



## ***Baobab (Aka Bottle Tree, Upside-down Tree)***

One of the most iconic trees in South Africa is the Baobab tree. Not only does this unique tree provide vitamin C to those who feed on its fruit, but it is also known as the tree of life – it can store up to 4,500 L of water in its trunk. The tree's impressive stature makes its strange upside-down appearance even more imposing. It can grow up to 20m tall and can live for up to 3000 years. One of the biggest baobab trees in South Africa might even have reached the 6000-year mark.

The sheer expanse of the plant means that they can create and sustain a mini-ecosystem. As the tree ages its centre hollows and can provide shelter to birds and animals. Some baobabs are among the South African trees that have claimed champion-status.



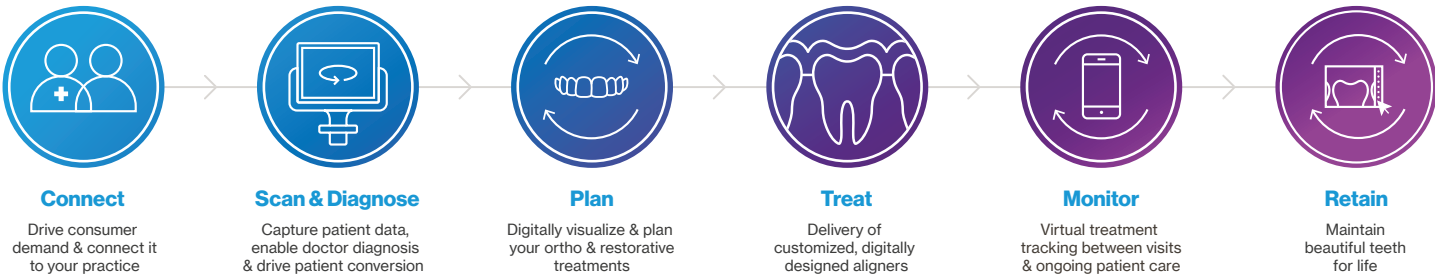


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## CONTENTS

## EDITORIAL

- Empowering Oral Health: Navigating the Future of Patient Education and Engagement in Dentistry – *Prof NH Wood* 1

## COMMUNIQUE

- Smile brighter: A glimpse into the future of tooth regeneration – *Mr Makhubele* 3

## RESEARCH

- Root and canal morphology of the maxillary first molar: A micro-computed tomography-focused review of literature with illustrative cases. Part 1: External root morphology – *CH Jonker, PJ van der Vyver, AC Oettlé* 4

- Bacterial contamination of disinfectants: prevalence and students' compliance with infection control practices – *NM Madzivani, SR Mthethwa, EM Sekati* 11

- Comparative evaluation of shear bond strength to dentin with three different aesthetic chemically bonded restorative materials – an In-vitro study – *Z Nivee Sanjana, VN Krishna, M Chandrasekhar, C Sunilkumar, KS Chandra Babu, KS Chandra Babu, R Bharathi Suma* 17

- Oral health care service delivery in schools for special needs in eThekweni District, KwaZulu-Natal – *Sinenhlanhla Gumede, Shenuka Singh, Mbuyiselwa Radebe* 21

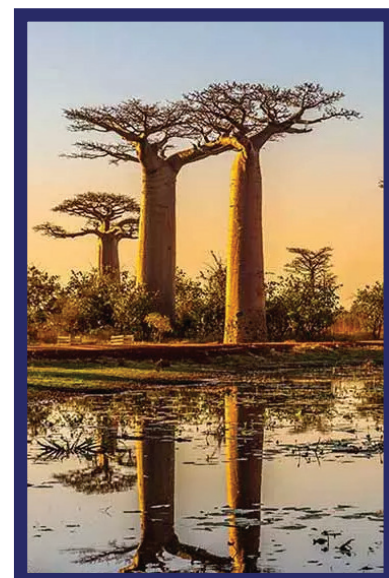
- Self-reported experience of Outreach activities amongst undergraduate Oral Health students at a University in South Africa – *C Kruger, NR Nkambule, A Bhaya* 30

## Our Front Cover for this Issue...

**Baobab** (Aka Bottle Tree, Upside-down Tree)

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**LITERATURE REVIEW**

A simplified and evidence-informed approach to removable partial dentures. Part 4. Seven simple steps to design – *CP Owen* 30

**CASE REPORT**

A gigantic unilateral neck mass in the submandibular region – *RE Rikhotso* 36

**EVIDENCE BASE DENTISTRY**

What's new for the clinician – summaries of recently published papers (February 2024) – *Prof V Yengopal* 45

**ETHICS**

Regulatory Overreach – Intervention or Interference  
*MI Makoea, M L Machete, T Bapela, P D Motloba* 49

**RADIOLOGY CORNER**

Maxillofacial Radiology, Double type III dens invaginatus –  
*C Smit, GD Buchanan, Z Yakoob, MYGamielien, L Robinson* 53

**CPD**

CPD questionnaire 56

**AUTHOR GUIDELINES**

Instructions to authors and author's checklist 58

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# Empowering Oral Health: Navigating the Future of Patient Education and Engagement in Dentistry

SADJ February 2024, Vol. 79 No.1 p1-2

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

## Introduction

As we embrace another year of exciting research, insightful discourse, and shared wisdom within our vibrant dental community, it is with great enthusiasm that we introduce a theme resonating deeply with the ethos of modern dental practice: Innovation in Patient Education and Engagement.

In an era where the intersection of healthcare and technology is more pronounced than ever, the dental field is witnessing a transformative shift in how we educate and engage with our patients. Gone are the days when patient education was confined to pamphlets and one-way conversations. Today, we stand at the forefront of a digital revolution that is reshaping patient interactions, making them more interactive, personalized, and empowering.

The significance of this evolution cannot be overstated. As dental professionals, our commitment extends beyond the treatment chair; we are educators and advocates for oral health, tasked with the critical role of guiding our patients through the complexities of dental care. In doing so, we not only enhance their understanding and comfort but also foster an environment where informed decisions and proactive health practices flourish.

This edition of the South African Dental Journal is dedicated to exploring the myriad ways in which innovation is driving patient education and engagement forward. From the advent of mobile health apps and virtual reality simulations to the personalized touch of digital communication platforms, these advancements are not merely changing how we communicate; they are revolutionizing the very fabric of patient interaction, making dental education an engaging, immersive experience.

As we delve into this theme, we invite you to reflect on the transformative potential of these innovations within your own practices. How can we leverage these tools to demystify dental procedures, alleviate anxieties, and ignite a passion for oral health among our patients? The answers to these questions are key to advancing our mission of providing exemplary dental care and education.

Join us as we embark on this journey of discovery, innovation, and growth. Together, let us redefine the boundaries of patient education and engagement, setting new standards for excellence in dental care and community well-being.



### The Evolution of Patient Education and Engagement

The journey of patient education and engagement in dentistry has been marked by continuous evolution, shaped by technological advancements, changing societal norms, and a deeper understanding of patient psychology. Traditionally, dental patient education was predominantly didactic, relying heavily on verbal instructions, printed leaflets, and static visual aids. These methods, while informative, often fell short in fully engaging patients or addressing the diverse learning styles and informational needs of a varied patient population.

One of the fundamental limitations of traditional patient education methods was their one-size-fits-all approach. Verbal instructions, for instance, depended greatly on the patient's ability to recall information post-consultation, a challenge compounded by the stress and anxiety many experience during dental visits. Printed materials, although useful as references, could not fully encapsulate the dynamic nature of dental procedures or the intricacies of oral hygiene practices, leaving gaps in patient understanding and engagement.

Moreover, the passive nature of these traditional methods limited patient interaction and feedback. Engagement was often unidirectional, with little room for patients to voice concerns, ask questions, or express preferences. This lack of interactive communication hindered the development of a collaborative patient-dentist relationship, essential for effective oral health management.

The digital era ushered in a paradigm shift towards more interactive and personalized patient education and engagement strategies. The advent of digital technologies in dentistry has been instrumental in overcoming many of the limitations associated with traditional educational tools. Digital platforms, including interactive websites, mobile applications, and social media channels, have transformed patient education into a more engaging, accessible, and customizable experience.

These modern tools cater to diverse learning preferences through multimedia content, including videos, animations, and interactive diagrams, which can demystify complex dental procedures and clarify preventive care practices in a more digestible and relatable format. The use of digital platforms also facilitates two-way communication, allowing patients to ask questions, provide feedback, and actively participate in their oral health journey.

The shift towards personalized patient engagement is particularly noteworthy. With the help of artificial intelligence and data analytics, dental professionals can now tailor educational content to match individual patient profiles, considering factors such as age, oral health status, and personal preferences. This personalized approach not only enhances the relevance and impact of the information provided but also fosters a sense of ownership and empowerment among patients regarding their oral health.

The evolution from traditional to modern patient education and engagement methods reflects a broader transformation in the healthcare landscape, one that values patient autonomy, personalized care, and the integral role of technology in enhancing patient experiences. As we continue to navigate this digital revolution, the potential

to further innovate and improve patient education and engagement in dentistry remains vast, promising a future where informed, engaged patients are at the heart of oral healthcare.

### Technological Innovations in Patient Engagement

Modern technologies, including interactive mobile apps and VR simulations, are transforming dental patient education. These tools offer immersive experiences, making complex dental concepts easier to grasp, which can decrease patient anxiety and lead to better treatment outcomes. Interactive mobile applications are used to offer step-by-step guides for oral hygiene practices, utilizing animations and interactive models to clarify proper brushing and flossing techniques. Virtual reality simulations are employed to simulate dental procedures for patients, helping to demystify the process and reduce anxiety by familiarizing patients with the treatment environment and steps in a controlled, virtual setting.

### Personalization and Gamification in Dental Education

The move towards personalized patient education programs acknowledges diverse learning needs and preferences. Incorporating gamification, such as quizzes and interactive modules, into dental education tools enhances engagement and retention of oral health information, making learning more effective and enjoyable. Educational programs are tailored to individual learning styles and preferences, using interactive elements like quizzes and progress tracking to engage patients. Gamification techniques, such as rewarding users for achieving oral hygiene goals, make the learning process more engaging and motivate better dental care practices. These approaches leverage the principles of active learning and behavioural psychology, enhancing the effectiveness of patient education by making it more relatable and enjoyable.

### The Future of Patient Education and Engagement

The future of patient education and engagement in dentistry is poised for transformative advancements. We anticipate further integration of AI and machine learning to provide hyper-personalized educational content, adapting in real-time to patient feedback and learning progress. Augmented reality could offer even more immersive educational experiences, allowing patients to visualize treatment outcomes. However, these innovations must be approached with caution, considering data privacy concerns and ensuring the digital divide does not widen access disparities. Dental professionals are encouraged to embrace these changes, critically evaluating how each innovation can enhance patient care while being mindful of potential challenges.

As we look to the horizon of dental patient education and engagement, it's clear that the field is on the cusp of remarkable innovations. Embracing these changes presents an opportunity to deepen our connection with patients, making dental care more effective, accessible, and enjoyable. By integrating new technologies and personalized approaches into our practices, we can not only enhance oral health outcomes but also foster a more informed and empowered patient community. I believe this will facilitate an improvement in patient-related and perceived outcomes of dental treatment. Together, let's welcome this new era of patient education with open arms, ready to explore its full potential for transforming dental care.



# Smile brighter: A glimpse into the future of tooth regeneration

SADJ February 2024, Vol. 79 No.1 p3

Mr KC Makhubele – CEO, South African Dental Association

Prepare yourselves for an extraordinary breakthrough in the field of dentistry, ladies and gentlemen! The year 2024 is already shaping up to be a promising one (forget NHI for a moment), as we anticipate the launch of innovative clinical trials aimed at regenerating our teeth. Yes, you read that correctly – the ability to regrow one's own teeth may become a reality sooner than you believe.

A group of devoted scientists, led by the visionary minds at Toregem Biopharma, is on the precipice of making a significant advancement that could transform dental care as we know it. After effectively growing new teeth in animal test subjects, this Japanese pharmaceutical startup is now preparing to conduct human trials. Imagine a world in which tooth loss is no longer a permanent concern, but merely a minor blip in the majestic symphony of life.

Dr Katsu Takahashi, the brains behind this innovative project and head of the dentistry and oral surgery department at the Medical Research Institute Kitano Hospital, could not contain his excitement when he said: "Every dentist's dream is to grow new teeth." He has devoted his entire existence to making this dream a reality and is now on the verge of accomplishing it.

In 2005, Dr Takahashi made an important discovery at Kyoto University: a gene in rodents that had a significant impact on their dental development. This gene, known as USAG-1, was responsible for stimulating tooth growth when it was inhibited. What followed was years of meticulous research, culminating in the development of a "neutralising antibody medicine" capable of blocking USAG-1.

The exciting portion? The discovery was not limited to rodents; it extended to ferrets, which have dental patterns

similar to humans. Imagine ferrets, previously deprived of their natural dental prowess, producing new teeth as a result of this regrowth medication. This demonstrates the immense potential of this innovation.

But the most thrilling chapter remains to be written. On the horizon are clinical trials involving healthy adult participants. A clinical trial for children between the ages of two and six with anodontia, a rare genetic disorder characterised by the absence of multiple infant and/or adult teeth, is also on the agenda if all goes according to plan.

As we anxiously await the outcomes of these trials, it is difficult not to be optimistic about the future. According to the Japan Times, the children participating in the clinical trial will receive a single dose of the drug to evaluate its efficacy in stimulating tooth development. If successful, this potentially game-changing medication could pursue regulatory approval by 2030.

Dr Takahashi envisions a future in which tooth-regrowth medicine proudly stands alongside dentures and implants as a viable option for individuals seeking to regain a complete set of teeth. It is a future where smiles are brighter, confidence rises and tooth loss concerns are a thing of the past.

Therefore, as we herald in 2024, let us celebrate the astounding progress made by these dedicated scientists. Tooth regeneration is no longer a far-fetched possibility; it is now imminent. Cheers to a future in which every smile is complete and no one needs to conceal their happiness behind closed lips. Prepare to bid farewell to your dental issues and say hello to a world where tooth regrowth is not just a hope but an imminent reality.

## NOTICE OF 22nd ANNUAL GENERAL MEETING (AGM) OF The South African Dental Association NPC ("SADA")

Notice is hereby given that the 22nd 2022 Annual General Meeting of Members (AGM) of The South African Dental Association (SADA) NPC, will be held on Thursday **25 April 2024 at 18h00**, which will be conducted virtually on this date through Zoom virtual meeting platform or similar digital platform. **The agenda together with supporting documents for the meeting will be posted on the SADA website.**

**SADA is your Association and your voice counts.**

**KC Makhubele**  
Chief Executive Officer  
February 2024



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

## Part 1: External root morphology

SADJ February 2024, Vol. 79 No.1 p4-10

CH Jonker<sup>1</sup>, PJ van der Vyver<sup>2</sup>, AC Oettlé<sup>3</sup>

### ABSTRACT

Cleaning and shaping of the root canal are profoundly affected by the complexity of root and canal morphology. Undiscovered roots or canals may lead to a reduced prognosis of a treated tooth as hidden causative organisms and their by-products can cause re-infection. Most maxillary first molars have three roots, namely mesio-buccal (MB), disto-buccal (DB) and palatal (P). They can be separate or fused, with incidences varying between populations. Anomalies have also been documented that include single-rooted, double-rooted, four and even five-rooted teeth. Additional roots are mostly in the form of additional palatal roots and are known as either a radix mesiolingualis (RML) or radix distolingualis (RDL). This paper is the first of two giving an overview, focused on micro-CT, of available literature on various aspects of the root and canal morphology of the maxillary first permanent molar. The aim of this paper is to provide an overview of relevant aspects of the external root morphology in different populations. The content is supported by illustrative micro-CT images and case reports

of rare morphological findings on maxillary first molars.

### Keywords

Micro-CT, number of roots, radix mesiolingualis, radix distolingualis, root fusion, taurodontism

### INTRODUCTION

Once a tooth becomes irreversibly inflamed, endodontic treatment is required. This involves removing infected tissues from the root canal system in a series of mechanical and chemical disinfection steps and eventual three-dimensional sealing of the prepared root canal spaces.<sup>1,2</sup> Cleaning and shaping of the root canal are profoundly affected by the complexity of root and canal morphology. Undiscovered roots or canals may lead to a reduced prognosis of a treated tooth, as causative organisms and their by-products can cause re-infection.<sup>2,3</sup> In addition to a complex internal structure, the external morphology of this tooth can be bizarre. In most cases, three roots are present: mesio-buccal (MB), disto-buccal (DB) and palatal (P).<sup>4</sup> Roots can be separate or fused, with incidences varying between populations.<sup>5-9</sup> Variations in the number of roots have also been noted, including single-rooted, double-rooted,<sup>10-12</sup> four and even five-rooted teeth.<sup>13,14</sup> These additional roots are mostly palatal.<sup>14</sup>

Recent technological developments, such as cone-beam tomography (CBCT) and micro-computed tomography (micro-CT), have made it possible to identify many of the complexities and anatomical variations of the roots and root canals of molar teeth in three dimensions that were often hidden in the two-dimensional view of conventional radiographs.<sup>15-17</sup> More specifically, micro-CT enables the observation of fine detail and the identification of complexities in a segmentation process known as the watershed. During segmentation each component of a tooth is virtually separated from the others using modern software (for example Avizo18). Different colours can be assigned to enamel, dentine or the pulp, images can be magnified, and a tooth can be rotated in multiple planes.<sup>18-20</sup>

The aim of this paper is to provide an overview of available literature on the external root morphology of the maxillary first molar, supported by illustrative clinical cases and micro-CT images. Studies have identified several investigative methodologies, and morphological findings differ from

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2. Peet J van der Vyver: Treated patients and clinical images, manuscript layout and proofreading – 25%
3. Anna C Oettlé: Proofreading and layout – 15%

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**Table I: Available studies reporting on the number of roots of maxillary first molars.**

Country	One root (%)	Two roots (%)	Three roots (%)	Four roots (%)	Author and date
Australia	-	5.6	94.4	-	Thomas et al. 1993 <sup>27</sup>
Australia	-	10.4	89.6	-	Martins et al. 2018 <sup>28</sup>
Brazil	-	3.8	96.2	-	Silva et al. 2014 <sup>29</sup>
Brazil	-	-	100	-	Lyra et al. 2015 <sup>30</sup>
Brazil	1.0	6.0	93.0	-	Estrela et al. 2015 <sup>31</sup>
Burma	-	-	100	-	Ng et al. 2011 <sup>32</sup>
China	0.3	1.8	97.8	0.1	Tian et al. 2016 <sup>9</sup>
China	-	-	100	-	Zhang et al. 2011 <sup>33</sup>
China	-	2.4	97.1	0.5	Jing et al. 2014 <sup>34</sup>
China	0.2	2.0	97.6	0.2	Wang et al. 2017 <sup>35</sup>
China	0.2	0.6	99.0	-	Zhang et al. 2017 <sup>36</sup>
China	-	0.8	99.2	-	Martins et al. 2018 <sup>28</sup>
China	-	0.4	99.6	-	Martins et al. 2018 <sup>37</sup>
China	0.1	2.2	97.6	0.1	Gu et al. 2015 <sup>38</sup>
Costa Rica	-	0.4	99.6	-	Martins et al. 2018 <sup>28</sup>
Egypt	-	-	100	-	Ghobashy et al. 2017 <sup>39</sup>
Egypt	0.4	6.4	92.8	0.4	Martins et al. 2018 <sup>28</sup>
Egypt	-	4.3	95.7	-	Salem et al. 2018 <sup>40</sup>
England	-	3.6	96.4	-	Martins et al. 2018 <sup>28</sup>
France	1.2	5.6	93.2	-	Martins et al. 2018 <sup>28</sup>
France	-	2.0	96.6	1.4	Monsarrat et al. 2016 <sup>41</sup>
Georgia	-	-	100	-	Beshkenadze and Chipashvili 2015 <sup>42</sup>
Greece	3.9	5.6	89.3	1.2	Nikoloudaki et al. 2015 <sup>43</sup>
Greece	0.4	12.4	85.6	1.6	Martins et al. 2018 <sup>28</sup>
Iceland	0.4	5.2	94.0	0.4	Martins et al. 2018 <sup>28</sup>
India	0.9	1.4	96.8	0.9	Neelakantan et al. 2010 <sup>6</sup>
India	-	-	100	-	Shenoi, Ghule 2012 <sup>44</sup>
India	-	1.2	98.8	-	Martins et al. 2018 <sup>28</sup>
India	-	2.7	96.8	0.5	Felsypremila et al. 2015 <sup>12</sup>
Iran	-	0.3	99.7	-	Khademi et al. 2017 <sup>45</sup>
Iran	-	1.3	98.7	-	Naseri et al. 2016 <sup>46</sup>
Iran	-	0.8	97.6	1.6	Rouhani et al. 2014 <sup>47</sup>
Iran	-	-	100	-	Faramarzi et al. 2015 <sup>48</sup>
Iran	1.2	6.1	92.2	0.5	Ghoncheh et al. 2017 <sup>49</sup>
Ireland	-	2.4	97.6	-	Shalabi et al. 2000 <sup>50</sup>
Italy	-	9.6	90.4	-	Martins et al. 2018 <sup>28</sup>
Italy	-	4.3	95.7	-	Plotino et al. 2013 <sup>51</sup>
Korea	0.4	1.7	97.9	-	Kim et al. 2012 <sup>7</sup>
Kuwait	0.8	2.4	96.0	0.8	Martins et al. 2018 <sup>28</sup>
Mexico	-	-	100	-	Martins et al. 2018 <sup>28</sup>
Netherlands	1.2	5.2	93.6	-	Martins et al. 2018 <sup>28</sup>
Poland	-	-	100	-	Olczak and Pawlicka 2017 <sup>52</sup>
Portugal	0.7	6.4	92.8	0.1	Martins et al. 2016 <sup>8</sup>
Portugal	0.6	8.3	91.1	-	Martins et al. 2017 <sup>53</sup>
Portugal	0.5	8.5	91.0	-	Martins et al. 2018 <sup>28</sup>
Russia	-	-	100	-	Razumova et al. 2018 <sup>54</sup>
Saudi Arabia	-	-	94.0	6	Alrahabi and Zafar 2015 <sup>10</sup>
South Africa	-	9.0	91.0	-	Irhaim 2016 <sup>55</sup>

South Africa	1.6	0.8	97.6	-	Martins et al. 2018 <sup>28</sup>
Spain	-	6.4	93.2	0.4	Martins et al. 2018 <sup>28</sup>
Spain	2.1	0.7	97.2	-	Pérez-Heredia et al. 2017 <sup>56</sup>
Syria	-	-	100	-	Martins et al. 2018 <sup>28</sup>
Taiwan	1.5	1.0	97.5	-	Lin et al. 2017 <sup>57</sup>
Taiwan	-	-	100	-	Alavi et al. 2002 <sup>21</sup>
Thailand	-	-	99.8	0.2	Ratanajirasut et al. 2018 <sup>58</sup>
Turkey	0.1	0.3	99.0	0.6	Altunsoy et al. 2015 <sup>59</sup>
Uganda	-	4.1	95.9	-	Rwenyonyi et al. 2007 <sup>5</sup>
Venezuela	0.4	11.6	88.0	-	Martins et al. 2018 <sup>28</sup>
USA	0.4	13.6	86.0	-	Martins et al. 2018 <sup>28</sup>
USA	-	0.9	99.1	-	Guo et al. 2014 <sup>60</sup>

population to population. However, the focus is on micro-CT reports.

### Number of roots

Several papers report on the number of roots in different populations and, in most, CBCT was used. The consensus is that the maxillary first molar has predominantly three roots but variations, including root fusions, have also been noted.<sup>5,21-26</sup> Many authors have described the number of roots in different populations, which vary between one, two, three or four-rooted first molars. Findings from available literature are shown in Table I. Figure 1 shows a typical three-rooted maxillary first molar with separated roots viewed through micro-CT and Avizo software. No studies that reported on the number of roots using micro-CT methodology were identified.

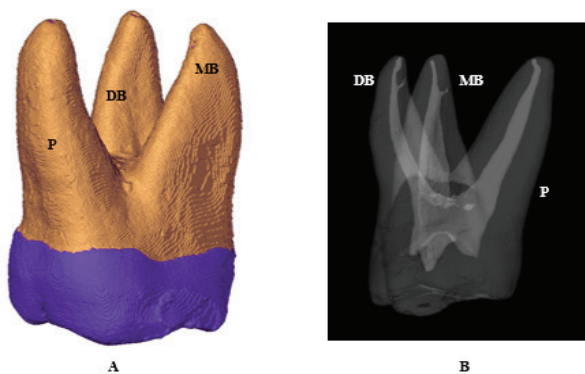


Figure 1: Micro-CT illustration of the root morphology of a typical three-rooted maxillary first molar; (A) Separate MB, DB and P roots viewed from mesio-palatal; (B) Adjusted transparency and increased radiolucency allowing separation between pulpal complex and root morphology.

### Radix mesiolingualis (RML) and radix distolingualis (RDL)

Additional roots can be present on either the mesio-palatal side (RML) or on the disto-palatal side (RDL).<sup>13</sup> Most of the reports on RML and RDL are case reports, but there are a few cross-sectional studies investigating the prevalence of RML and RDL. In a Danish study authors found a prevalence of 8.6% of RML in maxillary first molars using visual inspection. No RDL were identified.<sup>13</sup> Christie et al.<sup>61</sup> observed patients in vivo who displayed additional palatal roots and found a prevalence of 12.5% for a fourth root.<sup>61</sup> No studies reporting specifically on the RML or RDL in African or South African populations using micro-CT were identified, but a Ugandan investigation found no teeth with more than three roots. The same was reported in other African or South African populations.<sup>5,28,55</sup>

Figure 2 illustrates a case report of a South African who presented with a rare case of combined RML and RDL. The patient, a 54-year-old male, presented with irreversible pulpitis on his left maxillary first molar that had previously been restored with a large occlusal amalgam. A periapical radiograph provided limited diagnostic information and no additional roots could be observed between the MP and DB roots. However, CBCT images revealed the presence of two buccal and two palatal roots (RML and RDL). The defective amalgam restoration was removed and the pulp was exposed. Clinically, the crown of the tooth appeared enlarged compared to the contralateral first molar and was asymmetrical in shape. The pulp chamber floor was quadrangular in shape, with four distinct canal orifices arranged in each corner. The mesio-palatal and disto-palatal canal orifices were positioned more mesial and distal to the chamber floor than where a single palatal canal orifice would

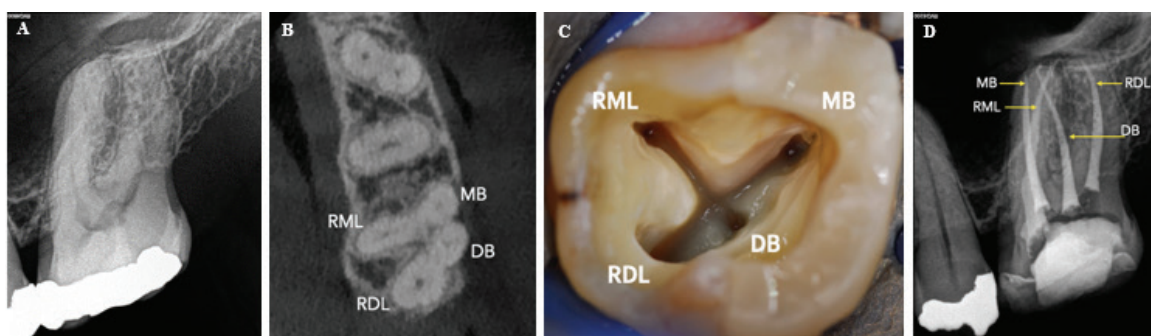


Figure 2: A maxillary left first molar with RML and RDL; (A) Pre-operative periapical radiograph; (B) CBCT image illustrating the root and canal configurations (MB, DB, RML, RDL); (C) Completed access cavity preparation after canal preparation; (D) The final obturation with temporary restoration in place. Note the different RML and RDL root canal systems.



