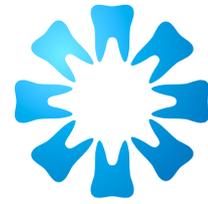


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Waterval Boven, whose Dutch name means "above the waterfall" is built above the Elands River Falls on the historic Pretoria to Maputo railway line. The sister town Waterval Onder is at the base of the escarpment. The falls used to be known as Waterval Boven and are situated at the village of Emgwenya, which once had the same name as the falls. They are now called the Elands River Falls, and are over 70 metres high, which makes them spectacularly impressive to witness from up close. The falls split into three dramatic drops as they flow over the cliff, creating an awesome reminder of the splendour, and power of nature. The Waterval Boven tunnel formed part of the Eastern or Delagoa Railway which was of great strategic importance to the Zuid Afrikaansche Republiek (ZAR) giving access to a non-British seaport. After extensive planning, work on the tunnel commenced in October 1892. Two teams blasted and drilled their way through the rock and joined up in September 1893. Railway tracks were laid and the tunnel walls were lined with stone masonry for strength. This outstanding piece of engineering was completed in 1894 and a year later the Eastern Railway opened to much celebration. The original tunnel and five arches bridge are now all national monuments. Proof that in engineering and similarly in dentistry, careful planning, meticulous workmanship, and fine attention to detail will enable man-made structures to survive many external onslaught.

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# Artificial Intelligence in Dentistry

SADJ May 2022, Vol. 77 No. 4 p187

Prof NH Wood - MDent, PhD

The development and progression in artificial intelligence has been rapid over the past decade. The expansion of artificial intelligence applications into areas that were previously thought exclusive to human control and expertise is now a measurable phenomenon. This is largely facilitated by rapid advances in data acquisition and consumption, machine learning, and computing infrastructure improvements.

The intention to introduce artificial intelligence applications into medicine and dentistry currently centers around patient care improvement, specifically to diagnostic capacity and prognostication, and to assist by providing tools for advanced decision making and even for treating patients remotely. This is an extremely complex field with close working relationships between various clinicians, researchers, and engineers.

The instant exchange and interpretation of large volumes of information will provide the clinician with a great advantage in the determination of treatment needs and implementation of treatment. However, the functions aren't limited to these only. Automation of claims processing, fraud detection, appointment scheduling and management, including the communication between similar systems in referral practices and dental laboratories, and resource management and control are some of the more immediate benefits provided by artificial intelligence systems.

Virtual automation in dentistry is not a distant imaginary concept anymore. However, the expert human aspect, and touch, remains a critical ingredient in successful patient care and service delivery in which artificial intelligence plays a complimentary role.

There are still some concerns regarding artificial intelligence and its applications. Consideration will be given to individual privacy rights and to autonomy. It is important to also address issues around trustworthiness as well as generalizability of any artificially intelligent application or implementation of such a system.

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## Your participation into our cover pages

SADA wishes to extend its heartfelt gratitude to you for your continued contributions to the journal and to research in the oral health space. Your contributions have helped the journal to be competitive with other scientific journals globally.

In the spirit of broader inclusivity we would like to invite authors to provide us with suggestions for the cover page content of the SADJ. This should be all encompassing and not limited in appeal to a single grouping. We hope that these contributions will better our journal in line with our main objectives.

We look forward to receiving meaningful contributions from our membership, and thank you for your continued support and participation.

Warm regards,  
Prof NH Wood – Managing Editor  
Dr N Metsing – Head: Professional Development SADA

# For the sake of the profession, we shall win!

SADJ May 2022, Vol. 77 No. 4 p 188-189

Dr Nthabiseng Metsing, Head: Professional Development, SADA

In this article, I reflect on the ineffectiveness of the HPCSA, focusing on their apparent absence to guide and serve the professions. I also report on the progression of the RVU, the SADA's submission on dental treatment under general anaesthetic for special-needs patients, the new terms for the Young Dentists Council (YDC), and that of the SADA National Council.

## HPCSA HAS FAILED DENTAL PRACTITIONERS.

Since the outbreak of the pandemic in 2020, when the HPCSA, like other organizations, had remote-working personnel, the Association and many of its members have asked, "Where has the HPCSA gone?" It now seems that not only are HPCSA employees working remotely, but they have also vanished. Members are dissatisfied that telephone lines are not answered, or when they do get through, they are placed on hold for an extended period before the call is disconnected; repeated e-mails are sent but not responded to, and restoring the names of practitioners removed from the register is a losing battle. In utter exasperation, members seek aid from their organization, which encounters the same lack of service when acting on their behalf.

Numerous letters and e-mails are sent to specified persons, yet they are not even acknowledged, much less read. After it has been three years since the outbreak of the pandemic, it is difficult to see why the HPCSA cannot continue its duties like other South African organizations and entities. A regulator is responsible for several health care professions and, as a result, for practitioners whose livelihoods rely on their active registration, as well as for a variety of other matters.

It seems that the HPCSA continues to lack effective leadership and has continually failed to give adequate direction to health professionals on a variety of topics. Members are encouraged to submit their complaints to the President of the HPCSA, Professor Simon Nmutandani (HPCSA President), at [Simon.Nmutandani@hpcsa.co.za](mailto:Simon.Nmutandani@hpcsa.co.za) or Ms Melissa De Graaff (Acting CEO) at [Registrar@hpcsa.co.za](mailto:Registrar@hpcsa.co.za) and Mr Emmanuel Chanza, Manager of Professional Boards, at [emmanuelc@hpcsa.co.za](mailto:emmanuelc@hpcsa.co.za).

Not because of the rands and cents, but on principle, we consider it a huge win that we were able to battle the HPCSA to repeal the gazette announcing the higher annual registration fees. This has never happened before in the history of the HPCSA, and we feel that the fact that they were compelled to cut the fees will serve as a lesson for the institution to engage its stakeholders more thoroughly in the future.

In 2022, SADA will strongly pursue the discussion that should lead to the formation of a new regulator primarily responsible for dentists and physicians. As stakeholders of the HPCSA, the practitioners can no longer be disregarded. In this context,

SADA will continue its efforts to meet with the HPCSA and, if required, the Minister of Health.

## WHERE ARE WE WITH THE RVU NEGOTIATIONS?

There is little question that members are wondering why the SADA Relative Value Units (RVU) programme, which was introduced last year, has seemingly not resulted in improved payments for dental benefits. SADA has been interacting aggressively with schemes over the RVU information. Medical schemes are now analysing the data, and in certain instances, meetings with our consultants have been scheduled to discuss methodology, comprehension, outcomes, and other information. This will be a continual, though sluggish, procedure. Aside from RVU conversations, SADA often meets with schemes and administrators to address member difficulties, benefit anomalies, and code and descriptor interpretation concerns.

## SADA'S SUBMISSION ON DENTAL TREATMENT UNDER GENERAL ANAESTHETIC FOR SPECIAL NEEDS PATIENTS.

Members of the Dental Practice Committee observed that public oral health institutions were being swamped with requests for dental treatment to be performed under general anaesthesia for special needs patients, even though these patients were members of a medical scheme. This was due to the decline in authorization for these procedures by various medical schemes, generally due to the patient's age.

In response, SADA recently submitted a policy document that highlights the importance of treating special needs patients in a controlled and safe environment to both the BHF and HFA. We are pleased to report that to date, Profmed is the first to respond positively to this request and is in full support of implementing our guidelines with immediate effect. We are encouraged by this constructive feedback and remain optimistic that other schemes will follow suit as soon as possible.

We encourage members to always speak to us on matters like the above where we can take the course and address it to the relevant authorities.

## THE YDC COMMITTEE TERM HAS COME TO AN END – A NEW COMMITTEE IS TO BE INAUGURATED.

The term of the previous YDC leadership had expired, and we solicited candidates from young practitioners under the age of 35 who were willing to stand for election and serve the profession. The YDC is particularly committed to addressing difficulties, seizing opportunities, mentoring, and helping newcomer practitioners. The YDC exists to accommodate and assist these young practitioners whose perspectives

and approaches to challenges vary from their colleagues. With the new leadership, we anticipate interesting initiatives and prospects designed to meet their requirements. Young practitioners are also encouraged to get engaged in their branch committees, to ensure the future of the dental profession and your organization.

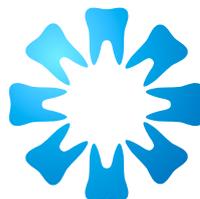
#### **A NEW TERM FOR SADA NATIONAL COUNCIL FOR 2022.**

A new four-year term for the SADA National Council, which represents all SADA chapters, will shortly begin. Some branches have planned and organized members' meetings at which they will solicit volunteers to serve on branch

committees and maybe represent their branch on the National Council. They have the chance to raise concerns impacting grassroots members to a national audience at this meeting. Members are asked to keep an eye out for these days, and in most instances, these gatherings may also include an educational speaker.

Lastly, as SADA, we are confident that this year we will make inroads on many fronts for the benefit of the profession at large

**Yours in Dentistry  
KC Makhubele**



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## **NOTICE OF AMENDMENT 22nd ANNUAL GENERAL MEETING (AGM) OF The South African Dental Association NPC (“SADA”)**

An amended notice is hereby given that the 22nd Annual General Meeting of Members (AGM) of The South African Dental Association (SADA) NPC, will be held on Thursday 7 July 2022 at 18h00, which will be conducted virtually on this date through the Zoom virtual meeting platform. The Agenda together with supporting documents for the meeting will be sent electronically to members and posted on the SADA website.

Members are advised that they must have access to a computer or smart device or dial-up facility in order to join the online meeting. In view of extraordinary circumstances and to ensure maximum participation of voting members on resolutions tabled at an AGM, we call for the early return of proxies from members who are unable to attend.

Questions from members: We are also encouraging members to raise questions prior to the AGM, thereby allowing those not in attendance, the opportunity to raise issues which can then be dealt with at the AGM or referred to National Council meeting. The questions and answers covered in the AGM will, following the meeting, be published on the Association's website.

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

**KC Makhubele  
Chief Executive Officer  
May 2022**

# Odontography

SADJ May 2022, Vol. 77 No. 4 p190

G H Sperber<sup>1</sup>

## INTRODUCTION

The curious combination of the contrasting hardest and softest tissues in the human body incorporated into teeth requires introspection. The vastly varying modalities of different tissue types, from soft dental pulp and periodontal ligament through cementum into dentine and enamel incorporated in human teeth is astonishing. The durability of human dentitions correlates with their longevity. Moreover, teeth are the longest lasting organs after death, defying postmortem decay, yet contrastingly so susceptible to caries during life.

The complex morphology of teeth reveals an historical background of food acquisition from palaeontological evidence.<sup>1</sup> The amount of detailed historical information that can be gleaned from a meticulous examination of teeth is incomparable. The molecular mechanisms of dental enamel formation are revealed in it being a unique acellular highly mineralized tissue.<sup>2</sup>

Apart from the immediate evidence provided by surface examination of the dentition, revealing attritional wear, indicative of abrasive dietary comestibles or habitual tooth grinding. The intrinsic composition of the tissues comprising teeth can be revelatory. Dietary intake of elements such as lead can integrate into the elemental components of enamel and dentine. The very shapes of teeth are determined by evolutionary inheritances that are designed for stress resistance and mitigation of strains.<sup>3</sup>

The various morphologies of teeth are optimal for stress resistance, but a trade-off for maximal crush efficiency and bite ability is achieved through their different dental shapes. Hence, incision by incisiform teeth anteriorly, caniniform punchability by canines intermediately and crushing by molars posteriorly indicate the division of masticatory functions among teeth. Maximum degradation efficiency with the least kinetic energy required is attained by the various tooth shapes during mastication.

### Differential Diagnostics.

Detailed dental wear analysis can reveal much about the dietary constituents of the subjects investigated. Herein, the detailed isotopic analysis of enamel can reveal meat or plant-based diets ingested, both currently and paleo-environmentally.<sup>4</sup>

Moreover, enamel growth revealed by incremental additions during morphogenesis can provide evidence of environmental

variations during development. Evidence adduced from ancient Roman dentitions developed during 70-400 AD indicate rapid enamel growth, that slowed in medieval times to modern day rates.<sup>4</sup>

Deciduous teeth composition can reveal the dietary intake of mother's milk contrasting with cow's milk or pablum ingestion. The occurrence of surface wear on deciduous teeth can indicate the age of weaning and the acquisition of masticatory ability in infants and the age of transition to comestibles.

The variation in enamel thickness among Primates is indicative of their habitual diets. Human dental enamel is thickest over molar cusps, up to 2.5 mm thick.<sup>5</sup> Orangutan dental enamel thickness and periodicities of development results in longer crown formation times.<sup>6</sup> Orangutan dental enamel in molars ranges from 0.75 to 2.18 mm, and is thicker than that of Chimpanzees.<sup>7</sup> This discrepancy reflects the harder fruits of Orangutan diets contrasting with the softer, riper fruits preferred by Chimpanzees.

## CONCLUSION

The amount of lifestyle information that can be extracted from teeth is phenomenal. The diet, climate of existence, metabolic status and approximate age at death can be elicited from the dentition. Any deviation of the genetically determined pathway of odontogenesis is permanently imprinted on the teeth. Teeth can tell postmortem tales like no other organ. The dentition is the ultimate lexicographer of lives lived.

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# The psychosocial effect of the COVID-19 national lockdown on Dentistry and Oral Hygiene students

SADJ May 2022, Vol. 77 No. 4 p191 - p198

R Basson<sup>1</sup>, D Smit<sup>2</sup>, R Maart<sup>3</sup>, N Gordon<sup>4</sup>

## ABSTRACT

### Introduction

The COVID-19 lockdown has had a psychological and social impact on dental students globally.

### Aim

To determine the psychosocial effect on students enrolled in dentistry and oral hygiene courses at UWC.

### Objectives

To determine the psychosocial effects (living conditions, levels of anxiety, fear of COVID-19, and food security levels) experienced by students during the lockdown.

### Design

A descriptive, cross-sectional study using a quantitative approach was used. Methods: A randomised sample (n=250), stratified by sex and academic year group, comprising undergraduate oral hygiene BOH total students = 90 and dentistry BDS total students = 450 (UWC, 2020) was used. Data was gathered via an online survey, (Google Forms). Survey questions included the GAD-7, FCV-19S questionnaire, and Food Security scales.

### Results

The data were analysed using Epi Info 7. The response rate was 36% (n=90); 69.67% were female; the mean age was 22.34 (SD = 2.66); 91% lived with their parents during lockdown. Students' main sources of funding were parents

(47%), NSFAS or bursary (42%) and self-funded (11%). Substantial psychosocial effects with high anxiety (33%), fear of COVID-19 (47.3%), and a lesser effect for food insecurity (FI) (5.49%) was reported.

### Conclusions

The study showed that the COVID-19 pandemic has contributed to psychosocial effects in a discipline that under 'normal' conditions is experienced as stressful. This requires educational institutions to develop a targeted approach through relevant support systems that would identify vulnerable students at critical times.

### Keywords

COVID-19 lockdown, anxiety, fear of COVID-19, food insecurity, dental students, oral health/hygiene students, psychosocial factors.

Oral health and oral hygiene are designators for the qualification as an oral hygienist. At UWC the designator oral health is used for the qualification (BOH).

## INTRODUCTION

The COVID-19 pandemic resulted in an immediate lockdown for an extended period for universities globally, followed by intermittent access as levels of lockdown fluctuated. In South Africa, the lockdown was initiated in March 2020, with students' return to campuses scaffolded as per the levels of lockdown imposed at a national level. The resultant disruption in academic activities has reportedly impacted living conditions, academic performance, food security, and the mental health of students,<sup>1-6</sup> resulting in increased anxiety and psychological distress.<sup>1,4,6,7</sup> Psychosocial factors affecting students are multifaceted even under "normal pre-COVID conditions". Dimensions of these factors range from socio-economic, environmental to psychological factors.<sup>8</sup>

Psychological distress is particularly evident in students in the health sciences including medical, dental, and oral hygiene students during their academic and professional years.<sup>9-12</sup> Experiences in dental education are reportedly more stressful than in medical education.<sup>9</sup> Some of the stressors of students studying dentistry and oral health/oral hygiene include the learning environment, fear of failure, heavy workload, difficulties in dealing with patients and with transitions in curricula, and challenging relationships with academic staff.<sup>10,12</sup> A systematic review of stress among dental students reported that stress is mainly due to the demanding nature of the training and that elevated stress may have adverse effects on the health and well-

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1. Reneda Basson: 25%
2. Dirk Smit: 25%
3. Ronel D Maart: 25%
4. Natalie Gordon: 25%

being of students.<sup>11</sup> Anxiety appears to be extended into professional practice as noted by Majeed *et al.*<sup>13</sup> who recorded severe fear and anxiety scores among Pakistan's dental surgeons (56.3%) and medical doctors (43.6%), however, the difference was not significant. Research investigating psychosocial effects related to the COVID-19 pandemic should therefore be cognizant of the fact that a confounding variable of results may be the inherently stressful nature of professions in the health sciences, particularly oral hygiene and dentistry.

COVID-19 related studies regarding dental students found differences across different contexts with high levels of anxiety reported by Hakami *et al.*<sup>9</sup> and Losif *et al.*<sup>14</sup> and lower levels reported by Cao *et al.*<sup>1</sup> and Khanagar and Alfadley.<sup>15</sup> Results by Wang and Zhao<sup>16</sup> showed that students suffered stress, fear, and unease due to the uncertainty of the pandemic. These results indicate that the COVID-19 pandemic has affected the levels of anxiety, albeit at varying degrees among dental students. Family support, economic stability, living with parents, and living in urban areas were protective factors in terms of college student anxiety, while a delay in academic activities, adverse economic effects, and stressful daily living were positively correlated to the experience of anxiety.<sup>1</sup> Symptoms of anxiety increased in instances where family members or acquaintances were COVID positive.<sup>1</sup>

Compromised food security is increasingly becoming a feature contributing to student anxiety among university students.<sup>17,18</sup> In recognition of economic challenges that may inhibit university access, the South African government implemented a structural support program for poor students by establishing the National Student Financial Aid Scheme (NSFAS). This initiative saw a fivefold increase in student loans between 1995 and 2005.<sup>19</sup> Psychological distress and compromised food security may have been exacerbated by the additional pressure imposed by the various levels of the lockdown. Psychological well-being is defined as peace of mind, good physical and mental health, belonging to a community, having freedom of choice, a dependable source of income, and access to food.<sup>19</sup> Thus, considering the disruption caused by the prolonged lockdown, one may assume a significant impact on the psychological wellbeing of students. Therefore, awareness of the psychosocial effects on students imposed by the additional stressors of a lockdown could guide planning and highlight the support that students may require.<sup>1,5</sup>

It is within this constantly shifting landscape that teachers engage students in online learning environments characterised by a marked variation in technological access, parental support, and academic expectations.<sup>20</sup> In this context, the purpose of this research was to determine the psychosocial impact of the COVID-19 lockdown (Refer to Addendum A) on University of the Western Cape (UWC) dental faculty students to provide evidence of the type of support that students may require in the future.

## METHODS

**Study design:** This was a descriptive, cross-sectional study using a quantitative approach.

**Study population and sample:** A randomised sample (n=250), stratified by sex and academic year group was selected, comprising undergraduate oral hygiene BOH

total students = 90 and dentistry BDS total students = 450 enrolled at UWC in 2020. Randomisation, by means of a computer-based randomised generator, and using class lists as a sampling frame was done to increase the power of the study and to limit selection bias. Students were grouped into junior (BOH1, BOH2, BDS1, BDS2) and senior (BOH3, BDS3, BDS4, BDS5) based on their clinical exposure at the time of the study. Junior students were deemed as preclinical and senior students as clinical.

**Inclusion criteria:** All undergraduate students registered in the BDS and BOH programmes in 2020 were included in this study.

**Materials:** In September 2020 the data were gathered by employing an online survey, using Google Forms. The questionnaire consisted primarily of closed-ended questions with several open-ended questions that allowed for elaboration on closed-ended questions posed.

**Variables measured:** These included student demographic information such as age, gender, place of residence, living conditions, and experiences of psychosocial stress. Living conditions, including experiences of food insecurity, were recorded on a validated, 10-item food security scale.<sup>21</sup> The 10-item food security scale used the United States Department of Agriculture Community Food Security Assessment Toolkit, adapted by Hughes *et al.* for university students.<sup>21</sup> Responses to the 10 questions were recorded as frequencies and categorised according to the level of food security (see Tables 11 and 111). The experience of psychosocial stress was guided by two instruments as indicated below:

1. Fear of Coronavirus-19 scale (FCV-19S), a valid tool for assessing fear of COVID-19.<sup>22</sup> Participants responded to 7 questions on a five-item Likert scale, ranging from "strongly disagree," to "strongly agree". Total scores, ranging from 7-35, were obtained by summing the responses. The higher the score, the greater the fear of COVID-19.
2. Generalized Anxiety Disorder 7-item (GAD-7) scale,<sup>23</sup> a validated, brief, self-report screening tool for generalized anxiety symptoms. The GAD-7 score is calculated by assigning scores of 0, 1, 2, and 3, to the response categories of 'not at all', 'several days', 'more than half the days', and 'nearly every day', respectively, and adding together the scores for the seven questions. Scores of 5, 10, and 15 are taken as the cut-off points for mild, moderate and severe anxiety, respectively.
3. Food insecurity was measured using two different food insecurity measures, namely: A single-question measure, adapted by Hughes *et al.* (2011) (for university students from the Australian National Nutrition Survey), and a more sensitive 10-item food security scale (a multi-question measure) from the United States Department of Agriculture Community Food Security Assessment Toolkit, adapted by Hughes *et al.* (2011) for university students.<sup>21</sup>

Respondents were classified as:

- food insecure if they answered "yes" question1 in the food security questionnaire.
- having low food security, or being food insecure "without hunger", if they answered "often true" or "sometimes true" to statements 2-4 in the food security questionnaire.

- having low food security, or being food insecure “without hunger”, if they answered “sometimes not enough to eat” or “often not enough to eat” in response to statement 5 in the food security questionnaire.
- being very food insecure, or being food insecure “with hunger”, if they answered “yes” to any of the questions 6-9 in the food security questionnaire.

Data was exported to Microsoft Excel 2019 and then statistical analysis was done by using Epi Info 7. Statistical analysis included using students’ t-tests to compare the means of different groups in the sample to determine a statistically significant difference. Chi-square and Kruskal-Wallis tests were used to test for associations.

### Ethical statement

An electronic link was emailed to selected students to enable them to access the online questionnaire accompanied by an information sheet explaining the purpose of the study, the voluntary nature thereof, anonymity and confidentiality, and their right to withdraw at any time without negative consequences. Information with relevant contact details about psychological support and food security assistance for students was included. Three reminders were sent out and students could only complete the questionnaire once. The study protocol was registered with the Biomedical Research and Ethics Committee (BM 20/8/1) of the University of the Western Cape.

## RESULTS

### Student demographics

The response rate was 36% (n=90) with the majority (69.67%) (n = 62) of participants being female with a mean age of 22.34 years. Students were grouped into junior (pre-clinical) and senior (clinical) years (Table 1). The majority (65%) of participants were staying in the Western Cape province at the time when the national lockdown was implemented and almost all (91%) stayed at their homes with parents or family members (Table I). The tables

illustrate examples of the questions and responses of the different scales.

### Living conditions

Students could identify more than one source of support during the COVID-19 pandemic. Parents were reportedly the main source of support to most students (n=85), followed by friends (n=72), other students (n=47), and social media (n=36). More than half (59.3%) reported having duties besides their studies which included household chores, family commitments, community support, and some had part-time employment. From the findings in Table I, NSFAS was the main source of funding in the junior years whereas parents were the main source of funding in the senior years. Self-funding increased from the junior to senior years.

Almost three-quarters of students (73.3%) indicated that they were able to keep up with their studies with the remainder responding negatively to this question. On the question of having sufficient money for study and living expenses and their capacity to cope, 46% had enough money and coped very well, half (50.5%) had just enough money for study and living expenses and coped fairly well, and 3.3% did not have enough money and did not cope.

Participants’ response to statements related to food security during the COVID-19 lockdown is summarised in Table II below. 5% of participants indicated that there were times that they ran out of food and could not afford to buy any more food during the COVID-19 lockdown (Question 1). Almost 20% were worried that their food would run out before they had money to buy more and almost a quarter (22%) could not afford to eat a balanced meal.

