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THE SOUTH AFRICAN DENTAL ASSOCIATION

A series of veils

Veils are a form of face covering that have been worn for many centuries. Veiling is mostly associated with women and sacred objects and has played a significant role in many customary and religious ceremonies. Elite women in ancient Greece and Persia wore veils as a sign of respectability, status, and rank in society. Roman brides wore saffron-coloured veils to protect them from evil spirits and in honour of the flame of Vesta, the goddess of hearth and home and protector of life. The practice of marital veiling is still seen today in many religions and cultures where brides wear veils as a symbol of purity, virginity, and modesty. The variety, beauty and intricacy of these adornments serve as a pleasant reminder that facial coverings can serve both a protective and aesthetic role in our lives.

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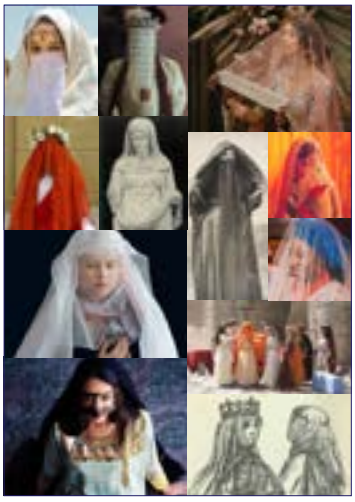
Our Front Cover for this Issue...

The theme for the Front Cover of the South African Dental Journal this year showcases various types of masks. Masks have been admired and worn throughout the world for centuries and play an integral part of many activities including customary rituals, cultural events, battles, entertainment, and for protection. The cover for June features a series of veils.



International Earth Day - 22 April

Veils are a form of face covering that have been worn for many centuries. Veiling is mostly associated with women and sacred objects and has played a significant role in many customary and religious ceremonies. Elite women in ancient Greece and Persia wore veils as a sign of respectability, status, and rank in society. Roman brides wore saffron-coloured veils to protect them from evil spirits and in honour of the flame of Vesta, the goddess of hearth and home and protector of life. The practice of marital veiling is still seen today in many religions and cultures where brides wear veils as a symbol of purity, virginity, and modesty. The variety, beauty and intricacy of these adornments serve as a pleasant reminder that facial coverings can serve both a protective and aesthetic role in our lives.

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The danger of caution-fatigue in the COVID-19 Pandemic

SADJ June 2021, Vol. 76 No. 5 p237

NH Wood
Managing Editor of the SADJ

We are firmly in the grip of the third-wave of the COVID-19 pandemic, with the Gauteng province being the current epicenter for the disease. We see numerous reports in the media that our hospitals are full, medical staff are struggling and that resources may run low. We have also learnt from WHO reports that we are facing the rapid spread of the Delta-variant of the virus and will perhaps soon see increases in the Lambda variant.

Since the start of this global pandemic, we have been given countless reminders and instruction to keep our distances, to stay masked, to sanitize regularly, not to touch our eyes, mouths, or faces in general, and many other iterations of these. The initial impact of these reminders can be quite effective under normal circumstances; however we are now facing a newer challenge with potentially serious consequences: Caution fatigue.

Caution-fatigue, or pandemic-fatigue has been called by many names, but there is a clear picture emerging on the effect thereof on populations. The strain of making a persistent effort to adhere to our personal daily precautions, and of actively having to remind oneself from each moment to the next to distance, sanitize, mask-up and stay safe is draining and places additional stress on a person.

Our minds have been bombarded with this information, but within our inherent capacity to de-escalate our fight-or-flight systems we lose some sensitivity to the very serious threat that COVID-19 poses. It may be that someone has not been infected and this can create a false sense of security. Furthermore, the decreased personal motivation contributes to this risky situation.

This is not the time to be complacent and “settle in”. We all need to positively reinforce our own personal behaviors and actions. This becomes a matter of developing safer habits, a form of muscle-memory if you will.

The habits that we need to form are not instinctual and do not form a part of the regular protective mechanisms we as humans possess, and therefore it must be practiced daily, and done so to a high standard. If done effectively, and combined with the vaccine roll-out, we should be able to turn around the third wave, but also preserve capacity in the event of a new-variant wave that may develop at a later point in time.

Please enforce these protocols with your staff, to your families and friends and also repeat the importance thereof often. The effort is not only good for one individual, but collectively for the whole community. I wish you well and stay safe out there.

Neil H Wood: *MDent(OMP), PhD,* Managing editor of the SADJ.
Email: neil.wood@smu.ac.za

Relative Value Units (RVU)

SADJ June 2021, Vol. 76 No. 5 p238 - p239

SADA Head Office

What is RVU?

RVU's are a means of measuring the complexity of dental procedures in terms of the experience, judgement, skill, effort and risk involved in performing the procedure as well as the time taken to complete the procedure. These values are the culmination of a 3-year study undertaken by SADA in conjunction with its consultants Deloitte, in order to provide to enable practitioners using the DCalc Tool to accurately and fairly calculate their fees for procedures. The RVU values published are indicative of an average value calculated from a representative sample of a size determined to be statistically relevant for the profession.

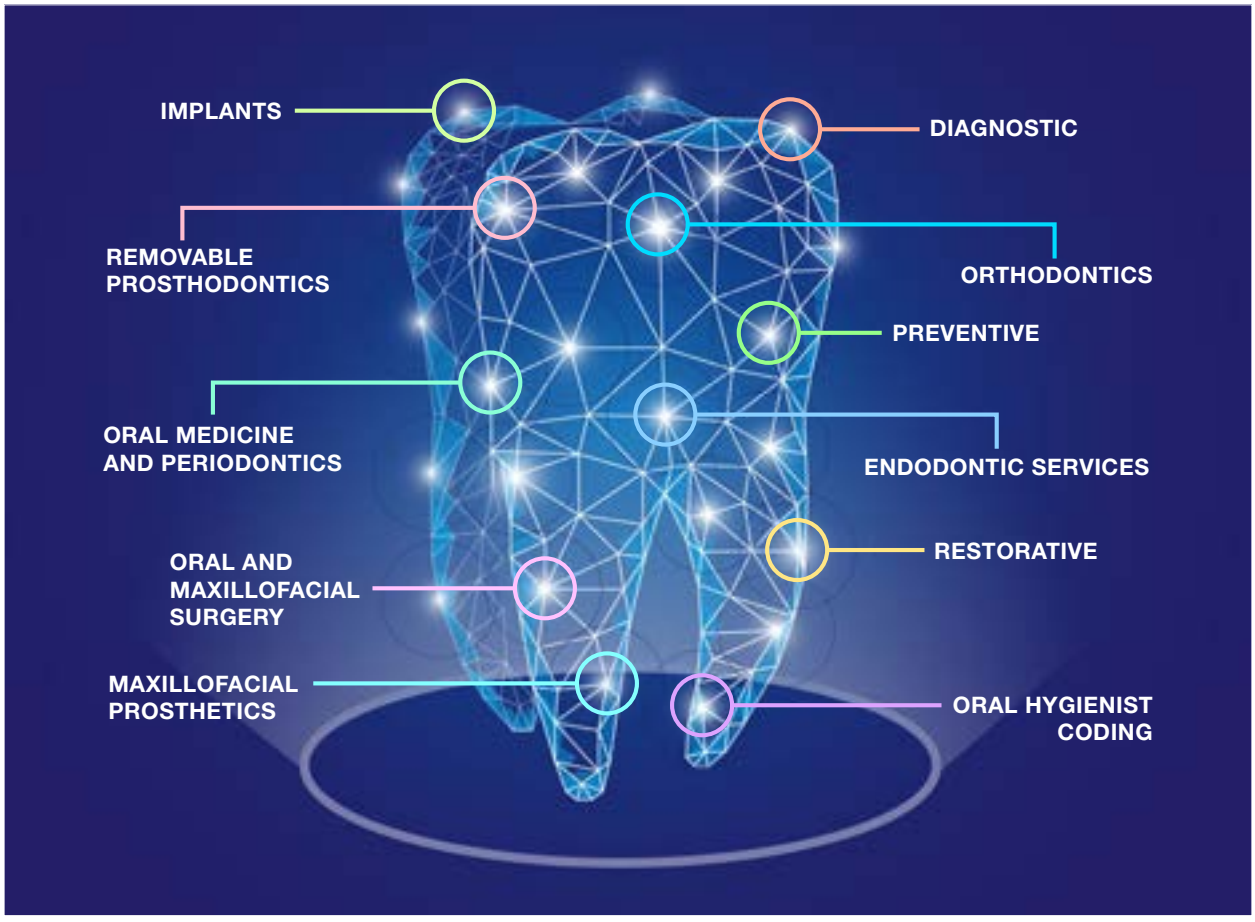
Why was the RVU study done?

The 2021 Dental Codes with an integrated Relative Value Unit (RVU) coding publication is the first of its kind in South Africa.

The policy landscape in the private healthcare industry was for a long time marked by intense regulation by the state through legislation such as the National Health Act and Medical Schemes Act of 1967 etc. The regulations allowed and promoted collective bargaining and co-operation between the medical schemes and the healthcare providers through their Associations. The industry was subsequently partly deregulated in the early 1990s.

In 2004, the Competition Commission was alerted to the above practices of the industry bodies collectively recommending and publishing health tariffs. Consequently, the Commission initiated an investigation against some Associations with regard to the above conduct. The matter was resolved amicably through a consent agreement in terms of which the Associations agreed to determine their own tariffs and individually negotiate its tariffs for reimbursement with individual healthcare providers, as may be required.

Annual determination of tariffs for benefits by schemes was primarily based on their own claims data, contribution or premium income and benefit allocation for dentistry. It bore no relationship to the actual costs of providing dental services and took no account of the fact that



dentistry has evolved tremendously since 2006. Annual increases were thus based on CPI or some equivalent index. Most Schemes also requested coding to be accompanied by data on Relative Value Units (RVUs) for the determination of their benefits. Evidence-based dentistry has resulted in a vast quantity of brand-new procedures for which there never was a relative value unit and therefore no means by which a funder can determine what value should be attached to these new procedures.

How was the study conducted?

SADA engaged Deloitte as consultants for the compilation of the RVU for the dental profession. The SADA RVU Steering Committee was appointed and electronic surveys were sent to practitioners to complete and return to Deloitte. The SADA CEO, RVU project manager and Deloitte project manager then travelled to branch events across the country to facilitate active survey participation. The response was overwhelmingly positive which met the requirements for statistical viability of results. With data collection final complete at the end of 2018, we were ready to calculate and analyse results. The draft RVU results were studied and anomalies addressed with the consultants and final results were accepted in the last quarter of 2020.

Use of RVUs

The RVU values will allow funders to understand value of new procedures by comparing them to existing procedures for which benefits are already available, by assessing the relativity between these procedures. It may go a long way in instilling confidence in the profession as to the manner in which schemes will determine their benefits.

Practitioners are able to use the SADA DCalc practice profitability simulator together with the published RVU to allow practitioners to calculate an individualised rand value for each procedure that factors in their unique practice expenses and expected return on investment. Practitioners will be assisted in this way to scientifically develop their own cost structures personal and custom to their own practice.

RVU and National Health Insurance (NHI)

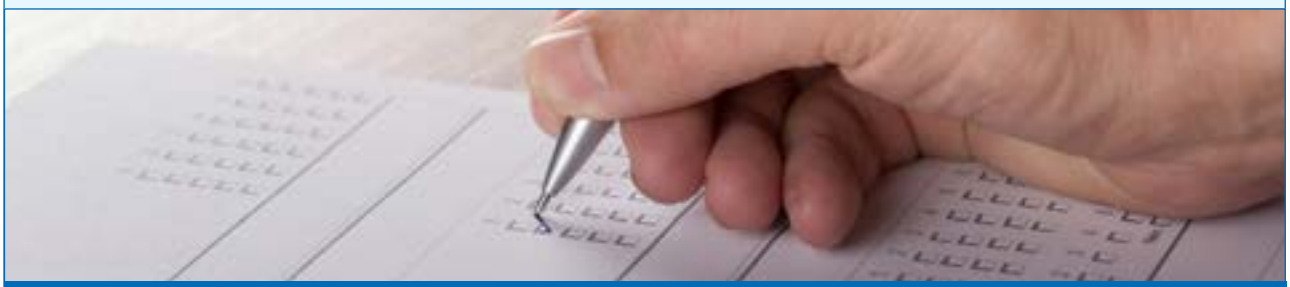
The Council for Medical Schemes (CMS) reported government's planned National Health Insurance is in full development, with plans to move to phase 3 of the programme from next year. Phase 2 of the NHI will include price regulation for all the services included in the NHI Comprehensive benefit framework as recommended by the Health Market Inquiry of the Competition Commission.

The RVU will provide a scientific framework to negotiate in the anticipated NHI bargaining chamber taking into account complexity of the procedures measured in terms of the skill and experience of the practitioner, the risk to both the patient and the dentist, the judgement of the dentist, the effort required to complete the procedure as well as the time taken to do so. These values will be the basis of negotiation between provider groups and the department in order to determine fair remuneration for the practitioner.

Members are advised that RVUs serve as an indicative guideline and there is no obligation on the practitioner to utilise the value provided. SADA is in no way or form using the RVU values as a method of prescribing any fees or any form of standardised pricing. Furthermore, the act of assigning an RVU to a specific code does not in itself guarantee acceptance of that code into the benefit structures of third-party funders.

Do the CPD questionnaire on page 294

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



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4. Select the questionnaire that you wish to complete.
5. Enter your multiple choice answers. Please note that you have two attempts to obtain at least 70%.
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The relationship between the mechanism of injury and mandibular fractures

SADJ June 2021, Vol. 76 No. 5 p241 - p244

I Abdoola[1], MMR Bouckaert[2], TI Munzhelele[3], M Ibrahim[4], JM Mchenga[5]

ABSTRACT

Introduction

This prospective study describes the mechanism of injury, patient demographics and clinical presentation of 100 consecutive patients encountered in the patient population served by the Department of Maxillofacial and Oral Surgery at the Sefako Makgatho Health Sciences University.

Objectives

To determine the demographics, presentation and mechanism of injury of patients presenting with mandibular fractures in the patient population served by Sefako Makgatho Health Sciences University.

Results

Seventy percent of mandibular fractures were secondary to assault. Although this was high in comparison to other studies, it was similar to studies performed in London and other regions of South Africa. Mandibular fractures resulting from MVA (motor vehicle accidents), falls and sports were found to be less than the norm.

Conclusion and recommendations

The high percentage of mandibular fractures due to assault concurs with similar studies previously conducted in South Africa. With some variables similar to international trends, while others are not; certain salient results highlight the need for interventional campaigns.

Keywords

Mandible, fracture, trauma, maxillofacial, injury, jaw.

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2. **Michael MR Bouckaert:** Corrections - 10%
3. **T Irene Munzhelele:** Corrections - 10%
4. **Muniera Ibrahim:** data analysis, researching relevant related articles - 10%
5. **James M Mchenga:** Corrections - 10%

INTRODUCTION

The oldest known literature describing mandibular fractures dates back to the 17th century BC; with the original manuscript believed to have been written during the pyramid age, approximately 3000 BC.[1] This Ancient Egyptian text proposes no treatment for mandibular fractures. Much knowledge and treatment methods were gained during the years of world wars.[2] (Hippocrates) said: *War is the only proper school for a surgeon*. Continued social violence and urban warfare have provided both the need and platform for continued research in the field. The basic principles of traumatology rest on a biologic and anatomic foundation, as was seen by similar fracture patterns by (René Le Fort) in 1901.[3]

DISCUSSION

With an exception of comminuted condylar head injuries, most (>75%) of mandibular fractures occur along areas of primary tensile strain.[4] Biomechanical analysis has shown a greater tendency of higher fractures, along the condylar head and neck, when the mouth was open at the time of injury; whereas a greater tendency of fractures inferior to the condylar head was noted in injuries sustained with the mouth in a closed position.[5,6] The presence of mandibular third molars increases the risk of mandibular angle fractures.[7]

Forces are conducted along buttresses and fractures occur at weak spots. The lowest force required to cause a mandibular fracture is 193 kg, which may fracture a single condyle. 243-250 kg is needed for bilateral condylar fractures and 386-420 kg is required for a symphysis fracture.

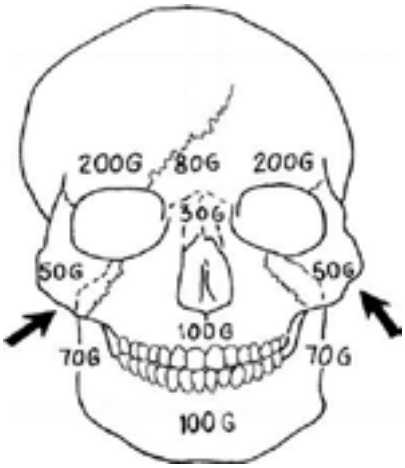

Figure 1. Resistance of force by facial skeleton.[8]

Maxillofacial trauma has been shown to have a wide range of effects, even affecting body posture, which subsequently improves following definitive treatment.[9] Television is widely accessible and is implicated in violent behavioural modification.[10] Alcohol consumption is rampant in South Africa and is associated with violence, traffic accidents, crime, considerable morbidity and mortality; with control measures largely being absent.[11]

Studies conducted in Johannesburg demonstrated that 65%[12] and 53.8%[13] of patients with mandibular fractures had a history of alcohol consumption at the time of injury. Table 1 compares the causes of mandibular fractures of studies from multiple geographic locations, while Table 2 compares the areas of the mandible fractured in these studies.

METHOD

The study sample included the first 100 consecutive, consenting patients who presented with mandibular fractures; thus being a random patient sample. Patient history, demographics and clinical presentation were recorded. Exclusion criteria included non-consent and inadequate history.

RESULTS

Patients were mainly of the third to fourth decade (71%). A male to female ratio of 4.9:1 and an unemployment rate of 65% were noted. The mechanism of injury is summarised in Figure 2. The fracture details and force vectors are summarised in Figure 3, Figure 4 and Table 3.

With 67% of patients injured between 19:00 and 06:00, an active night life appears to contribute to incidence of mandibular fractures. Although 65% of the study population reported unemployment, 76% were alcohol consumers and 55% inebriated at the time of injury; indicating a potential for unproductive efforts resulting in injurious results.

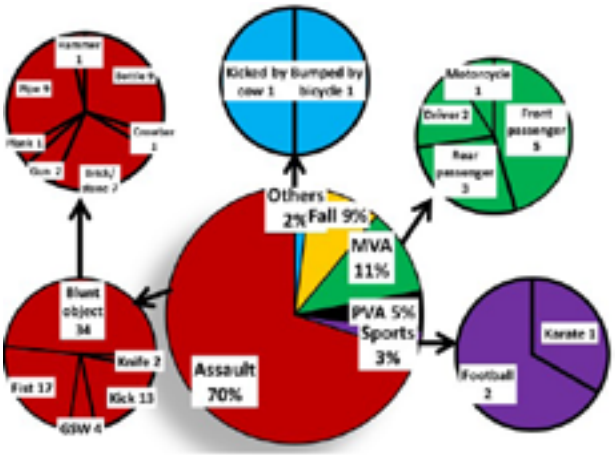

Figure 2. Mechanism of injury.

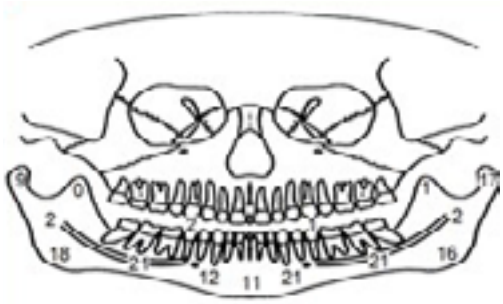

Figure 3. Area of mandible fracture.

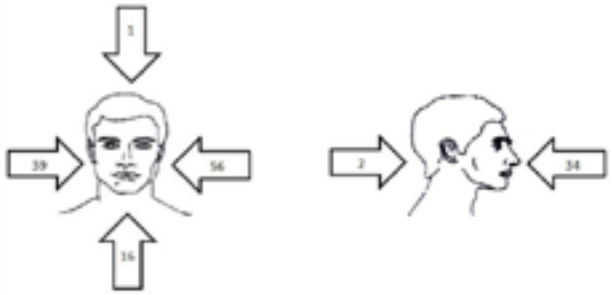

Figure 4. Direction of force sustained.

The percentage (70%) of mandibular fractures sustained secondary to assault was found to be high in comparison to other studies. A higher percentage of assault-related mandibular fractures were noted in London,[19] Pretoria[25] and Ga-Rankuwa[23] (same patient base as current study, but facial fractures studied).

Mandibular fractures resulting from MVA, falls and sports were found to be less than the national and international norm according to studies referenced.

A higher percentage of mandibular corpus and parasymphyseal fractures were found in relation to studies referenced; while a relatively lower percentage of dentoalveolar fractures were noted, possibly related to a referral bias.

With 58% of fractures occurring on the left and 88% of the population being right handed,[26] the effect of assault

Table 1. Comparative cause of fracture.

Model	% Assault	% MVA	% Sport	% Work	% Fall	% Other	Total	Facial/ Mandibular	Male/ Female
International									
Australia[14]	29.9	28	15.4	0	21.3	5.4	100	facial	4:1
Austria[15]	12.3	11.7	31.3	5.3	39.4		100	facial	2.1:1
Bahrain[16]	3.1	44.6	12.3	0	40	0	100	md	6:1
Brazil[17]	30.2	43.9	2.4	0	19	4.5	100	md	5.5:1
China[18]	10.1	43.6	0	4.5	40	1.8	100	md	2.8:1
England[19]	72	4	5	0	18	1	100	md	6.7:1
Pan-Europe[20]	39	11	11	3	31	5	100	facial	3.6:1
Africa									
Benin[21]	13.2	79.9	4.6	0.6	1.7	0	100	md	4.4:1
Nigeria[22]	24.5	67.5	1.3	2.6	3.5	0.6	100	md	4.3:1
Ga-Rankuwa, South Africa[23]	80.6	15	0	0	4.4	0	100	facial	6.6:1
Johannesburg, South Africa[24]	54.3	26.6	0	0	5.3	13.8	100	facial	4.9:1
Pretoria, South Africa[25]	72.5	14.2	1.6	0	8.8	2.9	100	md	5:1

Table 2. Areas of mandible fractured.

%	Condyle	Coronoid	Ramus	Angle	Corpus	Para symph	Symphysis	Dento-alveolar
International								
Australia[14]	7.3	0	16.1	25.1	30	21.5		0
Austria[15]	2.1	0	8.3	10.4			1.3	2.2
Bahrain[16]	24.6	0	0.6	39.1	20.6	15.1		0
Brazil[17]	30	1.3	2.3	15.3	24.3	16.4	8.5	0
China[18]	36.2	0.5	2	13.3	20.7	23.9		3.4
England[19]	27	<1	3	30	9	27	4	0
Pan-Europe[20]	34	2	3	19	22	17		3
Africa								
Benin[21]	9.8	0	8.6	12.3	47.1	15.6	6.6	0
Nigeria[22]	10.8	0.2	1.3	24.6	29.6	21.4	7.8	4.3
Ga-Rankuwa, South Africa[23]	8.5	0.8	3	35.6	18.1	21.4	12.5	0
Johannesburg, South Africa[24]	16.8	0	0	38.9	17.7	19.2	5.4	2
Pretoria, South Africa[25]	14.6	0.5	4.9	12.3	41.1	18.5	4.6	3.5

by the dominant hand of an assailant appears to have an effect on the mandibular fracture configuration of the study group.

