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SADA
THE SOUTH AFRICAN DENTAL ASSOCIATION

The Fontana di Trevi or Trevi Fountain in Quirinale, Italy

SADJ - Your Fountain of Knowledge

Fountains and springs are a symbol of new hope, vitality, and life. For this reason it was decided to features springs and fountains on the cover pages of the SADJ and use them as an analogy for dentistry and dental education. The first edition of 2022 features one of the world's most iconic and well-known water features, The Fontana di Trevi or Trevi Fountain in Quirinale, Italy. The name is derived from the word Trivium, as it stands at the intersection of three streets. The water will be used to signify knowledge. At the Trevi fountain, it is in plentiful supply and spills over freely to anyone who makes the effort to visit and take a sip. Drinking it will immediately refresh and energise the body and the mind. However, thirst is never sated and as such, visitors will need to constantly seek out new and fresh water supplies, which they may sometimes drink at short and regular intervals, or gulp down in volumes, depending on their thirst. Those who never imbibe, will soon become fatigued dehydrated and will perish.

The Trivium or intersection is symbolic of a meeting of minds. One cannot forever be taking from the fountain without adding back to the pool. The waters may be topped up with a wealth of knowledge coming from various sources, such as research and publications, presentations, discussions, reporting on cases and experiences, and teaching. At the Trevi fountain people add wealth by throwing coins into the water. The legend is that if a coin is cast in, the person will be sure to have further visits to the fountain, as well as safe journeys. Sharing wealth (knowledge) with others also has a beautiful ripple effect. The money is collected each night and given to an Italian charity called Caritas which supports a supermarket that gives rechargeable cards to the needy to help them purchase groceries. We hope that our sharing may also be collected and spread amongst those with a hunger for mental nourishment, growth and education.

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Our Front Cover for this Issue...

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Courtesy Prof Leanne Sykes

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Dental care access in South Africa – *Open the Debate*

SADJ February 2022, Vol. 77 No. 1 p1

Prof NH Wood - Managing Editor, SADJ

Patient access to dental care is still of serious concern in the South African setting. We need a detailed investigation to determine the facts and characteristics surrounding this challenge. Our profession cannot ignore the fact that large parts of our population still struggle to access dental care, and even then, concerns regarding the quality of such care are raised. Of course, the argument exists that at least some care is better than no care at all.

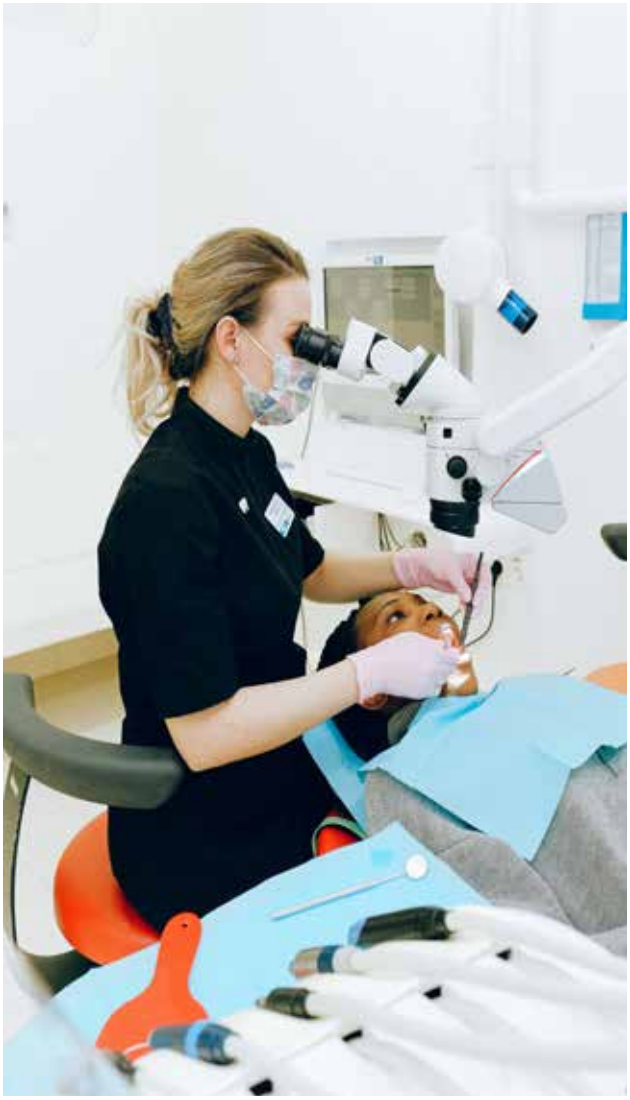
There are certain known hinderances to dental care access, but whether these are being addressed or not is an entirely different argument. Some of these include something as clear as dental anxiety, to the deep complexities of social injustice and inequality. Although patient-factors that influence the accessing of dental care is a major role player, these relate specifically to the patient's own lived experiences and mindset, to their actual social and psychologic situation. Factors like personal financial stability, dental phobias, own perceived need of treatment/delays in treatment all influence the personal aspect and motivation to access dental care. Despite this, there is still a major responsibility on the profession to facilitate access.

Of all the major concerns, finance, and time delays to seek or provide treatment appear to be the most frequently reported factors to hinder dental care access. But what about clinician/operator factors? Where do clinicians want to work? We quite often do not consider the needs and aspirations of oral healthcare professionals in the context of challenges to dental care access. I believe that this plays a part in the sustained development of services in any underserviced region and will remain stunted through higher clinician turnover rates.

To get to the root of this challenge, there would need to be a concerted effort supported by all role-players in oral health ranging from the relevant governmental departments, dental associations and organizations, and academic institutions. All aspects of dental care in South Africa would need to be dissected and closely inspected to conclude on the question: "Would it be possible to provide equitable oral health care, at all levels, for all communities?" In order to provide some meaningful answer to such a difficult question, some key points would also have to be raised that include remuneration plans and strategies, infrastructure development and support, the treatment needs of different population groups in the short and the long term, the role of mid-level oral health care professionals, dentists and dental specialists within the greater framework of access to high quality dental care.

I would therefore like to call on our various directorates of Oral Health, our academic institutions and leadership, and our dental associations and organizations to take up this challenge and set in motion a process that would focus on this challenge.

We present to you the February issue of the SADJ. As we do so we remember the many colleagues whom we lost since 2021. We also mourn the loss of Prof AJ Lighthelm, former Dean of the School of Dentistry at the University of Pretoria. Let us all endeavor to do our best for the upcoming year and to leave the profession in a better position than the year before.



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LOVE EXPRESSED THROUGH HEALTHY SMILES!!

SADJ February 2022, Vol. 77 No. 1 p2
Dr Nthabiseng Metsing, Head: Professional Development, SADA

Valentine's Day is an annual festival to celebrate romantic love, friendship and admiration. Every year on 14 February people celebrate this day by sending messages of love and affection to partners, family and friends. Looking at the history, this is a day whose inception can be traced to a tragedy that became a “Love story” that has become the day as we know it and celebrate today.

While Valentine's Day is celebrated in most countries, different cultures have developed their own traditions for this commemoration. In some parts of the world Valentine's Day is observed as a day for expressing love between family members and friends, rather than that of romantic couples. Some traditions include leaving sweets/chocolates and gifts for children and others include acts of appreciation between friends.

This year SADA would like to extend the love to the whole dental community and encourage its members to show the same love to their patients by continuing to put smiles on their faces and making them fall in love with these smiles. Also encouraging good oral hygiene practices so that they can also in turn show some love to their teeth and mouth in general.

Since this is the month of love, dentists have an opportunity to not only give beautiful smiles but also fresh breathes. A kiss is probably on the list for many people this Valentine’s Day. Before getting comfortable with loved ones this year, it is important to make sure the mouth is in good health because, as it turns out, a kiss is more than just a kiss. Let us encourage society to not suffer in silence because they either don’t know where to go or they are too anxious/afraid to visit a dentist. Bacteria is a big culprit of bad breath, so regular habits like brushing and flossing should especially be encouraged. Other ways to encourage patients to stay fresh are over-the-counter antimicrobial mouthwashes or chewing sugar free gum. Both can freshen their breath instantly and get saliva flowing, especially after they have eaten foods with a strong scent.

The month of February is also National Cancer Prevention Month. As we are aware that a lot of patients are not knowledgeable enough when it comes to the different cancers that affect the oral cavity, we would like to encourage members to raise awareness about the prevention and clinical presentation of the different oral cancer lesions. Oral cancer accounts for roughly three percent of all cancers diagnosed annually. As dentists we can use prevention and education as our love language this month in order to save the livelihood of patients under our care.

Oral cancer most often occurs in people over the age of 40 and affects more than twice as many men as women. Most oral cancers are related to tobacco use, alcohol use (or both), or infection by the human papilloma virus (HPV).

There are many more reasons than those stated above that patients can visit the dentist for and addressing these problems can be a beautiful love language for patients. Addressing dental problems can boost patients’ self confidence and this may have a positive impact on their interactions with others.

Let us continue to bring healthier, brighter and beautiful smiles to society. HAPPY VALENTINES’ DAY to the whole Oral Health Community.

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Association between dental and periodontal conditions with chronic kidney disease: A cross-sectional analysis of urban South Africans

SADJ February 2022, Vol. 77 No. 1 p3-11

C George[1], T E Matsha[2], S F G Davids[3], G M Hon[4], U Chikte[5], R T Erasmus[6], A P Kengne[7]

ABSTRACT

Introduction

Oral diseases are preventable causes of poor health outcomes in people with chronic kidney disease (CKD).

Aims and objectives

Investigate the association between dental and periodontal conditions with kidney function and determine whether inflammation mediate the association between periodontitis and CKD.

Design

Cross-sectional analysis of 1551 South African adults of mixed ancestry.

Methods

CKD was classified as estimated glomerular filtration rate (eGFR) <60mL/min/1.73m^2. Oral profile was captured by decayed, missing, filled teeth index (DMFTi), bleeding on probing (BOP), pocket depth (PD), clinical attachment loss (CAL), and periodontitis classified as PD ≥4 mm.

Results

Overall, 6% had CKD, with 93% and 66% of participants with and without CKD, respectively having a high DMFTi (p<0.0001). Further, 84% (CKD) and 43% (without CKD) were edentulous (p<0.0001). A great proportion of the dentate sub-sample (n=846) had periodontitis, however, BOP, PD ≥4mm and CAL ≥4mm were similar between the groups. DMFTi was associated with eGFR and prevalent CKD (p<0.023), with this association driven by the Missing component. Periodontitis was not associated with eGFR nor CKD (p>0.282).

Conclusion

In routine care of people with CKD, attention should be given to oral health.

Key words: chronic kidney disease; oral disease; periodontitis; dental; tooth loss; Africa

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INTRODUCTION AND BACKGROUND

Chronic kidney disease (CKD) is a major public health problem,[1] estimated to affect at least 10% of the global adult population.[2] Given that African populations are at even higher risk of developing CKD,[3] it is essential to identify and manage the modifiable risk factors for CKD and progression to end-stage renal disease (ESRD), to reduce the significant burden on an already ailing health system.

Oral diseases are estimated to affect nearly half the global population.[4,5] Of these oral diseases, periodontitis and dental caries have been implicated as a potential and preventable cause of poor health outcomes in people with CKD.[6-9] Periodontitis, which affects the tissue surrounding the teeth, is thought to contribute to renal deficiency via inflammatory pathways.[10-13] Indeed, several cross-sectional studies have reported that adults with periodontitis generally have elevated acute-phase systemic markers, like serum C-reactive protein (CRP) and oxidative stress responses,[14, 15] and are up to twice as likely to have CKD as their counterparts without periodontitis.[9, 16, 17] On the contrary, dental caries, characterized by the localized destruction of the teeth due to the accumulation of acidic by-products,[10] is much less

explored in the context of CKD. In fact, there is no consensus in the literature on dental caries prevalence and the association with CKD. Certainly, some studies have shown that patients with CKD presents with lower dental caries,[18,19] where others show that CKD is associated with a worse dental status[20] compared to those without CKD, with a few studies showing no association between dental complications and CKD.[21, 22]

Despite the advances made in the aetiology governing the development and progression of CKD, including the potential link with the oral cavity, population-based data on the overall oral status of people with CKD, particularly in Africa are lacking. We therefore aimed to, 1) characterise the dental and periodontal profile of those with and without CKD, 2) investigate the association between dental and periodontal conditions with kidney function and prevalent CKD, and further 3) evaluate whether systemic inflammation, as measured by hsCRP, mediates the association between periodontitis and kidney function and prevalent CKD in a community-based sample of urban South Africans of mixed-ancestry.

MATERIALS AND METHODS

Study setting and population

The data utilized in this analysis is from adult South Africans of mixed-ancestry (in South Africa referred to as the Coloured population).[23] The study was approved by the Research Ethics Committees of the Cape Peninsula University of Technology and Stellenbosch University (NHREC: REC—230 408–014 and N14/01/003) respectively and conducted in accordance with the Declaration of Helsinki. As such, voluntarily signed written informed consent was received from all participants after the explanation of all procedures.

