and marginal bleeding (primary outcomes), and self-reported oral health behaviours and their psychosocial factors (secondary outcomes). They hypothesized that dental plaque and marginal gingival bleeding would be reduced more in participants who combined use of the app with usual care than in controls.

MATERIALS AND METHODS

This was a two-armed, parallel-group; single-blinded randomized controlled trial (RCT) that tested the effect of the WhiteTeeth app against a usual care group in 12- to 16-year-olds with fixed orthodontic appliances.

The study population consisted of adolescents with fixed orthodontic appliances visiting orthodontic clinics. All eligible adolescents were invited to participate by

their dental-care provider and were randomized into either the control or intervention group.

Those assigned to the control group received usual care, which consisted of routine oral health education and oral health instructions during their visits for orthodontic treatment.

Participants randomized to the intervention group were asked to download the WhiteTeeth application (app), which was available free of charge in the App Store and Google Play store and was locked with a login code. Each participant received a unique personal login code for the app. The app was designed on the basis of the Health Action Process Approach (HAPA) theory, which has been shown to be a useful approach to understanding the oral health behaviours of adolescents with fixed orthodontic appliances. Using behaviour change techniques (BCTs) that target the psychosocial factors outlined by the HAPA theory, the app focused mainly on improving oral health behaviour, and thereby reducing dental plaque levels and gingival bleeding.

An independent researcher gave brief instructions and information on how to use the app and on how to share their user data with the research team. Afterwards, the participants received an email containing these instructions and information.

Upon opening the app, participants were required to answer registration questions and to provide personal details on their oral health behaviour and their motivation for maintaining good oral health. The app used this information to create positive reinforcement and to provide feedback on the participants' oral health performance. During registration, the app asked participants to use disclosing tablets and to take a selfie of their teeth on which any dental plaque had been disclosed red.

Next, the app asked the participants to register the amount of plaque by clicking the disclosed areas on the selfie (BCT: self-monitoring of behavioural outcomes). After interpreting the amount of plaque on the basis of the number of clicks, the app provided tailored feedback on the basis both of this plaque assessment and of the answers to the registration questions on oral health procedures. This feedback was provided as positive reinforcement regarding participants' behaviour, as oral health education, and/or as instructions in short videos (BCT: providing information on health consequences and demonstrating the desired behaviour).

Next, the app invited the participants to set a particular goal regarding oral health behaviour (BCT: goal setting) and to formulate when and where they would perform the oral health behaviour (BCT: implementation intentions). The app provided an option for setting the time at which they wished to receive daily push notifications to remind them of their oral health behaviour tasks and then to monitor them (BCT: behavioural goal reminders).

Every day throughout the 12-week intervention period, push notifications were sent instructing users to enter whether or not they had accomplished their daily oral health behaviour tasks (BCT: self-monitoring of behaviour) and to remind them to use the brushing timer when brushing their teeth. As well as showing where and how to brush teeth as recommended, the timer showed the time elapsed during brushing (BCT: practical support). When users had completed brushing, the app provided positive reinforcement.

Each week, the app asked users to evaluate their dental plaque levels by following the same procedure as in the registration phase: using a disclosing tablet, taking a selfie of their teeth and clicking the disclosed areas on the selfie (BCT: self-monitoring of behavioural outcomes). On the basis of the information registered on the amount of plaque and of the activities reported daily over the previous week, the app concluded whether the user's goals had been attained. Users were then invited to adjust their goals. If they had failed to attain their goals, they were invited to formulate coping plans, that is, "if-then" plans specifying how they could deal with difficult situations (BCT: coping planning). For this purpose, the app contained volitional sheets, that is, sheets outlining pre-established difficult situations and solutions.

The outcome measures were collected through clinical assessments and self-administered digital questionnaires. At baseline (T0), and at 6 weeks (T1) and 12 weeks (T2) of follow-up, the data were collected before the orthodontic check-up.

The primary study outcomes were the amount of plaque and the total number of gingival bleeding sites in the incisors, canines and first premolars of the maxilla and mandible. The Al-Anezi and Harradine plaque index was used to measure the amount of plaque on the buccal surfaces. The buccal surfaces of the first premolars, canines and incisors were divided into four sites according to the position of the orthodontic bracket: mesial, distal, gingival and incisal to the bracket.

Each of the four sites of the buccal tooth surface was given a score ranging from 0 to 3, where 0 indicated the absence of dental plaque, 1 indicated no plaque visible but an accumulation of soft deposit on a probe when used to clean the surface, 2 indicated a moderate accumulation of soft deposit on the tooth that could be seen with the naked eye and 3 indicated an abundance of soft matter on the tooth.