Authors	Year	Study
Thews et al. <sup>62</sup>	1979	Case report
Di Fiore <sup>63</sup>	1999	Case report
Alexandersen <sup>64</sup>	1999	In vitro (1/99; 1%)
Baratto-Filho et al. <sup>65</sup>	2002	Case report
Barbizam et al. <sup>66</sup>	2004	Case report
Adanir <sup>67</sup>	2007	Case report
Raju et al. <sup>68</sup>	2010	Case report
He et al. <sup>69</sup>	2010	Case report
Moghaddas, Tabari <sup>70</sup>	2010	Case report
Neelakantan et al. <sup>6</sup>	2010	<i>In vitro</i> (2/220; 0.9%)
Tomazinho et al. <sup>71</sup>	2010	Case report
Kottoor et al. <sup>25</sup>	2011	Case report

normally be. The four root canal systems were prepared after determining length and establishing glide path using the ProTaper Universal System (Dentsply Sirona).

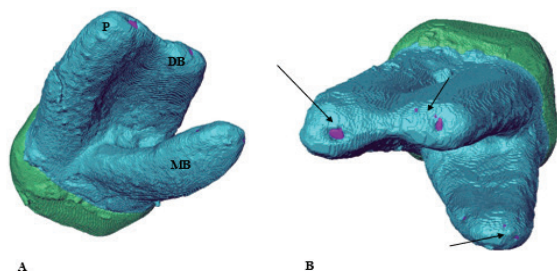
Other reports of four-rooted first molars are included in Table II but unfortunately the specifics and location of the fourth root were not given.

### Root fusion

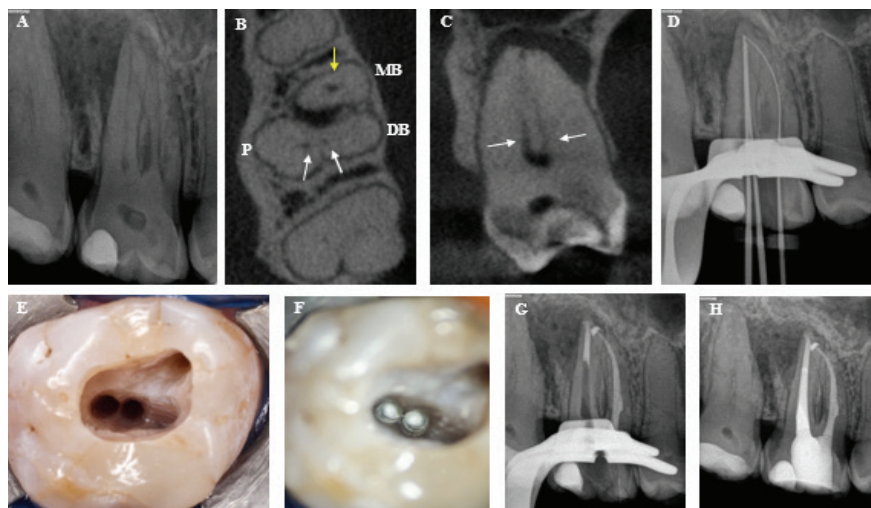
Although most maxillary first molars display a separate three-rooted configuration, fusion can occur between some or all the roots. The findings between populations differ. For example, in a Korean study, 0.7% of teeth in the sample displayed root fusion.<sup>7</sup> This is similar to the case of a North American population where 0.9% of fusion between roots occurred in the sampled teeth.<sup>60</sup> Both these figures are lower

than the 2.2% that was observed in a Chinese group.<sup>38</sup> In a Portuguese population, a larger number of teeth with fused roots were identified (7.1%).<sup>8</sup> Some populations in China, Burma, Iran, Poland and Taiwan had no teeth with fused roots in their samples.<sup>6,32,33,48,52,57</sup> The incidence of fusion in other populations is 1.3% in an Iranian population,<sup>46</sup> 2.1% in a Greek population,<sup>43</sup> 0.7% in a Spanish population,<sup>56</sup> 2.4% in another Iranian population,<sup>47</sup> 1.4% in China,<sup>9</sup> 11% in Ireland,<sup>50</sup> 2.1% in South China<sup>35</sup> and 7% in Saudi Arabia.<sup>72</sup> Rwenyonyi et al.<sup>5</sup> found fusion in 4.1% of teeth in Uganda. A prevalence of 9% of fused roots was found in a South African study. Unfortunately, no mention is made which population groups were included.<sup>55</sup> However, the Ugandan study contained individuals of African descent.<sup>5</sup> As South Africans are a diverse group of people it is difficult to make predictions for other groups. Nevertheless, the relatively higher prevalence noted is important to consider in the South African context. CBCT was the method used in most investigations, while micro-CT studies were limited (if any). Figure 3 shows a maxillary first molar that was isolated by segmentation using Avizo from a South African individual of African descent.

Figure 4 illustrates a case report of a 38-year-old South African female who presented with a non-vital right maxillary first molar with a large periapical radiolucency. A high-resolution CBCT scan revealed that the distobuccal and palatal roots were fused. The fused root contained two root canal systems that joined into one large apical foramen in the apical third of the root and the mesio-buccal root only had one root canal system. After root canal preparation with the ProTaper Ultimate system (Dentsply Sirona) it was noted that the apex was open where the two canals joined in the fused root. The open apex was closed with ProRoot MTA (Dentsply Sirona) before the mesio-buccal and remaining



LEFT: Figure 3: Micro-CT display of root fusion in a maxillary first molar; (A) Fusion between the DB and P roots (Type 3);<sup>73</sup> (B) Apical view displaying the portals of exit at the apex (black arrows); (C) Adjusted transparency with increased translucency displaying the correlation between root and pulp. Note the multiple portals of exit and accessory canals at the apex (white arrows).



BELOW LEFT: Figure 4: Clinical management of a right maxillary first molar with fused DB and P roots; (A) Pre-operative periapical radiograph; (B) Axial view at coronal level of the roots showing complete fusion of the disto-buccal and palatal roots and separate MB root (white arrows). Note the two root canal systems in the fused root (white arrows) and the single canal in the mesio-buccal root (yellow arrow); (C) Coronal view of the fused root showing two root canal systems in the coronal and midroot aspect of the root (white arrows), joining to open in a single apical foramen (yellow arrow); (D) Length determination radiograph showing that the two canals in the fused root join in the apical third of the root; (E) High-magnification view of the pulp chamber floor illustrating the close proximity of the two root canal system orifices in the fused root, as well as the orifice of the mesio-buccal root canal system; (F) High-magnification view at the level of the apical third of the fused root where MTA was packed to close the open apex; (G) Periapical radiograph showing the obturated mesio-buccal root canal system and a 5mm MTA plug in the apical third of the fused root; (H) Immediate postoperative periapical radiograph after obturation of the midroot and coronal aspect of the root canal systems in the fused root.

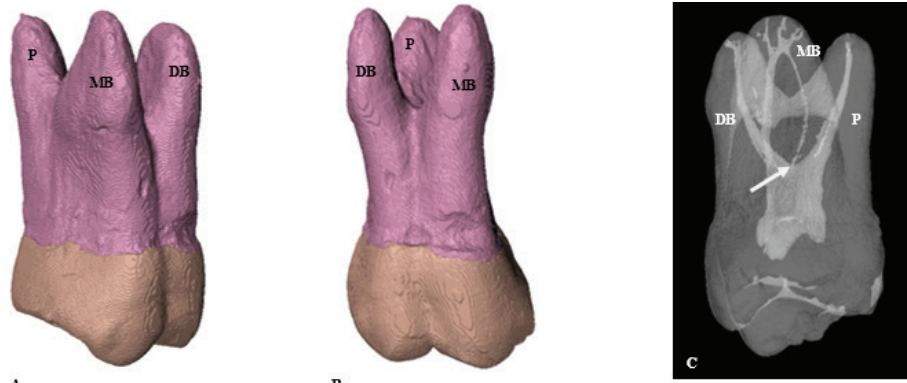


Figure 5: Micro-CT display of a maxillary first molar with taurodontic traits; **(A)** Mesio-buccal view. Note the shortened roots and apically displaced root bifurcations; **(B)** Buccal view displaying an elongated body and shortened roots; **(C)** Adjusted transparency with increased radiolucency displaying the relationship between pulp and roots. Note the apical displaced pulp floor (arrow).

parts of the root canals in the fused root were obturated using AH Plus Bioceramic cement (Dentsply Sirona) and gutta-percha cones.

### Taurodontism

In this type of root morphology a tooth often displays shortened roots and an elongated body where the pulp floor and root furcations are displaced apically, resulting in a large pulp chamber.<sup>74</sup> First described by Arthur Keith, a tooth with taurodontic traits has the appearance of a bull.<sup>75</sup> The reported prevalence ranges between 0.57% and 4.37%<sup>76,77</sup> but can be as high as 60%.<sup>78,79</sup> Prevalence between different population groups has been reported. In a Senegalese study involving individuals of African descent, panoramic radiographs were used to investigate maxillary first and second molars. The authors found that 18.8% of the teeth showed taurodontism with a higher prevalence in second molars.<sup>80</sup> In an early South African study, a researcher reported a prevalence of 30% in all molars after investigating skulls from different races including those from African descent. The prevalence in first molars was not specified but the author stated that taurodontism was more common in second and third molars.<sup>81</sup> Most available reports are case reports using radiographic examinations. The use of micro-CT in cross-sectional studies to report on the prevalence of taurodontism in maxillary first molars is scarce (if any). Figure 5 depicts an example of a maxillary first molar that was isolated with segmentation using Avizo in micro-CT from a South African of African descent.

### DISCUSSION

It is apparent that root and root canal morphology can differ among population groups and it has been determined that the anatomy of molars has a relation to genetic control.<sup>82</sup> The anatomy of the roots of molar teeth can also be influenced by geographic location or perhaps socioeconomic status.<sup>83,84</sup> It is important that treating clinicians are aware of any variations. Roots and their root canals that remain undiscovered increase the risk of treatment failure as infections can recur.<sup>2,85</sup>

The external morphology of the maxillary first molar predominantly shows three separate roots. Most studies identified in this paper reported three roots in 90% of teeth (Table 1). It is interesting to note that different population groups within a country can display varied root morphologies and number of roots. In China, for example, eight CBCT studies were identified on individuals who displayed differences in the number of one-rooted, two-rooted, three-

rooted and four-rooted teeth. Perhaps geographic factors or genetic make-up determined the differences between findings. Nearly all studies that reported on the number of roots used CBCT in their methodology. Micro-CT studies on root numbers are scarce and it appears that this technology has mainly been used to investigate complex internal morphology rather than to calculate the number of roots or macroscopic investigation of external root morphology. Although authors have determined that root morphological differences can be attributed to genetics or other factors,<sup>17,21-23</sup> it seems that the specific reasons why the number of roots differs between populations is not clear. Single-rooted (0% to 3.9%), double-rooted (0% to 13.6%), four-rooted (0%-6%) and five-rooted (mainly by case reports) teeth in different populations are less common (Tables 1 and 2). Teeth with root morphological anomalies outside the expected norm can create treatment challenges. Additional roots can easily be overlooked during root canal treatment<sup>14</sup> and may also cause difficulties during extractions such as fracture of roots. The aetiology of additional roots is not completely understood but it has been speculated that disease, trauma, ethnicity, genetics and external pressure on the developing tooth could contribute to its formation.<sup>86-89</sup> Additional roots can form either by splitting or folding of the Hertwig's root sheath (HERS), thereby forming independent roots with a variety of morphological features.<sup>90</sup> The highest incidence of a fourth root, 6%, was reported in Saudi Arabia.<sup>10</sup> As mentioned earlier, an additional palatal root can be present on the mesio-palatal and is referred to as RML. In teeth where the additional root is present on the disto-palatal, it is referred to as RDL. These root morphologies have been described and classified by various authors.<sup>61,91</sup>

The case report described earlier depicts a rare case where both a RML and RDL were present. A thorough radiographic investigation is required to identify landmarks that might alert a clinician to the presence of additional roots or variations in root morphology. The use of magnification in the form of the dental operating microscope may assist in the location of hidden root canals. Specialised diagnostic tools such as CBCT provide a three-dimensional view and assist in the diagnosis of root canal configurations and variations in root morphology.<sup>14</sup> It is important that clinicians follow a methodical approach to identify this type of root morphology and use specialised diagnostic tools and equipment. Although it is appreciated that dental practices may have limited access to specialised tools, they can increase the rate of endodontic success if correctly applied.<sup>2</sup>

The same can be said for teeth displaying taurodontism. Careful examination of pre-operative radiographs including panoramic views is needed, as taurodontic traits may not exhibit any significant clinical characteristics.<sup>92</sup> Magnification can be very beneficial in identifying orifices on an apically displaced pulpal floor.

Maxillary first molars can also display fusion of different roots. According to Zhang *et al.*,<sup>73</sup> roots can display six types of fusion. The MB root can be fused to the DB root (Type 1); the MB root to the P root (Type 2); the DB root to the P root (Type 3); the MB root to the DB root and either the MB or DB root to the P root (Type 4); the P root with the MB and DB roots (Type 5); and the MB, DB and P roots all fused into a cone shape (Type 6). As with calculating the number of roots, CBCT has mainly been used to report on fused roots. Root fusion is created when the HERS fails to develop or fuses in the region of the root furcation, or it can form with increased age when more and more cementum is deposited, joining roots.<sup>72</sup> This is some of the most complex root canal morphology and often root canals are merged. It has been established that merged root canals can be present in 4.5% to 27.9% of teeth.<sup>5,6,8</sup> Authors have also stated that root fusion in maxillary molars is more complex than in mandibular molars as two or three can be fused, altering both internal and external morphology.<sup>8,73</sup> Clinicians should be aware that fused morphology can be present and diagnostic tools such as CBCT are valuable in establishing its presence. Even if a clinician does not have access to CBCT technology, a proper investigation of pre-operative radiographs is vital. It may alert a treating clinician to abnormal root and canal morphologies. Clinical observation during access cavity preparation is of paramount importance to identify any additional root canal orifices and roots.<sup>2</sup>

In conclusion, the external root morphology of the maxillary first molar can be diverse and the number of roots, root fusion, additional roots and taurodontism vary among populations. Investigations in African and South African populations are limited, as is the use of micro-CT in investigations. Findings in different populations are important for pre-operative diagnosis, the clinical management of affected teeth and the management of morphological root variants.

### Declaration

The authors declare that there is no financial interest in this paper and that this paper has not been submitted elsewhere for publication. All authors agree with the content of the manuscript. This manuscript did not receive any funding from funding agencies in the public, commercial, or not-for-profit sectors.

### Conflict of interest

We declare that there is no conflict of interest.

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## CPD questionnaire on page 56

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



# Bacterial contamination of disinfectants: prevalence and students' compliance with infection control practices

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## ABSTRACT

### Introduction

Contaminated disinfectants have been occasional vehicles of healthcare associated infections.

### Aims and objectives

To determine the presence and level of bacterial contamination of disinfectants used to decontaminate suction devices and to assess the extent to which students comply with infection control practices.

### Design

A two-part cross-sectional descriptive study consisting of microbiological testing of disinfectants and a questionnaire-based observation of students

### Methods

Unannounced observation of students disinfecting suction devices were recorded using a questionnaire. The process involved collecting a prepared disinfectant from a storage bin using a kitchen measuring jug. Specimens of disinfectants and swabs of jugs were collected for aerobic culture. Data pertaining to compliance with infection control practices was gathered.

### Results

Only 33.6% of the students were observed unannounced. An overwhelming majority (84.9%) of students disinfected suction devices; 52% cleaned and disinfected the external surface of suction hoses and the spittoon bowl; 18.6% allowed the disinfectant to remain in the system long enough, and 14% advised their patients not to close their lips around the suction device. The majority of disinfectant

samples (56.3%) as well jugs (55.6%) were contaminated with bacteria.

Conclusion Bacterial contamination of disinfectants was common in addition to poor compliance with infection control practices.

## INTRODUCTION AND BACKGROUND

Healthcare-associated infections are a major global safety concern for both patients and healthcare professionals.<sup>1</sup> The biofilm-derived microorganisms from contaminated hoses of dental chair suction devices – for example, the high-volume suction and saliva ejector – are a potential source of cross-contamination and cross-infection.<sup>2</sup> High-volume evacuation systems (HVE) prevent contaminated aerosols from escaping the immediate operating site.<sup>3</sup> Studies have shown HVE to reduce more than 90% of aerosols arising from the operative site.<sup>4,5</sup> The efficiency of HVE is determined by the suction force of the appliance, the proximity of the HVE to the operating site and the number of evacuators used.<sup>6</sup> Clinicians need to check the power and airflow volume of the HVE periodically.<sup>7</sup> Saliva ejectors prevent contaminated aerosols from escaping the mouth.<sup>3</sup> They may, however, create unsanitary conditions by allowing a backflow of previous patients' waste material or substances from the tubing into a patient's mouth. Three interrelated predisposing factors for backflow have been identified. They are: simultaneous use of saliva ejector and HVE; the positioning of the suction tubing attached to the ejector above the patient's mouth; and the presence of less pressure in a patient's mouth than in the saliva ejector.<sup>8</sup>

International Organization for Standardization (ISO) standards recommend manufacturers provide appropriate cleaning and disinfection directions to use on the suction devices unit which should be followed.<sup>9</sup> Failure to clean suction devices daily leads to biofilm growth, a heavy bioburden and a greater risk of infections. Daily cleaning protects the equipment and maintains full suction power.<sup>10</sup> Inadequate disinfection of suction hoses and bacterial contamination of disinfectants are additional potential sources of healthcare associated infections.<sup>11</sup> Boyle and colleagues (2015) demonstrated that the method of disinfection influences the effectiveness of decontamination of suction hoses.<sup>12</sup> They found that standard aspiration disinfection was more effective in decontaminating high volume suction hoses than low volume suction hoses and that standard aspiration was less effective than manual or automated flood disinfection.<sup>12</sup> Contaminated disinfectants and antiseptics have been occasional vehicles of health-care associated infections

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and pseudo epidemics for more than 70 years.<sup>13</sup> Two recent reviews (a scoping review and a systematic review) found glaring differences in risk factors for bacterial contamination between low- and middle-income countries and high-income countries. The differences were found at the level of container (reused, recycled or inadequate processing vs design and functioning, presence of cork and cotton, biofilm formation) preparation (place, utensils or tap water, high and incorrect dilutions vs nonsterile water, overdilution) and practices (topping up or too long use vs too long expiry dates, inappropriate container reprocessing, topping up of containers and deviations from procedures).<sup>13,14</sup> The reviews found similarities in contaminating bacteria between low- and middle-income countries and high-income countries. Non-fermentative Gram negative rods and Enterobacterales were the most frequent isolates from contaminated antiseptics, disinfectants and hand hygiene products.<sup>13,14</sup> Previous research reported that members of the genus *Pseudomonas* (*P. aeruginosa*, for example) were the most frequent isolates from contaminated disinfectants.<sup>15</sup>

It has been reported that contaminated disinfectants exhibit decreased efficacy and effectiveness.<sup>16</sup> Also of therapeutic significance are reports that a number of bacterial contaminants isolated from disinfectants have exhibited resistance to commonly used antimicrobial agents.<sup>17</sup>

This study was designed to investigate the potential for healthcare-associated infections related to the process of disinfecting dental unit suction systems.

## OBJECTIVES

To determine the presence and grade of bacterial contamination of disinfectants used to decontaminate suction devices.

To assess the extent to which students comply with infection control practices.

## MATERIALS AND METHODS

### Study design

This two-part cross-sectional descriptive study consisted of microbiological testing of disinfectants and a questionnaire-based observation of students during the process of disinfecting suction devices.

### Target populations

The two populations studied were dental students who had clinical sessions and prepared disinfectant solutions, and jugs used to draw the solutions from storage bins. The study was conducted between June and August 2022 at a dental school in Gauteng, South Africa.

### Dental students

Slightly more than one-third (33.6%) of the total population of 143 dental students had clinical sessions during the study period. At the clinics, students, in their classes, were organised into equal-sized groups and allocated dental chairs for the purposes of supervision. The number of groups and their size was dependent on class size.

### Disinfectant solutions

A total of 16 60-litre capacity storage bins contained the disinfectant solutions. Nine one-litre capacity kitchen measuring jugs were used to draw from the bins.

## Data collection

### Microbiological testing

Five millilitre samples of disinfectants were collected in sterile universal containers using sterile pipettes from storage bins at the clinics over a period of one week during the 11am to 1pm clinic session while sterile swabs (premoistened with sterile saline) were used to collect samples for aerobic culture from the walls of the jugs. All samples reached the laboratory within 2 hours of collection and were processed immediately upon arrival.

Disinfectant samples were cultured on blood agar, incubated at 37°C for 24–48 hours, using two different methods as specified by Danchavijitr and colleagues (2005).<sup>18</sup> Each labelled swab was uncapped and lightly rolled over the entire surface of a blood agar plate with the same label and incubated at 37°C for 48 hours. Resultant colonies were graded on a scale of 0 to 4+ based on the number of quadrants on each plate that showed positive growth according to the procedure used by Bible and colleagues (2009).<sup>19</sup> They were classified according to the Gram stain procedure of Engelkirk and Duben-Engelkirk (2008).<sup>20</sup> A selection of colonies was subcultured in blood agar and the bacteria identified in VITEK®2, an automated instrument used for the identification and antimicrobial susceptibility testing.

### Observation-based survey

Unannounced observation of individual third, fourth and fifth-year dental students in their groups was performed by the researcher and co-supervisor using a questionnaire adapted from the Centers for Disease Control and Prevention's (CDC) Quick Observation Tools (QUOTs).<sup>21</sup> The questionnaire consisted of a series of closed questions which could only be answered with a yes or no. The questions related to precautions, activities or practices which were necessary for infection control. The process of disinfecting dental unit suction systems involved collecting a prepared dental suction disinfectant from a storage bin using a jug. The dental suction disinfectant, Bacterex, was prepared i.e. 4 x 15 gram sachets of chlorine disinfectant cleaner powder were mixed in 60 litres of cold water, in cleaned and disinfected storage bins. It was stored out of direct sunlight. It was not freshly prepared on each workday. The storage bins were not labelled with the date prepared and the use-by date. The jugs used to draw the prepared dental suction disinfectant for aspiration disinfection of the suction devices were hygienic. They were stored in a dry, cool, clean environment. None of the nine jugs was graduated in units of volume i.e. millilitres and litres. The order in which the groups were observed was decided randomly – the groups were assigned numbers; these were thoroughly mixed and drawn at random without replacement. The third and fourth-year clinics were held separately in the same floor of the hospital. The agreement of the observations between the researcher and co-supervisor was assessed in one group of students in each class.

### Definition of variables and terms

Overwhelming majority refers to a majority that is about 70% or more.

Vast majority refers to a majority that is 85% or more.



### Ethical considerations

The study protocol was approved by the University Ethics Committee (SMREC/D/208/2020:PG). Permission to conduct the study was granted by the Chief Executive Officer (CEO) of the Oral Health Centre.

### Statistical analysis/Hypothesis testing

Collected data was captured and analysed in SPSS software. Means and proportions (percentages) were calculated. The Chi-squared tests was performed to test for the statistical significance of the differences in proportions of the summary of observations. The chosen significance level for the tests was a p-value equal to or less than 0.05.

### Results

The results of microbiological testing and the observation-based survey are presented separately.

### Microbiological testing

Data obtained from microbiological testing of prepared disinfectant and swabs of the walls of the jugs were analysed.

**Table 1: Presence and grades of bacterial contamination of prepared disinfectants by clinics**

Clinics	Grades of bacterial growth					Total number of storage bins
	0	1+	2+	3+	4+	
Third year	2	0	0	0	2	4
Fourth year	1	4	0	0	3	8
Fifth year	4	0	0	0	0	4
Total number of storage bins	7	4	0	0	5	16

Bacterial contamination was found in 56.3% of the samples. Grade 4+ bacterial growth was detected in 31.3% of the samples.

**Table 2: Presence and grades of bacterial contamination of the swabs of jugs by clinic**

Clinics	Grades of bacterial growth					Total number of jugs
	0	1+	2+	3+	4+	
Third year	2	0	0	0	1	3
Fourth year	0	3	0	1	0	4
Fifth year	2	0	0	0	0	2
Total number of jugs	4	3	0	1	1	9

Bacterial contamination was found in 55.6% of the samples. Grade 1+ bacterial growth predominated.

### Microscopy

The overwhelming majority of the bacteria were Gram-positive. Cocci in pairs, clusters or chains predominated. Rod-shaped single cells were also seen.

### Bacterial identification

**Table 3: Identity of bacteria isolated from prepared disinfectants and swabs of jugs**

Bacteria	Sample type	
	Prepared disinfectant	Swabs of jugs
Kocuria varians	√	√
Staphylococcus saprophiticus	√	√
Sphingomonas paucimobilis	√	-
Aeromonas salmonicida	√	-
Bacillus species	√	-

√ = Present - = Absent

Five different bacteria were isolated from the prepared disinfectant while only two were isolated from the jugs.

### Structured observations

Data gathered from structured observations of classes of third, fourth and fifth-year dental students were analysed.

**Table 4: Observation report of the third-year class**

Student observation	Summary of observations		Total n (%)
	Yes n (%)	No n (%)	
The student is using personal protective equipment	9 (100)	0 (0)	9 (100)
The suction lines are disinfected at the start of the clinic session	9 (100)	0 (0)	9 (100)
The recommended volume (250ml) of the disinfectant is drawn through each evacuation system line	0 (0)	9 (100)	9 (100)
The external surface of suction hoses is disinfected and cleaned daily through wiping	3 (33.3)	6 (66.7)	9 (100)
The spittoon is cleaned and disinfected at the same time as the suction lines	5 (55.6)	4 (44.4)	9 (100)
The suction cleaning solution is allowed to remain in the system for at least 10 minutes	0 (0)	9 (100)	9 (100)
Patients are advised not to close their lips around the suction device. Is the re a notice?	0 (0)	9 (100)	9 (100)

None of the students: drew the recommended volume of the solution through the evacuation system lines; advised patients not to close their lips around the suction device; allowed the disinfectant to remain in the system for at least 10 minutes before they started working. Merely a third of the students disinfected the external surface of suction hoses during the time that they were disinfecting the suction lines.