Questionnaires and physical examination

All anthropometric measurements were taken three time and the average presented in this paper. An Omron body fat meter HBF-511 digital bathroom scale was used to determine body weight, with the individual in light clothing and without shoes. Waist circumference (WC) was measured with a non-elastic tape measure by standard procedure, thus at the level of the narrowest part of the torso, as seen from the anterior view. Body mass index (BMI) was calculated by means of the conventional calculation as weight divided by the square of height (kg/m^2). Systolic and diastolic blood pressure (SBP and DBP, respectively), taken in a seated position after 10 minutes of seated rest, were recorded three times on the right arm using a semi-automated digital blood pressure monitor (Omron M6 Comfort (Omron Healthcare Co., Ltd.). With the first measurement discarded, the average of the last two measures were used as the blood pressure measurement. A standardized oral examination, based on the World Health Organization (WHO) guidelines,[24] was performed on all participants by a trained dental practitioner and has been published earlier.[25] Briefly, bleeding on probing (BOP) was classified if bleeding was observed after a gentle periodontal probing around the tooth circumference. Each tooth was also examined for the presence of dental pockets by probing around the whole circumference and recording the highest score. Pocket depth (PD) categories included 0-3mm and ≥4mm. Finally, clinical attachment loss (CAL) was recorded with a periodontal probe as the highest score obtained for each sextant. Periodontitis was classified as the presence of PD ≥4 mm of one site. Decayed, missing and filled teeth (DMFT) index, which is a key measure of caries experience in dental epidemiology, was recorded for every participant, according to WHO guidelines.[24] In short, the DMFT index is applied to all permanent dentition and is expressed as the total number of teeth or surfaces that are decayed (D), missing (M), or filled (F). Based on the DMFT score, DMFT severity was categorized based on the WHO criteria,[24] as very low (<5.0), low (5.0-8.9), moderate (9.0-13.9) and high (>14). All participants were also asked about their perceived health of their mouth and to rate it as excellent, good, fair, poor or bad.

Biochemical analysis and classifications

The biochemical analyses were all conducted at an ISO 15189 accredited pathology practice (Path-Care, Reference Laboratory, Cape Town, South Africa) according to set protocols. Serum samples were processed for the measurement of creatinine, hsCRP and cotinine by the modified Jaffe-Kinetic method (Beckman AU, Beckman Coulter, South Africa), and chemiluminescent assays (Immun Diagnostik AG, Bensheim, Germany and Immulite 1000, Siemens) respectively.

Kidney function was estimated by means of the serum creatinine-based 4-variable Modification of Diet in Renal Disease (MDRD) equation,[26] without the ethnicity correction factor. Findings were mostly similar in secondary analyses based on CKD Epidemiology Collaboration (CKD-EPI) equation[27] estimated GFR (data not shown). As per the National Kidney Foundation Disease Outcomes Quality Initiative (NKF-KDOQI) guidelines,[28] CKD was classified as an estimated glomerular filtration rate (eGFR) <60 ml/min/1.73 m^2. Smoking and non-smoking were categorized as cotinine levels ≥15 ng/ml and <15 ng/ml, respectively. Hypertension was classified as SBP ≥140 mmHg and/or DBP ≥90 mmHg,[29] or a previous diagnoses of hypertension. Diabetes was classified as a history of previously diagnosed type 2 diabetes (T2D) or fasting glucose ≥7.0 mmol/l and/or 2-h glucose ≥11.1 mmol/l. Additional glucose tolerance categories were also classified based on the oral glucose tolerance test (OGTT)[30] as: (1) normal glucose tolerance [FG <6.1 mmol/l and 2-h glucose <7.8 mmol/l], (2) impaired fasting glucose (IFG, 6.1≤FG< 7.0 mmol/l), and (3) impaired glucose tolerance (IGT, 7.8<2-h glucose<11.1 mmol/l). A BMI≥25kg/m^2 and BMI≥30kg/m^2 were classified as overweight and obese, respectively.

Statistical analysis

Due to the skewed distribution of most variables, participant characteristics were summarised as median (25th-75th percentiles) or count and percentages. However, the DMFT index and total number of teeth were also presented as mean and standard deviation (SD), to comply with the standard presentation of data obtained from the WHO and mean comparisons with other studies. Group comparisons were done with chi-square tests (categorical variables) and Student-t test or Wilcoxon rank-sum test (continuous variables). Multivariable robust linear regression models were used to assess the independent association between eGFR and the DMFT index. Whereas multivariable logistic regression models were used to determine whether the DMFT index predicted prevalent CKD, independent of confounding variables (listed in the models below). Since individuals with edentulism are unable to experience periodontitis, a sub-analysis on dentate participants (n=846) were conducted. Thus, multivariable linear regression and logistic regression models were employed to assess the independent association of eGFR and prevalent CKD with periodontitis. The models used were as follows: Model 1: DMFT or periodontitis; Model 2: Model 1 + Age ≥60years; Model 3: Model 2 + smoking status + obesity; Model 4: Model 3 + hypertension; Model 5: Model 4 + diabetes; Model 6 (DMFT): Model 5 + edentulism; Model 6 (periodontitis):

Model 5 + hsCRP. All statistical analyses were performed using STATA version 15 (Statcorp, College Station, TX) and statistical significance was based on a p-value <0.05.

RESULTS

General characteristics of study population

The general characteristics of the study population are summarised in Table I. The original study sample comprised 1,979 participants. Of those, 428 participants were excluded from this analysis due to missing data on serum creatinine or variables required to estimate kidney function, including age and gender, as well as those participants who did not receive an oral examination. The final sample included 1,551 participants, of which 25.2% were male, with ages ranging from 20 to 91 years (median age of 51 years), and 6% having an eGFR <60 ml/min/1.73m^2. Of those with CKD, 79.2%, 15.6% and 5.2% where in stages 3, 4 and 5 CKD, respectively. Compared to the participants with normal kidney function, those with CKD were on average older (68 vs. 49 years; p<0.0001), had a greater weight (75.0 vs. 71.7 kg; p=0.049), with a higher WC (100.2 vs. 91.0 cm; p<0.0001) and BMI (30.8 vs. 28.2 kg/m^2; p=0.001). Further, 81.8% had a BMI in the overweight/obese range, compared to 65.0% in the group with normal kidney function. Of the participants with CKD, 11.8% and 44.7% had IFG/IGT and T2D, respectively, compared to 14.7% and 17.5%, respectively, in the group with normal kidney function. Also, those with CKD had a higher prevalence of hypertension compared to those without CKD (54.6% vs 35.1%, p<0.0001). Compared to those with normal kidney function, those with CKD also had higher hsCRP levels (4.7 vs. 3.9 µg/ml; p=0.044), with similar prevalence of smokers (p=0.765).

Dental and periodontal profile of study population

The dental profile of the study population is summarised in Table II and Figure 1. In the total sample, edentulism was found in 84.1% of those with CKD, compared to 43.1% of individuals with normal kidney function. On average those with reduced kidney function had significantly less teeth compared to those participants with normal kidney function (3.2 vs. 13 teeth; p<0.0001). Furthermore, CKD was characterized by a higher mean DMFT index compared to those without CKD (29.2 vs. 20.6; p<0.0001). Despite 93.2% and 66.0% of people with CKD and without CKD, respectively having a DMFT index greater than 14, 50% and 38.5% of those with and without CKD, respectively rated their overall oral health as either good or excellent. Based on the components of the DMFT index, for both groups the "missing" component had the highest contribution to the score with a greater contribution in those with CKD compared to those without CKD (87% vs. 69%; p<0.0001). On the contrary, compared to those without CKD, participants with CKD had a lower prevalence of decayed (8% vs. 25%; p<0.0001) and similar prevalence of filled teeth (5% vs. 6%; p=0.053) (Figure 1). Of the participants with CKD,

Table I. General characteristics of the study population by CKD status

Variables	Without CKD (n=1463)	CKD (n=88)	p-value
Age (years)	49 (36-59)	68 (62-74)	<0.0001
Age categories (n,%)			<0.0001
<24 years	103 (7.0)	0 (00	
25-34 years	230 (15.7)	1 (1.1)	
35-44 years	231 (15.8)	2 (2.3)	
45-54 years	376 (25.7)	4 (4.6)	
55-64 years	319 (21.8)	27 (30.7)	
65-74 years	161 (11.0)	33 (37.5)	
>75 years	43 (2.9)	21 (23.9)	
Gender (n,% male)	373 (25.5)	18 (20.5)	0.290
Weight (kg)	71.7 (59.1-85.4)	75.0 (65.5-87.6)	0.0491
Waist circumference (cm)	91.0 (77.8-103.0)	100.2 (89.5-106.5)	<0.0001
Body mass index (kg/m^2)	28.2 (22.7-34.1)	30.8 (26.4-36.3)	0.0013
Creatinine (µmol/l)	59.0 (51.0-67.0)	105.5 (89.0-141.5)	<0.0001
eGFR (ml/min/1.73m^2)	104.5 (88.6-121.5)	48.4 (33.8-56.2)	<0.0001
hsCRP (µg/ml)	3.9 (1.6-8.8)	4.7 (2.5-9.7)	0.0438
Smoking status (n, %)			0.765
Non-smoker	695 (49.5)	44 (51.2)	
Smoker	709 (50.5)	42 (48.8)	
BMI categories (n, %)			0.004
Normal weight	512 (35.0)	16 (18.2)	
Overweight	329 (22.5)	22 (25.0)	
Obese	622 (42.5)	50 (56.8)	
Hypertension (n, %)	513 (35.1)	48 (54.6)	<0.0001
Glucose tolerance categories (n, %)			<0.0001
Normal glucose tolerance	976 (67.9)	37 (43.5)	
IFG/IGT	211 (14.7)	10 (11.8)	
Type 2 diabetes	251 (17.5)	38 (44.7)	

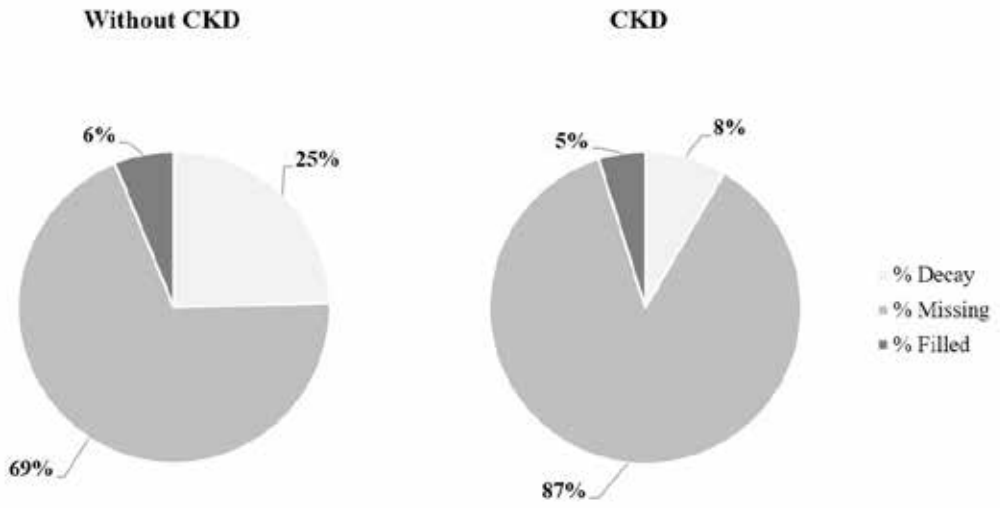
Data is presented as median (25th-75th percentiles), count and percentages. CKD, chronic kidney disease; BMI, body mass index; eGFR, estimated glomerular filtration rate; hsCRP, high-sensitivity C-reactive protein; IFG/IGT, impaired fasting glucose and impaired glucose tolerance.

Table II. Dental profile of total study population dichotomised by CKD status

Variables	Without CKD (n=1463)	CKD (n=88)	p-value
Edentulous (n, %)	631 (43.1)	74 (84.1)	<0.0001
No of teeth (median; 25th – 75th percentile)	13 (0-26)	0 (0-0)	<0.0001
No of teeth (mean±SD)	13.3 ± 2.7	3.2 ± 7.8	<0.0001
DMFT (score) (median; 25th – 75th percentile)	21 (10-32)	32 (32-32)	<0.0001
DMFT (score) (mean±SD)	20.6 ±11.4	29.2 ± 6.8	<0.0001
DMFT categories (n, %)			<0.0001
Very low (<5.0)	159 (10.9)	1 (1.1)	
Low (5.0-8.9)	143 (9.8)	0 (0)	
Moderate (9.0-13.9)	195 (13.3)	5 (5.7)	
High (>14.0)	966 (66.0)	82 (93.2)	
Dentures (n, %)	669 (45.7)	67 (76.1)	<0.0001
Perceived health of teeth (n, %)			0.032
Excellent	69 (4.7)	8 (9.1)	
Good	495 (33.8)	36 (40.9)	
Fair	610 (41.7)	37 (42.0)	
Poor	186 (12.7)	2 (2.3)	
Bad	45 (3.1)	3 (3.4)	
Unanswered	59 (4.0)	1 (1.1)	

Data is presented as median (25th-75th percentile), mean ± standard deviation, count and percentages. Due to the severe level of tooth extracted in the whole population skewing the data, the total number of teeth and the DMFT score is presented as both median (25th-75th percentiles) and mean ± SD. CKD, chronic kidney disease; DMFT, decay-missing-filled teeth. The DMFT index is categorized according to WHO criteria 24 as very low (<5.0); low (5.0-8.9); moderate (9.0-13.9); and high (>14.0). Category termed dentures includes top and bottom fixtures, as well as partial top, partial bottom and top only fixtures.

Figure 1. Average contribution of each component (decay, missing and filled) to the DMFT score for the total sample according to CKD status. Data is presented as percentages. CKD, chronic kidney disease



76.1% were fitted with dentures, compared to 45.8% of individuals with normal kidney function.