For the analysis, the scores per site were summed to obtain a total score for the amount of dental plaque accumulation per patient. Higher scores indicated greater accumulation. The range was from 0 to 192 (16 elements*4 sites*3 scores). To explore the effect on the presence of plaque in the mesial, distal, gingival and incisal sites, the plaque scores were dichotomized, with 0 indicating the absence of dental plaque and 1 indicating the presence of dental plaque. The score for the number of sites covered with plaque ranged thus from 0 to 16 (16 elements) per site and from 0 to 64 per patient (16 elements*4 sites).

Gingival bleeding was assessed using the Bleeding on Marginal Probing Index (BOMP). The mesio-buccal, buc-

cal and disto-buccal sites of the buccal surfaces of the first premolar, canines and incisors were assessed to determine whether probing elicited marginal bleeding (score 1) or not (score 0). For the analysis, all scores were summed to obtain the total number of bleeding sites per patient (ranging from 0 to 48; 16 teeth * 3 sites). Higher scores indicate more gingival bleeding.

To ensure the reliability of the clinical measurements, the clinical examiners were trained and calibrated by an experienced examiner. The secondary study outcomes were self-reported oral health behaviours and their psychosocial factors (HAPA factors).

To measure these outcomes, a self-administered digital questionnaire containing questions with both single and multiple response items was used. The questionnaire included questions on the frequency of oral health behaviours with which the following were used: a toothbrush, an interproximal brush, a toothpick, mouth rinse and other dental aids (such as dental floss).

The weekly frequencies for the use of each of the dental aids or products were summed to obtain a total oral health behaviour score that ranged from 0 to 122.5. Higher scores indicate a higher frequency of oral health-related activities. Self-reported tooth-brushing frequency and tooth-brushing duration were measured on the basis of two open questions, that is, “In the last four weeks, how many times have you brushed your teeth per day?” and “How much time do you spend on brushing your teeth at a time?”

The following psychosocial factors - HAPA factors - were assessed: risk perception, action self-efficacy, intention, maintenance self-efficacy, recovery self-efficacy, action control, action planning, coping planning, social influences and outcome expectancies. Risk perception was assessed on 5-point scales ranging from “very low” (1) to “very high” (5). Coping planning and action planning were assessed on 4-point scales ranging from “no plan” (1) to “a very clear plan” (4). For the remaining variables, a 5-point scale was used, ranging from “totally disagree” (1) to “totally agree” (5).

The following variables were regarded as potential confounders or effect modifiers and collected at baseline: (a) age (in years) (b) sex (boy/girl); (c) level of education (primary education, prevocational education, senior general secondary or pre-university education); (d) cultural background; (e) smoking status (smoker or non-smoker); and (f) the number of times of exposure to the acids or sugars in foods and/or drinks between main meals (times per day). Orthodontic patient files also provided information on baseline covariates: (g) the type of orthodontic bracket used (e.g. self-ligating or conventional brackets) and (h) the treatment duration (in days).

App usage data and the usability of the app and the user’s perceptions of several components of the app were collected during the 12-week intervention period using a System Usability Scale (SUS). The SUS ranges from 0 to 10, with responses ranging from “strongly agree” to “strongly disagree.” A SUS score above 68 was considered to be above average.

RESULTS

132 of the 230 eligible adolescents with fixed orthodontic appliances agreed to participate (response rate 57%); they provided informed consent, attended baseline and were randomly assigned to one of the two experimental arms.

Five patients dropped out of the intervention group, and three patients dropped out of the control group. One patient in each group dropped out because their appliances had to be removed prematurely due to poor oral hygiene. The total number of participants who completed all three questionnaires was 121 (92%).

Between T0 (baseline) and T1 (6 weeks), the mean number of weeks (SD) between each appointment was 6.2 weeks (1.4) for the intervention group and 6.2 weeks (1.1) for the control group (P = .997). Between T1 (6 weeks) and T2 (12 weeks), it was 6.6 weeks (2.1) for the intervention group and 6.7 weeks (2.3) for the control group (P = .962).

Due to technical complications, occasional malfunctions meant that the user data - including selfies - were not always sent during the intervention period. For this reason, less user data were available than expected. But according to the user data we received, 40 participants (65%) sent their user’s data an average of 4.94 times (SD = 5.2) to a secure server owned by the Academic Centre for Dentistry Amsterdam.

After 6 weeks, most patients used the app less often. In total, reminders were set by seven participants for brushing, by nine participants for rinsing, by 16 for self-monitoring of behavioural tasks and by 11 for taking a selfie. During the intervention period, 20 participants used the brushing timer an average of 9.61 times (SD = 27.8). In total, 38 participants took at least one selfie with the app; the mean number of selfies taken per person was 6.63 (SD = 4.46).