Table 5: Observation report of the fourth-year class

Student observation	Summary of observations		Total n (%)
	Yes n (%)	No n (%)	
The student is using personal protective equipment	29 (93.5)	2 (6.5)	31(100)
The suction lines are disinfected at the start of the clinic session	22 (71%)	9 (29)	31(100)
The recommended volume (250ml) of the solution is drawn through each evacuation system line	0 (0)	31 (100)	31(100)
The external surface of suction hoses is disinfected and cleaned daily through wiping	22 (71)	9 (29)	31(100)
The spittoon is cleaned and disinfected at the same time as the suction lines	16 (51.6)	15 (48.4)	31(100)
The suction cleaning solution is allowed to remain in the system for at least 10 minutes	6 (19.4)	25 (80.6)	31(100)
	6 (19.4)	25 (80.6)	31(100)

None of the students drew the recommended volume of the solution through the evacuation system lines. An equal proportion (19.4%) of students advised patients not to close their lips around the suction device as allowed the disinfectant to remain in the system for at least 10 minutes before they started working.

Table 6: Observation report of the fifth-year class

Student observation	Summary of observations		Total n (%)
	Yes n (%)	No n (%)	
The student is using personal protective equipment	3 (100)	0 (0)	*3 (100)
The suction lines are disinfected at the start of the clinic session	3 (100)	0 (0)	*3 (100)
The recommended volume (250ml) of the solution is drawn through each evacuation system line	0 (0)	3 (100)	*3 (100)
The external surface of suction hoses is disinfected and cleaned daily through wiping	3 (100)	0 (0)	*3 (100)
The spittoon is cleaned and disinfected at the same time as the suction lines	3 (100)	0 (0)	*3 (100)
The suction cleaning solution is allowed to remain in the system for at least 10 minutes	2 (66.7)	1 (33.3)	*3 (100)
Patients are advised not to close their lips around the suction device	0 (0)	3 (0)	*3 (100)

\*A total of eight students were present during the session. Of these, only three were observed. Trainee dental assistants disinfected the suction lines of the dental chairs of five students.

Table 7: Interclass comparison of the summary of observations

Student observation	Year of study						Chi-squared test
	3rd Year		4th Year		5th Year		
	Yes	No	Yes	No	Yes	No	
The student is using personal protective equipment	9	0	29	2	3	0	
The suction lines are disinfected at the start of the clinic session	9	0	22	9	3	0	
The external surface of suction hoses is disinfected and cleaned daily through wiping	3	6	22	9	3	0	
The spittoon is cleaned and disinfected at the same time as the suction lines	5	4	16	15	3	0	
The suction cleaning solution is allowed to remain in the system for at least 10 minutes	0	9	6	25	2	1	
Patients are advised not to close their lips around the suction device	0	9	6	25	0	3	

The differences in the proportions of summary of observations between the classes by year of study was significant for the observations: the spittoon is cleaned and disinfected at the same time as the suction lines ( $p=0.007$ ); the suction cleaning solution is allowed to remain in the system for at least 10 minutes ( $p=0.001$ ) and patients are advised not to close their lips around the suction device ( $p<0.001$ ).

Of the three students observed, two allowed the disinfectant to remain in the system for at least 10 minutes. None of the students drew the recommended volume of the solution through the evacuation system lines.

## DISCUSSION

This study set out to determine the presence and level of bacterial contamination of prepared suction system disinfectants and observe students' compliance with infection control practices.

### Microbiological testing

The most interesting finding was that the majority of the samples of prepared disinfectants (56.3%) and of the jugs (55.6%) were contaminated with bacteria. Bacterial contamination of a disinfectant prepared by dissolving a known mass of solute in a known amount of solvent has not previously been described. A great deal of the previous research has been performed on disinfectant prepared by diluting a stock solution.<sup>11,13,16</sup> The prevalence of contamination recorded in this study is 15% higher than the 40% range of published previous studies (3%,<sup>22</sup> 6.1%,<sup>23</sup> 7.9%,<sup>24</sup> 34.4%<sup>25</sup> and 43%<sup>11</sup>). It seems possible that the jugs played a significant role in the contamination of the disinfectants.

Another important finding was that the highest grade (4+) of bacterial growth was recorded in 31.3% samples of the prepared disinfectants. This rather disappointing finding suggests that the bacteria were able to adapt and multiply in solutions.<sup>26</sup> This could be related to the reduced efficacy of the disinfectant.<sup>27</sup> The factors that are known to affect the efficacy of disinfectants include: pH, concentration, temperature structure,<sup>15</sup> nature, composition and condition of the organism,<sup>28</sup> organic and inorganic load present, type and level of microbial contamination, presence of biofilms,<sup>15</sup> overdilution of disinfectants, poor personal hygiene, non-adherence to proper techniques in their uses and reuse, and improper storage.<sup>29</sup> The factors that may have played a role in this study are too long use and too long expiry dates related to the fact that storage bins were not labelled.

### Microscopic identification

The results of this study show that gram-positive cocci were the predominant organisms. Although these results differ from some published studies,<sup>14,15</sup> they are consistent with those Kgabi (2015) who found mainly gram-positive cocci and some gram-negative bacilli in samples of antiseptics and surface disinfectants.<sup>30</sup>

### Biochemical identification

Bacteria cultured in this study were identified as *Kocuria varians*, *Staphylococcus saprophiticus*, *Aeromonas salmonicida*, *Sphingomonas paucimobilis* and *Bacillus* species. The findings of the current study do not support the previous research in that neither *Enterobacteriales* nor *P. aeruginosa* were isolated from the disinfectants.<sup>13-15</sup> It seems possible that the contaminants isolated in this study originated from hand contact or oral contamination as they naturally inhabit the skin and mucous membranes.<sup>31,32</sup>

## OBSERVATION-BASED SURVEY

### Response rate

The results of this study show that the response rate was low at an average of 34%. This finding was unexpected. There are several possible explanations for this result: students were away on off-campus rotations; patients did not honour appointments and the days of data collection for the study coincided with test dates. The data of the observation-based survey must be interpreted with caution because the sample is not representative of the population as a whole.

The results of this study show that a vast majority (95.3%) of students used personal protective equipment during the time that they were disinfecting the suction lines (Table 7). It is disappointing that a few students (almost five percent) disregarded safety

precautions. The health effects of the chlorine-based disinfectant include the irritation and burning of eyes and hands, among others.

The results of this study indicate that an overwhelming majority (79.1%) of students disinfected the suction lines at the start of the clinic session (Table 7). The present finding confirms the existence of a disinfection policy at the clinics. This is consistent with the results of Shah and colleagues (2007) who found that 92% of orthodontics departments in the United Kingdom had a policy to disinfect waterlines and suction tubing.<sup>33</sup> It is rather disappointing that 20.9% of the students did not follow the policy as it is well established that improperly disinfected suction apparatus provides a favourable environment for biofilm proliferation.<sup>12</sup>

The most interesting finding was that none of the students drew the recommended volume of the solution through the evacuation system lines (Tables 4-6). This finding is not surprising considering that none of the nine jugs used was graduated in the most common units of volume i.e. millilitres and litres. Failure to follow the manufacturer's recommendation may affect the efficacy of disinfection practices.<sup>34</sup>

Another important finding was that a little less than 20% (18.6%) of the students allowed the disinfectant to remain in the system for at least 10 minutes before they started working (Table 7). One unanticipated finding was that the contact time for the disinfectant used (Bacterex) was five minutes.<sup>35</sup> This oversight makes it difficult to explain the results of this study. The oversight was due to the fact that most EPA-registered hospital disinfectants have a label contact time of 10 minutes.<sup>15</sup>

The results of this study show that the proportion of students who cleaned and disinfected the external surface of suction hoses together with the spittoon bowl at the same time as the suction lines varied widely i.e. the ranges were 66.7% and 48.4% respectively (Table 7). It is very concerning that not all students cleaned and disinfected the external surface of suction hoses and the spittoon bowl for the reason that *Staphylococcus* and *Bacillus* species have been isolated from these surfaces.<sup>36</sup>

The results of this study show that at most 14% (6 out of 43) of the students advised their patients not to close their lips around the suction device (Table 7). This result has not previously been described. This result may be explained by the fact that there were no notices in the clinics reminding student to comply with this recommendation. This finding is rather disappointing considering that the cross contamination potential of saliva ejectors has been investigated and reported on since 1990s. Although there is no direct proof of cross-contamination, a great deal of research has indicated that fluid can flow backward in low-volume suction lines when patients close their lips around the saliva ejector tip.<sup>37-39</sup>

## LIMITATIONS

## CONCLUSION

The current study found that bacterial contamination of disinfectants was common in addition to poor compliance with infection control practices.

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# Comparative evaluation of shear bond strength to dentin with three different aesthetic chemically bonded restorative materials – an *In-vitro* study

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## ABSTRACT

### Introduction

The use of glass ionomer cements (GIC) as a restorative material was limited to areas of low masticatory forces due to their low mechanical properties which were also affected by the powder/liquid mixing ratio of this material. Bond strength is important for the clinical success of adhesive material. The shear bond strength (SBS) is the maximum force that an adhesive joint can tolerate before fracture which is tested by SBS tests. The high bond strength helps the adhesive to resist stresses caused by resin contraction and forces for a longer time and thus prevents the problems of bond failure such as recurrent caries, tooth sensitivity

and restoration failure. GIC as a restorative material has the capacity to release fluoride and shows good bonding ability. The use of GIC in anterior applications appears to be satisfactory, but they have limitations for use in permanent posterior teeth, particularly with regard to large restorations. Zirconia-reinforced GI (Zirconomer, Shofu Inc, Japan) is a new class of restorative material containing reinforced glass ionomer with special zirconia fillers that promises the strength and durability of amalgam with the protective benefits of glass ionomer while eliminating the hazards of mercury. Amalgomer CR (Advanced Health Care, Tonbridge, Kent, UK), a novel ceramic-reinforced GIC, was introduced, which combines the benefits of GIC with the high strength of ceramics. In the present study, shear bond strength to the dentin with Zirconomer, Amalgomer CR and Fuji type IX GIC (GC Tokyo) are compared.

### Aim

To evaluate the shear bond strength of three different aesthetic materials to dentin.

### Methodology

Thirty extracted human molar teeth were taken, cleaned, stored and the occlusal surfaces of the teeth were flattened with a straight fissured bur at a depth of three millimetres until dentin was exposed. Acrylic blocks were prepared by cold cure acrylic resin and the samples were embedded into the blocks and conditioning of dentin was done using dentin conditioner (GC Corporation Tokyo, Japan). Out of 30 dentin-exposed samples, 10 samples were restored with Zirconomer, the other 10 with Amalgomer CR and the remaining 10 with GIC respectively. All the specimens were transferred to the universal testing machine individually and subjected to shear bond strength analysis.

### Result

Statistical analysis was done for all three groups by using descriptive statistics that include one-way ANOVA and Tukey's multiple post hoc procedures for intergroup comparison.

### Conclusion

Zirconomer showed better shear bond strength than Amalgomer CR and GIC.

### Keywords

Zirconomer, Amalgomer CR, glass ionomer cement, shear bond strength.

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## INTRODUCTION

The most common cause of tooth loss is dental caries which impairs the structure and function of the particular tooth.<sup>1</sup> This lost tooth structure is restored with restorative materials that regain aesthetic, functional and biological properties.<sup>2</sup> The need for restorative material with better adhesion and strength to withstand the stress of masticatory forces led to recent advances in restorative dentistry.<sup>3</sup>

Bond strength is one of the most important mechanical properties of a restorative material which restores the tooth structure in the posterior region.<sup>4</sup> Bond strength is defined as the amount of force required to break the connection between a bonded restoration and tooth surface with failure occurring in/near the adhesive interface.<sup>5</sup> Restorative material with poor mechanical properties will adversely affect the longevity of the tooth structure and the restoration, and a premature failure of restoration will. The base for aesthetics is laid by position, contour, texture and colour.<sup>7</sup> In the 1960s composites were used as an alternative to silicate cements and unreinforced methyl methacrylate direct filling resins for the restoration of anterior teeth (Bowen, 1962,1965a) and, in 1972, Wilson and Kent introduced an aesthetic restorative material – glass ionomer cement (GIC).<sup>8</sup> In 1962, Bowen developed the Bis-GMA monomer in an attempt to improve the physical properties of acrylic resins, as their monomers only allowed linear chain polymers to be formed. These early chemically cured composites required the base paste to be mixed with the catalyst, leading to problems with the proportions, mixing process and colour stability.<sup>9</sup> In 1970, composite materials polymerised by electromagnetic radiation appeared, doing away with mixing and its drawbacks.<sup>10</sup> GIC material bonds directly to teeth by chemical adhesion and also has a remineralising capacity because of fluoride content.<sup>11</sup> Since GIC has some disadvantages including lack of hardness and fracture resistance, low abrasion resistance and moisture sensitivity, many new aesthetic restorative materials were introduced with improved mechanical properties.<sup>12</sup>

Recently, a novel material called zirconia-reinforced glass ionomer cement was introduced which is also called “white amalgam” or “Zirconomer” and contains zirconium oxide, glass powder, tartaric acid (1-10%), polyacrylic acid (20-50%) and deionised water as its liquid.<sup>13</sup> In the early 1990s, zirconia was used in endodontic posts, implant abutments and hard framework cores for crowns and fixed partial dentures (FPDs).<sup>14</sup> Amalgomer CR, a novel ceramic-reinforced GIC, was introduced in the 2000s.<sup>15</sup> This tooth-coloured cement combines the benefits of glass ionomer cement with the high strength of ceramics.<sup>16</sup> The mechanism of bonding of Zirconomer and Amalgomer CR with the dentin is chemical in nature, thus lacking the reinforcement of bond with micromechanical interlocking.<sup>17</sup>

There are many in vitro studies and clinical trials conducted on the compressive and flexural strength of these materials but very few studies were done on shear bond strength. So, in the present study, the shear bond strength of dentin with Zirconomer (Shofu, Japan), Amalgomer CR and glass ionomer cements (GC Corp)

## MATERIALS AND METHODS

### Sample collection

#### Inclusion criteria

Thirty caries-free upper and lower permanent human molars that were extracted for periodontal reasons were collected, cleaned and then stored in distilled water until used for the study.

#### Exclusion criteria

Teeth with previous restorations, visible cracks, decay, fracture, abrasion or structural deformities.

#### Sample preparation

Teeth were mounted on self-cure acrylic blocks by using metal molds to embed the root portion and to expose the crown portion only. Then 3mm of the coronal tooth structure was removed using a diamond abrasive to expose the occlusal dentine. (Figure 1a). Teeth were randomly divided into three groups of 10 specimens each and restored as follows: Group 1: Zirconomer (Zirconomer improved-Zirconia reinforced glass ionomer cement, Shofu, Japan) (n=10), Group 2: Amalgomer CR (n=10) and Group 3: Glass Ionomer Cement (GC Corporation, Tokyo, Japan) (n=10). Conditioning of dentin was done to all the samples using a dentin conditioner (GC Corporation Tokyo, Japan) that contained 10% polyacrylic acid for 10 seconds. The surface was rinsed thoroughly with water and then blotted with a cotton pellet to remove excess water. Powder and liquid were hand mixed until putty-like consistency in a ratio of 1:1 according to the manufacturer's instructions (Figure 1b,c)<sup>18</sup> and cements were placed onto the occlusal surface using a straw as a template which was cut into dimensions (4mm x 4mm<sup>2</sup>) (Figure 1d).<sup>19</sup>

#### Experimental procedure

A universal testing machine was used to evaluate the shear bond strength, whereby the crosshead speed was 0.5mm/minute<sup>1</sup> and the load applied was 1kilonewton for all the samples. The shear bond strength of all samples was obtained and checked for statistical analysis (Figure 1e).

## RESULTS

Data were analysed using SPSS Version 20.0 with descriptive statistics that include one-way ANOVA and Tukey's multiple post hoc procedures for intergroup comparison. Statistical analysis was done for evaluating the bond strength. Table 1 shows the mean and standard deviation of shear bond strength values of different experimental groups. Group 1 showed the highest shear bond strength followed by Groups 2 and 3 (Graph 1). In Table 2, the shear bond strength of Zirconomer to dentin showed a statistically significant difference with Amalgomer CR and GIC ( $p < 0.001$ ).

Table 1: Descriptives: Mean and SD for all groups

	Group 1	Group 2	Group 3
Group 1	-	0.003 (S)	0.000 (S)
Group 2	0.003 (S)	-	0.000 (S)

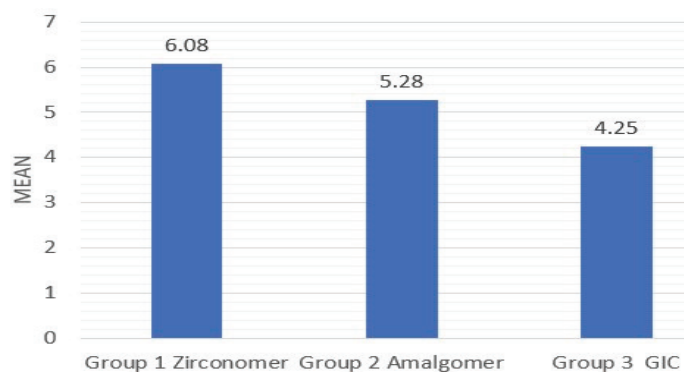
P-value is <0.001\*

## DISCUSSION

In the oral cavity, restorations undergo stress from masticatory forces producing different reactions that lead to deformation, which can ultimately compromise their



Table 2: P-value Tukey's post hoc test for pair-wise comparison



durability over time.<sup>20</sup> The selection of restorative material is mainly based on mechanical properties and manipulation.<sup>21</sup>

Among various mechanical properties, the bond strength of restorative materials is important because it usually replaces a large bulk of tooth structure and should give enough strength to resist the intraoral masticatory forces.<sup>22</sup>

The clinical success of restorative materials depends on good adhesion with tooth surfaces and resistance to various dislodging forces acting within the oral cavity.<sup>23</sup> The shear bond strength is described as the resistance to forces that slides restorative material past tooth structure.<sup>24</sup> It is assumed to have greater clinical importance because the most dislodging forces at the tooth restoration interface have a shearing effect.<sup>19</sup> Therefore, high shear bond strength shows better bonding of the restorative material to the tooth.<sup>25</sup> Many aesthetic materials like Zirconomer, Amalgomer CR and so on were introduced for better mechanical properties.<sup>26</sup>

In the present study, Zirconomer showed better SBS than Amalgomer CR and GIC. Zirconomer possibly exhibited superior

bond strength as the powder has various grain sizes and other ingredients such as yttrium oxide and alumina that are evenly dispersed throughout the substance. The material's porosity and translucency are influenced by the different grain sizes. This is in correspondence with the study done by Chalissery *et al.*<sup>14</sup> It showed improved resistance to erosion and abrasion, which is attributable to the cement's strength being derived from the ongoing development of aluminium salt bridges.<sup>27</sup> Zirconia is recognised as being a good material for strengthening and toughening in several contexts due to the special character of phase shift from tetragonal phase to monoclinic phase under stress.<sup>28</sup> This transformation produces a 4% change of volume which generates local compressive stress, which then offsets crack opening tension and so inhibits crack propagation and increases the incorporating material's fracture resistance.<sup>29</sup>

In the present study, Amalgomer CR showed better SBS than GIC but less SBS than Zirconomer. According to S Srinivasa Murthy *et al.*,<sup>30</sup> micronisation of the main glass components in the Amalgomer CR powder caused an increase in tensile strength, flexural strength and fracture toughness than those of conventional GICs and these properties could have made Amalgomer CR more resistant to shear stress.<sup>31</sup>

GIC showed less SBS than Zirconomer and Amalgomer CR because of its inferior mechanical properties such as low fracture toughness, tensile strength and brittleness when compared to other restorative materials and so it is better to avoid GIC in stress-bearing areas.<sup>23</sup> The bond strength tests for GICs cannot always express the interface bond strength as they report cohesive failures within the material, limiting the results to material strength.<sup>26</sup> The composition of GIC consists of powder: silica, alumina, aluminium fluoride, calcium fluoride, sodium fluoride and aluminium phosphate. Liquid: polyacrylic acid. The powder/liquid (P/L) ratio is one of the factors indicated in altering the mechanical properties of GICs; the higher amount of powder, the higher the mechanical properties.<sup>32</sup> The reason for less SBS than Zirconomer and Amalgomer CR is a modification of the powder composition

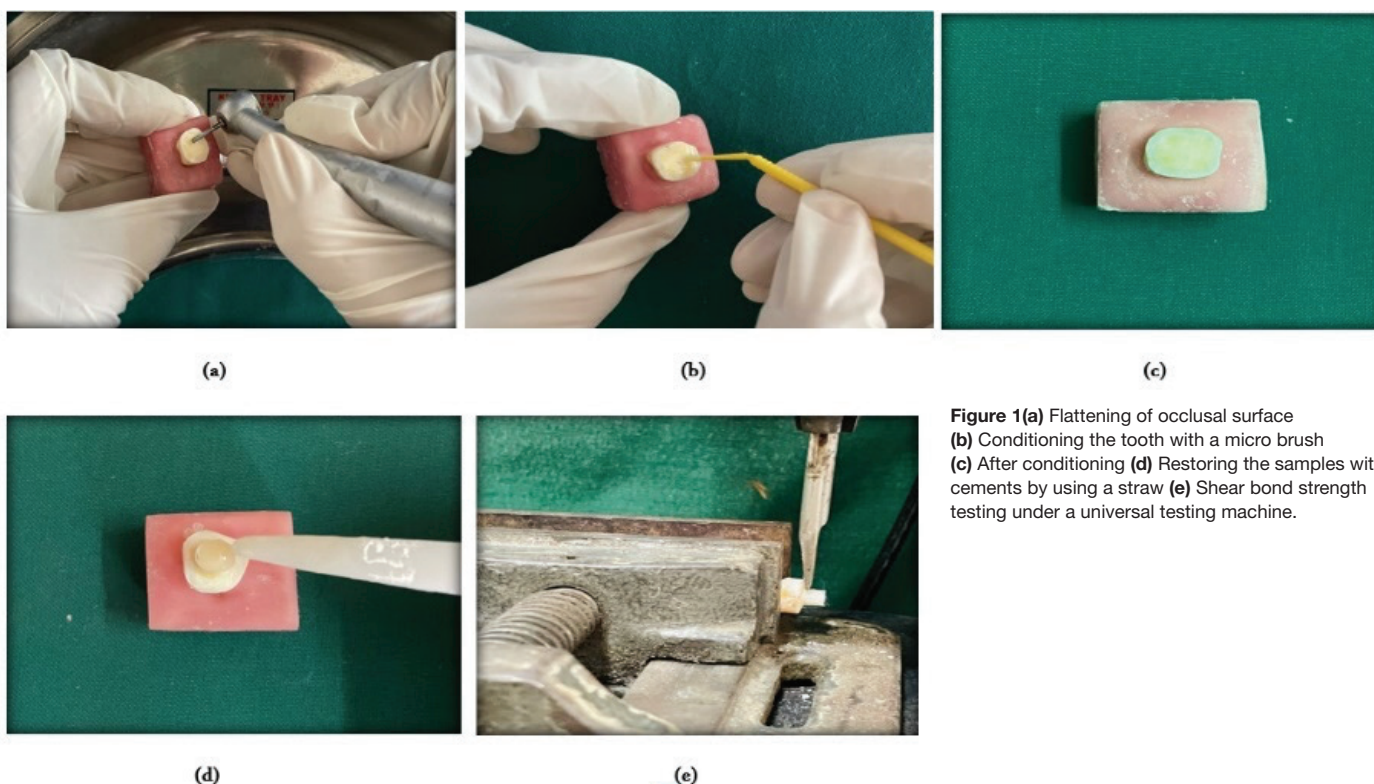


Figure 1 (a) Flattening of occlusal surface (b) Conditioning the tooth with a micro brush (c) After conditioning (d) Restoring the samples with cements by using a straw (e) Shear bond strength testing under a universal testing machine.

of GIC. The bonding strength of Zirconomer was increased by adding zirconia filler particles to the glass component of GIC.<sup>18</sup> Amalgomer CR powder includes a particulate ceramic component to increase its strength, supposedly without sacrificing the appearance or other general characteristics of GIC.<sup>33</sup> The manufacturer of Amalgomer CR claims the ceramic filler can partially react with the matrix to provide some bonding, increasing the overall strength of the restoration.<sup>34</sup>

## CONCLUSION

- Within the limitations of the in vitro study, all groups showed good shear bond strength with dentin.
- So, in comparison: Group 1 – Zirconomer showed the highest SBS followed by Group 2 – Amalgomer CR, and then with the least SBS is Group 3 – GIC.

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### Conflict of interest

None

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# CPD questionnaire on page 56

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



# Oral health care service delivery in schools for special needs in eThekweni District, KwaZulu-Natal

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## ABSTRACT

### Introduction

Caries and gingival disease are prevalent oral health issues affecting more than 80% of school-going children including those with special needs attending special schools. Schools play a crucial role in promoting oral health, providing education and identifying issues early. These school-based health programmes are essential for addressing these issues and can reach more than 1 billion children worldwide, as well as school staff, families and the community.

### Aims and objectives

To determine the current delivery of oral health care programmes in the identified special schools by means of a semi-structured interview with school managers.

### Design

A descriptive qualitative study design.

### Methods

All school managers (principals) who were responsible for the facilitation of the implementation and delivery of oral health services in each of the 22 special schools were invited to participation in the study. Purposive sampling was used to select the managers at the various special schools. Data collection comprised face-to-face, semi-structured interviews to explore the specific provision of oral health-related interventions and programmes (1 interview was conducted per school, n=22).

## Results

Six emergent themes were present in the study: oral health activities, implementation and evaluation process, implementation challenges, policy content perceptions, dental examinations and oral health prevalence in special schools. Oral hygiene was identified as a priority, with educators and school nurses responsible for school oral health education, supervised teeth brushing programme, pain management, oral examinations in some cases and referral for dental treatments through engaging parents, learners and health workers in oral health promotion, which was supported by the school's health policy with the departmental heads responsible for programme evaluation. However, the implementation of the programmes was impacted by five factors: lack of parental support, lack of professional guidance, lack of resources, lack of support from the oral health department and the Covid-19 pandemic further exacerbated these challenges.