A slightly increased incidence of fracture favourability and markedly decreased incidence of fracture comminution is in accord with the expected lower force encountered in the assaults as opposed to a higher velocity injury (Table 3).

To conclude the discussion on an optimistic note, the trend of cause of injury appears to have changed from a previous report.[23] Just as the most common cause of mandibular fractures in Baghdad changed over a period of 10 years from assault by fist to shell and bullet injury,[27] changes in patterns of injury are not uncommon in the same institution at different times. Although (Singh) considered the cause of facial fractures in general,[23] the current study using the same patient base reveals that assault is no longer as common an injurious cause as in 2009 (a decrease from 80.6% to 70%).

Table 3. Fracture details.

	Favourable	Unfavourable
Horizontal	54	46
Vertical	56	44
Teeth in fracture line	Yes	No
	88	12
Multi-rooted	Yes	No
	54	34
Fracture comminution	Yes	No
	26	74

The percentage (70%) of patients with mandibular fractures due to assault is indeed a point of concern, which interventional campaigns may target.

Motor vehicle usage patterns, safety features, road conditions and traffic legislature affect the injury patterns associated with MVA. The role of violent sport, occupational risks and other high risk behaviours are other factors that need to be considered when treating the traumatised patient and implementing preventative measures.

A renewed call is made to invest in campaigns reducing these contributing factors to high risk behaviour in light of the effect displayed on the health of the patient population studied.

CONCLUSION AND RECOMMENDATIONS

The correlation between high risk behaviour and social challenges, such as unemployment, violence, excessive alcohol consumption and disregarding the use of seat belts should be considered on an interventional basis.

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Ethics

SMUREC ethics reference number: SMUREC/D/8240 05: PG.

Conflicts of interest

The authors declare no conflict of interest.

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Primary surgery effect on dental arch relationships of patients born with unilateral cleft lip and palate using the GOSLON yardstick index

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ABSTRACT

Objectives

To score dental arch development using the Great Ormond Street, London, and Oslo (GOSLON) yardstick index, following primary surgery in patients with a complete unilateral cleft lip and palate (UCLP), and to compare the outcome score with the GOSLON score of Cleft Care UK (CCUK) as well as with the Clinical Standards Advisory Group (CSAG), United Kingdom.

Methods

Study models of patients (average age 12 years) with a non-syndromic complete UCLP, who had been surgically treated at the University of Pretoria Facial Cleft Deformity (UPFCD) clinic. They were assessed using the GOSLON yardstick index by certified raters from the Dental School in Dundee, Scotland. The mean outcome ratings were calculated from the scoring of 27 sets of plaster models. The other scoring rounds were used to calculate intra- and inter-observer agreement using Cohen's weighted kappa and Fleiss's multi-rater kappa.

Results

There were strong intra- and inter-observer agreement, with a weighted kappa of 0.92. The Facial Cleft Deformity (FCD) clinic data showed a good treatment outcome with a mean GOSLON rating of 2.85 compared to a rating of 3.2 for the CSAG and 2.62 for the CCUK cohort studies.

Conclusion

The UPFCD clinic primary surgical protocol displayed a good treatment outcome rating, in line with that of the CCUK cohort and better than the CSAG results.

Keywords

Cleft in Africa, Cleft audit. cleft outcome, plaster models.

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1. **Emad Ghabrial:** Primary author - 80%
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INTRODUCTION

Despite the advances in the surgical management of patients with facial cleft deformities (FCDs), there are still many controversies regarding the ideal primary surgical protocols for such deformities.[1-2] Consequently, there is a constant need to assess treatment outcomes of patients treated for cleft lip and palate (CLP) defects to monitor and implement the highest possible standards of care, thus improving treatment protocols for future patients.[3]

Cleft centres in Europe and America have conducted multi-centre studies, for example, Eurocleft and Ameri-cleft, both of which resulted in changes being made to the delivery of cleft care.[4] Although clinical audits have been implemented in different parts of the world,[5] have not yet been carried out in Pretoria, South Africa. This is a collaborative project established under the guidance of the Dental School in Dundee, Scotland. It is an audit for the current primary surgical treatment outcome of the UPFCD clinic.

LITERATURE REVIEW

FCDs represent the largest group of craniofacial deformities of the oral structures, with CLP being the most common.[6] In South Africa, CLP defects incidence is approximately 1.38 per 1 000 for the white and 0.42 per 1 000 for the black population groups.[7]

Facial growth is one of the key areas of interest for assessing the quality of cleft treatment outcomes.[8] Ensuring good facial growth may result in dental arch relationships that can be treated conventionally. Surgical correction of the skeletal bases is avoided, thus providing optimal re-

sults regarding function and facial appearance. It also minimises costs to the patients and health care providers, which consequently lessens the caregiver's burden.[4,9]

The World Health Organization (WHO), in its report "Global strategies to reduce the healthcare burden of craniofacial anomalies," recommended international collaborative research on craniofacial anomalies and issued guidelines for clinical management of patients with CLP.[10-11]

These guidelines have been followed in Europe, North America and other parts of the world. As a result, these regions implemented baseline standards of cleft care with recommendations on improving the quality of cleft services.[2] In Africa, there are many gaps in the knowledge and assessment of the treatment outcome of CLP care due to the shortage of multidisciplinary cleft care services and cleft specialists.[12]

The UPFCD clinic was established in 1983 and is the largest in Africa.[13] The clinic is an ideal setting to conduct studies due to the high volume of patients, ethnic diversity, and retrospective records availability.[14]

Treatment outcome studies allow for comparison between different centres and help provide evidence of cleft care success.[15] These studies also encourage co-operation and collaborative work.[3] Given the potential impact of primary surgical protocols on dentofacial growth and development, one of the most noteworthy findings of the Eurocleft study was the ability to detect differences in dental arch relationships using a simple, yet popular, outcome measure, namely the Great Ormond Street, London, and Oslo (GOSLON) Yardstick.[16]

The yardstick offers a reliable means of measuring dentofacial relationships,[17] using a set of dental study models arranged in five groups from the very best dental arch relationships in unilateral CLP subjects (GOSLON Group 1) to the worst (GOSLON Group 5) (Fig. 1).

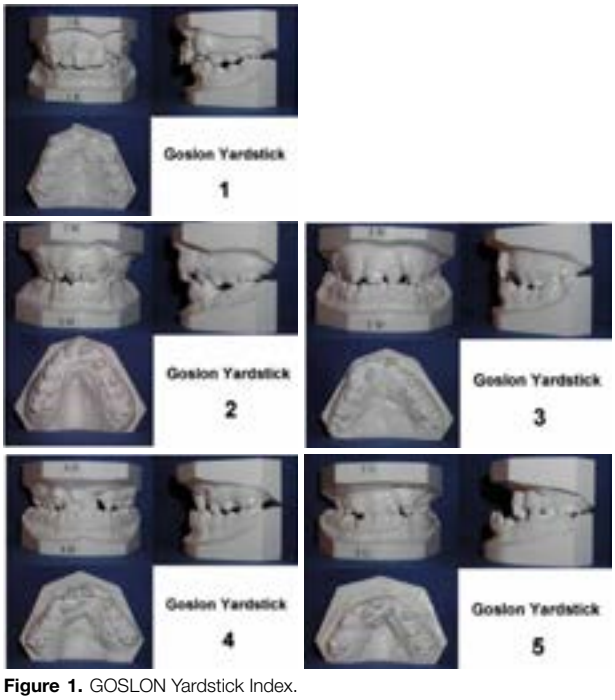


Figure 1. GOSLON Yardstick Index.

Cases falling into Groups 4 and 5 are generally considered so severe that they are beyond orthodontic correction alone and require surgical involvement (Table 1).[15]

Table 1. GOSLON five group's description.

Group	Description	Long-term outcome
Group 1	Positive overjet with average inclined or retroclined incisors with no crossbite or open bite.	Excellent
Group 2	Positive overjet with average inclined or proclined incisors with unilateral crossbite or crossbite tendency with or without open bite tendency around the cleft site.	Good
Group 3	Edge-to-edge bite with average inclined or proclined incisors or reverse overjet with retroclined incisors. Unilateral crossbite with or without open bite tendency around the cleft site.	Fair
Group 4	Reverse overjet with average inclined or proclined incisors. Unilateral crossbite with or without bilateral crossbite tendency with or without open bite tendency around the cleft site.	Poor
Group 5	Reverse overjet with proclined incisors, bilateral crossbite, and poor maxillary arch form and palatal vault anatomy.	Very poor

Numerous studies have been conducted using this measure.[4,16,18] They find GOSLON rating is a reliable, rapid, and clinically valid means of assessing dental arch relationships in patients with UCLP defects. The GOSLON rating is used to provide an audit for primary surgical outcomes and thereby identifies procedures that may need to be changed to improve the treatment outcome.[19] For this reason, the present study was undertaken to follow the worldwide cleft centres' effort to improve CLP care by monitoring the CLP treatment outcome.

OBJECTIVES

The study objective is to assess the effect of the CLP primary surgery protocol of the UPFCD clinic on the dental arches' relationship, using the GOSLON index rating.

METHODS

Ethics approval was obtained from the Research Ethics Committee of the University of Pretoria's Faculty of Health Sciences. The sample of 27 consecutively treated patients (average age 12 years with non-syndromic complete UCLP had not received any active orthodontic treatment. All patients in the sample had their primary surgery protocol performed by the same surgeon at the UPFCD clinic.

The plaster study models collected as part of the routine clinical records appointments were duplicated and sent to the Cleft Lip and Palate Centre at the Dental School in Dundee, Scotland. All models were trimmed in the same manner to eliminate bias and ensure that the assessors could not identify from which institution the models were sent. Numbers were randomly assigned to each model and marked in pencil. No other means of identification was recorded. In addition, matching clinical records sourced from the archives and details such as diagnosis, treatment planning, surgical interventions protocol, and treatment outcomes were recorded.

Data analysis

The GOSLON index was used for each study model, and it was analysed and rated by a blind panel at the Dental School in Dundee, using standardised rating schemes. Examiners were calibrated and went through repeatability and reliability tests to ensure the consistency of recordings.

Statistical methods

The Linear Weighted Kappa statistic and Kendall's Coefficient of Concordance statistic were used to determine agreement levels within and between raters.

RESULTS

There were a strong intra- and inter-rater agreement, with a weighted kappa of 0.92 indicating a very good Kappa values category (Table 2).

Table 2. Categorisation of Kappa values.

Value of K	Strength of agreement
<0.20	Poor
0.21 – 0.40	Fair
0.41 – 0.60	Moderate
0.61 – 0.80	Good
0.81 – 1.00	Very good

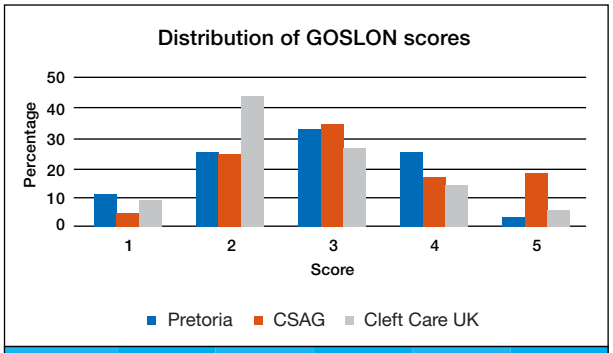
The distributions of the GOSLON score for each centre are shown in Fig. 2.

The mean GOSLON score of the UPCFD clinic was 2.85, which is better than the 3.2 for the CSAG and similar to the CCUK cohort studies of 2.62 (Fig. 3).

DISCUSSION

Treatment outcome audit

In agreement with Shaw et al.[2] and Asher-McDade, Roberts, C. ShawGallager 20 clinical audit and quality assurance to monitor cleft treatment outcome are regarded as a requirement to take remedial action for any treatment shortcomings.



	1	2	3	4	5
UPFCD	11.11	25.93	33.33	25.93	3.7
CSAG	4.5	25	34	17.5	19
CCUK	9.5	43.5	27.5	14	5.5

Figure 2. Distribution of GOSLON scores between UPFCD, CSAG, and CCUK.

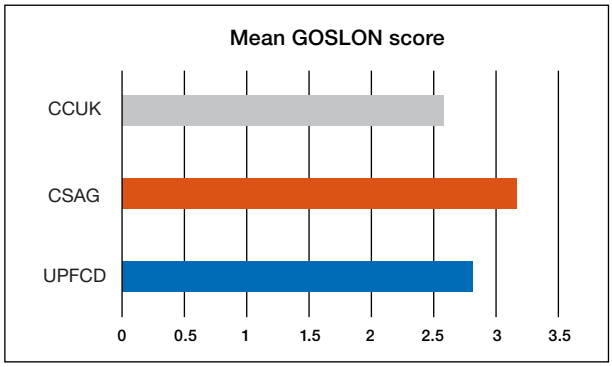


Figure 3. Mean GOSLON scores of UPFCD CSAG and CCUK.

The reason for choosing the GOSLON yardstick index

Assessment of primary cleft surgery's effect on midfacial growth (consequently on the dental arch relationships) is an accepted method.[21] Different indices have been developed based on scoring the dental arch relationship.[22-26]

From all different indices, the GOSLON yardstick index was chosen to score the sample due to its widespread acceptance and to allow multicentre score comparison.[27]

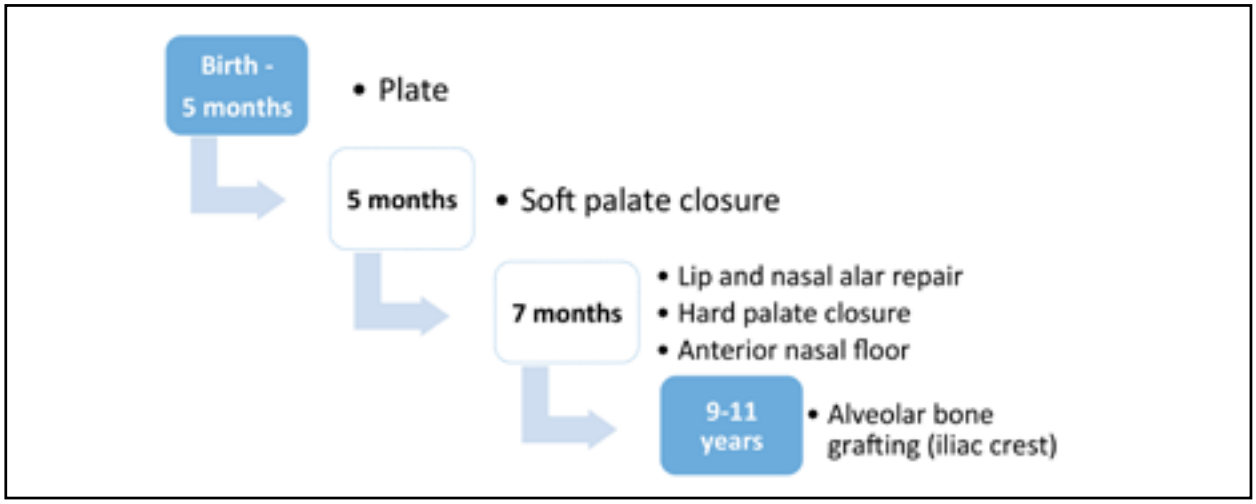


Figure 4. Surgical treatment protocol for UCLP applied to the study sample.

Treatment protocol

The UCLP care protocol of the UPFCD clinic (Fig. 4) consists of a pre-surgical infant orthopaedic (PSIO) plate inserted at age one to two weeks to assist with feeding and speech development to facilitate primary surgery.[28-32] At the age of five months, the soft palate is closed and the hard palate at seven months. Alveolar bone grafting is done at ages 9 to 11 years, using harvested bone from the iliac crest.

The UCLP primary surgery protocol includes two-stage palatal closure and delayed lip closure to assist with an intelligible speech before the child articulates and minimises the negative effect on midfacial growth (in agreement with Hollmann,[33] Precious, Goodday, Morrison, Davis[34]). This contrasts with Lilja, Mars, Elander, Enocson, Hagberg, Worrell,[35] who delayed hard palate closure after three years.

This study found that the hard palate's closure at age seven months did not lower the GOSLON rating. This is in line with the findings of Peterson-Falzone[36] and Willadsen, Boers, Schöps, Kisling-Møller, Nielsen, Jørgensen.[37] This study showed that surgery outcomes using different surgical protocols achieved similar GOSLON ratings.[38]

CONCLUSION

The UPFCD clinic displayed good treatment outcomes comparable to those of the CCUK cohort and the Americleft Study Centre C. This study outcome suggests that the clinical treatment protocol at UPFCD is an effective strategy for treating patients with UCLP regarding favourable maxillary development. Future research is recommended to continue monitoring the UPFCD surgical treatment outcomes and participate in multicentre studies.

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Oral health knowledge, attitudes and practices among school teachers in Tshwane district, South Africa

SADJ June 2021, Vol. 76 No. 5 p250 - p255

T Mfolo[1], TK Madiba[2], A Bhayat[3]

ABSTRACT

Introduction

Teachers are perceived as role models and studies have shown that they can enhance the oral health behaviour of young children.

Aims and objectives

To assess the oral health (OH) knowledge, attitudes and practices of public school teachers in a district in Pretoria, South Africa.

Methods

This was a cross sectional analytical study. The sample comprised of six schools that were randomly selected within the Tshwane West sub district. A total of 160 teachers were included. A modified, self-administered, validated questionnaire was used to obtain the data.

Results

Of the 160 teachers included, 97 (61%) completed the questionnaire. The majority (80%) were female and the mean age was 38.23 years (±12.85; 22-66). More than 80% had an adequate level of OH knowledge, 94% reported it was important to visit a dental practitioner (DP) regularly and 94% believed that OH education should form part of the teaching curriculum. The most common reason for visiting a DP was toothache (32%) while fear (35%) was the most common barrier.

Those with a higher mean age were more likely to brush frequently ($p<0.01$), utilise dental aids ($p=0.01$) and visit a DP regularly ($p=0.02$).

Conclusion

The majority of teachers had adequate OH knowledge. The respondents with a higher mean age were more likely to brush frequently, use dental aids and visit a DP regularly.

Workshops for teachers are required to improve current levels of knowledge and address any queries regarding prevention and diagnosing of dental diseases.

Keywords

Oral health, learners, knowledge, school teachers, attitudes, practices.

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2. **Thomas K Madiba:** Second author: scientific writing, proof reading manuscript - 35%
3. **Ahmed Bhayat:** Third author: data analysis, proof reading manuscript - 25%

INTRODUCTION

Children spend most of the time with teachers throughout their school years in which much of their knowledge and skills are developed.[1] Teachers are perceived as role models and studies have shown that teachers can enhance the dental health behaviour of young children.[1-3] It is therefore important to determine the oral health (OH) knowledge, attitude and practice of teachers in order to ensure that they provide appropriate and accurate OH information to their learners. Studies have reported that teachers with good OH knowledge are more confident in teaching young children about their OH compared to those with poor knowledge.[4-6]

Many studies carried out among future and current school teachers reported that their oral health knowledge was mostly insufficient and inaccurate.[6-9] The teachers' insufficient knowledge and lack of skills and motivation to offer OH education showed possible adverse consequences on learners' oral health.[7]

Schools provide an important setting for promoting good health by allowing learners to develop lifelong sustainable attitudes and skills.[10] It is essential to provide OH education in schools and it is considered to be easily integrated into general health promotion, school curricula and activities.[11] If teachers have sufficient OH knowledge, they could act as role models and sustain the schools' brushing and rinsing programmes. Dental health affects general health, well-

being, education and development of children.[11] Children suffering from dental caries (DC) and other OH problems have shown adverse effects in their development and participation in essential life activities.[11] The presence of oral pain and infection can limit food intake, consequently affecting the learners' growth, learning, communication skills and recreational activities.[12]

Children with oral diseases were more likely not to participate in normal activities and miss school hours compared to those without oral diseases.[11] A study has reported that more than 50 million school hours can be lost annually as a result of oral diseases which can affect learners' performance at school and success in later life.[13] Hence, the prevention of oral diseases at an early age could lead to a reduction in the initiation of systemic conditions, decrease the number of days lost from school and improve the general quality of life.

Limited studies have been conducted in South Africa to determine the OH knowledge, attitudes and practices of primary school teachers. The results from this study can help identify gaps in their knowledge in order for appropriate workshops to be conducted. The workshops can possibly improve their current knowledge and identify challenges faced by the teachers when implementing school brushing programmes.

The aim was to assess the OH knowledge, attitudes and practices of primary school teachers in Pretoria, South Africa.

MATERIALS AND METHODS

A cross sectional analytical study design was used. A cluster sampling technique was used to obtain the necessary sample of teachers. The study was conducted during February to March 2018. A list of all public primary schools in the Tshwane area were identified and due to time and financial constraints, only schools in sub district Tshwane West were selected. There were 86 schools in this sub district and each of them had an average of 30 teachers. In total there were 2580 teachers and with a confidence level of 95% and margin of error of 10%, a minimum of 93 teachers were required.

Six schools were randomly selected in order to obtain the minimum sample of 93. There were a total of 160 teachers employed at these schools and all of them were included in the study sample. Inclusion criteria compromised of all full-time primary teachers from the foundation phase to the intermediate phase (Grade 1 to Grade 7). All part time and student teachers, administrative staff and the principal were excluded from the study.

The data was collected using a modified self-administered questionnaire that was based on a previously validated questionnaire.[1] The original questionnaire was prevalidated hence no validity tests were done.[1] The questionnaire was paper based and in the English language. It was distributed to the teachers during school hours and consisted of four sections; demographic information (5 questions), knowledge (14 questions), attitudes (5 questions) and practice (6 questions) patterns of teachers towards oral health. There was one open- ended knowledge question namely: "What do you think caused the teeth to get rotten?" The questionnaire was anonymous and confidential. It was hand delivered to the principal of each school who then distributed it to the teachers. The completed forms were collected after one week. Written consent was obtained from each participant who signed the cover letter detailing the rationale for the study. Ethical clearance was obtained from the Faculty of Health Sciences Research Ethics Committee, the ethics clearance number is 245/2016.

The knowledge score was calculated by the sum of each knowledge based question which was scored either one (1) if correct or zero (0) if incorrect. The maximum amount of correct answers were 16 and a score of 75% or more was classified as "adequate" while a score below 74% was classified as "inadequate". The open-ended knowledge question responses were grouped according to themes and reported accordingly.

The attitudes and practice responses were classified as either "yes", "no" or "I don't know" Their attitudes were obtained through questions such as importance of dental visits, willingness to teach OH education to learners and whether it should be introduced into the teaching curriculum.

The OH practices of teachers was obtained by asking questions related to the reasons and frequency of dental visits, brushing frequency and oral hygiene aids used for maintaining good oral hygiene.

Data was entered into Microsoft Office Excel spreadsheets, after which, it was checked for completeness, duplicates and for missing values. Once verified to be complete, the data was exported to the Statistical Package for Social Science software, SPSS ver.25. Quantitative variables were summarized as proportions, frequencies and means with standard deviations, range and percentages. The Chi square and ANOVA tests were used to evaluate the association between variables and the mean scores. The level of significance was set at $P< 0.05$. The study received ethics clearance from the Research Ethics Committee.