Respondents were classified as having low food security, or being food insecure “without hunger”, if they answered “often true” or “sometimes true” to any of the statements in Table II (Table II illustrates 3 of the 10 items in the scale and presents an overview of the 10-item scale). An analysis of levels of food security among students is

Table I: Socio-demographic characteristics			
Demographic variables	Total number of students n (%)	Senior students n (%)	Junior students n (%)
Age (years) Mean ( $\pm$ SD)	22.31 (2.67)	23.34 (2.34)	20.92 (2.43)
<b>Sex</b>			
male	27 (30.34)	15 (28.30)	12 (34.29)
Female	62 (69.66)	38 (71.70)	23 (65.71)
<b>Programme</b>			
BDS (Dentistry)	82 (91.11)	51 (94.44)	31 (86.11)
BOH (Oral Health)	8 (8.89)	3 (5.56)	5 (13.89)
Course Seniority		54 (60)	36 (40)
No of people in household Mean ( $\pm$ SD)	4.52 (1.78)	4.24 (1.63)	4.94 (1.94)
<b>Main source of funding studies</b>			
Parents	46 (46.67)	28 (51.85)	14 (40)
National student funding scheme (NSFAS) or bursary	38 (42.22)	19 (35.19)	18 (51.43)
Self-funded	10 (11.11)	7 (13.73)	3 (8.57)
<b>Living arrangements during this period</b>			
At home with parents	82 (91.11)	47 (87.04)	34 (97.14)
On my own	1 (1.11)	1 (1.85)	0
Shared with other students	1 (1.11)	1 (1.785)	0
Other	6 (6.67)	5 (9.29)	1 (2.86)

**Table II: Responses on financial ability and food security**

Statement/Question	Often true **	Sometimes true **	Never true	I don't know	I don't want to answer
1. "I worried that my food would run out before I had money to buy more."	5,49%	13,19%	72,53%	6,59%	2,20%
2. "I couldn't afford to eat balanced meals."	8,79%	13,19%	74,73%	1,10%	2,20%
3 "The food that we bought in the household just didn't last, and we didn't have money to get more."	1,10%	7,69%	84,62%	3,30%	3,30%

\*\* indicates students with low food security who are food insecure.

**Table III: Food security amongst students**

Scoring	Grading of food security among students	%
<b>Single item score (Q1)</b>	Students who were food insecure	5,49%
<b>Multi-item score (Q2-5)</b>	Students with low food security being food insecure "without hunger"	13,19%
<b>Multi-item score (Q6-9)</b>	Students with low food security being food insecure "with hunger"	8,79%

Answers to three questions on the FI scale showed that a relatively low percentage of students reported being food insecure.

summarized in Table III.

### Fear of Coronavirus-19 Scale (FCV-19S)

Table IV shows student responses to 7 questions of the Fear of Coronavirus-19 scale.

The results showed a fear of the disease and fear of loss of life due to the disease by a substantial number of students. Nearly half (47%) were very afraid of COVID-19. Approximately 30% felt uncomfortable when thinking about COVID-19. Almost half (48.4%) were afraid of losing their life because of COVID-19, while around 37% indicated that they became nervous or anxious when watching news and stories about COVID-19. Roughly 25% agreed that their heart was racing when thinking about getting COVID-19.

There were no significant differences between sex, study year or program and fear of COVID-19. Females and oral hygiene students scored higher than male and dental students in their fear of COVID-19 but the results were not statistically significant.

### Generalized Anxiety Disorder 7-item (GAD-7) scale

Students completed questions dealing with general anxiety disorder on a 7-item scale instrument. Table VI reports on 7 questions from the GAD-7 scale. More than a third (36.3%-38.5%) of students reported experiencing nervousness or feeling on edge and worrying too much nearly every day. Between 20% and 30% report not being able to control worrying, having trouble relaxing, being so restless that it

was hard to sit still and becoming easily annoyed nearly every day. Just under 20% reported feeling as if something awful might happen almost every day. Based on the questions on feelings of anxiety, 19% of the sample indicated that they had no difficulty at all doing their work, taking care of things at home, or getting along with other people. Almost half reported that they found it somewhat difficult, 20% found it very difficult and 12%, extremely difficult.

No statistically significant differences in the GAD score were found by professional groups (0.23), clinical groups (0.07) or sex (0.26). However, mild to severe anxiety was experienced by 100% of the oral hygiene students, whereas 82.93% of dental students scored in that range. Females' mean scores (11.23) were higher than males' mean scores (9.85). More senior students (88.89%) scored mild to severe anxiety compared to junior students (77.78%).

Nearly a third (31.87%) of the study sample found it very difficult and extremely difficult to do their work, take care of things at home, or get along with other people.

## DISCUSSION

Research on the physiological and psychological reactions to the pandemic suggests that various psychosocial vulnerability factors may play a role, including individual difference variables such as the intolerance of uncertainty, perceived vulnerability to disease, anxiety, and food insecurity.<sup>24</sup> University students are characteristically susceptible to developing stress disorder and depression and the possibilities of such implications are expected to grow during the Covid-19 quarantine period due to the psychologically challenging conditions faced daily.<sup>24</sup>

Findings from a previous study on UWC oral hygiene (BOH) students found that factors associated with financial difficulties and lack of basic needs were additional stressors for first-year students.<sup>12</sup> Since many UWC students study under challenging conditions, their stress may be exacerbated by the implications of COVID-19 in terms of factors such as studying at home in overcrowded conditions,

**Table IV: Fear of Coronavirus-19 Scale**

Questions	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I am very afraid of COVID-19	3.3%	16.5%	18.7%	44%	3.3%
It makes me uncomfortable to think about COVID-19	9.9%	40.7%	18.7%	19.8%	11%
My hands become sweaty when I think about COVID-19	30.8%	40.7%	20.9%	4.4%	3.3%
I am afraid of losing my life	7.7%	8.7%	25.3%	29.7%	18.7%
When watching news and stories about COVID-19 on social media, I become nervous or anxious.	5.49%	26.4%	17.6%	31.9%	5.5%
I cannot sleep because I'm worrying about getting COVID-19.	33%	41.8%	18.7%	4.4%	2.2%
My heart races when I think about getting COVID-19	24.2%	26.4%	24.2%	17.6%	7.7%

**Table V: Fear of COVID-19 scores for Programme, Sex and Course seniority**

Fear of COVID-19 Scale Score	mean (SD) (range)	p-value
Total sample (n = 90)	19.66 (6.18) (7 - 35)	
<b>Programme</b>		0.036 *
BOH (Oral Hygiene)	24.75 (7.38) (15 - 35)	
BDS (Dentistry)	19.25 (5.85) (7 - 32)	
<b>Sex</b>		0.135
Males	18.19 (5.90) (7 - 31)	
Female	20.02 (6.04) (8 - 32)	
<b>Course seniority</b>		0.598
Junior	19.72 (6.74) (9 - 35)	
Senior	19.76 (5.80) (7 - 31)	

\* p-value is less than 0.05 which resembles statistical significance

food and financial insecurity, limited social support due to the disruption of daily activities, and uncertainty of the future. Consequences related to using remote, online learning and teaching impact students differently and could influence their mental state. In addition, a large number of students at UWC have internet connectivity limitations (UWC, Communications 2020) that influence their academic activity and progress.

A study conducted in Saudi Arabia to assess the psychological impact of the pandemic on dental students found that female students, students who lived alone, and students in the beginning years of dental college were more likely to experience mental health issues.<sup>9</sup> Chaturvedi, *et al.*<sup>25</sup> reported that students from less privileged backgrounds experienced larger negative impacts due to the Covid-19 outbreaks. The present study showed that 40% of students were dependent on the NSFAS indicating that they came from less privileged backgrounds. This could suggest that their less privileged background would

have a similar negative impact due to the pandemic as reported by Chaturvedi, *et al.*<sup>25</sup> Preclinical (junior) students were more dependent on NSFAS support whereas in the senior years more students were dependent on parents. Although the majority (91%) of the students in the present study lived at home with their families, the high incidence of fear (47%) and anxiety (83% experienced moderate and severe anxiety) indicates the possible psychological impact of the COVID 19 lockdown as an additional factor to the already challenging professional programmes. This study shows some ambivalence regarding the protective nature of living at home. Most students (91%) lived at home during the lockdown and reported being able to cope with their studies (72%), yet relatively high levels of stress and anxiety were reported. For this group of students, living at home may have been a protective factor in terms of daily support to cope with their studies rather than protective in terms of COVID-19, as reported by other studies.<sup>1</sup> However, the high levels of stress and anxiety reported in this student population may be indicative of a broader dynamic within the family or community that was not the purview of this study, highlighting the complexity of factors influencing stress and anxiety.

The almost instantaneous closure of Universities resulted in emergency remote teaching (ERT). ERT offers rapidly developed temporary instructional support in a crisis without pre-planned resources or infrastructure.<sup>20</sup> This new context places demands on students to work independently, be disciplined, and learn new technologies with no prior preparation. The finding that almost three-quarters of students (72%) were able to keep up with their studies despite the concurrent report of fear and anxiety, gives some indication of the resilience of these students. Most (91%) of the students in this study lived at home during this lockdown period, suggesting that living at home and having parental support, despite possible economic challenges, may act as protective factors during the

**Table VI: Responses on Generalized Anxiety Disorder 7-item (GAD-7) scale**

Over the past month, how often have you been bothered by the following problems?	Never	Several days	Not at all sure	Over half the days	Nearly every day
Feeling nervous, anxious, or on edge	6.6%	40.7%	0%	16.5%	36.3%
Not being able to stop or control worrying	17.6%	37.4%	0%	14.3%	30%
Worrying too much about different things	4.4%	41.8%	0%	15.4%	38.5%
Trouble relaxing	17.6%	35.2%	0%	18.7%	28.6%
Being so restless that it's hard to sit still	38.5%	26.4%	0%	14.4%	20.9%
Becoming easily annoyed or irritable	12.1%	46.2%	0%	18.7%	23.1%
Feeling afraid as if something awful might happen	24.2%	37.4%	0%	20.9%	17.6%

**Table VII: Analysis of the GAD-7 scale by professional, clinical groups and sex**

GAD-7-scale score	mean (SD)	p-value	No anxiety n (%)	Mild n (%)	Moderate n (%)	Severe n (%)
Total sample (n = 90)	10.9 (6.21)		15 (16.48)	31 (34.07)	17 (18.68)	28 (30.77)
<b>Programme</b>		0.23				
BOH (Oral Hygiene) (n=8)	13.25 (6.65)		0 (0)	4 (50.00)	1 (12.50)	3 (37.5)
BDS (Dentistry) (n=82)	10.76 (6.15)		14 (17.17)	27 (32.93)	16 (19.51)	25 (30.49)
<b>Sex</b>		0.26				
Males	9.85 (6.92)		7 (25)	8 (28.57)	3 (10.71)	10 (35.71)
Female	11.23 (5.85)		8 (12.7)	23 (36.51)	14 (22.22)	18 (28.57)
<b>Course seniority</b>		0.07				
Junior	9.5 (6.21)		8 (22.22)	14 (38.89)	6 (16.67)	8 (22.22)
Senior	11.96 (6.05)		6 (11.11)	17 (31.48)	11 (20.37)	20 (37.04)

COVID-19 pandemic. Living with parents may not in itself reduce stress and anxiety but could be a facilitating factor in student resilience. The fact that almost half of the students (46%) had sufficient money for their studies and living expenses and coped very well may be an indication of the support these students can access as well as an indication of the economic diversity of the student population.

Social capital, embedded in the relationships that develop at an individual or group level contributes to personal and interpersonal resources.<sup>26</sup> The social support of students in terms of family, friends, and social media indicates their networks. The creation of an environment that would foster a culture of social capital amongst students may support them and enhance resilience to cope with challenges ahead and serve as a protective factor in support of student wellbeing.

The levels of food insecurity experienced by participants in this study were substantially lower than reported in international studies<sup>2,17</sup> and South African literature.<sup>17</sup> A South African study found that 60% of students experienced food insecurity "with hunger" and 26% experienced food insecurity "without hunger".<sup>17</sup> According to Defeyter *et al.*<sup>2</sup> the best predictor of food security during the COVID-19 pandemic was the living arrangements of students. Students living with parents were less likely to experience low or very low levels of food security than those living on their own or with other students. The role of parents as a factor of living conditions is supported in this study where most students identified their parents (85%) as their main source of support. Most students (91%) in this study lived at home and a fairly high percentage (73%) were from the Western Cape, the province where the University is located, which may have been a protective factor in terms of food security. Although minimal, it is of concern that there were students who were food insecure during this period. Poor students are more likely to drop out of university than to expose their poverty, as the stigma of being poor silences them.<sup>19</sup> We could argue that some of the students that participated in this study could have been reluctant to respond truthfully. For university students, institutions of higher education should be cognisant of the background characteristics and needs that include the pressing issue of 'hungry students', which is a fairly recent unaddressed phenomenon.<sup>8</sup>

While the present study found that 47% of students were afraid of Covid-19, a study by de Souza *et al.*<sup>27</sup> found most dental students at a private university in Brazil showed little fear of COVID-19 using the FCV-19S. These differences may be an indication of how social contexts possibly influence student experiences. Differences in anxiety were reported in terms of sex and student levels of seniority in several studies.<sup>7,9,10,12,28</sup> In a study by Majeed *et al.*<sup>13</sup> gender was significantly related to anxiety and fear scores ( $p < 0.05$ ). Our study found higher scores in females, but the results were not significant ( $P > 0.05$ ) and since the distribution of males and females in our study was skewed (69.67% being females) no substantiated conclusions could be drawn.

Approximately 33% of the sample in the present study indicated that they experienced severe anxiety, while 50% experienced a moderate level of anxiety. These findings are consistent with a study conducted in Saudi Arabia on the psychological impact of the COVID-19 pandemic on dental

students by Hakami *et al.*<sup>9</sup> who recorded high levels of anxiety (37.02%) as well as elevated levels of stress and depression among students. Losif *et al.*<sup>14</sup> found high (26.54%) and very high (24.26%) levels of anxiety among Romanian dental students which is consistent with the findings of our study. Cao *et al.*<sup>1</sup> using the GAD-7 scale, found that 0.9% of the respondents in a Chinese student population experienced severe anxiety, 2.7% moderate anxiety, and 21.3% mild anxiety. An assessment of the psychological impact of the COVID-19 pandemic on dental interns in Saudi Arabia, who were primarily female (mean age 25.1 years) found levels of anxiety to be considerably lower (7.3%)<sup>15</sup> than our study (28.57% of females showed severe anxiety) and was not seemingly influenced by demographic characteristics ( $p > 0.05$ ). Lingawi and Ibtesam<sup>28</sup> studied the anxiety levels during Covid-19 on dental students in Saudi Arabia using the GAD-7 scale. The authors noted moderate (17%) and severe (4%) anxiety in students, respectively, with non-significant associations between anxiety and gender or level of study. Although anxiety among students as a consequence of the COVID-19 is a reality, there appear to be variations in the global picture of student experiences thereof. The dental profession is considered to be highly stressful. Mild and severe anxiety scores in dental students may be due to academic and socio-cultural factors (e.g. Covid-19 lockdown), while social support issues (emotional and financial) may act as mitigating factors. It can thus be concluded that the COVID-19 Lockdown, while not the sole cause of anxiety as indicated in the GAD-7 scores, may have been a contributing factor.

Higher anxiety was recorded in senior students in our study, possibly due to being in the clinical setting as opposed to junior students who had online teaching. Hakami *et al.*<sup>9</sup> on the other hand found that junior students were more likely to experience psychological problems.

The experiences of stress and anxiety in students in this study is a matter of concern, considering that these professions are inherently stressful.<sup>11</sup> Elani *et al.*<sup>11</sup> reported that the effects of stress are felt on academic performance, psycho-emotional wellbeing and physical health. Although our study did not look at physical health, student reports of the other dimensions as noted by Elani *et al.*<sup>11</sup> suggest that COVID-19 has resulted in additional experiences of stress. One may thus argue that actions need to be taken to embed the necessary skills to manage stress and anxiety in dental educational programs as a 'new norm' rather than an intervention. In addition, it should be acknowledged that students studying in the current COVID-19 environment may need additional and targeted actions to provide the necessary support and skills to cope with their current situation. This may better prepare them for entering the world of work, having had a substantial aspect of their education under COVID-19 related conditions. In this regard, new policies and guidelines would mitigate some of the negative effects and prepare educators and students for future health crises.<sup>25</sup>

## CONCLUSION

Results of this study indicated that the COVID-19 national lockdown affected dentistry and oral hygiene students in terms of anxiety. Students reported significant experiences of stress, yet most were able to cope with their studies. Living with parents or at home did not appear to be as

much a protective factor as reported in the literature. However, living at home or with parents did appear to contribute to student resilience in coping with their studies. The study further showed that the COVID-19 pandemic has added to psychosocial effects in a discipline that under 'normal' conditions is experienced as stressful. Given that various psychosocial vulnerabilities contribute to the students' anxiety and stress, the authors are cautioned to make assumptions and conclusions regarding isolating the impact of COVID-19 on the psychosocial effect of dental students. It is however clear that the COVID-19 impact on dental education highlights the importance of holistic student support that embeds the mental health and well-being of the students.

### Recommendations

Students in this study appeared to cope with their studies despite experiencing substantial stress and anxiety, possibly due to their resilience and support structures. However, these effects may have long term effects on their well-being. The multiplicity of stressors such as financial concerns, food insecurity, psychological stressors, and unsuitable study environment highlights the need for support by parents, fellow students, academic staff, and the university. Considering the inherent stressors of the professions in this study, we recommend that skills to empower students for the challenges of their professional training be embedded in the curriculum and that these be targeted to the specific challenges that students face over their academic program. Such an initiative, provided by suitably trained professionals may enrich the curriculum and encourage holistic development of graduates able to manage stressors associated with the professions. This requires educational institutions to develop a targeted approach through relevant support systems that would identify vulnerable students at critical times of their study.

### Limitations of the study

The fact that the sample for this study only represents one university's dental students restricts the generalisation of the results. The small sample of oral hygiene (BOH) students who responded to the study may also have skewed the results for oral hygiene students in the study.

### Addendum A

The term "Lockdown" refers to the National Lockdown gazetted by the National Government implemented from the 26th March and applies to all levels (Gazette 43168 of 26 March 2020).

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# The prevalence and classification of mandibular third molar impactions and associated second molar pathology in a Gauteng population group. *A retrospective study.*

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## ABSTRACT

### Introduction

An impacted tooth is one that has not erupted or is unlikely to erupt into its functional position within the dental arch<sup>1</sup>, and which has remained embedded in the jawbone or mucosa for more than 2 years following its physiological eruption time<sup>2</sup>. It may be visible, not visible but palpable, or neither visible nor palpable but evident on a radiograph.<sup>1,3</sup> Third molars are the most commonly impacted teeth followed by maxillary canines, with reported variations in prevalence amongst different population groups<sup>2,4</sup>. In 2000 The National Institute for Health and Clinical Excellence (NICE) issued guidelines stating that third molars should only be removed if there is evidence of pathology, and advocated that the practice of prophylactic removal be discontinued.<sup>1</sup>

In 2007 The American Association of Oral and Maxillofacial Surgeons (AAOMS) published guidelines where extraction of third molars may be warranted as indicated in Figure 15.

In 2011 the AAOMS issued a position paper on third molar management that stated, "Predicated on the best evidence-based data, third molar teeth that are associated with disease, or are at high risk of developing disease, should be surgically managed. In the absence of disease or significant risk of disease, active clinical and radiographic surveillance is indicated"<sup>6</sup>. Based on this, all patients should be evaluated by an expert for third molar management and their problems assessed over time before any extractions take place.<sup>7</sup> The South African Society of Maxillo-Facial and Oral Surgeons (SASMFOS), supported the AAOMS policy statement that "surgical management of impacted and erupted third molar teeth, even if asymptomatic, should

**Figure 1. Indications for the removal of impacted third molars**

Pain	To facilitate prosthetic rehabilitation
Pericoronitis	To facilitate orthodontic movement
Untreatable caries	To ensure stability of occlusion
Untreatable periapical or pulpal pathology	Interference with mandibular fracture management
Abnormalities of tooth shape or size precluding normal function	Interference with orthognathic/ reconstructive surgery
Chronic infection	Association with tumours and cysts
Ectopic position	External or internal resorption of tooth or adjacent teeth
Associated periodontal disease	Anatomic position with the potential for damaging the adjacent teeth
Tooth follicle pathology	Where it may prevent the normal eruption of an adjacent tooth

only be carried out in the presence of and / or potential for pathology related to / or caused by the these teeth.<sup>8</sup>

Despite these recommendations, there is still controversy in the literature related to this issue and the practice has continued.

### Literature review

The dental health of the population has improved in many countries resulting in a reduced incidence of early loss of first molars. This loss previously resulted in the second molars drifting forwards thus creating space for eruption of the third molars. With retention of the first molars, many patients now have insufficient space in their arches, which may contribute to higher levels of impacted 8's<sup>1,6</sup>.

There is no general consensus in the literature regarding prophylactic removal of impacted third molars. On the one hand the SASMFOS, AAOMS and JCDA (Journal of the Canadian Dental Association) recommend early removal of all third molars during adolescence, before completion of root formation. It was suggested that this may result in less postoperative complications and morbidity than that seen in patients who had extractions after the age of 25.<sup>9,10</sup> However, others are opposed to this as one of the most common complications of impacted third mandibular molar removal is injury to the inferior alveolar nerve bundle (IANB) which has resulted in countless medico legal issues against the dentists.<sup>11-13</sup>

The standard diagnostic preoperative assessment tool for the risk of IANB injury is a panoramic radiograph or the more modern cone-beam computed tomography (CBCT).<sup>11,14</sup>

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3. L Dawson: 40%;

Monaco *et al.* suggested that in those cases where the roots were close to the IANB, neurologic complications could be avoided or reduced by performing a coronectomy procedure. They advocated that this would result in minimal postoperative complications of which most were migrated root rests.<sup>15-17</sup>

Coronectomy was first proposed in 1984 by Ecuyer and Debien to decrease the risk of nerve damage in cases with IMTM roots in close proximity to the mandibular canal. Monaco *et al.* did a follow up study in 2019 regarding the success rate of coronectomy in IMTM cases with close relations to IANB and concluded: "no cases of neurologic lesions, a low rate of immediate postoperative complications, and no cases of late infection of the retained roots from the third to fifth year of follow-up. This technique should be planned before surgery and after an accurate diagnosis is made using CBCT to reduce intraoperative root mobilisation. Further investigations should include a follow-up study at 10 years and more research about the mechanism of pulp healing."<sup>16,17</sup> Monaco *et al.* did caution that no matter what procedure was used, it is of utmost importance to adequately inform patients of the associated surgical risks prior to considering any form of impacted molar extraction.<sup>15,18</sup>

Numerous studies have investigated reasons for prophylactic extraction of impacted third molars.<sup>12-16</sup> The most commonly grounds for the high rates were their association with pericoronitis, caries in the third or second molars, periodontal defects distal to the second molar, various odontogenic tumours and cysts and mandibular incisor crowding.<sup>19-23</sup> Other studies have found that a semi-impacted third mandibular molar with

a mesial angulation and in contact with the adjacent second molar often results in carious lesions developing on the distal root surface of the second molar. This was postulated to be due to the impacted third molar resulting in a deficient gingival collar around the second molar thus exposing the distal surface of the root to the oral cavity. This area is extremely difficult to keep clean, and may warrant third molar extraction for both hygiene purposes as well as to enable restoration of the second molar. If left untreated, the destruction could progress to the point where both teeth need to be extracted.<sup>13, 24, 25</sup>

McArdle *et al.* agreed that prophylactic removal of partially erupted third mandibular molars with a mesial inclination is indicated in order to prevent potential distal carious lesions developing on the second molars. However, the limitations of their study were that the cost-benefit aspect wasn't considered, nor possible other complications associated with impacted third mandibular molar removal.<sup>1,25</sup>

Polat *et al.* (2008) noted that one should take the impaction depth and angulation of impacted third mandibular molars into consideration when an extraction decision is needed. They suggested that mesially and horizontally angulated (especially class A depth) impacted third mandibular molars could be prophylactically extracted.<sup>26</sup>

In this study the Pell and Gregory's classification<sup>27</sup> was used for all visually confirmed impactions: In this system teeth are classified according to Class, position, and angulation. Rood and Shehab's classification was used to determine inferior alveolar nerve involvement<sup>28</sup>. The conditions are classified as follows:

Class	Class I:	Class II:	Class III:
	Sufficient space between the ramus and the distal of the second molar for accommodation of the mesio-distal diameter of the third molar. (ICL/ICR=0)	Space between the distal of the second molar and the ramus of the mandible is less than the mesio-distal diameter of the third molar. (ICL/ICR=1)	All or most of the third molar is in the ramus of the mandible. (ICL/ICR=2)
Position	Position A: Part of the tooth is above the occlusal plane. (IPL/IPR=0)	Position B: The highest portion of the tooth is between the occlusal plane and the CEJ of the second molar. (IPL/IPR=1)	Position C: The highest portion of the tooth is level with the CEJ of the second molar. (IPL/IPR=2)
Angulation	Horizontal (IAL/IAR= 0) Disto-angular (IAL/IAR= 3)	Mesio-angular (IAL/IAR= 1) Inverted (IAL/IAR= 4)	Vertical (IAL/IAR= 2) Other (IAL/IAR= 5)

Inferior alveolar nerve canal involvement	Radiographic signs were present (diversion, narrowing and interruption in the white line of the canal, and darkening of the root). (IANL/IANR= 1)	No radiographic signs of involvement. (IANL/IANR= 0)
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The second mandibular molar associated with impaction was radiographically examined for tooth destruction (carious lesion or external resorption)	No tooth destruction (CL/CR= 0)	Advanced tooth destruction which involve enamel and ½ of the dentine (CL/CR= 1)	Severe tooth destruction which involve enamel, more than ½ of the dentine and possible pulp involvement (CL/CR= 2)	Tooth destruction involving the cementum (CL/CR= 3)
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**Figure 1.** OPG of a patient with class II, position A, mesio angular third molar impactions with severe tooth destruction of the second mandibular molars on left and right side.