Thirty-six participants entered action plans into the app, and seven used the volitional sheets to set a coping plan. Thirty-four participants watched at least once the video on dental plaque and/or on cleaning their teeth with a manual toothbrush, an electric toothbrush and/or interproximal brushes. Personal appearance and attractiveness (white teeth) were given as the commonest motives for cleaning their teeth. The mean SUS was 75 (range 0-100), which indicated a good score for usability.

At 6-week follow-up, the intervention effect on the total amount of dental plaque and the total sites covered with plaque was not significant. Nonetheless, at 12-week follow-up, the reductions in dental plaque accumulation and in the presence of dental plaque were significantly greater in patients in the intervention group than in the controls: while, on average, plaque was present on 62% of teeth in the intervention group, it was present on 73% of teeth in the control group.

Regarding the intervention effects on gingival bleeding, bleeding scores had improved more in participants in the intervention group than in controls at 6 weeks of

follow-up ($p<0.05$). At 12 weeks of follow-up, however, the intervention effect was no longer significant ($p>0.05$).

In terms of oral health behaviour, the only significant intervention effect was for fluoride use at the 6-week follow-up; it favoured the intervention group. No significant intervention effects were found for the oral health behaviour score, tooth-brushing (frequency and duration) and interproximal brush usage.

With regard to the psychosocial factors, significant adjusted effects were found for coping planning regarding tooth-brushing and intention towards fluoride mouth rinse use at both 6-week and 12-week follow-up. Although not significant, the scores on most psychosocial factors at 12-week follow-up were better in the intervention group than in the control group.

CONCLUSIONS

The results show that adolescents with fixed orthodontic appliances can be helped to improve their oral hygiene when usual care is combined with a mobile app that provides oral health education and automatic coaching.

Implications for practice

This trial has provided clear evidence of the benefits of using mobile apps as an adjunct to the usual oral hygiene methods to improve oral hygiene among adolescent orthodontic patients.

Reference

1. Scheerman JF, van Meijel B, van Empelen P, et al. The effect of using a mobile application ("WhiteTeeth") on improving oral hygiene: A randomized controlled trial. International Journal of Dental Hygiene. 2020; 18: 73-83

Do the CPD questionnaire on page 518

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

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3. Select the CPD navigation tab.
4. Select the questionnaire that you wish to complete.
5. Enter your multiple choice answers. Please note that you have two attempts to obtain at least 70%.
6. View and print your CPD certificate.

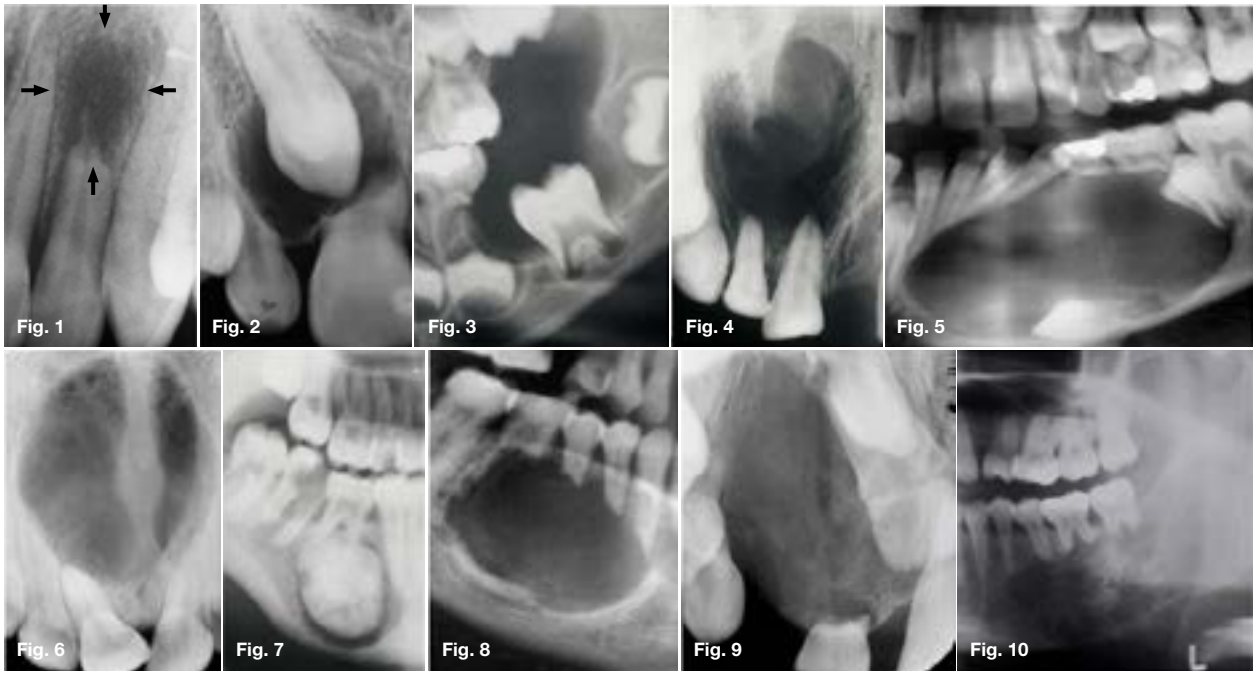
http://dx.doi.org/10.17159/2519-0105/2020/v75no9a6