## Conclusion

The study reveals that special schools have preventative and promotive oral health programmes, but they need therapeutic or curative services to address unmet treatment needs. Factors affecting these programmes have led to gaps in implementation processes. Together, these findings point to an urgent need for a review of oral health care programmes in KwaZulu-Natal special schools to ensure proper support and collaboration between key stakeholders to reduce negative effects and improve overall oral health programmes.

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### Conflict of interest

The authors declare that there is no conflict of interest.

## INTRODUCTION

Every day, learners with special needs deal with the negative effects of each of their unique disabilities, including the manner in which these effects impact their oral health.<sup>1</sup> The South African National Oral Health Policy, which presents measures to address learners' oral health needs in school settings, the Integrated School Health Policy document (2012) and the School Health Policy and Implementation Guidelines (2011) all suggest that learners' oral health needs are to be identified and addressed through targeted services offered to specific age groups.<sup>2-6</sup> These include oral health screening, fissure sealant placement on permanent molar teeth, fluoride varnish treatments and the administration of Atraumatic Restorative Technique (ART).<sup>7</sup>

Oral health-related problems, namely caries and gingival disease, are among the most widespread conditions in the human population, affecting more than 80% of school-going children. This has been noted in the special schools as well. A study conducted in Turkey reported 84% of decayed teeth among individuals with disabilities.<sup>8</sup> Furthermore, the oral hygiene status of participants was poor, with heavy plaque accumulation found in approximately one in three subjects.<sup>8</sup> The results reported that people with intellectual disabilities



had poorer oral health. This included greater numbers of tooth extractions, more caries, fewer fillings, greater gingival inflammation, greater rates of edentulism, had less preventative dentistry and poorer access to services when compared to the general population.<sup>9,10</sup> According to a study conducted on children with special health care needs in Ile-Ife, Nigeria, the majority of the decayed teeth were left untreated and 49.0% had progressed to involve the pulp.<sup>11</sup> Contrary to these findings, a study conducted in Johannesburg, South Africa (SA) reported that children with special health care needs had lower caries prevalence compared with the general population. However, they also had higher unmet treatment needs regardless of their type of disability.<sup>12</sup>

Many oral health conditions are preventable and reversible in their early stages.<sup>13</sup> However, there is a lack of reported awareness among learners, parents, caregivers and educators on the causes and prevention of oral disease (particularly in people with special needs). The disability also makes most of these individuals dependent on parents, siblings and caregivers for general care as well as oral hygiene, especially among the young, severely impaired and institutionalised.<sup>14</sup> Most of these caregivers may not have the necessary knowledge to recognise the importance of oral hygiene and proper diet. This lack of knowledge may result in these individuals being pampered with unhealthy food or cariogenic snacks, eventually disregarding oral hygiene practices and failing to seek necessary oral care as recommended.<sup>15</sup> There are 1,179 schools in SA of which 464 (40%) are special needs schools and 14% (64) of those special schools are located in KwaZulu-Natal.<sup>16</sup> Schools are one of the important settings for oral health promotion, oral health education and early identification of oral health-related issues. Schools can reach more than 1 billion children worldwide – this could also involve the school staff, families as well as the community at large.<sup>9</sup> This is normally accomplished through school-based health programmes. SA has recognised the value of school-based interventions that include oral health initiatives.<sup>17</sup> However, the evidence is lesser in special schools.

This iterates the need for preventive measures and improved access and availability of oral health clinical care for children with special needs.<sup>18</sup> The school environment is capable of carrying out combined preventive and promotive oral health programmes provided these are adequately funded with sufficient resources.<sup>17</sup> Therefore, there should be an emphasis on appropriate oral health promotion activities for individuals with special needs. Such activities could include improving the health literacy and quality of care to caregivers, and providing the dental team with specialised training related to special needs dentistry.<sup>19</sup> The school environment as part of the health promotion settings approach, therefore, requires further interrogation to determine the viability of offering such services.

This study is part of a bigger study which aims to determine oral health needs for school-going children with disabilities in KwaZulu-Natal eThekweni district. This will be achieved through a systematic collection of commonly occurring oral health-related epidemiological data, as well as by implementing and evaluating an oral health promotion intervention in selected schools, so as to inform a framework

for oral health care for children with special needs. However, the objective of this paper was to determine the current delivery of oral health care programmes in the identified schools by means of a semi-structured interview with school managers. This was conducted to assess the extent to which oral health care programmes are implemented and evaluated within the special needs schools located in eThekweni district. The study concentrated on these four major categories: Oral health policy, oral health programmes, contextual variables influencing oral health promotion and prevalence of oral conditions.

## METHODS AND MATERIALS

### Study design

An exploratory study design was used for the qualitative data collection of this study.

### Setting

Participants in this study were school managers (principals) chosen from a community of special schools in the eThekweni district, KwaZulu-Natal (KZN), South Africa.

### Study participants

All school principals were invited to participate in the study. These managers were responsible for the facilitation of the implementation and delivery of oral health services in each of the 22 special schools that gave consent to participate in the study.

### Study size

Purposive sampling was used to select the managers at the various special schools. The inclusion criteria included all identified school principals who had been at least employed in the identified special school for a minimum period of one year in order for them to have a clear understanding of how the school runs (n=22).

### Ethical consideration

The study was approved by the University of KwaZulu-Natal's Biomedical Research Ethics Committee (BREC00003814/2022) and ethical procedures were followed to protect data confidentiality. The KZN Department of Education granted the gatekeeper permission to access the study participants.

### Data sources/measurement

Data collection comprised a face-to-face, semi-structured interview with 22 principals who volunteered to participate in the study; one interview was conducted per school. The purpose of the interview was to explore specific oral health priorities of the facilities' provision of health interventions, screening programmes for oral disease identification, policy statements on oral health care, integration of oral health into general healthcare within the primary healthcare (PHC) system and the dietary practice at school. The interview schedule included questions such as: Does the special school have a comprehensive oral health promotion programme? If yes, who is responsible for its implementation? How do budgets affect the implementation and sustainability of the programme? List all oral health services and oral health promotion provided by the facility. Which methods are used to evaluate your oral health promotion programmes? The questions also include further probes such as: What evidence is available in terms of statistical annual reports or

records to prove or support that oral health programmes are included and implemented in the school? and What are the barriers and challenges facing the staff in implementing oral health promotion? which were used to obtain responses in knowledge and comprehension.

For the data collection procedure, interviews were conducted with the identified school principals as per their choice and availability. Informed consent was obtained from all participants before the interview commenced. The audio recording was only done when permission was obtained from the interviewee and after all issues of confidentiality were explained. The researcher was engaging with participants by impartially presenting questions, while paying close attention to participants' responses, for approximately 30 minutes in duration, from August to September 2022. Field notes were made after the interviews.

### Data analysis

Thematic analysis was used to analyse the qualitative data, the analysis was inductive. Responses from interviews were transcribed verbatim and checked for quality. The initial set of codes representing the meaning and patterns were refined and coded. Links were formed between the codes and supporting data, codes were further grouped into themes and the themes were reviewed and revised. The conclusions drawn from the analysed data and the results were then presented as a narrative. The data analysis process was conducted in four stages – finding initial concepts, coding the data, sorting the data by theme and interpreting the data. Trustworthiness was created by ensuring that the questions asked of interviewees were closely related to the study's purpose. Data saturation

occurred during the first 11 interviews, despite the fact that the fundamental components of the meta themes were already present in the first five interviews. Confirmability was established by using actual quotes to convey the opinions of participants. Individual member checking was done through one-on-one conversation verbally throughout the interviews. Techniques such as paraphrasing and summarisation were used to clarify participants' answers. An email was then sent after the interviews were transcribed, asking for feedback on themes from the participants.

### RESULTS

Based on the three groups of interview questions, six themes were developed from the data. The first group focused on oral health programmes, which included three themes: (1) oral health priorities, (2) oral health activities, (3) implementation and evaluation process. These themes highlighted the current oral health programmes offered by special schools as part of oral health education and promotion, by describing the contributions and challenges encountered by schools when raising health awareness to prevent oral conditions and assisting learners in developing oral health care skills, as it involves parents, educators, health workers and the health department. The second group focused on oral health policy, with one theme – perceptions of policy content. This theme analysed policy contributions in oral health, based on the existing oral health policy, policy implementation and policy evaluation. The final group was the oral conditions, which included two themes – dental examinations and prevalence of oral conditions, which highlighted the current state of oral health conditions among learners with special needs attending special schools in KZN.

Groups	Themes	Codes	Illustrative quotes
Oral conditions	Dental examinations	Examination	<i>No, our nurse mostly addresses oral health complaints once there is pain and refers for additional testing and care, so we are reactive in a sense. However, without access to regular check-ups etc, it is difficult to know what interventions are needed (P3). Yes, since we have routine monthly check-ups to assess their general oral health and medication review (P1&amp;5).</i>
	Prevalence of oral conditions	Estimation of conditions	<i>There is generally a relatively moderate prevalence of caries, and low prevalence of periodontitis and gingivitis (P1&amp;5).</i>
		Evidence or oral conditions	<i>All this data is kept by the school sister (medical staff) in each student's health file (P1&amp;5).</i>
Oral health programmes	Oral health priorities	Oral health priorities	<i>Oral hygiene</i>
		Oral health promotion programmes	<i>Yes, tooth brushing programme, oral health education lessons including dietary advice and monthly mouth check-ups (P1). Yes, tooth brushing programme, oral health education lessons (P3).</i>
	Oral health activities	Staff responsible for implementation	<i>Educators, together with their assistants (P3). Medical staff (professional nurse, speech therapist (P1).</i>
		Evidence of oral promotion programmes	<i>Yes, teacher lesson plan (P3) and curriculum (P2). Professional nurse monthly record together with the health file of the learner (P1).</i>
		Evaluation of oral health programmes	<i>Quality management programmes, assessment worksheets (P1&amp;11). Departmental heads (P1).</i>
	Is the programme working?	<i>Yes – the oral health status of students has improved from the time they initially come to the school and we can identify caries early now (P1).</i>	

Implementation Challenges	Barriers and challenges	<i>Parents who don't teach their kids to brush their teeth or continue what was learnt in school (P1,2&amp;11). Little professional guidance in terms of oral health needs of learners and interventions needed (P3).</i>
	Support of other departments	<i>It is lacking, City Health used to do many years ago but there is nothing we are getting currently (P1) .</i>
	Food service providers	<i>Yes, they are not allowed to serve unhealthy food (P2).</i>
	Resources	<i>Time due to curriculum demands (P4), inadequate facilities, tools, resources and finances (P5,8&amp;10).</i>
	Pandemic	<i>Covid-19 has placed a hold on the implementation of programmes (P6).</i>
	Budgetary allocation	<i>Parents do provide the resources that cost money, like toothpaste and toothbrushes, for their kids, so the school only pays the water bill (P1). Lack of funds makes it impossible to go on with toothbrushing programmes, since we lack resources like toothpaste and toothbrushes. We are fully dependent on donations from companies like Colgate (P2).</i>
	Skills	<i>The staff all had little to no professional guidance in terms of oral health needs of learners.</i>
	Training	<i>Yes, because when teachers come in, they are not aware that they need to teach students how to brush (P2).</i>
	Areas of improvements	<i>Yes – we need a more proactive approach and support from the oral health department and companies like Colgate, especially with resources and education and dental screenings through oral health care workers visiting the school on a regular basis (P3).</i>
	Policy	Perceptions of policy content
Oral health policy objectives		<i>1) To enhance oral health through programmes with oral health departments, 2) Proper brushing of teeth twice a day, 3) Oral health education as part of our curriculum (P1).</i>
Policy implementation		<i>Yes, a health and safety policy is currently implemented at the school but not a specific oral health policy.</i>
Implementation effect		<i>The implementation will definitely improve the oral health status of students and the lack of implementation will not improve the oral health status of the students.</i>
Evaluation		<i>This is done by the department of education .</i>

## ORAL HEALTH PROGRAMMES

### Theme 1: Oral health priorities

Many interviewees stated that oral hygiene was a priority in their schools. This was addressed in a variety of ways by educators' efforts to promote learners' oral health, including: providing oral health education and dietary advice in the health education lesson or life skills lesson, supervised tooth brushing programme, in which educators frequently check that learners have brushed their teeth in the morning, after meals and before going to bed for those who are boarding. Pain management and oral examination was only offered by a few schools

Please provide oral health priorities that your oral health care programme addresses in the school.

*Oral hygiene and oral health education*

Are there any oral health services or oral health promotion programmes that are provided by the school to meet the oral health priorities? If yes, please list them.

*Yes, Tooth brushing programme – teachers check that learners have brushed their teeth in the morning, after meals and before going to bed. Oral health education lessons including dietary advice and monthly mouth check-ups (P1).  
Yes, Tooth brushing programme and oral health education lessons (P3).*



## Theme 2: Oral health activities

The implementation of actual oral health activities was carried out by the educators and educators' assistants in the classrooms with the help of school nurses, although not all schools had nurses. They gave information on the causes and prevention of oral diseases as well as skills training to prepare learners to practise good oral hygiene care. To discourage learners from developing eating habits that lead to oral disorders, they also offered information about the side effects of oral diseases, such as pain and cavities. The evidence to support this was the educators' lesson plan and curriculum. Food service providers were also not permitted to serve unhealthy food as they are required to present a menu of the food that they serve. Quality management programmes with the use of assessment worksheets were the tools used by the departmental heads to evaluate the oral health care programmes.

Which category of staff is responsible for implementing oral health programmes at the school? Please explain your response.

*Educators, together with their assistants (P3).  
Medical staff (professional nurse, speech therapist) (P1).*

Is there any evidence to support your statement that oral health programmes are included and implemented in your programme? Please indicate yes or no and substantiate on your answer.

*Yes, educator's lesson plan (P3) and curriculum (P2).  
Professional nurse's monthly record together with the health file of the learner (P1).*

Are the food service providers aware of their role in promoting oral health?

*Yes, they are not allowed to serve unhealthy food (P2).  
They have to provide the menu of the food they will serve to students (P1).*

Name the tools that are used to evaluate these oral health programmes. And who is involved in the evaluation of these programmes?

*Quality management programmes, assessment worksheets (P1&11).  
Departmental heads (P1).*

## Theme 3: Implementation challenges

The implementation of the programme was impacted by five factors: lack of parental support, lack of professional guidance, lack of educators' training, lack of resources and lack of support from the oral health department. The Covid-19 pandemic further exacerbated these challenges. These factors influenced the programme's implementation in various ways, either directly or indirectly.

Parents were key actors when it came to learners referred for further treatment. However, the principals mentioned a potential disadvantage of this open method is that some parents are hesitant to take their children to oral health care facilities for treatment. Some parents did not even teach their kids to brush their teeth at home or continue what was learnt in school.

What are the barriers, challenges and strengths facing the staff in implementation of these activities or programmes?

*Parents who do not take their children to a dentist after a referral letter is sent home (P3).  
Parents who don't teach their kids to brush their teeth or continue what was learnt in school (P1,2&11).*

The participants reported a lack of professional guidance and teacher training in terms of oral health needs and interventions needed.

What are the barriers, challenges and strengths facing the staff in implementation of these activities or programmes?

*Little professional guidance in terms of oral health needs of learners and interventions needed (P3).*

Do you think oral health promotion should be included in your training as educators employed in this institution?

*Yes, because when teachers come in they are not aware that they need to teach students how to brush (P2).*

The participants reported a lack of support from the oral health department and non-government oral health organisations such as Colgate, who used to visit schools with mobile clinics and provide oral health education, dental examinations and, occasionally, treatment. This usually helped teachers because they knew where to refer students and who to ask for professional guidance.

Is there support from the department of health with regard to the delivery of dental services in schools?

*It is lacking, City Health used to do many years ago but there is nothing we are getting currently (P1).*

Some of the most important details in this theme were the lack of time, resources and finances for oral health and promotion in the schools. There is not enough time spent on oral health and promotion because there are curriculum demands and school syllabuses that must be completed within a certain time frame. Parents do provide the necessary resources that cost money, such as toothbrushes and toothpaste. However, many schools lack funds, making it impossible for them to continue with some of their oral health programmes. This paucity of resources was brought on by the fact that oral health is not included in the school's healthcare budget, resulting in schools being fully dependent on companies such as Colgate to donate toothpaste, toothbrushes and educational charts.

What are the barriers, challenges and strengths facing the staff in implementation of these activities or programmes?	Parents who do not take their children to a dentist after a referral letter is sent home (P3). Parents who don't teach their kids to brush their teeth or continue what was learnt in school (P1,2&11).
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The participants reported a lack of professional guidance and teacher training in terms of oral health needs and interventions needed.

What are the barriers, challenges and strengths facing the staff in implementation of these activities or programmes?	<i>Little professional guidance in terms of oral health needs of learners and interventions needed (P3).</i>
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Do you think oral health promotion should be included in your training as educators employed in this institution?	Yes, because when teachers come in they are not aware that they need to teach students how to brush (P2).
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The participants reported a lack of support from the oral health department and non-government oral health organisations such as Colgate, who used to visit schools with mobile clinics and provide oral health education, dental examinations and, occasionally, treatment. This usually helped teachers because they knew where to refer students and who to ask for professional guidance.

Is there support from the department of health with regard to the delivery of dental services in schools?	<i>It is lacking, City Health used to do many years ago but there is nothing we are getting currently (P1).</i>
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The Covid-19 pandemic has changed the way teachers contribute to oral health promotion activities in schools, limiting interactions between children, educators and the community. These measures include limiting the number of oral health education sessions, school days and health assessments, and restricting other healthcare stakeholders from accessing school premises.

What are the barriers, challenges and strengths facing the staff in implementation of these activities or programmes?	<i>Covid-19 has placed a hold on the implementation of programmes (P6).</i>
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Despite the fact that students' oral health has improved since they first enrolled in the schools, these implementation challenges reveal a clear need for adjustments in several areas. To enhance the oral health status of students, a more proactive strategy with complete stakeholder engagement is required, as alluded to by the interviewers.

Do you think there is room for improvement in your oral health promotion programmes? Please explain.	<i>Yes – we need a more proactive approach and support from the oral health department and companies like Colgate, especially with resources and education and dental screenings through oral health care workers visiting the school on a regular basis (P3).</i>
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In your opinion, have the identified oral health promotion programmes in your institution been successful in contributing to improved oral health of the students? What evidence do you have to support your statement? Please explain.	Yes – the oral health status of students has improved from the time they initially come to the school and we can identify caries early now (P1).
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## POLICY

### Theme 4: Perceptions of policy content

Interviewees agreed that schools don't have a separate oral health policy, but rather it is integrated into other health policies. The improvement of oral health through programmes with oral health departments, appropriate tooth brushing twice daily and oral health education as part of the school curriculum were among the main oral health policy objectives that were highlighted. These existing policies are currently implemented and have improved the oral health status of students, while the lack of implementation will deteriorate the oral health status of the learners. The department of education evaluates these policies and no tools were specified.

Does your policy statement mention improvements in oral health as one of your programme's health goals?	<i>No, we don't have a policy as such – we are guided by the health and safety policy (P1). Yes, we do have a health policy which includes oral health as well (P2).</i>
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List any operational oral health policy objectives which have been set by your institution with respect to the oral health status of the learners in the school.	<i>1) To enhance oral health through programmes with oral health departments. 2) Proper brushing of teeth twice a day. 3) Oral health education as part of our curriculum (P1).</i>
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Have these oral health policies been implemented in the school? Please explain.	<i>Yes, the health and safety policy is currently implemented at the school, but not a specific oral health policy.</i>
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What effect do you think the implementation or lack of implementation has on students' oral health?	<i>Definitely the implementation will improve the oral health status of students and the lack of implementation will not improve the oral health status of the students.</i>
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Name the tools that are used to evaluate these oral health policy objectives. Please explain.	<i>This is done by the department of education</i>
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## ORAL HEALTH CONDITIONS

### Theme 5: Dental examinations

The majority of interviewees stated that no oral examinations were conducted in their schools; rather, a student's complaint would prompt a check-up and referral to an outside public health facility for oral health investigation, diagnosis and treatment. Some interviewees, however, stated that their schools were active in the assessment, management and monitoring of learners' health. The school nurse would conduct routine health inspections once a month in the nurse's room. During these health inspections, the nurse performs a visual inspection of the learners, including their mouths, and also checks the medication of those learners who receive treatment while at school. When concerns with a learner's dental health were discovered, the nurse made the decision to supply a form of management at school or refer them to an oral health institution. At school, the most prevalent therapy was basic pain alleviation with medicine. Nurses referred more complex cases to local oral health clinics by writing the condition in the communication book or calling the parents to inform them. Plans for continued care of oral issues have been informed through the health inspections, including alerting parents of their children's oral health status and providing guidance to learners on basic oral hygiene.

One of the most important elements in oral health promotion is screening. Do any of your programmes address this aspect during oral health promotion? Please explain.	<i>No, Our nurse mostly addresses oral health complaints once there is pain and refer for additional testing and care. So, we are reactive in a sense. However, without access to regular check-ups etc it is difficult to know what interventions are needed (P3). Yes, since we have routine monthly check-up to assess their general and oral health and medication review (P1&amp;5).</i>
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**Theme 6: Prevalence of oral conditions**

Interviewers from schools that provide oral examinations agreed there was generally low to moderate dental caries prevalence and low prevalence of periodontitis, gingivitis and oral lesions. Medical records of learners kept by the schools were the only epidemiological evidence available to corroborate the prevalence of oral diseases at the schools.

Please estimate or respond according to available information (if any) on the prevalence of the oral conditions in your school.

*There is generally a relatively moderate prevalence of caries, and low prevalence of periodontitis and gingivitis (P1&5).*

*All this data is kept by the school sister (medical staff) in each student's health file (P1&5).*

**DISCUSSION**

This study revealed that certain critical components of health-promoting schools (HPS) were in place, such as school health education, a healthy school environment, a social environment, community relationships, nutrition and food services.<sup>3</sup> Leaving out one of the key components of the HPS; the school health services, since oral health services were not necessarily provided on the school premises, revealing a gap in unmet treatment needs. This is similar to what is reported in the Integrated School Health Programme (ISHP) which states that the health services package for the ISHP includes a significant component of health education for each of the four school phases, health screening (such as screening for vision, hearing, oral health and TB) and onsite services such as deworming and immunisation.<sup>20</sup> This leaves out the provision of oral services and the only exception is documented on the integrated school oral health policy where oral health services are stated to be provided in the foundation phase (when available).<sup>5</sup> Each of these components provides numerous opportunities to address oral health concerns and it is critical that these initiatives are supported by school health policies.<sup>21,22</sup> As the study participants stated, schools do not have a separate oral health policy; rather, it is integrated into other school health policies that are implemented. This is consistent with the results of a study conducted on health-promoting schools which state that a policy can be established to handle a particular issue, but it may be advantageous to address multiple risk factors in a single policy.<sup>3</sup>

This study found that each school was in charge of facilitating oral health care programmes, as it was stated that oral hygiene was prioritised in schools and addressed through providing oral health education, dietary advice and supervised tooth brushing programmes in the health education lesson or life skills lesson, as skills training to prepare learners to practice good oral hygiene care, reducing oral condition and improve oral health status. These results are similar to that of a systematic review on the effectiveness of oral health education programmes which revealed that oral health education programmes are given in the form of instructions, demonstration of oral hygiene practices, group discussions and lectures.<sup>23</sup> The school principals further stated that educators were the people responsible for implementing the oral health programme, which is consistent with the results of a study conducted in Bhopal, India, where educators were suggested and made responsible for the implementation of oral health programmes.<sup>24</sup>

These schools' oral health programmes were geared more toward a preventive care approach rather than a therapeutic or curative care approach. The majority of interviewees

stated that no oral examinations were conducted in their schools; rather, a student's complaint would prompt a check-up, pain management and a referral to an outside public health facility for oral health investigation, diagnosis and treatment. This is contrary to what was specified in the Integrated School Health Policy which emphasises providing health services over screening and referral in schools, with a commitment to expanding services over time, including mechanisms for ensuring additional services are provided for learners assessed as needing them.<sup>5</sup> Furthermore, other studies on the effectiveness of oral health education programmes revealed that they include preventive and therapeutic interventions in addition to oral health education.<sup>23</sup>

The implementation of school-based oral health promotion programmes in this study has been impacted by factors such as lack of parental support, professional guidance, teacher training, resources and support from the oral health department. The Covid-19 pandemic has further exacerbated these challenges. This is consistent with the Integrated School Health Policy, which identifies the suboptimal provision of school health services due to factors such as insufficient collaboration between the Department of Health and Education (DOH) and Department of Education (DBE), inequitable resource distribution, competition for limited resources, the demand for curative services over preventive and promotive services and poor data management, which also impacts reporting of school health services.<sup>5</sup> Furthermore, in Tshwane, South Africa, research revealed a mismatch between policy and practice, with poor prior planning, insufficient funding, poor school facilities and a lack of cooperation from key stakeholders.<sup>7</sup>

**STRENGTHS AND LIMITATIONS**

The current study provided a good understanding of oral health care service delivery in special needs schools in eThekweni District, KZN. However, several limitations were noted: the study participants were facilitators of the oral health programmes rather than actual implementers of the oral health programmes within the schools. As a result, their responses to questions could have been skewed toward the ideal answers (social desirability) rather than what is actually happening on the ground. Thus, there could have been overreporting of the execution of oral health programmes at the identified schools. Another reason could be that the participants were not health professionals and could have a limited understanding of the actual running of the oral health programmes, resulting in limited responses. There was a lack of current and clear publicly available records of the oral health programmes' evaluation and therefore the need to strengthen the monitoring and evaluation systems by the schools and the departments. Future research is required to

compare the schools' manager's statements with the educators, school nurses and oral healthcare providers' perspectives about the current state of oral health care delivery in special schools so as to improve the sample's representativeness and gain input from the people in the implementation levels.

## RECOMMENDATIONS

To improve school oral health services and programmes, there should be an increased number of school health nurses and staff training for sustainable oral health strategies there. Each special school should have at least one school health nurse employed so as to help with the facilitation and implementation of oral health care programmes and services.<sup>5</sup> Educators and school nurses should be trained to inspect learners' mouths periodically to facilitate early detection of anomalies or changes in oral health status.<sup>25</sup> Parents should be informed about the consequences of not attending to or treating their children's oral health needs and positive reinforcement should be used to acknowledge improvements in learners' oral hygiene practices.<sup>26</sup> Educators should be encouraged and supported to implement oral health interventions with or without school health nurses and oral health personnel. Furthermore, educators should receive continuous oral health promotion training to carry out oral health promotion programmes.<sup>3,27</sup> Oral health education should also be integrated into the curriculum of teacher training programmes, which require negotiations with South African educator training institutions.<sup>28</sup>

Educators should collaborate with dental professionals to promote oral health concepts and hygienic skills in learners, thus increasing their own knowledge and skills for effective oral health promotion programmes.<sup>26</sup> Schools should include close associations between educators, parents and dental professionals to increase parents' knowledge and skills, minimise learners' dental caries risk and reduce parental resistance to oral health activities.<sup>29</sup> Public oral health or dental facilities should be strengthened to supervise preventive dental education and provide services such as oral health screening, fissure sealant placement, fluoride varnish treatments and Atraumatic Restorative Technique on school premises.<sup>7</sup> Collaboration between the DOH and DBE is needed to resolve and improve many problems encountered by educators during the implementation of oral health programmes in these special schools.<sup>17</sup>

## CONCLUSION

It was evident in the current study that special schools do have oral health programmes in place which are mostly preventative and promotive in nature. However, this highlighted the need for therapeutic or curative services to cater for unmet treatment needs of the learners. Furthermore, gaps in the implementation of the oral health programmes were impacted by a number of factors. Together, these findings point to the urgent need to review oral healthcare programmes for learners in special schools

in KwaZulu-Natal. This review should ensure proper support and collaboration between the key stakeholders and special schools to reduce negative effects and improve the overall oral health programmes within the schools.