#### Problem statement

Clinicians are often confronted with patients presenting with pathology related to impacted third molars. This may include conditions such as pericoronitis, trismus, and carious or periodontally involved second molars. They may be reluctant to extract the third molars, especially if the Orthopantomogram (OPG) indicates a close relationship to the inferior alveolar nerve canal. Many times they will manage these symptomatic patients by prescribing antibiotics and analgesics and referring them to a specialist for treatment. However, once the pain and symptoms subside a number of patients will not follow this route due to fear of surgery, time or financial constraints, long waiting periods before getting an appointment, or the belief that the problem has been resolved.

The prevalence of patients presenting with carious second molars and / or external resorption associated with impacted mandibular third molars has not been widely studied, especially amongst a South African population. A high incidence of such impacted third molar related pathology, could influence the treatment decision regarding prophylactic extraction of third molars, as well as the education of students and patients in this field.

#### Objectives.

1. Quantitatively determined the number of patients that presented with impacted mandibular molars for treatment at an Oral and Dental Hospital in Gauteng.
2. Quantitatively determined the number of patients that presented with carious/ external root resorption on second molars associated with mesially angulated impacted mandibular third molars (IMTM).
3. Determined the age and gender of patients with carious second molars associated with IMTM.
4. Determined the classification type according to the Pell and Gregory<sup>22</sup> Classification (Class, Position and Inferior Alveolar Nerve Canal involvement <sup>23</sup>) of

impacted teeth that had associated carious second molars.

## MATERIALS AND METHODS

#### Study design.

A Retrospective, analytic, cross-sectional study was performed using data from a three-month period. A daily report of all patients who had consulted in the Maxillo-facial and Oral Surgery Department during a three-month period from the 1 April to 30 June 2018 was generated on the GoodX Dental Studio system. During this time, 2250 had presented for oral surgery treatment. Patient file numbers that occurred more than once were eliminated manually. The random function in Microsoft Excel was utilised to randomly select half of the patients from the list and to generate a final sample size of 959 patients.

The files were examined and only those with an OPG not older than two years old (using 30 June 2016 as the cut-off date) were included in the study. Those that had been taken on the Sidexis system were categorised as O=1; those generated on Cliniview as O=2, and files with no / old / poor quality radiographs as O=0. The researcher was calibrated prior to radiographic examinations. The presence of impacted mandibular third molars (IMTM) on either of both sides was visually confirmed by the researcher. These were then all classified according to the Pell and Gregory's classification system, with the inferior alveolar nerve canal involvement being classified according to Rood and Shehab's guidelines as described above.

All the second mandibular molars associated with impactions were radiographically examined for any signs of tooth destruction (carious lesion or external resorption). They were then charted as those with No tooth destruction (CL/CR= 0); more advanced tooth

destruction involving enamel and ½ of the dentine (CL/CR= 1); Severe tooth destruction (Figure 1) involving enamel, more than ½ of the dentine and possible pulp involvement (CL/CR= 2) and tooth destruction involving the cementum (CL/CR= 3). Finally the age and gender of all patients who had been identified with IMTM was captured from the GoodX Dental Studio records using their file numbers for patient identification.

Repeatability was tested by having the primary researcher repeat the data extraction of 25 cases identified with the Random function of Microsoft Excel on a separate occasion without looking at the original data. Reliability was verified by having a second, experienced clinician carry out the same procedure on these 25 cases.

Data obtained from the data extraction sheet was captured on Microsoft Excell and imported into IMB SPSS statistics version 24 (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp) by Prof TC Postma who acted as the bio statistician. Approval to conduct the study was obtained by the Research committee of the school (RESCOM) as well as the ethics committee of the faculty (REC). Patients' identification was kept anonymous as only file numbers were used in the study. Confidentiality was maintained throughout the study.

## RESULTS

Of the 959 patient file numbers selected, 238 (24.8%) had OPGs taken with the Sidexis system and 354 (36.9%) with Cliniview. Three hundred and sixty five (38.3 %) of the patients had no OPG that were older than 30 June 2016. Thus a total of 592 (61.7%) patient files were available for examination. From these a total of 100 (16.9%) and 112 (18.9%) were identified having IMTM on the left and right hand sides respectively.

Mesially angulated Class II Position A impactions constituted 32 (28.6%) out of 112 impactions on the right and 19% on the left. Mesially angulated Class II Position B impactions constituted 29 (25.9%) out of 112 impactions on the right and 20% on the left (Table 1). All other classification permutations rendered a very low prevalence.

There was possible IAN involvement in 66 (66%) of 100 impactions on the left and 66 (58.9%) of 112 on the right. Of all the patients that presented with impactions 50.4% (67) were female and 49.6% were male. Indicating no gender predilection. The mean age of the sample was 31.15 (SD:11.12, 95%CI: 29.24-33.06) years old.

Signs of tooth destruction of the second mandibular molars on the left side (37) associated with IMTM were as follows: None 59 (59%), Advanced 16 (16%), Severe 20 (20%), Cementum 5 (5%).

On the right (47) the results were: None 64 (57.1%), Advanced 9 (8%), Severe 21 (18.8%), Cementum 18 (16.1%) The relationship of IMTM classification components and tooth destruction on the distal surface of adjacent second molars is presented in Table 2.

Severe caries was detected on the distal surface of the second molar in relation to 10 out of 32 (31.3%) mesially angulated Class II Position A impactions on the right side

**Table 1. Impactions and IAN involvement classified according to the Pell and Gregory and Rood and Shehab classification systems respectively**

IMTM	Left		Right	
	n	%	n	%
<b>Class</b>				
I	4	4	2	1.8
II	91	91	107	94.7
III	5	5	4	3.5
<b>Position</b>				
A	41	41	50	44.6
B	49	49	55	49.1
C	10	10	7	6.3
<b>Angulation</b>				
Horizontal	6	6	6	5.4
Vertical	10	10	5	4.5
Distal	23	23	32	28.6
Mesial	57	57	66	58.9
Other	4	4	3	2.7
IAN Involvement	66	66	66	58.9

**Table 2. Relationship of IMTM classification and tooth destruction severity**

IMTM	Left		Right	
	n	%	n	%
<b>Class</b>				
I	0	0	0	0
II	19	20.9	21	19.8
III	1	20	0	0
<b>Position</b>				
A	11	26.8	12	24
B	9	18.4	9	16.4
C	0	0	0	0
<b>Angulation</b>				
Horizontal	1	16.7	1	16.7
Vertical	0	0	0	0
Distal	1	4.3	1	3.1
Mesial	18	31.6	19	28.8
Other	0	0	0	0
IAN Involvement	11	16.7	9	13.6

and 5 out of 19 (26.3%) on the left. Severe caries was detected on the distal surface of the second molar in 9 (31.3%) out of 29 mesially angulated Class II Position B impactions on the right side, and 3 (15.0%) out of 20 on the left. It should be noted that the prevalence of severe caries in relation to other impaction classification permutations is not reported due to very low prevalence (prevalence count of one or less) detected during this study.

## DISCUSSION

The results showed that there was no gender predilection for third molar impactions. Most of the patients who presented with these were between the age of 24 and 33 years old, highlighting that clinicians should consider investigating for these when examining patients within this age group. Mesially angulated Class II Position A and Position B

impactions were the most common and constituted 28.6% and 25.9% on the right and 19% and 20% on the left respectively. Of greater significance is that of all the impacted mandibular third molars approximately 2/3 (66% on the left and 58.9% on the right) had IAN involvement on radiographic examination. Thus the taking of OPG and careful radiographic examination is essential and justified when planning removal of IMTM in order to minimise or prevent IANC damage. One should also consider taking an additional CBCT in high risk cases of IANC damage to make a more accurate location of the IANC.

These results differed slightly from those of Mitra *et al*, who found that the majority of patients presenting with IMTM were males between the age of 21-25 years, and the least were females older than 45 years. However they too found the Mesioangular impactions to be the most common type.<sup>29</sup> These results correspond closely with studies done in other populations as well. Polat *et al* found that amongst their Turkish population group, those between the ages of 26 and 35 years showed a high number of associated dental and orofacial complications if their impacted third molars had been retained. They also found there to be caries in 5.3% of the impacted lower third molars. In the same study teeth with horizontal and mesio-angular impactions had more associated pathological conditions than other types, most especially in the class A group with deeply seated teeth<sup>20</sup>. However these results should be viewed with caution and do not automatically indicate the need for prophylactic extraction of all IMTM. Both angulation and impaction depth of impacted lower third molars should be taken into consideration when making a decision as to whether or not to extract. Khawaja *et al* studied a Saudi Arabian population group and found a high frequency of caries, external bone resorption and periodontitis in the second molars that were in close proximity to retained mesio-angular and horizontally tilted impacted third molars<sup>10</sup>.

In the present study only adjacent teeth showing signs of severe tooth destruction were reported as it is difficult to state categorically whether the mild tooth surface loss and cementum radiolucency is tooth destruction or radiographic cervical burnout. However, severe radiolucency can be distinguished from burnout and is thus undisputed. This could mean that the reported tooth destruction rates of 20% on the left and 18.1% on the right second mandibular molars associated with IMTM is an underestimation, and more than likely some of the milder cases those with cementum radiolucency did in fact have tooth destruction.

The reported rates of caries in the second molars associated with IMTM vary widely from as little as 1%<sup>20</sup> to the 31.3% found in the present study. Thus caries alone should not be used as an indication for prophylactic third molar extractions. Other factors such as the extent of damage, the likelihood of its progression, and the potential for IAN damage during third molar removal need to be carefully considered when making a treatment decision. The latter is extremely important given that the present study found 66% of patients with IMTM on the left and 58.9% with it on the right had associated IAN involvement.

## CONCLUSION

This study found no gender predilection with regards to IMTM, with most patients who presented with symptoms being 24 and 33 years of age. The most common type

of impactions were mesially angulated, class II, position A and B. These were also associated with a higher level of tooth destruction on adjacent second molars as well as IAN involvement. The results help justify the taking of OPGs and an additional CBCT to evaluate IANC position associated with IMTM's in young patients with suspected IMTM and highlight the need for careful clinical examination of the associated second molars in order to prevent future tooth surface loss and other associated pathoses. While the study found that mesially angulated class II, position A and B IMTM have an increased risk of causing tooth destruction on the adjacent second molars, the significance is too small to justify prophylactic surgical extraction of impacted third molars alone, and the decision needs to be weighed up against the risks of possible IAN damage. This highlights the importance of annual dental visits to evaluate IMTM using OPGs and decide the need for an additional CBCT.<sup>14</sup>

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# A radiographic analysis of Mandibular Symphysis dimension in black South African adult patients with differing skeletal patterns

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## ABSTRACT

### Introduction

Orthodontic treatment often involves planned tooth movement within the confined spaces of the alveolar bone trough. Tooth movement within the alveolar trough may be limited by thin labial and lingual cortical plates. Moving lower incisors beyond the mandibular symphysis dimensions may result in damage to roots and alveolar bone.<sup>4</sup>

### Aim and objective

The aim of the study was to evaluate limitation of treatment in different skeletal patterns due to mandibular symphysis dimension in order to evaluate limitations of tooth movement within the confines of the mandibular alveolar trough. The objective was to determine the mandibular symphysis dimensions in subjects with differing skeletal patterns

### Design

The design was a retrospective, cross-sectional study.

### Methods

A sample of 180 pre-treatment lateral cephalometric radiographs of black South African subjects were stratified into three groups based on their skeletal classification. Each Class was further divided into equal numbers of males and females. Descriptive statistics, Student's t-test, ANOVA test and Pearson correlation coefficient were used to analyse the data and p-values of <0.05 were considered statistically significant.

### Results

Subjects with skeletal Class I pattern had a greater LA compared to subjects with skeletal Class II pattern. Subjects with skeletal Class I pattern had a greater LH and LA in females

than in males. Subjects with skeletal Class III pattern had greater LH in males than in females.

## INTRODUCTION AND LITERATURE REVIEW

In order to have a balanced skeletal jaw relationship, the maxilla and the mandible must be in harmony. If there is a skeletal jaw discrepancy either in a vertical, or anteroposterior dimensions the dento-alveolar structures may compensate to camouflage the skeletal jaw discrepancy.<sup>1,2</sup>

In skeletal Class II subjects, where the mandible is retrusive in relation to the maxilla, the lower incisors may procline in order to achieve contact with the upper teeth. This may result in the root apices of the lower incisors being closer to the lingual cortical plate of the mandibular symphysis skeletal Class III subjects, where the mandible is protrusive in relation to the maxilla, the lower incisors may retrocline in order to make contact with the upper teeth.<sup>2</sup> This may result in the root apices of the lower incisors being closer to the buccal cortical plate of the mandibular symphysis.<sup>3</sup> Mulie<sup>4</sup> found that the labial and lingual cortical plate of the mandibular symphysis and the status of the periodontal tissue of the lower incisors could limit the movement of the lower incisors. Therefore, the mandibular symphysis dimensions and the position of the lower incisors must be considered during orthodontic diagnosis and treatment planning.<sup>5</sup> If the lower incisors are moved in an antero-posterior direction beyond the mandibular symphysis dimensions, the movement of incisors will be inhibited; the roots of the lower incisors may touch the cortical plates, causing damage to the periodontal tissues.<sup>4</sup> This damage may include alveolar bone loss, dehiscence, gingival recession, root resorption and mobility of the teeth.<sup>4,6</sup>

The alveolar bone thickness vary according to location and facial type.<sup>7</sup> In general alveolar bone thickness is greater at the apex, then in the cervical third of the lower incisors and towards the lingual surface compared to the labial surface.<sup>7</sup> This explains the higher prevalence of bone dehiscence and fenestration on the labial surface when lower incisors are moved anteriorly during orthodontic treatment. Several authors reported that the mandibular symphysis determines the beauty of the face in general, but particularly the lower part of the face.<sup>8-9</sup>

There are several factors that may affect the mandibular symphysis dimensions, such as:

### The functional environment.

Previous studies<sup>10-12</sup> reported that the functional environment of the mandibular symphysis shows an adaptive

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morphological response to the biomechanical loads experienced at different locations during the chewing process. The change in cross sectional shape of the mandibular symphysis correlates with the change in loading to which the mandibular symphysis is subjected.<sup>10-12</sup>

#### Vertical jaw relationship.

During growth, the mandible tends to rotate in a clockwise direction, resulting in a long and narrow symphysis, or it rotates in an anticlockwise direction, resulting in a shorter and wider symphysis.<sup>13</sup> Similarly, Swasty *et al.*<sup>14</sup> reported that long-faced patients had slightly narrower symphyses than average faced and short-faced patients.

#### Sagittal jaw relationship.

Studies<sup>6,15</sup> have shown that patients with skeletal Class III malocclusion showed high and narrow symphyses with greater anterior projection and increased lingual inclination of the long axis. Patients with a skeletal Class III often presented with extruded and retroclined mandibular incisors that caused the bone lingual to lower incisors (LP) apex to increase, whereas the bone labial to lower incisors apex (LA) and the bone inferior to mandibular incisor apex (LH) decreased.<sup>3</sup> Skeletal Class II patients often presented with extruded and proclined lower incisors that caused the bone lingual to the lower incisors apex to decrease, whereas the bone labial to lower incisors apex and the bone inferior to mandibular incisor apex increased.<sup>3</sup>

#### Inclination of the lower incisors.

Prior studies<sup>16-18</sup> have reported that when the lower incisors are retroclined, so too is the alveolar bone. The shape of the mandibular symphysis therefore corresponds to the inclination of the lower incisor. Yu *et al.*<sup>17</sup> reported that when the lower incisors are more proclined, the lingual alveolar bone of the mandibular symphysis becomes thinner. Nojima *et al.*<sup>15</sup> reported that the inclination of the lower incisors corresponds to the shape of the mandibular symphysis, and is influenced by facial type. This argument dates back to the era of Tweed, who reported that patients with high mandibular planes, presented with the lower incisors that were tipped lingually, whereas subjects with low mandibular planes presented with lower incisors that were tipped buccally.<sup>19</sup> This indicates that the stability of orthodontic results and facial aesthetics may be affected by incorrect positioning of the lower incisors.<sup>19</sup>

#### Genetic factors and ethnicity.

The mandibular symphysis is regarded as a multifaceted structure and its shape results from the interaction of various genetic, non-genetic, adaptive and non-adaptive factors.<sup>11,12</sup> Handelman<sup>6</sup> discovered that no cephalometric norms that took mandibular symphysis dimensions into consideration existed. He conducted a study of 107 Caucasian subjects to establish the standard norms of the mandibular symphysis dimensions and suggested that these cephalometric norms of mandibular symphysis dimensions should be incorporated in the cephalometric analysis.<sup>6</sup>

## AIM AND OBJECTIVE

The aim of this study was to evaluate the limitation of treatment in different skeletal patterns due to mandibular symphysis dimensions and the objective was to determine the mandibular symphysis dimensions in black South

African adult patients with skeletal Class I pattern, skeletal Class II and skeletal Class III. Knowledge on the thickness of the mandibular symphysis dimensions before orthodontic treatment may help in selecting the best treatment mechanics for specific skeletal patterns to prevent iatrogenic sequelae.

## DESIGN AND METHODS

The Sefako Makgatho University Research Committee (SMUREC) approved the study (project number: SMUREC/D/30/2018). The Head of the Department of Orthodontics and the CEO of MOHC gave permission to utilise the hospital records obtained from the Department of Orthodontics at MOHC. Patient's pre-treatment lateral cephalometric radiographs, panoramic radiograph and study models were used for this study

One hundred and eighty pre-lateral cephalometric radiographs (90 males and 90 females) were selected for this study. The criteria for selection included pre-treatment lateral cephalometric radiographs of black South African adult patients 18 years and older (race and citizenship were verified by referring to hospital files). Pre-treatment lateral cephalometric radiographs of subjects with skeletal Class I, Class II or Class III. Pre-treatment lateral cephalometric radiographs of patients who had never received orthodontic treatment.

Pre-treatment lateral cephalometric radiographs of good quality that had been taken with teeth in maximum intercuspation. All selected lateral cephalograms were subjected to the same X-ray machine, using the same technique at MOHC, Sefako Makgatho Health Science University with (Siemens, Orthopantomogram 10<sup>®</sup> – analogue and Kodak 8000C<sup>®</sup> – digital cephalograms).

The selected lateral cephalometric radiographs were traced manually using a 4H pencil (0.5 mm) and a tracing protractor template on acetate tracing paper over a light viewing box in a darkened room. Measurement bias (tracing and landmark identification) were avoided by tracing no more than 10 radiographs at a time, in order to avoid operator fatigue.

These lateral cephalometric radiographs were then traced, using Handelman's criteria.<sup>6</sup> The dimensions of the mandibular symphysis were measured in millimetres, using a ruler. In order to assess the mandibular symphysis dimensions, two reference lines were used, i.e. the occlusal plane line and the tangent line parallel to the occlusal plane passing through the apices of the lower incisors (refer to Figure 2). The following mandibular symphysis dimensions were measured on the tangent line that runs parallel to the occlusal plane: the dimension of the bone labial to the root apex of the lower incisor apex (LA), the shortest distance from the root apex to the outer surface of the labial cortical plate; the dimension of the bone lingual to the root apex of the lower incisor (LP), the shortest distance from the root apex to the outer surface of the lingual cortical plate; and the dimension of the bone from the lower incisor apex to the lowest point of the mandibular symphysis (LH), that is the shortest distance from the root apex to the inferior part of the mandibular symphysis (see Figure 2). These measured variables were recorded on the data collection form, and entered into an Excel spreadsheet.

The traced lateral cephalograms were grouped into three classes, based on their skeletal relationship. The ANB<sup>20</sup>, facial plane angle<sup>21</sup>, convexity<sup>22</sup> and Wits analysis<sup>23</sup> were used to confirm each patient's skeletal relationship. ANB was used to classify skeletal jaw relationship (ANB =50 normal, ANB >50 Class II and ANB <50 Class III). The control group comprised 60 skeletal Class I lateral cephalometric radiographs. The test group comprised 120 lateral cephalometric radiographs, divided equally into a group of 60 skeletal Class II and a group of 60 skeletal Class III of black South African adult patients. There were equal numbers of males and females in each skeletal Class.

#### Lateral cephalometric landmarks and measurements Measurements according to skeletal relationship

The classification and verification of the patient's skeletal relationship was achieved by using the following cephalometric angular linear measurements (refer to Figure 1):

- **SNA angle:** angle formed where the lines connecting nasion and point A to S-N plane intersect.<sup>20</sup>
- **SNB angle:** angle formed where the lines connecting the nasion plane and point B to S-N plane intersect.<sup>20</sup>
- **ANB angle:** subtraction of SNB angle value from SNA angle value.<sup>20</sup>
- **Wits appraisal:** a perpendicular line from point A of the maxilla and from point B of the mandible onto the Occlusal plane (OP).<sup>23</sup>
- **Convexity:** a linear measurement of the distance from Point A to the nasionpogonion line.<sup>22</sup>
- **Face plane:** angle formed between the Frankfort horizontal plane and the nasionpogonion line.<sup>21</sup>

#### Measurements of the mandibular symphysis dimensions

The following linear measurements were used in this study (Figure 2), following Handelman's criteria<sup>6</sup>.

- **LP – bone lingual to mandibular incisor apex:** a line drawn through the apex of the mandibular central incisors to the lingual cortex, parallel to the occlusal plane.
- **LA – bone labial to mandibular incisors apex:** a line drawn through the apex of the mandibular central

incisors to the labial cortex, parallel to the occlusal plane.

- **LH – bone inferior to mandibular incisor apex:** the shortest distance from the apex of the mandibular incisors to the lowest point on the mandibular symphysis, that is crossed by a line parallel to the occlusal plane.

Eighteen radiographs were selected for intra-examiner reliability to evaluate and assess the accuracy of the single investigator. The measurements were repeated a month later. Inter-examiner reliability was established in order to evaluate and assess the accuracy of the measurements of the first and second investigator.

Statistical analysis system (SAS) 9.4 computer software program was used to determine all the continuous variables. Student's t-test was administered to compare the mean values of the mandibular symphysis dimensions of males and females, and to check for any major differences.

The value  $p < 0.05$  signifies the level of confidence. One-way ANOVA test was administered to compare the mean values of the mandibular symphysis dimensions of different skeletal types and facial types, and to check for any major differences. The value  $p < 0.05$  signifies the level of confidence. All the  $p$  values equal to or greater than 0.05 were considered statistically significant. The magnitude of association between the original and second measurements of the mandibular symphysis dimensions were analysed using the Pearson Correlation Coefficient.

## RESULTS

The intra-examiner and inter-examiner reliability was tested by randomly selecting and re-measuring 10% of the total sample and the results were analysed using the Pearson correlation Coefficient. Results showed strong correlations between the repeated and the original measurements for all measured variables of the mandibular symphysis dimensions. These findings are consistent with those of a study by Alhadlaq<sup>24</sup> who mentioned that the method of measurement of the manual cephalometric tracing was reliable and reproducible. The results are summarized in tables 1 to 3.

#### Comparisons of skeletal class I pattern (control group) and various classes of malocclusion

Table I: Comparison of mandibular symphysis dimensions of female skeletal Class I with Class II and III samples

Variable	Mean (+ SD) Class I females n=30	Mean (+ SD) Class II females n=30	p - value	Mean (+ SD) Class III females n = 30	p - value
LP (mm)	4.20 + 4.63	4.37 +1.67	0.691	3.93 +1.99	0.321
LA (mm)	4.70 +1.48	4.63 +1.35	0.857	4.23 1.56	0.242
LH (mm)	22.80 +3.96	22.77 +4.33	0.977	21.67 +5.57	0.371
LA + LP (mm)	8.90 +1.74	9.03 +2.05	0.788	8.17 +2.56	0.201

(+ SD) = standard deviation;  $p < 0.05$  is considered statistically significant; n = sample

#### Comparison of measured variables between female skeletal Class I and Skeletal Class II

The study found no statistically significant differences between skeletal Class I and skeletal Class II.

Figure 1: Linear and angular measurements to verify that patient had skeletal class I, II or III pattern: 1) SNA, 2) SNB, 3) ANB, 4) convexity, 5) face-plane, 6) Wits.