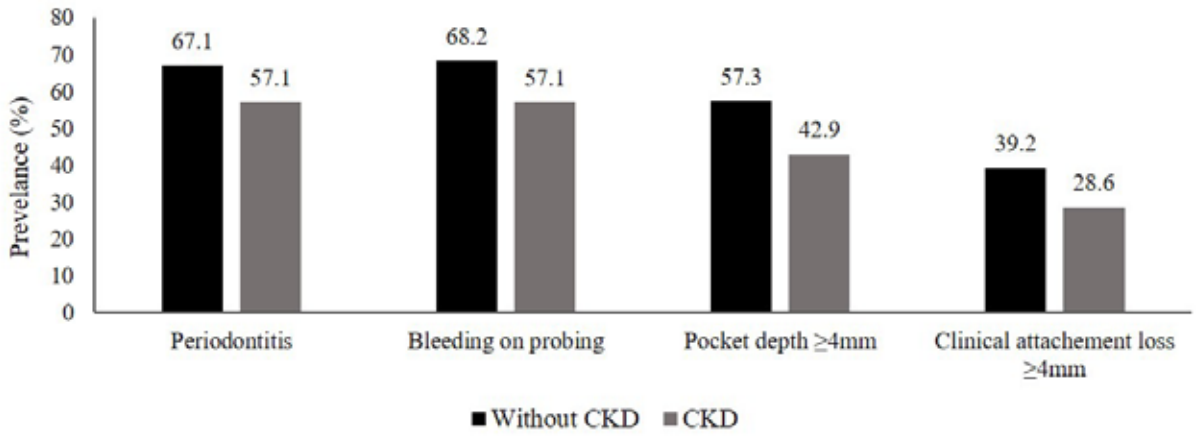
The periodontal profile of the dentate sub-sample (n=846) is presented in Table III and Figure 2. Compared to the participants with edentulism, those in the dentate sub-sample were on average younger (40.4 vs. 59.5 years; p<0.0001), had a higher eGFR (112.7 vs. 91.7 ml/min/1.73m^2; p<0.0001) and lower prevalence of CKD (2% vs. 11%; p<0.0001). The periodontal profile of those with CKD were not different to those with normal kidney function. On average, people with CKD had similar total number of teeth compared to those without CKD (19.9 vs. 23.3 teeth; p=0.075). Despite the high prevalence of periodontitis, no differences were observed between those with and without CKD (67.1% vs. 57.1%; p=0.301) (Figure 2). Likewise, similar prevalence of BOP, PD ≥4mm and CAL ≥4mm was observed for participants with and without CKD (p>0.276 for all). Furthermore, the average number of teeth with BOP and PD ≥4mm was similar for individuals with CKD and those without CKD (p>0.391 for all). Also, similar prevalence levels of bleeding teeth and teeth with dental pockets greater than 4mm were observed between the two groups (12.2% vs. 10.9%; p=0.656 and 14.9% vs. 7.7%; p=0.246, respectively).

Relationship between dental caries and periodontitis with kidney function and prevalent chronic kidney disease

The unadjusted and adjusted associations for eGFR and prevalent CKD by DMFT index and periodontitis are presented in Tables IV and V, respectively. In robust linear regression analysis, higher DMFT scores were associated with lower eGFR (p<0.0001 for all), independent of older

Table III. Periodontal profile of the dentulous sub-sample dichotomised by CKD status			
Variables	**Without CKD (n=832)**	**CKD (n=14)**	**p-value**
Total number of teeth	23.3 ± 7.1	19.9 ± 6.7	0.075
Bleeding on probing			
Number of teeth bleeding on probing	2.8 ± 3.5	2.1 ± 3.2	0.391
% bleeding on probing (of total teeth)	12.2 ± 15.2	10.9 ± 13.8	0.656
Dental pockets			
Teeth with pockets <4mm	15.7 ± 7.3	15.4 ± 5.4	0.634
Teeth with pockets ≥4mm	2.1 ± 3.2	1.6 ± 2.3	0.535
% teeth with pockets <4mm	85.1 ± 23.2	92.3 ± 10.7	0.345
% teeth with pockets ≥4mm	14.9 ± 23.2	7.7 ± 10.7	0.246
Sextant with pockets <4mm	4.3 ± 1.9	4.3 ± 1.8	0.946
Sextant with pockets ≥4mm	0.7 ± 1.1	0.6 ± 1.2	0.477
Data is presented mean ± standard deviation. CKD, chronic kidney disease.			

Figure 2. Prevalence of periodontitis, bleeding on probing, pocket depth ≥4mm and clinical attachment loss ≥4mm depth, categorized by CKD status. Data is presented as %.



age (≥60 years), smoking status, obesity, hypertension, and diabetes status (Table IV, Models 1-5). However, this association was not independent of edentulism (p=0.261) (Table IV, Model 6). Similarly, higher DMFT scores predicted prevalent CKD (p<0.023 for all) (Table V, Models 1-5), however not independent of edentulism (p=0.645) (Table V, Model 6). Periodontitis on the other hand was not associated with eGFR (p>0.558 for all) nor prevalent CKD (p>0.258 for all) (Tables IV and V, respectively; Model 1-5), before and after adjustment for relevant confounding variables.

Effect modification by hsCRP on the relationship between periodontitis and kidney function and prevalent CKD

There was no evidence of effect modification by hsCRP on the relationship between periodontitis and eGFR (p=0.792) (Table IV, Model 6), nor did hsCRP mediate the association between periodontitis and prevalent CKD (p=0.390) (Table V, Model 6), as the addition of hsCRP to the models had no effect on the association.

DISCUSSION

To the best of our knowledge, this is the first study to evaluate the periodontal and dental status of people of mixed ancestry with CKD. This study shows that adults of mixed ancestry, with and without CKD, have a severely impaired periodontal and dental status, with the clear majority experiencing periodontitis, dental caries and/or edentulism. Yet, despite the high prevalence of periodontitis in this population, this inflammatory condition seemingly had no effect on renal function nor could it predict CKD in this sample. However, given the small sub-sample of dentate individuals with CKD, this result should be viewed cautiously. We further showed that even though CKD is associated with a higher level of dental caries experienced, given the high DMFT index, this association is driven by the "missing" component and particularly the high level of edentulism in this group. Indeed, evaluating the components of the DMFT score, we found that CKD is associated with less decayed and filled teeth, but more missing teeth.

Though there is support for an association between periodontitis and CKD[6] and periodontitis has been identified as a potential source of inflammation in CKD patients,[31,32] the current evidence is insufficient to link periodontitis with CKD, through an inflammatory pathway. Contrary to our study, previous studies evaluating the link between periodontitis and CKD are either in patients undergoing haemodialysis or peritoneal dialysis or in the instance where the studies are conducted in predialysis patients, these patients have severe CKD, thus close to initiating dialysis.[6,16,33] Also, the association between periodontitis and CKD is dependent on the severity of periodontitis. As such, the strength of the link between periodontitis and CKD increases with increasing severity of periodontitis.[6,34] Even though we found no association between periodontitis and reduced kidney function in this study, we cannot exclude the possibility of such an association. Thus, it is not possible to determine, based on the existing evidence, if the relationship is truly

Table IV. Multivariable robust linear regression models for eGFR by DMFT index and periodontitis

Models	DMFT			Periodontitis		
	β	95% CI	p	β	95% CI	p
1	-0.87	-0.98 to -0.76	<0.0001	0.93	-2.83 to 4.69	0.628
2	-0.51	-0.63 to -0.39	<0.0001	1.07	-2.52 to 4.66	0.558
3	-0.45	-0.57 to -0.33	<0.0001	0.62	-2.93 to 4.17	0.732
4	-0.44	-0.56 to -0.32	<0.0001	0.50	-3.03 to 4.03	0.782
5	-0.44	-0.57 to -0.32	<0.0001	0.41	-3.14 to 3.96	0.820
6	-0.13	-0.36 to 0.10	0.261	0.48	-3.08 to 4.03	0.792

Data is presented as β-coefficient, 95% confidence interval and p-value. DMFT, Decayed, Filled and Missing Teeth; Model 1: DMFT/Periodontitis; Model 2: Model 1 + Age ≥ 60 years; Model 3: Model 2 + smoking status + obesity; Model 4: Model 3 + hypertension; Model 5: Model 4 + diabetes; Model 6 (DMFT): Model 5 + edentulism; Model 6 (Periodontitis): Model 5 + hsCRP

Table V. Multivariable logistic regression models for chronic kidney disease by DMFT index and periodontitis

Models	DMFT			Periodontitis		
	β	95% CI	p	β	95% CI	p
1	1.10	1.07 to 1.14	<0.0001	0.57	0.20 to 1.67	0.307
2	1.04	1.01 to 1.08	0.023	0.55	0.19 to 1.63	0.282
3	1.05	1.01 to 1.09	0.012	0.52	0.17 to 1.61	0.258
4	1.05	1.01 to 1.09	0.013	0.58	0.18 to 1.80	0.343
5	1.05	1.01 to 1.09	0.016	0.59	0.19 to 1.86	0.370
6	1.02	0.94 to 1.10	0.645	0.60	0.19 to 1.92	0.390

Data is presented as odds ratio (OR), 95% confidence interval and p-value. DMFT, Decayed, Filled and Missing Teeth; Model 1: DMFT/Periodontitis; Model 2: Model 1 + Age ≥ 60 years; Model 3: Model 2 + smoking status + obesity; Model 4: Model 3 + hypertension; Model 5: Model 4 + diabetes; Model 6 (DMFT): Model 5 + edentulism; Model 6 (Periodontitis): Model 5 + hsCRP

absent in this group, or whether our study was not sufficiently powered to detect the difference, given the reduced sample of dentulous individuals. This hypothesis therefore needs further investigation.

With more than two thirds of the population presenting with a DMFT score greater than 14, the severity of caries experienced in this under-studied South African population is more comparable to higher income countries, such as the USA, Australia and Canada as opposed to other African countries,[35] or even other population groups in South Africa.[36] Furthermore, and perhaps of greater concern, is that CKD is associated with even higher DMFT scores. Indeed, in people with CKD nearly all teeth are somehow affected, with the M (missing) component making the largest contribution to the DMFT score. Given that untreated dental caries is one of the main causes of tooth loss,[37, 38] with the prevalence increasing with age,[39] it could be assumed that higher dental caries and thus higher tooth loss associates with CKD. However, because the DMFT index quantifies the life-long caries experience and do not account for teeth lost for reasons other than decay, it is difficult to say whether the prevalence of the missing component in this population is solely because of untreated caries. In fact, there is no consensus in the literature on caries prevalence in people with CKD.[19, 21] Thus, based on the cross-sectional design of this study it might be more appropriate to evaluate the contribution of each component making up the score, as opposed to the overall score.

In this study, compared to the F (filled) and M (missing) component, we found that the D (decayed) component contributed less to the DMFT index in those with CKD, compared to the contribution of this component to those with normal kidney function. This lower prevalence of decayed teeth in people with CKD has been reported in other studies,[19, 33] and this finding has previously been ascribed to the high salivary urea and phosphate levels in people with CKD.[18, 33, 40] Even though those end-points were not measured in the current study, the lower prevalence of decayed teeth in those with CKD could be explained by the higher pH environment originating from urea hydrolysis in the saliva, resulting in the neutralization of the end products of bacterial plaque and consequent reduced tooth decay.[18, 33, 40] People with CKD also presented with a significantly smaller proportion of filled teeth and higher proportion of missing teeth, reflecting the low utilization of curative dental care in the CKD population. Certainly, in resource-poor public healthcare settings, recommended regular preventive dental care may not be readily accessible.[35, 41, 42] Also, the perceived importance of oral health in this older population with CKD is of importance. Indeed, there is a perception that the loss of teeth, as the result of dental caries, are an inevitable consequence of ageing[43] and therefore preventative measures are not generally perceived as priority. Consequently, tooth extraction is often the socially acceptable solution to the pain or discomfort due to caries, in exchange for fitted dentures, rather than restoring the natural teeth.[35, 43] Also, there is a lack of awareness regarding the importance of oral health and disease.[44] Previous research indicates that a significant positive predictor of the utilisation of dental care is the "perceived need" for it.[45] This is indirectly shown through our findings, where despite the very high DMFT scores in 93% of people with CKD, all rated their overall oral health as either, fair, good or excellent. This perception of adequate oral health can be explained by the fact that people often rate their oral health status based on undesirable oral symptoms displayed[46] and since those with high DMFT had dentures the perception of good oral health are very likely.

Edentulism, which is the condition of being completely toothless, is also a major concern in this subpopulation with CKD, as 84% of the group had no teeth; an estimate substantially higher than most other countries.[47] Indeed, according to the latest systematic review, the global prevalence of edentulism in people with CKD is estimated at around 20% for adults aged 65 years and above.[37] This disparity from global estimates could be explained by the main factors associated with tooth loss and edentulism. According to the findings of a recent multi-country study, factors including older age, lower education, non-communicable diseases, obesity, tobacco use, and inadequate fruit and vegetable consumption are some of the risk factors predicting edentulism.[47] Indeed, more than half of the population with CKD in the current study were obese, 39% had diabetes and 64% had hypertension. Further, those with CKD were older, with 83% being older than 60 years, compared to those without CKD. Thus, the high exposure to risk factors and high prevalence of edentulism (because of age) are likely to explain the higher missing component and thus higher DMFT scores reported in the CKD population compared to the group with normal kidney function.