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## CPD questionnaire on page 56

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



# Self-reported experience of Outreach activities amongst undergraduate Oral Health students at a University in South Africa

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## ABSTRACT

### Introduction

Outreach activities (OAs) are structured learning experiences, combining intentional learning goals with services to underserved communities. Oral health students participated on the Phelophepa Train (PT) and school-based programmes (SBPs) as part of their OAs.

### Aim and objectives

To evaluate the self-reported experiences of OA amongst undergraduate oral health students.

### Design

Cross-sectional which included final year dental (N=62) and oral hygiene students (N= 13) registered in 2019.

### Methods

Information was obtained using a modified, self-administered questionnaire which included the number and type of procedures performed; work-related limitations, personal work benefits, academic development and civic responsibility.

## Results

The response rate was 93% (N=65) and students performed more procedures on the train compared to the SBP. Most common procedures undertaken by dental students were screening (64%) and restorations (56%) for oral hygiene students it was screenings (92%) and examinations, fissure sealants and screenings 39% on the train and 31% at SBPs. The most common challenges on both the train and SBPs were inadequate materials (74% and (41%), poor infection control (15%) and (41% and defective equipment (31%) and (38%) respectively.

## Conclusion

Although students performed a variety of clinical services they reported to have faced a number of challenges. The majority of students reported that OAs exposed them to the needs of the communities and encouraged them to improve their independence and accountability towards patients.

## Key words

Outreach activities, oral health students, dental services, self and social development, academic, civic responsibility.

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### Key words:

Outreach activities, oral health students, dental services, self and social development, academic, civic responsibility.

### Author contribution

1. Mrs C Kruger 40% – Identification of topic, literature review, write up and data collection.
2. Dr NR Nkambule 30% – Introduction, data analysis and writing up of paper.
3. Prof A Bhayat 30% – Methodology section, discussion and writing up of paper.

## INTRODUCTION

Outreach activities (OAs) is defined as structured learning experiences combining intentional learning goals for students with service to the community.<sup>(1,2)</sup> The three main objectives of an outreach program are to improve learning, promoting civic engagement, and strengthening communities through addressing their societal needs. Although teaching and training of dental professional follows the traditional teacher-centred method of instruction in which teachers deliver and students receive lessons, OAs activities enhance students learning and prepare them to serve communities. Since the introduction of these activities into the undergraduate dental program, it has shown to educate students, to meet the health care needs of their patients and gain a holistic understanding on the provision of dental care to patients in need.<sup>(3,4)</sup> Students who participated in OAs, reported to have gained additional experience of specific clinical procedures, increase in confidence and awareness of career opportunities.<sup>(5,6)</sup> These activities have shown to play a vital role in exposing students to community issues such as the barriers to accessing dental care, their civic responsibility to communities, academic development and self-confidence when providing dental care to underserved populations.<sup>(7)</sup>

Final year dental undergraduate students enrolled in the Bachelor of Dentistry (BChD) and Bachelor of Oral Hygiene (BOH) programmes at the School of Dentistry, University of Pretoria participated in OAs as recommended by the Health



Professions Council of South Africa (HPCSA) as part of service learning and teaching. (8) These activities take place under supervision of qualified dentists and oral hygienists via two platforms, local school-based programmes (SBP) in close proximity to the dental school and via the Phelophepa Train (PT). The SBPs include clinical and preventative procedures; the oral hygiene (OH) students perform mostly preventative procedures, whilst dental students perform dental restorations and attend to the relief of pain and sepsis. These procedures often take place in environments different to their current training facility but which could be expected in their eventual working environment.

The PT is regarded as a mobile hospital that provides primary healthcare services to underserved communities through various health specialities in the health sector where infrastructure does not allow. The PT follows a fixed route to different provinces in South Africa and offers medical and dental services. These services are rendered by undergraduate medical and dental students at a minimum cost to communities. The dental services include dental extractions, restorations, scaling and polishing's (S&Ps) and oral hygiene education (OHE).

SBPs take place at identified primary schools in close proximity of the institution of higher learning in a sponsored mobile unit. School children at these schools are screened for possible dental treatment in the beginning of each year. Class lists supplied by the schools are used to identify the school children and possible treatment needed. As part of their Public Oral Health module (POH), dental and oral hygiene students attend these schools two times per week on outreach. This takes place from February to October each year. Procedures that are performed are mostly preventative procedures. All materials, equipment and personal protective equipment (PPE) needed for procedures to be performed are taken from the institution of learning. Students have been involved in the SBPs and PT since 2015 but the impact of these activities has not been evaluated. This study was the first of its kind at a South African University to evaluate its impact on students. Whilst teaching and training of dental professionals is more teacher and patient centred, the inclusion of OAs in the curricula of the dental professional aims to prepare graduates to become independent, confident dental professionals experiencing real life authentic training and learning.

## MATERIALS AND METHODS

A cross-sectional analytical study was conducted amongst all final year undergraduate dental (BChD V) (n=62) and oral hygiene (BOH III) (n=13) students registered at a South African University during the 2019 academic year. Therefore,

a total of 70 students met the criteria and were included in the sample population. No sampling was required as all final year dental and OH students were invited to participate. A self-administered modified questionnaire consisting of both open and closed questions was used to obtain the necessary information. (9, 10) The questionnaire was anonymous and was assigned a unique serial number.

It consisted of five sections and 42 questions in total. The first section dealt with demographics, including age, race and gender.

The second and third sections dealt with the PT and SBPs respectively and included the types and numbers of clinical procedures performed, work related limitations, personal work benefits and traits of self and personal development. The number of procedures performed were classified into five categories (0, 1-5; 6-10; 11-15 and more than 16) and students were asked to choose which category best described the number of specific procedures performed. Based on the range of data we received and for statistical ease, it was decided to categorise the data into these categories.

The fourth and fifth section dealt with the academic development and civic responsibility of the students and included their academic curriculum, levels of theoretical learning, contribution to rendering dental services, motivation to contribute to social responsibility of underserved communities and responsibility and moral obligation to communities.

Data was captured on an Excel spreadsheet and then imported onto Statistical Package for the Social Sciences (SPSS) software version 27 and descriptive statistics for reporting the results.

Ethical clearance and permission to conduct the study was obtained from the University of Pretoria, Research Ethics Committee of the Faculty of Health Sciences (643/2019). All information was strictly confidential.

## RESULTS

Of the 70 students who met the criteria, 65 (93%) signed the consent forms and were included in the study (response rate=93%). The mean age was 22.7yrs (±5.46) and 71% were females.

### Number and type of activities performed by dental students on the PT

Almost two-thirds (64%) reported they screened more than 16 patients per day while 46% reported to have provided (OHE) to between 11 and 15 patients per day. Almost

Table I: Number and types of activities performed by dental students on the Phelophepa Train (N=52)

	Examination	Screening	Extraction	Restoration	S&P	OHE	Fissure seal	Desensitize	ART	PRR
None	7 (13.5%)	7 (13.5%)	2 (3.8%)	12 (23.1%)	1 (1.9%)	10 (19.2%)	42 (80.8%)	38 (73.1%)	52 (100%)	52 (100%)
1 to 5	4 (7.7%)	3 (5.8%)	4 (7.7%)	32 (61.5%)	5 (9.6%)	5 (9.6%)	8 (15.4%)	9 (17.3%)	0 (0.0%)	0 (0.0%)
6 to 10	14 (26.9%)	3 (5.8%)	14 (26.9%)	1 (1.9%)	15 (28.8%)	9 (17.3%)	0 (0.0%)	4 (7.7%)	0 (0.0%)	0 (0.0%)
11 to 15	12 (23.1%)	6 (11.5%)	16 (30.8%)	3 (5.8%)	19 (36.5%)	24 (46.2%)	2 (3.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
More than 16	15 (28.8%)	33 (63.5%)	16 (30.8%)	3 (5.8%)	12 (23.1%)	4 (7.7)	0 (0.0%)	1 (1.9%)	0 (0.0%)	0 (0.0%)

Table II: Self-reported number of procedures performed daily by OH students on the Phelophepa Train (N=13)

	Examination	Screening	Restorations	S&P	OHE	FS	Desensitize	ART	PRR
None	4 (30.8%)	0 (0.0%)	11 (84.6%)	0 (0.0%)	0 (0.0%)	9 (69.2%)	9 (69.2%)	12 (92.3%)	12 (92.3%)
1 to 5	1 (7.7%)	0 (0.0%)	0 (0.0%)	1 (7.7%)	0 (0.0%)	2 (15.4%)	4 (30.8%)	1 (7.7%)	1 (7.7%)
6 to 10	3 (23.1%)	1 (7.7%)	1 (7.7%)	2 (15.4%)	2 (15.4%)	2 (15.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
11 to 15	1 (7.7%)	0 (0.0%)	1 (7.7%)	6 (46.2%)	3 (23.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
More than 16	4 (30.8%)	12 (92.3%)	0 (0.0%)	4 (30.8%)	8 (61.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

Table III: Self-reported number of procedures performed daily by dental students during SBPs (N=52)

	Examination	Screening	Extraction	Restoration	S&P	OHE	FS	Desensitize	ART	PRR
None	22 (42.3%)	32 (61.5%)	30 (57.7%)	16 (30.8%)	41 (78.8%)	36 (69.2%)	45 (86.5%)	48 (92.3%)	52 (100%)	52 (100%)
1 to 5	22 (42.3%)	9 (17.3%)	19 (36.5%)	29 (55.8%)	7 (13.5%)	12 (23.1%)	7 (13.5%)	3 (5.8%)	0 (0.0%)	0 (0.0%)
6 to 10	5 (9.6%)	3 (5.8%)	2 (3.8%)	5 (9.6%)	4 (7.7%)	2 (3.8%)	0 (0.0%)	1 (1.9%)	0 (0.0%)	0 (0.0%)
11 to 15	2 (3.8%)	2 (3.8%)	0 (0.0%)	2 (3.8%)	0 (0.0%)	1 (1.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
More than 16	1 (1.9%)	6 (11.5%)	1 (1.9%)	0 (0.0%)	0 (0.0%)	1 (1.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

two-thirds (62%) performed one to five restorations per day and 37% reported to complete between 11 and 15 S&Ps per day. None reported to have performed Atraumatic Restorative Treatment (ART) or Preventive Resin Restorations (PRR) as shown in Table I.

#### Number and type of activities performed by OH students on the PT

Almost half (46 %) reported that they performed between 11 and 15 S&Ps, 92% reported to have performed 16 or more screenings and 61% reported to have delivered 16 or more OHE sessions per day. Only 30% reported to complete fissure sealants (FS) and desensitizing procedures. (Table II)

#### Number and type of activities performed by dental students on SBPs

Over half (56%) reported that they performed one to five restorations while 85% reported to have completed five or fewer examinations per day. Almost two-thirds (58%) reported not completing any extractions per day. None reported to have performed ART or PRRs in Table III.

#### Number and type of activities performed by OH students during SBPs

Almost a third (31 %) reported to have screened more than 16 patients while 31% reported to have placed between 11 and 15 FS per day. Almost a quarter (23%) performed

one to five OHE sessions per day while 23% reported to complete between 1 and 5 S&Ps per day. Only less than 10% performed any ART while 15% reported to have placed PRRs as shown in Table IV.

#### Work related limitations experienced by dental and OH students

The most common limitations reported were inadequate materials at the PT (74%) and SBPs (42%) respectively; defective equipment on PT (31%) and at SBPs (39%) and inadequate infection control measures (42%) at SBPs and (15%) on the PT. (Table V)

#### Self-development benefit experienced by dental and OH students

Almost all students (70%) reported that their self-development improved because of working independently on the OAs. Half (49.3%) of students reported that their self-development improved due to personal growth while 39.3% felt that their competency skills improved on the outreach. (Figure 1)

#### Academic development

Majority of students (91%) agreed that taking accountability for their own learning after participation in OAs and that involvement with other disciplines improved their awareness of OAs. The majority of students (86%)

Table IV: Number and types of activities performed by OH students during SBPs (N=13)

	Examination	Screening	Restorations	S&P	OHE	FS	Desensitize	ART	PRR
None	4 (30.8%)	0 (0.0%)	9 (69.2%)	8 (61.5%)	3 (23.1%)	1 (7.7%)	11(84.6%)	12 (92.3%)	11 (84.6%)
1 to 5	5 (38.5%)	5 (38.5%)	4 (30.8%)	3 (23.1%)	3 (23.1%)	5 (38.5%)	1 (7.7%)	1 (7.7%)	2 (15.4%)
6 to 10	2 (15.4%)	1 (7.7%)	0 (0.0%)	1 (7.7%)	3 (23.1%)	1 (7.7%)	1 (7.7%)	0 (0.0%)	0 (0.0%)
11 to 15	1 (7.7%)	3 (23.1%)	0 (0.0%)	1 (7.7%)	1 (7.7%)	4 (30.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
More than 16	1 (7.7%)	4 (30.8%)	0 (0.0%)	0 (0.0%)	3 (23.1%)	2 (15.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

Table V: Work related limitations experienced by dental and OH students (N=65)

	PT		SBP	
	Frequency	%	Frequency	%
Time constraints	12	18.5	23	35.4
Inadequate materials	48	73.8	27	41.5
Defective equipment	20	30.8	25	38.5
Heavy workload	18	27.7	4	6.2
Infection control	10	15.4	27	41.5
Accommodation	6	9.2	16	24.6
Transport	8	12.3	2	3.1

reported that their academic curriculum prepared them effectively to treat patients of diverse ethnicity on OAs and 82% reported that their applied theoretical leaning assisted them on OAs.

## DISCUSSION

The response rate was 93% and this was similar to other studies that reported on the impact of dental outreach programs that had response rates between 90% and 97%.<sup>(7, 11, 12)</sup> The response rate could be due to the questionnaire being handed out to participants during a contact lecture session.

The participant's average age was 22 years with 71% being female. This is consistent with the demographics of dental and oral hygiene students as in the recent years, more females have been accepted to these professions.<sup>(13)</sup>

At both outreach sites students reported performing a number of different types of procedures. The most common procedures performed were screenings and OHE. The most common procedure performed by dental students were examinations and restorations. The high number of screenings could be due to the high number of patients that presented at these sites who needed to be treated. The demand for extractions and restorations were similar to another study, which reported that dental students

completed mostly examinations, dental extractions and restorations (Bhayat *et al.*, 2011).

The high demand for extractions is possibly attributed to the high volume of patients in underserved communities with low socioeconomic status seeking relief from pain and sepsis.<sup>(14)</sup> This often results in decay extending into the pulp which limit the options and extractions are then the only means dealing with the disease. This is similar to the survey completed by South African Demographic and Health Survey (SADHS) (National Department of Health and ICF, 2019) in 2016 where respondents reported that the main reasons for them not seeking treatment was that treatment was too expensive; all services were not available and that sites were far to access the treatment. A similar study by Bhayat *et al.* reported that the most common procedures performed at Primary Oral Health Care Facilities (POHCF's) in Gauteng were dental extractions, restorations and fissure sealants.<sup>(15)</sup> In addition, OH students reported to perform more FS at SBPs and this could be due to the fact that FS are placed mostly on school children while more S&Ps were performed on the PT which could be due to the adult population that attended for services and the possible lack of good oral hygiene aids like toothbrushes and toothpaste.

During SBPs, students had time to complete more procedures. This was possibly as a result that there were

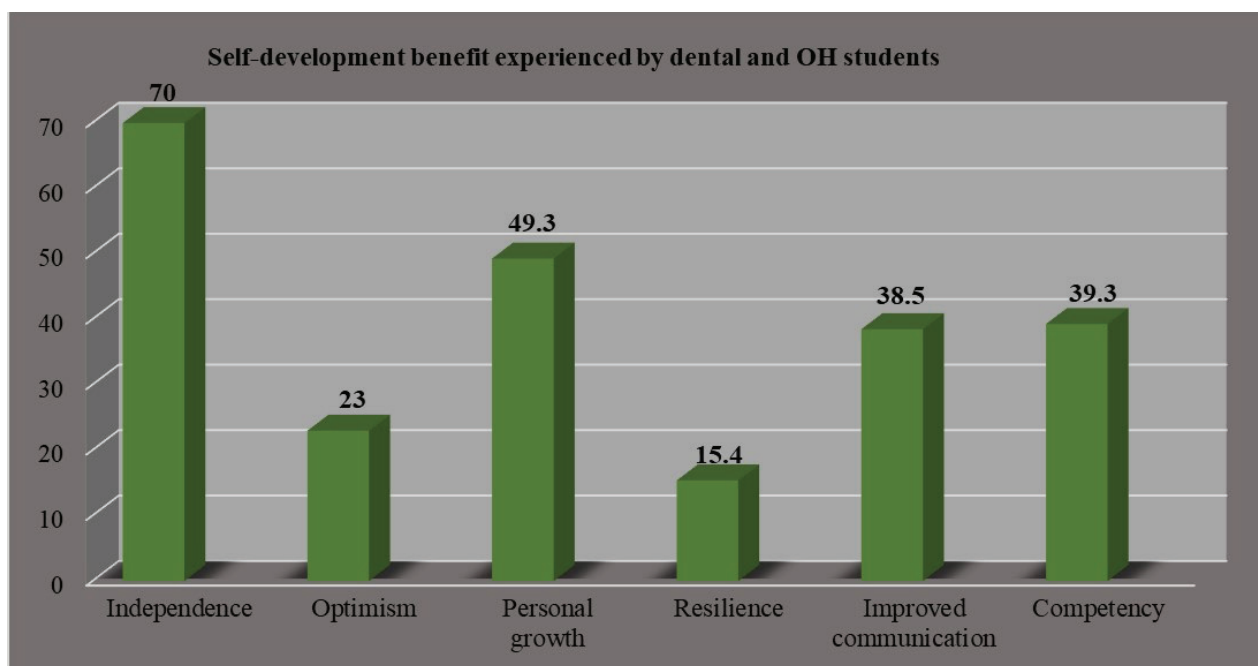


Figure 1: Self-development benefit experienced by dental and OH students.

fewer patients that needed treatment; however, they completed more preventive procedures at the school. Possibly due to patients being young and more relaxed as opposed to the normal dental setting and had a better dental IQ by creating a space for patients to voice their choices. It could also be due to the fact that these children were screened and early caries was detected and prevented rather than waiting for patients to attend dental clinics after having pain and irreversible tooth damage and alleviate anxiety.

Possible reasons for the low performance of ART and PRRs were the severe state of caries that patients presented with which resulted in more invasive treatment options, a lack of radiographic equipment to diagnose the severity of the carious lesions and a possible lack of materials and equipment. As result students were forced to perform more extractions and restorations rather than conservative ART and PRR procedures.

The most common work-related limitation was inadequate materials which was similar to other studies.<sup>(11,14)</sup> Inadequate materials should not necessarily be perceived as not having enough materials to perform procedures. The possibility exists that students weren't exposed to similar materials used at their institution of higher education. Facilities and institutions are obligated to manage and improvise when materials are supplied due to inadequate budgets.<sup>(16)</sup>

Defective equipment was another work-related limitation and this was also reported by other authors.<sup>(11, 14)</sup> The defective equipment could possibly be due to damaged equipment, old dental units not being maintained regularly, budget constraints forcing staff at the facilities not to replace defective equipment and modern hand pieces and equipment's non-availability.

More than half reported that infection control measures were insufficient. This compared to a similar study where 26% of students objected to infection control measures that were implemented at an outreach site.<sup>(10)</sup> In addition, possible cross infection contamination was of a concern to students, as the situation was different as to what they experienced at their clinical training institution.

More than two thirds (70%) of students felt that their confidence had greatly improved due to the increased independence and being allowed to make own decisions clinically which was similar to a previous study.<sup>(17)</sup> This could be as a result of them being allowed to formulate a clinical diagnosis independently, work in a multi-disciplinary team of professionals and work at rural sites and within communities which occur at OAs compared to the dental school environment. In the present study, 98% of students reported that their personal growth had improved. This could be due to the impact of OAs on academic development which could have made it easier for participants to understand the theory from lectures in a greater degree as reported by previous studies.<sup>(7)</sup>

Less than half (39%) reported that their competency skills improved compared and this was considerably lower to another study which reported that between 83-97% of students rated themselves as being more confident in preventive treatments.<sup>(18)</sup>

Outreach activities impact on the Academic development and Civic responsibility of students

### Academic development

Almost all of the respondents (91%) strongly agreed that participating in OAs made them more accountable for their own learning and that involvement with other disciplines improved their awareness of OAs. This was considerably higher than other similar studies, which reported that between 51% and 74% of students who felt the same.<sup>(7, 14)</sup> This could be due to them being exposed to various patient groups, ages, different cultures and socioeconomic background.

Experiential learning is constructing knowledge and meaning from real-life experience. In the context of medical education, the term is most commonly applied to experiences which have been included in a curriculum design to bring the learner into contact with others in a particular role and context.<sup>(19)</sup> Experience gained in authentic workplaces that are concurrently involved in education and delivering real-life services is the most important medium through which people learn to practice as healthcare professionals. Most of the students strongly agreed that their academic curriculum prepared them effectively to treat patients similar to other studies.<sup>(7,11)</sup> As a result, when participants understand and apply theoretical concepts in real life situations, it improves the quality of services.

### Civic responsibility

Almost all students reported that during and after participation of OAs they were more responsive to the needs of attended communities and they believed their motivation to treat underserved communities would contribute immensely to their social responsibility after qualifying as dental professionals. This was similar to studies which showed over 96% of students became more aware of the needs of communities, made them aware of their roles in the community and agreeing that they have a responsibility to serve the community.<sup>(7, 11, 14, 20, 21)</sup>

Students experienced an 88% responsibility and moral obligation to the community and the people after participation. This was similar to other studies which reported that over 99% of participants agreed they have a responsibility to serve the community and become more aware of the community's needs and that it was their responsibility to serve their community.<sup>(7, 11)</sup> Therefore the supposition that reconnecting with communities, critical thinking in applying their skill and building relationships with people who have authentic challenges is a manner in which OAs assists students accepting responsibility and realizing the need that exists in the underserved communities.<sup>(7)</sup>

### LIMITATIONS

In this retrospective cross-sectional study, students expressed and associated their experiences on OAs based on what they remembered after a period of time had passed and therefore resulting in response bias. The students could have also responded according to what they felt was the correct response rather than the actual occurrences (Response acquiescence). Unfortunately, these are common limitations of cross-sectional survey design studies. No inferential statistics were performed as this was a cross sectional descriptive study.



## RECOMMENDATIONS

Defective equipment needs to be assessed, replaced and maintained within budgetary limits. Future studies should be done to evaluate compliance to infection control policies and practices at outreach sites to align to the institution of higher education.

## CONCLUSION

Students performed a range of preventive and restorative procedures during the OAs which were in line with their scope of practice and with the dental demand of patients attending these sites. The most common challenges faced on OAs included defective equipment, inadequate materials and a lack of infection control measures. Autonomy to work alone and the exposure to the community encouraged students to develop and improve their independence, accountability, humanitarianism and compassion towards communities and patients through their engagement of service learning on outreach programs.

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## Online CPD in 6 Easy Steps



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



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

## Part 4. Seven simple steps to design

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CP Owen<sup>1</sup>

### SUMMARY

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

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

### INTRODUCTION TO PART 4

This part will introduce a simple step-by-step procedure to design removable partial dentures using either acrylic resin as a base, or a framework. The illustrations will use a cast metal framework, but it could be cast, milled or sintered, and other material (such as polyetherketoneketone for example) could also be used. The principles remain the same, but the guidelines for clasp placement<sup>2</sup> at the time of writing only exist for wrought and cast chrome-cobalt materials.

It should go without saying, but just as a reminder, before deciding on the design, it is necessary to have the following:

- study (diagnostic) casts of both arches, either articulated or model trimmed for hand articulation, with the aid of a bite registration if necessary
- patient records (history, examination, radiographs etc)
- dental surveyor
- large diagram of the remaining dentition.

The latter is not absolutely necessary, but it is useful to draw the design as it progresses, and it might be useful to have a drawing of a full arch first, such as in Figure 1 which can be copied and pasted into a simple graphics programme such as Paint, where it is simple matter of erasing the lines representing the missing teeth.

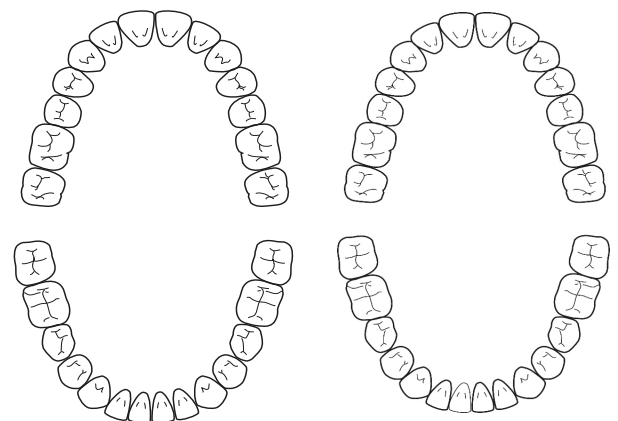


Figure 1. Drawings of the maxillary and mandibular arches which can be cut and pasted into a simple graphics programme. Left: Vector graphic in .emf format. Right: Graphic in .jpg format.

The steps to a simple design are summarised in the box and will be dealt with sequentially.

The seven steps to making a design

1. Identify the need for replacement teeth and the materials to be used
2. Determine the path of insertion and survey the cast

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A simplified approach to designing RPDs

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3. Provide support
4. Provide retention
5. Connect the separate components
6. Ensure that there is horizontal and rotational stability
7. Record the prescription preferably as a drawing

### Step 1. Identify the need and the materials to be used

Not all missing teeth need to be replaced, though this has been an adage used in promotional material put out by dental associations to assist practitioners in persuading patients that it is, in fact, necessary to replace every missing tooth. The main reason for replacing teeth as requested by patients is for aesthetics, but if there is evidence that the health of the remaining dentition depends on replacing teeth, then this is justified. Generally, if the patient has five or more posterior occluding pairs of teeth, chewing ability will not be impaired, but patients are not always willing to accept posterior spaces despite this evidence. Again, in keeping with the premise of these papers, the adage is to keep it simple, and only replace teeth when there is an evidence-informed decision to do so.