Maxillofacial Radiology 185

SADJ October 2020, Vol. 75 No. 9 p511

CJ Nortjé

Below are cropped radiographic images of various lesions that may present in the jaws of a patient during a radiographic examination. What is the cardinal feature that are present in every case presented?



INTERPRETATION

The cardinal feature that is discernible in every case is the presence of external root resorption. Resorption of teeth occurs in many circumstances other than the normal process associated with the shedding of deciduous teeth. Since resorption of a tooth may begin either on the external surface or on the inside of the tooth, general terms such as "external resorption" and "internal resorption" are used to distinguish between the two types. The purpose of this communication is to discuss external resorption in the presence of certain lesions. Resorption of calcified dental tissue occurs in the same fashion as that of bone and, in most instances, the presence of osteoclasts is an outstanding feature in areas of active resorption, however there is considerable evidence that osteoclasts may not be essential for the resorption. Periapical granuloma resulting from death of pulp caused by traumatic injury resulted in resorption of the roots (Fig. 1). Resorption also occurs as a result of pressure exerted by an impacted tooth (Fig. 2). Roots of primary teeth may undergo resorption due to the eruption force of an eruption cyst (Fig. 3). An apical cyst arising as a result of pulp infection may exert pressure on the apex of the involved or adjacent tooth that the intervening connection tissue is stimulated, osteoclasts form and resorption begins (Fig. 4). Benign and malignant tumours may cause root resorption. Although a benign lesion such as a dentigerous cyst (Fig. 5) are more likely to produce displacement than destruction of the tooth. In most cases connective tissue present between the tumour and the tooth and it is from this tissue that the osteoclasts develop which appear responsible for the root resorption. Cysts cause root resorption in a manner similar as benign tumours chiefly by pressure as demonstrated by the nasopalatine duct cyst (Fig. 6) causing resorption of the central incisors. Figure 7 shows a cementoblastoma causing resorption of the mesial root of the first molar tooth. A classic example of the knife edge resorption normally seen in an ameloblastoma is demonstrated in Figure 8. Extensive root resorption is demonstrated by a central giant cell tumour (Fig. 9). Malignant tumours may also cause root resorption. Figure 10 is a longstanding chondrosarcoma and resorption showing a mixed radiolucent/opaque lesion with rounded, speckled, mottled or flocculent calcifications, periosteal new bone perpendicular to original cortex and resorption of the roots of the 36 and 37. Resorption is rarely important but very occasionally results from some destructive disease such as a tumour. Pressure is probably the main factor. However, in some cases no cause is apparent. Resorption is mainly carried out by osteoclasts which, during active phases, may be seen in the lacunae in the hard tissue with which their cytoplasm to merge. When resorption is very slow, osteoclasts may be seen and, being intermittent in their action, disappear during the inactive periods.

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1. Shafer, WG, Hine, MK, Levy, BM. A Textbook of Oral Pathology, 3rd ed. W.B. Saunders Company, Philadelphia & London. 1974: 295-99.

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Dentistry and COVID-19
- Is there a moral duty of care?

SADJ October 2020, Vol. 75 No. 9 p514 - p517

PD Motloba[1], H Miniggio[2], NL Makwakwa[3]

INTRODUCTION

The world is witnessing the spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), with countless serious and fatal cases of corona virus disease (COVID-19). The impact of this pandemic has been most devastating among the health professionals due to the nature of their work. The risk of COVID-19 is particularly greater among oral health professionals due to their proximity to the oral cavity and production of aerosols. This scenario then raises the question, is there a moral duty for dental professionals to care for patients when doing so exposes them to significant risks of COVID-19.

Duty of care is considered by most health professionals, synonymous to obligations to care for patients without the possibility of refusal. This duty of a solemn pledge "to treat the ill to the best of one's ability, to preserve a patient's privacy, to teach the secrets of medicine to the next generation…" is often taken in a state euphoria, oblivious to the nature and extent of the sacred promise which places into questions the validity of consent by practitioners to the duty of care.[1,2]

It is well established that the profession of dentistry is amongst the occupations with the highest risk of COVID-19.[3,4] Most dental professionals consider caring for their patients to be fundamental to their professional duties. Yet most dental professionals do not have a deep understanding of the moral, ethical and legal underpinnings of this obligation. In this article we show that the duty of care, as is generally imposed on practitioners (by society or self) is ethically difficult to defend during times of pandemics, such as COVID-19, using the common contractual and special skills argument. Rather, we argue that the duty to care during pandemics should be considered as a virtue that dental professionals should aspire to as "an ideal of professional character".[5]

While we acknowledge that various duty-based arguments have been proposed, for the purpose of this article, we limit our discussion to the most commonly used arguments of reciprocity and special skills.