This study has some limitations, which includes the high female to male participation, however this is a common trend in South African population studies. The association across CKD categories could not be evaluated as there were very few participants in the advanced stages of CKD (stage ≥4). Our study also used a single serum creatinine measure to determine the grade of kidney function and did not include estimates of albuminuria. It is however a common practice in community-based studies to diagnose CKD using a single measurement of serum creatinine. Also, because such a large proportion of people with CKD were edentulous, removing those with no teeth rendered the group with CKD very small. Also, we never gained information centred around the reason for tooth loss, and we are therefore unable to confirm whether tooth loss was due to caries, periodontitis or due to any other reasons. However, despite these limitations, we are not aware of other studies that have assessed the association between oral disease and CKD and the potential mediatory effect of systemic inflammation on this association in this previously understudied South African population group.

CONCLUSION

It is crucial that decision makers implement health strategies that focus on promoting good oral health and preventing oral disease, such as periodontitis and dental caries, also shifting away from the current predominantly emergency service of dental extractions. Due to the complex nature of the determinants of oral disease, both for people with and without CKD, exploring CKD patient preferences and priorities for dental care could guide additional research and practice interventions.

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The author contributions are as follows: Conceived and/or designed the work that led to the submission (TEM, UC, RTE, APK, CG), acquired data (TEM, SFGD, GMH, UC), and/or played an important role in interpreting the results (UC, APK, CG), drafted (CG) or revised the manuscript (all authors), and approved the final version (all authors). The authors have no conflict of interest to disclose.

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Shaping ability of WaveOne Gold reciprocating instruments compared to two analogous counterparts

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ABSTRACT

Introduction

The aim of this study was to evaluate and compare canal centering ability and transportation of three analogous reciprocating shaping instruments after glide path preparation.

Methods

Radiographs were used to select sixty untreated mesiobuccal canals with curvatures of 25° to 35° from extracted, human, mandibular molars. The canals were randomly divided into three groups for glide path preparation and shaping (n = 20): Group TWOG (WaveOne Gold Glider + Primary WaveOne Gold); Group TEF (Edge GlidePath + Primary EdgeOne Fire); and Group TOFG (One File G Reciprocating Glide Path File + Primary Shaping file). Pre- and post-preparation micro-CT scans were compared at levels 7 mm (coronal), 5 mm (midroot), and 3 mm (apical) from the apex to evaluate transportation and centering ratios.

Results

There were no significant differences in centering ratios at the coronal and midroot levels ($P > 0.05$). Transportation values were similar at the coronal level and for the combined mean values ($P > 0.05$). Transportation values for TEF and TWOG were similar ($P = 0.98$) at the midroot level but significantly lower than TOFG ($P = 0.04$). Apically, TEF remained significantly more centered with significantly lower transportation values than TWOG and TOFG ($P < 0.05$). Combined results showed that TEF was significantly more centered than TWOG but similar to TOFG ($P = 0.017$).

Conclusions

Centering ratios and transportation values were more favorable in the apical region after use of TEF. All three groups evaluated in this study proved to be safe for the preparation of moderately curved root canals.

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INTRODUCTION

Micro computed tomography (micro-CT) studies produce the most accurate and non-invasive 3D images that allow researchers to examine the effects of endodontic instruments within root canal systems.[1–4] The interaction of three main instrument factors can have an effect on the preservation of the original canal anatomy during endodontic treatment: the cross-sectional design of the file, kinematics, and the alloy of the nickel-titanium (NiTi) instrument.[5] Several kinematic studies have examined shaping ability following the use of instruments in either a rotational or a reciprocal motion and concluded that reciprocation results in superior shaping and fewer transported canals.[6–9] Thermomechanical processes have resulted in the development of NiTi endodontic glide path and shaping files with increased flexibility and fatigue resistance compared to their predecessors. Companies are now developing analogous instrumentation systems that are similar in form and function to their competitors' but are constructed from differing proprietary heat-treated NiTi.

The WaveOne Gold Glider (Dentsply Sirona, Ballaigues, Switzerland), a single glide path file, and WaveOne Gold (Dentsply Sirona) shaping files are reciprocating systems manufactured from Gold wire. The Edge GlidePath file (EdgeEndo, Albuquerque, New Mexico, USA) is a variable tapered single rotary glide path file and EdgeOne Fire (EdgeEndo) is a reciprocating shaping system similar to WaveOne Gold. Both systems are manufactured from a proprietary heat-treated NiTi known as "FireWire".[10,11] The One File G Reciprocating File System (Pac-Dent, Brea, CA, USA) consists of a single glide path file and four shaping

files. One File Shaping files (Pac-Dent) are used with the same handpiece settings as WaveOne Gold. The One File Glide Path- and Shaping files are constructed from a proprietary heat-treated NiTi wire.[12]

Root canal transportation is assessed by measuring the amount of dentine remove (in millimetres) from the outside wall of the canal due to the tendency of root canal shaping instruments to restore to their original shape.[13] This procedural error may lead to ledge formation or even strip perforation. Centering ability is defined as how well the shaping instrument preserved the original canal anatomy when equal amounts of transportation occur in all directions relating to the original canal anatomy. Centering ability is measured as a ratio of transportation and a measurement closest to 1, indicates a more centered root canal preparation.[14] The purpose of this *ex vivo* study was to use micro-CT to compare canal centering ability and transportation of three reciprocating shaping instruments after glide path preparation: WaveOne Gold Glider combined with the Primary WaveOne Gold; Edge GlidePath followed by the Primary EdgeOne Fire; and One File Glide Path file combined with the Primary One File Shaping file. The null hypothesis tested was that there are no differences in canal centering ability and canal transportation values between the three groups. Currently, there are no published studies comparing canal centering ability and transportation of these analogous shaping systems.

MATERIALS AND METHODS

Specimen preparation

Mandibular first molar teeth extracted for reasons unrelated to this study were used in accordance with approval from the local ethics committee. Radiographs (Carestream Health Inc., NY State, USA) were taken to select sixty previously untreated, curved, separate mesiobuccal canals, each with a curvature of 25° to 35° according to the Schneider method.[15] Immature molars with open apices, and resorption was excluded from this study. Molars with sclerosed mesio-buccal canals was also eliminated from the study during the preparation stage.

Specimens were engraved from 1 to 60 before being randomly divided into three experimental instrumentation groups of 20 canals each (Research Randomizer version 4.0).[16]

A pre-instrumentation scan of each selected tooth was carried out using a XTH 225 ST micro-focus X-ray CT system (Nikon Metrology, Leuven, Belgium). The micro-CT system was used at settings of 100 kV, 100 mA and an isotropic resolution of 22 µm. The roots of each tooth were placed in a polystyrene platform (2.5 x 2.5 x 2.5 cm) and aligned perpendicular to the scanning beam. VGStudioMax visualization software (Volume Graphics GmbH, Heidelberg, Germany) was used to confirm the curvatures of the mesiobuccal canals.

After access cavity preparation using and Endo Access Bur (size 2) (Dentsply, Mailefer), each mesiobuccal canal was located and patency was confirmed with a size 08 K-file. Working length (WL) was determined by deducting 0.5 mm from the length of the canal measured to the major apical terminus under 10 times magnification using a surgical microscope (Zumax Medical Co. Ltd, Suzhou, China). An initial manually reproducible micro-glide path was prepared by negotiating size a 08 K-file, followed by a size 10 K-file, to WL with increasing amplitudes of 1–3 mm.

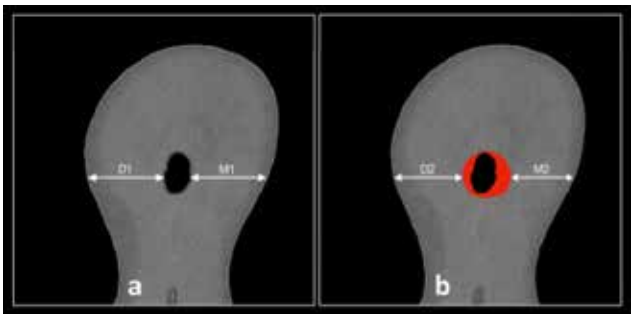

Figure 1. Pre-instrumentation (a) and post-instrumentation (b) micro-CT images in the axial plane showing the effects of instrumentation (red), and points of measurements used for determination of centering ability and canal transportation.

Glide path preparation and root canal shaping

Glide path preparation and root canal shaping were carried out by the same operator and new files were used for each tooth. RC Prep (Premier, Pennsylvania, USA) was used as a lubricating agent during glide path enlargement and canal shaping. The mesiobuccal canals were irrigated with 2 ml of 3.5% sodium hypochlorite following the use of each instrument. Patency was maintained throughout the glide path and root canal preparations with a size 08 K-file.

Group TWOG (n=20)

The X-Smart IQ endodontic motor (Dentsply Sirona) was used in reciprocation mode for both glide path preparation with the Wave One Gold Glider (WOGG), and shaping with the Primary Wave One Gold (WOG). This was done on the WaveOne (Dentsply Sirona) setting, according to the manufacturer's instructions.

Group TEF (n=20)

The Edge GlidePath File (EGP), according to the manufacturer's instructions, was used to prepare glide paths using the X-Smart IQ endodontic motor in rotation mode on the ProGlider (Dentsply Sirona) setting at a speed of 350 rpm. Root canal shaping in this group was carried out as per the manufacturer's guidelines, using the same motor in reciprocation mode on the WaveOne setting with the Primary EdgeOne Fire file (EOF).

Group TOFG (n=20)

The X-Smart IQ endodontic motor (Dentsply Sirona) was used in reciprocation mode for both glide path preparation with the One File Glide Path file (OFGP), and shaping with the Primary One File Shaping file (OFS). This was done on the WaveOne setting according to the manufacturer's instructions.

The teeth were scanned again to generate a post-instrumentation scan for each specimen. Using VGStudioMax software (Volume Graphics GmbH), specimen images from the pre- and post-instrumentation scans were identified by their engraved numbers and aligned according to the Cemento Enamel Junction (CEJ). This enabled superimposition of each mesiobuccal canal and allowed for pre- and post-instrumentation analyses.

Data collection and measurements

Cross-sections of each mesiobuccal canal at levels: 7 mm (coronal), 5 mm (midroot), and 3 mm (apical) from the anatomical apex were evaluated. The three levels chosen to evaluate file system performance and canal preservation represent the apical, middle and coronal aspects of the curvature, where the

root is most susceptible to iatrogenic aberrations.[17,18] The shortest distance from the prepared canal to the mesial or distal wall of the tooth at these levels were measured to determine the centering ratio and canal transportation values according to the formulae set out below.[14,18–20]

Canal transportation = (M1-M2) – (D1-D2). A transportation value closest to 0 indicated that no transportation occurred. Canal centering ratio = (M1-M2)/(D1-D2) where (D1-D2 > M1-M2) or (D1-D2)/(M1-M2) where (M1-M1) > (D1-D2). A value closest to 1 indicated a perfect centering ability.[14] M1 is the shortest distance from the mesial margin of tooth measured to the mesial margin of uninstrumented canal and M2 is the shortest distance from mesial margin of tooth measured to the mesial margin of the instrumented canal. Similarly, D1 is the shortest distance from the distal margin of tooth measured to the distal margin of the uninstrumented canal and D2 is the shortest distance from the distal margin of tooth measured to the distal margin of the instrumented canal (Fig. 1).

Statistical analysis

Canal transportation and centering ratio values were compared between the three groups by a one-way analysis of variance (ANOVA). Comparison among groups was also done using the non-parametric Kruskal-Wallis H test.

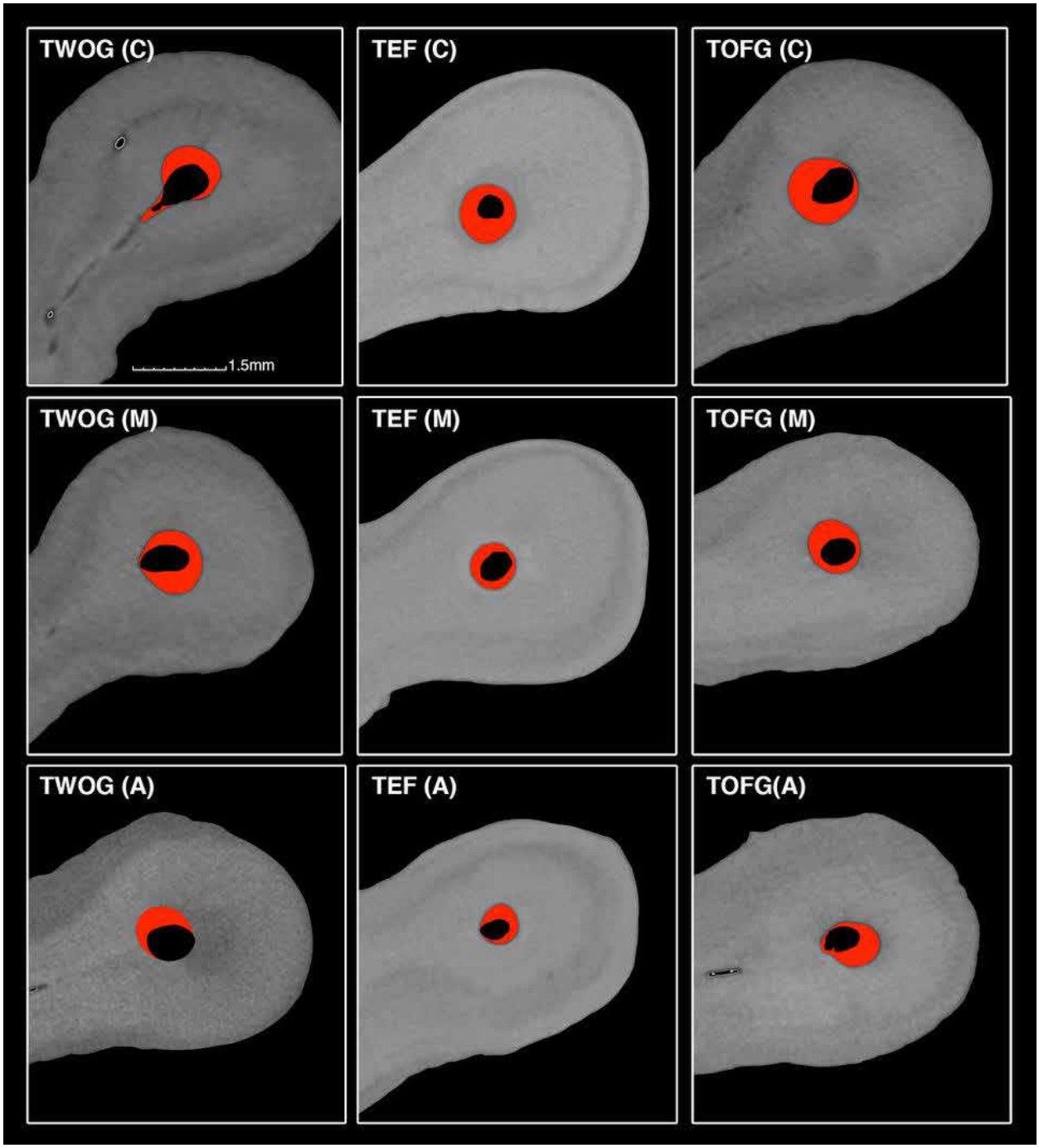

Figure 2. Representative cross sections of the superimposed root canals before and after final shaping (red) at the: coronal (C), middle (M), and apical (A) thirds.