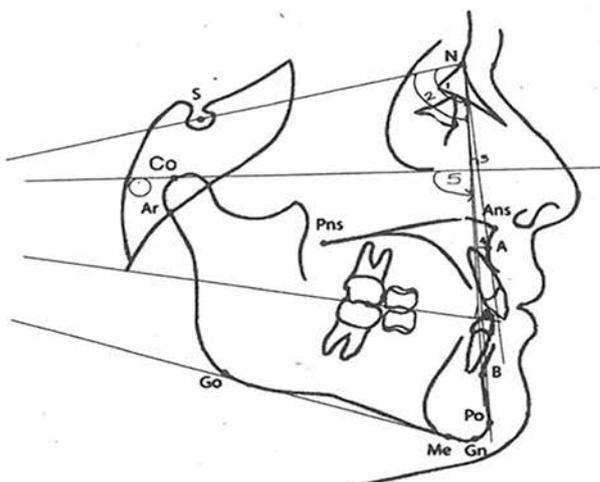
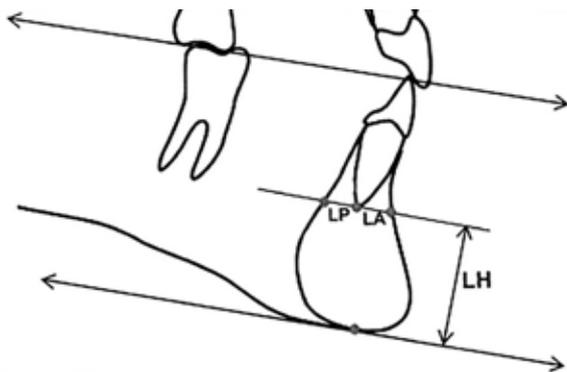


Figure 2: The dimensions of the symphysis: LP, LA, and LH<sup>6</sup>



#### Comparison of measured variables between female skeletal Class I and Skeletal Class III

The study found no statistically significant differences between skeletal Class I and skeletal Class III.

#### Comparison between male skeletal Class I and Skeletal Class II

There were no statistically significant differences between the skeletal Class I and skeletal Class II male sample, except for the LA (bone labial to lower incisor apices). This was significantly larger in skeletal Class I as compared to the skeletal Class II.

#### Comparison between male of skeletal Class I and Skeletal Class III

No statistically significant differences were found between the skeletal Class I and skeletal Class III male sample for any of the measured variables.

#### Gender comparisons

##### Comparison between male and female skeletal Class I

The bone inferior to the lower incisor apices was significantly greater in females than in males with a skeletal Class I pattern.

##### Comparison between male and female skeletal Class II

The bone labial to the lower incisor apices was significantly larger in females than in males with a skeletal Class II pattern.

##### Comparison between male and female skeletal Class III

The bone inferior to the lower incisor apex was significantly greater in males than in females with a skeletal Class III pattern.

#### Comparisons of the mandibular symphysis dimensions in average (control group) and different facial type

##### Comparison between average and horizontal facial type

No statistically significant differences were found between the horizontal and average facial types, indicating that none of the mean values for the mandibular symphysis dimensions differed significantly. A trend emerged in the average sample of the increased bone labial to lower incisor apices, increased bone inferior to lower incisor apices and increased bone lingual to the lower incisor apices. In the horizontal sample, there was a tendency for the total width of the mandibular symphysis to be greater than that of the average sample but this was not significant.

##### Comparison between average and vertical facial type

Two of the measured mandibular symphysis dimensions demonstrated statistically significant differences. The mean values of the mandibular symphysis dimensions of (the bone inferior to the lower incisor apices and the total width of the mandibular symphysis) of the vertical facial type were significantly greater than those of the average group sample.

##### Comparison between vertical and horizontal facial types

Three of the mandibular symphysis dimensions demonstrated statistically significant differences. The mean values of the mandibular symphysis dimensions (the bone labial to the lower incisor apices, the bone inferior to the lower incisor apices and the total width of the mandibular symphysis) of the horizontal facial type were significantly larger than those of the vertical group.

Table II: Comparison of mandibular symphysis dimensions of skeletal Class I with Class II and III male samples

Variable	Mean (+ SD) Class I males n=30	Mean (+ SD) Class II males n=30	p - value	Mean (+ SD) Class III males n = 30	p - value
LP (mm)	4.33 +1.37	5.03 +1.95	0.114	4.33 +1.78	1.000
LA (mm)	4.70 +1.53	4.377 +1.56	0.027	4.10 +1.49	0.130
LH (mm)	25.67 +3.96	24.03 +33	0.133	24.97 +5.79	0.587
LA + LP (mm)	8.87 +1.73	8.80 +2.38	0.902	8.47 +1.77	0.381

(+ SD) = standard deviation; p < 0.05 is considered statistically significant; n = sample

Table III: Gender comparison of mandibular symphysis dimensions of skeletal Class I, Class II and III samples.

Variable	Class I (n = 30)			Class II (n = 30)			Class III (n = 30)		
	Mean (+ SD) Males	Mean (+ SD) Females	p value	Mean (+ SD) Females	Mean (+ SD) Males	p value	Mean (+ SD) Females	Mean (+ SD) Males	p value
LP (mm)	4.33 +1.37	4.20 +1.56	0.72	4.36 +1.67	5.03 +1.95	0.16	3.93 +1.99	4.33 +1.78	0.41
LA (mm)	4.70 +1.53	4.70 +1.48	1.00	4.63 +1.35	3.76 +1.56	0.03	4.23 +1.56	4.10 +1.49	0.73
LH (mm)	25.67 +3.96	22.8 +4.02	0.007	22.7 +4.91	24.04 +3.3	0.294	21.66 +5.57	24.96 +5.79	0.028
LA + LP (mm)	8.86 +1.73	8.90 +1.74	0.94	9.03 +2.05	8.80 +2.38	0.68	8.16 +2.56	8.46 +1.77	0.60

(+ SD) = standard deviation; p < 0.05 is considered statistically significant; n = sample

**Table IV: Comparison of mandibular symphysis dimensions between average and horizontal facial types**

Variable	Mean(+SD) Average (n = 55)	Mean(+SD) Horizontal (n = 17)	p - value	Mean(+SD) Vertical (n=108)	p - value
LP	4.61 +1.68	4.52 +1.97	0.85	4.21 +1.74	0.162
LA	4.50 +1.59	5.17 +1.87	0.11	4.14 +1.40	0.151
LH	21.8 +4.23	21.1 +6.97	0.623	24.97 +4.50	0.001
LA + LP	9.10 +1.97	9.70 +2.22	0.288	8.34 +2.00	0.023

(+ SD) = standard deviation; p < 0.05 is considered statistically significant; n = sample

**Table V: Comparison of mandibular symphysis dimensions of vertical and horizontal facial types**

Variable	Mean (+ SD) Horizontal (n = 17)	Mean (+ SD) Vertical (n = 108)	p - value
LP	4.52 +1.97	4.21 +1.74	0.488
LA	5.17 +1.87	4.14 +1.40	0.010
LH	21.1 +6.97	24.97 +4.50	0.0023
LA + LP	9.70 +2.22	8.34 +2.00	0.010

(+ SD) = standard deviation; p < 0.05 is considered statistically significant; n = sample

## DISCUSSION

In this study, the cephalometric norms of the mandibular symphysis dimensions of black South African adult patients were established (LA 4.7mm, LP 4.27mm, LH 24.2mm and LA+LP 8.8mm) and compared across different skeletal patterns. The sample was grouped according to skeletal relationship, gender and facial types.

This study found that values of LA (the bone labial to the lower incisor apices) were greater in males with a skeletal Class I pattern (control) than in males with a skeletal Class II pattern. It is possible that males with a skeletal Class I pattern had more proclined lower incisors than males with a skeletal Class II pattern. Proclined lower incisors in subjects with a skeletal Class I pattern are associated with bimaxillary protrusion. However, in this study Skeletal Class I patients presented with features of Bimax one (BM<sub>1</sub>) that present with a balanced profile and efficient lips which is considered an ideal profile in most south African black population, but these features are considered protrusive when compared to Caucasian population.<sup>25-27</sup> This type of bimaxillary protrusion (BM<sub>1</sub>) does not require extraction or treatment at all. Treatment of patients with bimaxillary protrusion two (BM<sub>2</sub>) and bimaxillary protrusion three (BM<sub>3</sub>) may require the extraction of premolars, followed by retraction of the incisors as well as surgery in some cases. It is therefore important to know the boundaries of the mandibular symphysis dimensions before retracting the lower incisors, as moving teeth beyond these boundaries may cause damage to the periodontal tissues, resulting in root resorption, dehiscence and fenestrations.<sup>4</sup>

The findings of this study correspond with those of Alhadlaq<sup>28</sup> who reported an increased LA (bone labial to the lower incisor apices) in males and females with a skeletal Class I pattern when they were compared to males and females with a skeletal Class II pattern. The findings of this study are also consistent with those of Molina-Berlanga<sup>29</sup> who reported that increased LA (bone labial to the lower incisor apices) was associated with protruded lower incisors; when the lower incisors are protruded their root apices tend to rotate towards the lingual side, causing the thickness of LA (the bone labial to the lower incisor apices) to increase.

No statistically significant differences were found in this study in any of the measured variables when comparisons

were made between males with a skeletal Class III pattern and males with a skeletal Class I pattern (control group), as well as between females with a skeletal Class III pattern and females with a skeletal Class I pattern (control group). These findings are in contrast to those of Alhadlaq<sup>25</sup> who found significant differences between males and females with a skeletal Class I pattern when compared to males and females with a skeletal Class III pattern. Alhadlaq<sup>29</sup> found that males with a skeletal Class I pattern had an increased LA (bone labial to the lower incisor apices) than males with a skeletal Class III pattern. An increased thickness of LA (the bone labial to the lower incisor apices) is associated with proclined lower incisors where the root apex rotates towards the lingual side causing the LA (bone labial to the lower incisor apices) to increase.<sup>29</sup> Retraction of the lower incisors in patients with a skeletal Class I pattern should be carefully planned to avoid perforation of the lingual cortical plate, which may cause root resorption.<sup>6</sup>

The findings of this study are similar with those of Molina-Berlanga<sup>29</sup> who found no significant differences of measured variables of the mandibular symphysis dimensions between subjects with a skeletal Class I pattern and subjects with a skeletal Class III pattern, although their study did not account for gender.

There was a trend towards increased bone inferior to the lower incisor apices in males and females with a skeletal Class III pattern than in males and females with a skeletal Class I pattern (control group), although this was not significant. This finding corresponds to that of Alhadlaq<sup>28</sup> who further explained that increased bone inferior to the lower incisor apices in subjects with a skeletal Class III pattern demonstrated a dentoalveolar compensation caused by over-eruption of the lower incisors to approximate the upper incisors. Over-eruption of the lower incisors leads to a narrow mandibular symphysis dimension. Handelman<sup>6</sup> reported similar findings, although his sample was not stratified according to gender. Patients with narrow mandibular symphysis of less than normal 8.8mm, should involve tipping movements of the lower incisors rather than bodily movement, to prevent damage to the periodontal tissues.<sup>30</sup>

Treatment of patients with bimaxillary protrusion depend on the severity of the case. Patients with mild protrusion classified as Bimax one (BM<sub>1</sub>), usually accept their facial

profile and do not request treatment. Those with moderate Bimax two (BM<sub>2</sub>) and severe protrusion Bimax three (Bmx<sub>3</sub>), request treatment to have their teeth retracted.<sup>27</sup> During retraction of anterior teeth, reciprocal movement of teeth may be allowed in Bimax<sub>2</sub> patients, however, Bimax<sub>3</sub> patients will require devices to prevent anchorage loss so that the space created through extraction of two upper first premolars and two lower first premolars is largely utilized for retraction of anterior teeth. In extreme cases of bimaxillary protrusion treatment may include both orthodontic and surgical treatment e.g. four first premolars extraction followed by segmental alveolar osteotomies to close the extraction sites to reduce the dental protrusion. When comparisons were made between males and females with a skeletal Class I pattern in this study, no statistically significant differences were found between any of the measured variables, except in the case of the bone inferior to the lower incisor apex. In this regard, there was a more significant increase of the bone inferior to the lower incisor apices in males with a skeletal Class I pattern than in females. This indicated that males with a skeletal Class I pattern demonstrated a more vertical growth pattern than their female counterparts.<sup>13</sup> Individuals with a vertical growth pattern present with increased bone inferior to the lower incisor apices as a result of extruded lower incisors and elongated mandibular symphysis dimensions.

This finding corresponds to that of Alhadlaq<sup>28</sup> who found that males with a skeletal Class I pattern had increased bone inferior the lower incisor apices when compared to their female counterparts. This finding is also similar to that of the previous studies<sup>7,31</sup> both of whom found that the height of the mandibular symphysis dimensions was greater in males than in females. Clinicians should know that patients with increased bone inferior of the lower incisor apices have a narrow (less than 8.8mm of the total width), mandibular symphysis which means that the movement of the lower incisors is limited. Such patients should be treated with a combination of orthodontic treatment and surgery in order to avoid iatrogenic sequelae.<sup>32</sup>

There were no statistically significant differences found between male and female subjects with a skeletal Class II pattern, other than the bone labial to lower incisor apices. A significant increase of the bone labial to the lower incisor apices was found in females with a skeletal Class II pattern when compared to male counterparts. This may have been the result of extruded and proclined lower incisors causing the bone labial to lower incisor apex to increase, as the root apex of the lower incisor rotates towards the lingual side.<sup>3,29</sup> In other words, the labial movement of the lower incisors in females with a skeletal Class II pattern should be avoided since the roots of the lower incisors may make contact with the lingual cortical plate and suffer root resorption.<sup>6</sup> These findings correspond in part with those of Alhadlaq<sup>28</sup> who found significant differences between the males and females with a skeletal Class II pattern in all variables.

In this study, comparisons of males and females with a skeletal Class III pattern showed no significant differences in any of the measured variables except for the bone inferior the lower incisor apices. In this regard, there was a significant increase of the bone inferior to the lower incisor apices in the males when compared to their female counterparts. Males with a skeletal Class

III pattern demonstrated a more vertical growth pattern, resulting in extruded lower incisors and narrow mandibular symphysis dimensions.<sup>13</sup> When treating patients with narrow symphyses, the lower incisors should be moved by tipping rather than bodily.<sup>30</sup> Similarly, Alhadlaq<sup>28</sup> found that males had an increased bone inferior to the lower incisor apices than their female counterparts. In this study, the males showed greater mean values than their female counterparts, which correlated with other such studies.<sup>33,31</sup> This study found no statistically significant differences between subjects with a horizontal facial type and those with an average facial type. The findings of this study are in contrast with those of Handelman<sup>6</sup> who reported that the LP and the LA + LP were significantly thicker in subjects with horizontal facial types compared to subjects with average facial type. These patients with horizontal facial types present with less proclined or normal position of lower incisors.<sup>29</sup>

In this study an increased LH (bone inferior to the lower incisor apices) and a decrease LA+LP (total width of the mandibular symphysis) were noted in subjects with a vertical facial type when these were compared to subjects with an average facial type. These results correspond to those of Handelman<sup>6</sup> who found subjects with a vertical facial type had a narrow LA+LP (total width of the mandibular symphysis) and increased LH (bone inferior to the lower incisor apices) when compared to subjects with a horizontal facial type and those with average facial type. Handelman<sup>6</sup> explained that an increased LH (bone inferior to lower incisor apices) and decreased LA+LP (total width of the mandibular symphysis) are associated with over-erupted lower incisors and a thinning of the mandibular symphysis dimensions. Such thinning results in the labial movement of the lower incisors as well as their retraction of the lower incisors causing damage to the periodontal tissues.<sup>6</sup>

In the present study, subjects with a horizontal facial type were found to have significantly increased LA (bone labial to lower incisor apices), and increased LA+LP (total width of the mandibular symphysis dimension), as well as decreased LH (bone inferior to the lower incisor apices) when compared to subjects with a vertical facial type. Findings were similar to those of a study by Ponraj *et al.*<sup>34</sup> who reported that decreased LH (bone inferior to lower incisor apices) in subjects with a horizontal facial type could be the result of the mandible rotating forward, in the absence of vertical mandibular symphysis remodeling with increased growth of the ramus. These patients thus presented with a deep bite and a reduced lower facial height. Ponraj *et al.*<sup>34</sup> further reported that increased LA (bone labial to lower incisor apices) and increased LA+LP (total width of the mandibular symphysis dimensions) in the subjects with a horizontal facial type might be attributable to extreme muscle activity, since the masseter activity is significantly longer in subjects with a horizontal facial type. The distance between the root apex of the lower incisor and the LA (bone labial to lower incisor apex) was shown to be greater in subjects with a horizontal facial type than in subjects with a vertical facial type.<sup>35</sup> Ponraj *et al.*<sup>34</sup> reported that the thick anterior alveolus in subjects with a horizontal facial type allows the clinician to move lower incisors freely, without any fear of adverse effects. A decrease in the LA (bone labial to lower incisor apex) and in the LA+LP (total width of to the mandibular symphysis dimension)

in subjects with a vertical facial type demonstrated that subjects with a vertical facial type had narrow mandibular symphysis dimensions. The increase in the LH (bone inferior to the lower incisor apices) may be due to over-eruption of lower incisors, causing the mandibular symphysis to elongate. These results correspond with those of previous studies<sup>34,29</sup> that reported narrower mandibular symphysis dimensions in subjects with vertical facial type than in subjects with horizontal facial type. Further retraction of lower incisors in subjects with vertical facial types could be achieved without any loss of torque. During the retraction stage, careful mechanics must be used to ensure that teeth are positioned within the cancellous bone to prevent iatrogenic side effects. According to Ponraj<sup>34</sup> corticotomy might be beneficial in subjects with a vertical facial types since the procedure is less traumatizing to the teeth and to the alveolar bone. Corticotomy will allow 4mm en masse retraction of anterior teeth along with alveolar housing thereby preventing iatrogenic effects such as root resorption and dehiscence.<sup>36</sup>

## CONCLUSION

Significant differences in mandibular symphysis dimensions were not found when variables of skeletal Class I subjects (control group) were compared to those of skeletal class II and III patterns except LA (the bone labial to the lower incisor apices) that was significantly larger in skeletal Class I sample as compared to skeletal Class II sample. When the mandibular symphysis dimensions were compared according to gender, no statistically significant differences were found except LH (the bone inferior to lower incisor apices) was significantly larger in males than in female sample of skeletal Class I pattern.

With regard to facial type, significant differences in mandibular symphysis dimensions were observed, particularly when the average faced subjects were compared with the vertical faced subjects, and when the vertical faced subjects were compared to the horizontal faced subjects. No statistically significant differences were found when the average faced subjects were compared to the horizontal faced subjects.

Clinicians should take into consideration the mandibular symphysis dimensions when treating patients with a vertical facial pattern as these patients are more likely to have narrow (less than 8.8mm of the total width) mandibular symphysis dimensions and may require surgery or corticotomy.

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# The perceived business management knowledge and skills of dentists in private practice in South Africa

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## ABSTRACT

### Purpose

This study evaluated the perceived business (practice) management knowledge and skills of dentists involved in the management of a private practice in South Africa by means of a self-administered web-based questionnaire.

### Method

Invited participants were members of the South African Dental Association (numbering 2,462) as well as dentists in their second and third year of practice after graduation (numbering 199). There were 533 respondents but not all of these were involved in management and 63 of these failed to complete the survey, leaving a total of 367 respondents.

### Results

Overall, the respondents reported that their undergraduate training had not prepared them adequately for the non-clinical aspects of practice management; 56% had not had a formal undergraduate course. However, for those who did, 71% reported that the course was only slightly or not at all useful. Only 29% attended any form of postgraduate course, but only three of these were considered to be effective. Management knowledge and skills were also obtained from accountants as well as financial advisors, friends, family and lawyers.

### Conclusion

In line with the opinion expressed by the majority of respondents (86%), it is recommended that appropriate dental practice management courses be introduced throughout the curriculum, preferably in association with a Business School, and that postgraduate courses should be made available for continuous professional development in this field.

## Keywords

Dental practice management; business management; practice management courses

## INTRODUCTION

A private dental practice is a small business, operating to provide a health care service and generate a profit, which determines the personal income of the operating dentist. A general dentist, usually the owner of the practice, has to facilitate managerial and administrative tasks similar to any business. However, it has been shown that many dentists and dental students perceived their undergraduate dental curriculum to have lacked non-clinical training in areas such as business management, practice management and leadership skills.<sup>1-6</sup> Many dentists and dental students also believe dental schools should include or improve programmes on non-clinical training in the undergraduate curriculum or offer this as a postgraduate course.<sup>2-5,7</sup>

Dental practices are capital intensive and have one of the highest costs per square metre of any small business.<sup>8,9</sup> Therefore, being able to develop a business model that increases revenues is important to guarantee growth. With little or no training or experience, most dentists depend on their reputation, practice location and professionalism for success in business. However, these aspects are considered insufficient to receive the expected revenue in the long term.<sup>10</sup> Modern dental practices require deliberate management and sound business knowledge which requires specialized training.<sup>1,2</sup>

A study in the U.S.<sup>2</sup> revealed that 85% of the dental graduates surveyed felt uncomfortable with their practice management education and only 7% felt comfortable with their knowledge of accounting, human resources and dental insurance. The perception of this knowledge and their confidence levels increased significantly only after having spent several years in the workforce. This study also reported that the majority of graduates believed there was a need for the curriculum to include practice management especially health insurance, finance, and accounting. Some of the respondents suggested that practice management courses should be introduced in earlier years of the dental curriculum and should be in collaboration with Business Schools.<sup>2</sup>

In 2014-15, a study on non-clinical skills and dental practice management in the four dental schools in South Africa found that students perceived non-clinical skills as being important for clinical care and managing services, but indicated that there should be a greater focus on leadership, business skills and management training.<sup>5</sup>

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In 2016, a survey of the views of new graduates and established practitioners of their undergraduate training in the United Kingdom revealed that a greater emphasis was needed to teach business and practice management and communication skills.<sup>6</sup> A recent U.S study<sup>11</sup> of dental schools with and without an associated dual dental/medical MBA programme reported that most (95%) respondents acknowledged that dental practice required business acumen and 68% of those in schools without an associated MBA programme would welcome such a programme. Unfortunately for statistical purposes all respondents were considered together so it was not possible to compare schools with and without the MBA programme. Nevertheless, only 12% reported that they were satisfied with the business-related training offered. Specific items of training, though, were not covered.

A survey of the 10 Canadian dental schools revealed a total of 22 practice management courses ranging from 27 to 109 hours of teaching and were taught by dentists on three main topics: ethics, human resource management, and running a private practice. However, no opinions on the efficacy of these courses were sought.<sup>12</sup>

The present study aimed to evaluate the perceived business (practice) management knowledge and skills of dentists involved in the management of private practices in South Africa to determine how well equipped they were to manage the practice. It was felt that this information might also provide guidance for improving current undergraduate curricula including the need for postgraduate training.

## METHODS

Ethical clearance was granted by the Human Research Ethics Committee (Medical) of the authors' institution (clearance number M170569). The study was carried out in 2018 and was voluntary, anonymous and there were no consequences for choosing to participate or not participate in the study or from withdrawing. There were no incentives for participation and there were no unintended consequences identified.

The study was a quantitative and qualitative (mixed) questionnaire-based study pertaining to participants' views and perceptions. Hence a self-administered questionnaire was appropriate so that inferences may be drawn from any associations and opinions. The database of the largest national voluntary dental association (which claims on its public website to represent the majority of dentists in the country) was used to distribute the questionnaire. The disadvantage was that only those dental practitioners who were members of the association and who were interested in this topic would have been likely to respond. Nevertheless, it was considered that their opinions on business management would be a guide for the directions the dental curricula could take.

The population sample included dentists who were in private practice (2462) and in addition, those in their second and third year after graduation (199) who would be expected to work in private practice. Dentists in their first year of graduation were excluded as they were within their public-sector community service period and had not been exposed to private practice. Respondents numbered 533; some of these were not involved in management and 63

failed to complete the survey, leaving 367 final participants. Based on a worst-case estimate for a sample size of 50%, with 5% precision and 95% confidence level, a sample size of 385 would be required. The actual sample size of 367, corresponded to a precision of 4.7%,<sup>13</sup> and was considered acceptable.

The questionnaire (available from the authors) was based in part on questions that had been used in similar studies to enable comparisons and contained some open-ended questions. Section A recorded demographics and Section B sought opinions on the relevance of the undergraduate training in light of the respondents' experiences. Section C related to postgraduate training and sources of information used by dentists to improve their knowledge or skills in practice management.

The questionnaire was converted into a web-based version using Qualtrics survey software (Qualtrics, Utah, United States). The dental association distributed an email containing a link to the web-based questionnaire to its members and an attached information letter describing the study explained that participation in the questionnaire would assume consent.

### Statistical Analysis

Categorical variables were summarized by frequency and percentage tabulation and continuous variables were summarized by the mean, standard deviation, median and interquartile range, according to their distribution. Participants were categorized into three groups on the basis of the number of years of experience they had in private practice management (0-4 yrs, 5-15 yrs, >15 yrs). One question required participants to rank alternatives and this was analyzed by assigning each response to a category derived from the previous question if possible, or excluded if not. A ranking of 1 was assigned 3 points, a ranking of 2 was assigned 2 points, and a 3 was assigned 1 point. The final ranking was determined by summing the points for each item. Data analysis was carried out in Statistical Analysis Software (SAS) Software Version 9.3 for Windows (SAS Institute Inc., North Carolina, USA). The 5% significance level was used.