This article, addresses the following questions:

i). Is it morally required or expected of dental professionals to treat possible COVID-19 infected patients in the face of considerable risk to themselves and their families?
ii). If so what is the basis of this moral duty or obligation?
iii). How far does this duty extend?
iv). How should the health system respond or reciprocate the duty of care by practitioners?
v). Lastly, what becomes of dental professionals who openly refuses to treat symptomatic patients?

Dentistry and COVID-19

Dental patients may predispose the practitioner to transmissible diseases, amongst others, COVID-19, before, during and after dental treatment. Invariably, dentists perform conical work in closest proximity to the patient's face, mouth and nose, which are the notable the sources of the virus.[6]

Additionally, the dental instruments including, the rotary instruments, 3-in-1 (water and air syringe), and sharp instruments generate generous aerosols and droplets. In dentistry the virus is spread directly through the droplets between persons, and indirectly through contact with contaminated fomites.

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3. **Nokukhanya L Makwakwa:** Third author - 15%

Creation of aerosols makes the viruses airborne and viable over extended periods of time, which is exacerbated by the humidity created in the dental surgery.[7] As a consequence, dental professionals will inhale suspended airborne virus or contract the virus via the nose, mouth and eyes from the droplets and aerosols that are propelled during coughing and talking.[8]

Despite the risks associated with the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) outbreak, dentists have continued to provide essential services to their patients albeit, in a limited fashion. In discharging their duties, most practitioners have relied on symptoms, travel history and telephonic interviews to triage patients, in order to limit transmissions. Unfortunately, these measures are inadequate and do not eliminate the risk of spread of the disease. This means asymptomatic carriers could be presenting for care and spreading the disease in dental practices.

Recent evidence indicates that the asymptomatic carriers may shed the virus for several weeks before becoming symptomatic. The incubation period ranges between 1 and 19 days, during which these patients test negative on RT-PCR.[9] The false negative results may give a false sense of security to the practioners, and encourage patients to unknowingly spread the infection even more. Unfortunately, most dental practices do not have the capability nor the appetite to provide testing services to patients.

Suffice to say that the provision of dental services places dental practitioners in harm's way every time they chose to treat patients. These acts, selfless or motivated by commercial imperative raise critical moral and ethical questions. A case in point is the reported suicide of a renown E-R doctor in the USA who succumbed to depression due to COVID-19.[10] This case and similar raises further moral and ethical questions about the expectations of society on practitioners in times of pandemics like COVID-19.

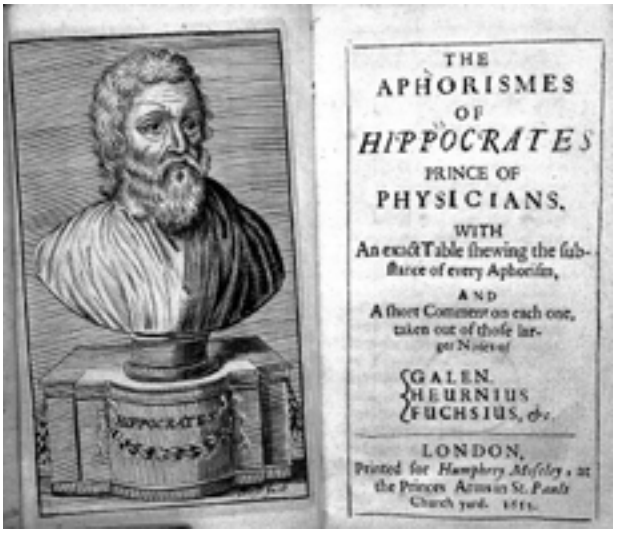
Is the duty of care an obligation or a virtue?

The ethical foundation of the duty of care derives from the principle of beneficence, which defines the practitioner's obligations towards the wellbeing of their patients, and the establishment of practioner-patient relationship. This special relationship is the stringent form of beneficence by health professionals which is Kantian, or obligation-based in nature. This Kantian obligation is an established culture and universal law among health professionals. Several arguments have been advanced to establish duty of care as a moral obligation.[11]

The most commonly advanced argument is the social contract or reciprocity argument. Protagonists invoke the notion of reciprocity to establish the morality of duty of care. The concept of reciprocity suggests that for benefits and privileges provided and received by health professionals, there is inherent obligation to incur certain risks or commensurate duties.[12,13] Hence the legitimization of the expectation of the health professionals to lead in the response to COVID-19, despite the associated risks.