RESULTS

Out of the 160 teachers invited to participate, 97 (61%) completed the questionnaire and were included in the study. The majority (80%) were female and the mean age was 38.23 years (±12.85; 22-66). Only 87 respondents recorded their age and were included in the associations between age and other variables.

Knowledge

The majority of respondents answered the questions correctly (**Table 1**). More than two-thirds (84%) had a score of 75% or more and were classified as having an "adequate" level of OH knowledge. Although not statistically significant ($P =0.15$), teachers who obtained "adequate" knowledge score (≥75%) were generally older (38.7 years) compared to those who obtained a "inadequate" (<75%) knowledge score (33.4 years).

For the open-ended qualitative question that sought to find causes of "rotten" teeth, three themes were identified. The authors agreed to these themes after examining the responses. Only seventy-eight responded to the question which meant that 19 (24%) probably did not know the right answer. Out of the seventy eight that responded, twenty nine (37%) responded that the cause of dental caries was a combination of dietary factors such as sweetened diets including drinks and poor oral hygiene practices (Theme 1). Thirty-eight (49%) explained that the cause of dental caries is poor oral hygiene practices (Theme 2) whilst eleven (14%) indicated that the cause of dental caries was poor diet including sugar sweetened beverages (Theme 3).

Attitudes

The majority (94%) of respondents felt it was important to visit a dental practitioner (DP) regularly; 88% indicated that they were willing to teach learners about OH while 94% felt that OH education should form part of the curriculum (Table 2). Of those who felt that OH should not be taught at school, more than half (53%) cited lack of time as a barrier while 42% felt that they had inadequate knowledge which deterred them from teaching OH education.

Practices

A third of the respondents (35%) claimed to visit the DP annually and 25% reported to only visit a DP when in pain (Table III). The most common reasons for visiting a DP were toothache (32%) and sensitive teeth (13%).

The majority of teachers reported to have not visited a DP due to fear (35%) and the high cost of dental treatment (32%) (Table 3). More than half (53%) confirmed that their DP spoke to them about prevention of dental diseases at their last visit. The majority of respondents (83%) reported brushing twice a day with 33% reporting to use toothbrush, toothpaste, floss and a mouth rinse.

Approximately two-thirds of the participants (66%) reported to brush both morning and evening and 14% brushed only in the mornings. Almost half of the teachers (47%) reported to be replacing their toothbrush every three months and 29% reported to replace their tooth brush every six months. There was a positive correlation ($P<0.01$) between those who received preventive information from their DP and the need for the inclusion of OH education into the teaching curriculum.

Table 4 displays the associations between the mean age and OH practices. Those with a higher mean age were inclined to brush more frequently ($P<0.01$), use a toothpick more often to clean their teeth ($P=0.01$) and visited a DP more regularly ($P=0.02$) compared to their colleagues with a lower mean age. The number of respondents included in the association between age and oral health practices (87) were much lower than those reported in Table 3 (93). This was due to the fact that not all respondents included their age and as such, when performing the statistical test, these were excluded.

DISCUSSION

More than 70% of the respondents had adequate knowledge concerning OH and this was much higher than other similar studies in India, where the teacher's level of knowledge was reported to be between 44% and 56%.[14,15] In a study conducted in Tanzania, the knowledge of teachers was reported to be 50%.[6]

The fact that teachers in this study had adequate knowledge is encouraging as these teachers play an important role as role models to the learners. It was also interesting to note that older teachers had more knowledge than younger teachers and this might be due to the fact that they had experienced dental problems in their lives and might also have been exposed to dental education.

The finding is similar to a study done by Shodan et al., which showed that experienced teachers had more knowledge as they might have gained knowledge through years of teaching experience.[16] In an open-ended qualitative question, only twenty nine (37%) had a correct answer for the causes of dental caries which was that dental caries had a multifactorial aetiology (complex of "bacteria + sugar"). The majority of teachers (49%) exhibited knowledge of the role of bacteria in caries aetiology, and very few (14%) of them were aware that high

Table 1. Distribution of respondents who answered the questions on oral health knowledge (n=97).

Knowledge item	Correct answers - n (%)	Incorrect answer - n (%)
1. What do you think can cause bleeding gums?	**96 (99)**	1 (1)
2. How can you protect yourself from gum disease?	**90 (93)**	7 (7)
3. What is dental plaque?	**67 (69)**	30 (31)
4. What is calculus?	49 (51)	48 (49)
5. What can dental plaque cause?	89 (92)	8 (8)
6. Can eating sweets cause dental problems?	**95 (98)**	2 (2)
7. Can drinking soft drinks (Coke, Fanta, etc) cause dental problems?	**95 (98)**	2 (2)
8. Does the health of mouth and teeth impact on the health of the body?	94 (97)	3 (3)
9. Do you think we need to treat tooth pain and bleeding gums?	96 (99)	1 (1)
10. Does brushing and cleaning your teeth regularly prevent rotten teeth?	**95 (98)**	2 (2)
11. Does your current toothpaste contain fluoride?	**82 (85)**	15 (15)
12. What does fluoride in toothpastes do for your teeth?	90 (93)	7 (7)
13. Does using a tooth brush help to prevent gum disease?	87 (90)	10 (10)
14. Does using dental floss help prevent gum disease?	88 (91)	9 (9)

Table 2. Attitudes of teachers about oral health (n=97).

Attitudes	Yes - n (%)	No - n (%)	I Don't Know - n (%)
Are regular visits to the dentist necessary (n=96)	**90 (94)**	6 (6)	**0 (0)**
Introducing oral health into the school curriculum (n=97)	**91 (94)**	4 (4)	**2 (2)**
Are you willing to teach learners about oral health and brushing techniques? (n=95)	**84 (88)**	9 (9)	**2 (3)**
Reasons for not willing to teach learners about oral health in the school curriculum (n=9)			
Lack of time (n=5)	53%		
Inadequate knowledge (n=3)	42%		
Not interested (n=1)	5%		
It's not important (n=0)	0		
*The n varies since not all respondents answered all the questions on attitudes.			

Table 3. Practices of teachers in relation to their oral health care (n=97).

Frequency of DP visits (n=92)	N* (%)
Once a year	**32 (35)**
Twice a year	**23 (25)**
When in pain	**23 (25)**
Occasionally	14(15)
Reasons for the last visit (n=93)	
Toothache	**30 (32)**
Sensitive teeth	12 (13)
Dentist advice	10 (11)
Others (check-up, halitosis, gingivitis, advice from friends and family)	**41(44)**
Reasons for not visiting a DP (n=92)	
Fear of dental treatment	32 (35)
High cost of dental treatment	29 (32)
No reason	20 (22)
No time	11(11)
Frequency of brushing (n=93)	
Once daily	10 (11)
Twice daily	77 (83)
More than two times	6 (6)
What aids do you use to maintain good oral health (n=93)	
Toothbrush and paste	**26 (28)**
Toothbrush, paste and mouthwash	11(12)
Toothbrush, paste and floss	20 (22)
Toothbrush, paste, floss and mouthwash	**31 (33)**
Others	**5 (5)**
What aids do you use to maintain good oral health (n=93)	
Every month	**9 (9)**
Every 3 months	44 (47)
Every 6 months	27 (29)
Annually	**6 (7)**
When its worn out	**7 (8)**
*The n varies since not all respondents answered all the questions on practices.	

Table 4. Association between oral health practices and mean age of respondents.

Daily frequency of brushing (n=87**)	N	Mean age	P value*
Once	**10**	32.00	
Twice	**72**	37.82	**<0.01**
More than two times	**5**	53.60	
Method of cleaning (n=75**)			
Toothbrush and paste	25	37.36	
Toothbrush, paste and floss	**17**	34.94	0.01
Toothbrush, paste, floss and mouthwash	28	38.29	
Toothbrush, paste, floss and toothpick	5	59.83	
Frequency of dental visits (n=85**)			
Once per year	31	39.87	
Twice per year	**19**	43.84	0.02
When in pain	23	36.88	
Occasionally	12	30.08	

*Chi-Square.
**The n varies since not all respondents answered all the questions on practices.

level of sugar consumption can cause dental caries. This is in contrast with the studies done by Sekhar V et al., Verma et al., and Khan et al where the majority of the study participants had knowledge regarding causes of dental caries i.e. bacteria + sugar complex.[2,17,18]

The findings of this study are concerning and indicative of the gaps in knowledge and the need to conduct oral health workshops for the teachers, to thoroughly explain the cause of dental caries. This will in turn, empower the teachers to disseminate correct information to their learners.

Twenty three (25%) reported to have visited a DP only when in pain; this was lower than a similar study that reported that 38% of teachers visited a DP when they had pain.[15] A vast majority of teachers (94%) felt it was important to visit a DP regularly and this was higher than similar studies.[2,19] The results of this study are encouraging as it shows that the teachers realized the role that DP play in the prevention of oral diseases.

It was interesting to note that the teachers with a higher mean age were more likely to brush their teeth and visit a DP more frequently compared to those with a lower mean age. These results are similar to a study conducted in Saudi Arabia where older teachers, with more experience, believed in brushing more frequently and visiting the DPs regularly.[20]

In general, these teachers with a higher mean age had more knowledge about OH diseases than their counterparts with a lower mean age. The younger teachers could have had less exposure about oral health education compared to the older teachers. The older teachers are more likely to have children and grandchildren; therefore, they might have taken them to the DPs, as a result giving them more exposure to oral health information. This finding suggests that when offering oral health education messages in schools, special emphasis should be placed on younger teachers to inform them of the danger of neglecting oral health.

This study's findings should be interpreted with caution, as there are some study design limitations. For example, this was a cross-sectional study; therefore, causality cannot be inferred. Although the minimum sample size of 93 was reached, the response rate of 61% was considered low and this could be due to the fact that the questionnaires were left at schools to be collected later or due to a lack of time or interest.

The majority of teachers were female (80%), this is similar to the studies done by Sekhar V et al. in Pondicherry and Verma et al. in Faridabad, where most of the study subjects were female i.e. 79% and 80% respectively.[2,17] This might have been due to gender differences in job-related preferences and societal roles. This might have a positive input in disseminating OH messages to the learners, as females are generally primary caregivers. Response acquiescence is common among questionnaires that tend to determine habits that are considered taboo or have negative connotations. There was no oral examination conducted to verify the OH status of these teachers and to corroborate their responses.

The majority of teachers reported to have an acceptable level of OH knowledge. Almost half reported to visit a DP regularly and agreed on the importance of including OH into the teaching of young children. This was an important finding as it showed that teachers realised the importance of good oral health and were willing to include it into the teaching curriculum. Meetings and workshops should be arranged between teachers and oral health workers to improve their knowledge by providing oral health infographics and posters. These teaching aids can assist in spreading oral health information amongst both teachers and learners.

The most common reason for visiting a DP was toothache and the most common barrier to dental care was fear. This shows that teachers did not visit dentists or oral health care workers for prevention and only when in pain. Additional information must be shared with the teachers highlighting the importance of prevention in dental care compared to curative care. The high levels of fear preventing access to dental care could be the reason why these participants stated they only visited a dentist when in pain.

CONCLUSION

Although the knowledge, attitudes and practices were adequate, gaps were identified and workshops should be implemented in order to improve the existing levels of OH knowledge amongst this cohort of teachers. Teachers should be allowed more time for including OH into their teaching curriculum.

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Publication

No prior or duplicate submission of the manuscript has been made elsewhere of any part of the work.

Conflicts of interest

There are no conflicts of interest.
The manuscript has been read and approved by all the authors. The requirements of authorship have been met and each author believes that the manuscript represents honest work.

Clinical significance

This study is essential when considering the role that teachers play in the development of young children. If the teachers can impart good oral hygiene practices to young children, it will have an impact on their oral and general heath in their future and the future of the next generation.

This study identified gaps in the oral health knowledge of teachers. As a result, workshops will be planned by our staff members for all the teachers in these schools to improve their current levels of knowledge and answer any queries they may have regarding the prevention and identifying of dental diseases.

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Perceptions of dental therapy students regarding the teaching and training with dental amalgam, in a dental school in KwaZulu-Natal, South Africa

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INTRODUCTION

Dental amalgam has been used as a restorative material in dentistry for the past 150 years. This material has been used to restore posterior teeth throughout the world and is also used in South Africa.

Dental amalgam has been the material of choice for patients presenting with large tooth decay areas, including the loss of cuspal areas.[1] The reason for this is that dental amalgam was always considered strong and durable. Compared to alternate dental materials, this material could also withstand the significant forces associated with chewing and biting.[2] Dental amalgam is also considered more cost-effective than alternate dental materials such as conventional glass ionomers, resin-modified glass ionomers, resin composite and ceramic restorations, making it more feasible and material of choice in lower economic countries, including South Africa.[3]

Due to the increased awareness of mercury toxicity, there has been an introduction of alternate dental materials such as glass ionomers, resin ionomers, and resin composites.[2] Resin composites have been available for the past 40 years.[3] During this time, numerous developments have been made to improve the material's strength and aesthetics. Resin composites are now the material of choice due to their high aesthetic value. Resin composites also require minimal tooth preparation, resulting in the conservation of a healthy tooth structure.[3]

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1. **Sharmila Bissoon:** Study design, data collection, data analysis, and drafting the manuscript, read and approved the final manuscript - 50%
2. **Rajeshree Moodley:** Supervision of the entire work, study design, and manuscript review, read and approved the final manuscript - 50%

They are generally micro-mechanically bonded to the tooth, which results in the tooth's overall strength. The newer composite materials are also more durable and, therefore, comparable to amalgam restorations in terms of strength. However, documented studies by Fernandes, Vally and Sykes (2015) and Hurst (2014) reveal that a composite restoration's survival rate is lower than an amalgam restoration in the long-term evaluation.[4,5] This is due to polymerisation shrinkage, which occurs during the setting reaction, resulting in microleakage underneath the restoration.

Another disadvantage of a composite restoration is the difficulty in achieving tight contact between teeth due to poor matrix band application. This results in secondary caries, which in turn requires the replacement of the restoration.[6] There are now advances in matrix systems and composite materials and the improved skills and expertise of the practitioner. We can now look at replacement rather than repair.[7]

The earlier composite material, the micro fills, lacked condensable properties and strength and were not used in load-bearing areas such as posterior teeth. Now bulk-fill composite material has been introduced.[8]

The Minamata Convention was an international conference that was held in October 2013 in Kumonata, Japan, which included delegates from 140 countries, including South Africa.[9] This treaty was introduced to protect human and environmental health from the emissions and release of mercury and mercury compounds.

The Minamata Convention also called for a phase-down approach to dental amalgam through greater emphasis on prevention, research into new dental materials, and best management practice regarding amalgam disposal.[10] In November 2019, the parties considered a proposal to phase out dental amalgam by 2024, except in cases where no alternative is available.[11]

This study was conducted at the dental faculty of the University of KwaZulu-Natal, South Africa, to gain insights from the students regarding their perceptions about dental amalgam training.

The School of Dentistry is located within the Faculty of Health Sciences. The programmes offered include the Degree in Dental Therapy and in Oral Health. Teaching in the basic and social sciences and the preclinical components occur at the Westville campus. All clinical teaching occurs at the Oral and Dental Training Centre, in Sydenham, KwaZulu-Natal.[12]

The scope of practice of dental therapists in South Africa is considered more extensive than in most other countries.[13] They can treat adults and children and do not require any supervision from dentists or dental therapists once they have completed their mandatory service.[13]

METHODOLOGY

This was a descriptive cross-sectional case study conducted between February and June 2020 to determine undergraduate dental students' knowledge and attitudes towards the use of dental amalgam in the current dental training curriculum.

A combination of quantitative and qualitative data was obtained to ensure that the data's strengths and limitations were balanced. This helped to ensure greater understanding by integrating both types of data.[14]

The study site was the University of KwaZulu-Natal, a university with five campuses in KwaZulu-Natal in South Africa. UKZN is one of two universities in the South that offers the Bachelor of Dental Therapy degree.

All participants in this study included dental therapy students (n=109) because the university, at this stage, was not enrolling oral hygiene students. The response rate was nearly 70%. The second- (n=50) and third-year (n=59) students participated in the study. Students in the first year of study were excluded because they had no experience in restorative dentistry. Students in the second year of study are introduced to dental materials in the lectures and have preclinical laboratory training on the phantom head and observe the third-year students in the clinic while working on patients. The third-year students are involved in clinical training at the Oral and Dental Hospital, where they perform restorative procedures.

Data captured from the questionnaire were entered into Microsoft Excel and analysed using Statistical Package for the Social Science (SPSS), version 26. Descriptive and inferential statistics were calculated, including the percentage and 95% confidence interval positive response to questions. A Chi-square test was used to test the associations between variables. All the tests are two-tailed, and the criterion for statistical significance was set at 5% level.[15]

Data collection

The research instrument included a self-administered questionnaire comprising both open-ended and closed-ended questions. Open-ended questions were used to allow the participants to express themselves to answer based on their complete knowledge, feeling and understanding of the topic. An example was, "Do you feel that the university prepared you adequately to place restorations, provide a reason". The open-ended questions analysis from the students' responses contributed to the study's qualitative method.

The questionnaire included 20 items designed to assess students' knowledge and perceptions regarding the use of dental amalgam, both in the preclinical laboratory and the dental clinic. The first part of the questionnaire consisted of sociodemographic data, such as age, sex, year of study, knowledge of dental amalgam, and understanding of the relationship between what is taught and what is practised.

The second part of the questionnaire included variables, such as exposure to various dental materials, the first dental material introduced to the phantom head, clinical training time for dental amalgam, clinical training time for resin composite, and the material used more often on outreach programmes. The questionnaire also included questions on the choice of dental material used in the clinic, the clinical supervisor's influence on the type of material used, and the type of cavity design preparations.

The questionnaire also included questions regarding knowledge of the Minamata Convention and the phase-down of dental amalgam. The third part of the questionnaire focused on the knowledge regarding trends in other countries regarding the use of dental amalgam and whether composite should completely replace amalgam in dental training. Scientific validity is applicable in quantitative research andis concerned with how an assessment tool measures what it is intended to measure.[16] This questionnaire was designed to allow the researcher to achieve the intended aims and objectives for this study.

Reliability in quantitative study design can reproduce the same results if a particular instrument is used at different times and by different researchers.[16] Reliability was maintained by double-checking the data during data entry and was verified by the research supervisor.

Ethical approval

The study was granted ethical clearance by the Humanities and Social Sciences Research Ethics Committee at the University of KwaZulu-Natal (ref. no. HSSREC/00000622/2019). Gatekeeper permission was also granted from the registrar at UKZN. Written informed consent was obtained from all participants. Students were made aware that the study was voluntary and that participants were free to withdraw from the study at any stage without any negative consequences.

The questionnaire was administered in the English language after confirming that all the participants were comfortable with the language. All other ethical issues, such as confidentiality and anonymity, were maintained. Data were analysed using SPSS version 26.0 (IBM Corp., USA). The responses to the open-ended questions were grouped, and emergent themes were examined and compared for possible associations. Inferential techniques included Pearson's $\chi 2$ test to assess a possible relationship between the independent variables (age, sex, and year of study) and the dependent variables (first material used

in the preclinical dental laboratory, and use of dental material in outreach programmes). A $p<0.05$ level was established as being significant.

The participants were given codes to identify them when the responses to the open-ended questions were pre sented: Second-year students were numbered from P1 -P41, and the third-year students were numbered from Pi- Pxxxiv.

RESULTS

One hundred and nine questionnaires were distributed among the second- and third-year dental therapy students. Seventy-five questionnaires were returned, yielding a 70,75% response rate. The response rate was in proportion to the population total, i.e., 34 students in the third year of study and 41 students in the second year of study. In the second year, the gender distribution of students comprised an almost equal distribution of females 51,22% (n=21) to males 48,78% (n=20).

The third-year students were mostly female 85,3% (n= 29) with 14,7% (n=5) males. The data collected was presented separately for the second- and third-year students, as the second-year students were involved in preclinical training in a skills laboratory and assisted and observed the third-year students in the clinic. The third-year students had performed restorations on patients.

The separation of the results helped prevent the data from being skewed and to prevent bias. However, both the second- and third-year students were given lectures and tutorials on dental amalgam as well as other dental materials.

1. Knowledge regarding dental amalgam training

Second-year students

The results of the data gained from the questionnaires revealed that 100% (n=41) of second-year students indicated that the first material introduced in the preclinical laboratory was resin composite. Approximately eighty-five percent (n=35) of the students had also indicated that more than 50% of their preclinical time was spent on teaching and training in resin composite and other dental materials. 60,5% (n=25) of students indicated that they did not have adequate training in the various types of cavity design preparations. 36,6% (n=16) indicated that they had sufficient exposure to the various types of material in the dental clinic. 55% (n=23) second-year students indicated that they felt that the university prepared them adequately to place restorations.

Third-year results

The third-year students' findings indicated that 85,3% (n=29) were female, and 14,7% (n=5) were male. Approximately seventy-five percent (n=25) agreed that the university prepared them adequately to place restorations, 17,65% (n=6) were unsure (neutral), and 8,8% (n=3) disagreed that the university had prepared them sufficiently to place restorations. Students also had varying responses with regards to them having adequate exposure to the various types of dental materials available in the clinic: 50,1% (n=17) agreed, 38,2% (n=13) were unsure (neutral), and 11,7% (n=4) disagreed.

2. Preparedness of students

Students' preparedness was an indication of whether students felt that they were sufficiently prepared to per form cavity preps for amalgam and composite restorations and if they felt that they had enough exposure to the different types of material required for restorative dentistry.

Second-year students

The qualitative data analysis indicated some of the reasons students felt that they did not have adequate exposure to the various types of cavity preparations 60,5% (n=25).

One of the reasons stated for this was firstly a large number of registered students. The following statements supported this:

P2: "Due to the large number of students in this degree, we do not get much time to practice."
P3: "There were many students, and due to that, it was hard to be taught properly."
P4: "Due to large class sessions, everyone does not get adequate exposure to perform restorations."
P17: "not enough practice"
P38: "We had a short time to learn everything about restorations."

Some of the responses from participants who felt that the university prepared them sufficiently to place restorations are as follows:

P5: "There was plenty of restorative pracs in the lab."
P23: "We are taught things that we are supposed to know, no time wasted on things we don't need to know."
P16: "Because they gave us important information for restoration placement."
P27: "very well trained lecturers."

Third-year students

The following quotes justify some of the reasons given by the students who agreed that the university prepared them sufficiently to place restorations:

Pv: "I know the different materials and how to manipulate them for different situations and restoring and constructing is my favourite compared to extractions."

Pvi: "Learnt all about recent materials, cavity design and minimal intervention dentistry."

Pviii: "The clinical practical were so useful."

Pxxiv: "Subject was well done in which we manage to know the advantage and disadvantage, the indications and contra indication and the chemistry of the dental, materials."

Pxvii: "The lectures and notes that were given were detailed and I found it very useful. It gives explanations and reasons why you need to prepare your cavity in such a way, and also we learnt about the properties of materials and how to manipulate these."

Pxii: "Adequate information were given about restorative materials and which one is more effective. My knowledge has increased about their properties and it's use."