Table 1 Descriptive statistics of the mean centering ratio values for the tested groups (n=20)

Group	Coronal		Midroot		Apical		Combined	
	Mean ± SD	Min-Max	Mean ± SD	Min-Max	Mean ± SD	Min-Max	Mean ± SD	Min-Max
TWOG	0.39a ± 0.27	0.07 – 0.97	0.42a ± 0.26	0.03 – 0.84	0.38b ± 0.28	0.03 – 1.00	0.40b,c ± 0.27	0.03 – 1.00
TEF	0.44a ± 0.25	0.07 – 0.92	0.56a ± 0.27	0.01 – 0.98	0.63a ± 0.31	0.02 – 1.00	0.54a ± 0.29	0.01 – 1.00
TOFG	0.51a ± 0.27	0.08 – 0.97	0.42a ± 0.25	0.09 – 0.83	0.41b ± 0.32	0.02 – 0.94	0.44a,c ± 0.28	0.02 – 0.97

Different superscript letters in the same column indicate a significant difference at $P < 0.05$.

Table 2 Descriptive statistics of the transportation values (mm) for the tested groups (n=20)

Group	Coronal		Midroot		Apical		Combined	
	Mean ± SD	Min-Max	Mean ± SD	Min-Max	Mean ± SD	Min-Max	Mean ± SD	Min-Max
TWOG	0.19a ± 0.18	0.01 – 0.87	0.09a ± 0.07	0.01 – 0.26	0.13b ± 0.07	0.02 – 0.25	0.14a ± 0.12	0.01 – 0.87
TEF	0.19a ± 0.14	0.00 – 0.52	0.09a ± 0.08	0.01 – 0.27	0.06a ± 0.06	0.00 – 0.24	0.11a ± 0.07	0.00 – 0.52
TOFG	0.14a ± 0.14	0.01 – 0.66	0.19b ± 0.24	0.02 – 0.77	0.16b ± 0.20	0.00 – 0.74	0.16a ± 0.20	0.01 – 0.77

Different superscript letters in the same column indicate a significant difference at $P < 0.05$.

Statistical significance was set at $P < 0.05$. All statistical procedures were performed on SAS (SA Institute Inc, Carey, NC, USA), release 9.4, or higher running under Microsoft Windows (Redmond, WA, USA).

RESULTS

Following instrumentation, all the canals remained patent without any loss of working length. No instrument fracture or deformation was noted. Figure 2 represents cross sections of the superimposed root canals before and after final shaping at the coronal (C), middle (M), and apical (A) thirds levels of analysis for each of the three groups.

Centering ratio

The results for canal centering are summarized in Table 1. Centering ratios for TEF were the highest at each level. However, no statistically significant differences between the three groups were found at the coronal and midroot levels. The TEF group displayed significantly better centering ratio values at the apical level. When all the results were combined, TEF was shown to be significantly more centered than TWOG but similar to TOFG. TWOG and TOFG displayed similar apical and combined centering ratios.

Canal transportation

Canal transportation results are summarized in Table 2. No statistically significant differences between the three groups were found at the coronal level. At the midroot level, transportation values for TEF and TWOG were the same. Both these groups performed significantly better than TOFG at this level. TEF performed significantly better at the apical level than the other two groups, which were found to be statistically similar. No significant differences were observed when the results were combined.

DISCUSSION

Assessment of centering ratios and transportation values after root canal instrumentation may reveal how effective instruments are in maintaining the original root canal anatomy and minimizing the risk of shaping errors. The present micro-CT study evaluated the ability of three different glide path files combined with their corresponding shaping systems to produce centred preparations without transportation, in curved root canals. There are no studies comparing these new analogous file systems to the existing WOG system. Although instruments of comparable diameter and taper were used for final canal preparation in the present study, there were some differences in their respective designs and alloy construction that could have influenced their shaping ability.[21] Additional factors that can affect the shaping ability of an instrument include the cross-sectional design of the file, operator technique, and canal system anatomy.[22,23] In this study a single operator instrumented all the mesiobuccal canals with similar curvatures using glide path and analogous shaping files in the same motor, according to the manufacturer's instructions.

Single glide path and root canal shaping instrument systems were used in this study to achieve final apical preparation sizes of ISO 25. The combination of EGP and EOF (TEF) performed significantly better than the other two groups when centering ability was assessed at the apical level and when the results for all three levels were combined. In the apical third, mean transportation values for TEF were significantly lower than the other two groups, which were found to be similar. TWOG and TEF exhibited the same mean transportation value in the middle third, which was significantly lower than TOFG.

The shaping performance of the TEF group at the apical level in this study could be attributed to its annealed heat-treated FireWire NiTi composition and/or the design of the EGP and EOF. EOF files have similar cross-sectional designs, three-dimensional characteristics, and tip sizes to the WOG system. Each of the three shaping files in in the current study has a parallelogram-shaped cross-section. The EOF however has a fixed taper (D1–D3) of 6% compared to WOG and OFS, which both have 7% fixed tapers (D1–D3). Only the Primary WOG has semi-active guiding tip, whereas the Primary EOF and Primary OFG tips are non-cutting. The individual tip designs could explain why TEF performed more favourably than TWOG in the apical region while transportation results in the middle third for these two groups were the same.

Each instrument was used in a reciprocating motion except for the EGP, which was used in continuous rotation before final shaping with the Primary EOF.

Recently EdgeEndo launched its reciprocating glide path file, EdgeOne Fire GlidePath, which was not available at the time this research was undertaken. EGP presents with a triangular cross-section and a progressive taper, while WOGG and OFGP each have a parallelogram-shaped cross-section with a variable and progressively decreasing taper. The WOGG was the only glide path file with a semi-active tip. Although each canal was shaped to final size of ISO 25, final glide path sizes were not equivalent. EGP has an ISO 19 tip compared to ISO 15 tip sizes of the other two glide path files. The importance of glide path preparation was reiterated in a recent review concluding that glide path preparation helps preserve the original canal anatomy.[24] It could be speculated, although this was not evaluated in this study, that use of the EGP file, in continuous rotation, prior to the EOG instrument positively influenced the favourable results ultimately delivered by the TEF group.

FireWire seems to exhibit superior cyclic fatigue resistance and flexibility to Gold/Blue heat-treated instruments. According to recent studies, these characteristics can be attributed to the "peculiar three-dimensional aspect of the crystalline matrix" of this alloy.[25,26] A study by Hasheminia *et al* (2018) compared canal transportation and centering ability of Reciproc (VDW), WaveOne (Dentsply Sirona), and EdgeFile (EdgeEndo), which is made from the same FireWire heat-treated NiTi as EdgeOne Fire. In their study, EdgeFile exhibited the lowest transportation and the best centering ability of all the groups tested.[27]

A recent study by Lee *et al.* [26] compared the mechanical properties of ProGlider (Dentsply Sirona), One G (MicroMega), and EGP. They concluded that EGP had the highest residual angle of the three systems tested. The residual angle is measured by bending a file along its main axis while it remains fixed in a jig at its apical end. This angle is defined as "the angle between the bent file and the first position where the bent file did not return to the starting position". A file with a high residual angle is able to retain its modified shape at a higher angle, which aids in maintaining the centre of the root canal.[26,28,29]

Overall, in the apical region, centering ratio and transportation values were found to be significantly more favourable after the use of TEF therefore rejecting the null hypothesis. Although significant differences in canal transportation and centering were found in the apical region, their clinical relevance remains questionable and probably has limited importance in these moderately curved canals. According to a review by Peters[30] and a recent study by Pinheiro *et al.*,[31] apical canal transportation of up to 0.15 mm may be considered acceptable. In the current study, the mean transportation value of only TOFG exceeded 0.15 mm at the apical level.

The three combination groups evaluated in this study proved to be safe for the preparation of mesiobuccal canals of mandibular molars with moderate curvature. The limited information on EdgeEndo and One File G systems in the literature made it impossible to compare the results obtained in this study with other studies. To date, no article has been published on the shaping ability of these file combinations. It is however recommended that further studies are needed to evaluate the different performance of these endodontic glide path and shaping systems.

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Frozen sections in head and neck surgery and the impact of intraoperative analysis on final resection margins: An institutional study

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ABSTRACT

BACKGROUND
Frozen section (FS) analysis is an indispensable tool for intraoperative patient management.

AIMS
To assess the utilisation of head and neck FS analysis, with a particular focus on the concordance rate between the intraoperative FS margin analysis and the final FFPE results. Additionally, to determine whether FS analysis had any impact on intraoperative patient management. Lastly, to determine the impact of the FS analysis on the final margin status of resection specimens.

MATERIALS AND METHODS
Histopathology reports from January 2015 to December 2018 were reviewed at Pretoria Oral and Dental Hospital to analyse all FS requests involving the head and neck region. Captured data was analysed to determine the concordance rate, discordance rate, and FS deferral rates, with correlations performed using the Chi-square test.

RESULTS
Eighty-two frozen section cases were reviewed with a total of 312 FS tissue sections performed. The majority (73%) of the FS requests were from the Maxillofacial and Oral Surgery (MFOS) department for the assessment of surgical margins. The FS-FFPE concordance and discordance rates were at 97.5% and 2.4% respectively, with a deferral rate of 1.2%. Additional surgical margins were only received in 16 of the 26 cases with positive margins on intraoperative FS analysis. There was no statistically significant correlation between intraoperative FS positive margin status and advanced pathological T staging.

CONCLUSIONS
The concordance rate between intraoperative FS margin analysis and final FFPE results were within an acceptable range. In a significant number of cases, the intraoperative FS margin analysis did not influence further surgical management.

Keywords: Head and Neck Pathology, Frozen Section Analysis, Resection Margins

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INTRODUCTION
Frozen section (FS) analysis is an invaluable adjunct in surgical pathology. The procedure is done for immediate intraoperative diagnosis to guide intraoperative patient management.[1] The reasons for intraoperative FS requests include the evaluation of surgical margins, confirmation of malignancy, tumour classification, assessment of tissue viability for organ transplant, and the evaluation of lymph nodes for sentinel metastasis.[2] Due to the constraints of the head and neck tissue spaces, FSs are most commonly requested to assess surgical margins.[3-7] In an ideal clinical setting, an intraoperative FS analysis confirming involved margins by tumour should propel surgeons to alter the surgical management and submit additional margins.[7-8]

Several head and neck studies exist in the literature evaluating the concordance rates between intraoperative FS diagnosis and the final formalin-fixed paraffin-embedded (FFPE) tissue diagnosis. In these studies, the reported concordance ranges between 90-97%.[2, 9-11] Literature is sparse on the concordance rate between intraoperative FS margin analysis and final FFPE results, and the impact of FS analysis on the final resection margin status.[11,12] The current study aims to determine the utilisation of head and neck FS analysis at our institution, with a particular focus on the concordance rate between the intraoperative FS margin analysis and the final FFPE results. Additionally, to determine whether FS analysis had any impact on intraoperative patient management. Lastly, the study aims to determine the impact of the FS analysis on the final margin status of resection specimens.

MATERIALS AND METHODS

A four-year retrospective study evaluating pathology reports at Pretoria Oral and Dental Hospital, Gauteng was undertaken. This included patients operated at the Steve Biko Academic Hospital, located within the vicinity of the histopathology laboratory. All FS requests involving the head and neck region performed from 1 January 2015 to 31 December 2018 were included in the study. Reports were accessed from the electronic pathology database of the Department of Oral Pathology and Oral Biology.