Another argument invoked to motivate the duty to care is premised on the fact that health professionals are highly trained and have special skills which enables them to minimize harm to themselves and their patients.[14] This argument is further supported by consequentialism, a utilitarian moral thought, that seeks to maximize "the greatest happiness for the greatest number".[15] Hence the expectation by society for the health professional to be at the forefront of the pandemic, saving lives that would otherwise be lost.

The arguments above are a great attempt to establish the moral necessity for a duty of care. However, they fall short in explicating the nature and extent of the duty to care by practioners towards patients. This is because, any duty of care ought to provide a set of minimal standards of conduct which are within the reach of all general professionals. Such prescriptions will enable the codification of duty of care into professional rules. Failure to provide absolute clarity about the extent and nature of duty, makes codification, consent and obligation difficult to interpret. So far, this level of clarity has not been reached and the experience with various infectious diseases, such as, COVID-19, SARS, MERS, H1N1, HIV/AIDS and Ebola highlight the difficulty of imposing absolute duty on clinicians.[16,17] It is critical for this expectation to be specified apriori, so that consenting professionals are made aware of the risks associated with the benefits accrued. This is unfortunately not the case, and would be unfair to impose the duty of care of clinicians *post facto*.



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We argue that the COVID-19 related risks are extreme to be obligatory akin to biblical commandments like "thou shall not kill". That the Hippocratic oath and other impositions on health professionals during COVID-19 are not explicit obligations for all professions. The expectation on healthcare professionals to treat patients, often at significant risk to themselves, to their family members and to others, in times of pandemics such as COVID-19 is supererogatory or "going beyond the call of moral duty".

This makes duty of care during such times, a virtuous, saintly and heroic act, thus morally neutral, inconsequential and not required but admirable. In this way, the per-

spective of a duty of care, changes from a duty-based viewpoint to a character-based trait or virtue, characteristic of a virtuous professional. A virtue is defined as an "acquired habit or disposition to do what is morally right or praiseworthy".[18] This type of perspective contrasts obligations-based approaches in that the character of the individual is the main concern, combined with emotions and internal motivations. Thus "rights, obligations and duties are not the only sorts of moral considerations that move people to act".[19]

Another form of inspiration for action is to strive for excellence in character or virtues because we are internally motivated to do so.[18] From a virtue based viewpoint then, "the willingness to care for risky patients is a very good and selfless thing, which exemplifies the highest ideal of the profession".[20] Furthermore, those healthcare professionals that are prepared to care for patients despite the significant risks "express a virtue of professional character that all physicians should strive for but that not all will achieve".[19]

A virtue-based perspective and virtues are valuable in addressing the duty to care, as it provides significant room for the incorporation of emotions as well as internal motivations. For example, in regards to healthcare professionals that refuse to care for patients in the face of considerable risk to themselves and their family members, Tomlinson writes:

> *Those who refuse out of an overwhelming fear for themselves, of fear for the safety of their families, should be judged differently from those who refuse because they have no altruism or benevolence, and so have no sense of regret or moral loss when they act solely out of self-interest…such persons can live by the rules, performing as duty demands, but are defective in their professional character.*[20]

The incorporation of emotions as part of deliberations of whether or not to provide care to patients is important, as fear for one's safety and the safety of one's family, can be a forceful motivation for action.[20] More importantly, the capacity of persons to overcome such fears "varies considerably from person to person, and in some persons from occasion to occasion…few of us have perfect mastery over our fear…"[20]

Thus, considering the duty of care as a virtue which all healthcare professionals should strive for, allows for a more flexible and context dependent approach, in assessing the internal motivations and emotions that lead to individual decisions regarding the duty to care.

We now turn our focus to answer the question: What becomes of dental professionals who openly refuse to treat symptomatic patients? Given the desirability of supererogation in times of pandemics, we advance the view that the profession should not condemn those clinicians who are unable to master the courage to be in the frontline. For those clinicians who prioritize themselves and their families, their actions should not be regarded as uncharacteristic of the professions. Instead we should all strive for the ideals and virtues, such as altruism and empathy. Leaders in health organizations, should thus lead this revolution by example and guided by internal motivations and not sanction dissent. Leaders in health organizations should also be sensitized to the fact that:

> *Once we acknowledge the aspirational quality of this ideal, we can sympathetically understand that there will be some health professionals - perhaps sometimes many, perhaps even ourselves - who will fall short, not being able to master their fear, for themselves and for their families. And we will appreciate that even good people will have this virtue to varying degrees, in varying circumstances. We will be reluctant, then, to condemn or punish those who are overcome by their fear on particular occasions but whose behavior otherwise suggests their allegiance to the ideal. This stands in contrast to our response to someone's failure to perform a duty, where what is usually called for is moral disapproval, often accompanied by sanctions*.[20]

On a final note, anecdote indicates that the role and practice of dentistry has not changed much during the past epidemics, so why would it change now? In fact, majority of patients are likely to postpone routine dental care. For the few who might need dental care, dentists are not obligated to treat COVID-19 positive patients, especially when the nature of care requested is not urgent or necessary. However, the refusing dentist is obligated to refer the patients to colleagues, who are willing and competent.