Approximately 11.2% (n=4) of students did not agree that the university prepared them sufficiently to place restorations. Some of the responses stated by the participants were as follows:

Pi: "Students are not adequately prepared as demonstrations were done only once in groups of 20 students, as well as inadequate exposure to patients due to lack of equipment and a large number of students."

Pii: "We had learnt the basics that would enable us to place restorations, but this could have been improved by increased exposure to various materials and techniques."

Piii: "There was not enough clinical exposure throughout the year."

Piv: "Hardly got to do amalgam restorations and as a result, feel that I lack the skill to do an amalgam as more time went spent doing and getting used to composite materials."

Students were satisfied with the lectures and tutorials. However, due to the limited time and large class numbers, 11.2% (n=4) felt that they did not have enough practical training in placing the various types of dental materials.

3. The practice of students using dental amalgam

Second-year students

The findings indicate that 100% (n=41) of students indicated that composite resin was the first dental material introduced to them in the preclinical laboratory. This was also the material that their respective supervisors encouraged them to use.

The reason for this, as stated by the participants, was because composite material was:

P2: "safer than amalgam".
P39: "you need one session to finish".
P38: "better aesthetics and minimal cavity prep".
P33: "for aesthetics and easier to use".
P14: "they say that it is easier to use".

Hundred percent of second-year students indicated that composite resin was the material that they used more often in the preclinical laboratory for all one, two, and three surface restorations. The reasons given for their choice of material, for the majority of students (29%, n=12) was the ease of use (manipulation of the material), 24.3% (n=10) indicated aesthetics as a contributing factor, 22% (n=9) felt that safety of material was their reason of choice, and 12.3% (n=5) indicated that cost and patient preference, 12.3% (n=5), was a factor. The data also showed that 73.2% (n=30) of students used composite resin for complex restorations (4 surface and more).

The reason for their choice was given as: P38: "composite has better aesthetics and is not sensitive to temperature."; P39: "composite has better aesthetic and less mercury toxicity"; P16: "easy manipulation"; and the fact that P6: "composite was the only material that we have been exposed to thus far".

Almost twenty-seven percent (n=11) of students agreed that they would use dental amalgam for complex restorations. The following quotes justified this: P2: "amalgam is stronger and more load-bearing compared to composite"; P11: "provides more physical strength and compressibility"; P19: "amalgam is more strong and has higher compressive strength"; P17: "a lot more strength, less prone to breakage".

Third-year students

Sixty percent (n=20) of students indicated that less than 50% preclinical training was done on dental amalgam. Eighty-three percent (n=28) of students indicated that more than 50% of phantom head training in the dental laboratory was practised on other dental materials, such as resin composite. Nearly ninety-two percent (n=31) indicated that they used resin composite material more often in the dental clinic.

Eighty percent (n=27) of students indicated that they inform patients regarding the type of material used. The predominant reason for their choice of dental material (composite) was, firstly aesthetics 35% (n=12), secondly, patient preference (23,5%, n=8), thirdly, safety (20,5%, n=7), fourthly, ease of use (manipulation) (15%, n=5), and lastly, cost (6%, n=2) which was the least contributing factor.

Nearly 88% (n=30) of students indicated that their dental supervisors encouraged them to use resin composite more often in the clinic. The reason for this was "better aesthetic", "phasing down of amalgam", and "minimal loss of tooth structure". It was indicated that supervisors encouraged the use of resin composite. The reasons for this was Pii: "supervisors want to improve our composite restorative technique as they recognise that composite is the most widely used material in private practice, which is where the majority of students will end up working".

Approximately forty-four percent of students (n=15) of students use composite material more often on dental outreach programmes, 12,5 % (n=4) use glass ionomer, and 15,6% (n=5) use dental amalgam. Almost ninety-two percent of participants (n=31) have indicated that they have seen resin composite being used more often in private practice. 100% (n=34) of third-year students indicated that they use resin composite more often for one, two, and three surface restorations. 35,3% (n=12) of students use dental amalgam more often for complex restorations (4 surfaces and more).

In the third year, students use both types of material, i.e., amalgam and composite, in their clinical training. The students were asked which material they used more often

for class 1, class 2, and complex restorations. Figure 1, below, indicates their choice of material.

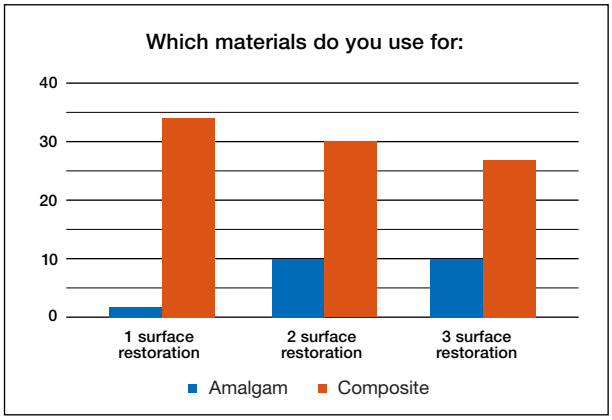

Figure 1. The material used by third-year students for 1, 2, 3 surface restorations

The qualitative data gained in support of dental amalgam being used for complex restorations are as follows:

Some of the reasons given by about thirty-five percent (n=12) of third-year students for using dental amalgam in complex restorations are as follows:

Pviii: "it is stronger and last longer, have good compressive strength, most complex cavities are in posterior teeth, so there is not much need for aesthetics."

Pvi: "More adept with using amalgam, also if in a high load-bearing area, amalgam is more durable."

Pvii: "Amalgam may be considered for more complex restorations as strength is of main importance and amalgam has more to offer when it comes to strength and durability than composite."

Pxvi: "if posterior teeth can withstand occlusal forces."

Pxix: "it is more durable and more easily packable."

Approximately sixty-five percent of the third year (n=22) students indicated that they use composite resin for more complex restorations, and the reasons given to justify this choice are as follows:

Pxv: "Composite is bonded, which makes it reliable and more conservative, also for aesthetics."

Pxxxii: "I love composite and trust it for improved aesthetics, easy to handle and polish-ability plus no health hazards as compared to amalgam."

Pii: "Composite bonds to tooth structure thereby strengthening the tooth as opposed to amalgam which looks un-aesthetic in a large cavity prep."

Pxvii: "it involves minimal invasive intervention, less removal of tissues, and the ability of the material to bond to tooth surfaces."

Pxxxv: "to enhance retention, preserve tooth structure."

4. Choice of dental material

The second- and third-year students were asked what their main reason was for choosing dental material when restoring a tooth was. The main reasons that emerged were aesthetics, cost of material, ease of use, material safety, and ease of manipulation.

The responses were presented on a graph so that a comparison can be seen between the second- and third-year students.

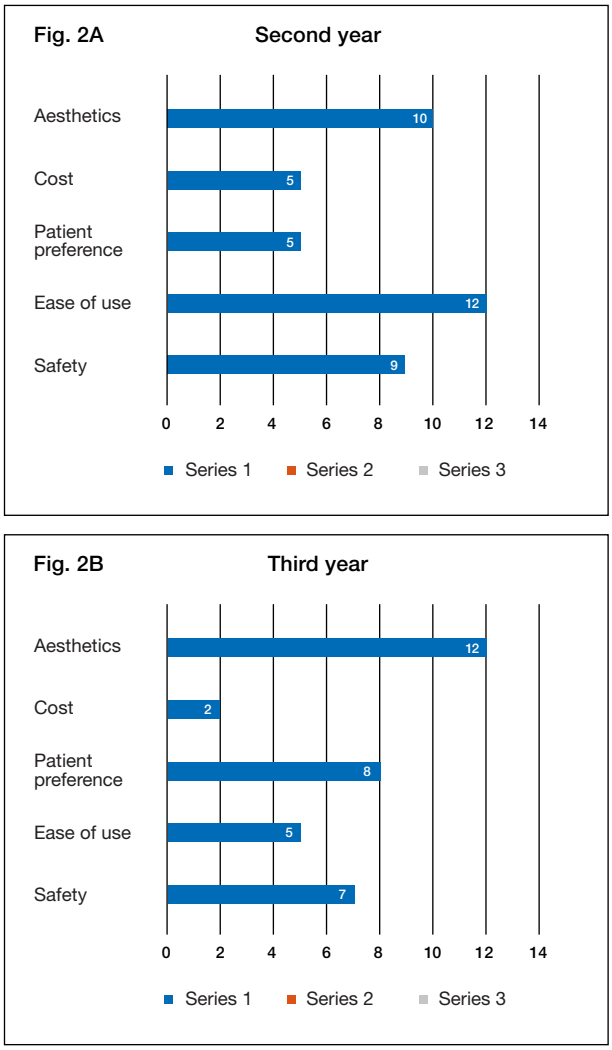

Figure 2. A comparison between the second-year preclinical student and the third-year clinical students regarding their choice of material.

The above figures (2A and 2B) illustrate why students consider their choice of restorative material.

Ease of use (manipulation) of the dental material was the main contributing factor for the choice of material for second years (30%, n=12), while aesthetics was the main reason for the choice of material for the third year (35,29%, n=12).

5. Minamata convention and amalgam usage internationally

The majority of second-year students indicated that they have not heard of the Minamata Convention and 82,1% (n=34) of the students stated that they were not aware

of the phase-down of dental amalgam. Almost eighty percent (n=27) of third-year students have heard of the Minamata Convention, and 73,5% (n=25) of students are aware of the phase-down of dental amalgam.

5.1. Students were asked a question as to why amalgam is banned in some countries. There was a 91% response to this question.

The main reason that emerged from both the second- and third-year participants was the mercury content in amalgam.
The participants answered as follows:

Second-year students

P9: "because of mercury exposure."
P13: "because of mercury release and is not aesthetically pleasing."
P27: "people are concerned about the mercury issue."
P14: "due to the controversy about mercury toxicity."

Third-year students

Pvii: "Because certain countries are strict against the dangers of mercury toxicity. I even had a patient whose old amalgam had come off, and she didn't want us to put another amalgam restoration as she had read on the internet that it is dangerous to your mental health, so a lot of people do not fully trust the use of it and would rather just not use it."

Pii: "there is a risk mercury toxicity as well as a harmful impact on the environment if not disposed of correctly."

Pvi: "the mercury scare on all forms of media, studies showing mercury unsafe."

Pxx: "too many lobbyists for tooth-coloured material and business-minded."

Pxv: "it doesn't meet aesthetic requirements and minimal inversion (invasion technique)."

5.2. Students were questioned as to why dental amalgam is still used in some countries such as South Africa and America. There was a 97% (n=33) response to this question. The predominant factor that emerged was the cost of the material, and is validated by the following quotes:

Second-year students

- P1: "... it's cheaper…"
- P2: "cost-effective, cheaper than other dental restorative materials."
- P3: "cost less and is durable."
- P4: "cheaper for the patient, and for the ease to handle."

Third-year students

Pxiv: "because of its strength and longevity, also cheaper than composite."

Pxxvii: "it is because of cost. People can afford to pay."

Pxii: "it is the strongest material, easy to use and cheaper than composites."

Pvi: "other studies showing high performance and durability of amalgam. Relative ease of use (not technique sensitive) and relatively lower cost."

Pvii: "I think because they haven't had many cases of people refusing amalgam, the people aren't aware of mercury toxicity as other people in other countries."

6. The participants were asked whether they felt that resin composite should completely replace dental amalgam in dental training.

Approximately seventy-three percent (n=30) of second-year students indicated that composite should replace amalgam in dental training, while 26,8% (n=11) of students indicated that amalgam should not be replaced in dental training. Some of the reasons that emerged from the participants who agreed that dental amalgam should be replaced by resin composite are as follows:

6.1. Aesthetics and bonding to the tooth structure

Aesthetics is a significant factor in students' choice of material, as patients are becoming more aesthetically aware and demanding aesthetically pleasing material not just for anterior teeth but also for posterior teeth.

Students are also highly aware of conserving tooth structure, therefore preparing cavities with minimal loss of healthy tooth structure. The students have justified their reasons with the following responses:

Second-year students

Approximately twenty-four percent of second-year students considered aesthetics as a contributing factor in their choice of material. The following quotes support this:

P2: "it is easier to handle and more aesthetically pleasing."
P3: "…aesthetically, it is better..."
P37: "it is safe, tooth coloured, easier to use, patients pre fer it."
P35: "Resin composite has good aesthetics, conservative…much safer than amalgam."

Second-year students stated that bonding to the tooth structure and minimal cavity preparation was another reason they agreed that composite should replace amalgam in dental training. The following quotes confirm this:

P35: "Resin composite has good aesthetics, conservative…much safer than amalgam."
P11: "Easier to use…smaller cavity design."
P22: "Resin composite is safer and better bonding to the tooth."
P39: "resin composite is easy to use, less toxic…requires less sized cavity prep."

Third-year students

Students were asked if they felt that resin composite could completely replace amalgam in dental training.

Approximately 41% were unsure (neutral), 35% agreed that amalgam should be replaced, and 20,6% disagreed that dental amalgam should be entirely replaced by composite. The participants presented the following responses, as to the influence that aesthetics and bonding to tooth structure have on their reason for dental amalgam being replaced:

Piii: "because composite uses minimal invasive technique, therefore saves more tooth structure than amalgam."

Pxxiii: "because of aesthetics, amalgam don't have the same colour as teeth."

Pxiv: "amalgam is still the strongest material being used today, but composite has a few advantages… like being aesthetic and easy to manipulate."

Pvii: "Even in private practice, we see that amalgam use is fading away…the point is that patients do not want it due to aesthetics."

Pxxxii: "Composite have no health hazards, it improves aesthetics, plus it is easy to handle."

6.2. Mercury toxicity

Students were asked their reasons for responding that amalgam should be replaced by dental composite. A major contributing factor that had emerged was the toxicity of dental amalgam due to the mercury content. The second-year students justified this response with the following quotes:

P41: "amalgam may be toxic to the oral cavity because of its content of mercury."

P36: "because amalgam results in galvanism… not safe."

P42: "because of the environmental dangers as it contains mercury."

The third-year students responded with the following quotes:

Pii: "There is a risk of mercury toxicity as well as a harmful impact on the environment if not disposed of correctly."

Pxii: "Because of mercury release, and it is not aesthetically appealing."

Pxi: "Because of the environmental dangers, as it contains mercury."

7. Compressive strength of amalgam

Participants were asked to explain why they felt that dental amalgam should not be replaced by composite. The compressive strength of amalgam emerged as the main contributing factor.

Second-year students

Approximately twenty-seven percent of second-year students felt that dental amalgam should not be replaced by resin composite in dental training. The strength of amalgam was the major contributing factor:

P33: "it is strong."
P23: "composite is not as strong."
P18: "amalgam is the strongest."
P17: "amalgam will remain the material of choice for generations to come."

Third-year students

Approximately twenty-one percent of third-year students felt that amalgam should not be replaced with a dental composite. The main reason that emerged from the qualitative data was due to the compressive strength of amalgam. Some of the responses are as follows:

Piv: "In some extensive preps, composite cannot replace amalgam as a higher strength would be needed."

Pxiii: "Composite can never replace amalgam... Composite can easily fail in cavities in which amalgam will last for years. So I cannot say amalgam should be replaced by composite in training. My opinion on amalgam is: Phase it down? Yes. Replace it? No."

Pxxv: "We still need amalgams in complex posterior preparations."

Pxx: "Amalgam will remain the material of choice for many generations to come"

Px: "Still strongest material. Placed properly should not pose a problem. Students should be taught how to handle amalgam responsibly. Both restoration material has its strong and weak points. In cases where composite cannot be placed amalgam can be used."

Pii: "I think that composites should be used as a first choice but should not replace amalgam altogether. Amalgam can be used in instances of composite failure and where economics and moisture control is an issue."

DISCUSSION

In this study, there were more female than male participants. This is in line with a South African study investigating the dental therapy cohorts at a South African university. The study found a progressive rise in the proportion of female student enrolments during the decade between 2004 and 2014 (51.5% in the first year, 55.6% in the second year, and 60.9% in the third year of study, respectively).[17]

The teaching of posterior composites is well established in dental training in the UK, Ireland, United States, Canada, Japan, Spain, Brazil, and Iran.[18] Students in the UK and Ireland gain more experience in posterior composite placement than dental amalgam.[18] This change in the teaching trend is due to the shift towards minimally invasive dentistry.[18]

The minimal intervention approach focuses more on the prevention and detection of dental caries at its earliest. If restoration is required, a minimally invasive technique is

used that conserves as much tooth structure as possible. The minimally invasive technique uses adhesive materials such as glass ionomer cements and resin composites. The micro-mechanical bonding that bonds the restoration to the tooth structure allows for minimal removal of healthy tooth structure, negating the conventional GV Black cavity design.

The new techniques for minimal cavity design include sonic techniques, air abrasion and bioactive glasses, chemo-mechanical treatment and the atraumatic restoration technique.[19] In our study, it was found that more time was spent on composite in both preclinical and clinical training.

Pre-clinical skills experience in the restoration of posterior teeth is now on composite material, rather than amalgam, for most students.[18] Therefore, it is anticipated that the future generation of dentists and dental therapists joining the dental professional workforce will be more skilled in the placement of composite restorations than amalgam. Therefore, this generation will be more conservative in their approach to cavity design. GV Black's old approach, "extension for prevention", has been transformed into a more preventively orientated, patient-centred approach. In most UK dental schools, amalgam placement is no longer taught on child patients.[20]

According to a previous American Dental Association survey, posterior composite resin restorations now outnumber amalgam restorations in the United States.[21] A study conducted in Ibadan, Nigeria, found that amalgam, as a choice of restoration material, was gradually being replaced by composite.[22] Our survey also recorded a reduction in amalgam usage by both students and clinical supervisors.

In South Africa, it was stated that developing countries would face a challenge to phase-down amalgam due to the lack of comparable alternative restorative materials. This was due to the high cost and technique sensitivity of the restoration, which increases dental care costs.[23] However, due to the UN treaty from the Minamata convention, a phase-down of dental amalgam is necessary to reduce mercury exposure. It was recommended that

Table 1. Second year results.

Variables	Do you feel that resin composite should replace amalgam in dental training?				Fisher Exact P-value
	Yes		No		
	N	%	N	%	
Gender					
Male	14	70.0%	6	30.0%	0.655
Female	16	76.2%	5	23.8%	
Do you think that you had adequate exposure to the various types of restorative materials, used in the clinic?					
Yes	10	66.7%	5	33.3%	0.475
No	20	76.9%	6	23.1%	
Do you think that you had adequate training in the various types of cavity design preparations?					
Yes	12	80.0%	3	20.0%	0.475
No	16	69.6%	7	30.4%	
What was the first dental material that you were introduced to in the dental clinic?					
Composite	29	72.5%	11	27.5%	-
How much of clinical training time was spent on the teaching and training of amalgam?					
<50%	25	71.4%	10	28.6%	0.543
>50%	5	83.3%	1	16.7%	
How much of clinical training time was spent on alternate dental materials?					
<50%	9	75.0%	3	25.0%	0.817
>50%	20	71.4%	8	28.6%	
One surface restoration use					
Amalgam	1	50.0%	1	50.0%	0.482
Composite	27	73.0%	10	27.0%	
Two surface restoration use					
Amalgam	3	100.0%	0	0.0%	0.262
Composite	23	69.7%	10	30.3%	
Three surface restoration use					
Amalgam	3	60.0%	2	40.0%	0.541
Composite	22	73.3%	8	26.7%	
Which material do you use most often for complex restorations (4 surface restorations)?					
Amalgam	8	72.7%	3	27.3%	0.984
Composite	21	72.4%	8	27.6%	
Which material did your clinical supervisor encourage you more often to use? Give a reason for your answer.					
Composite	29	72.5%	11	27.5%	-

oral health care practitioners promote alternate materials such as composites, glass ionomers, and ceramics, especially in occlusal cavities and deciduous teeth. Quotas are set to guide work done by students, but patient choices inform the choice of materials used. As seen in our study, resin materials are, therefore, more widely used.

Best management practices should be employed for the safe disposal of amalgam and more oral health education on preventing caries, and supporting more research on the discovery of suitable alternative restorative materials should be offered.[24] In a previous study carried out in 2017, it was stated that dental amalgam no longer was the preferred material for the restoration of posterior teeth in South Africa. Resin composite was most widely used to repair or replace defective amalgam restorations.[7] Composite was the preferred material, as is seen from the results of our study.

A recent study published in June 2019 determined the transition from amalgam to other restorative dental materials in the United States predoctoral paediatric dental clinics. This study was conducted among 44 dental schools. At the time of the study, the US dental schools did not appear ready to phase out dental amalgam training, and amalgam was still widely used in paediatric predoctoral training to restore both primary and permanent teeth.[25] Teaching with dental amalgam continues at UKZN moreover in SA, and this is in line with many countries.

The results from this study have indicated that both the second- and third-year students have a sound knowledge of dental amalgam and other dental materials. The undergraduate restorative dentistry programme introduces resin composite as the first dental material that students are exposed to in the preclinical laboratory. This concurred with the study conducted in Israel, which found

Table 2. Third year results.

Variables	Do you feel that resin composite should replace amalgam in dental training?				Fisher Exact P-value
	Yes		No		
	N	%	N	%	
Gender					
Male	2	66.7%	1	33.3%	0.476
Female	8	44.4%	10	55.6%	
Do you think that you had adequate exposure to the various types of restorative materials, used in the clinic?					
Yes	6	46.2%	7	53.8%	0.155
No	2	100.0%	0	0.0%	
Do you think that you had adequate training in the various types of cavity design preparations?					
Yes	7	53.8%	6	46.2%	0.466
No	3	37.5%	5	62.5%	
What was the first dental material that you were introduced to in the dental clinic?					
Amalgam	3	42.9%	4	57.1%	0.757
Composite	7	50.0%	7	50.0%	
How much of clinical training time was spent on the teaching and training of amalgam?					
<50%	3	25.0%	9	75.0%	0.017*
>50%	7	77.8%	2	22.2%	
How much of clinical training time was spent on alternate dental materials?					
<50%	1	33.3%	2	66.7%	0.563
>50%	9	50.0%	9	50.0%	
One surface restoration use					
Amalgam	0	0.0%	1	100.0%	0.329
Composite	10	50.0%	10	50.0%	
Two surface restoration use					
Composite	10	47.6%	11	52.4%	-
Three surface restoration use					
Amalgam	2	50.0%	2	50.0%	0.919
Composite	8	47.1%	9	52.9%	
Which material do you use most often for complex restorations (4 surface restorations)?					
Amalgam	3	42.9%	4	57.1%	0.757
Composite	7	50.0%	7	50.0%	
Which material did your clinical supervisor encourage you more often to use? Give a reason for your answer.					
Amalgam	1	50.0%	1	50.0%	0.943
Composite	9	47.4%	10	52.6%	

Keys: (*) indicates the association is significant at α=0.05.
Interpretations: According to Fisher's exact test, year of study was significantly associated with feeling for resin composite should replace amalgam in dental training.

that today some universities teach composite resin before introducing amalgam.[26] This study's results indicated that dental amalgam is now less than 50% of the total practical time. Similar results were seen in the United Kingdom, where the researchers found that preclinical time for resin composite has increased since 1997.[27]

The researchers also concluded that composite might soon overtake or become the material of choice in posterior teeth. While competency was achieved and students felt competent enough to place restorations, certain factors hindered training. However, when the participants in our study were questioned about having sufficient exposure to place restorations, it emerged that students were happy with the lectures and tutorials given. However, they felt that there was not sufficient practical experience due to insufficient patients and larger class numbers. In a previous study conducted at the same site, it was found that there was an exponential rise in student numbers.[17]

Both the second- and third-year students indicated that their clinical supervisors encouraged them to use composite more often. This is in agreement with a previous study conducted, which also found a shift from dental amalgam to resin composites in dental training institutions.[28] In another study conducted in Palestine, it was found that composite resin was used two to three times more than amalgam in the dental clinic.