These reports were given study numbers to ensure anonymity. The information collected included: surgical departments requesting the FS, reasons for the request, initial histological diagnosis if known, number of tissue fragments frozen per surgical procedure, intraoperative FS margin analysis *(positive or negative for tumour),* final FFPE results *(positive or negative for tumour),* resection specimen margin status *(positive for tumour, tumour <5mm from margin or negative for tumour),* lymph node status and the final pathological diagnosis. Discrepancies between the intraoperative FS analysis and final FFPE results were documented as yes or no, and the reasons, if available, were recorded. Errors, whereby the FS analysis did not correlate with the final margin status, were recorded as processing errors (gross sampling, histological sampling and surgical sampling) or interpretation errors (false positive and false negative results) based on the final pathology reports. Tumour misclassifications, whereby the intraoperative FS tumour diagnosis did not correlate with the final FFPE diagnosis, were not assessed in this study.

Statistical analysis

Statistical analysis was performed using SPSS (IBM, version 25) software. Captured data was analysed to determine the concordance rate, discordance rate, and FS deferral rates. The concordance rate was determined by comparing the agreement between the intraoperative FS analysis and the final FFPE findings. Correlation of the FS analysis and the final FFPE results were performed as well as a calculation of sensitivity and specificity of the FS analysis compared to the final FFPE results. FS analysis was correlated with the final margin status and the pathological staging. Correlations were performed using the Chi-square test, where a p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 82 cases, whereby FS analysis was requested, were reviewed. In total 312 FS tissue sections were performed, with an average of 3.16 FS tissue sections performed per surgical case. Most of the surgical FS requests were from the Maxillofacial and Oral Surgery (MFOS) department (51%), with the majority (73%) of the requests to determine surgical margin status. Most tissues were submitted from the oral cavity (46.3%), mainly from the tongue (13.4%). None of the patients received prior chemotherapy and or radiation. These results are summarised in Table 1.

Concordance rates between the intraoperative frozen section margin analysis and the final FFPE results

The concordance rates were calculated on 79 of 82 cases as shown in Table 2. In these 79 cases, only two cases were discordant, resulting in a FS-FFPE concordance rate of 97.5%. Only in a single surgical case was the diagnosis deferred, with a deferral rate of 1.2%.

Impact of the intraoperative frozen section margin analysis on the final margin status

Intraoperative FS analysis was performed to determine margin status in 60 of 82 cases. In these 60 cases, 26 were diagnosed with positive margins involved by tumour and a single case with atypical cells. Additional surgical margins were only submitted in 15 (55.5%) of these 27 cases.

Table 1: Patient demographics and summary of frozen section requests

	Number (%)
Gender	
Female	29 (35.4)
Male	53 (64.6)
Age at surgery (years)	
Mean (SD)	54.43 (14.53)
Median (range)	57 (7-77)
Number of frozen section surgical cases	**82**
Number of frozen sections	**312**
Mean (SD)	3.8 (2.53)
Min	1
Max	14
Requesting departments	
Maxillofacial and Oral Surgery (MFOS)	42 (51.2)
Head and Neck, General Surgery	38 (46.3)
Ear, Nose and Throat (ENT)	1 (1.2)
Plastic Surgery	1 (1.2)
Primary surgical sites	
Oral cavity including the oropharynx	38 (46.3)
Lip	10 (12.2)
Nasal mucosa/maxillary sinus	1 (1.2)
Parotid gland	2 (2.4)
Skin of maxillofacial region	30 (36.6)
Pre-operative diagnosis	
No diagnosis	1 (1.2)
Acinic cell carcinoma	1 (1.2)
Adenoid cystic carcinoma	1 (1.2)
Adenocarcinoma, NOS	1 (1.2)
Ameloblastoma	1 (1.2)
Basal cell carcinoma (BCC)	15 (18.3)
Dermatofibrosarcoma protuberans	2 (2.4)
Ectomesenchymoma	1 (1.2)
Epithelial myoepithelial carcinoma	1 (1.2)
Low-grade papillary adenocarcinoma	1 (1.2)
Pleomorphic adenoma	1 (1.2)
Polymorphous low-grade adenocarcinoma (PLGA)	2 (2.4)
Squamous cell carcinoma (SCC)	51 (62.2)
SCC/BCC	1 (1.2)
Sebaceous carcinoma	1 (1.2)
pTNM staging status	
Stage I	13 (15.9)
Stage II	17 (20.7)
Stage III	18 (21.9)
Stage IV	14 (17.1)
IVA	10 (12.2)
IVB	4 (4.9)

Table 2: Concordance between intraoperative frozen section margin analysis and final FFPE results

Frozen section cases n=82 (%)	Intraoperative FS analysis	Final FFPE results	Discrepancy Y/N
31 (37.8)	Positive	Positive	N
45 (54.9)	Negative	Negative	N
1 (1.2)	Positive	Negative	Y
1 (1.2)	Negative	Positive	Y
2 (2.4)	Atypical cells	Negative	-
1 (1.2)	Atypical cells	Positive	-
1 (1.2)	Deferral	Negative	-

FFPE: formalin-fixed paraffin-embedded

Table 3: Impact of intraoperative frozen section margin analysis on final margin status

FS cases for margin assessment n=60 (%)	Intraoperative FS analysis	Final FFPE results	Discrepancy (Y/N)	Additional margins received Y/N, (n)	Final margin status
1 (1.6)	Positive	Negative	Y	N (0/1)	<5mm
7 (11.6)	Positive	Positive	N	Y (6/7)	Negative
8 (13.3)	Positive	Positive	N	Y (6/8)	<5mm
10 (16.6)	Positive	Positive	N	Y (3/10)	Positive
1 (1.6)	Atypical cells	Positive	-	Y (1/1)	<5mm
1 (1.6)	Negative	Positive	Y	-	Positive
9 (15)	Negative	Negative	N	-	<5mm
8 (13.3)	Negative	Negative	N	-	Positive
15 (25)	Negative	Negative	N	-	Negative

FFPE: formalin-fixed paraffin-embedded

Thirty-three (55%) FS cases were diagnosed with negative margins. In these cases, 15 had a final negative surgical margin status, 9 with close margins (<5mm) and 9 with positive margins. These results are summarised in Table 3.

Intraoperative frozen section margin analysis, final margin status and pathological staging

An intraoperative positive margin status was recorded in 27 FS cases (26 positive margins and a single case showing atypical cells). This was correlated with the final pathological TNM staging (UICC, TNM Classification of Malignant Tumours, 7th Ed.)[13] as depicted in Table 1. Of these, only a single surgical case was not staged. In those with a pathological TNM staging, the majority of the cases were pT2 (42%), followed by pT1 (34%), pT3 (15.3%) and pT4 (7.9%). There was no statistically significant correlation between an intraoperative FS positive margin status and an advanced pT staging (p=0.42). However, a statistically significant correlation existed between advanced tumour stage (III-IV) and a final positive margin status (p=0.001).

DISCUSSION

Frozen section analysis forms an integral part of surgical pathology with the main objective of effective and timely intraoperative patient management.[13] Essential information required before performing the FS procedure should include the date and time of the surgery, reasons for the FS request and preoperative diagnosis, if available.[14] Not all FS requests in cases where a preoperative diagnosis is unknown will yield an immediate diagnosis, and if any doubt, the diagnosis may be deferred. The practice of intraoperative FS analysis places pathologists directly within the patient management decision-making team, hence the results of the FS should be documented in the patients' operative notes. FS requests should aid patient care and caution must be exercised to avoid inappropriate FS requests.[15] Frozen section should not be requested if the results have no bearing on intraoperative patient management.

Intraoperative FS artefacts may hinder histological assessment and diagnosis. These include tissue shrinkage, folds and tears, and bubbles under the coverslip amongst others.[16] Cautery artefact produced from electrocautery during surgery may also hinder accurate histological assessment, both intraoperatively and on the final resection specimen. Pathologists may request tissue from the surgical bed which was not cauterised to improve assessment. In addition, discordance between the intraoperative FS margin analysis and the final FFPE results may occur.[9] These discrepancies may result from pre-analytical errors in gross sampling, histologic sampling or surgical sampling. Gross sampling errors occur when the lesional tissue is present in the specimen, but was not sampled during the FS. Lesional tissue present within the tissue frozen, but not on the FS slide accounts for histologic sampling error. In contrast, surgical sampling errors are surgeon dependent, and occur when non-lesional tissue is sampled by the surgical team for FS analysis and subsequently lesional tissue submitted as a separate specimen for final analysis.[9] Post-analytical interpretation errors include false positive and false negative results, as well as tumour misclassifications whereby the intraoperative FS tumour diagnosis does not correlate with the final FFPE diagnosis.[9] Not all tissue is suitable for intraoperative FS analysis. Adipose tissue is difficult to freeze, whilst cartilage is difficult to keep on the slide as it often washes off in alcohol. Bone is difficult to cut with a cryostat and often requires decalcifying. FS analysis on tissue from the marrow cavity of bony margins is however possible, and may be useful in assessing the presence of tumour in the bony margin intraoperatively.

Clear margins are crucial in determining the need for additional surgical resection and/or neoadjuvant therapy, and for overall patient prognosis.[17,18] The head and neck region is a confined space with continuous tissue compartments, posing challenges in obtaining

tumour-free margins. Numerous studies have evaluated the use of FS analysis in the head and neck region to assess surgical margins, with correlation of intraoperative FS findings and final FFPE results.[4, 5, 9, 11, 12, 19] The adequacy of intraoperative FS margin analysis for head and neck squamous cell carcinomas has been reported at approximately 97%, with 83% sensitivity and 98% specificity.[11] While figures are variable in reported studies, it is nonetheless consistently above 90%, which compares favourably with FS margin status evaluation at other body sites.[20]

The discordance rate between FS findings and the final FFPE diagnosis in the current study was 2.4%, with a sensitivity and specificity of 96.9% and 97.8% respectively. This is in line with current literature, where discordance rates in the head and neck region ranged from 1.4% to 11.8%, with a mean of approximately 3.2%.[11] The two cases in our study which contributed to this discordance rate culminated from sampling errors and misinterpretation respectively. Sampling errors occur when the FS analysis is tumour-free and the final FFPE diagnosis shows the presence of tumour. A study by Gandour-Edwards *et al.,*[21] found that 83.8% of errors resulted from sampling rather than an interpretive error. Intraoperative tissue sampling techniques for margin assessment is a contentious issue. Thomas-Robbins *et al.,*[3] reviewed literature comparing two tissue harvesting techniques, the tumour-directed (from the resected specimen) sampling approach and the patient-directed (from the tumour bed) sampling approach. Their study found the tumour-directed specimen approach to be superior in assessing margins. Interpretation errors occur when the results of the FS analysis are not confirmed on the final FFPE permanent sections.[22] When in doubt, the pathologist may defer the diagnosis, which prevents interpretive error. In this study the deferral rate was 1.2%, which is within ranges reported in the head and neck region in the literature.[8]

It was interesting to note that intraoperatively, additional surgical margins were only received in 16 of the 26 cases with positive margins on intraoperative FS analysis. This finding shows that in 10 cases, the results of the FS analysis did not have any influence on further intraoperative patient management. The reasons why additional margins were not submitted were not documented in the surgical notes. A variety of speculative reasons exist why additional margins were not submitted, including limited operative time and anatomical constraints. Hence, proper preoperative surgical planning is crucial to ensure adequate resectability of tumours.

Nine cases with negative intraoperative FS margin analysis showed positive margins on the final resection specimen. This was attributed to an intraoperative gross sampling error by either the surgeon or the pathologist. A 2006 pathological survey found that most surgeons submit small tissue fragments to pathologists for intraoperative margin assessment.[10] Although this approach has its advantages, it may also underestimate the real status of resection margins, particularly in complex tumour resections. Hinni *et al.,*[23] recommended that intraoperative margin surveillance should be specimen dependent, with surgeons and pathologists participating in specimen mapping. This approach allows for effective intraoperative communication between surgeons and pathologists, ensuring that true margins are adequately sampled and assessed.

The current study noted several cases with positive final margins even after additional surgical margins were taken. To enable accurate additional resection, a study by van Lanschot *et al.,*[24] advocated a paired tagging of the tumour bed and the resection specimen to allow for easy review in cases of positive margins. In general, tissue under tension will contract following resection. Studies addressing margin shrinkage in patients with head and neck cancer found mucosal contraction in the order of 20% to 25%.[8,21] This is in contrast to Chen *et al.,*[25] who reported average shrinkage in length, width, and depth at 4.40%, 6.18%, and 4.10% respectively.

This study also evaluated the correlation between the FS margin status and the final resection margin status. Two out of 60 cases (3.3%) showed discordant results between the FS analysis and the final resection margin status, with one case having a positive final margin status. This figure is well below the rates reported by Ord and Aisner in which 7 patients (14.5%) had final positive margins not detected on FS analysis.[6] The current results on final margin status should be viewed with caution, as a clear margin on FS analysis is dependent on whether the whole margin was examined histologically and if the margin submitted intraoperatively is the same margin sampled on the resection specimen.[4]

This study did not find any significant correlation between intraoperative positive margin status and pathological T stage. However, a statistically significant correlation was noted between final positive margin status and pTNM staging. Tumours with an advanced tumour stage (III-IV) were more likely to show positive margins on the final resection specimen. These results are similar to a study by Gerber *et al.,*[26] in which positive final surgical margins increased by a factor of five in pT4-stage tumours compared to pT1 tumours. These findings are likely due to the extent of disease in T4 tumours with infiltration into the surrounding soft tissue and bone affecting the ability of surgeons in acquiring tumour-free margins.