### Validity

In terms of external validity, the study was context specific, and limited to dentists in private practice in South Africa. In terms of internal validity, the questions used in the research instrument were short and in a language that was easy for all respondents to understand, with the avoidance of double-barrelled, loaded and potentially confusing questions. Prior to conducting the study, a pilot study was conducted on part-time faculty members at the University of the Witwatersrand School of Oral Health Sciences who were also working in private practice. Their feedback was obtained regarding the appropriateness and ease of understanding the questions and changes that were required were implemented.

## RESULTS

### Demographics

The 367 participants represented a response rate of 14%. Of these, 99% worked in the private sector, 8% worked in the public sector, and 1% in other areas (academia, governance or retired). Some participants worked in more than one sector. Of the participants who were involved

in managing a private practice (n = 365), the majority were owners (73%), 13% were associates, 9% were co-owners and 4% were either locums or had other roles.

The number of years in practice management (n = 362) were categorized into three groups, 0-4 yrs (n = 116, 32%), 5-15 yrs (n = 116, 32%), and >15 yrs (n = 132, 36%). The median was 10 years (IQR 3-23 years; range 0-58 years).

**Undergraduate Preparation for Practice Management**

The extent to which undergraduate training had prepared participants in various aspects of practice management is shown in Figure 1, which shows the extent of agreement or disagreement with each of 16 statements, ranked in order of decreasing agreement.

Participants agreed that their undergraduate training had prepared them in the areas of ethics, patient safety and patient relationships. There were mixed responses regarding the level of preparedness around time management, stress management and work delegation. However, there was agreement that undergraduate training had not prepared respondents for all other aspects of practice management.

**Undergraduate Practice Management Courses**

Fifty-six percent of the participants reported that they had no formal undergraduate practice management course. Of those who had a course, 68% took place in their final year of study. The courses varied in length: 78% were in one year of study, and 18% and 4% were over two and three years of study respectively.

Only 18% found their course to be useful, and 71% found it to be only slightly or not at all useful. Participants were able to comment on this and 64 responses were received: 70% (45) were negative, expressing varying degrees of inadequacy of the course(s) they had received, with comments varying from "Ineffective and useless" through "It didn't feel relevant to equip you in starting your own practice" to "If I remember correctly it was 5 x 60 minutes lectures. With the hindsight of 35 yrs I know that these presentations were a TOTAL waste of time". Ten of the comments did mention some positive aspects such as "Experience cannot be taught but the exposure to private practice was a boost"; "Gave me the basic understanding of management, but not detailed practical advice". It was clear, therefore, that amongst those prepared to comment, the experiences were mixed with by far the majority being negative. An associated question asked participants to reflect on the

**Figure 1. Level of agreement that undergraduate training had prepared the respondents in various aspects of practice management.**



usefulness of undergraduate training in light of their current experience. Analysis of these responses revealed that 106 (84%) felt that an undergraduate course was necessary, 105 (83%) felt their course was inadequate, and 26 (21%) made content suggestions. Seven respondents specifically suggested both under- and postgraduate courses were necessary. Suggestions for the content of such courses included the following:

- Private practice mentorship
- Finance management of a private practice
- Computer studies
- Control management
- Procurement
- Ethical conduct
- People management and interaction skills, business skills, marketing skills and investment skills
- Exposure to private practice during the undergraduate course

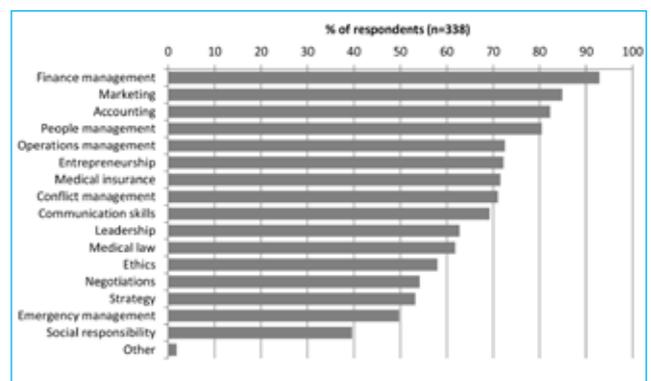
**Analysis of Postgraduate Training**

Only 29% (n = 97) of the respondents had formal postgraduate business/practice management training. The most common forms of training were Continuing Professional Development (CPD) courses in business/practice management (56%) and management/leadership seminars (45%). None of these courses was perceived as being particularly effective, but the management/leadership seminars and business school degrees were perhaps somewhat more effective than the rest.

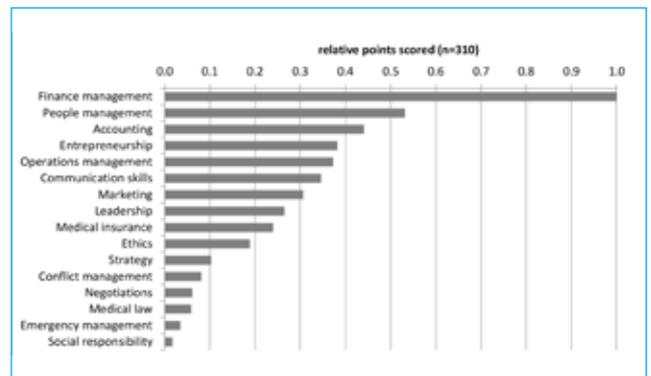
**Practice Management Course Recommendations**

The participants were given a list of all possible topics that could be included in a practice management course, and were asked to indicate the most important topics (Figure 2). They were then asked to rank the top three most important topics which should be included in a practice management course (n = 310) (Figure 3).

**Figure 2. Topics to be included in practice management courses**



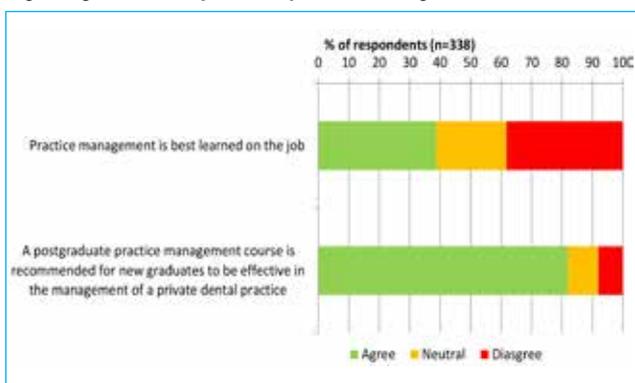
**Figure 3. Ranking of topics to be included in a practice management course**



**Acquisition of Practice Management Knowledge and Skills**  
The participants were asked to provide information regarding any help they had received in acquiring their knowledge and skills in practice management ( $n = 338$ ). The most common assistance was from an accountant/auditor (67%). In light of their experience, they were then asked their level of agreement to a series of options to best learn practice management knowledge and skills. The participants ( $n = 338$ ) were divided on whether practice management was best learned on the job, but strongly agreed that a postgraduate course was needed, and preferred this to on the job learning (Figure 4).

The participants were given an opportunity to freely make any other comments, and 53 responded. Although a few of these were merely to compliment the researcher on conducting

**Figure 4. Respondents' agreement/ disagreement on statements regarding the best way to learn practice management**



this survey,<sup>18</sup> were comments that were not very helpful or were irrelevant. There were some interesting observations such as "Someone should write a really good book for [local] conditions" and there were four comments suggesting that dentistry is a business first and should be taught as such, although this was countered by one impassioned plea for the opposite attitude.

## DISCUSSION

Almost all participants (99%) worked in the private sector. Most (73%) who were involved in the management of a practice were owners. The median number of years in practice management was 10. Young graduates are likely to stay on in the public sector following community service or to practice as a locum dentist under a more experienced dentist for a few years, gaining experience, before owning or managing a practice.<sup>1</sup>

The majority of participants agreed that what training they had received had prepared them in areas of ethics, patient safety and relationship building with patients. This is understandable as the curriculum in most dental schools is likely to place an emphasis on these aspects. There were mixed responses regarding the level of preparedness around time management, stress management and work delegation. Although these are all part of clinical dentistry, there was evidence that there was room for improvement in training these aspects. Overall, most participants agreed that their undergraduate training had not prepared them for most aspects of practice management. These results are similar to other studies<sup>2,11</sup> which found that the dental curriculum focused on developing skills during clinical education and it was only after graduation that dentists realized that there were many other aspects of practice management that needed development.

In a South African study<sup>4</sup> dental students perceived non-clinical skills pertaining to ethics and professionalism as least important; in this study, these were the aspects that participants reported their undergraduate programme had prepared them the most for. These results are also in agreement with studies where dentists and dental students alike, perceived their undergraduate curriculum to be lacking in non-clinical training in business/practice management.<sup>1,2,5,6,11</sup>

Whilst 34% of respondents did have a formal practice management course, 71% of these found their course to have been only slightly useful or not at all useful. However, 10% did experience the course(s) to be helpful in some aspects.

In a U.S. study,<sup>2</sup> dental graduates suggested that practice management courses should be introduced in the earlier years of the curriculum and be continuous throughout, and also suggested collaboration with Business Schools. Another study,<sup>11</sup> when proposing a dual dental/medical-MBA course, found that 63% of students would enroll in such a course. In this study, the majority of participants received such training in the final years and 78% reported that the course was only during one year of study. Interestingly, 86% of the participants felt that courses should be offered at both the undergraduate and postgraduate levels, while only 10% and 4% felt the course should be offered only at the undergraduate or postgraduate level, respectively. Content suggestions made by participants coincided with the perceived lack of preparation in several aspects of practice management as well as the recommendations for what topics should be included.

Participants in several studies recommended postgraduate training to overcome the lack of time in the undergraduate curriculum.<sup>1,2,5,7</sup> Although the majority of the participants in this study recommended postgraduate training in addition to undergraduate training, only 29% reported having pursued some form of postgraduate training. The most common forms were CPD courses in business/practice management (56%) and management / leadership seminars (45%). None of the postgraduate courses attended by participants in this study were perceived to be effective, although the management/leadership seminars and business school degrees were perceived as being slightly more effective than the others. Certificate and CPD courses in business/practice management and diplomas at business school were not as effective. The least effective included online management/leadership courses, distance learning and diplomas in business/practice management. A reason for this could be that the courses are not in context or tailor-made to dental professionals.

Content suggestions made by participants coincided with their perceived lack of preparation in several aspects of practice management. The majority of participants indicated finance management, marketing, accounting and people management as being the most important topics. Topics such as entrepreneurship, operations management, communication skills, leadership, medical insurance and ethics had less importance. Least important were topics such as strategy, conflict management, negotiations, medical law, emergency management and social responsibility. Other topics suggested, which were not listed, included time management, stress management, tax, labor relations and dental software. These findings correlated with the participants' reports

concerning their inadequate preparation to manage the finances of a practice, to market their practice or to manage the performance of their employees.

The results of this study are in agreement with those of Barber *et al.*<sup>2</sup> where the largest area of concern for dentists was accounting, finance, human resources and dental insurance. A study in South Africa<sup>14</sup> also found dentists to lack finance management skills and recommended that universities include a finance management course for undergraduate dental studies.

Studies have shown that dentists have to seek help to gain business management knowledge and skills or to assist them in managing some aspect of their practice.<sup>2,5,7</sup> Two-thirds of the participants (67%) commonly used the assistance of an accountant/auditor to acquire business management knowledge and skills. Just over 50% relied on their colleagues. Participants also commonly used financial advisors, friends, family members, lawyers and mentors. Management consultants and business coaches were the least likely to be called upon.

Experience alone was considered insufficient to gain the skills to manage a practice and hence a postgraduate course was recommended over learning on the job. These findings were also in agreement with those of Barber *et al.*<sup>2</sup> who found that practice management skills can take five to 10 years or more to gain experientially and recommended that these skills should not be learned on the job, but rather interventions are needed to close the gap between graduates' knowledge and practice.

Without changes to the undergraduate curriculum to include or improve courses on dental practice management, dentists in South Africa will not be prepared to manage a practice in many aspects. Postgraduate practice management courses can be useful to expand on the knowledge and skills developed in undergraduate training as well as to be applied to experience in private practice. It is therefore recommended that all South African dental schools should include courses in dental practice management throughout the undergraduate curriculum, and that it would be preferable to offer such courses together with the University's business school. In addition, South African dental schools, business schools, and private companies should offer postgraduate courses on practice management to expand on the undergraduate curriculum, and the content and delivery of such courses should be continually reviewed, and tailored to dental practice management requirements.

### Limitations

The response rate was poor, such that only large effect sizes would be detected as direct statistically significant associations. Nevertheless, results of such a study are extremely useful and are likely to be broadly representative of the opinions of the wider population of dentists, especially in light of the agreements with other studies both in South Africa and internationally.

### CONCLUSIONS

Under the conditions and limitations of this study the following conclusions can be drawn:

- The current undergraduate curriculum in South African

Dental Schools is not effective in preparing graduate dentists in most aspects of non-clinical practice management.

- The majority of dentists in private practice in South Africa are unlikely to have had a practice management course during their undergraduate training.
- Of those dentists who did have an undergraduate practice management course, the majority did not find the course at all effective, and most experienced it during only one year of study.
- The most common form of postgraduate training attended by dentists was continuing education courses in business/practice management and management/leadership seminars.
- Most forms of postgraduate training were found to be not relevant to a dental practice.
- The majority of respondents recommended that a practice management course should be offered throughout the undergraduate curriculum, as well as at postgraduate level.
- The most important topics recommended to be included in a practice management course were finance management, accounting, marketing and people management.
- The majority of respondents required the help of an accountant, a colleague and a financial advisor to acquire business/practice management knowledge and skills.
- The majority of dentists suggested postgraduate training would be more valuable to gain management knowledge and skills rather than on-the-job-learning.

### ACKNOWLEDGEMENTS

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# Criteria that must be considered in order to optimise the success of computer aided designed and computer aided manufactured (CAD/CAM) restorations

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## ABSTRACT

Several factors influence the success or failure of ceramic dental restorations, and need to be considered and understood prior to embarking on these restorations. It is incumbent on the clinician to have an in-depth knowledge on the science of ceramic materials, current bonding agents and techniques, understanding and working proficiency of computer aided design and computer aided manufacture (CAD/CAM) computer hardware and software, an appreciation of oral biology, the role of occlusion and occlusal schemes, as well as recognition and management of patients with parafunctional habits. This paper will cover the principles of cavity preparation and tooth preparation designs, maintenance and / or achievement of inter-arch stability, preservation of marginal integrity, provision of occlusal stability, and digital impression techniques required to optimise accuracy. Provision of a chairside manufactured CAD/CAM dental restoration requires dentists to perform both the clinical and the laboratory aspects of the procedure. The responsibility for the quality of the final restoration thus rests in their hands alone and it is their duty to ensure they are adequately trained and skilled in all aspects of CAD/CAM if they wish to make it part of their practices.

## INTRODUCTION

Since the introduction of the CEREC® I system in 1987, CAD/CAM manufactured dental restorations have become a large component of many modern dental practices. However, the success of these procedures is dependent on the expertise, knowledge and skills of the operator. There are a number of factors that contribute to their quality, clinical acceptability and long term durability. These include:

1. Cavity preparation / tooth preparation design
2. Inter-arch stability
3. Marginal integrity
4. Occlusal stability
5. Digital impression accuracy

### 1. Cavity preparation and tooth preparation design

"The benefits of a smooth, crisp, cavity preparation for CEREC® restorations cannot be overstated. Excellent CEREC® restorations are the result of excellent preparations." - Prof. Dennis Fasbinder (personal communication).

The tooth preparation or cavity design criteria that must be considered in order to optimise the success of CAD/CAM restorations can be divided into 3 main categories:

- 1.1 General preparation guidelines.
- 1.2 System (hardware) guidelines.
- 1.3 Material guidelines.

### 1.4 General preparation guidelines

In all CAD/CAM preparations there are key design principles that have to be adhered to. The margins must be precise, well-defined, rounded and clearly visible, and there must be even tooth reduction. The amount of reduction will then be dictated by the:

- Preparation type (Crown, Inlay/Onlay, Veneer, Implant)
- Restorative material to be used
- Minimal thickness needed for the material and restoration type
- Preparation form and shape
- Surface that is being bonded to
- Adhesive luting material and procedure
- Occlusion and presence of other parafunctional habits<sup>1</sup>

Prior to embarking on the preparation for bonded restorations the clinician needs to consider the durability of the tooth to be restored, and conduct a biomechanical analysis before and during the cutting.<sup>1</sup> The CAD/CAM tooth preparations must ensure that there are smooth flat surfaces, few retentive features, minimal taper (3° to 6° degrees), visible round internal angles and a large modified shoulder to allow the milling machine burs to reproduce these features accurately. Minimal invasive tooth preparations are desired, however biomechanical analyses may dictate the need to reduce or remove unsupported tooth structure / cusps, and areas with doubtful stability.<sup>1</sup> Ahlers et al<sup>5</sup> and Arnetzl and Arnetzl<sup>2,3,4</sup> have described 8 guidelines to follow when preparing teeth for bonded all-ceramic restorations.

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Figure 1. J-Lipping



Figure 2. Knife edge



Figure 3. Shoulder



Figure 4. Chamfer

(Images courtesy of Dr. SL van Reede van Oudtshoorn)

- Keep the basic geometry simple. The ideal tooth preparation should have dentine that is still surrounded by enamel.
- There must be an appropriate and uniform thickness of reduction to ensure the same thickness of the restoration (minimum 1.5-2mm).<sup>1</sup>
- There must not be any corners or sharp edges, and aim for soft transitions between concavities and convexities.
- Avoid tensile stresses and try transform tensile stresses to compressive strengths by changing the preparation design.
- Stress peaks and sudden changes in cross-section should be avoided by providing soft and smooth transitions.
- Minimize notch stresses.
- Aim to create as large as possible contact surface with the ceramic restoration.
- Strive to end restorations in enamel whenever possible.<sup>2-5</sup>

Consideration of cusp retention will need to take into account aesthetic and functional concerns. They should be retained when there is enough tooth cusp material to support occlusal forces, and will not flex during mastication. The decision will be guided by performing a biomechanical analysis of anticipated forces and loading on the tooth before and during the tooth preparation, and evaluating the tooth during latero-trusive movements.<sup>1</sup> Crowns on endodontically treated teeth are prepared by removing the undercuts in the pulp chamber allowing the endodontic cavity and the pulp chamber to become continuous.<sup>8,9</sup> The success rate of endocrowns made by CEREC® III and Vita Mk II in a CAD/CAM system spanning 12 years and 55 patients was reported to be 90.5% for molars and 75% for premolars.<sup>8,9</sup>

Sectioning the enamel prisms obliquely will result in enamel being supported by dentin due to stresses that will be relocated.<sup>1</sup> A non-retentive tooth preparation is recommended as part of the above described concept, resulting in a favourable biomechanical loading of the bonded restoration-cement-tooth complex.<sup>1</sup>

There is no consensus on the optimal internal cement space (Spacer) for adhesively luted ceramic restorations. While most agree that the cement layer (occlusal and radial spacer) needs to be as small as possible,<sup>1</sup> there is no consensus on the optimal internal cement space.<sup>1</sup> Greater or larger resin cement film thickness decreases the bond strength of the core material to lithium disilicate ceramics.<sup>6</sup> Gianfranco Politano *et al* (2018) advocated a space of between 50-100 µm.<sup>1</sup>

However, although the suggested factory setting in the CEREC® system is 120 µm, and others have even recommended a larger spacer setting of 200 µm.<sup>6</sup> They report this will result in a better fit, but has a higher risk for malpositioning during

cementation and negligibly thinner porcelain. For onlays/inlays with a recommendations are 1.5mm occlusal thickness, a spacer of 100 µm is proposed<sup>14</sup>, as larger spaces will result in more polymerization shrinkage. In addition, the bond strength of composite cements to glass ceramics decreases with increased cement film thickness.<sup>1,7</sup> The final preparation of the enamel is then carried out after application of immediate dentine sealing (IDS).

A recap of factors to consider when examining the CAD/CAM tooth preparation and prior to scanning:

- Ensure strict isolation and gingival retraction if necessary
- Walls should have a 6°-8° taper
- Rounded internal line angles, with smooth crisp margins and no bevels. Shoulders should be 90° and chamfers 90°-130° (Figures 1- 4 illustrate various margin designs)
- Adequate tooth reduction in all dimensions

Both the J-lipping finish (Figure 1) and knife edges (Figure 2) are unsuitable for all-ceramic crowns, because a correct, anatomical contour cannot be constructed.<sup>15</sup> Both shoulders (Figure 1C) and Chamfers (Figure 1D) are preferred, however the stress distribution for chamfers is larger near the marginal line, which is one of their biggest disadvantages.<sup>15</sup>

Rocca *et al* (2015)<sup>9</sup> described the following clinical step-by-step protocol for the cavity preparation of bonded indirect restorations:

1. Apply local anaesthesia.
2. Check occlusal contact and aesthetic needs of the tooth (Authors comment: The occlusion should be checked with the patient in an upright position before administering the local anaesthetic. Occlusion in an upright position could differ from a supine position and the local anaesthetic could influence the bite registration.)
3. Proper shade selection.
4. Remove unsound restorations, excavate caries and prepare the cavity, but do not finish the margins at this stage.
5. Check inter-occlusal space in centric and during lateral movements.
6. Isolate the cavity with rubber dam and in cases with subgingival margins, place a metal matrix band.
7. Apply a dual bonding (DB) / immediate dentin sealing (IDS) agent and seal all of the dentin with the adhesive system following manufacturer's instructions. This procedure must also include any thin subgingival margins.
8. Light-cure bonding resins for 20 seconds.
9. Cavity Design Optimization (CDO) and Cervical Margin Relocation (CMR). This is achieved by applying a layer of composite resin to cover the dentin, fill retention grooves and relocate margins supragingivally if necessary. Light-cure each increment of composite resin for 40 seconds

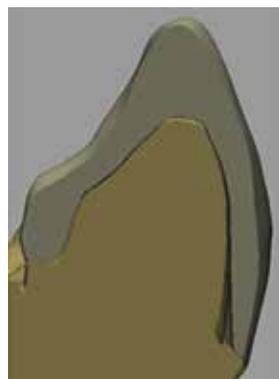
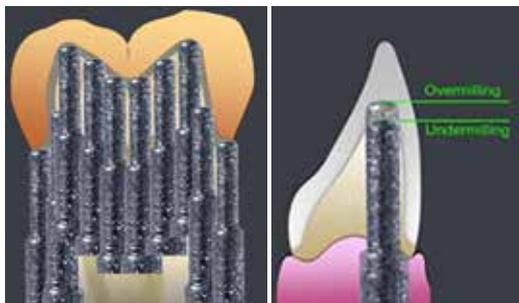
before adding successional layers. (Authors note: CMR does not meet the criteria of a solid shoulder that needs to absorb the compressive forces, and may compromise durability of the tooth and / or restoration.)

10. Isolate the cavity with a layer-forming glycerine gel, and light cure this again for 10 seconds.
11. Finally finish the enamel and / or composite margins with fine diamond burs, but do not expose dentin during this stage.
12. Re-check the cavity to confirm: Detailed clear margins; absence of undercuts; accessibility of supragingival margins; absence of contact between the cavity and the adjacent teeth and adequate interocclusal space in centric and during lateral movements (this can only be done after rubber dam removal).
13. The digital impression can then be taken and the restoration designed and fabricated.

### 1.2 System (hardware) guidelines

The CEREC® step-burs mill the fitting surface of the ceramic blocks to correspond to the prepared tooth surface. There are 3 burs available with diameters of 0.85mm, 1.0mm, and an ultra-fine bur with diameter of 0.3mm. Figure 5 illustrates the path of movement the bur follows when grinding (cutting) the internal surfaces for crowns.

**Figure 5. Internal milling process (Illustrations courtesy of Sirona and Dr. SL van Reede van Oudthoorn) The software and machine set-up will not allow the burs to mill undercut areas and over milling will take place, weakening the restoration (Figure 6).**



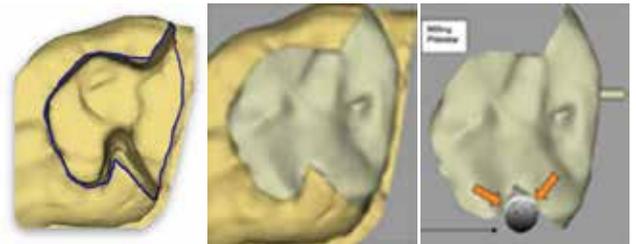
**Figure 6. Crown preparation with undercuts and resulting overmilled restoration (Illustration courtesy of Sirona)**

The Step bur has a 3° taper increase after every step of the bur, these being 4mm apart (Figure 7). This configuration results in formation of convergence angles of 3° - 4° after the first 4mm preparation height and a further 3° - 4° for the next 4mm preparation height

Any corners within the preparation need to have a diameter large enough to accommodate the 0.85mm and 1.0mm burs. Sharp corners, or those with diameters less than 1.0mm will either not be milled or will be undermilled, leading to restorations that do not fit properly (Figure 8).