Treating clinicians must be well protected, this includes by providing the necessary support including IPC (Infection, Prevention and Control) measures and PPEs (Personal Protection Equipment). There is presently a global shortage, which necessitates rational use of these scarce resources. Therefore, clinicians without these armamentaria cannot be expected to discharge their duties. In case of private practitioners, there is an urgent need to review the medical schemes compensation of towards IPC and PPEs.

Presently the provisions by the health care insurance does not encourage strict infection control practices. The costs to transition towards COVID-19 IPC and PPE require massive financial inputs. For most practitioners, it will be financially difficult to establish and sustain the practice.

CONCLUSION

It might be morally defensible but unethical for dental professional to refuse to treat patients. The commonly advanced arguments of reciprocity and special skills, do not offer adequate moral justification for a duty of care in the face of considerable risk to dental professionals.

To impose a moral duty on healthcare workers to treat patients, just because they are health workers is indefensible. A more suitable alternative to invoking the duty of care, is by considering that the provision of care during pandemics such as COVID-19 should be considered as a virtue which "exemplifies the highest ideals of the profession".[20]

Debates about what the duty of care means, how far it extents and the implications thereof, will continue to be the subject of fierce ethical consideration. For oral health, there is a need to test its application in order to guide the professions especially during the COVID-19, and similar future outbreaks. In closing, we propose that the duty of care for patients during pandemics such as COVID-19, should be considered and discussed as a virtue that all healthcare professionals should aspire to, rather than being considered merely as a duty.

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CPD questionnaire

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GENERAL

Contamination of used toothbrushes and their decontamination with disinfecting agents

1. Choose the CORRECT answer.
   The percentage of toothbrushes in which microorganisms were observed is:
   A. 65%
   B. 78%
   C. 73%
   D. 50%

2. Choose the CORRECT option.
   Which microorganism was found in a high number of toothbrushes?
   A. Coagulase-negative staphylococci (CoNS)
   B. Escherichia coli
   C. Staphylococcus aureus
   D. Pseudomonas aeruginosa
   E. Coliforms

3. Which of the following is CORRECT.
   No growth was observed in the following number of toothbrushes:
   A. 22
   B. 20
   C. 15
   D. 10

4. Choose the CORRECT answer.
   The least commonly isolated microorganism was:
   A. Candida albicans
   B. Staphylococcus auerus
   C. Pseudomonas aeruginosa
   D. Escherichia coli

5. Choose the CORRECT answer.
   Sterile distilled water decontaminated:
   A. 15% of toothbrushes
   B. 30% of toothbrushes
   C. 66% of toothbrushes
   D. None of the above

Schwannoma of the infratemporal fossa - A rare case report

6. Select the INCORRECT answer. Clinically schwannoma could present with all of the following, EXCEPT?
   A. Paraesthesia
   B. Hoarseness
   C. Dysphagia
   D. Hearing loss

7. Choose the CORRECT answer.
   Trigeminal schwannoma MOSTLY grows in the?
   A. Posterior cranial fossa
   B. Anterior cranial fossa
   C. Middle cranial fossa
   D. Equally among any of the above

8. Which of the following options is CORRECT.
   Trigeminal schwannoma constitutes what percentage of intra-cranial tumours?
   A. 2%
   B. 0.2%
   C. 20%
   D. 2.2%

Granulomatosis with polyangiitis - An oral medicine case book

9. Choose the CORRECT answer.
   Granulomatosis with polyangiitis is characterised by the following histological features:
   A. A mixed pattern of inflammation
   B. Vasculitis
   C. Varying degrees of necrosis
   D. Granulomas
   E. All of the above

10. Choose the INCORRECT option.
    All of the following are orofacial manifestations of granulomatosis with polyangiitis EXCEPT:
    A. Gingival enlargement
    B. Oral ulceration
    C. Saddle nose deformity
    D. Salivary gland hypoplasia
    E. Osteomyelitis

Root canal preparation with reciprocating instruments - a literature review and clinical application