Finally, it should be noted that achieving negative surgical margins does not guarantee local disease control. Many researchers have suggested other methods to stratify patient risk for local disease recurrence, regardless of clear surgical margins intraoperatively. For example, a commonly used method proposed by Brandwein-Gensler *et al.,*[17] suggests using a histologic risk assessment based on the worst pattern of invasion to differentiate indolent from more aggressive tumours.

The limitations of this study centers around its retrospective nature, based solely on pathological reports within a small sample size. In addition, there was no information as to why additional margins were not submitted in cases with positive intraoperative margins. When assessing margins intraoperatively, dysplasia at margins was not documented in most cases, and surgical margins were usually recorded as positive or negative for tumour. A 5 mm cut-off was used to indicate a close margin on the final resection specimen, however, this criteria was not applied during intraoperative FS analysis. These limitations may have influenced the final resection margin status.

CONCLUSION

Although the concordance rate between intraoperative FS margin analysis and the final FFPE results in this study is within an acceptable range, there is room for improvement. Preoperative surgical planning, including advanced diagnostic imaging, is important to avoid unnecessary FS requests that have no impact on intraoperative surgical management. This was illustrated in the current study by the lack of additional margins in cases with positive intraoperative FS margins. It is vital that adequate sampling is done intraoperatively to avoid false negative results. A negative FS margin status may not correlate with a tumour-free margin on the resection specimens as this is dependent on tissue sampling.

DECLARATIONS

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Conflict of Interest

The authors declare that they have no conflict of interest.

Ethics approval

This study was approved by the University of Pretoria, Faculty of Health Sciences Research Ethics Committee (Reference no.: 531/2018). All procedures followed the ethical standards of the Helsinki Declaration of 1975, as revised in 2008.

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Will "selfies" solve the identification crisis in lower socio-economic South Africans? A dental feature analysis of "selfies"

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ABSTRACT

Identification in forensic odontology requires that a known characteristic of an individual's dentition be compared with the same characteristic of the unknown decedent. In South Africa a number of factors render forensic identification of unknown individuals challenging. Many South Africans do not have access to modern dentistry, and consequently do not have ante-mortem dental records. In South Africa, 22 million people are said to own a smart phone, which accounts for close to 40% of the country's population. The aim of the study was to investigate selfies as a source of dental feature information in a government clinic catering to previously disadvantaged patients.

Identifiable dental features were observed in 61 (5.6%) of the collected images (N=1098). The low number of useable selfies collected in this study could be attributed to: a lack of smiles seen in the received images. Individuals with poor dental aesthetics would commonly choose to take a selfie with a closed mouth where their teeth would not be visible. The most commonly identified dental features included: diastemas (49.2%), dental jewellery (37.7%), crowding (16.4%), difference in tooth height (16.3%), discoloured (8.2%) and missing teeth (8.2%). This study found that selfies cannot solve the identification crisis in lower socio-economic South Africans. Awareness of the importance of selfies in forensic identification should be increased.

Key words

Forensic Odontology, identification, record keeping, mobile phones, selfies, dental features.

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The role played and the respective contribution:

1. **Vimbai Manyukwi:** Primary researcher, manuscript preparation
2. **Christy L. Davidson:** Supervisor, manuscript preparation and editor
3. **Paul J. van Staden:** Conducted statistical analysis
4. **Joyce Jordaan:** Conducted statistical analysis
5. **Herman Bernitz:** Supervisor, manuscript preparation and editor

INTRODUCTION

Rapid and accurate identification of non-natural deaths is a key component of a good forensic service.[1] This is important for ethical, criminal and civil reasons.[1] Post mortem (PM) identification requires that a known characteristic of an individual be compared with the same characteristic of the unknown decedent. This forensic comparison plays a role in the identification of victims of violence, disasters or mass tragedies.[2] If a positive match is found, the individual may be identified and a death certificate can be issued. This provides some degree of closure for an individual's loved ones.

The high number of unidentified decedents at medico-legal laboratory facilities in South Africa (SA) is a source of great concern.[3] There are a number of legal consequences for families in cases where a loved one is missing but the death cannot be confirmed. Often there is an absence of medical and dental records especially in the black, previously disadvantaged rural populations of the country. This renders forensic identification of unknown individuals a challenge.[3] It is not a rare occurrence to have to identify a person where there is minimal antemortem (AM) data, as in the case of street children, asylum seekers, undocumented foreign nationals and individuals living in remote rural areas.

A lack of DNA reference samples, the high cost of DNA analysis as well as the damage that occurs to fingerprints during the decomposition and carbonization processes present challenges for the identification of unknown individuals.[3] An absence of medical and dental records, further hinders the identification process.[3] The Covid-19 pandemic has created large pools of vulnerable persons who, due to their worsened economic situation, were recruited for labour or sexual exploitation in their local area.[4] Loss of livelihoods and restrictions on movement have led to increased numbers of human traffickers recruiting victims in their local areas.[4] Recent statistics reveal that less than 1% of these victims are ever rescued, and that they often have no identification documents which would aid in their discovery.[4] A 2016 study revealed that of the world's population,

Table I. Descriptive statistics for the age of the participants that provided selfie photographs

	Mean	Standard deviation	Range	Minimum	Maximum	Percentiles		
						25th	50th	75th
Age	30.5	6.9	48.0	18.0	66.0	26	29	35

nearly 70% own a mobile phone.[5] Africa has shown phenomenal growth of mobile cellular ownership in recent years. The popularity of prepaid subscriptions and low-cost phones have made it possible for many of the country's youth living in poverty to own or use a phone themselves.[5] In SA, 22 million people are said to own a smart phone, which accounts for close to 40% of the country's population.[6, 7]

Current techniques utilised in forensic identification in SA remain more suited for first world countries, where dental records are generally available throughout all socio-economic groups.[8] Within SA, alternative methods of identification need to be investigated. Mobile phones are easily accessible and found in most sectors of our population, making selfies a possible source of dental information. Yet, there is minimal information regarding the use of selfies within forensic dentistry.

AIM

The aim of the study was to investigate selfies as a source of dental feature information in a government clinic catering to previously disadvantaged patients.

MATERIALS AND METHODS

Patients older than 18 years that attended a Provincial Hospital dental clinic from November 2019 to May 2020 were requested to provide a single selfie photograph of themselves. The selfie could be any selfie of their choosing, of them either alone or in a group. All the collected images were stored on a database and given a unique study number that correlated with their patient file number.

The following patient and selfie information was recorded: age of the individual, gender, ethnicity, date the photograph was taken, as well as the dimensions and size of image. Additionally, a clinical oral examination was performed for each patient as part of their routine dental treatment.

Usability of each of the provided selfie images was assessed and the images were classified as follows:

- Images where the dentition was visible and identifying dental features could be seen. These images were scored 1.
- Images where the dentition was visible but identifying dental features could not be seen. These images were scored 2.
- Images where the dentition was not visible or quality of the image was poor. These images were scored 3.

The images where the dentition was visible were further analysed for a number of identifiable dental features. Intra and inter observer reliability were carried out on 300 random selfies during the analysis period. The data analysis consisted of frequencies and descriptive statistics such as means, standard deviations and percentiles.

Table II. Gender distribution of the participants that provided selfie photographs

	Frequency (%)
Female	805 (73.3%)
Male	293 (26.7%)
Total	1098

Table III: Usability of the collected selfies.

	Frequency	Percentage (%)
Dentition is not visible	638	58.1
Dentition is visible, but identifiable features cannot be seen	376	34.2
Identifiable features are seen in the mobile image	61	5.6
Quality of image is insufficient	23	2.1
Total	1098	100.0

Table IV. A summary of the most common identifiable dental features visualised on the 61 selfie photographs.

Feature	Frequency	Percentage of the 61 images where features were seen (%)
Diastema	30	49.2
Dental jewellery	23	37.7
Crowding	10	16.4
Difference in tooth height	10	16.4
Discoloured tooth	5	8.2
Missing Tooth	5	8.2
Number of tooth chips	5	8.2

This study was approved by the Faculty of Health Sciences Research and Ethics Committee. (Ethics number 740/2019) of the University of Pretoria in terms of the National Health Act (Act 61 of 2003) and the Code of Ethics for Research of the University of Pretoria. Participation in this study was voluntary.

RESULTS

A total of 1 098 selfies were collected during the study period. Table I summarizes the descriptive statistics for the age of the patients that provided selfies. The number of selfies received by females (F=805) was far more than those received by males (M=293) (Table II). The dentition was visible in 437 (39.8%) of the collected selfies. Of these images, 61 (5.6%) selfies showed identifiable dental features (Table III).

The maxillary anterior teeth were most frequently visible in the collected selfies. The highest frequency of anterior teeth seen was a smile span of 6 visible teeth (n=18). Table IV presents a summary of the most common dental features seen on the 61 selfies where features could be identified.

The intra observer reliability was 0.972 and the inter observer reliability was 0.966 showing a good agreement and reproducibility in the methodology of identifying the dental features.

Figure.1A Selfie of an individual with a closed mouth, B Intra-oral image of the same patient's dentition.

DISCUSSION

The results of this research unfortunately showed that most of the study participants did not provide smiling selfies. The majority of the selfies that were collected were of individuals with their mouths fully or partially closed. The dentition was visible in 39.8% of the 1098 collected images and identifiable dental features could only be seen in 5.6% of these images (n=61).

A possible contributing factor to the low number of smiling selfies collected in this study could be the dental /oral health status of the participants. Individuals with poor oral health, tooth loss and untreated carious lesions may be self-conscious and therefore may not take smiling photos or be willing to share such images.[9, 10] Individuals living in lower socio-economic areas have poor access to oral healthcare and therefore oral health awareness is low.[11] The majority of individuals that provided a selfie where their dentition was visible had good oral health with no restorations or dental decay. In contrast, individuals with a poor state of their dentition frequently provided a selfie with a closed mouth where their teeth were not visible.

There was only one selfie collected which showed dental caries in this study (1.6%). In this image it was almost as if the individual was trying to conceal the visible dental decay in their smile line by not smiling widely. This finding emphasized the fact that those with decayed teeth chose to not smile in their selfies. Considering that globally 2.3 billion people are estimated to suffer from caries of permanent teeth, it was surprising to note the low number of dental caries seen in the collected selfies.[12]

An example where a selfie was provided with a closed mouth can be seen in Fig.1A. This patient reported that she did not want to show her teeth while smiling due to embarrassment about the state of her dentition. After obtaining consent, the investigator took an intra-oral photograph of the individual's dentition which revealed multiple carious teeth and decayed root remnants (Fig.1B). In 2018, Weiser et al. reported that the recent substantial growth of social media has led to more individual self-promotion and competition.[13] This could explain why those individuals with undesirable dentition would choose to take a selfie with a closed mouth where their teeth would not be visible. In many of the non-smiling selfies provided in this study, the participants reported that they were self-conscious about their poor dentitions and therefore hid their smiles.

The mean age of the participants in this study was relatively young at 30.5 years old. In the cases where older individuals had camera phones, most reported that they did not take selfies. The availability of selfies for identification is thus generally restricted to younger individuals and may become more difficult to source in older persons requiring identification. This is not an unusual finding as studies have shown that there is a higher prevalence of use and ownership of mobile phones in adolescents than in adults.[14] In fact, in the past few years, phone usage rates have also considerably increased among preschool children aged 6–10 years.[14]

There were more female participants (73.3%) who provided selfies than male participants. This might simply be due to

Figure.2 An example of a good selfie with 2 identifiable dental features; midline diastema and non-vital 21.

more females attended the dental clinic than men. However, literature has shown that women are more likely to schedule a dentist visit and are more proactive than men in maintaining healthy teeth and gums.[15] Furuta *et al.* claimed that women have a better understanding of what oral health entails, as well as a more positive attitude towards dental visits.[15]

In 1986, Mckenna et al. investigated the role that anterior dentition visible in photographs can have in forensic identification.[16] In their study, 100 different photographs and dental models were studied. They found that 96% of the study participants had at least one feature in their dentitions which could be classified as unique.[16] Their study was expanded in which they examined 1000 different photographs to identify the percentage of individuals who showed anterior teeth in their photographs. Their findings revealed that 60.9% of the photographs showed special attributes, or unique dental features and that 76.7% of their collected photographs were usable in the identification of missing and unidentified person. Their results are in sharp contrast to the present study.

There are a number of characteristic dental features that can be used for forensic identification.[17] These include the shape of the crown, morphological characteristics, dental anomalies, and alignment between the teeth.

Consideration of the population demographics in which a study is conducted is important when analysing any study data. This study was conducted in Gauteng and the incidence of missing teeth was low at 6.5% (n=5). The most common reason provided by the study participants for having missing teeth, was extraction subsequent to tooth decay. Had this study been conducted in Cape Town, an area known for individuals having a "passion gap" or "Cape Town smile", the incidence of missing teeth would have been higher.[18] In the Cape, it is a cultural practice for individuals to electively extract their maxillary central and lateral incisors (teeth 11, 12, 21 and 22) for aesthetic purposes. A selfie from the Western Cape population where all 4 maxillary central incisors were extracted would not be a significant finding.

The more dental features present in one's selfie, the more significant the findings are. Figure 2 is an example of a selfie that showed more than one visible dental feature. In this selfie a non-vital discoloured maxillary central incisor (tooth 21) with a large midline diastema was visible. Maxillary midline diastema was the most common finding in this study (49.2%). If this selfie portrayed an isolated midline diastema, this would not have been a significant finding in this study population. The fact that the individual also has a discoloured tooth 21 adds significance to the dental features. When combined, these 2 dental features are of more forensic significance compared to each feature being found in isolation.