Having established the need, then decide on the materials to be used. This will almost always be a financial decision as to whether a framework will be used or an acrylic resin base. The principles in the design will remain the same: the difference is the gingival coverage required. A framework-based denture may never have to cover a gingival margin; an acrylic-based denture will have to cover gingival margins to provide support and strength and reciprocation.

### Step 2. Determine the path of insertion and survey the cast

This will almost always be perpendicular to the occlusal plane, and must be done on a surveyor, because a slight tilt of the model might reveal a usable undercut. However, the tilt should not be excessive because the path of insertion so created may make manipulating the denture by the patient too difficult. Once the path of insertion is determined then the model must be surveyed in the normal manner, including the marking of re-locating marks on the cast. This will assist in comparing the surveying done on the diagnostic cast with that of the final cast, to ensure the same placement. This, of course, implies that you have a surveyor in the first place. If not, it is highly recommended to purchase one (it will last a lifetime) or do this designing together with your dental technician.

### Step 3. Provide support

As has been shown in previous parts of this series, tooth support is an essential feature of every removable partial denture. Guidelines for preparing rest seats were given in Part 2 of this series,<sup>2</sup> but in the design phase the position of the rests must now be determined. Point 8 of the guidelines stated that at least three rests are required, as widely spaced as possible.

This provides stability in support: for example, three legs to a stool is the least number possible – you would fall off a two-legged one. Point 9 stated that rests must be adjacent to any edentulous space being replaced. In a bounded saddle, that means on either side of the saddle. In a distal extension, that means on the abutment.

There has been, and still is, controversy as to the placement of rests on the abutment teeth for distal extension bases. Part 3 of this series dealt with the clasp systems that have been proposed for distal extension bases and much of that mythology still persists, often in the form, not of the RPI system, but of the placement of a mesial, rather than a distal, rest.<sup>3</sup> This is still based on the clinically unproven idea that the abutment tooth is subjected to a torquing force.

There is very little evidence that a mesial rest makes any difference, and it often overcomplicates the design. In a somewhat inconclusive *in vivo* study of just four patients with mandibular distal extension bases with different occlusal rests on the distal abutments, no definitive conclusion could be drawn on the pressure distribution beneath the distal extension bases, whether the rests were both mesial and distal, mesial only, or distal only.<sup>4</sup> So, in keeping with the theme of simplicity, a simple distal rest with a circumferential clasp (often wrought wire because of the length of the clasp arm as it is usually on a premolar or canine) has no evidence to contraindicate it.

As an example, a simple maxillary Class III, Modification 2 design will be used to illustrate the steps. Further designs, and how all these principles apply, will be shown as examples for all the other Kennedy classes and will be given in Part 5 of this series. So, on a suitable diagram draw in the possible sites for the rests, having identified which teeth will be replaced (Figure 2).

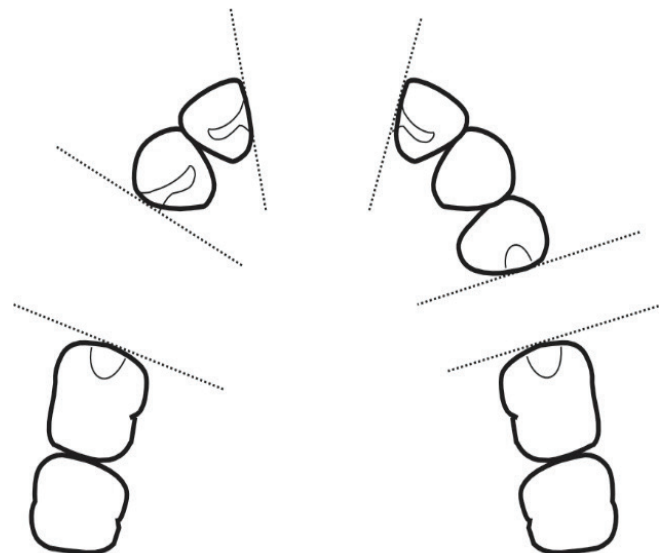


Figure 2. The edentulous areas to be replaced are marked with the dotted lines, which is where the guide planes on the teeth will be prepared. Potential rest seats are marked as being on either side of each saddle. Note that the rest seats will all be continuous with the guide planes. Because of the distribution of the edentulous areas there will automatically be widespread and more than tripodal support.

At this stage all potential rests are drawn in, but in many cases not all will necessarily be used. This may be because some teeth may not be suitable to sustain additional occlusal loads, some may be assisted by the distribution of loads and some, such as anterior teeth, may not have sufficient enamel and would require a restoration which could be avoided if other teeth can be enlisted for support. This, in fact, is illustrated in this case. Consider tooth 12: if the palatal surface is thin, because the 13 is going to receive a rest, only one tooth away from the anterior saddle, it will not be necessary to rest the 12.

### Step 4. Provide retention

The first stage in this step is to write down the size of the undercuts that you have already measured after having surveyed the casts after having determined the path of insertion. With experience, you will already have an idea of which teeth will be clasped, but if you are fairly new to this, then measure everything (Figure 3).

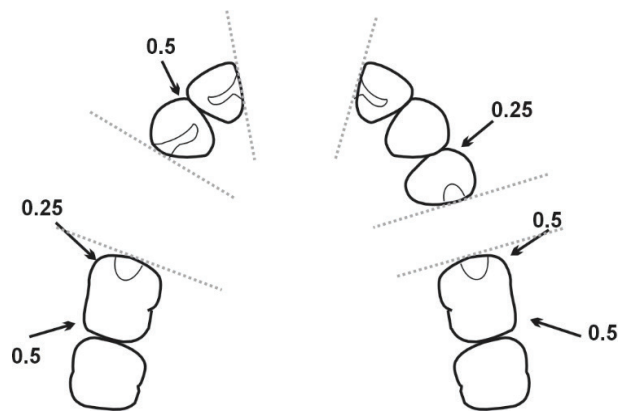


Figure 3. The undercuts that were measured on the surveyor (in mms).

The guidelines for clasp placement given in Part 3 (Point 5) stated that generally only one clasp per side of the arch is sufficient unless there is a long span edentulous space of three or more teeth to be replaced. This is a good rule of thumb and certainly works clinically, but in some countries dental technicians are paid per component, so they are keen to add as many as possible. Another reason why clinicians should be designing partial dentures.

In the case being designed here, it is a moot point whether clasps are required at all, because three saddles means six guide planes and guiding surfaces. But for the sake of this exercise, the most obvious teeth to receive clasps would be the first molars, with a circumferential clasp engaging the distal undercuts. There needs to be no consideration of indirect rotation, for rotation is extremely unlikely given all the guide plane retention.

#### For an acrylic base

Now draw the position of the clasp arms on the diagram. For the sake of clarity, and to aid communication with the dental technician, it is recommended that you and your technician understand that, however you draw the clasp, the terminal third will be in the undercut. For the drawing in this series, the line representing the buccal surface of the teeth will be taken to represent the survey line, so by drawing the terminal third of the clasp outside that line, it is understood that it is below the survey line (Figure 4). Note that according to the clasp guidelines for wrought wire (see Part 3),<sup>5</sup> the undercut to be used on a molar is 0.5mm.

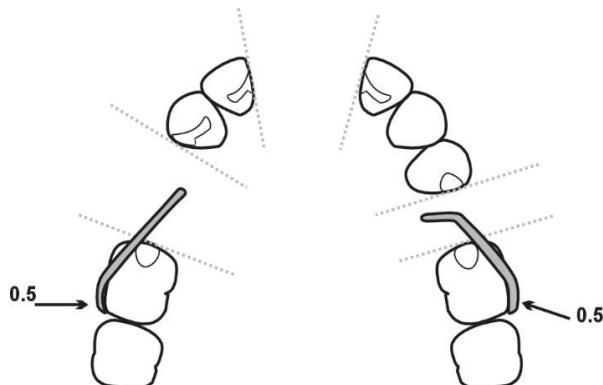


Figure 4. Two clasp arms are drawn in, showing the terminal third outside the buccal line of the tooth, which is taken to represent the survey line, thereby conveying a sense of three dimensions, though only drawn in two.

Note also that all active clasps must be reciprocated, and

this must be borne in mind when carrying out the next step.

#### For a framework-based denture

At this stage, as the clasps are part of the framework, it is only necessary to ensure that the correct undercuts are specified. For cast clasps, the undercut should be no more than 0.25mm, so this must be noted because the undercut on the molars is 0.5mm and therefore the technician must be aware to use the portion of the undercut that corresponds to 0.25mm, which will be nearer the survey line.

#### Step 5. Connect the separate components

This is now where the design of the major connector will differ significantly depending on the base materials to be used.

#### For an acrylic base

The principle to follow is to try not to cover all gingival margins if at all possible. As a rule of thumb, to prevent hyperplasia at least two teeth should remain uncovered if possible, and never just one tooth. Clearly clasps need to be reciprocated by the inner surface of the acrylic base, and cingulum rests need to be covered. Occlusal rests will be in half-round wire and these can be drawn in first (Figure 5).

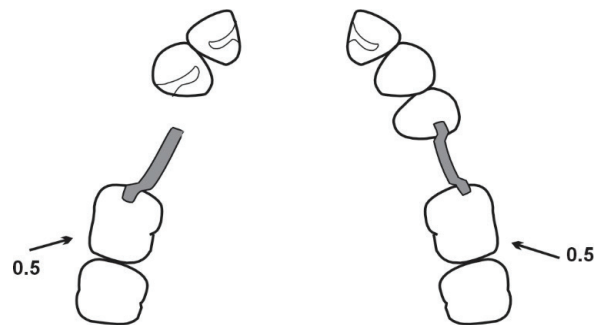


Figure 5. Half-round wire will be used for the occlusal rests and these can extend across a saddle to reach both teeth on either side. Again, use whatever drawing convention you and your technician understand.

This situation currently has cingulum rests on each of the lateral incisors. The rest on the 22 is absolutely necessary, even if it requires a restoration; however, the rest on the 12 is not necessary as there must be a rest on the 13. This does not prevent the base having to cover the gingival margin of the 12, but does prevent a rest preparation (the 12 will still have a guide plane prepared, of course). There is no clasp on the 24 and no rest on the 23, so the gingival margins of these teeth do not need to be covered, and the second molars also do not need to be covered. Joining everything up, then, gives us the final design (Figure 6).



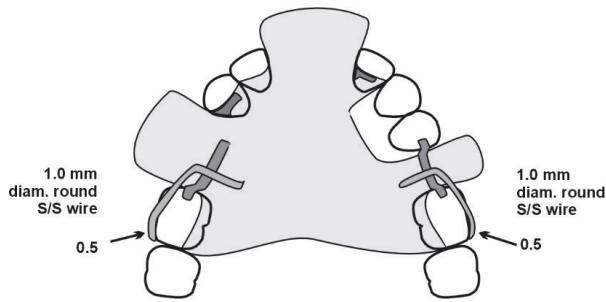


Figure 6. The final design for the acrylic-based denture for this case. Note that there is no need to cover the gingival margins of the 23 and 24. Note also that the wrought wire to be used has been specified but this should not be necessary as you and your technician would understand that this is the required wire as per the guidelines.<sup>5</sup>

#### For a framework-based denture

Because the framework is the major connector with all the components in one unit, without, of course, the teeth and acrylic for the edentulous areas, the previous step would have been left with identifying only the necessary undercuts (Figure 7). Similar decisions need to be made for the cingulum rest on tooth 12. In this case, it has been decided to place a rest there (Figure 8). Note the difference in the gingival coverage between this design and that of the acrylic-based denture in Figure 6. In this case, there is no gingival coverage at all, one of the major advantages of framework-based dentures.

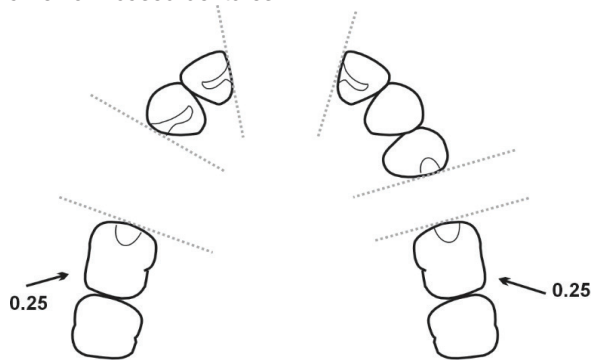


Figure 7. The stage of the drawing after step 4, for a framework-based denture.

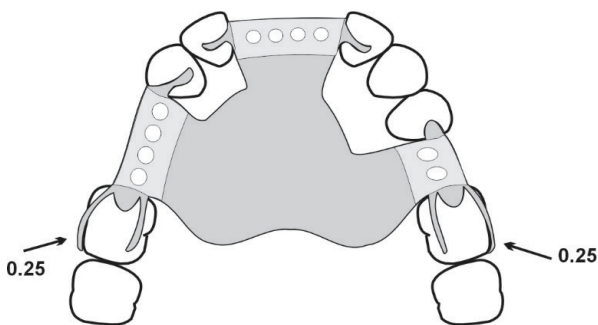


Figure 8. The final drawing of the framework, to which has been added the retention for the edentulous areas.

#### Step 6. Ensure that there is horizontal and rotational stability

With edentulous areas on either side of the arch, as well as an anterior area, there is unlikely in this case to be any concern about either horizontal or rotational stability. This step is a mere check in this case, but would be important in other designs, and will be covered in the last part of this series, where examples of designs for all Kennedy classifications will be shown.

#### Step 7. Record the prescription, preferably as a drawing

This would seem self-evident, but unfortunately the evidence is that this is seldom done, and hence the reason for this series of papers. Even though in the US, for example, it is mandatory to complete a work authorisation form<sup>6</sup> one study found that more than 88% of dental laboratories reported that the dentist's communication to them was lacking<sup>7</sup> and similar findings have been reported elsewhere.<sup>8-10</sup>

### CONCLUSION

It is suggested here that by following a few simple steps, it is possible to quickly design an RPD that conforms to evidence-informed principles and that there is therefore no excuse for clinicians not doing this. At the very least the design phase could be done in consultation with the dental technician and there must be clear communication between the two at all times.

The principle suggested here should result in hygienic designs, no matter what material is used, but, in either case, the removable partial denture is a foreign body with many surfaces to attract biofilm. A critical review of the relationship between RPDs and periodontal health concluded that while there is no agreement on the ideal RPD design, clinical trials have shown that periodontal health can be maintained if the basic design principles are followed, together with frequent recalls for oral hygiene and prosthetic maintenance.<sup>11</sup>

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# A gigantic unilateral neck mass in the submandibular region

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RE Rikhotso<sup>1</sup>

## INTRODUCTION

Pleomorphic adenoma (PA) is the most common salivary gland neoplasm, mainly affecting the major rather than the minor salivary glands. The parotid gland is the most commonly affected site (75-80%), followed by the submandibular (10%) and minor (10%) salivary glands.<sup>1-4</sup>

Intra-orally, the palate represents the most common location of PA, followed by the lip, cheeks, tongue, floor of the mouth and oropharynx.<sup>5-6</sup> Histogenesis of PA is characterised by simultaneous proliferation of parenchymatous glandular cells along with myoepithelial components.<sup>7</sup> Cells of epithelial origin give rise to ductal structures and are closely intermingled with mesenchymal elements that may give rise to myxoid, hyaline, cartilaginous and osseous change. The expression of varying proportions of epithelial and mesenchymal features give rise to a wide spectrum of histological findings, hence the term "pleomorphic". It is also called a "mixed tumour", because it possesses a mixture of ductal and myoepithelial elements in one single tumour. Unlike in minor salivary glands, PA is usually encapsulated when it arises in the major salivary glands.<sup>8-9</sup>

PAs are most prevalent in the fourth to six decades, with a slight predominance in women.<sup>8,10</sup> PA appears as a

painless, slow growing round or ovoid rubbery tumour with a smooth surface, exhibiting firm consistency and variable dimensions. Treatment of choice for PA is surgical excision. Untreated or recurrent PAs may reach giant proportions, especially in major salivary glands.

We report on a case of a giant pleomorphic adenoma of the submandibular gland of 10 years' duration.

## CASE REPORT

A 59-year-old black female presented to the Maxillofacial and Oral Surgery unit at Wits Oral Health Centre for evaluation of a painless mass at the right side of her neck in the right submandibular region that had been enlarging slowly for 10 years (Figures 1A, B, C). There was no history of dysphagia, dyspnea or dysphonia. According to the patient, a similar but smaller mass was excised from the same location by general surgeons in another district more than 10 years previously. The patient soon thereafter noticed that the mass started growing again. She had no knowledge of the diagnosis of the excised lesion. The swelling has been growing slowly throughout the years, but the patient noted a gradual increase in size in the past three years. The patient's medical history was significant for hypertension. The patient denied any drug and alcohol use in the past. No history of smoking and weight loss were reported by the patient. The patient was not febrile nor in any acute distress.

Head and neck examination revealed a nontender, rubbery firm, freely mobile, well-circumscribed mass in the right submandibular region extending to the lower right side of the neck to the level of the clavicle in the ipsilateral side. The mass was not warm to touch and measured approximately 8.5cm x 7.5cm, with no regional omolateral or contralateral

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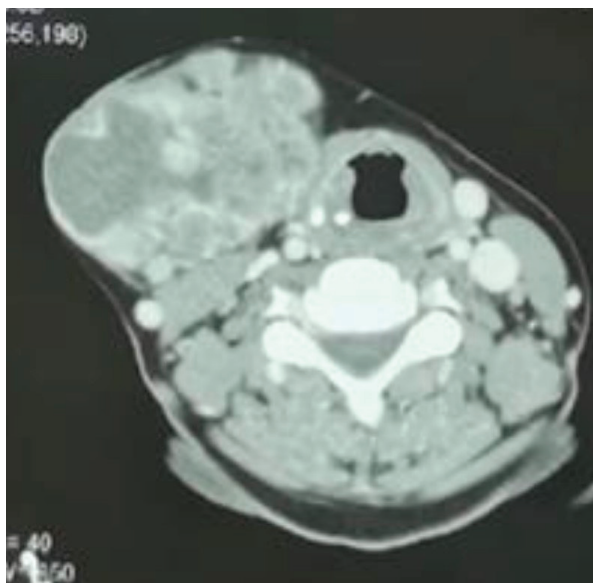
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Figures 1A, B and C: Clinical photographs in frontal (A), inferior (B) and profile (C) views showing the well-circumscribed mass in the right submandibular region extending to the level of the right clavicle. A hypertrophic scar is noted on the skin.





Figures 2A and B: Axial (A) and Coronal (B) Contrast-enhanced CT scans showing an 8.5cm x 6cm solid mass extending from the submandibular region toward the left thyroid lobe. The lesion contained multiple dense calcifications and low-density necrotic areas.

lymphadenopathy. The swelling was lobulated, freely mobile and not fixed to the underlying tissues. The overlying skin was normal in colour and texture, except for what appeared to be a scar from the previous incision but was not ulcerated or fixed to the swelling.

On ultrasonographic examination, a solid tumour with heterogenic low echo areas and multiple calcifications was observed. A contrast-enhanced computed tomographic (CT) scan confirmed an 8.5cm x 6cm solid mass extending from the right submandibular region to neck midline. The lesion contained multiple dense calcifications and low-density necrotic areas (Figures 2A, B). After clinical and CT examinations, a differential diagnosis of pleomorphic adenoma was made. An incisional biopsy was performed, which confirmed the diagnosis of a pleomorphic adenoma. The patient was operated on via a submandibular approach under general anaesthesia. The tumour was bounded

by the anterior belly of digastric muscle anteriorly; the retromandibular fossa and the sternocleidomastoid posteriorly, the lower border and lateral surface of the mandible superiorly; and the submandibular triangle and lateral aspect of neck inferiorly. Medially, the lesion extended toward the submandibular fossa and the inferior pole of the parotid gland. The cortical bone on the lateral side of the mandible was intact, with a minimal defect due to pressure resorption. The 8.5cm x 7.5cm x 4cm solid, smooth mass was completely excised along with adjacent glandular tissue (Figure 3). The excised gross specimen showed a gray-yellow colour and a surrounding thick capsule (Figure 4). Microscopic examination of the lesion confirmed the diagnosis of pleomorphic adenoma with clear margins. Sections showed a well-circumscribed neoplasm surrounded by a thin rim of fibrous connective tissue with adjacent seromucous salivary gland parenchyma and fibroadipose tissues. There were proliferating epithelial and

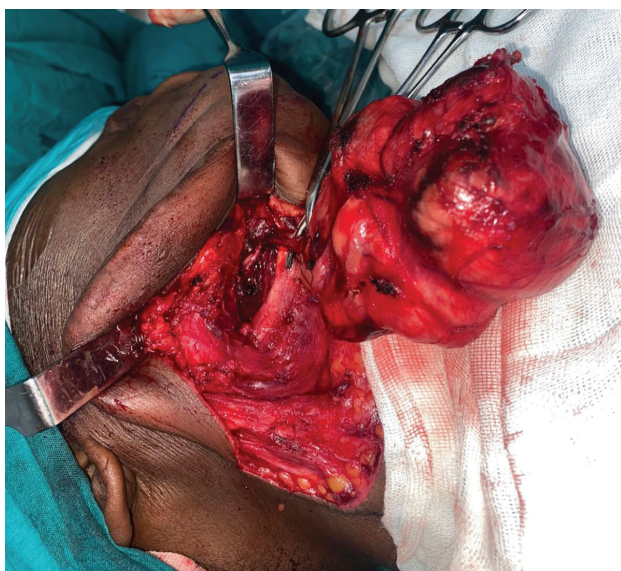


Figure 3: Solid, smooth tumour mass being excised along with attached submandibular gland.

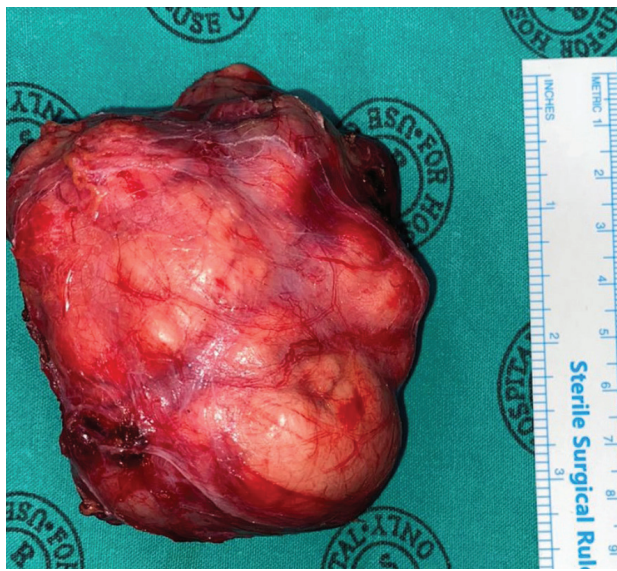
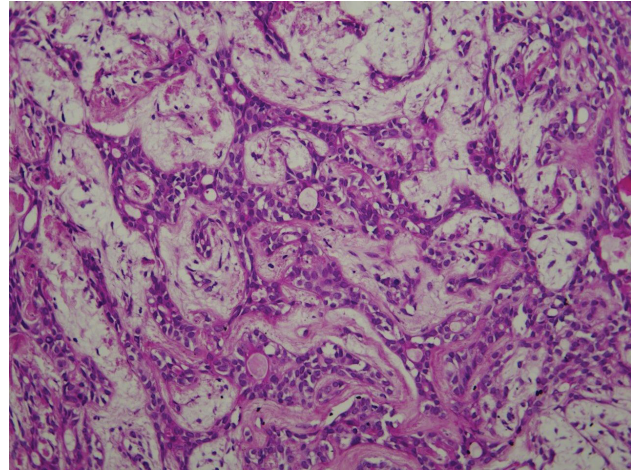
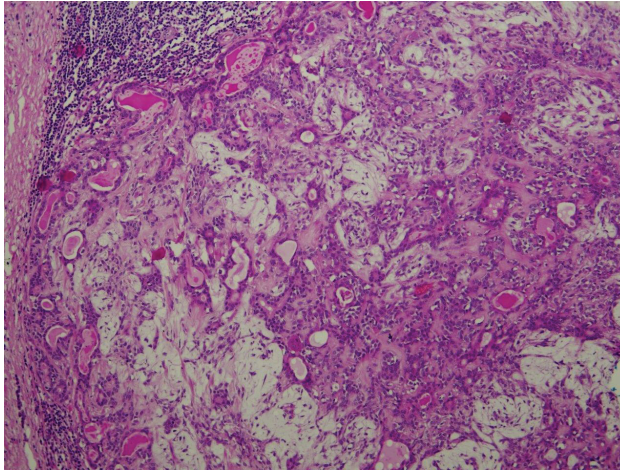


Figure 4: The excised gross specimen showed a grey-yellow colour and a surrounding thick capsule.





Figures 5A and B: Hematoxylin and eosin (H&E) stained histopathologic images showing proliferating epithelial and myoepithelial cells with minimal pleomorphism arranged in tubules, cords and small groups in a myxochondroid matrix with a surrounding capsule (A: x10; B: x20).

myoepithelial cells with minimal pleomorphism arranged in tubules, cords and small groups in a myxochondroid matrix with a surrounding capsule which was not infiltrated by the tumour (Figure 5). On serial sectioning, no atypical mitoses, necrosis or malignant change were observed.

No complications were observed in the postoperative period. Two years after surgery, there were no clinical signs of recurrence of the tumour and the patient is under periodic examination (Figure 6).

## DISCUSSION

PA accounts for 60% of all benign salivary glands.<sup>8,11,12,13</sup> PA of the submandibular gland is rare and represents about 5-10% of affected cases. It generally presents as an asymptomatic, slow growing tumour which seldom exceeds 6cm in diameter.<sup>14</sup> However, if left untreated for many years, it can reach large and grotesque proportions, as exemplified by the present case, which comprised a circumscribed multilobulated tumour mass measuring 8.5cm x 7.5cm x 4cm, with attached salivary gland measuring 2.5cm x 1.5cm x 0.8cm.

Clinical guidelines recommend that a histological sample be obtained for histopathological confirmation of salivary gland tumours prior to deciding on the treatment modality, especially when a high index of suspicion of malignancy exists. Traditionally, fine-needle aspiration (FNA) biopsy has been used for histopathological confirmation of salivary gland tumours. Fine needle aspiration biopsy of the present case was suggestive of a benign tumour of salivary gland origin. FNA biopsy is a readily available and inexpensive diagnostic tool for evaluating neoplastic and non-neoplastic lesions, especially in superficial or easily palpable masses. FNAs are, however, unable to diagnose the exact pathology without architectural context for morphology and further staining techniques for molecular and genomic profiling.<sup>15</sup> The major drawbacks of FNA include a lower sensitivity than specificity and a relatively high rate of non-diagnostic results.<sup>16</sup>

Because of concerns about its limited sensitivity and significant false negative ratio, and the purported risk of seeding the tumour along the needle tract, some clinicians do not support its widespread usage.<sup>15</sup> For these reasons,

FNA must be seen as an additional tool in the evaluation of salivary glands or cervical masses rather than a diagnostic procedure on which therapeutic decisions can be based.