The only time that it was found that amalgam was used more in the dental clinic was for complex restorations (more than three surfaces). Our study also showed that 35,3% of third-year students prefer to use amalgam for complex restorations (3 surfaces or more).[25]

One of the reasons for this factor has been that they have noticed that the 'younger' clinical supervisors encourage resin composite and the 'older' supervisors encourage dental amalgam. More research should be carried out in this regard. Another reason was that the clinical supervisors are preparing them for private practice, as more resin composite is used in private practice. This is in agreement with most second- and third-year students, who stated that they have seen composite being used more often in private practice.

Private dental practitioners showed an inclination to replace existing well-placed amalgam restorations with resin composites, as reported in earlier studies.[29] The dental material of choice for simple, compound, and complex restorations was composite, which was indicated by most of the students in our study. The main reason for this was the ease of manipulation of the dental material. This was supported by the study conducted in Malaysia, which found that 49,2% of students preferred to use composite to restore posterior teeth, compared to 35% favoured amalgam.[6]

Nearly 36% of students in our study indicated a preference for amalgam in complex restorations. An Israeli study had similar results, where the researchers found that, in complex restorations, amalgam was still the material of choice.[26]

The majority of the third-year students were aware of the Minamata Convention and its implications, including the phase-down of dental amalgam. Most of the second-year students had not heard of the Minamata Convention, and just 18% (n=7) were aware of the phase-down of dental amalgam.

This is concerning since the Minamata Convention advocated for the complete phase-down of amalgam by 2030. More emphasis regarding knowledge of this convention should be included in the second year curriculum training.

A study conducted in Jordan amongst second-year students found that only 13,8% of dentists knew about the Minamata Convention and only a few of them were aware of the phase-down of amalgam.[30] However, almost half (41,2 %; n=14) of third-year students were unsure of whether dental amalgam should completely replace composite in dental training.

Twenty-six percent of students agreed that amalgam should be replaced. The major contributing factor was aesthetics and the fact that dental composite was bonded to the tooth structure, resulting in minimal cavity preparations. This is also in agreement with the FDI policy on minimally intervention dentistry which requires the conservation of healthy tooth structure and to maintain healthy teeth for life.

Techniques such as lasers, chemo-mechanical caries removal, air abrasion and glass ionomer cement are some of the techniques used to conserve tooth structure.[31] An amalgam restoration cavity design is extensive and does not follow minimal intervention techniques; however, a bonded amalgam does. Students also mentioned 'ease of use' (manipulation of the material) as another deciding factor in using dental composite.

Approximately twenty-one percent of students disagreed that amalgam should be replaced. The major reason is that dental amalgam was still considered the strongest dental material with the highest compressive strength. This is also evident from a study conducted in Saudi Arabia, which compared students' attitudes toward restorative materials and the future of amalgam and concluded that most students felt that amalgam could not be replaced entirely with composite.[32]

Amalgam is still a widely placed material in state-run oral health services. The complete phase-down of dental amalgam poses a threat to such services and threatens to widen oral health inequalities.[33] This factor was iden tified by the participants in this study as well when they responded that dental amalgam was still being used in developing countries (South Africa and Brazil). Emphasis must be placed on preventing dental caries and promoting good oral health to minimise the need for restorations.

The dental curriculum is presently designed so that the core skills of preventive dentistry are introduced in the second year of study. The third year of dental therapy training focuses mainly on building clinical skills in relief of pain, sepsis (extractions), and restorative dentistry (fillings).

The implications of these findings suggest that students need sustained exposure to preventive care in their undergraduate training to maximise greater awareness of caries prevention, more clinical exposure and a reduction in the use of amalgam.[34] The researchers suggest that the curriculum be reviewed in this regard.

Limitations of the study

The study provided extensive insight into dental undergraduate students' knowledge regarding dental amalgam training's attitudes and practice, but some limitations were noted. The study focused exclusively on one dental school. Ideally, all dental schools (including students studying dentistry) should be included to gain all students' perspectives and the curriculum review regarding dental amalgam.

CONCLUSION

This study's findings indicated that both the second and third-year dental students were confident that they had adequate training to place restorations. A higher number of students prefer to place composite rather than amalgam restorations. The dental curriculum should be reviewed to ensure that the university keeps up with international trends, especially with the complete phase-down of dental amalgam.

Since dental amalgam is being phased out due to 'mercury toxicity, more research needs to be carried out on resin composite safety and its curing process before it can be hailed as 'the silver bullet' in restorative dentistry. An amalgam replacement material needs to be developed in the near future. More research is required to explore the clinical and pre-clinical learning environment further, taking into account the attitudes and perceptions of academics, patients and clinical supervisors, and recently graduated dental therapists.

Declarations

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Authors' contributions

SB was responsible for study design, data collection, data analysis, and drafting the manuscript. RM was responsible for the supervision of the entire work, study design and manuscript review.

All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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Quality of root canal treatment performed by undergraduate students at the Wits Oral Health Centre

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ABSTRACT

Purpose

In 2012, the School of Oral Health Sciences at the University of the Witwatersrand modified its undergraduate endodontic curriculum which led to a need to assess the impact of curriculum changes on root canal treatment outcomes. This study was an audit of root canal treatment performed by undergraduate BDS students using postoperative radiographs, and compared the results between different undergraduate clinical years of study.

Methodology

Postoperative periapical radiographs of patients treated by undergraduate students were examined to assess length, density and taper. Two independent investigators were first calibrated, and thereafter assessed 299 endodontic cases that were performed by third, fourth and fifth year students during the 2013-2015 period at the Wits Oral Health Centre.

Results

68.9%, 73.6% and 70.9% were found for adequate length, acceptable density and acceptable taper of root filling respectively. The most acceptable length, density and taper results were seen in patients treated by final year students, while the lowest results were observed in the fourth year student cohort. There was a tendency for third year students to overfill due to over-instrumentation of anterior teeth.

Conclusion

The change in the curriculum has been justified, though room for improvement exists. The superior result found in the 5th year student cohort was most likely due to their relative experience, and the use of rotary instrumentation and dental operating microscopes. Endodontic teaching should further emphasize the importance of length control during endodontic treatment and more stringent steps may be necessary during patient allocation and clinical supervision of fourth year dental students.

Keywords

Quality, root canal treatment, undergraduate student.

ACRONYMS

AC:	Apical Constriction
CDJ:	CementoDentinal Junction
AF:	Apical Foramen
AP:	Apical Periodontitis
AAE:	American Association of Endodontists
ESE:	European Society of Endodontology
NiTi:	Nickel-Titanium
PTN:	ProTaper Next files
Mx:	Maxillary
Mn:	Mandibular

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INTRODUCTION

Root canal treatment is a complicated procedure that requires careful attention to detail and meticulous execution. This allows for effective cleaning and shaping of the root canal while avoiding any procedural error that may impact treatment outcome. A prerequisite to achieving treatment at a high standard of care includes inventive training of dental students to elicit high quality treatment.

Quality guidelines in root canal treatment

The European Society of Endodontology (ESE) in 2013 expressed their concern that despite tremendous technical advances in endodontics, studies continue to exhibit displeasing technical results for endodontic treatment

in European societies.[1] The ESE 2013 guidelines quote several studies to prove that these results are a reflection of the achievement of the initial proficiency shown in undergraduate training where requirements remain variable.[2-6] The society also emphasized the necessity of ensuring that undergraduate practice is performed to a standard that confirms thorough understanding of the crucial factors that play a role in clinical outcomes.

The ESE (2006) reported a set of guidelines for undergraduate syllabi, to promote the advancement of high quality undergraduate dental teaching. According to these guidelines, the student is expected to possess the ability to perform nonsurgical endodontic treatment on single and multi-rooted teeth. The guidelines also included the expectation that students should identify and know how to avoid any iatrogenic errors that might occur with conventional endodontic treatment.[7,10] Educational guidelines dictate that dental schools ensure the competence of each graduating student in the field of endodontics.[11]

Eleftheriadis and Lambrianidis (2005) proposed that the assessment of technical outcomes of endodontic treatment and the detection of iatrogenic errors are based on the immediate postoperative radiographs.[2] Consequently, the ESE (2006) advised that the quality of root canal filling should be assessed through postoperative radiographs.[10]

The use of periapical radiographs in root canal treatment

Periapical radiographs are commonly in endodontic treatment for preoperative diagnostic assessment, working length determination, master apical file fit, master cone and postoperative assessment of the quality of obturation. Endodontic treatment success is often predicted by the quality of the root canal treatment, as depicted on postoperative radiographs. Although Siqueira (2001) agrees with this recommendation, he cautions that the radiographic judgement of the root filling may not be indicative of root canal sealing.[12] The author concluded that the major cause of failure of most well-treated endodontic treatment cases is due to persistence of infection. It should be recognized that periapical radiographs represent a two dimension image and have limitations, such as the superposition with adjacent tooth structures, especially in the region of the maxillary molars.[13,14]

Numerous studies have used postoperative radiographs to assess the quality of root canal treatment. Table 1. describes studies that assessed the quality of endodontic treatment performed by undergraduate students by examining postoperative radiographs. Although there is considerable consistency among the studies listed, not all the studies used the same criteria.

Criteria used to determine the quality of root canal treatment

Various studies have shown that the outcome of root canal treatment is dependent on the technical quality of the root canal filling.[24-26] In addition, studies have also used the absence of voids and the length of root fillings as assessment criteria.[24,27,28] Furthermore, Santos et al. (2010) considered the length, density and taper of root canal fillings in their assessment of the quality of root canal treatment, while Bołtacz-Rzepkowska and Pawlicka (2003) concluded that the radiographic technical quality of root canal treatment is more related to the health of the periapical area, rather than substandard root fillings.[29,30] Ramachandran Nair (2003) reinforced the view that the

Table 1. Studies that assessed the quality of endodontic treatment performed by undergraduate students, all of which examine postoperative radiographs.

Authors	Year	Students	Criteria	Country	Sample
Greene and Krell[15]	1990	**3rd year students.**	Ledge formation.	**USA**	171 cases or 336 canals.
Kapalas and Lambrianidis[16]	2000	**Undergraduate clinic and endodontists.**	Ledge formation.	**Greece**	626 root canals (367 by undergraduate students).
Barrieshi-Nusair et al.[17]	2004	**4th and 5th year.**	Length, density and taper.	**Jordan**	542 teeth or 912 root canals.
Eleftheriadis and Lambrianidis[2]	2005	4th and 5th year.	Length, density, ledge, perforations (root, furcation and strip) fractured instruments.	Greece	620 root canals 388 teeth.
Er et al.[18]	2006	4th and 5th year.	Length, density and taper.	Turkey	1893 teeth or 3692 root canals.
Lynch and Burke[11]	2006	**Undergraduate**	Length and density.	**Ireland**	100 single rooted teeth.
Pettigrew et al.[19]	2007	**Undergraduate**	Length, and presence of voids, fractured instruments and perforation.	**Scotland**	100 single rooted teeth.
Balto et al[20]	2010	4th and 5th year	Length, Density, Taper, ledge, gouging, zipping, apical transportation, fractured instruments, perforations (apical, root, strip and furcation), lack of straight-line access and missed canal.	Saudi Arabia	550 teeth.
Khabbaz et al.[6]	2010	4th and 5th year	Length, density, ledge, fractured instruments, perforations (foramen and root).	Greece	1109 root canals or 759 teeth.
Rafeek et al.[21]	2012	**Undergraduate**	The length, presence of voids, taper, curvature of canal and fractured instruments.	**Trinidad**	288 or 460 root canals.
Román Richon et al.[22]	2014	**4th year students**	Length, density and taper.	**Spain**	561 extracted teeth.
Smadi et al.[23]	2015	4th and 5th year	Length, density, taper, ledge, transportation and perforation.	Jordan	213 teeth.

primary cause of postoperative apical periodontitis (AP) in well-treated teeth is due to the presence of microbial infection.[31]

When examining postoperative radiographs, several criteria act as predictors of successful endodontic treatment outcome. Some of which include: (1) length of root canal filling, (2) density of the root canal filling, and (3) taper of the root canal.

Length of the root canal filling

The length of the root canal filling is an important evaluative parameter and is determined by measuring the apical terminus of the obturation from the radiographic apex of the tooth on postoperative radiographs. Zhong et al. (2008) showed that microbes and their by-products are responsible for the failure of endodontic treatment in teeth with inadequate length of condensed obturation material and a low density of the obturation.[32]

Underfilling results in voids in the apical region of the canal which subsequently provides spaces for bacterial colonization. On the other hand, overfilling of the obturation material is the extension of a semi-solid or solid core root canal material beyond the apical foramen.[33] Schaeffer et al. (2005) stated that extruded obturation material beyond the radiographic apex correlated with a decreasing prognosis of root canal treatment while Siqueira (2001) associated overfilling with intraradicular and/or extraradicular concomitant infections.[12,34] The ESE has suggested that the working length should be determined between 0.5 -2 mm from the radiographic apex.[10] This is the guideline that is prescribed at the University and was thus used in this study.

Density of the root canal filling

The density of the root filling is another essential factor that influences the outcome or prognosis of endodontic therapy. Kirkevang et al. (2000) found that the presence of voids in root canal fillings have a substantial impact on the incidence of AP.[35] Furthermore, Hommez et al. (2002) found that the incidence of AP had a 47.1% occurrence in samples of non-homogeneous root canal filling, and a 27.7% occurrence in samples of homogeneous root canal filling.[36] Periapical radiographs are used to determine the quality of root canal treatment by qualifying the homogeneity of obturation, which depends on the absence or presence of voids.[6] In this study, the presence of voids in the root filling was considered unacceptable.

Taper of the root canal filling

The taper of the root canal is defined by Schilder (1974) as a continuous tapered funnel shape of the root canal system to enable cleaning and facilitate obturation.[37] Root canal taper is a reflection of shaping the root canals and not the obturation. Arvaniti and Khabbaz (2011) reported that there was no substantial difference in root canal cleanliness between the different tapers (0.04, 0.06 and 0.08) in root canals that were prepared to an apical size 30.38 Zogheib et al. (2012) assessed the influence of different tapered preparation on the sealing ability of Real Seal 1 at the apical 5 mm of the obturated canals using micro-CT for analysis.[39] The results showed that the smallest taper size (0.04) had significantly greater volume of voids, while the large taper sizes (0.06 and 0.08) revealed fewer voids. In this study any inconsistent taper of canal preparation from crown to apex was considered unacceptable. Table 2 portrays the results of various studies utilizing length, density and taper to determine the quality of the root canal treatment.

Following the implementation of the revised endodontic curriculum at the Wits School of Oral Health Sciences in 2012, no study has been done to assess the impact of the curriculum change on treatment outcomes. The aim of this study was to assess the quality of root canal treatment performed by undergraduate students at the Wits Oral Health Centre.

MATERIALS AND METHODS

This was a retrospective study, composed of 299 postoperative periapical radiographs of patients treated by 3rd, 4th and 5th year undergraduate dental students, in the Wits Oral health Centre at the School of Oral Health Sciences (University of the Witwatersrand), between January 2013 and December 2015.

The endodontic patients' radiographs were examined using a magnifying lens (2x magnification) and an endodontic ruler in a dark room using a radiographic viewer. Twenty cases, not included in the study sample, were used to compare the interrater agreement between the

Table 2. Studies determining the quality of root canal treatment by gauging the length, density and taper of root canal filling.

Authors	Year	Country	Results				
			Length			Density	Taper
			Adequate	Underfilling	Overfilling		
Barrieshi-Nusair et al.	2004	Jordan	61.3%	34.5%	4.2%	72.6%	85.3%
Eleftheriadis and Lambrianidis	2005	Greece	62.7%	7.4%	1.8%	82.6%	-
Er et al.	2006	Turkey	69.6%	17.4%	13%	53.2%	68.3%
Lynch and Burke	2006	Ireland	70%	21%	9%	90%	-
Pettigrew et al.	2007	Scotland	80%	5%	15%	80%	-
Balto et al.	2010	K.S.A	79.6%*	11.3%	9.1%	34.9%	59.6%
Rafeek et al.	2012	Trinidad	63.1%	24.3%	12.6%	27.6%	72.2%
Smadi et al.	2015	Jordan	61.5%	14.1%	24.4%	50.5%	56.1%

*Balto et al. 2010 defined the adequate length when root filling ends ≤2 mm from radiographic apex, and they also defined flush when root filling at the radiographic apex. Their result of 79.6% includes both adequate length and flush.

two main investigators. Ethical clearance and permission to conduct the study was obtained from the Human Research Ethics Committee (Wits University) and the Risk Assesment committee (Wits Oral Health Centre).

Criteria for study inclusion incorporated all teeth endodontically treated by the third, fourth and fifth year undergraduate students under supervision, teeth with complete root apices excluding 3rd molars, completed root canal treatment, patient files with postoperative radiographic records of good condition, and postoperative radiographs exhibiting a minimum of 2 mm beyond the root apex. Any teeth with complex anatomy such as severe root canal curvature, root fracture, or root resorption (external or internal) prior to root canal obturation were excluded from the study.

The three main criteria assessed on the postoperative radiographs were: length, density and taper. Length of the root filling was characterised as 'Adequate' where the root filling was 0-2 mm from radiographic apex, "Overfilling" when the root filling extending beyond the radiographic apex, and "Underfilling" when the root filling was >2 mm from the radiographic apex.

The Density of the root filling was regarded as "Acceptable" when there were no voids between root filling and root canal walls or within the root filling, and "Unacceptable" when voids were present between root filling and root canal walls or within the root filling. The taper of the root canal was regarded as "Acceptable" when there was a consistent taper from the orifice to the root apex, and "Unacceptable" when the taper was inconsistent.

IBM SPSS 24.0 was used for analysis. Cohen's Kappa was used to measure the inter-rater reliability of the root canal treatment variables between two clinicians. Descriptive statistics of frequency and percentages were used for data summary. Inferential statistics using Fischer's exact test were used to determine the association between independent and dependent variables.

RESULTS

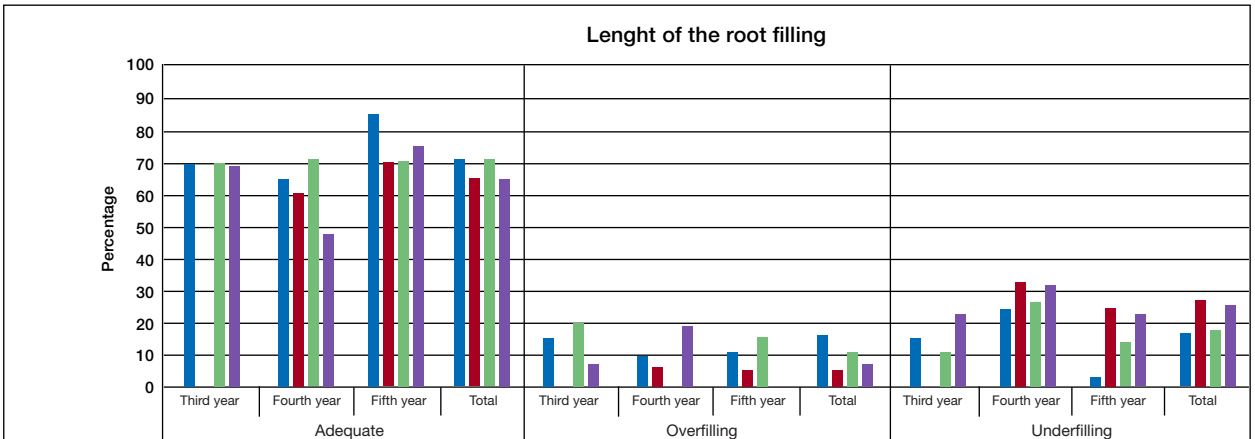
Inter-rater agreement was determined using Cohen's kappa across the three assessed parameters. The results was determined as 1.00 (length of root filling), 0.93 (density), and 0.77 (taper).

The distribution of the 299 included patient cases for the third, fourth and fifth year students were 85, 106 and 108 respectively. The distribution of tooth location and position are shown in Table 3.

The quality of the root canal filling was determined by reporting the length, density and taper of the root canal

Table 3. Tooth position and location.

Teeth characteristics		Third year		Fourth year		Fifth year		Total		p value
		N	%	N	%	N	%	N	%	
Tooth type	Central incisor	47	55.3	27	25.5	26	24.1	100	33.1	<0.001
	Lateral incisor	29	34.1	9	8.5	-	-	37	12.7	
	Canine	9	10.6	6	5.7	1	0.9	16	5.4	
	1st premolar	-	-	17	16	8	7.4	25	8.4	
	2nd premolar	-	-	28	26.4	8	7.4	36	12	
	1st molar	-	-	14	13.2	38	35.2	53	17.7	
	2nd molar	-	-	5	4.7	27	25.0	32	10.7	
Teeth location	Anterior	85	100	41	38.7	27	25	153	51.2	<0.001
	Posterior	-	-	65	61.3	81	75	146	48.8	
Teeth position	Maxillary	46	54.1	65	61.3	44	40.7	155	51.8	<0.001
	Mandibular	39	45.9	41	38.7	64	59.3	144	48.2	



	Adequate				Overfilling				Underfilling			
	Third year	Fourth year	Fifth year	Total	Third year	Fourth year	Fifth year	Total	Third year	Fourth year	Fifth year	Total
Anterior	69.4%	65.8%	85.2%	71.2%	14.1%	9.8%	11.1%	12.4%	16.5%	24.4%	3.7%	16.4%
Posterior	0%	61.5%	70.4%	66.4%	0%	6.1%	4.9%	5.5%	0%	32.3%	24.7%	28.1%
Maxillary	69.6%	72.3%	70.5%	71%	19.6%	0%	15.9%	10.3%	10.9%	27.7%	13.6%	18.7%
Mandibular	69.2%	48.8%	76.6%	66.7%	7.7%	19.5%	0%	7.6%	23.1%	31.7%	23%	25.7%

Figure 1. Length of the root filling categorized by tooth location and year of study.

filling. The total number of canals with adequate length was 68.9%, while total acceptable density of root filling was 73.6%, and the total acceptable taper of root filling was 70.9%.

The adequate length and overfilling results were higher in teeth with straight roots, than in teeth with moderately curved roots where a higher frequency of underfilling was noted. Figure 1 and Figure 2 summarizes the results of length, density and taper by tooth type and location across the three years of study.

The highest acceptable density and taper was recorded for central incisors, while the lowest was noted in second molars. 'Acceptable' density and taper was greater in teeth with straight roots than in teeth that had moderately curved roots.

Table 4. The minimum clinical quota for undergraduate students at Wits School of Oral Health Sciences (for the 2013-2015 period).