**Figure 7. Step bur with spaced taper and resulting preparation configuration. (Illustrations courtesy of Sirona)**



**Figure 8. Undermilling of areas with tight corners (Illustrations courtesy of Sirona)**

### 1.2 Material guidelines

Material type and preparation design influences the incidence of tooth fracture.<sup>10</sup> Restorations grinded from feldspathic porcelain are weaker than restorations made of glass-ceramic or resin-composite materials.<sup>10</sup> Material guidelines provide clinicians with parameters of minimal reduction required to ensure adequate material thickness for any given restoration design and material type.

Dejak *et al* (2020)<sup>15</sup> compared the strength of thin walled molar crowns made of various materials, including zirconia, porcelain, gold and composite crowns. Simulated mastication, analysing contact stresses at the adhesive interface between the cement and tooth structure under the crowns were analyzed.<sup>15</sup>

The results found were:

- Equivalent stresses in the crowns, did not exceed the tensile strength of their material.
- The modified von Mises (mvM) failure criterion is used to evaluate the strength of materials under compound stress states.<sup>15</sup> (The criterion considers the ratio between the compressive and tensile strength).
- Stresses in resin cement under Zirconia crown were 1.3 MPa. Under composite crowns 6 times higher.<sup>15</sup>
- Tensile and shear contact stress under stiffer crowns (ceramics and gold) are several times lower than under composite crowns.<sup>15</sup>
- The higher the elastic modulus of the crown material, the higher the values were of the equivalent mvM stresses in prosthetic crowns.<sup>15</sup>
- In the zirconia crown the highest stress value (51.5 MPa) was observed under the distobuccal cusp.<sup>15</sup>
- In the porcelain crown the maximum stresses concentrated on the same area although their value did not surpass 35.2MPa.<sup>15</sup>
- Under composite crowns the mvM stresses reached the value of 11.4 MPa.in the central groove.<sup>15</sup>
- In the cervical area mvM stresses were several times lower than on the occlusal surface.<sup>15</sup>
- The equivalent stresses in the crowns were 14.5 times lower than the tensile strength of Zirconia-based ceramics.

The maximum mvM stresses in the tooth structure for the zirconia crown were only 2.8 MPa, compared to that for the composite crowns were 6.4 MPa. The higher the elastic modulus of the crown, the lower the equivalent stresses in the composite luting cement and in the tooth structures. Also contact stresses decreased with the increasing stiffness of the crowns.<sup>15</sup>

Zirconia is a rigid material with little or no elastic deformation. Crowns made from this material have a high modulus of elasticity (MOE), allowing any compressive forces to be directed towards the margins /shoulders. In contrast, resin crowns are more elastic with a lower MOE allowing compressive forces to be directed towards the underlying cement, resulting in an increased risk for debonding. Finite element analysis of masticatory forces suggest that the majority of compressive forces are transferred to the shoulder areas on the crowns, and as such a shoulder marginal preparation is advocated in order to provide a large enough surface area to absorb these. A rounded shoulder is particularly suitable for the telescopic crown technique with all-ceramic primary copings.<sup>15</sup>

## 2. Inter-arch stability

The position of the teeth in the dental arch is determined by the size of the teeth and the amount of space available to accommodate them. Discrepancies between the mesio-distal tooth widths, and arch dimensions may be associated with tooth positional nonconformities. The size and shape of the teeth with respect to their dental arches can have implications in treatment planning and prosthetic reconstruction, as it affects the space available, dental aesthetics, and stability of the dentition. The 2 main factors accountable for dental crowding are teeth with increased mesio-distal dimensions in mouths with decreased dental arch sizes. These are factors to consider when deciding if orthodontic treatment is necessary, and whether conservative inter-dental stripping and crown recontouring would suffice, or if more invasive extraction and / or banding and / or surgical regimes are needed.<sup>21</sup> Many cases illustrate that crowded arches have larger teeth than the normal arches and that smaller teeth, in particular mandibular incisors may be responsible for dental spacing. Furthermore, both the mesio-distal and bucco-lingual dimensions can affect dental alignment.

Crown dimensions of permanent teeth in young men with good occlusions were compared with those in persons requiring orthodontic treatment. Results showed that tooth crown dimensions (MD as well as BL) were significantly larger in subjects with malocclusions and crowded arches than in those with good occlusion. It was interesting that only the maxillary first molars, canines, and mandibular incisors were found to be different and statistically significant.<sup>21</sup> Differences in the tooth and arch dimensions are associated with dental arch discrepancies and has implications in both restorative diagnosis and treatment planning, and must be considered when deciding on the most suitable treatment option.

Correct proximal contours and a well designed and constructed contact point is important with regards to inter-arch stability, and the success of class II restorations. Ideally there should be a tight contact area at a distance of approximately 5mm from alveolar crest, or in the area of the height of contour of the tooth.<sup>21</sup> Resin composite restorations show looser proximal contacts than amalgam regardless of whether a high viscosity or medium viscosity composite was used. Indirect restorations manufactured with CAD/CAM

have a better potential for generating anatomic forms and ensuring the points are in the correct position, of the desired size and generate the recommended force on the adjacent teeth.<sup>12</sup> Indirect CAD/CAM manufactured restorations have a better potential for generating anatomic forms, compared to direct resin composites, amalgam and even high viscosity composites.<sup>11</sup>

### Constructing a contact point with the CEREC® system.

The manufacturers recommend use of the Equalizing method (hand polishing) method to create the ideal contact area. Before beginning, the clinician needs to know and understand the colour configurations involved in the construction of the contact points, and decide which amount of force is needed for each situation.

#### Note:

- **Red:** Represents a distance of 100 µm + into the neighbouring tooth.
- **Yellow:** Represents a distance of 50 to 99 µm into the neighbouring tooth.
- **Green:** Represents a distance of 1 to 49 µm into the neighbouring tooth.
- **Blue:** Represents a distance of 1 to 25 µm away from the neighbouring tooth. (The same values apply to the occlusal contacts).
- Two factors need to be considered when constructing the contact point.

They are:

- The system parameter setting. (Factory setting 25 µm)
- The colour configuration. The interface of two colours, yellow with red disappearing when digitally polished (interface approximately 99-100 µm or yellow disappearing on a green background. (interface approximately 49-50 µm)
- On the interface of two colours the operator can predict the distance into the neighbouring tooth accurately compared to a one colour which is unpredictable because the colour spans a distance of 50 µm.

The recommended interface of two colours is yellow disappearing on a green background. This value might differ between systems. It is therefore important to understand the colour configuration values and set the system contact point strength values accordingly.

Steps to follow when constructing a contact point:

1. View the virtual model with restoration proposal from the occlusal aspect (Figure 9). Establish whether the bucco-palatal contour is convex. The distal aspect is convex whereas the mesial aspect is more flat. (Figure 9).
2. View the virtual model from the buccal side (Figure 10) and establish if the gingival-occlusal contour is convex.
3. View the restoration proposal from the mesial aspect. (Figure 11) Polish the whole area with Form tool / Smooth to create a convex contact area viewed from the buccal as well as from the occlusal (Figure 12).

The restoration proposal with the mesial and distal surfaces convex and smooth, however the mesial contact is open and needs to be corrected (Figures 13 ).

4. Once the required size of the contact has been decided upon the virtual model can be set at a 45° angle (Figure 15) and the area drawn out until the desired size is attained

Figure 9. Occlusal view of a mandibular molar.

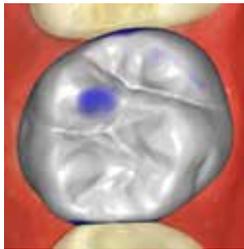


Figure 10. Buccal view of mandibular molar.

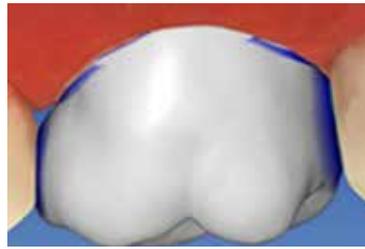


Figure 11. Unpolished mesial aspect.

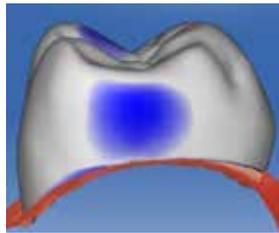


Figure 12. Polished convex mesial aspect.

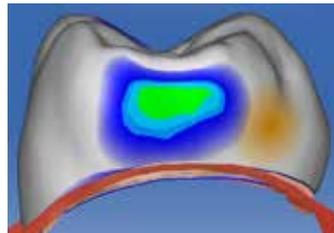


Figure 13. Polished surfaces with open mesial contact

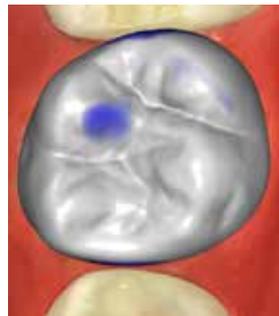


Figure 14. Restoration proposal and virtual model tilted 45°

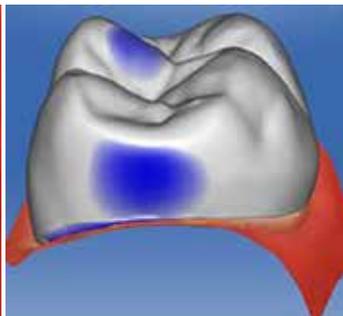


Figure 15. Contact area built out.

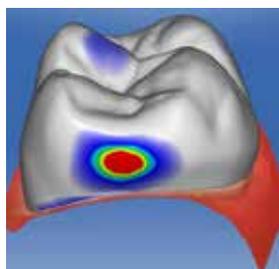
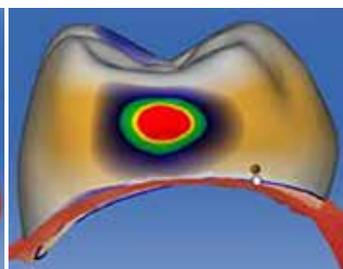


Figure 16. Shape anatomically activated.



- Final polishing is performed by turning the proposed restoration and virtual model so that it can be viewed directly from the mesial aspect. The surface is polished with the Form polishing tool on the red areas beginning at the gingival aspect and moving upwards to the occlusal aspect. (Figure 18). Note that the size that the polishing tool should be set smaller than the area to be polished (red in this case). The bucco-palatal and the gingival-occlusal dimension of the contact point must remain the same size after the polishing (Figures 18-20).

Figure 17. Red contact area to be reduced.

Figure 18. Yellow area remaining after reduction of the red area.

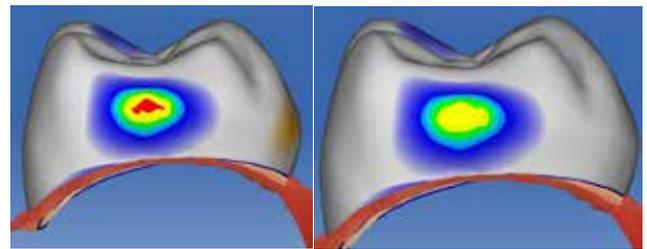


Figure 19. Yellow contact area being polished.

Figure 20. Green contact area with a small dot of yellow in the centre.

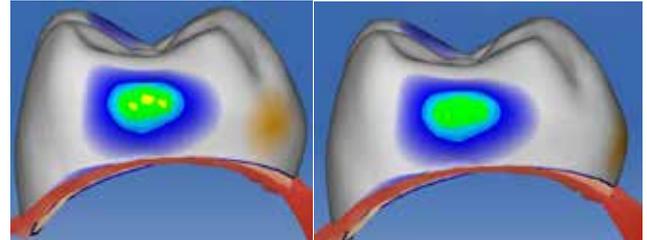
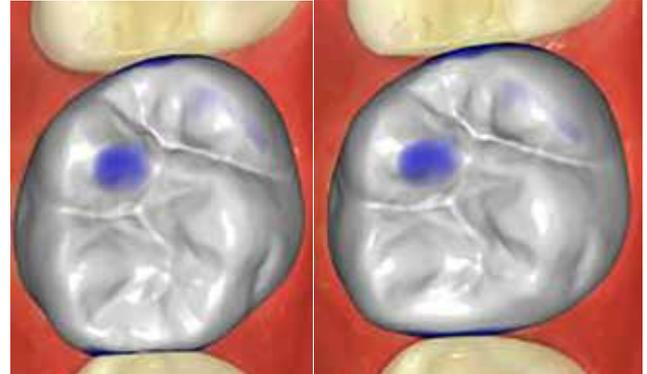


Figure 21. Crown design before correcting the contact point.

Figure 22. Crown after correction.



and the surface is convex. This final shape is attained by utilizing the Shape Anatomical tool, digitally manipulating the restoration proposal into the neighboring tooth (Figure 16). **Note:** The yellow band in the middle of the restoration indicates the Shape Anatomical tool activated the middle third of the restoration. The Shape Anatomical tool is a medium management tool.

- The yellow area is then polished until it has almost disappeared (Figure 19) and there is a smooth interface between the next two colours. The principal contact area is green with a small dot of yellow indicating a colour interface representing a distance of 49-51µm (Figure 20). The bucco-palatal dimension as well as the gingival-occlusal dimension has stayed the same.

### 3. Marginal integrity

Poor marginal fit will allow degradation of the cement in the oral environment, resulting in micro leakage, marginal discoloration, recurrent caries and periodontal disease.<sup>1</sup> In addition, increased marginal discrepancy MD values reduce the fracture resistance of the crown and the veneering porcelain. There is no clear scientific evidence or general consensus on the maximum clinically acceptable MD, with suggested values ranging between 50 µm and 200 µm, but in theory it should be small enough to prevent ingress of saliva and/or lactic acid, the by-product of bacterial metabolism. According to Kramer et al, restorations with marginal discrepancies in the region of 100 µm are clinically acceptable,<sup>13</sup>

The marginal gap (discrepancy) for the CEREC® I system that was first introduced in the 1980's was approximately 300 µm, but this was refined and improved in CEREC® II to be 200 µm. Currently, the clinical goal for a cemented restoration is a MD value ranging 25 µm to 40 µm.<sup>13</sup> CAD/CAM manufacturers aim to produce dental restorations within these values. The comparison between CAD/CAM technology and traditional

fabrication processes with respect to marginal adaptation has been extensively studied.<sup>13</sup> A point to remember is that milling machines are not able to produce the contour of the restoration in areas that are smaller than the diameter of the milling burs.<sup>13</sup>

The marginal adaptation of indirect restorations is affected by preparation design, impression technique and thickness of the luting agent.<sup>13</sup> In the early days of CAD/CAM, impressions were taken using polyether materials as these had performed well since the middle 1960's. Their main advantages include a relatively fast chair side setting time, good flow and detail reproduction, high Modulus of Elasticity (MOE), and hydrophilic.<sup>14</sup> Despite these favourable characteristics, there were still many other factors that could cause distortion of the models, including operator's ability and impression technique, temperature variations, movement during setting period, laboratory handling of the impressions, cast pouring procedures and gypsum expansion.<sup>14</sup> Digital scanning overcame many of the complications associated with conventional impression taking. They were not superior to conventional impressions when comparing reliability, accuracy and detailed reproduction, but do have the advantage of reduced clinical chairside time, patient and operator preference and improved patient comfort.<sup>14</sup>

The preparation margin must ideally be located in enamel to ensure long term stability to the large dentin adhesive surface.<sup>1</sup> Restoration margin exposed to occlusal wear can result in extensive marginal discrepancies, especially in partial crowns that do not cap all cusps. It is imperative that the fit and adaptation at the occlusal surface is near to perfect with the luting marginal gap being as small as possible.<sup>1</sup> (The CEREC® factory setting for this value is programmed on 60µm and is referred to as the "holy zone" that represents the first 400µm from the preparation margin inwards.)

Onlay preparations designed with a modified shoulder provides a better marginal adaptation compared to flat cuspal reduction. The presence of lipped finishing lines and spikes on finishing lines may cause problems in the adaptation of CAD/CAM crowns and therefore the margins and internal line angles should be carefully evaluated and sharp angles eliminated.<sup>14</sup>

In Figure 23, tooth 46 onlay has a shoulder preparation of approximately 1.0mm and margins that are smooth due to the use of an oscillating blade with 50µm grid. The 4 mandibular anteriors in Figure 24 were prepared with a shoulder of 1.0mm lingually preserving as much enamel as possible, and a deep chamfer of 1.0mm labially. Tooth 11 in Figure 25 was also prepared with a shoulder of 1.0mm lingually for enamel

preservation, and a deep chamfer of 1.0mm labially. The crown height was >4mm.

#### 4. Occlusal stability

Occlusal functional stresses are responsible for the inherent vulnerability of ceramic restorations and need to be compensated for by having a thicker restorative layer occlusally, as well as use of the correct adhesive bonding system.<sup>10</sup> This often entails sacrificing enamel and dentin thereby weakening the tooth structure.<sup>10</sup> Thicker overlay restorations are stronger and have higher static fracture strength than the more conservative ones. However this comes with a biological cost, as they also display an increased incidence of failures, which are generally more dramatic and irreversible due to the thinner and weaker dental tissues underneath them.<sup>10</sup> Minimal occlusal restorative thickness required depends on the intrinsic mechanical features (static and dynamic reaction to stress) of each different material, and is brand dependant.<sup>10</sup> It is recommended to have at least 2mm occlusal reduction for lower strength ceramics (Vita MK II) and 1-1.2 mm for higher strength ceramics.(IPS e-max CAD).<sup>10</sup> These dimensions are limited to monolithic ceramic restorations as layering could result in including imperfections that weaken the material.<sup>10</sup>

Occlusal coverage is recommended for cavity walls of 1mm or thinner, while for those with an "intermediate thickness" (1-2mm), the occlusal factors such as tooth position, presence of para-functional habits and lateral guidance (canine or group guidance) should guide the final decision.<sup>10</sup>

The presence or absence of marginal ridges can also play a role in the final strength of the residual wall, especially in endodontically treated teeth.<sup>10</sup> When designing the crown form, the clinician may use the correlation method or the dental database (library) method.

- Correlation method. An optical impression of the tooth is taken prior to preparation of the tooth. The software copies the pre-operative image and final restoration proposal will then be a copy of the unprepared tooth.
- Dental database (library method). The software extrapolates information from the teeth captured in the optical impression, mesial and distal from the prepared tooth. A proposal of the restoration will then be digitally constructed. In the case of inlays/onlays, the software of the system utilizes the information of remaining unprepared tooth structure to digitally construct and propose the restoration. CAD/CAM crowns designed using the correlation method are easier and more accurate to fabricate and have better occlusal relationships than those designed using the library method, especially at the initial fit.<sup>17</sup> They also had relative occlusal force (ROF) that were higher than that of crowns designed using the

Figure 23. Tooth 46 with 1mm margin



Figure 24. Teeth with 1mm lingual margin



Figure 25. Anterior crown shoulder preparation.



library method and correlated positively with the force of the tooth before preparation.<sup>17</sup>

### 5. Digital impression accuracy

Conventional Poly Vinyl Siloxane (PVS) impressions and gypsum dies have inherent problems and varying degrees of accuracy due to the many factors described in point 3 above.<sup>22</sup> Digital scanning of tooth preparations offered clinicians a faster, more user friendly and reportedly more accurate alternative, even when highly accurate impression materials were used.<sup>20</sup> The precision of digital impressions continues to develop and improve with each new scanner that comes onto the market. For example the new CEREC® Bluecam camera can record details of as fine as 19 µm in single-tooth images, while quadrant images can be taken with accuracy of approximately 35 µm. The newer devices are also more user friendly as they have a built-in shake detection in the automatic capture mode. While technology has certainly aided clinicians, the quality of the optical impressions (scans) and the images obtained depends on the operator's experience, complexity of the preparation design, position of the teeth and gingival margins, as well as the compliance of the patient.<sup>14</sup>

Most digital impression systems can record full dental arches,<sup>19</sup> but show a higher local deviation of the dental arch compared to conventional impression methods.<sup>19</sup> Errors increase in the transition from a single crown to partial prosthesis up to a full arch scan.<sup>21</sup> Fortunately full arch digital impressions are not regularly required in dental practice where the majority of cases involve sections of the arch with a limited number of preparations. There are also notable differences in accuracy between different scanners and systems and clinicians need to take cognisance of this and study peer reviewed scientific papers on each before purchasing this costly equipment. Studies have shown significant differences in terms of scan time and number of images captured per scan, between default resolution and high resolution in terms of accuracy on the crown preparation cavo-surface finish line, and depending on the tooth surface, with the distal surface demonstrating the lowest accuracy.<sup>17</sup>

The high-resolution mode of the software obtains more data over a longer time (increased scanning time), but does not benefit scan accuracy.<sup>16</sup> Tooth preparation and surface parameters do affect accuracy.<sup>16</sup> Crown preparation quality as measured by tooth surface smoothness has an effect on CAD/CAM-fabricated crowns, the scanner does not.<sup>16</sup>

Indirect digital scanning techniques present a smaller marginal discrepancy compared to direct scanning techniques.<sup>14</sup> Digitizing conventional impressions with extroral scanner is not more accurate than direct intraoral scanning.<sup>18</sup>

## CONCLUSION

Provision of a chairside manufactured CAD/CAM dental restoration requires dentists to perform both the clinical and the laboratory aspects of the procedure. The responsibility for the quality of the final restoration thus rests in their hands alone and it is their duty to ensure they are adequately trained and skilled in all aspects of CAD/CAM if they wish to make it part of their practices.

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# An evidence-based guide to occlusion and articulation. *Part 4: Unworn dentitions*

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## SUMMARY AND PREAMBLE TO THE SERIES

Although this is essentially a review, it has not been written in the passive, third-person style normally associated with scientific writing, as it is intended to be thought-provoking and, hopefully, educational. It has therefore been written in more of a conversational style, and is aimed at students, dentists and dental technicians who are receptive to a slightly different view of occlusion and articulation, based on evidence.

Occlusion is a topic that has become a kind of archaic minefield of conflicting ideas, propositions, and above all, solutions, most of which are based on a complete lack of understanding of the evolution and development of teeth, and by extension, of clinically objective evidence.

That in itself is a statement of conflict (and perhaps even heretical), but it is by way of warning that this guide is not going to be much like anything you will find in standard text-books of dentistry or dental technology. It is, rather, an attempt to help you navigate through what you will read elsewhere, in the hope that eventually you will find an understanding that you can live with. It will appear as a sequential series in 7 Parts.

### Unworn dentitions

So now we must turn to unworn dentitions which nearly all of us have, with the exception of some aboriginal populations. The question is, What scheme do we follow? Do we deliberately set out to grind the teeth and create artificially what nature used to create naturally? Well, apart from my somewhat tongue-in-cheek suggestion to give teenagers chewing gum with carborundum paste,<sup>1</sup> clearly that would be absurd and (probably) unnecessary.

So first, we have to find out what all this analysis over the years of our unworn dentitions has revealed, because (a) we may want to change tooth positions if they have erupted with some difficulty in jaws that cannot accommodate them all neatly and (b) we may need to replace parts or all of some teeth or even all of them. This means that observations of the static relationships

of unworn dentitions can have value, but as we shall see, will be a problem if misinterpreted and not looked at functionally. It is often this misinterpretation that gave rise to certain dogmas for which it appeared later, there was no evidence.

The discussion in Part 3 was concerned with where and how to place teeth in complete dentures so that they will not only be in harmony with the movements and functions of the mandible, but more importantly will assist in stabilising the dentures in function and parafunction. In the naturally wearing dentition, the eruption of teeth at different times helps this harmony with movement, by producing wear of cusps that might *interfere* with the movements of chewing (and grinding, and parafunction). Initially, the cusps are steep, with the canine cusp angles being the steepest (it is effectively a single cusp, hence the term 'cuspid' is more apt, to distinguish it from the premolars, or 'bicuspid'), followed by the premolars and then the molars. So when moving sideways, the contacts on the canines provide some protection for the erupting premolars and second and third molars. As wear occurs and continues, wear on the canines creates contacts on the posterior teeth in all phases of chewing, and the chewing load is spread throughout the arch, producing not only stability, but a more axial direction of forces, all of which is just what the system is set up to do.

If there is no such wear, however, then observations of which teeth contact and when, have given rise to two main theories of tooth contact when chewing: anterior and canine 'disclusion' and group function. These terms are merely from the observation that in order to incise, i.e. use our teeth as cutting tools, the jaw needs to move forwards and in doing so, it might be useful not to have any other teeth interfere with moving the mandibular incisors against the maxillary ones. Without food, a forward movement of the mandible results in the anterior teeth contacting, and *discluding* the posterior teeth. When moving the jaw sideways, the steeper inclines of the canines do the same, and disclude the posterior teeth.

This presupposes of course, that the canines *are* the steeper inclines, and that there is no wear, and that we all have the same morphology of cusps. This of course is not the case, and so in some dentitions, when moving sideways, *group function* is observed. This may not happen all at once, progressively more teeth may be recruited into contact the more the mandible moves sideways, hence the term *progressive* group function.