Accuracy of ultrasound-guided core-needle biopsy in salivary gland tumours is high, with a very high sensitivity and a reliable diagnosis of malignancy. It should be considered the technique of choice when a nodule is detected in the salivary glands.<sup>17</sup> The size of the present case and ease of access made an incisional tissue biopsy a tissue sampling of choice, which confirmed the diagnosis of pleomorphic adenoma, considered to be a recurrent lesion based on previous surgical history.



Figure 6: Postoperative clinical photograph at two years showing satisfactory outcome.



The dominant histologic feature of the pleomorphic adenoma is its great heterogeneity. The present case consisted of lobules composed of spindle myoepithelial cells, chondromyxoid stroma, plasmotoid myoepithelial cells and bilayered ductal structures lined by bland cuboidal epithelium. There were no focal areas of necrosis or atypical mitoses suggestive of possible malignant transformation. When malignant transformation of a pleomorphic adenoma occurs, it is usually in the form of moderate to poorly differentiated adenocarcinoma referred to as carcinoma within a pleomorphic adenoma (carcinoma ex pleomorphic adenoma). Longevity and recurrence are considered risk factors for malignant transformation.<sup>18</sup> The risk of malignant transformation is reported to be between 1.8% and 6.2%.<sup>19,20,21</sup> Carcinoma ex pleomorphic adenoma appears to be more aggressive and lethal than either adenocarcinoma or adenoid cystic carcinoma.<sup>22</sup>

Early stages of PA in the submandibular triangle may clinically be indistinguishable from malignant submandibular gland tumours and enlarged submandibular lymph node. Our patient's presentation with an enlarging asymptomatic mass on the right submandibular region extending down into the neck necessitated a differential diagnosis from other cervical masses. The rule of thumb when evaluating neck masses is the "rule of 80", which pertains to adults over the age of 40, as described by Skandalakis et al.<sup>23</sup> This rule states that 80% of non-thyroid neck masses are neoplastic. Of the neoplastic masses, 80% are malignant. Of the malignant masses, 80% are secondary. Of the secondary masses, 80% occur above the clavicle. They also described a secondary way of predicting the diagnosis based on the duration of the lesion using the "rule of 7s". If a mass has been present for 7 days, it is more likely inflammatory in nature; if present for 7 months, it is likely neoplastic in nature; and if present for 7 years, it would most likely be developmental. These generalisations are, however, no substitutes for detailed history taking and thorough clinical examination in reaching a correct diagnosis. Acuity of onset, location in the neck, duration, rate of growth, presenting symptoms, gender and age are other important considerations towards establishing accurate diagnosis.

Cervical masses are thus categorised into the three following categories: inflammatory, neoplastic (benign, malignant) and congenital/developmental.<sup>24</sup> In children and young adults, neck masses are mostly due to inflammation.<sup>24</sup> These can either be acute or chronic, and may either be of viral origin, bacterial, parasitic or manifestation of granulomatous diseases (such as sarcoidosis). The non-febrile nature and 10 years' duration of the mass in the present case ruled out an inflammatory origin. Polymerase chain reaction (PCR) result of aspirates from the lesion also yielded a negative GeneXpert MTB/RIF ultra-assay.

The slow rate of growth over a 10-year period of the mass in the present case was suggestive of a benign lesion. These lesions are usually unaesthetic over the years and may in addition result in mass effect on important structures of the neck.

CT scans with contrast in the present case revealed a large well-defined mass in the right submandibular space extending to the neck with no evidence of fixation to the surrounding structures. The mass was mobile but firm.

Also, there was no facial paralysis or other neurologic deficits associated with the mass. Cervical lymph node examination did not reveal any fixed lymph node suggestive of metastatic cervical lymphadenopathy from primary head and neck squamous cell carcinoma (SCC), oropharyngeal SCC or distant metastasis. There was also no history of alcohol or smoking on this patient. The non-smoking history, however, should be interpreted with caution as it is now common knowledge that human papilloma virus (HPV) causes oropharyngeal SCC in adult patients with zero smoking history.

In addition, the patient didn't present with symptoms such as fever, weight loss and night sweats suggestive of lymphoma, the second most common head and neck malignancy which also presents as an enlarged neck mass commonly in the posterior triangle.<sup>24</sup> Lymphomas also commonly affect the paediatric population.<sup>24</sup> FNA flow cytometry also excluded diagnosis of lymphoma.

The most common submandibular gland malignant tumours – first, mucoepidermoid carcinoma and second, adenoid cystic carcinoma – can also present as single, unilateral firm neck masses. However, unlike in the present case, these malignant diseases have limited mobilities because of their location within the parenchyma of the gland.<sup>25</sup>

Although PAs are encapsulated, expansible growth-producing protrusions into the surrounding gland can be caused by incomplete pseudocapsule, pseudopodia of PA tissue and extracapsular extension.<sup>26</sup>

Surgical extirpation remains the primary choice of treatment of PA, with excellent prognosis and low rate of recurrence when clear margins are achieved. In our case, the tumour was excised without rupture of the capsule. Recurrence after excision has been reported in 1%-5% of cases.<sup>27</sup> Risk factors for recurrence include pseudopodia, capsular penetration of the tumour, incomplete excision and tumour rupture or spillage during surgery.<sup>28</sup> Simple enucleation is also associated with high recurrence rates (2%-25%) and is thus not recommended.<sup>29</sup> Postsurgical adjuvant therapies such as chemotherapy and radiotherapy are not routinely indicated for pleomorphic adenoma. They may, however, play a role in inoperable tumours, treatment of local recurrences, tumours with nerve involvement, tumour spills and multifocal diseases.<sup>3</sup>

Though PA is associated with good prognosis postoperatively, follow-up with regular US monitoring is mandatory. After a two-year follow-up, no recurrence was observed in the clinical case described.

#### Ethics approval

This study was approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand and was performed in accordance with the principles of the Declaration of Helsinki on medical protocols and ethics (Approval number M220969).

#### Acknowledgement

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## Online CPD in 6 Easy Steps



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



# What's new for the clinician – summaries of recently published papers (February 2024)

SADJ February 2024, Vol. 79 No.1 p45-48

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

## 1. IS THERE ANY ASSOCIATION BETWEEN MATERNAL DEPRESSION IN THE FIRST 1,000 DAYS OF LIFE AND EARLY CHILDHOOD CARIES PREVALENCE?

The first thousand days of life refer to the period between conception and 24 months of life and it is a critical period in which foundations for the healthy development of the child are laid, having a huge impact on the health of unborn babies, infants and young children. Pregnancy and the postpartum period are considered a phase where women have an increased vulnerability to mental disorders. Studies have shown that around 12% of pregnant women experience depression in the antenatal period and the prevalence of postpartum depression ranges from 10%-15%.<sup>1</sup> These psychiatric disorders are not only associated with poor maternal health but also with negative effects on children, affecting the cognitive development and behaviour.<sup>1</sup> Studies have also shown that there is a strong correlation between the oral health knowledge, practice and behaviour of the mother and the oral health status of the young child. Mothers who have poor oral health often have children who have higher levels of early childhood caries (ECC). Mothers with mental disorders have also been shown to be unable to take care of their own health optimally thereby also placing the health (and oral health) of their children at risk. Due to a lack of longitudinal studies investigating the influence of maternal depressive disorders on the occurrence of child's dental caries, da Fonseca Cumerlato and colleagues from Brazil (2023)<sup>1</sup> reported on a study that sought to investigate the effect of the trajectory of maternal depressive disorders in the first thousand days of the child's life on the prevalence of early childhood dental caries at 48 months of age in a birth cohort.

### MATERIALS AND METHODS

This was a longitudinal prospective study developed from data collected in a population-based birth cohort in the city of Pelotas, Brazil. In 2015, a population-based birth cohort study was started with the recruitment of pregnant women during antenatal care, thus allowing for the prospective collection of pregnancy-related variables. To identify pregnant women expected to give birth during 2015, 123 health facilities and private clinics providing antenatal care in the city were visited by the research team between May 2014 and December 2015. These women were visited at home or invited to the research clinic between 16 and 24 weeks of gestation to answer a health questionnaire. This antenatal study obtained a response rate of 79.8% (n=3,199) from all mothers who had their children included in the 2015 birth cohort.

During 2015, all infants born in the five hospitals of Pelotas were identified, and the mothers of live-born infants were invited to join the cohort. Until the present study, this cohort has been followed up five times. The follow-up visits included home visits at 3, 12 and 24 months. The 4-year follow up occurred between January to September 2019. A total of 4,010 children were followed up.

The 48-month assessment fieldwork was conducted at a clinic. Oral health clinical examination was conducted by dentists, previously trained and calibrated, to investigate dental caries and other clinical conditions. The outcome of this study was early childhood dental caries assessed using the International Caries Detection and Assessment System (ICDAS). It was considered the merged ICDAS classification which classifies the tooth surface for the presence of dental caries into four categories as follows: 0, no evidence of caries; A, initial caries; B, moderate caries; C, extensive caries. The ICDAS also separately classified tooth surface for the presence of dental restoration. The other three codes were included in both assessments (dental caries and restorations): 97, missing surface due to tooth decay; 98, missing surface due to other reasons; 99, unerupted tooth surface. The merged ICDAS classification is in accordance with a protocol for early childhood caries diagnosis developed by researchers from the World Health Organization (ECC-0 sound; ECC-1 smooth white spot lesion; ECC-2 enamel breakdown; ECC-3 cavity into dentin).

For analysis purposes, the dmfs index variable was created from the ICDAS as follows: Decayed surface (d) included moderate caries and extensive caries categories (ECC-2 and ECC-3), once initial lesion involves only enamel and it is not considered in dmfs index; missing surface (m) included missing surface due to tooth decay category; and filled surface (f). The dmfs index variable was considered in analysis models in two ways including presence of ECC (no [dmfs=0] and yes [dmfs≥1]) and severity of the ECC (count variable considering number of tooth surfaces decayed, missed and filled).

As exposure variables, two maternal depressive symptom trajectories were created (screening and diagnosis of depression) from the scores obtained in the Portuguese version of the Edinburgh Postnatal Depression Scale (EPDS) applied in four moments of the cohort study (antenatal, 3-, 12- and 24-month follow-ups). The EPDS assesses the presence and intensity of depressive symptoms in the previous week. A score greater than or equal to 10 was used as a cut-off point for screening of depression, and a score greater than or equal to 13 was used as a

cut-off point to define clinically relevant symptoms of depression (diagnosis). Other variables collected included maternal education which was considered as completed schooling years of mothers and categorised into 0-4, 5-8, 9-11 and 12+ (years). Maternal age was collected in years and classified into four categories: <19, 19-24, 25-34 and 35+ (years). Familiar income was collected in continuous way in Brazilian real (BRL) and categorised in quintiles (1st-lowest quintile and 5th-highest quintile).

## RESULTS

A total of 3,645 children were included in this study, representing a response rate of 90.9% considering the eligible population at 48-month follow-up ( $n=4,010$  children; 217 were losses, 139 refusals and 9 missing data related to the outcome). There were no differences between the samples for the tested variables. For depression variables, considering screening cut-off, almost 30% (29.2%;  $n=1,063$ ) of mothers presented a high trajectory of depression symptoms, and almost one-fifth (18.84%;  $n=686$ ) of mothers presented a high trajectory of depression diagnosis. ECC was observed in 26.7% ( $n=973$ ) of children at 48 months.

It was possible to observe that the prevalence of ECC was greater in children from younger mothers, with less completed schooling years and with lower familiar income ( $p<0.001$ ). In addition, the mean number of surfaces affected by ECC increased as the mother's age, completed schooling years and familiar income decreased. Among the maternal depressive symptoms' trajectories, children from mothers with high depressive symptoms trajectories (screening and diagnosis) presented both a higher prevalence and higher number of surfaces affected by ECC ( $p<0.001$ ).

Multivariate analysis showed that both ECC prevalence and severity of dental caries at 48 months of age were associated with maternal depressive symptom.

Trajectory for positive screening of depression and for depression diagnosis was associated to presence of ECC. Children whose mothers presented high trajectory for screening and for diagnosis of depression presented 1.14 (RR=1.14; 95% CI 1.02-1.28) and 1.19 (RR=1.19; 95% CI 1.05-1.35) higher risk of having at least one surface affected by dental caries at 48 months, respectively, when compared to children whose mothers presented low depression trajectory for both screening and diagnosis of depression.

Children whose mothers presented high trajectory for diagnosis of depression had mean number of surfaces affected by caries 26% higher (RR=1.26; 95% CI 1.02-1.54) compared to children whose mothers presented low trajectory for diagnosis of depression.

## CONCLUSIONS

Maternal depression trajectories from pregnancy to 24 months increased the risk for early childhood dental caries at 48 months of age. It was observed that children from mothers with high depression trajectory had higher risk of having early childhood caries compared to children from mothers with low depression trajectory.

## IMPLICATIONS FOR PRACTICE

Early detection and treatment of maternal mental disorders should be considered of high priority in health services. The children of these mothers are at higher risk for developing ECC and should be targeted for preventative approaches.

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## 2. ASSESSMENT OF CARDIOVASCULAR ALTERATIONS AND CATECHOLAMINES SERUM CONCENTRATION AFTER ORAL SURGERY IN PATIENTS RECEIVING LOCAL ANAESTHETICS WITH EPINEPHRINE

Vasoconstrictors (VCs) are widely used in conjunction with local anaesthetic (LA) solutions in dentistry. An important issue related to potential toxicity is the systemic effects of vasoconstrictors after intraoral injection. A related question faced by the dentist is whether to administer a vasoconstrictor-containing local anaesthetic solution to a patient with cardiovascular disease. Local anaesthetic with vasoconstrictors (LAVCs) increase the duration of anaesthesia, promote local haemostasis and reduce the absorption speed of LA, thereby decreasing the risk of systemic intoxication.<sup>1</sup> However, the safety of LAVCs has been debated for decades, especially in patients with cardiovascular problems. Factors such as pain caused by anaesthetic infiltration, psychological stress, intravenous vasoconstrictor application and drug interaction, in addition to the systemic absorption of vasoactive agents, may contribute to these cardiovascular alterations.<sup>1</sup>

Most vasoconstrictors used in dentistry are classified as sympathomimetic amines or catecholamines. Ideally, vasoconstrictors should act on alpha-adrenergic receptors, which are responsible for increasing peripheral circulatory resistance (vasoconstrictor effect). Nevertheless, all the vasoconstrictors currently used exhibit some beta-adrenergic effect, including increased heart rate (HR) and heart muscle contractility, decreasing peripheral resistance in the skeletal muscle arterioles and bronchial muscle relaxation.<sup>1</sup> The most widely used vasoconstrictor in dentistry is epinephrine, which exhibits both alpha and beta-adrenergic effects. Given that the substance is applied in the oral mucosa, where the alpha-adrenergic receptors predominate, its beta-adrenergic effects are minimised. Despite that, there is tissue absorption of the vasoconstrictor with consequent action in beta-adrenergic receptors, causing undesired cardiovascular effects. Older patients with heart disease may therefore display a more marked systemic response to vasoconstrictors, precipitating complications such as angina, infarction and arrhythmias, among others.<sup>1</sup>

An electrocardiogram (ECG) can be used to detect arrhythmias and myocardial ischemia in patients submitted to oral surgery with LAVCs. Another tool that can be used to assess the effects of LAVCs is to measure the serum catecholamine concentration (epinephrine, norepinephrine and dopamine).

Da Silveira and colleagues (2023)<sup>1</sup> reported on a trial that sought to assess the effects of LAVCs on the



cardiovascular system and their relationship with serum catecholamine concentration in hypertensive and healthy patients who had oral surgery.

## MATERIALS AND METHODS

This was a randomised clinical trial that consisted of 20 healthy and hypertensive patients requiring tooth extraction with LAVCs. The aim was to compare cardiovascular parameters with serum catecholamine concentration in healthy and hypertensive patients. The cardiovascular parameters analysed were HR, oxygen saturation (SO<sub>2</sub>) and systolic (SBP) and diastolic blood pressure (DBP), in addition to the number of ventricular and supraventricular extrasystoles (VES and SVES respectively) and ST segment depressions, which were measured in the perioperative and 24hr postoperative periods using a Holter monitor. Data on infiltration anaesthesia volume, transoperative pain level and total surgery time were collected from both groups.

The inclusion criteria were healthy patients and those with high blood pressure diagnosed by a cardiologist and who needed tooth removal surgery with LAVCs. The exclusion criteria were patients who declined to participate in the study, were allergic to LAVCs or the drugs used in the research, and those with health problems that prevented them from undergoing outpatient surgery.

A total of 23 patients were screened for the study. Two were excluded for refusing to participate and one for incorrect recording on the Holter monitor. The 20 remaining patients were divided into two groups: control group (CG) composed of healthy patients and experimental group (EG) consisting of hypertensive patients. All the patients underwent oral surgery with 2% lidocaine and 1:100,000 epinephrine.

The patients were submitted to a clinical examination and a thorough review of the patient's medical history to identify health problems and prepare a treatment plan. For hypertensive patients, a medical report was provided by the cardiologist with a diagnosis, and all the drugs used were recorded on their medical chart. Before surgery, the patients received a drug protocol consisting of 500mg of dipyrone, 8mg of dexamethasone and 1000mg of amoxicillin. None of the patients reported being allergic to the medication used.

All the surgeries were performed in the morning, and the treatment protocol was the same for all the patients. After the patient arrived at the clinic, vital signs were measured to identify any possible systemic alteration that could contraindicate surgery. Next, the patient took the pre-emptive medication, the Holter monitor was installed and venous access to the arm was obtained. The patient then rested for 30 min. This rest period before the first blood collection was necessary to avoid changes in catecholamine levels caused by venous puncture pain. In addition to the perioperative period, the patient wore the Holter monitor for 24hr after surgery, which was removed the following day.

Analyses were conducted at three different times (initial, trans and final). After the rest period, the first measurement (initial) was made, followed by onset of the surgery. The trans period was assessed after the anaesthetic solution

was already infiltrated and the exodontia was being performed. The last measurement (final) occurred at the end of suturing. HR, SBP and DBP were recorded with an automatic device and SO<sub>2</sub> with a pulse oximeter. The occurrence of VES, SVES and ST segment depressions was recorded on a Holter monitor for each time interval as well as in the 24hr after surgery and were evaluated by a cardiologist who was blinded to the heart comorbidity of the patients.

Blood samples were collected to measure serum catecholamine concentration during each period of evaluation.

## RESULTS

Of the 23 patients screened for the study, 20 were assessed, six of whom were allocated to the Control Group[CG] (1 M and 5 F) and 14 to the Experimental Group[EG] (6 M and 8 F). Two patients refused to participate, and one could not be included because the Holter test was not correctly recorded. The average age of EG patients was almost twice that of their CG counterparts.

Variables related to the surgical procedures such as transoperative pain, number of anaesthetic tubes used and surgery time obtained similar results in both groups, with no statistically significant differences. SO<sub>2</sub> exhibited a statistically significant difference between the experimental and control groups in the initial period ( $p=0.001$ ), with EG patients obtaining lower values than those of their CG counterparts. No differences were found in the trans and final periods. A statistically significant difference in SBP was also observed at the three measurements, with EG patients exhibiting higher values than those of the CG. DBP was similar between the two groups at the three assessments.

Arrhythmias were measured via the occurrence of ventricular and supraventricular extrasystoles. VES showed a statistically significant difference only in the 24hr postoperative period ( $p=0.041$ ), with the group of hypertensive patients (EG) obtaining a higher number of events. Assessment of SVES demonstrated no difference for the two groups in any of the assessments. Serum catecholamines exhibited no intergroup differences for the three measurements.

Intragroup comparison revealed that the hypertensive patients (EG) obtained a statistically significant difference for HR ( $p=0.001$ ) with the transoperative HR demonstrating a higher value than that seen in the initial and final periods. The CG showed no difference in the three measurements for this variable ( $p=0.070$ ). SO<sub>2</sub> also remained stable for both groups, with no statistically significant difference for the three assessments.

SBP was significantly different for the EG in the three measurements ( $p=0.041$ ), with the transoperative period obtaining higher values than in the initial and final periods. The CG results were not different between the three assessments ( $p=0.513$ ) and, unlike the EG, the highest SBP values were observed in the initial period. DBP remained stable over the three periods for the CG ( $p=0.483$ ) and EG ( $p=0.066$ ). In both groups, the highest DBP values occurred in the initial period.

Intragroup analysis for the variables VES and SVES was conducted with and without excluding extrasystole measurement in the 24hr postoperative period. Normotensive CG patients had no VES events during the perioperative period. However, EG hypertensive patients demonstrated VES episodes during the three assessments, albeit not significantly different ( $p=0.305$ ) (Table 16). SVES also showed no statistically significant difference in the three periods assessed for the CG ( $p=0.135$ ) or the EG ( $p=0.549$ ), as shown in Table 17. Analysis of VES and SVES, including the 24hr assessment period, showed that only the CG exhibited no significant difference for the variable VES ( $p=0.112$ ) (Tables 18 and 19). The VES events for the EG ( $p=0.000$ ) showed a significant difference when the 24hr period was compared to the initial and trans periods. Assessment of SVES events for the EG ( $p=0.000$ ) demonstrated a difference between the initial and 24hr periods, while for the CG ( $p=0.013$ ) this difference was observed between the 24hr period and its initial and trans counterparts.

Intragroup serum catecholamine concentration demonstrated no significant difference between

assessment periods for both groups. This shows that the variation in these substances remained stable during the surgery with LACV infiltration (trans period) for both normotensive and hypertensive patients.

### CONCLUSIONS

Teeth extraction with LAVC can be safely executed in hypertensive patients. Blood pressure should be monitored in these patients since the sysBP presented significant differences during the surgical procedures. Cardiac arrhythmia and the serum catecholamines concentration levels seem not to be altered by the surgical procedure. Also, serum catecholamines do not influence cardiovascular changes in this type of surgery.

### IMPLICATIONS FOR PRACTICE

LAVC can be safely used in hypertensive patients and does not increase the risk of arrhythmias or cardiac ischemia.

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## Online CPD in 6 Easy Steps



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# Regulatory Overreach – Intervention or Interference

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## ABSTRACT

There is a prevalent notion among healthcare professionals that their private lives have no bearing on their work. Yet, the public has expectations about the conduct of health professionals while at work or in public. Citizens are quick to broadcast information, and express opinions, and beliefs about the conduct of health partitioners via social media. Consequently, incidents and behaviours traditionally confined to the work environment, have been brought into the public domain, attracting interest and scrutiny. The exposure of personal information can have serious ramifications to the individual and professional reputation. We have witnessed in recent times, the regulator having to acknowledge, process and adjudicate professional conduct emanating outside the work environment.

In this article we interrogate the jurisdiction of the HPCSA regarding “unprofessional conduct” outside work. Several contextual questions are discussed: (i) what does it mean for the HPCSA to protect the public? (ii) How far does the HPCSA’s mandate to protect the public go extend? (iii) How should the regulator interact with social media as a source of information about practitioner’s behaviour and conduct. We contend that, in some cases, the HPCSA as a regulatory authority, can exercise its jurisdiction and prescribe how their members should conduct themselves outside of work. Eventually, Health Professions Council of South Africa, must protect the public and regulate the profession – “by all means necessary” or only when the “means are necessary”

## Background

Reputation is a significant feature in a social construct since it is used to determine a person’s social standing in

society. Professional reputation means being regarded as loyal, trustworthy and possessing skill and expertise. How health professionals conduct themselves could be a matter of public interest or concern. It is through this lens that the public can construct a picture of the person in whom they place their trust. There is therefore an implied expectation by the patient, public and profession for the dentist to be a person of high moral standards, honest and trustworthy at all times. The dentist is obliged to act professionally, anticipate and avoid situations that could harm the profession and the public. Similarly, the regulatory bodies, such as the Health Professions Council, are dutybound to safeguard the interests of the public by regulating the professional conduct. Several pathways exist for the HPCSA to regulate the professions:

- (i) The aggrieved party can lodge a complaint against their practitioner.
- (ii) Third party’s life the medical schemes can approach the HPCSA to seek retribution against the practitioner.
- (iii) The court of law can refer a matter to the HPCSA seeking further sanctions against the practitioner.
- (iv) Unprecedented and not codified by the HPCSA, issues emanating from social media could potentially attract sanctions from the HPCSA. “Matters of “public interest” or “that interest to the public”.
- (iv) In all the scenarios above the HPCSA must make a determination to initiate a disciplinary process. There is sufficient procedural certainly in dealing with the first three scenarios. Regarding the fourth scenario, the HPCSA lacks clear guidelines and process.

## CASE STUDY

Over the weekend, a well-known dental professional registered with the HPCSA went on a drinking spree. He was involved in a car accident, incurred minor injuries, and caused the death of another person. Images of the incident then went viral on various social media platforms. The state charged the practitioner with recklessly operating a motor vehicle, endangering other individuals and property, and negligently killing another person while under the influence of alcohol. The court found him criminally liable on all allegations and gave him a suspended sentence. Meanwhile, he concluded an out-of-court settlement with the deceased’s family to avert civil litigation. The HPCSA also charged the practitioner with unprofessional conduct and launched an investigation.

## QUESTIONS

- Should public opinion on professional behaviour influence how the Health Professions Council of South Africa (HPCSA) governs the profession? In other words,
- (i) Should the HPCSA investigate matters of “public interest” or matters that “interest the public”.
  - (ii) Does the HPCSA have jurisdiction or mandate on

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- matters of public interest? If so, how far does this jurisdiction extend.
- (iii) Is public interest necessary and or sufficient for the HPCSA to act?

In relation to the practitioner, the following issues for debate arise.

- (i) Is the mis(conduct) of practitioner a matter of “public interest”, in other words, should the public have interest in the conduct of practitioners outside the workplace.
- (ii) If so, how does conduct outside the workplace (essentially life outside the workplace) translate into a matter of public interest.

## DISCUSSION

We ground our discussion of the case on the following premises:

**Premise 1:** The mandate of the HPCSA provides the basis for extended jurisdiction.

### (a) The role of the Health Professional Council of South Africa

In regulating the profession, the HPCSA has jurisdiction over improper professional conduct of the registered members.

Question: What constitutes improper conduct of the practitioner (legal and ethical constructs)? How far should the HPCSA go in regulating the conduct of members?

- (i) In protecting the public, should matters of “public interest” inspire the HPCSA to regulate practitioner’s conduct.