Procedure	Quota			Cumulative quota
	Third year	Fourth year	Fifth year	
Single-rooted teeth	2	2	1	5
Dual-rooted teeth	-	2	2	4
Multi-rooted teeth	-	2	2	4
Re-treatment	-	-	1	1
Use of microscope - molar tooth*	-	-	1	1

*Means that the microscope must be used to perform one of the molar endodontic treatments

Acceptable root canal filling

An acceptable root canal filling is based on length and density or length, density and taper of the filling (Figure 3). Acceptable root filling based on the length and density were greater than 63% in all years. However, the treatment performed by the fifth year students (71.9%) revealed the highest acceptable root filling when compared to the third year students (69.4%) and the 4th year students (63.2%).

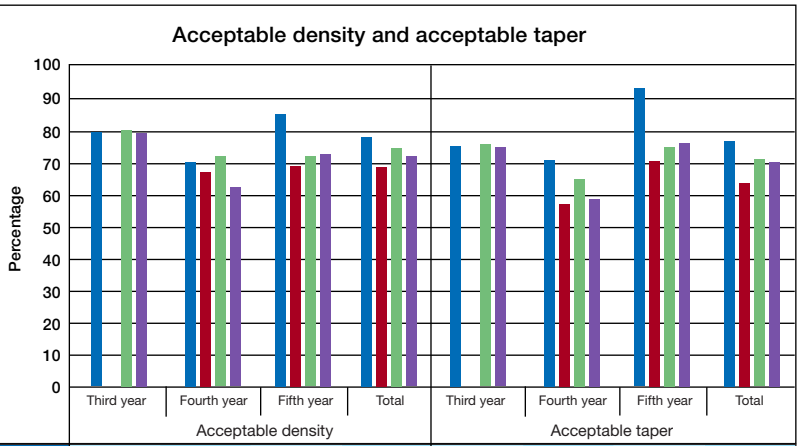
Acceptable root canal filling based on the length, density and taper were greater than 55% in all student years. However, the teeth treated by the 4th year students were the least acceptable result (55.7%) when compared to the 5th year (68.5%) and 3rd year (63.5%) students, as shown in Figure 3.

The Fischer's exact test was used to examine the association between year of study and the quality of root canal filling. The test revealed that there was no significant association between the year of study and all the measures of quality of the root canal filling ($p > 0.05$).

Table 5. Frequencies of length, acceptable density and acceptable taper of root canal filling in previous studies.

Authors	Year	Country	Results				
			Length			Density	Taper
			Adequate	Underfilling	Overfilling		
Barrieshi-Nusair et al.	2004	Jordan	61.3%	34.5%	4.2%	72.6%	85.3%
Eleftheriadis and Lambrianidis	2005	Greece	62.7%	7.4%	1.8%	82.6%	-
Er et al.	2006	Turkey	69.6%	17.4%	13%	53.2%	68.3%
Lynch and Burke	2006	Ireland	70%	21%	9%	90%	-
Pettigrew et al.	2007	Scotland	80%	5%	15%	80%	-
Balto et al.	2010	K.S.A	79.6%*	11.3%	9.1%	34.9%	59.6%
Rafeek et al.	2012	Trinidad	63.1%	24.3%	12.6%	27.6%	72.2%
Smadi et al.	2015	Jordan	61.5%	14.1%	24.4%	50.5%	56.1%
Current study	2017	R.S.A	68.9%	22.1%	9%	73.6%	70.9%

*Balto et al. 2010 defined adequate length when root fillings that end ≤2 mm from radiographic apex, and defined flush as root fillings that end at the radiographic apex. Their result of 79.6% includes both adequate length and flush.



	Acceptable density				Acceptable taper			
	Third year	Fourth year	Fifth year	Total	Third year	Fourth year	Fifth year	Total
Anterior	80%	70.7%	85.2%	78.4%	75.3%	70.7%	92.6%	77.1%
Posterior	0%	67.7%	69.1%	68.5%	0%	56.9%	70.4%	64.4%
Maxillary	80.4%	72.3%	72.7%	74.8%	76.1%	64.6%	75%	71%
Mandibular	79.5%	63.4%	73.4%	72.2%	74.4%	58.5%	76.6%	70.8%

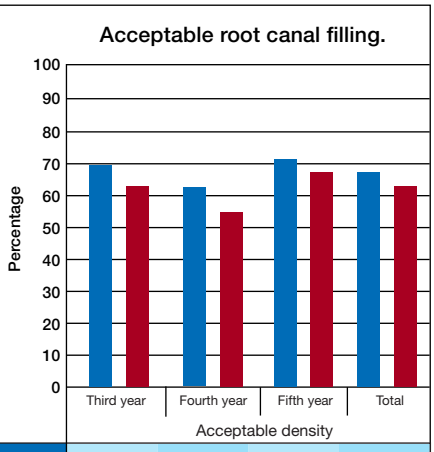
Figure 2. Acceptable density and acceptable taper categorized by tooth location and year of study.

DISCUSSION

A new undergraduate curriculum was implemented in 2012 at the University of Witwatersrand, whereby the endodontic undergraduate preclinical course began in the second year, instead of the third year of study. Several changes were made to the didactic and clinical teaching schedule.

The absolute minimum clinical quota for undergraduate students at Wits Oral Health Centre is shown in **Table 4**. All clinical requirements (quota) for clinical students must be completed by the penultimate month of their final year of study.

The staff: student ratio is 1:7 for preclinical teaching and 1:5 for clinical teaching at the Wits Oral Health Centre.



Lenght and density	69.4%	63.2%	71.9%	67.9%
Lenght, density and taper	63.5%	55.7%	68.5%	62.5%

Figure 3. Acceptable root canal filling.

The preclinical staff:student's ratio was superior to those described by other authors with ratios of (1:8),[11] (1:12)[19] and (1:15).[23] The time dedicated to preclinical endodontic teaching at Wits University is 60 hours, which is greater than the University Dental School and Hospital, Cork (48 hours),[11] Glasgow Dental Hospital and School (32 hours)[19] and the University of the West Indies (54 hours),[21] while it was similar to the University of Jordan (56 hours).[23]

The clinical staff: student's ratio at Wits University of 1:5 was lower when compared to several other universities including Jordan University of Science and Technology (1:6),[17] Aristotle University of Thessaloniki (1:8),[2] University Dental School and Hospital, Cork (1:8),[11] Glasgow Dental Hospital and School (1:12 for 5th year),[19] King Saud University (1:7 for 4th year and 1:2 for 5th year),[20] the University of the West Indies (1:10)[21] and finally the University of Jordan with a ratio of 1:12.[23] It is important to consider the influence of staff:student ratio when considering the outcomes of patient treatment under supervision. It is expected that a lower ratio allows for greater supervision decreasing the opportunity for mishaps while improving treatment quality and outcome.

Standard endodontic protocol in the 3rd and 4th years included the step-back preparation and lateral condensation obturation techniques. Stainless steel K-files with a triangular cross section were used with all files and cones being ISO 2% tapered. A 2% sodium hypochlorite irrigation solution was advocated for irrigation, coupled with the use of EDTA (RC Prep) for chelation and lubrication. The use of 2.5x magnifying dental loupes was compulsory for all endodontic procedures. The root canal sealer available in the WOHC polyclinic was Topseal (Dentsply, South Africa).

Table 6. The highest frequency of length, acceptable density and acceptable taper in previous studies according to tooth type, arch and location.

		Barrieshi-Nusair et al. 2004	Er et al. 2006	Lynch and Burke 2006	Pettigrew et al. 2007	Balto et al. 2010	Rafeek et al. 2012	Smadi et al. 2015	Current study
Adequate length	Tooth	Mx Incisors	Mn Premolars	Mn Lateral incisors	Mx 2nd premolar and Mn 1st premolar	Incisors	Mx Canines	Mx Anteriors	Central incisors
	Arch	-	Maxillary	-	-	-	Maxillary	-	Maxillary
	Location	-	-	-	-	-	Anterior	-	Anterior
Overfilling	Tooth	Mx Canines	Mn Incisors	Mx Lateral incisors	Mn Central Incisor	Molars	Mn Incisors	Mx Molars	Central incisors
	Arch	-	Maxillary	-	-	-	Maxillary	-	Maxillary
	Location	-	-	-	-	-	Anterior	-	Anterior
Underfilling	Tooth	Mn Molars	Mn Molars	Mx 2nd Premolars	Mn Lateral incisor	Molars	Mx Molars	Mn Molars	2nd Molar
	Arch	Mandibular	-	-	-	-	-	-	Mandibular
	Location	-	-	-	-	-	-	-	Posterior
Density	Tooth	Mx Canines	Mx Canines	Mx Lateral, Mn Central and Lateral	Mn Central, lateral and Canines	Canines	Mn Incisors	Mx Anteriors	Central incisors
	Arch	-	-	-	-	-	Maxillary	-	Maxillary
	Location	-	-	-	-	-	No significant	-	Anterior
Taper	Tooth	Mn Canines	-	-	-	Canines	Mn Incisors	Mx Anteriors	Central incisors
	Arch		Mx Incisors	-	-	-	No significant	-	Maxillary
	Location	-	-	-	-	-	Anterior	-	Anterior

Mx: Maxillary, Mn: Mandibular, LF: Left

The 5th year students predominantly utilised rotary instrumentation for canal preparation which included ProGlider (Dentsply, South Africa) files for glide path preparation followed by Protaper Next (Dentsply, South Africa) files to complete canal preparation. The endodontic clinical protocol specified certain radiographs that should be taken during and after every root canal treatment.

Thus, no additional radiographs were required for this retrospective study. Teeth were excluded from the study when these radiographs were unreadable or unavailable. Standard endodontic protocol ensured that all endodontic radiographs be taken using an Endo Rinn® instrument, at a preset exposure to ensure image quality.

The European Society of Endodontology (1992) recommended that students have to perform endodontic treatment on uncomplicated teeth (single and multirooted), and they have to be familiar with problems encountered in complicated endodontic treatments.[7]

The ESE, in their definition of uncomplicated treatment, included tooth curvature of less than 15° from the axis of the roots. The 3rd year students treated only the anterior teeth of which 75.3% were straight, while the 4th year students treated posterior teeth (61.3%) for the first time in the clinic, of which 58.5% were moderately curved teeth.

These differences in the complexity of cases between the different student groups explain why the result of the 3rd year students in general was better than the 4th year students. There was a significant difference in the number of roots and root curvature of the teeth treated between the 3rd, 4th and the 5th year students ($p<0.001$). One method to limit relatively difficult cases being allocated to novice undergraduate students is for supervisors to screen and allocate patients accordingly to ensure careful patient selection for students in the different clinical years of study.

The third year students had the lowest percentage of underfilled canals when compared to the 4th and 5th year students (16.5%, 29.2% and 19.4% respectively). Yet interestingly, the 3rd year students had the highest number of overfilled canals (14.1%, 7.5% and 6.5% respectively). This was attributed to this these students only treating anterior teeth with relatively wider and straight canals with little difficulty in finding the full length. However, a possible explanation for their high rate of overfilling is their inexperience and their inability to confine the instrumentation to within the canal. Thus, the high rate of overfilling was possibly due to over-instrumentation.

Thus, it is advised that greater emphasis be placed on working length control throughout canal preparation procedures during preclinical teaching. The density and taper of maxillary teeth treated by the 3rd year students was better than in the mandibular teeth. The simple explanation for this is the relative difference in the size of the canals; that maxillary teeth have larger canals than mandibular teeth.

In this study, 35.5% of the teeth assessed were treated by the 4th year students. 61.3% of these teeth were posterior teeth with 58.5% of them presenting moderately curved roots. With the exception of overfilling, the results of the main criteria assessed (length, density and taper) show that the fourth year students produced the lowest quality rating among all student years.

Anterior teeth treated by the 4th year students displayed a higher prevalence of adequate length, underfilling, acceptable density and taper when compared to posterior teeth. These results were attributed to the inexperience of this student cohort in treating posterior teeth. In addition, the inexperience of the students were compounded by the allocation of relative challenging root canal anatomy cases.

75% of treated teeth by the 5th year students were posterior teeth, with 72.2% of these teeth presenting with moderately curved roots and 67.6% being multirooted teeth. The 5th year students had the best adequate length and overfilling results which highlighted the impact of experience in the ultimate quality of root canal treatments, more so when treating teeth with more challenging anatomy. In addition, the use of rotary endodontic systems and more advanced methods of magnification account for the superior findings in this student group.

Total acceptable root canal filling

The total acceptable root canal filling of this study, based on the length and density, was 67.9%. This result was higher than the studies by Eleftheriadis and Lambrianidis (2005) at 55.3%, and Khabbaz et al. (2010) at 54.8%. Similar to other studies, the 5th year student cohort performed superior.[6]

The total acceptable root filling based on the length, density and taper was 62.5%, which was better than the University of Pretoria study by Mostert & Jonker (2016) (59,66%), Barrieshi-Nusair et al. (2004) (47.4%), Er et al. (2006) (33%) and Smadi et al. (2015), which was 29.2%.[17,18,23,40] Again, similar to Balto (2010), the 5th year student cohort performed superior to earlier years of study.[20] Table 5. and Table 6. summarize the results of previous studies across the 3 parameters assessed, and include the results of this study for comparison.

CONCLUSIONS

The results of this study indicated that the quality of root canal treatment performed by undergraduate students is similar to other studies conducted at various dental schools around the world. The change in the curriculum has been justified, though room for improvement exists. There was a tendency for third year students to overfill due to over-instrumentation of anterior teeth.

The 5th year students had better results because of their relative experience and the opportunity to use dental operating microscopes. Endodontic teaching should further emphasise the importance of length control during endodontic treatment and more stringent steps may be necessary during patient allocation and clinical supervision of fourth year dental students.

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A comparison of failure rates and canal preparation times between WaveOne Gold and One Curve file systems with and without glide path preparation in simulated canals

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ABSTRACT

Introduction

The aim of this study was to compare the failure rate and canal preparation times of the Primary WaveOne Gold file (Dentsply Sirona, Ballaigues, Switzerland) with the One Curve file (Micro Méga, Besançon, France). The influence of glide path preparation on failure rate and final preparation times were also evaluated.

Methods

Endo training blocks (Dentsply Sirona) with simulated canals were separated into four groups: Group 1: Primary WaveOne Gold with WaveOne Gold Glider; Group 2: Primary WaveOne Gold without glide path; Group 3: One Curve with One G; Group 4: One Curve without glide path. The number of training blocks that were shaped before instrument fracture occurred was recorded. Glide path and final preparation times were also recorded.

Results

Where no glide path was prepared, One Curve file prepared a significantly higher number of canals (14.33± 0.58) than the Primary WaveOne Gold (4.6 ± 1.34) before instrument fracture occurred (p<0.001). The One Curve with One G Glide Path file prepared significantly higher number of simulated canals (28±1.41) than the Primary WaveOne Gold with WaveOne Gold Glider (15 ± 1.41) before instrument fracture (p<0.001).

Glide path preparation times with WaveOne Gold Glider (4.8s) were significantly faster compared to the One G Glide Path file (7.29s)(p<0.001). Significantly faster final canal preparation times were achieved in groups where glide path were prepared (p<0.001).

Conclusion

One Curve files exhibits a greater fracture resistance than Primary WaveOne Gold files. Glide path preparation increases the longevity of preparation files and results in faster final canal preparation.

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2. **Martin Vorster:** Scientific writing and editing - 30%
3. **Peet J van der Vyver:** Scientific writing and editing - 30%

INTRODUCTION

Canals with complex anatomy and severe curvatures remain a constant challenge during root canal preparation, increasing the risk for procedural errors.[1-3] Nickel Titanium (NiTi) files which were developed in the 1980s, have become increasingly popular due to their superior flexibility, effective shaping and enlarging of root canals, minimized ledge formations, perforations and zips compared to traditional stainless steel files.[4] Despite these advantages, NiTi files have an increased fracture risk, especially in canals with complex curvatures due to the cyclic fatigue and torsional stresses on these files.[5]

The last decade has seen instrument manufacturers making significant modifications to NiTi alloy to reduce the incidence of instrument fracture.[6] Factors such as the alloy, kinematics, metallurgical properties and operational settings of the instrument contribute to fracture resistance.[7] The Primary WaveOne Gold file (Dentsply Sirona) is a single-file reciprocating system which replaced the NiTi generation of WaveOne instruments. While maintaining the reciprocation motion of files, the cross section, alloy, dimensions and geometry were improved. Files are manufactured from Gold wire by means of using a post-

manufacturing heating process followed by slow cooling, resulting in high flexibility and a gold color. The cross section is an alternating, off-centred parallelogram with two 85 degree cutting edges. The M-Wire alloy has been changed to Gold wire. The Primary WaveOne Gold instrument has 50% greater resistance to cyclic fatigue and is 80% more flexible than the WaveOne Primary file.[8] The WaveOne Gold files are available in four different tip sizes and tapers 20/07 (Small), 25/07 (Primary), 35/06 (Medium) and 45/05 (Large).[9]

The One Curve (Micro Méga) endodontic file was introduced to the dental market in 2018 as the evolution of the One Shape (Micro Méga) file system. The One Curve file is a single use, single-file system used in continuous rotation motion developed with controlled memory NiTi alloy technology. One Curve files have an ISO size 25 tip, a constant 6% taper, with variable cross sections, S-shaped near the shaft and triangular shaped at the tip.[10] The manufacturer claims that continuous motion with controlled memory alloy technology allows for 33% faster root canal preparation in comparison to the reciprocating single-file systems and 59% faster preparation compared to sequential instrumentation. The variable cross section along the instrument blade allows for improved cutting efficiency and centering ability.[11]

The aim of this study was to compare the failure rate as well as canal preparation times of the Primary WaveOne Gold file with the One Curve file. The influence of glide path preparation prior to final canal instrumentation on the fracture rate and preparation times were also evaluated and compared between these two systems.

MATERIALS AND METHODS

The principles and techniques outlined by Berutti et al.[12] were used in this study. Four hundred Endo training blocks (Dentsply Sirona) with simulated canals were selected. A working length of 16.5 mm for each training block was confirmed with a size 10 K-file (Dentsply Sirona). The training blocks were separated into four groups. These groups were: Group 1: Primary WaveOne Gold file in combination with the WaveOne Gold Glider (Dentsply Sirona); Group 2: Primary WaveOne Gold file without any glide path; Group 3: One Curve in combination with One G (Micro Méga) Glide Path file; Group 4: One Curve without any glide path.

Group 1: Primary WaveOne Gold file in combination with the WaveOne Gold Glider

In all training blocks in this group, a pre-curved stainless steel size 10 K-file was negotiated to working length with increasing amplitudes of 1-2 mm to create an initial manually reproducible glide path. Thereafter the glide path was enlarged with a WaveOne Gold Glider in a reciprocating motion according to the manufacturer's instructions.

After glide path preparation the canals were prepared with a Primary WaveOne Gold file in a reciprocating motion according to the manufacturer's instructions. Final root canal preparation was checked by ensuring that a Primary WaveOne Gold Gutta Percha Cone (25/08) (Dentsply Sirona) could be fitted to full working length.

Group 2: Primary WaveOne Gold file without any glide path

For all training blocks in this group, there was no glide path preparation. The canals were prepared with a Primary WaveOne Gold file in a reciprocating motion according to the manufacturer's instructions. Final root canal preparation was checked by ensuring that a Primary WaveOne Gold Gutta Percha Cone (25/08) could be fitted to full working length.

Group 3: One Curve in combination with One G glide path file

A pre-curved stainless steel size 10 K-file was negotiated to working length with increasing amplitudes of 1-2 mm to ensure an initial manually reproducible glide path. Thereafter the glide path was enlarged with a One G Glide path file in a continuous rotation motion, according to the manufacturer's instructions. After glide path preparation the canals were prepared with a One Curve file in a continuous rotation motion, according to the manufacturer's instructions. Final root canal preparation was checked by ensuring that a One Curve Gutta Percha Cone (25/06) (Micro-Mega) could be fitted to full working length.

Group 4: One Curve without any glide path

For all training blocks in this group, there was no glide path preparation. The canals were prepared with a One Curve file in a continuous rotation motion, according to manufacturer's instructions. Final root canal preparation was checked by ensuring that a One Curve Gutta Percha Cone (25/06) could be fitted to full working length.

All simulated canals were prepared using files with an X-Smart Plus Endo motor (Dentsply Sirona) according to the manufacturer's instructions of each individual file system. Throughout the instrumentation process Glyde Root Canal Conditioner (Dentsply Sirona) was used as a lubricating agent and 3.5% sodium hypochlorite was used for canal irrigation after the use of each file. All of the preparations were done by one skilled operator. The outcome was measured by recording the number of simulated canals that were prepared by the WaveOne Gold Primary and One Curve instruments, in the glide path group and no glide path group, before failure occurred. This was repeated five times within each group to ensure reliability. All preparation times were recorded with an electronic stopwatch. Canal preparation times for each group was recorded by starting at the point of entry into the canal and stopping the clock at the point of instrument retrieval. The time it took to clean the debris from the instrument flutes, irrigate, re-captitulate and to re-irrigate the canal was not recorded.

Statistical analysis

IBM SPSS version 25 was used to analyse the data. A p-value of smaller than 0.05 was considered as statistically significant. The data for the number of simulated canals prepared before file fracture as well as preparation times were compared between the four groups using one-way ANOVA testing, while individual pair-wise group differences were assessed with Bonferroni adjusted t-tests.

RESULTS

In the group where no glide path was prepared prior to final canal preparation, the One Curve file prepared a significantly higher number of canals (14.33 ± 0.58) than the Primary WaveOne Gold (4.60 ± 1.34) before instrument failure occurred (p<0.001). The One Curve file in combination with the One G Glide Path file prepared a significantly higher number of simulated canals (28.00 ± 1.41) than the Primary WaveOne Gold in combination with WaveOne Gold Glider (15.00 ± 1.41) before instrument failure occurred (p<0.001).

Primary WaveOne Gold used in combination with WaveOne Gold Glider (15.00 ± 1.41) prepared a significantly higher number of simulated canals than the Primary WaveOne Gold without glide path (4.60 ± 1.34) before instrument failure occurred (p<0.001). The One Curve in combination with One G Glide Path file (28.00 ± 1.41) prepared a significantly higher number of simulated canals than the One Curve without glide path (14.33 ± 0.58) before instrument failure occurred (p<0.001).

Glide path preparation times with WaveOne Gold Glider (4.80s) were significantly faster compared to the One G Glide Path file (7.29s)(p<0.001). There was no significant difference in canal preparation times between the Primary WaveOne Gold without glide path group compared to the One Curve without glide path group (p=1.000).

Similarly, there was no significant difference in canal preparation times between the Primary WaveOne Gold in combination with WaveOne Gold Glider group compared to the One Curve in combination with One G Glide Path file group (p=1.000).

Significantly faster canal preparation times were achieved with the Primary WaveOne Gold group with prior glide paths prepared with WaveOne Gold Glider (17.60s) compared to the Primary WaveOne Gold group without glide path (22.48s) (p<0.001). Similarly, significantly faster canal preparation times were achieved by the One Curve group with prior glide paths (16.78s) prepared with One G Glide Path file compared to the One Curve group without glide path (23.49s) (p<0.001).