11. Choose the CORRECT answer. Which of the following are possible outcomes of loss of apical patency during root canal instrumentation?
    A. Apical blockage
    B. Loss of working length
    C. Risk of debris extrusion
    D. Preventing flow of shaping instruments
    E. All of the above

12. Which is the INCORRECT option. Which one of the following is NOT a reciprocating glide path preparation system?
    A. PathFiles
    B. ProGlider
    C. WaveOne Gold Glider
    D. EdgeOne Fire Glide path

13. Select the CORRECT answer. Which of the following is an advantage of endodontic instruments used in reciprocation motion?
    A. An increase in rotation cycles
    B. Decreased torsional fatigue resistance
    C. Increased cyclic fatigue resistance
    D. None of the above

14. Choose the CORRECT answer. Which of the following is an advantage of reciprocating endodontic instrumentation systems compared to instrumentation systems used in rotation motion?
    A. Less debris extrusion
    B. Dentinal crack formation
    C. Faster preparation times
    D. None of the above
    E. All of the above

15. Select the INCORRECT option. Which one of the following is NOT a reciprocating final root canal preparation system?
    A. Reciproc Blue
    B. One File G
    C. TruNatomy
    D. WaveOne Gold

Clinical window: What's new for the clinician?

16. Select the CORRECT option below.
    In the Mühlemann et al. trial:
    A. Both groups received the zirconia implant crown
    B. Patients in the control group received the zirconia implant crown
    C. Patients in the test group received the zirconia implant crown
    D. None of the above

17. Select the CORRECT option below.
    In the Mühlemann et al. trial:
    A. The plaque and bleeding on probing score was significantly lower in the Mono-ZrO2 group
    B. The plaque and bleeding on probing score was significantly lower in the PFM group
    C. Only the plaque score was significantly lower in the Mono-ZrO2 group
    D. There was no difference between the groups for the plaque and bleeding on probing scores

18. Select the CORRECT option below.
    In the Scheerman et al. trial:
    A. Reduction of plaque at 6 and 12 weeks was significantly greater in intervention group
    B. Reduction of plaque at 6 and 12 weeks was significantly greater in control group
    C. Reduction of plaque at 12 weeks was significantly greater in intervention group
    D. Reduction of plaque at 12 weeks was significantly greater in control group

19. Select the CORRECT option below.
    In the Scheerman et al. trial:
    A. In terms of oral health behaviour, the only significant intervention effect was for fluoride use at the 6-week follow-up; it favoured the intervention group
    B. In terms of oral health behaviour, the only significant intervention effect was for fluoride use at the 6-week follow-up; it favoured the control group
    C. In terms of oral health behaviour, the only significant intervention effect was for fluoride use at the 6-week follow-up; it favoured neither group
    D. In terms of oral health behaviour, the only significant intervention effect was for fluoride use at the 12-week follow-up; it favoured the intervention group

Maxillofacial radiology 185

20. Which one of the following statements is INCORRECT:
    A. Knife edge resorption is normally seen in ameloblastomas
    B. Periapical granulomas resulting from pulp death caused by traumatic injury can cause root resorption
    C. Root resorption may be present in malignant tumours
    D. A dentigerous cyst always produces destruction of the tooth rather than tooth displacement

ETHICS

Dentistry and COVID 19 - Is there a moral duty of care?

21. Identify the CORRECT answer. The concept of duty of care is underpinned by this ethical principle:
    A. Beneficence
    B. Nonmaleficence
    C. Justice
    D. Autonomy

22. Identify the CORRECT statement.
    One of the arguments for the motivation for duty of care is based on the fact that:
    A. Heath professionals take the Hippocratic oath; therefore, they owe their patients duty of care in all circumstances
    B. The HPCSA ethical guidelines indicate that health professionals cannot refuse patient care
    C. Duty of care is a moral obligation based on the social contract or reciprocity argument
    D. Health professionals are highly trained and well remunerated which enables them to minimize harm to themselves and patient

23. Identify the INCORRECT answer. The concept of health professionals 'going beyond their call of duty' during pandemics can be seen as:
    A. Supersession
    B. Saintly
    C. Heroic
    D. Virtuous

24. Identify the CORRECT answer.
    Healthcare professionals who refuse patients care during pandemics and prioritize themselves and their families should:
    A. Be capacitated and supported until they can start treating COVID-19 positive patients
    B. Be sanctioned
    C. Be seen as being unethical
    D. Not be condemned, but be shown empathy

25. Identify the CORRECT statement.
    Virtue ethics is based on what is morally right or praiseworthy, therefore, health professionals:
    A. Are morally and ethically obligated to treat COVID-19 positive patients
    B. Who continue to treat patients, during pandemics express a virtue that all should achieve
    C. Are inspirational and exemplify the highest ideal that professionals should aspire to
    D. Owe patients a duty of care

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