**Question:** What is public interest? And how far can the HPCSA go to ensure the protection of “public interest”.

- (i) In discharging the roles (i) and (ii), the HPCSA should always protect the individual liberties.

**Question:** What professional protection and liberties are beyond the jurisdiction of the HPCSA, therefore should be protected at all costs. How does the HPCSA balance the public and practitioner’s interest.

**Premise 2:** Professionalism engenders self-regulation beyond self-interest.

### (b) Understanding the nature and essential elements of the profession]

The concept of “profession” is disputed in literature, and the discourse, on its nature remains divergent. Some authors suggests that the notion of ‘profession’ is not amenable to definition, yet a degree of description is desirable to provide the basis for professional conduct and regulation. The paper by Ali Abadi cites perspectives such as the trait, taxonomic, functional, process, power, and contemporary frameworks as helpful in delineating the nature of the profession.<sup>1</sup> Despite these many permutations, the general definition of profession encapsulates “a specialised, knowledge-based and legally self-regulating occupation that renders its services

to the public and society through a complex, reciprocal relationship based on competence, recognition and trust”.<sup>1,2</sup> In practice, the profession should be incarnate with a great sense of “internalised moral responsibility that transcends professional self-interest and shows itself in a sentiment of care for the client and society at large”.<sup>3</sup> From this viewpoint, by becoming a member of the profession, the candidate vows and publicly declares to abide by the codes of conduct and ethos of the profession. In summary, the profession should have the following core characteristics and attributes.

- (i) A specialised, knowledge-based occupation with a profession-specific body of knowledge.
- (ii) Professional authority enabling regulated training, credentialing, autonomy self-regulation and governance.
- (iii) Transactional and reciprocal relationship with the public and society; public interest is paramount.
- (iv) Regulative codes of ethical and professional conduct, with membership conditional on acceptance and adherence to these codes.

Premise 3: Public trust shapes attitude and behaviour towards health

### (c) Without trust, there can be no healing.

Patient trust in their doctor is the cornerstone of the doctor-patient relationship. Health professionals are still the most trusted professionals, however, there is increasing evidence that this level of trust is eroding very fast.<sup>4</sup> The lack of trust in doctors is reaching a crisis level globally “Our line is that peoples’ beliefs/concepts about trust may have changed from a blind or assumed trust to a more conditional trust, although there are still high levels of trust in the medical profession, particularly in individuals as opposed to the institution”.<sup>5</sup> The creep of commercialism and commodification of health, incursion of social media into the private lives of clinicians are among the commonly cited reasons for declining trust of the profession.<sup>6</sup> The Internet is among the leading sources of health information for the general public. This resource is available for patients, to communicate, and make decisions, which may change their attitude toward clinicians.<sup>7</sup> Though few studies have been conducted on the impact of Internet of public trust, Meng and colleagues found that internet use is negatively associated with residents’ trust in doctors. Similar studies found that physicians social media behaviour, such as appearing intoxicated on photographs can affect patient trust.<sup>8,9</sup>

**Premise 4:** Misconduct is a necessary condition for the regulatory intervention.

### (d) Misconduct and unprofessional conduct

Misconduct is a heterogeneous phenomenon, produced by multiple causes. Viewed as a continuum, misconduct ranges from actions that are illegal (prohibited by criminal and civil laws) to actions that are unethical (contrary to societal norms and expectations) or unprofessional (against professional codes of conduct and protocols). Theoretically therefore, misconduct by professionals can include a range of examples of actions deviant to the laws, norms, and protocols.

Unprofessional conduct is defined in the HPCSA (Section



2 of the Health Professions Act 56 of 1974), as a “set of attitudes, behaviours, and characteristics deemed desirable in members of a profession. It defines the profession and its relationship to its members and to society”.<sup>10</sup> The Act also defines, unprofessional conduct as “improper or disgraceful or dishonourable or unworthy conduct or conduct which, when regard is had to the profession of a person who is registered in terms of this Act is improper or dishonourable or unworthy”. The expanded legal definition of unprofessional conduct according to Law Insider includes “conduct unbecoming a licensee or detrimental to the best interests of the public, including conduct contrary to recognized standards of ethics of the licensee’s profession or conduct that endangers the health, safety or welfare of a patient or client.”<sup>11</sup> This means commission or omission of acts or behavior that fail to meet the minimally acceptable standard expected of similarly situated professionals constitute unprofessional conduct. The conduct maybe harmful to the public, but also reflect negatively on one’s fitness to practice. There is no contestation about unprofessional conduct occurring in the context of professional practice or work. That is during interaction with patients or third parties in the execution of professional activities. However, implied, even though not widely accepted is the notion that harm can occur at the level of the public, which goes beyond the confines of the clinical practice. Based on the definitions above the unprofessional conduct implies the following:

1. The offender is a bonafide member of the profession, a licensed professional in good standing.
2. There should be commission or omission of an act or behaviour.
3. The act or behaviour is detrimental to the patient.
4. The act or behaviour is harmful to the public.
5. The act or behaviour is damaging to the profession.

Each of the criteria above are necessary and not mutually exclusive. They would apply individually and in concert.

**Premise 5:** Public Interest a necessary condition for regulatory intervention.

#### (e) The Public Interest Theory

Public interest represents the notion that an action or process or outcome will benefit the public at large, promoting general welfare of the public or better serving the public. Public interest is purposefully undefined so that it can apply under different context and circumstances. This lack of definition allows flexibility and applications across jurisdictions and on a case-by-case basis.<sup>12</sup> Ultimately public interest is about what matters and why it matters.<sup>13</sup> On the contrary, what interests the public is sensational or heightens curiosity, without any meaningful benefits or harm. A matter that interests the public could translate into a matter of public interest; the reverse is also true. Public interest is often dismissed as a vague, lacking robust criterion, hence difficult to apply rationally and based on empirical evidence.<sup>14</sup> According to Public Interest Theory, regulation should, (i) protect and benefit the public at large or (ii) be imposed in order to maximise the welfare of the public. Therefore, public officials and organizations should ensure that the objectives, process and procedures and outcomes are aligned to the two concepts.

The following criteria represents an extensive list to be considered when evaluating matters of public interest:

- (i) The action or regulation will advance the interest of the public.
- (ii) The actions or regulation will advance the interest of the profession.
- (iii) The action or regulation will advance the interest of the of the practitioner.
- (iv) The procedure and process are compliant with the applicable law (letter and spirit)
- (v) The actions or procedures are reasonable.
- (vi) The action causes embarrassment to the council of profession
- (vii) The actions or procedures causes loss of confidence in the council or profession.
- (viii) The actions or procedures should be done or permitted to be done.

**Premise 6:** Legal precedence provide jurisdiction for the HPCSA.

#### (f) Council the primary *custos morum* of the health professions

On 25 November 2014 the respondent, Dr G was charged with unprofessional conduct. In his appeal, he cited that the HPCSA lacked jurisdiction over matters under review. His internal appeal was dismissed resulting in him going to the courts. In the High court Dr G contented that the Council had no authority to institute the disciplinary proceedings as the conduct complained of did not relate to the health profession. The High Court recognised the HPCSA authority over the conduct of its members. The Council is therefore not merely a medical malpractice watchdog; it is also the primary guardian of morals of the health profession. *Preddy and Another v Health Professions Council of South Africa*. At the end the Court, reiterated that the Council has jurisdiction over improper, or disgraceful or dishonourable or unworthy conduct. However, such a relationship is not a prerequisite for the council’s jurisdiction. This court ruling interpreted the extent of the jurisdiction of the HPCSA, noting the centrality of proven misconduct on the part of the practitioner.

#### Argument

The Health Professions Council of South Africa has a mandate to regulate professional’s conduct beyond the confines of work. In other words, the jurisdiction of the HPCSA can extend beyond the doctor-patient interaction. Being a professional places further responsibility on the practitioner to develop and maintain public trust at all times. We argue that in protecting the public the HPCSA should be vigilant and cognizant of issues that could undermine public trust. Such issues can get on the agenda of the HPCSA through several pathways. We note that improper conduct by practitioners is not restricted to the work environment but could originate from non-work, “private” situations. Particular to this case, the improper conduct by the practitioner occurred in their “private”. The HPCSA could evoke the “public interest” stance to consider private conduct by a practitioner. It is recommended that an extensive test of public interest be undertaken to determine the impact of the practitioner’s conduct. There are legal precedent cases that the HPCSA can refer to in dealing with this case or similar. The rapid adoption of the internet and social media has brought substantial changes in the way the HPCSA, the public and practitioners interact. In future more and more cases of improper misconduct by practitioners will go viral and attract curiosity and sensationalism from the public. The regulator cannot miss this opportunity to

develop guidelines aimed at addressing these impending trends.

### CONCLUSION

We conclude that it is undesirable and irresponsible for the professionals to ignore their presence and relationship with social media. Similarly, the regulator must develop guidelines to manage conduct of practitioners as they interact with social media.

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## MAXILLOFACIAL RADIOLOGY

# Double type III dens invaginatus

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### CASE

A 27-year-old male patient presented with a six-month history of swelling involving the left posterior mandible. The patient's medical history revealed no co-morbidities and the dental history was non-contributory. Extra-orally, there was a localised hard bony swelling involving the left posterior mandible. Intra-oral examination revealed a full complement of teeth with the left maxillary lateral incisor crown appearing malformed and a retained left maxillary deciduous canine. A panoramic radiograph revealed a well-defined, multilocular radiolucency with scalloped inferior borders in the left posterior mandible associated with the first to third molars (Figure 1). On further examination, a periapical was taken and revealed that the left maxillary lateral incisor appeared malformed with a periapical radiolucency (Figure 2). The periapical radiograph confirmed the presence of a double dens invaginatus on the mesial and distal aspects. The patient was referred for an incisional biopsy of the lesion in the left posterior mandible, which was subsequently

diagnosed as an inflamed odontogenic keratocyst and managed accordingly.

Concurrent referral for endodontic assessment of the left maxillary lateral incisor was made. The tooth had an exaggerated response to vitality testing and was diagnosed with irreversible pulpitis. A decision was made to perform a small field of view cone beam computed tomography (CBCT) scan (90KVp, 8mA and 12 seconds, voxel size 200µm) to better visualise the root canal morphology (Figure 3). The CBCT scan of the left maxillary lateral incisor confirmed two type III dens invaginatus and two canals. The mesial invagination was classified as a type III-A and the distal invagination as a type III-B. Additionally, c-shaped canals were noted both anteriorly and posteriorly. The distal invagination lost continuity with the enamel lining in the apical region. External root resorption was present at the apical and mesial aspects of the tooth with associated peri-invasinatus periodontitis.

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### INTERPRETATION

Dens invaginatus is a dental anomaly consisting of a coronal or radicular surface invagination.<sup>2-4</sup> The prevalence of this dental anomaly varies according to the study population, but has been reported to be as high as 12%.<sup>5</sup> A low prevalence of this anomaly was, however, reported in a black South African population.<sup>1</sup> The affected teeth typically display an altered clinical appearance, with the morphology of the anomaly often varying in presentation.<sup>3</sup> In most cases, the invagination is completely lined by enamel, although in some instances, this lining may be interrupted. The theorised pathogenesis involves two developmental errors in odontogenesis. First, an area of retarded growth is engulfed by the rest of the developing tooth germ.<sup>6</sup> Second, the cells of the enamel organ proliferate and

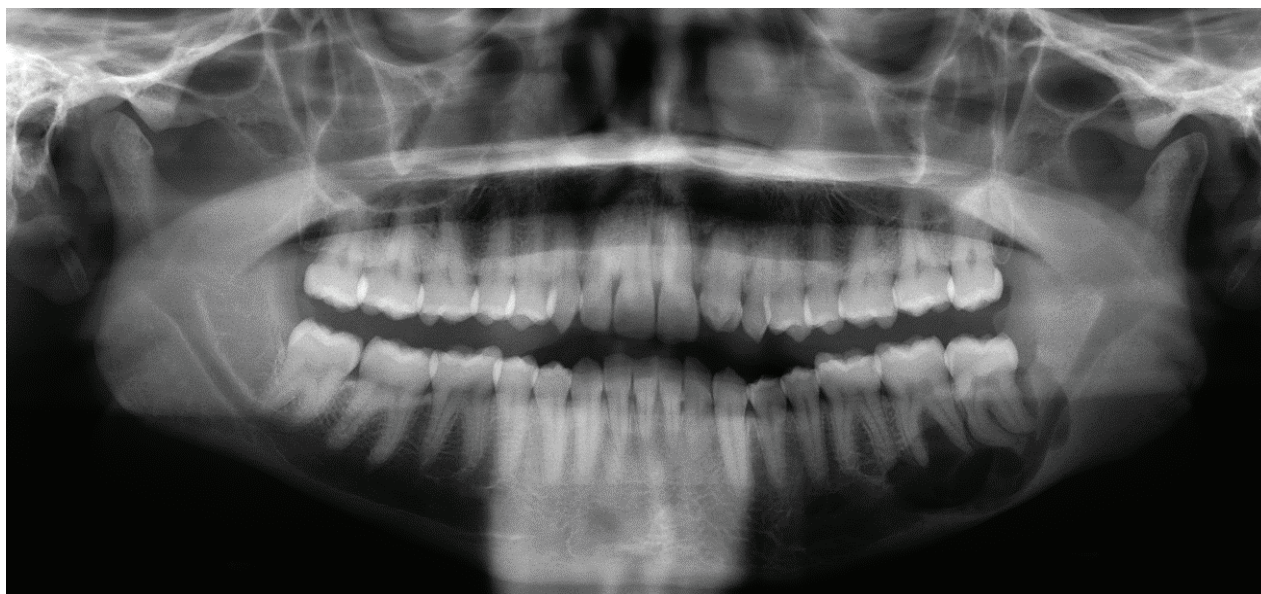


Figure 1: Panoramic radiograph revealing the radiolucent lesion in the posterior left mandible and the malformed left maxillary lateral incisor.





Figure 2: Intraoral periapical radiograph of the left maxillary lateral incisor.

invaginate into the dental papilla.<sup>7</sup> Coronal dens invaginatus, according to Oehlers<sup>3</sup>, can be classified according to the depth of surface invagination. Type I describes a surface invagination confined to the crown of a tooth, terminating coronally at the cemento-enamel junction (CEJ). In type II, the anomaly extends beyond the CEJ but is confined to

the tooth structure, such that there is no communication with the periapical tissues. Micro-communications with the pulpal tissue may be possible. Type III describes a coronal surface invagination that can terminate in either the lateral periodontium (type III-A) or the periapical tissues (type III-B). Type III results in a direct communication, allowing a path for oral flora to the periodontium, leading to peri-invagination periodontitis.<sup>3</sup> Pulpitis and pulp necrosis often develop due to the close proximity of the microorganism-harboring defect and the pulp, through patent dental tubules.<sup>2</sup>

A study by Kirzioglu and Ceyhan found that type I dens invaginatus were present in 11.3% of the study population, whereas types II and III were only present in 0.7% and 0.8%, respectively. None of the type I cases displayed periapical pathoses, while the incidence increased in types II and III with 4% and 33%, respectively.<sup>5</sup> Teeth demonstrating double dens invaginatus on a single tooth have also been reported, but these usually present with type I or II configurations.<sup>8-12</sup> Four cases of a double dens invaginatus (type III with type II) have been reported in the literature, two of which were successfully treated with non-surgical endodontic therapy.<sup>13-16</sup> A single tooth affected by a triple type II dens invaginatus has been reported, but subsequent radiographic features resemble a compound odontoma.

To the authors' knowledge, there has only been one report, apart from the current case, of a double type III dens invaginatus. This anomaly presented in a fused supernumerary tooth and a maxillary central incisor. Unfortunately, the authors did not report on the treatment of this tooth.<sup>17</sup>

Dens invaginatus have been treated with different modalities. Successful outcomes were influenced by the pulp vitality, complex anatomy of the invagination and the pulpal or periodontal communications. Treatment can range

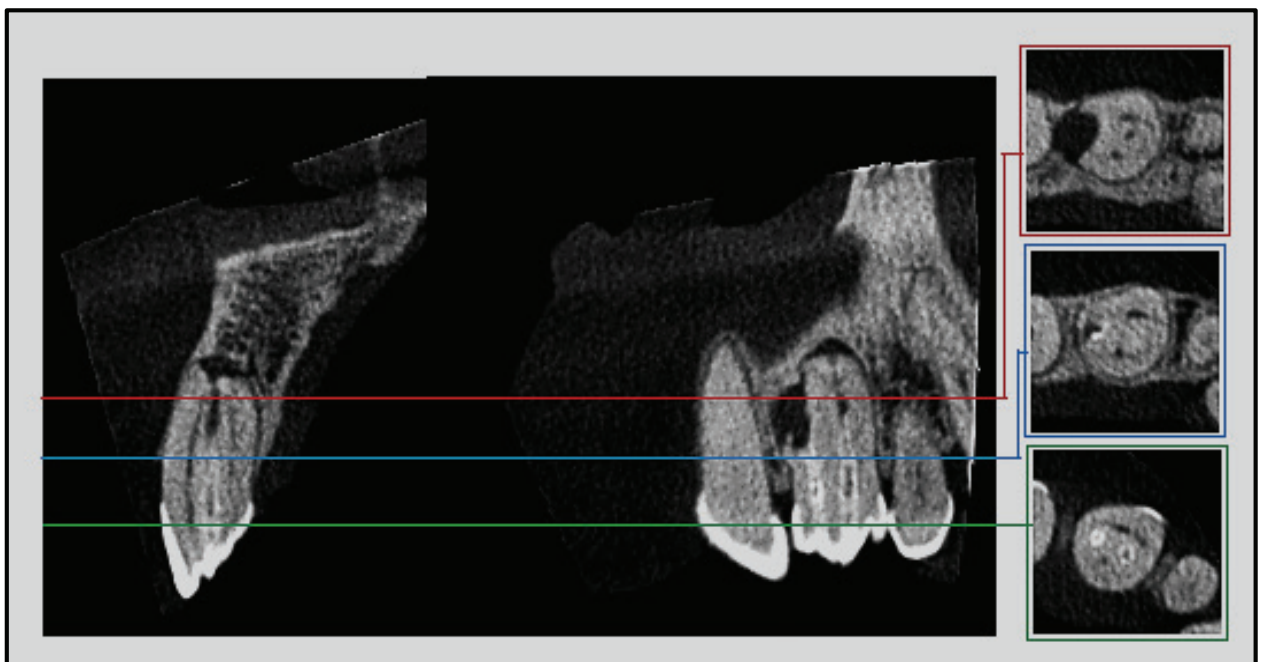


Figure 3: CBCT images confirming an invagination type III-A and III-B on the left maxillary lateral incisor (image adapted from Buchanan et al (2022)1).



from fissure sealants, restorations and endodontic therapy to extractions. Treatment success tends to decline as the surface invagination becomes progressively deeper and more complex.<sup>18</sup> A combination of surgical and non-surgical endodontic treatment of a type III invagination has also shown successful outcomes. Authors emphasise that non-surgical endodontic treatment should initially be performed, following which surgical treatment can be utilised if the non-surgical approach fails.<sup>19</sup> In the current case, the double type III dens invagination was managed via non-surgical endodontic treatment.

In conclusion, careful radiographic evaluation can lead to the identification of these anomalies as they are most often asymptomatic in the early stages, and early detection can lead to preventative measures instead of complex endodontic treatments.

## AUTHORS' DECLARATION

### Funding

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

### Conflict of Interest

The authors declare that they have no conflict of interest.

### Ethics approval

This study was approved by the University of Pretoria Ethics Committee (Reference no 76/2020). All procedures followed the ethical standards of the Helsinki Declaration of 1975, as revised in 2008.

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# CPD questionnaire

## Bacterial contamination of disinfectants: prevalence and students' compliance with infection control practices

1. Select the **CORRECT** percentage. What proportion of aerosols are reduced by the high-volume evacuation systems (HVE)?
  - A. 70%
  - B. 80%
  - C. 90%
  - D. 100%
2. Choose the **CORRECT** statement. The following factors affect the efficiency of the HVE
  - A. The suction force of the appliance
  - B. The proximity of the HVE to the operating site
  - C. The number of evacuators used
  - D. All of the above
3. Which of the following is **CORRECT**. The following are risk factors for backflow
  - A. Simultaneous use of saliva ejector and HVE
  - B. The positioning of the suction tubing attached to the ejector above the patient's mouth
  - C. The presence of less pressure in a patient's mouth than in the saliva ejector
  - D. All of the above

## Comparative Evaluation Of Shear Bond Strength Of Dentin With Three Different Aesthetic Materials – An Invitro Study

4. Choose the **CORRECT** answer. Zirconia-reinforced glass ionomer present in which of the following cements?
  - A. Amalgomer
  - B. Glass Ionomer
  - C. Zirconomer
  - D. Composite
5. Choose the **CORRECT** answer. Glass Ionomer Cement has the following disadvantages.
  - A. Solubility
  - B. Decreased wear resistance
  - C. Lack of Hardness
  - D. All the above
6. Select the **CORRECT** option. Microionization of glass components seen in which of the following types of cement?
  - A. Amalgomer
  - B. Zirconomer
  - C. Glass Ionomer
  - D. All the above
7. Which option is **CORRECT**. Which of the following is correct. Zirconia undergoes phase transition under stress from
  - A. Tetragonal to Monoclinic
  - B. Monoclinic to Tetragonal
  - C. Trigonal to Monoclinic
  - D. Monoclinic to Trigonal

## School managers' perspectives on oral health care service delivery in schools for special needs in eThekweni District, KwaZulu-Natal

8. Choose the **CORRECT** answer. Who was responsible for programmes implementation in the study
  - A. Learners
  - B. School managers
  - C. School educators
  - D. Parents
9. Which answer is **CORRECT**. What oral health services were offered by the schools.
  - A. Tooth brushing programmes
  - B. Pain management,
  - C. Oral examinations (in some cases)
  - D. Referral for dental treatments
  - E. All of the above

## Self-reported experience of Outreach activities amongst undergraduate Oral Health students at a University in South Africa.

10. Which of the following is **CORRECT**. Main objectives of an outreach program are to:
  - A. Improve learning
  - B. Promote civic engagement
  - C. Strengthen communities by addressing their societal needs
  - D. All answers are correct
11. Choose the **CORRECT** answer. Students who participated in OAs, reported to have gained:
  - A. Additional experience of specific clinical procedures
  - B. Improved communication skills
  - C. Increased confidence
  - D. All answers are correct
  - E. Answers A and C are correct
12. Select the **CORRECT** answer. Responsibility and moral obligation to the community and the people experienced by participants after participation was
  - A. 88%
  - B. 97%
  - C. 89%
  - D. 75%
13. Select the **INCORRECT** answer. Main reasons for not seeking treatment by respondents according to the South African Demographic and Health Survey (SADHS) completed in 2016 were:
  - A. Too expensive
  - B. Sites were far to access
  - C. Defective equipment
  - D. All services were not available

### Radiology Corner

14. Choose the **CORRECT** answer. Dens invaginatus is an anomaly lined by:
- Dentine
  - Cementum
  - Enamel
  - Pulp
15. Select the **CORRECT** statement. Type III dens invaginatus is described as an invagination
- confined to the crown
  - that extends past the CEJ with an opening in the periodontium
  - that extends past the CEJ without opening in the periodontium
  - that does not extend past the CEJ
16. Select the **CORRECT** answer. The lesion related to the patient's main complaint in the above case was diagnosed as
- Ameloblastoma
  - Odontogenic primordial cyst
  - Odontogenic keratocyst
  - Odontogenic tumour

### A simplified and evidence-informed approach to designing removable partial dentures. Part 4. Seven simple steps to design.

17. Choose the **CORRECT** answer. When deciding with the patient on the material to be used for the base, this is almost always based on:
- Patient preference
  - Cost
  - The dentist's preference
  - The technician's advice
18. Select the **CORRECT** statement. After determining the path of insertion what is done next?
- Decide which teeth should be clasped
  - Decide where the rests should be
  - Take the shade of the remaining teeth
  - Mount the cast on a surveyor

### Evidence Based Dentistry

19. Choose the **CORRECT** statement. In the da Fonseca Cumerlato et al study, the researchers
- Found that only ECC prevalence at 48 months of age was associated with maternal depressive symptoms
  - Found that only the severity of dental caries at 48 months of age was associated with maternal depressive symptoms
  - Found that both ECC prevalence and severity of dental caries at 48 months of age were associated with maternal depressive symptoms
  - Found no association between ECC prevalence, severity of dental caries at 48 months of age and maternal depressive symptoms
20. Which of the following statements is **CORRECT**. In the da Silveira et al trial, SO2 levels
- Remained stable for both groups, with no statistically significant difference for the three assessments.
  - Remained stable only in the Control group for the three assessments.
  - Remained stable only in the experimental group for the three assessments.
  - Remained stable for both groups, with a statistically significant difference for the three assessments
- Ethics: Regulatory Overreach – Intervention or Interference**
21. Select the **INCORRECT** option. Which of the following is **NOT** a characteristic of professionalism
- Kindness
  - Competency
  - Morality
  - Complacency
22. Which of the following is **CORRECT**. What does it mean for the HPCSA to protect the public?
- To defend the public in the court of law
  - To act as a statutory body to regulate the profession
  - To alert the public about fake doctors
  - To ensure the doctors are registered with HPCSA
23. Choose the **CORRECT** answer. Commonly, the HPCSA investigates:
- Matters brought to its attention
  - Matters involving Doctor - Patient relationship
  - Matters interesting to the public
  - Matters of public interest
24. Select the **CORRECT** answer. Conduct is generally regarded as
- Good behaviour
  - To act or failure to act
  - Directing doctors towards ethical behaviour
  - How a doctor behaves in the presence of her patient
25. Choose the **INCORRECT** answer. Which of the following is **NOT** a definitional element of a misconduct?
- Illegal conduct
  - Conduct likely to cause harm to the public
  - Deviation from the HPCSA's guidelines
  - all of the above
  - None of the above



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Have you submitted details of the contribution of each author... can be percentage or descriptive... or both?  
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8

Is the first author under the age of 35 on submission of the article?  
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9

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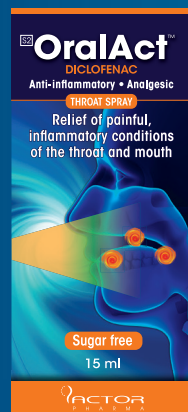
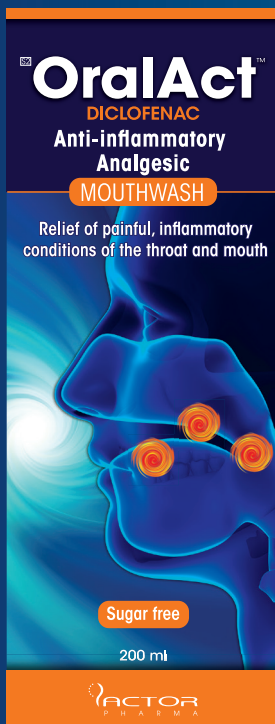
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