DISCUSSION

Clinicians are faced with the challenge to provide faster, more efficient, cost effective treatment whilst maintaining sterile conditions. Hurrying root canal treatment together with disrespecting the limitation of NiTi rotary instruments increases the risk of instrument failure.[13] Instrument fracture within a root canal may prevent the disinfection of the canal, which may compromise the outcome of the endodontic treatment.[14]

Glide path preparation enables the acquisition of canal patency, facilitates the use of rotary files and results in increased efficacy of root canal preparation.[12,15] Patino et al.[16] reported a reduced incidence of instrument fracture in canals where there was glide path preparation prior to preparation of the root canal with rotary instruments. Another study by Shen et al.[17] reported a higher incidence of fracture and distortion of NiTi files where there was no prior glide path preparation.

According to the results of this study it can be concluded that the presence of a glide path significantly influenced the number of simulated canals prepared. When no initial glide path was created, the One Curve prepared a significantly higher number of simulated canals (14.33 ± 0.58) compared to the Primary WaveOne Gold (4.60 ± 1.34) before instrument fracture occurred (p<0.001). When a prior glide path was created with One G Glide Path file, One Curve prepared a significantly higher number of simulated canals (28.00 ± 1.41) before instrument fracture occurred compared to the Primary WaveOne Gold when prior glide path preparation was created with Wave One Gold Glider (15.00 ± 1.41) (p<0.001).

Table 1. Descriptive statistics for number of simulated canals prepared before failure in each test group.

Group	Mean(s)	Standard Deviation	Coefficient of Variation (%)	95% Confidence Interval
Primary WaveOne Gold without glide path	4.60[a]	1.34	29.13	(3.43; 5.77)
Primary WaveOne Gold with WaveOne Gold Glider	15.00[b]	1.41	9.40	(13.05; 16.95)
One Curve without glide path	14.33[b]	0.58	4.05	(13.67; 14.99)
One Curve with One G Glide Path file	28.00[c]	1.41	5.04	(26.05; 29.95)

Mean values with the same superscript letters were not statistically different at p<0.05

Table 2. Descriptive Statistics for canal preparation times in each test group.

Group	Mean(s)	Standard Deviation	Coefficient of Variation (%)	95% Confidence Interval
Primary WaveOne Gold without glide path	22.45[a]	4.17	18.55	(20.52; 24.38)
Primary WaveOne Gold with WaveOne Gold Glider	17.60[b]	2.78	15.8	(16.57; 18.63)
One Curve without glide path	23.49[a]	3.80	16.18	(22.35; 24.63)
One Curve with One G Glide Path file	16.78[b]	2.12	12.63	(16.21; 17.35)

Mean values with the same superscript letters were not statistically different at p<0.05

Table 3. Descriptive Statistics for canal preparation times for WaveOne Gold Glider and One G Glide Path file groups.

Group	Mean(s)	Standard Deviation	Coefficient of Variation (%)	95% Confidence Interval
WaveOne Gold Glider	4.80[a]	1.23	25.63	(4.2; 5.4)
One G Glide Path File	7.29[b]	1.06	14.54	(6.77; 7.81)

Mean values with the same superscript letters were not statistically different at p<0.05

Statistically significant differences existed between the mean values for the number of simulated canals that could be prepared with the One Curve file compared to the Primary WaveOne Gold file. In previous studies, instruments manufactured from controlled memory were reported to demonstrate higher resistance to cyclic fatigue/instrument failure than those manufactured from conventional NiTi alloy.[14,18,19]

When a prior glide path was prepared with WaveOne Gold Glider, the Primary WaveOne Gold prepared more simulated canals (15.00±1.41) than the Primary WaveOne Gold without prior glide path preparation (4.60±1.34) before instrument fracture occurred ($p<0.001$). Similarly, One Curve prepared more simulated canals (28.00±1.41) when prior glide path preparation was created with One G Glide Path file than the One Curve without prior glide path preparation (14.33±0.58) before instrument fracture occurred ($p<0.001$).

According to the results of this study, when no prior glide path was created a mean of only 4.60 and 14.33 simulated canals could be prepared before instrument fracture with Primary WaveOne Gold and One Curve files respectively. When a prior glide path was created a mean of 15.00 and 28.00 simulated canals could be prepared with Primary WaveOne Gold and One Curve files respectively. Statistically significant differences were observed when mean values for the number of simulated canals with prior glide path preparation were compared to canals without prior glide path preparation.

Within the limitations of this study, it is evident that glide path preparation has a considerable influence on instrument efficacy, increasing the longevity of the Primary WaveOne Gold and One Curve instruments and enabling a greater number of simulated canals to be prepared before instrument failure. These findings are consistent with the findings of similar studies.[13,20]

The results of this study further demonstrates that the One Curve file can prepare a significantly higher mean number of simulated canals before fracture occurred compared to the Primary Wave-One Gold file. This result contrasts with the findings of a study by Yilmaz et al.[11] in which the One Curve file demonstrated the lowest cyclic fatigue resistance compared to the Hyflex EDM (Coltene/Whaledent), WaveOne Gold and RPC Blue (VDW) file systems, however it must be noted that the One Curve files were used at 450 rpm and 2.5 gcm^{-1} compared to this study where the files were used at 300 rpm and 2.5 N.cm as per the manufacturer's instructions.

The results of this study showed the One Curve instrument to have a greater fracture resistance compared to the Primary WaveOne Gold. Similarly, Serafin et al.[10] reported the One Curve instrument to resist cyclic fatigue 2.4 times more than the One Shape instrument. Serafin et al.[10] postulated that the heat treatment of the NiTi alloy, file diameter and cross section may be the reasons for improved resistance of One Curve to cyclic fatigue.

Galal[21] concluded that the increase in flexibility and torsional resistance of controlled memory files can be attributed to the metallurgical improvement of the files. Comparative studies of endodontic instruments manufactured with CM Wire, conventional alloys and M-Wire have shown CM Wire to possess significantly greater cyclic fatigue resistance than the others.[14,22,23]

The minimised contact area from the shaft of 6% taper of the One Curve as compared to the 7% variable taper of the Primary WaveOne Gold must also be taken into consideration when analysing the results. Previous studies have reported that smaller instruments exhibited increased flexibility and cyclic fatigue resistance.[24,25]

The results of this study showed that glide path preparation times with the WaveOne Gold Glider (4.80s) were significantly faster compared to the One G Glide Path file (7.29s) ($p<0.001$). A study by Vorster et al.[26] showed similar results, reporting the WaveOne Glider to be faster than other glide path preparation techniques.

When there was no initial glide path prepared, there was no significant difference in preparation times between the Primary WaveOne Gold and One Curve files ($p=1.000$). Similarly, there was no significant difference in preparation times when an initial glide path was prepared between the Primary WaveOne Gold in combination with WaveOne Gold Glider group and the One Curve in combination with One G Glide Path file group ($p=1.000$). No comparative data on the preparation times between Primary WaveOne Gold and One Curve instruments could be found in the literature.

The results of this study also demonstrated that the preparation time to prepare a simulated canal with Primary WaveOne Gold when an initial glide path was created with WaveOne Gold Glider (17.60s) was significantly faster compared to preparation with the WaveOne Gold without prior glide path preparation (22.45s) ($p<0.001$). This result is consistent with the findings of Vorster et al.[26] where final shaping times with Primary WaveOne Gold were significantly longer in the groups where no initial glide path was prepared. Similarly, a significantly faster preparation time was achieved by the One Curve group with initial glide path created with One G Glide Path file (16.78s) compared to the One Curve group without prior glide path preparation (23.49s) ($p<0.001$). Similar findings have been made in other studies comparing canal preparation with and without initial glide path.[26,27]

CONCLUSION

Within the limitations of this study, it can be concluded that the rotating One Curve instrument resisted instrument failure better than the reciprocating Primary WaveOne Gold instrument in simulated canals, with and without prior glide path preparation.

The presence of prior glide path preparation enabled a significantly greater number of simulated canals to be prepared before instrument failure, for both Primary WaveOne Gold and One Curve instruments. The presence of prior glide path preparation also significantly reduced simulated canal preparation times with both Primary WaveOne Gold and One Curve instruments.

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

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Compiled and edited by V Yengopal

1. Comparison of the effect of therapeutic elastic bandage, submucosal dexamethasone, or dexketoprofen trometamol on inflammatory symptoms and quality of life following third molar surgery

A Erdil, N Akbulut, A Altan, MS Demirsoy. Comparison of the effect of therapeutic elastic bandage, submucosal dexamethasone, or dexketoprofen trometamol on inflammatory symptoms and quality of life following third molar surgery: A randomized clinical trial. Clinical Oral Investigations. 2021; 25: 1849-57

INTRODUCTION

Extraction of third molars is one of the most common procedures performed by oral surgeons. Generally, these surgeries do not encounter difficulties but at times can result in complications. Postoperative complications may include swelling, pain, trismus, prolonged bleeding, dry socket, infection and sensory alterations of the inferior alveolar nerve or lingual nerve. For the swelling, the most common therapies include corticosteroids, non-steroid anti-inflammatory drugs (NSAIDs), or a combination of these agents.

Elastic bandage application (Kinesio taping) is a technique that originates from sports sciences. Studies have reported its beneficial effects on swelling and trismus symptoms after oral and maxillofacial surgeries.[1] It has been claimed that elastic tapes reduce postoperative swelling by creating space between the dermis and fascia layers and thus increasing lymphatic and blood flow.[1] Their alleviating effect on postoperative pain is due to dermal stimulation.[1] Erdil and colleagues (2021)[1] reported on a trail that sought to compare the effectiveness of submucosal dexamethasone injection, a therapeutic elastic bandage (Kinesio tape), and an NSAID (dexketoprofen trometamol) on postoperative swelling, trismus, pain following third molar surgery and alterations in the quality of life in the first postoperative week.

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MATERIALS AND METHODS

The inclusion criteria for this randomized clinical trial were healthy adult patients, age between 18 and 65 years who required surgical removal of impacted third molars.

Patients who were outside the age range, were smokers, had been diagnosed with chronic systemic and psychiatric diseases, had received antibiotic therapy or analgesic therapy for related impacted teeth in the last 30 days, or presented with active complaints on the surgery day and patients with a history of allergy to any of the medications or devices utilized in the study and whose total surgery time exceeded 45 min were excluded.

The participants were randomized into three groups:

- Corticosteroid group (CS): Preoperative submucosal 8 mg/2 ml dexamethasone injection
- Therapeutic elastic bandage application group (KT): Postoperative Kinesio tape application
- Non-steroid anti-inflammatory drug group (DT): Postoperative 25 mg dexketoprofen trometamol prescription.

Inferior alveolar, lingual, and buccal nerve blockades were obtained with 2 ml of a local anaesthetic containing 40 mg/ml articaine and 0.005 mg/ml epinephrine (Maxicaine) in all groups. For the patients in the Corticosteroid group (CS) group, 2 ml of a solution containing 8 mg dexamethasone 21-phosphate was injected at the depth of the buccal sulcus near the operation site after local anaesthesia. One mandibular third molar was extracted from each participant, and all surgeries were performed by the same experienced practitioner.

In the Kinesio tape (KT) group, after completion of the surgeries, the 2-inch-wide tapes were measured as the distance between the tragus-commissure line and clavicle, individually. The arranged tapes were cut into five equal pieces and applied to the operated sides to cover the submental, mandibular, submandibular, preauricular, parotid, and superficial cervical lymph node regions. The tapes were removed on the second postoperative day.

All the patients were given the same postoperative recommendations, but none of them applied ice packs. Amoxicillin + clavulanic acid 625 mg (twice a day for 5 days) and chlorhexidine gluconate + benzydamine hydrochloride mouthwash (every 8 h for 7 days) were prescribed for all groups to reduce the effect of infection on the postoperative course as much as possible.

Paracetamol 500 mg (every 8 h for 7 days) was prescribed for the patients in the CS and KT groups. Dexketoprofen trometamol 25 mg (every 8 h for 7 days) was prescribed for patients in the DT group, and paracetamol 500 mg was prescribed as a rescue analgesic. The participants were advised not to exceed 6 tablets per day to avoid acute liver failure.

The study variables were classified as demographic, anatomic, and outcome variables. The demographic variables were age, and gender, the anatomic variable was the surgical difficulty. The primary outcomes were pain intensity, trismus, and oedema. The healing rates of surgical sites and the quality of life (QoL) scores were considered as secondary outcomes. In all groups, baseline characteristics and demographic parameters were observed preoperatively on surgery day (T0), and inflammatory symptoms and healing rates of operated sites were evaluated on the postoperative second (T1) and seventh (T2) days. The total operation time was recorded individually to specify the surgical difficulty, and patients whose operation time exceeded 45 min were excluded.

Baseline facial dimensions were measured with a tape measure between the reference points of the tragus-lateral commissure and lateral canthus-angulus on the operated sites. Oedema was indicated by an increase in the baseline mean distances.

Trismus was observed as a decrease in preoperatively measured maximal mouth opening, which was measured as the distance between the upper and lower right or left central incisors.

Pain intensity was evaluated subjectively using a Numerical Rating Scale (NRS) on which “0” means no pain, “5” means moderate pain, and “10” means worst imaginable pain. Additionally, analgesic consumption was individually recorded as tablets per day for the T0-T1 and T1-T2 intervals, and the total postoperative period.

Quality of life (QoL) was measured at T0, T1, and T2 in all groups using the Oral Health Impaction Profile-14 (OHIP-14) scale where each item is scored as 0, never; 1, hardly ever; 2, occasionally; 3, fairly often; and 4, very often. Total scores vary between 0 (absence of problems) and 56 (experiencing the mentioned problems very often).

For healing, the extraction sites were examined in terms of tissue colour, response to palpation, existing granulation tissue, and condition of the incision margin and scored as 1, very poor; 2, poor; 3, good; 4, very good; and 5, excellent. From this, a healing score was determined.

The postoperative 1-week period from the viewpoint of the participants was evaluated with the Postoperative Symptom Severity Scale (PoSSe) on T2. PoSSe contains seven subscales and 15 questions that were devised from common clinical questions to assess symptoms of the patients with third molar extractions. The obtainable minimum score is 0% (least severe response), and the maximum score is 100% (most severe response).

RESULTS

The study population consisted of 57 patients. Of this, five patients (two for exceeded surgery time, three for loss to follow-up) were excluded. The remaining patients completed the study protocol and the requested questionnaires. Data obtained from 52 patients were analysed; 36 were female, 16 were male, and the mean age was 24.9 years. After exclusion, the groups consisted of 17 patients in the dexketoprofen trometamol (DT) group, 16 patients in the Corticosteroid group (CS) group, and 19 patients in the Kinesio tape (KT) group. No significant difference was found between the three groups regarding baseline variables. Neither participant experienced complications such as alveolar osteitis, infection, dehiscence, sensorial disturbance, or any other postoperative complication.

The preoperative mean maximal mouth opening was 42 mm. In all groups, a reduction in mouth opening was detected on T1, with a statistically significant difference between the DT group and the other groups ($p=0.002$). The mean restriction in mouth opening was 21 mm in the DT group, 12 mm in the CS group ($p=0.003$), and 16 mm in the KT group ($p=0.014$).

The most severe oedema accumulation was observed in the DT group on T1, and a statistically significant difference was found with the other groups ($p=0.014$). However, on T2, the difference between groups was statistically insignificant ($p=0.112$). Compared with baseline levels on T2, swelling persisted mildly in the DT group and approached the baseline values in both the CS and the KT groups.

There was a statistically significant difference in total mean pain rating (NRS) scores between the KT group and the other groups ($p=0.001$). On T1, there was no statistically significant difference between any of the groups. On T2, there was a significant difference between the KT group and the other groups ($p=0.010$). Regarding analgesic consumption, at all-time intervals, the DT group consumed significantly more tablets than the other groups.

The clinically assessed healing rates significantly differed between groups on T1 and T2 ($p=0.015$, $p=0.047$, respectively). On T1, the lowest scores were obtained in the DT group; however, on T2, the CS group had the lowest scores.

According to the subjective assessment of QoL in the postoperative period, total mean OHIP-14 scores did not differ between groups on T0 (p=0.497), T1 (p=0.217), and T2 (p=0.969). Nevertheless, the mean total scores in all three groups decreased on T2 compared with T0 and T1. On T2, there was a significant difference between the groups in terms of psychological discomfort (p=0.027); the dexketoprofen trometamol (DT) and Corticosteroid group (CS) groups were similar to each other (p>0.999). In contrast, the Kinesio tape (KT) group significantly differed from the DT group (p=0.039). However, the total mean PoSSe and eating subscale scores differed significantly between groups (p=0.016, p=0.032). The participants involved in the DT group reported the highest scores, whereas the participants in the KT and CS groups exhibited similar results.

CONCLUSIONS

This trail found that Kinesio taping could provide results in terms of trismus, oedema, and QoL that were similar to those of a corticosteroid with long-acting and high glucocorticoid potency. However, Kinesio taping was less effective than dexamethasone for postoperative pain.

Implications of practice

In cases where NSAIDs (anti-inflammatory medication) and corticosteroids are contraindicated, or additional anti-inflammatory measures are required, the therapeutic elastic bandage application appears promising and should be considered as a supportive care modality. The combination of Kinesio taping with other pain-relieving methods should provide benefits similar to that of using corticosteroids in patients who have undergone third molar surgery.

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2. Evaluation of the effect of probiotic lozenges in the treatment of recurrent aphthous stomatitis: A RCT

RL Aggour, SH Mahmoud, A Abdelwhab. Evaluation of the effect of probiotic lozenges in the treatment of recurrent aphthous stomatitis: a randomized, controlled clinical trial. Clinical Oral Investigations. 2021; 25: 2151-8.

INTRODUCTION

Recurrent aphthous stomatitis (RAS) is the most common painful oral mucosal disease. It affects nonkeratinized mucosa in men and women of all ages, races, and geographic regions. Minor RAS is the most common form, which accounts for approximately 70 to 87% of the population with RAS and usually has 1 to 5 ulcers at one episode, with a size of less than 1 cm in diameter.[1] For RAS patients, the ulcer pain associated with each episode may severely interfere with eating, speaking, and swallowing. The aetiology of RAS remains unknown and thus all current systemic or topical treatment methods are to relieve symptoms and accelerate healing. Most systemic medications, although effective, have side effects that limit their general use. Therefore, topical agents remain the first choice for the treatment of RAS, due to their effectiveness and safety.

The application of host-modulating bacteria for therapeutic purposes, which, when administered in an adequate amount, confer a health benefit on the host is being increasingly used. Majority of probiotic bacteria belong to the genera, *Lactobacilli*, *Bifidobacterium*, and *Propionibacterium*.

Probiotics have been documented to exert several actions on a wide variety of immune cells shifting it towards the anti-inflammatory pathway.[1] Additionally, probiotic action could be augmented by using prebiotics such as inulin. This combination is known as symbiotic[1] Aggour and colleagues (2021)[1] reported on a randomized clinical trial that sought to explore the effectiveness of lozenges containing *Lactobacillus acidophilus (L. acidophilus)* and *Bifidobacterium lactis*, plus inulin in the treatment of minor RAS in adult and paediatric RAS patients.

MATERIALS AND METHODS

Sixty adult (group A) and 60 children patients (group B) with diagnosis of minor RAS were included in this randomized clinical trial (RCT). Each group was divided into two subgroups as follows:

- **Adult Group AI:** ChocBalls (L. acidophilus containing lozenges)
- **Adult Group AII:** (control) Oracure oral gel (15gm, Amun)
- **Child Group BI:** ChocBalls (L. acidophilus containing lozenges)
- **Child Group BII:** (control) Oracure oral gel (15gm, Amun)

The inclusion criteria for group A was as follows: (1) males and females aged 18-45 years old, (2) patients presenting with RAS with the following characteristics:

(a) minor aphthous ulcers less than 48 h duration prior to enrolment, (b) size no greater than 10 mm in diameter, (c) a history that ulcers normally more than 5 days to resolve without treatment.

The inclusion criteria for group B are the same except age; children with RAS aged between 3 and 12 years were recruited for the study. The exclusion criteria are as follows: a known history of hypersensitivities, immunologic or systemic diseases, pregnancy, smoking, treatment with systemic steroid, or other immunomodulatory agents within 1 month before the study; use of non-steroidal anti-inflammatory drugs or oral anti-histamines within 1 month prior to the study; treatment of the ulcer with any preparation or medication within 72 h prior to the study, and treatment with systemic anti-biotics within 2 weeks prior to the study and a history of adverse reactions to lactose or fermented milk products. Children with a positive family history of RAS were excluded. The nutritional status of the children was evaluated.

After taking a detailed history and clinical examination, all patients eligible for study participation were randomly assigned to the test subgroups (*L. acidophilus* containing lozenges) or control subgroups. Adult lozenge was composed of the following: *L. acidophilus* 1.5 billion cfu, *Bifidobacterium lactis* 1.5 billion cfu and inulin 0.13 g per lozenge. For children, lozenge was composed of the following: *L. acidophilus* 0.5 billion cfu, *Bifidobacterium lactis* 0.5 billion cfu, and inulin 0.13 g per lozenge.

Patients were instructed to melt the *L. acidophilus* containing lozenges in the mouth slowly twice daily for 5 days (day 1 to day 5). The baseline parameters were taken and recorded on the day of the first visit. Effectiveness evaluations were made on the morning of day 3 visit and day 5 visit.

The index ulcer's size was measured on treatment days 0, 3, and 5. To evaluate pain, a visual analog scale (VAS) consisting of a 10-cm horizontal line between poles connoting no pain (origin) to unbearable pain was used. Subjects were told to mark the line with a vertical line at the point that best represented the present pain level of the ulcer.

The effectiveness indices (EI) of the ulcer size and pain improvement were measured at day 3 visit and day 5 visit. The effectiveness indices were evaluated on a 4-rank scale: (1) heal: EI ≥ 95%; (2) marked improvement: EI < 95%, but ≥70%; (3) moderate improvement: EI < 70%, but ≥30%; and (4) no improvement: EI < 30%. Participants were asked to estimate the average duration of episodes during the past 6 months and the potential to reduce the outbreak frequency of RAS within the next 6 months was investigated.

RESULTS

A total of 60 patients (39 females, 21 males) were included in group A (adult group) and 60 healthy children (34 females, 26 males) in group B (paediatric group). All patients enrolled in the study completed the trial. The baseline characteristics of the study groups showed no significant differences within each group.

For ulcer size reduction in adult patients (group A), the effectiveness index of AI was greater than AII at both evaluation periods; however, the difference was statistically insignificant ($P=0.2149$, $P=0.08914$; respectively). Regarding pain reduction, subgroup AI had statistically greater effectiveness index when compared with subgroup AII at both evaluation periods ($P=0.0455$, $P=0.0093$; respectively). For "improvement" rate, at day 3, the subgroup AI had higher values for both ulcer size reduction and pain moderation (80% vs. 53.33%) when compared with subgroup AII. At the day 5 visit, compared with subgroup AII, subgroup AI maintained a greater improvement rate for pain moderation only. No change in outbreak frequency was reported within the 6 months next to treatment ($P>.05$)

For ulcer size reduction in paediatric patients (group B), the effectiveness index of BI is greater than BII at both evaluation periods; however, the difference was statistically significant at only the day 5 visit ($P=0.0080$). Regarding pain reduction, subgroup BI had slightly greater effectiveness index when compared with subgroup BII at both evaluation periods; the difference was statistically insignificant ($P=0.1585$, $P=0.3787$; respectively). For "improvement" rate, at day 3, the subgroup BI had higher values for both ulcer size reduction and pain moderation when compared with subgroup BII (90% vs. 73.33% and 63.33% vs. 53.33% respectively). At the day 5 visit, compared with subgroup BII, subgroup BI had a slightly higher improvement rate for ulcer size reduction and identical pain moderation. A statistically significant decrease in outbreak frequency was reported for subgroup BI within the 6 months next to treatment. The change was significantly different from subgroup BII ($P<.05$).