It would be useful to know how common these observations are, and if we really do not wear our teeth at

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all. Fortunately others have asked this question and have surveyed many natural unworn dentitions and it is worth briefly reviewing their findings, because they may well surprise you. In 1969, a study<sup>2</sup> looked at 1,200 “young men”, ages 17 – 25, and measured cuspid contact in centric, protrusive and lateral excursive movements. At the time, it was generally considered that dentitions would display a cuspid guidance (disclusion) and certainly dentitions were restored to this scheme. However, this study found the following rather surprising results:

- In lateral excursions, there was *bilateral* cuspid contact in 57% of the dentitions, unilateral contact in only 16%, and no contact in 27%
- In protrusive, there was no cuspid contact in 99% of the dentitions
- In centric, there was cuspid contact in 92%.

These findings, however seem to have been largely ignored, as have the findings of a 2008 study, in which 834 subjects with a natural dentition and no prosthetic replacements were examined.<sup>3</sup> Their ages ranged from 20 to 63 years. During clinical examination of lateral and protrusive tooth-guided excursions of the mandible, the authors identified 5 distinct “dynamic” occlusions:

- **bilateral canine-protected occlusion**, defined as “no occlusal contacts of the posterior teeth (premolars and molars) during lateral and protrusive excursions of the mandible. The only occlusal contacts on both working sides were usually between opposing canines, while contacts of opposing central incisors and sometimes of lateral incisors were noted in protrusive position of the mandible”.
- **unilateral canine-protected occlusion**, defined as “contacts of opposing canines and posterior teeth were seen on 1 working side, while on the other working side, the only occlusal contact was found between opposing canines”. Protrusive contacts were similar to those of bilateral canine occlusion.
- **group function occlusion**, defined as “during lateral

*mandibular excursions occlusal contacts of opposing canines, premolars, and sometimes first molars were observed on both working sides. However, such occlusal contacts were absent on both balancing sides”. Protrusive contacts were similar to those of bilateral canine occlusion.*

- **balanced occlusion**, defined as “multiple contacts of all posterior and anterior teeth occurring in all tooth-guided mandibular excursions, that is, in both working and balancing sides and in protrusive position of the mandible”.
- **“other occlusions”**, “established for occlusions that differed from the previously defined schemas of occlusion”.

Fig. 1 is the graph derived from their data, on the percentage occurrence of each of these occlusions per age cohort. The results may surprise many who have been taught to always and only use canine guidance.

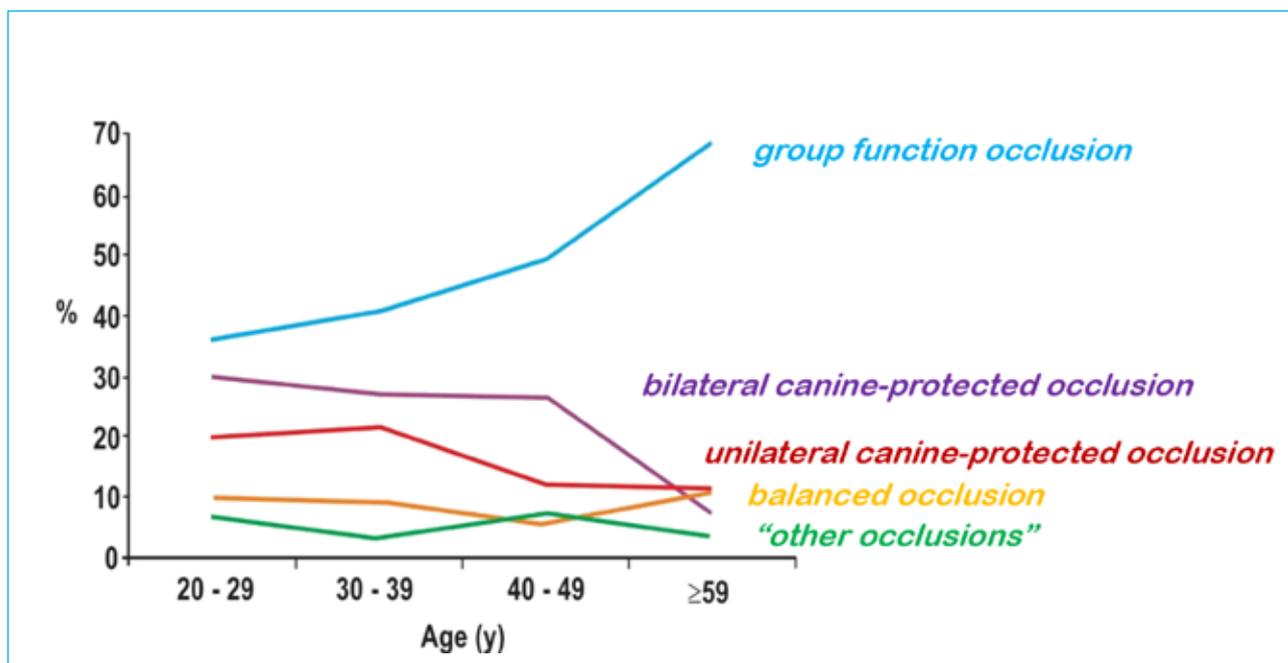
A systematic review of the clinical implications of lateral occlusal schemes in 2015<sup>4</sup> reviewed 13 comparative and 13 clinical outcome studies. Two lateral excursive schemes were identified, canine guided occlusion and group function. Their conclusion was that “the long-term studies indicated that there is no difference between the 2 schemes in patient comfort and restoration longevity”.

So what conclusions can we draw from these studies? The most obvious one of course, is that everyone is different, or “unique, just like everyone else”.<sup>5</sup> Also that occlusions change over time, and patients adapt in the long term. And that canine guided occlusion or disclusion should not to be the goal of every occlusal scheme, which the gnathologists in the USA and elsewhere would no doubt gnash their teeth at.

#### Restoring unworn dentitions: to change or not to change?

If you are still with me, you may now be asking whether every time an occlusal surface must be replaced by an artificial material, it should look like a worn down tooth.

Fig. 1. Distribution of occlusions relative to age cohort (redrawn from Panek et al 2008<sup>3</sup>)



But of course, this is not the case (well, not quite, we'll come to that) and there is ample evidence now that there are two approaches to occlusion in unworn dentitions, the conformative and the re-organised approach.

The *conformative* approach is characterised by the fact that not every occlusal surface or tooth is to be replaced. So when it is replaced, it needs to be as close to what it was originally, depending on the material used, but more importantly, in harmony with how all the other teeth are working and moving over each other. A paper in 1976 was probably the first time this was described as a *conformative* approach, though the emphasis of the paper was more technical, on how to reproduce a functional occlusal surface.<sup>6</sup> The authors stated that "A stable occlusal position that shows no evidence of occlusal disease should not be altered. Conformative restorative dentistry deals with making restorations that are in harmony with existing jaw relations." This was confirmed in a review paper several decades later in which it was stated: "One important outcome of the modern understanding of occlusion ... should be avoidance of occlusion-changing procedures in healthy functioning patients".<sup>7</sup>

This would or should seem to be self-evident, yet because many clinicians are unaware of the dynamics of functional occlusion, it is a sad fact that artificial occlusal morphology often unwittingly introduces morphology that is not in harmony with the patient's normal function. This has become more acute of late with the increased use of ceramics, and the comparative ease with which they can be produced in-office using digital procedures.

The *re-organised* approach is more commonly associated with the replacement of the majority of occlusal surfaces for partially or completely edentulous situations. This is, or should be, in the realm of the specialist Prosthodontist and it is not my intention to step on the toes of the very demanding years of training that prosthodontists undertake. But it is necessary to step on the toes of general dental practitioners who undertake full mouth rehabilitation without such training and by training I do not mean weekend courses unless such courses are accredited by the Regulator of the profession.

One of the reasons for all the confusion around the terminology of occlusion, such as the current definition of centric relation, is that when confronted with a broken down dentition, or the need to replace it entirely, the need to position the teeth (a) in the correct place and (b) at the correct height becomes a huge problem, because there is no reference point. Remember that the mandible is held in a sling, the joint that allows its movement is 5 times more slippery than ice on ice, and is the only joint in the entire body whose limitation is outside the joint itself. And that limitation, the teeth, is now under our control as clinicians.

Remember that definition of centric relation in the Glossary of Prosthodontic Terms?<sup>8</sup> Here's a reminder: "A maxillomandibular relationship, independent of tooth contact, in which the condyles articulate in the anterior-superior position against the posterior slopes of the articular eminences; in this position, the mandible is restricted to a purely rotary movement; from this unstrained, physiologic, maxillomandibular relationship, the patient can make

*vertical, lateral or protrusive movements; it is a clinically useful, repeatable reference position".* The really only important part of that nonsense is the very last part, a clinically useful, *repeatable* position. As we have seen, this has to be found clinically, because we now know that a pure hinge movement simply does not occur: there is always some translation as well. So it is necessary to find what appears clinically to be a repeatable movement (and it does not matter where the condyles are in the fossa) and this generally does *appear* to be hinge-like. This is the movement we try to repeat when making complete dentures and when re-organising a dentition.

Experienced clinicians will, however, tell you that this pathway changes. In the elderly, a centric position for a complete denture made one year may not be the same the following year: in a full-mouth rehabilitation, provisionals are (should be) recommended to be worn for several months and generally require continual adjustment to maintain freedom of movement, as the jaw positions itself into its most comfortable orientation.

Now although I rather facetiously said that it doesn't matter where the condyles are in the fossa, that's not strictly true, because their position is under the influence of the ligaments of the joint, the disc, and most importantly, of the muscles. As long ago as 1973, Celenza<sup>9</sup> observed that after restoring a dentition to what he called the "ligamentous position", which was basically his term for a terminal hinge movement, he found that the customary intercuspal position adopted by his patients was, in 30 of the 32 patients followed up over a period of up to 12 years, anterior to the original position. So it does change, and is not an immutable position. This is why prosthodontists are trained to do two things when carrying out full mouth rehabilitation: (1) use an inter-occlusal appliance for some weeks to (a) assess the vertical dimension to be used and (b) to try to 'undo' the habitual closing patterns and reduce stress in the muscles; and (2) to place patients in provisional restorations, sometimes for up to 18 months, with constant monitoring and adjustment of the interocclusal relationships prior to the definitive restorations being placed, because the antero-posterior position of the mandibular closing arc does change. And as said earlier, experienced clinicians will tell you that in the elderly, a centric position for a complete denture made one year may not be the same the following year.

This is why the concept of interdigitation makes little sense, and the freedom of movement in all planes makes the most sense and is probably one of the main reasons why patients show a preference for lingualised occlusal schemes in complete dentures, and why steep cusps should be avoided in dentate rehabilitations. However, the question of the most appropriate morphology of the occlusal surfaces remains, as well as the manner in which all teeth interact. We have dealt with the issue of complete dentures and we will deal with the occlusal morphology in Part 5 but for conventional fixed prosthodontics, there are some principles that can be derived from a non-mechanistic view of occlusion, as there seem to be some common threads from the literature that have taken such a view,<sup>10-13</sup> but with the caveat that "There are no controlled studies on the optimum features of a harmonious natural and/or restored occlusion".<sup>14</sup>

I would respectfully suggest, therefore, that the principles in conventional fixed prosthodontic treatment should be as follows:

- An acceptably aesthetic vertical facial height after treatment;
- An acceptable and comfortable interocclusal distance with the mandible at rest ;
- Intra-arch stability obtained from firm interproximal contacts;
- Inter-arch stability obtained by providing occlusal contacts on all opposing teeth;
- There should be bilateral synchronised contacts in the intercuspal position;
- Cusp inclinations should be shallow and there should be minimal fossa depths with no occlusal grooves (see Part 5);
- In protrusion there should be anterior contacts with none posteriorly;
- There should be freedom of movement in all eccentric movements with no interferences to chewing motion naturally generated;
- If appropriate there should be conformity to existing excursive contacts;
- Existing tooth mobility can be maintained but there should be no worsening of any mobility;
- Occlusal plane orientation should be determined predominantly by aesthetics but can be modified by differing gonial angles;
- There should be no soft tissue impingement during occlusal contact.

To end this section, a word about occlusal plane orientation, especially with respect to complete dentures. There are many myths that surround prosthodontics in general and complete dentures in particular,<sup>15,16</sup> and one of the most common is that the occlusal plane should orient to Camper's plane or line. There are several problems with this, not least of which is just what Camper's plane is, as its definition has changed over time. But more importantly, the evidence is that the natural occlusal plane does not orient to Campers plane. This has been shown in a number of studies and reviews over the years: for example a 1996 study<sup>17</sup> concluded that *"the reliability of Camper's line as a guideline to simulate the natural occlusal plane is questionable"* and in 2003 a paper concluded "Cephalometric analysis alone cannot determine the location of the occlusal plane in edentulous patients. Intra-oral structures should also be considered."<sup>18</sup> A more recent study in 2017 confirmed this by advising that whilst a horizontal plane or even Camper's plane may be useful initially, "additional anatomic and aesthetic parameters are required for verification of an aesthetically pleasing occlusal plane angle".<sup>19</sup> In developing an appropriate technique for complete dentures we have found that the most consistent method of obtaining an occlusal plane that is functionally stable is to use an aesthetically acceptable arrangement of the maxillary anterior teeth as an anterior determinant, and the unchanging retro-molar pad as the posterior determinant.<sup>20</sup>

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

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## 1. Is there an association between tooth loss and cognitive function?

More than 90% of the world's population suffer from one or more oral conditions that affects their oral health related quality of life. Edentulism (partial or full) is a major public health problem especially in poorer settings where people have limited options to manage tooth pain, tooth decay or periodontal disease. Often the only treatment option available is tooth extraction resulting in early tooth loss. In other settings, for example, the Western Cape, cultural and traditional norms practiced over generations has resulted in some of the highest edentulism rates in the world.

Neurological disorders are the leading cause of disability-adjusted life-years (DALY) globally. Neurocognitive disorders (NCDs) is also expected to escalate worldwide in parallel with the longer lifespans of people. One of the most common NCDs is mild cognitive impairment (MCI).<sup>1</sup> MCI is a syndrome defined as cognitive decline greater than that expected for an individual's age and education level but that does not interfere notably with activities of daily life, and may be indicative of Alzheimer's disease or another dementia.<sup>1</sup> Alzheimer's disease and other types of dementia are the second group of disorders to which DALYs are risk attributable, only after stroke. Among such risk factors, the 2020 report of the Lancet Commission for Dementia proposed three new risk factors, namely, alcohol intake, head injury, and air pollution, in addition to the nine previously proposed in 2017 (i.e., less education, hypertension, hearing impairment, smoking, obesity, depression, physical inactivity, diabetes, and infrequent social contact).<sup>1</sup>

The possible etiologic role of edentulism in the development of MCI and dementia has attracted the attention of researchers in recent years<sup>1</sup>. Possible mechanisms supporting this relationship include the following: (1) the inflammation/infection mechanism: *Porphyromonas gingivalis*, a well-known periodontopathogen, may induce the local release of pro-inflammatory cytokines and subsequently increase both the peripheral

circulation and brain accumulation of amyloid- $\beta$ ; (2) the masticatory mechanism: preclinical and clinical studies have demonstrated the negative effect of impaired masticatory function on the incidence of cognitive performance<sup>1</sup>; (3) the diet and nutrition mechanism: this is strongly related to the masticatory one, since tooth loss may influence dietary patterns, which can have a deleterious effect on intraoral food pre-processing before deglutition, leading to a reduction in the intake of nutritional components that have a neuroprotective effect and also promote obesity<sup>1</sup>.

Galindo-Moreno and colleagues (2022)<sup>1</sup> sought was to investigate the association between edentulism and cognitive function through a combined analysis of large national health surveys. They hypothesized that cognitive function depended, at least in part, on tooth status and masticatory function when other potential important factors, such as age or socioeconomic status, were controlled.

### MATERIALS AND METHODS

This was a retrospective observational study in which data from two national health surveys were analysed to assess the potential association between oral health and cognitive status. The United States of America's (USA) National Health Interview Survey (NHIS, 2014–2017) and the National Health and Nutrition Examination Survey (NHANES, 2005–2018) were used. These are public databases and no ethics approval is required to use their data. They both measured the cognitive status (memory/concentration problems) subjectively. The NHIS asked the participants four questions relevant to understand their cognitive function: (1) degree of difficulty remembering or concentrating? (no difficulty, some, a lot, cannot do at all), (2) difficulty remembering, concentrating, or both? (remembering only, concentrating only, both), (3) how often do you have difficulty remembering? (sometimes, often, all the time), and (4) number of things you have difficulty remembering? (a few, a lot, almost everything). This survey also presents some limitations regarding dental status, as only either presence of complete adult dentition or absence of at least one tooth was registered. The NHANES survey asked the participants only a cognitive question (memory/concentration problems), but included an examination of the dentition status with detailed information

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regarding each individual tooth. Both surveys collected information about age, sex, education level, socioeconomic status (SES), body mass index.

The primary outcome was cognitive function relative to edentulism in adults 45 years or older. Age, gender, SES, education level, cardiovascular health index, body mass index, exercise, alcohol and smoking habits were used as covariates. In the NHIS analysis, depression and anxiety were added as confounders. In the NHANES analysis, only depression was included. For the analyses, the independent variable was edentulism as measured in each survey, and the dependent variables were the cognitive function measures, as defined in each survey as well.

## RESULTS

The National Health Interview Survey (NHIS, 2014–2017) sample was composed by 17,134 (1169 missing) in 2014, 15,075 (1864 missing) in 2015, 15,350 (1128 missing) in 2016, and 12,122 (1203 missing) in 2017. It was observed that the presence of teeth was beneficial in the maintenance of a good cognitive status. Relative to the reference category “no problem,” completely edentulous subjects exhibited a larger Odds Ratios for having difficulties in remembering only, concentrating only and both. This was also observed for gender, education, SES, and CV risks variables.

After quantification of memory failures in function of edentulism, it was found that, relative to the reference category “no problem,” completely edentulous subjects exhibited an increased probability of forgetting “a few things” and “a lot of things”. The same trend was observed for age, education, SES, cardiovascular health, exercise, and anxiety and depression.

Data from the NHANES surveys (N= 17,189, missing=5061, overall) were used to precisely analyze the impact of tooth loss on the development of cognitive problems. The analysis indicated that the best cut-off was 20.5 remaining teeth. Results showed that, compared with no edentulism (more than 20.5 teeth), edentulism has a significantly higher probability of being associated with confusion/memory problems. When analysed independently by tooth type, the worst results emerged when molars were missing. It was also found that people under age 45 showed an increased probability of having memory/confusion problems [OR= 1.877 (95% CI [1.331, 2.646]).

## CONCLUSION

In this sample of more than 100 000 individuals, the authors noted that there was an association between edentulism and a decline in cognitive function.

### Implications for practice

Maintenance of functional teeth through the promotion of oral health may contribute to the preservation of memory/ concentration and other essential cognitive functions

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## 2. Stainless steel crown vs bulk fill composites for the restoration of primary molars post-pulpectomy

Placement of a stainless steel crown (SSC) is the most commonly recommended restoration following endodontic treatment of primary molars,<sup>1</sup> as it provides a good coronal seal, preventing microbial infiltration or restoration failure over time. However, dental aesthetics are compromised due to colour characteristics of the SSCs, which may influence child's and parent's acceptance, especially when compared to more aesthetic options such as composite resins (CRs).<sup>1</sup>

The main problem of CR, however, is the high polymerization shrinkage that results in marginal deficiencies, cracked cusps, and material fracture, especially in multisurface restorations after pulp treatment.<sup>1</sup> The fracture of the restoration can lead to a microbial infiltration, resulting in the failure of the endodontic treatment. In order to solve this problem of polymerization shrinkage, bulk fill composite resin (BF) was launched in the market, with promising evidence level in both clinical and in vitro studies<sup>7</sup>; however, no clinical trial has been performed to date using BF as a restorative material after pulp treatment in primary teeth.

Olegário *et al* (2022)<sup>1</sup> reported on a randomized clinical trial that sought to evaluate the 1-year survival rate of endodontic treatment followed by stainless steel crowns (SSCs) or bulk fill composite resin (BF) as a restorative option and also the acceptance of these restorations by the child and parent.

### MATERIAL AND METHODS

Allowing for a 25% lost-to-follow-up rate, 147 subjects were This was a two-arm, controlled, 1:1 allocation ratio, non-inferiority clinical trial reported in the CONSORT (Consolidated Standards of Reporting Trials) format.

Informed consent was obtained from the parent or guardian of each child before participation in the study. Inclusion criteria were as follows: healthy (ASA I) cooperative children aged 3-8 years, who had at least one primary molar indicated for endodontic treatment irrespective of sex or socio-economic status; Primary molars with irreversible pulpitis or non-vital pulps with restorable tooth structure (adequate sound coronal tooth structure and periodontal support), confirmed by clinical and periapical radiographic examinations. Potential patients were excluded they presented with underlying systemic conditions and special healthcare needs or there was a presence of bone rarefaction involving more than a half of the root, severe mobility, or resorption of more than half of the root or root perforations.

Participants were randomly assigned to two different treatment groups: SSC: restorations using SSC for primary molars (3M ESPE) that were cemented with a glass ionomer cement (GC Fuji Plus); and BF: restorations using BF (Filtek Bulk Fill) using Scotchbond™ Universal Adhesive (3M ESPE).

All treatments were performed by a single operator. After clinical and radiographic examination, baseline variables

related to demographic and tooth/lesion characteristics were collected. Child's age (3-5 or 6-8 years) and sex, and the presence of fistula, initial diagnosis (necrosis without or without furcal rarefaction or irreversible pulpitis), number of surfaces of the caries lesion (one, two, or more than two surfaces involved), molar (first or second molar), and jaw (upper or lower) were evaluated by the operator of the trial in order to analyse whether those variables could be related to treatment success. All children included in this trial received endodontic treatment following a standardized protocol. All the pulpectomies and restorations were performed in a single session. After finishing the endodontic treatment, the randomization envelope was opened by a third person and the child was treated according to the following treatment groups: (1) In the SSC group, the crowns were cemented with a glass ionomer cement (GC Fuji Plus). Tooth preparation was only carried out when there was insufficient space to fit the crown, (2) In the BF group, the cavity walls of the treated tooth were cleaned, etched with a 37% phosphoric acid, washed, and dried using 3:1 air/water syringe. For occluso-proximal restorations, a metal contoured matrix and a wooden wedge were used to provide an appropriate contour. Scotchbond™ Universal Adhesive was applied with a microbrush and light-cured for 10s. The restoration was completed using BF (Filtek Bulk Fill). If the cavity size was greater than 4 mm deep, two increments were applied.

All restorations were light cured using LED light, ensuring a minimum irradiance of 400 mW/cm<sup>2</sup>. When necessary, a finishing bur was used for adjustments.

The primary outcome of this study was the success of the endodontic treatment after 12 months. All treatments were evaluated by a calibrated independent examiner. Clinical evaluation took place after 1, 3, 6 as 12 months while radiographical evaluation took place after 3, 6 and 12 months. Clinical failure was considered when the tooth presented with fistulae, abscess, or pathological tooth mobility. Radiographical failure was considered when there was a progression of inter-radiolar radiopacities, increased pathological root resorption, or absence of periodontal integrity.

The clinical and radiographic criteria to determine success were the absence of all the conditions described above until the end of the follow-up period. In case of failure of the endodontic treatment, the extraction of the tooth was performed.

In addition to the clinical and radiographical evaluation of the endodontic treatment, the restoration success was also evaluated by examining the marginal integrity and checking for secondary caries, and fracture restoration. Furthermore, the SSCs were evaluated for the presence of perforation and crown loss.

Acceptance of the type of treatment questionnaire were administered immediately after treatment by an external

researcher who did not participate during the endodontic treatment phase, and who was instructed to read the questions and show the possible answer in the same way for all the participants to avoid interview bias. The new restoration was shown to patients and their parents using a mirror to identify the treated tooth.

The questionnaire for the children (C) consisted of five questions in Portuguese regarding appearance, acceptability, treatment experience, and their views on the metal crown or composite restoration. The questionnaire for the parents (P) consisted in five questions in Portuguese regarding their attitudes towards the SSC or composite restoration and how they felt their child had coped with the dental treatment. The child's and parent's answers for each question were enumerated from 0 to 4 (0 = strongly agree; 1 = agree; 2 = no opinion; 3 = disagree; and 4 = strongly disagree). Thus, for the total score, all scores from the answers were summarized per children and parents, and the higher the total score, the worse their acceptance in general.

## RESULTS

A total of 91 children were included in this study and received the interventions. Among the participants, 37 (40.66%) were female and 54 (59.34%) were male and the mean DMFT/dmft was 7.2 ( $\pm 3.2$ ; min 5–max 14). A total of 46 teeth were restored with BF and 45 with SSC. After 12 months, 14 children were not evaluated because they moved to another city or changed their mobile phone numbers (dropout = 15.38%).