CONCLUSIONS

The researchers concluded that topical application of probiotics decreased pain intensity and accelerated RAS healing. The effectiveness in pain reduction was more evident in adult patients while acceleration of healing was greater in children.

Implications for practice

Probiotics is a well-tolerated, topical therapeutic agent for the management of minor RAS in both adults and children.

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Maxillofacial Radiology 191

SADJ June 2021, Vol. 76 No. 5 p288

J Walters

A 9-year-old female presented with a history of a firm painless bony swelling at the left mandible. A pantomograph (Figure 1) revealed a large radiopaque mass in the mandibular body with impaction of the 36. What are the most distinguishing radiological features and what is your provisional diagnosis?


Fig. 1


Fig. 2

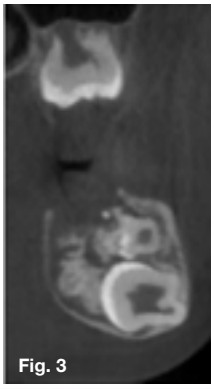
Fig. 3

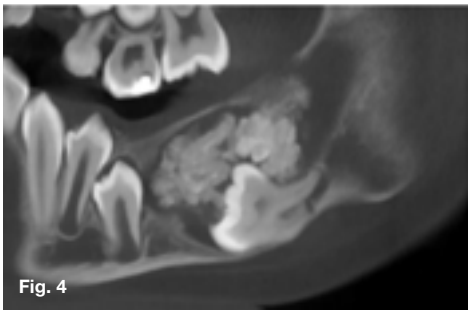
Fig. 4

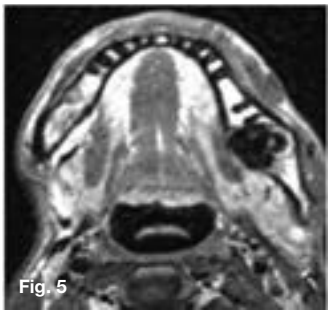
Fig. 5

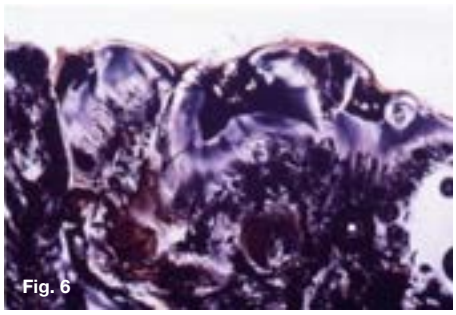
Fig. 6

INTERPRETATION

The lobulated radiopaque lesion appears encapsulated within a cystic-like shell demonstrated as a thin radiolucent corticated rim. 3D rendering (Figure 2) shows an expansile lesion in the left mandibular body. Coronal (Figure 3) and sagittal oblique (Figure 4) CBCT slices depict the lesion as a predominantly tooth-like intermediate-density with high densities throughout similarly to dentine and enamel. Multiple pulp-like structures can be observed as low densities superior to the impacted molar. Buccal lingual expansion, transposition of the inferior alveolar nerve canal, thinning of cortices, irregularity of inferior mandibular border, displacement of the 35, and dilaceration of the 36 mesial root was noted. The T1-weighted gadolinium-enhanced axial MRI (Figure 5) demonstrates another patient with a similar lesion in the left mandible appearing as a well-circumscribed low signal intensity surrounded with a soft tissue capsule and septation. A photomicrograph (Figure 6) of a histological slide shows haphazardly arranged dental hard and soft tissue.

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The complex odontoma is defined as a malformation with all dental tissues being represented where dental hard tissue is well developed but occur in a disorderly pattern. Differentiation between odontoma variants may be considered subjective. As it is based on the appearance of the internal contents' arrangement. The complex often has an ovoid appearance when compared to the compound which is irregular in shape. The content of these lesions appear greater in density compared to bone. With the complex variant demonstrating characteristically haphazard arrangement and the compound odontoma appearing more organized consisting of multiple denticles.

Generally asymptomatic, slow-growing, and expansile. The mean age of diagnosis is at 19-years-old. A predilection for the posterior mandible has been demonstrated. The association of multiple odontomas in Gardner's syndrome has been widely reported. Even though the complex odontoma is considered self-limiting. When inadequately treated in its initial predominant soft tissue stage, recurrence may occur.

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Virtue ethics in dentistry - a model for developing virtuous dental practitioners

SADJ June 2021, Vol. 76 No. 5 p290 - p293

HD Miniggio[1], PD Motloba[2], CS Wareham[3]

INTRODUCTION

There is a renewed appreciation of the contribution of virtue ethics in clinical healthcare practice, including dentistry. This interest in virtue ethics highlights the limitations of only focusing on the development of clinical skills and competence or mere adherence to a set of ethical rules and guidelines. There is also a growing interest and appreciation that an equally important and integral aspect of dental practice is the development of a virtuous character. From this virtue ethics perspective, a virtue is an excellent trait of character, a disposition, well entrenched in its possessor.[1]

When applied to health care, virtues are those character traits that are important for healthcare practitioners to develop, thereby improving the dental practitioner-patient relationship. In so doing, the healthcare practitioner is able to reciprocate the trust that patients place in the profession. In the context of dental practice, the development and exercise of the virtues of trustworthiness, integrity, discernment, conscientiousness and compassion are considered essential in guiding dental practitioners in their interactions with patients.[2] A virtuous character develops from continuous practice and from emulating good role models.[3]

In the case of dental practice, one of the sources of role modeling[a] these virtues would presumably be the clinical supervisors[b] who teach dental students during supervised dental treatment and interaction with the patient at the chair-side. Although great strides have recently been made in identifying the clinical competencies and qualities which are required for effective clinical teaching, these qualities are discussed in the literature in a fragmented fashion under the umbrella of professionalism in dental practice.[3] Further to this, evidence suggests that "clinicians often occupy a clinical teaching role without being adequately prepared for or orientated to the associated demands".[4-7] Given the significance of this source of role modeling in shaping the moral character of future dental practitioners, it is surprising that the virtues that clinical supervisors should develop and routinely demonstrate during dental chair-side teaching and patient interaction are not directly addressed in current literature.

In this article we propose a preliminary model for understanding and incorporating virtues as part of the development of the moral character of the dental practitioner drawing on Aristotelian virtue ethics. We firstly provide a brief overview of Aristotelian virtue ethics and the development of a virtuous character and then describe how Aristotle's virtue ethics can be integrated in dental chair-side teaching. To this end, we propose an interactive model with the following conceptual propositions:

(i). Virtues can be taught by role modeling as part of the authentic *patient-dental student-clinical supervisor* interaction during clinical teaching at the chair-side.

(ii). Clinical supervisors are in an ideal position in their dual function of dental practitioner and teacher in this real-life clinical scenario, thus are able to play a critical role in the development of character during chair-side dental training.

(iii). Through this relationship, clinical supervisors can inspire and shape the development of a virtuous character in future dental practitioners by enacting these virtues in every interaction with the student and patient, respectively.

(iv). The refinement of these virtues will conceivably continue beyond in routine dental practice.

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2. **Pagollang D Motloba:** First draft, revision, final write-up and final approval - 25%
3. **Christopher S Wareham:** First draft, revision, final write-up and final approval - 10%

[a] In this context a role model is one that "demonstrates a standard of excellence which should be imitated".[9]

[b] "Clinical supervision in the context of dental training can be defined as the monitoring, guidance and feedback on matters of personal, professional and educational development in the context of patient care".[9]

The discussion in this paper is confined to the role of virtues in the *patient-dental student-supervising clinician* relationship while acknowledging that these virtues may be equally valuable for teachers in the non-clinical dental subjects.

In the sections to follow, we provide a brief overview of how Aristotle's virtue ethics can be integrated in the dental chair-side teaching. We do so by first conceptualizing virtues and then exploring how virtues can be instilled as part of the patient-dental student-supervising clinician relationship.

The role of virtue in the development of a virtuous character

We begin by exploring Aristotelian virtue ethics and the development of a virtuous character. Virtue ethics is an ethical theory that is primarily concerned with the development of a virtuous character which is considered an essential ingredient in living a good life. For Aristotle, who is considered the founding father of virtue ethics, a good life represents a "condition of human flourishing" known as *eudaimonia*[c].[3] Aristotle is of the view that no-one can live a happy and fulfilled life, unless they possess and exercise certain moral virtues. A moral virtue can be defined as an "acquired habit or disposition to do what is morally right or praiseworthy".[8]

Such a virtue or character trait is desirable for its own sake and can be identified in the balance of two extremes, one of deficiency and one of excess; both such imbalances impact negatively on the virtue. Let us consider the virtue of compassion which is considered essential in healthcare practice as case in point to illustrate Aristotle's concept of the 'golden mean'.

Compassion refers to "an active regard for another's welfare with an imaginative awareness and emotional response of deep sympathy, tenderness and discomfort at another's misfortune or suffering".[10] Compassion is the virtue that is achieved through the appropriate balance of two extremes; a deficiency in compassion leads to callous attitude while an excess in compassion leads to an overly compassionate or pitying attitude, both of which would not be desirable in the context of healthcare provision.

The question then arises; how does one ensure that the right balance is achieved between the two extremes in particular scenarios encountered in healthcare provision? The answer to this question lies in the correct application of what Aristotle deems to be the dominant virtue through which all other virtues are balanced, namely phronesis or practical wisdom.[3] Practical wisdom requires that a careful and insightful choice is made in the "proper order of priority and to make the right and good decision in the most difficult situation".[11] Such wisdom equips individuals with the insight necessary to differentiate right from wrong, based on the context of a particular situation.[12]

[c] "*Eudaimonia* is happiness, contentment, and fulfillment; it's the name of the best kind of life, which is an end in itself and means to live and fare well".[13]

As with all other virtues, practical wisdom can be learnt through practice as Horn explains: "every time one is faced with a new situation that requires moral deliberation and choice, the virtue of practical wisdom is strengthened".[14]

The aim of virtue ethics is then to attain excellence in moral character which in turn is achieved by practicing good habits through good teaching and continuous practice. Further to this, "a virtuous person reaches a level of internal harmony or integration between cognition and emotion, freedom and adherence to ideals, and individuality and community".[12] In order for individuals to achieve a virtuous character they need to develop and continuously exercise the following habits:

- "recognize or perceive moral situations correctly (to be sensitive to what is at stake in a situation)";
- "respond emotionally to the situation in the right way (this may include being dispassionate in the right circumstances)";
- "think well about what to do in the situation (either to know how to act or to reason appropriately about how to act)" and;
- "be motivated strongly enough to carry the right action through".[15,16]

Having considered the role of virtue in the development of a virtuous character, in the next section we propose a model for understanding and incorporating virtues as part of the development of the moral character of the dental practitioner in the patient-dental student-supervising clinician relationship.

Virtues in action during dental chair-side teaching

The training of healthcare practitioners, including dental practitioners places great emphasis on "the objective and quantifiable science and clinical practice, which at time cripples the patient-physician relationship".[12] In the dental clinical context, research suggests that "clinical performance of students was positively correlated with proficiency in moral reasoning" and that "moral reasoning could be improved through classes in medical ethics and small-group discussion of ethical issues, based on actual clinical scenarios".[15]

Interestingly it has been shown that "there are strong similarities between wise ethical judgement in medicine and what we would ordinarily call 'clinical judgement'".[16,17] Both clinical judgement and ethical judgement "requires repetitive and supervised practice over years of training so that the trainees can learn a skill that comes by experience".[17]

A virtue ethics approach focuses on such practical wisdom and good clinical judgement.[16] Specific "kinds of human activities elicit specific virtues, which Aristotle described as 'states of character'".[3,12] Individuals who role model the ideal character traits and the "ideal performance for such activities serve as a standard by which to judge performance and a template on which to model one's own actions".[12]

We propose a preliminary virtue-based model in which the clinical supervisor represents one of the sources of role-modeling virtues within the authentic real-life clinical interaction between the patient, dental student and the supervising clinician during the chair-side teaching ex perience. From such a perspective, clinical supervisors convey not only clinical skills, experience and subject knowledge during this real-life experience, but also practical wisdom as they guide students as to "how best to negotiate the clinical encounter".[12]

"In doing so, students can recognize and appreciate how virtue can help to provide the best possible clinical decision and action".[12] Further to this, chair-side teaching is relational and is "integral and constitutive of the teaching relationship and role modeling is a powerful strategy by which character development can be instilled".[18] This implies that certain character traits would be expected from the clinical supervisors in their interaction with dental students and patients, respectively. In the model that we propose, the supervising clinician would:

i. exhibit a "strong internal sense of appropriate and good behaviors, based on a robust set on inbuilt values and virtues".[16]

ii. role model the virtues of trustworthiness, integrity, conscientiousness, discernment and compassion towards the patient during chair-side teaching thereby inspiring dental students to develop these virtues.

iii. express the virtues of honesty, fairness, compassion and patience towards dental students in the chair-side interaction and in this way support and shape the development of their individual moral character.

iv. offer support and guidance to students (and colleagues) who fail to display the expected excellence in character during this patient interaction.[16]

v. role model these virtues as a way of advancing the goals of dental practice at every clinical encounter, namely "the good of the patient in relation to promoting, maintaining and restoring oral health".[1]

In sum, a virtuous clinical supervisor is one who shows compassion and active regard to the well-being of the patient and the student in her interaction in the patient-dental student-supervising clinician relationship at the chair-side. Further to this, she builds trust with the patient by meaningful collaborations and by taking time to understand the oral healthcare needs of each patient. She is also fair towards the student and honest with the patient. She responds sensitively to the specific situation and displays wise judgment during her interactions in the patient-dental student-supervising clinician relationship.

Such a virtuous clinical supervisor is more likely to inspire, motivate and create the foundation upon which dental students can develop their own character by first emulating that which she role models. In cases in which students deviate from such standards of excellence modeled by the clinical supervisor, which is likely occur from time to time, a virtuous clinical supervisor would empathetically and patiently guide the student in understanding where they went wrong and advising on ways to correct such deviations.[16] In this way, the development and continued exercise of these virtues is ensured in the patient-dental student-supervising clinician relationship, thereby encouraging insightful practical wisdom in the clinical decision making process and ensuring that the good of the patient in relation to promoting, maintaining and restoring oral health is fulfilled.

Nevertheless, it could be argued that one cannot in fact expect that clinical supervisors should develop and model specific character traits and that even an intolerant, insincere, indifferent and unfair clinical supervisor could nonetheless still oversee the procedural technical correctness of a class II cavity preparation or an extraction that the student is required to perform.

Whilst this might be so by a very small margin, it is unlikely that a supervising clinician with such character traits could motivate, inspire and assist the student in developing their individual, internally motivated virtuous character. This is because teaching at the chair-side is relational, such an activity "demands the participation of both teacher and learner, so the character of the teacher is part of the puzzle of what makes a moral and ethical teacher".[18] Further to this "teaching as professional work requires constant practical judgement to ensure that the moral requirements of everyday practice are met".[18] "Medical education is not simply about conveying knowledge; it is also concerned with transformation in nurturing the character of the good doctor".[2]

CONCLUSION

In this article we proposed a preliminary virtue ethics model for understanding and incorporating virtues as part of the development and shaping of the moral character of the dental practitioner; this may enhance dental chair-side training and education strategies and in this way promote excellence in dental training and beyond in routine dental practice. In our proposed model, virtues are taught by role modeling as part of the authentic patient-dental student-clinical supervisor interaction during clinical teaching at the chair-side.

To this end we showed how through this relationship, clinical supervisors can inspire and shape the development of a virtuous character in future dental practitioners and that the development of a virtuous character in future dental practitioners should not be overshadowed by clinical skills and subject knowledge during chair-side teaching. Clinical supervisors should further be empowered and encouraged to use a virtue model "as a touchstone for accomplishing their goals in training students" and achieving excellence in clinical teaching.[12]

There is great scope for further empirical research in this field which could investigate the various pedagogical strategies which Dental Schools could develop to ensure that character development is adequately addressed and incorporated in dental chair-side teaching. This would be an important initiative in addressing virtues of future dental practitioners at its source, "for not to teach virtues, is to leave the door open for vices".[12]

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CPD questionnaire

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GENERAL

The relationship between the mechanism of injury and mandibular fractures

1. Select the CORRECT answer.
   Is there a gender predilection toward a greater incidence of mandible fractures?
   A. No
   B. Yes, males are more likely to sustain mandible fractures
   C. Yes, females are more likely to sustain mandible fractures
   D. Yes, but it is notably variable depending on where the study was conducted

2. Select the CORRECT statement.
   Which factor increases the risk for mandibular angle fractures?
   A. The presence of mandibular third molars
   B. The height of the patient
   C. The weight of the patient
   D. The left- or right-handedness of the patient

Oral health knowledge, attitudes and practices among school teachers in Tshwane district, South Africa

3. Select the INCORRECT answer as it pertains to this study:
   A. Teachers are perceived as role models
   B. Teachers can enhance the dental health behaviour of young children
   C. Teachers can enhance the oral health behaviour of young children
   D. Studies have reported that teachers with good oral health (OH) knowledge are less confident when teaching children about their OH compared to those with poor knowledge

4. Which of the following statements is INCORRECT regarding this study?
   A. The majority of respondent felt it is important to visit a dental practitioner regularly
   B. Less than 50% indicated that they are willing to teach learners about OH
   C. Majority of respondents believed that Oral health education should form part of the curriculum
   D. Of those who felt that OH should not be taught at school, more than half cited a lack of time as a barrier

5. Concerning the outcomes of this study, which statement is CORRECT?
   A. The most common reasons for visiting a dental practitioner were for restorative work
   B. The majority of teachers reported to have not visited a DP due to high cost
   C. Less than half confirmed that their dental practitioner spoke to them about prevention of dental diseases at their last visit
   D. The majority of respondents reported brushing twice a day

6. Select the CORRECT answer. A study has reported that more than how many school hours can be lost annually as a result of oral diseases?
   A. 50
   B. 20
   C. 25
   D. 10
   E. 30

Perceptions of dental therapy students regarding the teaching and training with dental amalgam, in a dental school in KwaZulu-Natal, South Africa

7. Select the CORRECT answer. Why is resin composite the material of choice for restorations?
   A. High aesthetic value
   B. Requires minimal tooth preparation
   C. Patient Preference
   D. All of the above

8. Choose the CORRECT option. It is anticipated that the future generation of dentists and dental therapists joining the dental professional workforce will be more skilled in the placement of:
   A. dental amalgam
   B. resin composites
   C. glass ionomers
   D. resin compomers

9. Which is the CORRECT answer. What was the main limitation of this study?
   A. Student numbers were not adequate
   B. First-year students were not allowed to participate
   C. The questionnaire was not validated
   D. Only one dental school participated in the study

10. Select the CORRECT answer. What is the main reason that dental amalgam is being phased out?
    A. Poor aesthetics
    B. Mercury toxicity
    C. Loss of healthy tooth structure
    D. Cavity preparation is time-consuming

Quality of root canal treatment performed by undergraduate students at the Wits Oral Health Centre

11. Choose the CORRECT answer.
Periapical radiographs are not used in endodontic treatment for:
A. diagnosis of irreversible pulpitis
B. working length determination
C. master cone fit
D. postoperative assessment of the quality of obturation

12. Select the CORRECT answer.
When examining post-operative radiographs, which of the following can be used as predictors of successful endodontic treatment outcome:
A. Length of root canal filling
B. Density of the root canal filling
C. Taper of the root canal
D. All of the above

13. Which of the following answers are CORRECT.
Keeping in context the results of this study, a greater emphasis on working length control throughout canal preparation procedures during preclinical teaching most likely decreases the occurrence of:
A. strip perforation
B. transportation
C. overfilling
D. file fracture

14. Select the CORRECT option.
The most likely reason for superior results being noted in the 5th year student cohort, when compared to 3rd and 4th year students is:
A. more experience having completed more root canal treatments
B. access to rotary instruments for canal preparation
C. more time allocated for root canal treatment in the clinic
D. a greater staff:student ratio in the 5th year cohort

A comparison of failure rates and canal preparation times between WaveOne Gold and One Curve file systems with and without glide path preparation in simulated canals

15. Select the CORRECT answer.
Glide path preparation prior to final endodontic shaping has the following benefit:
A. Decreased instrument efficacy
B. Increased longevity of preparation instruments
C. Deceased number of prepared canals before instrument failure
D. Prior glide path preparation has no effect on instrument failure or longevity

16. Which of the statements is CORRECT. The following results from glide path preparation prior to final canal shaping in simulated canals:
A. Significantly increased simulated canal preparation times
B. Increased instrument failure rates
C. Significantly greater number of simulated canals being prepared before instrument failure
D. Glide path preparation prior to final canal shaping has no effect on final canal shaping times in simulated canals

Clinical Window: What's new for the clinician?

17. Select the CORRECT answer. In the Erdil et al. trial, the greatest improvement in mean maximal mouth opening postoperatively was seen in:
A. Dexketoprofen trometamol (DT) group
B. Corticosteroid group (CS) group
C. Kinesio tape (KT) group
D. All groups were the same

18. Which of the following options is CORRECT. In the Erdil et al. trial, at time interval T2, the reduction in oedema was greatest in:
A. Dexketoprofen trometamol (DT) group
B. Corticosteroid group (CS) group
C. Kinesio tape (KT) group
D. All groups were the same

19. Choose the CORRECT option. In the Aggour et al. trial, the ulcer size was reduced post treatment in:
A. group A1 only
B. group A2
C. group B1 and B2
D. in ALL groups

20. Which option is CORRECT. In the Aggour et al. trial, regarding pain reduction, subgroup AI had statistically greater effectiveness index when compared with subgroup AII:
A. At both evaluation periods (day 3 and 5)
B. At day 3 only
C. At day 5 only
D. At day 0

ETHICS

Virtue ethics in dentistry – a model for developing virtuous dental practitioners

21. Choose the CORRECT option.
Virtue ethics is a theory with a central focus on:
A. the role of character
B. the application of ethical principles
C. the consequences of actions
D. the application of codes of ethics

22. Select the CORRECT answer. In the context of dental chair-side teaching, the source of modeling virtues would be:
A. the dental student
B. the clinical supervisor
C. the patient
D. None of these as virtues cannot be taught or modeled

23. Which of the following options is CORRECT.
Phronesis which Aristotle considers as the chief virtue, refers to:
A. an active regard for the wellbeing of others
B. a state of happiness or fulfillment
C. excellence in moral character
D. practical wisdom

24. Select the CORRECT answer.
A virtue is considered as:
A. happiness and fulfilment
B. practical wisdom
C. weakness of character
D. an admirable character trait

25. Choose the CORRECT option.
One of the virtues identified as being essential in oral healthcare practice is:
A. compassion
B. wit
C. humility
D. open mindedness

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