The survival rate after 1 year was BF = 75% and SSC = 88% ( $p = 0.45$ ). The non-inferiority hypothesis between the treatment's survival could not be concluded (HR = 1.41; 90% CI 0.57-3.43,  $p = 0.645$ ). Intention-to-treat analysis found that the success rates after 12 months were 86.7% and 82.6% for SSC and BF groups, respectively. An absolute difference of -4% was found, however since the lower confidence limit was -19% the non-inferiority between the groups could not be claimed (RR = 0.95; 0.78-1.16,  $p = .149$ ).

In terms of the restorations, there were 9 in the BF group and 0 in the SSC group. The second primary molars had lower risk of endodontic failure when compared to the first primary molars ( $p = .026$ ). All other analysed variables (sex, age, size of inter-radicular lesion, presence of fistula, abscess, or mobility) were not associated with the failure of the endodontic treatment in this secondary analysis.

Two parents and two children from the BF group did not answer the acceptance questionnaire after treatment. The reasons for the non-response were as follows: the child was sleeping after the treatment ( $n = 2$ ) so they were unable to answer the questions; and the parents had to rush to another appointment ( $n = 2$ ). Those questionnaires were excluded from data analysis due to missing data (response rate = 97.8%). Most of the answers are either 'strongly agree' or 'agree', showing a high acceptance for all responses, regardless of the treatment group

## CONCLUSION

The results of the trial indicate that it is not possible to affirm that restorations of teeth with endodontic treatment performed with BF resin are non-inferior to restorations made by SSC; however, failures in BF restorations lead to a failure of the endodontic treatment. In terms of acceptance, both materials were well accepted by both children and their parents.

### Implications for practice

The finding of this trial suggest that both materials were equally effective and accepted by patients and their parents. BF composites however should more failures with respect to the restorative phase of the treatment than SSCs.

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## CPD questionnaire on page 242



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

# Probing *Status Quo Bias* in Dentistry

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LM Sykes<sup>1</sup>, G Babiolkis<sup>2</sup>;

## ABSTRACT

The status quo bias in dentistry refers to a practitioner's preference for certain treatment modalities and resistance to contemplating the need for a change. Lack of updating skills and amending their work routine accordingly can result in them providing treatment that is dated or even totally obsolete. It could even be detrimental to their patient's oral health and open them up to the risk of litigation. The concept of Continuing Professional Development (CPD) was introduced to try enforce clinicians to improve their knowledge and skills, and keep abreast of current best practice recommendations. However, it should not be seen as a mere points collecting exercise that has little effect on bringing about changes in their work. Dentists need to continually review their work, and make adjustments when necessary in order to do better and be better. Only then can they claim to be acting in their patients' best interest and fulfilling their duty of beneficence.

## INTRODUCTION

The status quo bias relates to a person's "preference for the current state of affairs, resulting in their resistance to change."<sup>1</sup> It can occur in any situation where people have become accustomed to and content with "the norm." Making a change would require a conscious decision, followed by a definitive action, which requires both mental and physical effort. Unless the individual starts to suffer under their present situation, they may find it far easier to leave things the way they are than to try make a change. It may be argued that for many trivial issues, staying in a functioning and comfortable situation "frees up mental resources for other more important tasks."<sup>1</sup> However, it also leads to the risk of "missing out on new opportunities that could be more beneficial."<sup>1</sup> In dentistry, a greater risk is that a lack of effortful planning could lead to decisions and actions that are not always based on "sound and considered reasoning." This, in turn, could result in clinicians providing treatment that is not in the best interest of their patients.

## *Status quo bias* in dentistry

The status quo can be likened to the "default position" or the "habitual" practice in dentistry. It serves as the baseline for treatment planning and often results in clinicians treating

patients in a routine manner, based on their training, experience, and at times, personal preferences. Their preference for the default is an easier option than spending time and effort on clinical debate and reasoning before commencing with each new case. However, it is not always an indication of laziness. Sometimes, it is chosen because the norm is "familiar and comfortable," and clinicians know what outcomes to expect. It thus acts as a shield to protect them from potential risks associated with trying out new methods. This stance can be seen as a form of "loss aversion or regret avoidance," where practitioners place greater weight on the potential losses they may face than the gains that could be achieved if they attempted something new.<sup>1</sup> They will rather avoid choices and decisions that may result in them having to face feelings of regret later on. They tend to be blind to the possible advantages of purposeful deviation and don't even contemplate the potential gains that could be achieved by choosing alternatives.<sup>2</sup>

At the same time, access to social media has allowed patients to become far more aware of and knowledgeable about different treatment options available. This has led them to place increasingly high and, at times, unrealistic and/or unachievable demands on the clinicians. Furthermore, there has been an explosion in new dental materials, techniques, and treatment modalities becoming available. It is no wonder that modern dentists often feel overwhelmed with all the options and resort to the status quo because it is "safe." Research into status quo bias substantiates this notion. Nebel (2015) showed that its influence is "positively correlated with the number of options available."<sup>3</sup> Others suggest that this "choice overload" may lead to people making worse decisions.<sup>4</sup> It is then easy to see why busy practitioners routinely resort to their usual and preferred treatment modalities. This may be useful for minor and mundane decisions where it may save time and "free up mental resources for the more important decisions."<sup>5</sup> However, dentists who charge consultation fees are ethically and legally obliged to justify these by thoroughly assessing each patient, weighing up all the options, and formulating a definitive treatment plan tailored to their needs.

This reliance on the status quo can have negative consequences. If it is always the preferred position, it never allows practitioners to progress or improve their skills and services. Patients, too, will suffer by being treated with methods and materials that may be dated and not in accordance with current evidence-based best practices. Imagine if dentists still did cavity preparations according to the GV Black design principles or believed in "extension for prevention" when removing caries. These concepts may seem ludicrous to clinicians in 2022, yet they were taught to dental students who studied in the eighties and nineties. Some practitioners continue to "prophylactically" remove wisdom teeth or do full mouth clearances on patients scheduled for radiation therapy to the head and neck regions despite there being no conclusive literature to support the former and abundant papers negating the need

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2. George Babiolkis: 40%

for the latter. The above examples illustrate how those who cling to the status quo may be doing a disservice to their patients, and this could even be accused of malpractice.

### Attempts to overcome the challenges of status quo bias

Having a qualification is no guarantee that clinicians will maintain their proficiency, keep abreast of current philosophies and treatment modalities, or maintain lifelong competence.<sup>6</sup> Yet, patients have a right to therapy that is provided by practitioners who are skilled, up to date, and competent.<sup>7</sup> As long ago as 1972, Dubin first spoke of the "half-life" concept in medicine, wherein he estimated that knowledge becomes outdated in as short a time as five years after graduation.<sup>8</sup> Several years later, the professional medical and dental bodies worldwide took cognisance of this tendency for established clinicians to fall into the status quo bias trap and the associated risks this posed for their patients. To try and mitigate these, they introduced the requirement for all practitioners to undergo compulsory lifelong academic training in the form of Continuing Professional Development (CPD) activities. Compliance is monitored by the relevant governing bodies in each country

The Health Professions Council of South Africa (HPCSA) introduced mandatory CPD point acquisition in 2007. Those who failed to comply would have their names erased from the register and effectively be unable to continue practicing. The reasoning behind CPD was that it would allow professionals to constantly update their knowledge and, by implication, their skills as technology advances.<sup>9</sup> The problem with CPD is that there is a lack of evidence that it results in concrete changes, such as clinicians changing their routine habits or updating their practices to embrace the latest modalities.<sup>10</sup> Dentistry, in particular, has and continues to, undergo rapid advancement in terms of materials, equipment and techniques. This makes it easy for stagnant practitioners to become dated in the services they offer and provide to their patients. CPD points can be gained through journal clubs, online courses, research projects, supervision of students, and professionals meetings such as congresses/conferences. Journal clubs are popular as they can be arranged at convenient times and locations. In addition, they encourage the participants to analyse and review research papers and discuss them critically.<sup>11</sup> Most other CPD activities are also preferred over formal testing, but very few are structured to test and ensure clinical competency. In addition, mere attendance and point compliance are of little use if the information and skills gained are not implemented on a practical level. It is thus the responsibility of the practitioner to ensure that they do this in order to provide treatment that is in keeping with current, evidence-based best practice. To this end, the profession and service providers should focus less on using CPD as a money-making venture and more on promoting activities such as journal clubs, discussion circles, and skills transfer courses. These will allow dentists to engage in critical thinking and robust debates with colleagues, gain convincing knowledge and improve their practical skills. Clinicians themselves need to view CPD courses as constructive means of self-improvement and not punitive regulated obligations.

### CONCLUSION

Clinicians need to be aware of the status quo bias to recognize when they may be resorting to this mode out of ignorance, laziness, fear of the unknown, or feeling

overwhelmed. Breaking out of this habit requires a conscious effort. It also necessitates spending time and mental energy weighing up all the options and making the best decision for each patient based on sound reasoning and knowledge of the current best-practice recommendations. Only then can dentists genuinely claim to be acting in their patients' best interest and fulfilling their duty to beneficence.

Perhaps clinicians should conduct regular introspective status quo bias reviews. When necessary, they may need to make mindset edits and delete phrases such as "This is what I've always done, so why change what works?" and replace them with more proactive affirmations like "This is what I've always done, but how can I do better?"

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# Maxillofacial Radiology 199

SADJ May 2022, Vol. 77 No.4, p240 - p241

C Smit<sup>1</sup>, Z Yakoob<sup>2</sup>

## CASES

Two sisters presented with a family history of chronic episodes of osteomyelitis due to an underlying fibro-osseous bone disorder. The patients reported no co-morbidities or long bone fractures. What are the pertinent radiological features and your diagnostic hypothesis?



Figure 1: Panoramic radiograph of patient 1

## INTERPRETATION

Both patients presented with extensive sclerosis limited to the tooth-bearing regions of the jaws. The areas affected by secondary osteomyelitis show radiolucent zones surrounding the radiopaque lesions (Figure 1). The first patient presented with a jaw fracture following a failed extraction attempt (Figure 1 - arrow). Due to the extensive bony sclerosis, associated impacted teeth are common (Figure 2).

Genetic conditions including hyperparathyroidism-jaw tumour syndrome (HPT-JT), gnathodiaphyseal dysplasia

(GDD) and familial florid cemento-osseous dysplasia (FFCOD) must be considered as part of the differential diagnoses. Following strict clinicopathological correlation, as well as the patients lacking a history of co-morbidities and long bone fractures, both HPT-JT and GDD were excluded.

FFCOD has a similar radiographic presentation to conventional florid cemento-osseous dysplasia with subtle differences. They are similar in that they present with mixed radiolucent-radiopaque lesions limited to the tooth-bearing regions of the jaws, characteristically affecting multiple quadrants. The conditions differ in that the familial variant presents at a younger age with an earlier onset of bone sclerosis, an increased propensity for expansion, and multiple tooth impactions. Additionally, the familial variant shows a decreased predilection for females. Both variants have a risk for the development of secondary osteomyelitis due to the hypovascularity of the bone. Therefore, optimal oral hygiene and preventive measures ensuring tooth retention must be prioritised. Extractions should be avoided as far as possible to reduce the risk of osteomyelitis, which is extremely difficult to treat in these instances.<sup>1</sup>

These cases highlight the importance of radiographic imaging in the diagnosis of benign fibro-osseous lesions and for thorough case workup before dental interventions are performed.

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### Authors contribution:

Chané Smit: 70%  
Zarah Yakoob: 30%



Figure 2: Panoramic radiograph of patient 2

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## CPD questionnaire on page 242



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

# CPD questionnaire

This edition is accredited for a total of 3 CEUs:

1 ethical plus 2 general CEUs

## GENERAL

**The prevalence of mandibular third molar impactions and associated second molar pathology in a Gauteng population group. A retrospective study.**

- Select the CORRECT statement. An impacted tooth is one that:
  - Is unlikely to erupt into its functional position
  - Has remained embedded in the jawbone 2 months after its physiological eruption time
  - Is never visible in the oral cavity
  - Both a) and c) are correct
  - Both a) and b) are correct
- Which of the following options is CORRECT. According to The American Association of Oral and Maxillofacial Surgeons (AAOMS), extraction of third molars may be warranted if:
  - Its presence hampers orthodontic treatment
  - It is causing disruption of the occlusion
  - To aid hygiene of the second molar
  - All the above are correct
  - Only a) and b) are correct
- Select the CORRECT statement. A coronectomy procedure on impacted third molars may:
  - Be suited to cases where the roots are short or fused
  - Result in migration of the root rests
  - Lead to frequent infections of the remaining root rests
  - Increase the risks of inferior alveolar nerve damage
  - Both b) and c) are correct
- Which of the following options is CORRECT. According to the Pell and Gregory's classification of third molar impactions:
  - Class II have most of the third molar in the ramus of the mandible
  - Inferior alveolar nerve involvement is scored as 0
  - Position A has none of the tooth above the occlusal plane
  - Mesio-angular teeth are scored as 3
  - No inferior alveolar nerve involvement is scored as 0.
- Select the CORRECT option. In the current study, Dawson *et al* found:
  - Teeth on the right were more often impacted than those on the left
  - The mesially angulated Class II position B impactions were the most common type on the right
  - There were significantly more females with impacted third molars than males
  - All the above are correct
  - None of the above are correct

## **A Radiographic Analysis of Mandibular Symphysis Dimension in Black South African Adult Patients with Differing Skeletal Patterns**

- Select the CORRECT option. Subjects with vertical growth pattern in this study present with the following mandibular symphysis dimensions.
  - Narrow mandibular symphysis dimensions
  - Thicker mandibular symphysis dimensions
  - Broader mandibular symphysis dimensions
  - Normal mandibular symphysis dimension
- Which one of the following choices is CORRECT. During orthodontic treatment the movement of the lower incisors beyond the boundaries of the mandibular symphysis may lead to the following iatrogenic sequelae:
  - root resorption, dehiscence and fenestrations
  - root resorption only
  - Crowding of the lower incisors
  - Proclined and extruded lower incisors
- Choose the CORRECT answer. Dentoalveolar compensation of patient with skeletal class III include
  - Proclined lower incisors
  - Retroclined lower incisors
  - Upright position of the lower incisors
  - Normal incisor position

## **An evidence-based guide to occlusion and articulation. Part 4: Unworn dentitions**

- Which of the following answers is CORRECT. In the general population the following occlusal scheme is most likely to be encountered:
  - bilateral canine-protected occlusion
  - balanced occlusion
  - unilateral canine-protected occlusion
  - anterior guidance

10. Choose the CORRECT answer. The conformative approach to replacing occlusal surfaces is used
- when all the teeth are to be replaced
  - when only the anterior teeth are to be replaced
  - when few occlusal surfaces are to be change, to maintain existing function
  - in patients with TMJ dysfunction
11. Which option is CORRECT. A repeatable, hinge-like movement of the mandible
- is constant throughout life
  - means the mandible moves on an arc around a hinge axis through the condyles
  - can be measured by tracing the mandibular movement
  - is only observable clinically as an end point when the teeth meet
12. Select the CORRECT statement. The occlusal plane
- runs from the superior border of the tragus to the inferior border of the ala
  - runs from the inferior border of the tragus to the superior border of the ala
  - runs from the centre of the tragus to the centre of the ala
  - runs from the tip of mandibular canine to halfway up the retromolar pad

### Radiology corner

13. Choose the CORRECT answer. Which of the following places the patient at risk for secondary osteomyelitis
- Hypervascular bone
  - Hypovascular bone
  - Avascular bone
  - None of the above
14. Select the CORRECT option. Which of the following findings are often seen in patients with FFCOD?
- Hypodontia
  - Supernumery teeth
  - Impacted teeth
  - All of the above
15. Select the CORRECT statement. Which of the following are true for both conventional florid osseous dysplasia and the FFCOD variant?
- Mixed radiolucent-radiopaque lesions in the jaws
  - Have the potential to develop secondary osteomyelitis
  - Extractions should be avoided where possible
  - All of the above
16. Which of the following is CORRECT. Familial florid cemento-osseous dysplasia differs from the normal variant in the following ways:
- Younger age of onset
  - Increased expansion
  - Multiple impactions
  - All of the above

### Evidence-based Dentistry

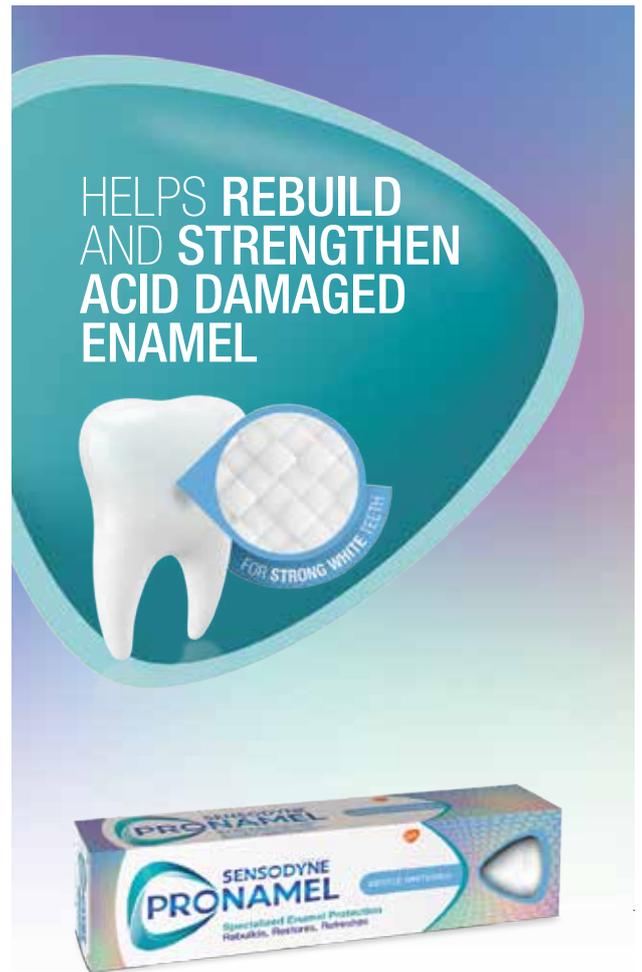
17. Select the CORRECT answer. Which of the following study design can be used to imply causality?
- Cross-sectional study
  - Case-control study
  - Randomised clinical trial
  - Case Study
18. Which of these statements is CORRECT. In the Galindo-Moreno et al study, the following can be regarded as true:
- edentulism has a significantly higher probability of being associated with confusion/memory problems
  - edentulism has a significantly lower probability of being associated with confusion/memory problems
  - edentulism has a significantly higher probability of not being associated with confusion/memory problems
  - edentulism has a significantly higher probability of being associated with no problems
19. Which of the following options is CORRECT. In the Olegário et al trial, the non-inferiority hypothesis between the treatment's survival could not be concluded. This implies that:
- BF is inferior to SSCs
  - SCCs is inferior to BF
  - Both BF and SSCs are inferior
  - Neither BF, nor SSCs are inferior when compared to each other
20. Choose the CORRECT answer. In the Olegário et al trial, the responses from the child and parental questionnaires can be regarded what type of outcome?
- Objective
  - Subjective
  - Clinical
  - Inferior

### Ethics: Probing Status Quo Bias in Dentistry

21. Select the CORRECT statement. If a new and well researched material comes on the market, dental practitioners should not use it if:
- They still have stock of old materials so as not to waste
  - They don't have time to read up on how to use it
  - The can still purchase the old materials at a better price
  - All of the above are correct
  - None of the above are correct

## CPD questionnaire

22. Choose the CORRECT statement. Clinicians who are comfortable with the *status quo*
- Should not change if they get stressed in situations that are unfamiliar to them
  - Should weigh up pros of a new regime against cons of possible failure of the new
  - Should get used to taking chances and trying new things
  - All of the above are correct
  - Only A. and B. are correct
23. Which of the options is CORRECT. Choosing the status quo is unethical because
- The preferred option may not always be the best option
  - It doesn't allow practitioners to improve their skills
  - Patients may suffer by being treated with dated methods
  - All of the above are correct
  - None of the above are correct
24. Select the CORRECT answer. Ethically clinicians should obtain Continuing Professional Development points to
- Act in their patients' best interest and fulfil their duty to beneficence by Improving their knowledge and skills
  - Adhere to the rules and regulations outlined by the HPCSA
  - Obtain certificates of attendance to display in their offices and provide their patients with comfort
  - None of the above are correct
25. Which option is CORRECT. Adhering to the status quo bias in dentistry can be seen as:
- Maleficent towards the patient as you are not providing the best or latest treatment
  - Beneficial to the patient as the treatment will always be the same
  - Giving the patient autonomy by providing them with only one treatment option that you have used for years
  - Being just to the patient as the treatment has been done for many years.



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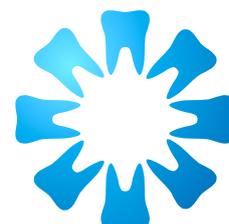
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Email: [marketing@sada.co.za](mailto:marketing@sada.co.za)

[www.sada.co.za](http://www.sada.co.za)



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Be confident knowing you can access expert clinical advice and support. Whatever the issue, whenever it happens, we're here for you 24/7.

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- Advice for any eventuality your career may face
- Fast to respond to unexpected situations
- Support today, tomorrow and yesterday

**Always there for you**

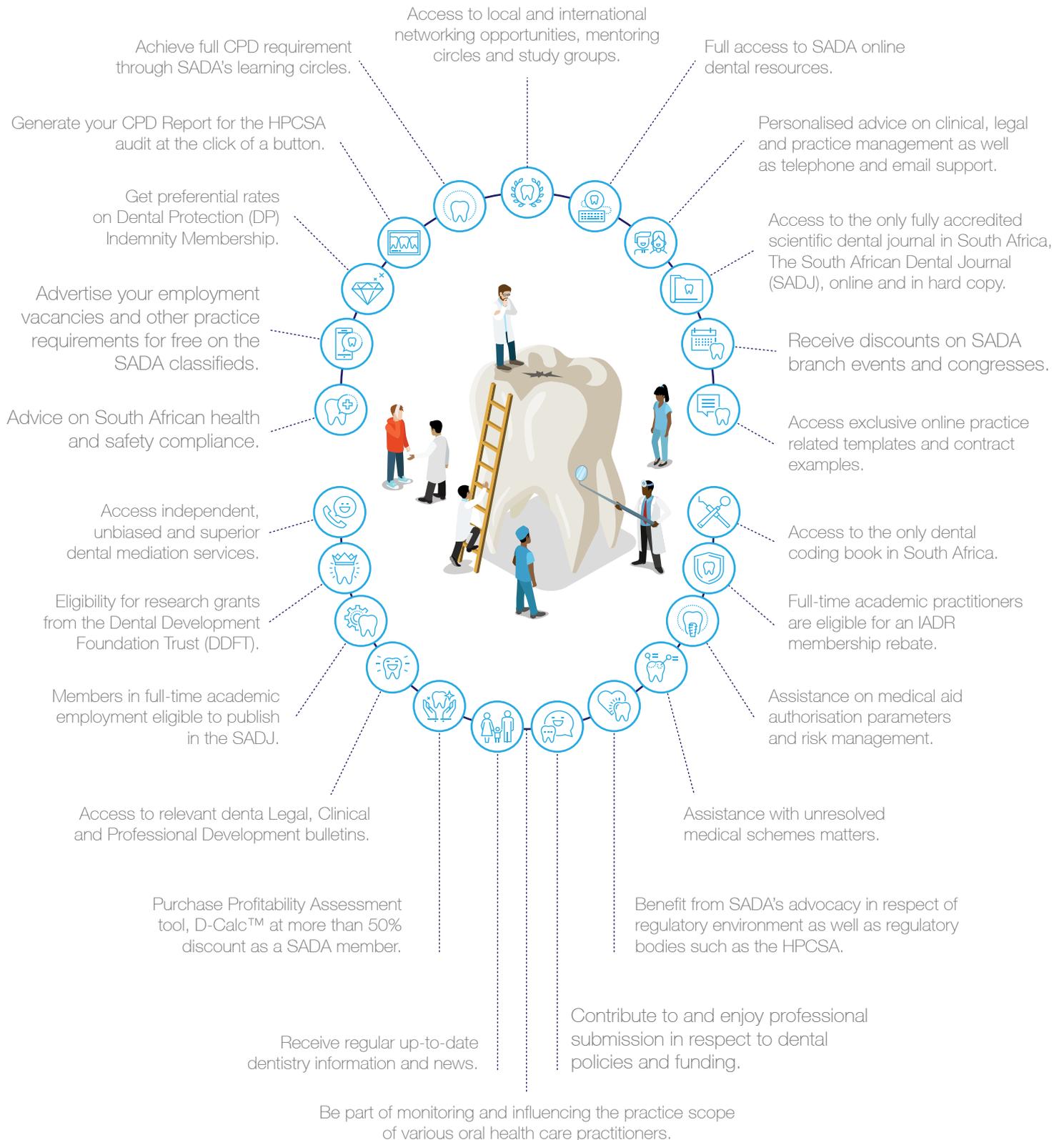
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[dentalprotection.org](https://dentalprotection.org)

# BENEFITS OF JOINING SADA

SADA supports its members throughout their time in the profession - from their time as students in the field, straight through their professional careers, and into retirement.

**Our members benefit from the below advantages, amongst others.**



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