A commonly found feature in this study was dental jewellery on the anterior teeth, which was seen on more than one third (37.7%) of the collected selfies (n=23). Dental jewellery, especially gold inlays and onlays, are a common finding in many different population groups.[19, 20] The gold slit/inlay was the most commonly seen dental jewellery in this study. For forensic purposes a gold inlay alone would be of little significance. However, if more than one gold inlay is found in one individual (Fig.3) or if two full gold crowns (Fig.4) are found in one individual, the forensic significance is greater.

Figure.3 'U' shaped gold inlays on maxillary central incisors (teeth 11 and 21)

Figure 4. Two full gold crowns on both maxillary lateral incisors (teeth 12 and 22).

Figure 5. Unaesthetic dental crown with high forensic value.

Figure 6.A Smiling selfie with visible lower anterior crowding. B The same individual's dentition in a post mortem photograph. Images courtesy of Prof H. Bernitz)

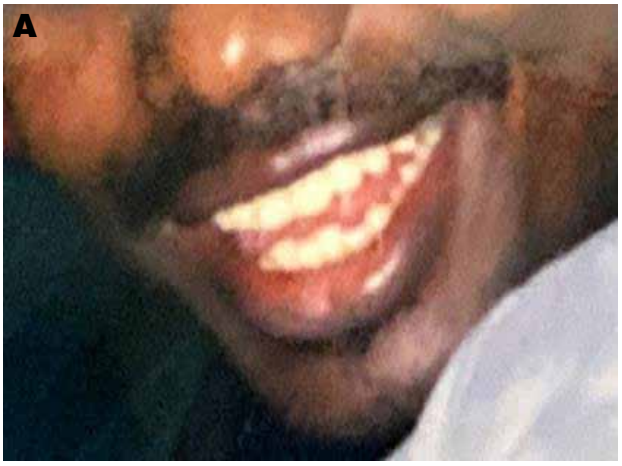

Figure.7 A-C Multiple-angled photographs taken during post mortem examination. *(Courtesy of Prof H. Bernitz)*

In one of the provided images, a conspicuous unaesthetic, tooth-coloured crown could be seen on the left maxillary canine (tooth 23). This crown was extremely white in colour and positioned out of the dental arch (Fig.5). While this would not be an ideal crown for the patient's aesthetic needs, it provides good forensic identification value. It is highly unlikely that another individual would present with a crown showing similar features to those seen in this selfie. Interestingly, a more clinically pleasing crown would be of less forensic value as it would be less conspicuous and more difficult to see on the image.

Anterior teeth have been shown to have specific numerical rotational value and form part of an individual's unique identity.[21] Dental crowding is defined as a discrepancy between tooth size and jaw size resulting in a misalignment of the teeth in the arch.[21] The aetiology can include physical trauma, discrepancies in the relationship between tooth size and arch size, emergence of the third molars and periodontitis.[21] Dental crowding was only observed in 10 of the selfies (16.4%) in this study. The last of the most observed dental features in this study was the presence of a difference in tooth height between the upper central incisors. Ten selfies (16.4%) were found to show a difference in tooth height between the maxillary anterior incisors.

A practical example of using a selfie showing characteristic dental features being used for a positive identification can be seen in Figures 6A and 6B. These images clearly show the absolute pattern match between the upper and lower dentition visualised on the AM selfie and the PM image of the victim. In this specific case, a conclusion of absolute certainty was made through the use of the AM and PM images.

When comparing a selfie to a deceased individual's dentition, the orientation of the selfie image and the PM image needs to be considered. An AM photograph is crucial when taking PM photographs, as the angulation of the PM photograph should be reproduced for accurate comparison.[22] Mirror images, where the selfie was taken in a mirror, need to be considered as these could be misleading when orientating the selfie.[22] Additionally, to avoid any confusion, the investigator should thoroughly correlate the clinical PM examination notes with the photographs of the deceased's dentition. We recommend that during PM procedures multiple angled photographs of the deceased's dentition be taken to use for comparison with a provided selfie, see Figure.7A-C. The angulation of the photograph must be reproduced in the X, Y and Z (depth) axes for accurate comparison.[22]

Selfies are easy to use, low cost and accessible sources from which dental identification could be performed. From this study it was evident that the more teeth seen in a selfie, the higher the likelihood that the investigator would see identifiable dental features. The 6 most commonly seen dental features in this study were diastemas, dental jewellery, crowding, a difference in tooth height, discoloured and missing teeth.

CONCLUSION

The results of this study were contrary to those that were expected and revealed that selfies cannot solve the identification crisis in lower socio-economic South Africans. This study may not be a true reflection of identifying dental features on selfies as most of the images provided were where the dentition was not visible. Considering the growing trend of selfie taking and the availability of these images, the use of selfies in the forensic identification of individuals still requires further exploration.

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Conflict of interest

The authors report no conflict of interest. This article has not been previously published and is not currently being considered for publication elsewhere.

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An evidence-based guide to occlusion and articulation. *Part 1: Occlusal terminology and a guide to jaw movement.*

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CP Owen[1]

SUMMARY AND PREAMBLE TO THE SERIES

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

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

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

Occlusal terminology and a guide to jaw movement.

The first thing to understand, is that no-one was really concerned about the term *occlusion* until the late 19th century, about 40 years after the industrial revolution (which was from about 1760 to 1840). Before 1880, occlusion meant, according to an online etymological dictionary:[1]

"act or fact of being stopped up," 1640s, from Medieval Latin occlusionem (nominative occlusio), noun of action from past-participle stem of Latin occludere (see occlude). Dentistry sense "position of the two sets of teeth relative to each other when the mouth is closed" is from 1880".

Quite how occlusion came to mean that, no-one seems to know. Coincidentally, toothpaste in a tube was invented at about the same time, and in the US the first national examining board was created. All of which are just coincidences. There were no apparent theories of occlusion until an American dentist, Edward Angle, described what he called different *mal*occlusions, in 1898. He also attempted to define "normal" occlusion.[2] In the next 40 years or so, all sorts of assumptions were made about the relationship of occlusion to all sorts of symptoms from muscle spasms to joint pain, ear ache and tinnitus and, even this: *"In the evaluation of this survey, there appears to be a close relation between malocclusion and insanity"* quoted in a 1956 paper![3-5]

In 1961 two much-quoted and still seemingly revered but now somewhat discredited papers (which were basically the same study published in two different places) reported the use of occlusal adjustments to relieve muscle and joint pain and bruxism.[6,7] There was no evidence for such adjustments and the author even stated *"Unavoidable resettling of the teeth after the first two or three adjustments occasionally resulted in new interferences that had to be eliminated".* There was no control group and no follow-up of the patients, merely a claim that their muscle pain and bruxism was relieved. Tons of enamel have since been destroyed on the altar of those scientifically flawed papers, quite unnecessarily.

There is a distinct lack of evidence in many of theories of occlusion and you will find it all over text-books of occlusion and very many people will continue to believe in the dogmas they want to believe in, without really questioning the evidence. Recent political events all over the world attest to the fact that facts often get in the way of beliefs. So what *are* the facts? The fact (sorry) is, there is no relationship between malocclusion, occlusion, and symptoms related to orofacial pain, the temporomandibular joint, ear ache or insanity. [2,8-10] Although to be fair, there is evidence of brain activity associated with chewing, and some neuroscientists believe that that the inability to chew may be linked to dementia; but once again a direct causal relationship has not been shown.[11]

All of which doesn't really help us when we need to replace the occlusal surface of some or all of the teeth, or to simply replace all of the teeth themselves. In order to do this, we do need to know something of how the jaw moves, and what happens when we do chew. So that is what this guide is going to try to do: explain as simply as possible just what the relationship is between jaw movements and the way teeth come together statically and, more importantly, functionally, so that we can understand how to replace

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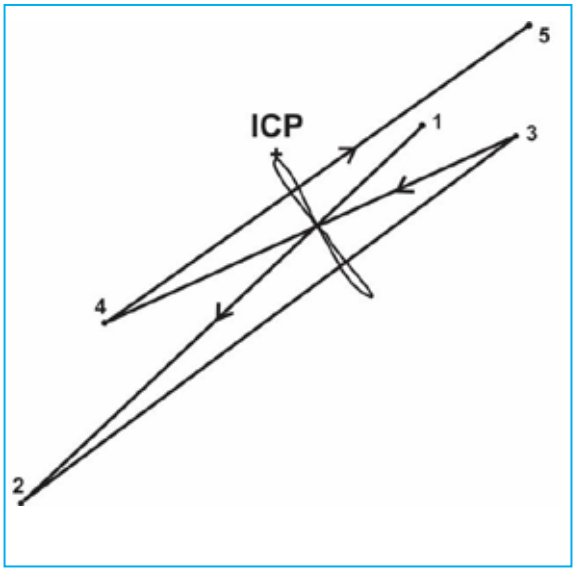
either the occluding surfaces of the teeth, or the teeth themselves. You will, without doubt, at both undergraduate level and post-graduation, have read and heard much on jaw movement and the TMJ, so I won't bore you with more of that here, but rather just make some points which I hope may clear up any confusion you may have and possibly help you sort out some of the many myths around this strange joint.

- It is a strange joint because it is the only joint which has no inherent anatomical limit (as anyone who has dislocated their jaw can verify). It is held like a sling by several muscles, and the limit to its movement is uniquely *outside* the joint: the teeth.
- The mandible as a result of being slung like this is never still unless the teeth are in occlusion (i.e. together in what is generally known as the *intercuspal* position or ICP). When not, it is constantly moving: even at rest with the teeth apart, it is making very small difficult to detect movements. We know all this from real-time functional MRI scans.
- The joint is the most slipperiest (if there is such a word) in the body. It has been estimated as being 5 times more slippery than ice on ice. Articulating cartilage surfaces lubricated by synovial fluid produce a coefficient of friction (μ) on the order of ~0.01 or less.[12,13] Ice on ice has a coefficient of 0.05. No wonder it is never still.
- You will have learnt about the border movements of the mandible known as Posselt diagrams, but I doubt you were told these are *not* normal movements. They are called border movements because they describe the *limit* of movements that can be made. Only in extreme nocturnal bruxism does anyone use those limits (we know this from watching people in sleep labs). In normal eating, speaking and chewing, they are not used in the manner shown in the original Posselt diagrams.[14]
- One of those movements, though, has long been considered useful. That is the *terminal hinge movement,* when the mandible supposedly makes a purely hinge-like movement, opening and closing on an arc. It was thought (and still is, by some) that the hinge is created by the condyles staying more or less in the same place in the joint fossa. However, it has been shown through the use of jaw tracking[15] and more recently by functional magnetic resonance imaging (MRI)[16] that the mandible does not make a pure hinge movement as there is always some translation involved.
- So if you believe in a pure hinge movement, then you will also believe in an axis of rotation, passing through the condyles. And this, as we shall see later, is the basis for an equal belief in the use of mechanical devices to reproduce jaw movement, i.e. articulators.

Figure 1. This depicts the major segments of the instantaneous centres of rotation from tracing the incisal point, with the trace shown sagittally. ICP = the intercuspal position from which movement was initiated (redrawn from McMillan *et al* 1989[15]).



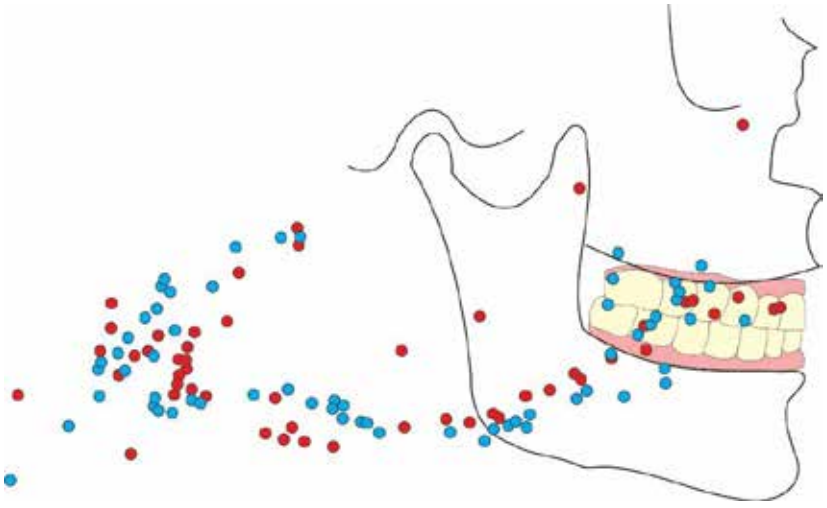


Figure 2. Mean ICR coordinates of all subjects during one full cycle of mouth opening (blue) and closing (red) (re-drawn after Krohn *et al* 2020).[16]

- However, if you understand that the mandible is held sling-like in a slippery joint, you will understand that any axis of rotation is likely to change and move as the mandible moves, and this is known as creating *instantaneous centres of rotation* (ICR). These are mostly nowhere near the condyles. Fig. 1 for example shows the result of tracking an incisal point by means of a kinesiograph, of a subject performing open/close movement patterns. For the movement shown (open from the intercuspal position to rest position and back again), there were 5 different instantaneous centres of rotation relative to the condyles. Fig. 2 shows the ICRs from calculations made using real-time MRI of subjects who were asked to open wide from the intercuspal position (ICP) and close again to ICP. The mean ICR pathways were *never* located within the condyle for both opening and closing movements.
- So if there is no pure hinge movement and no such thing as an intercondylar axis, is there any chance of reproducing jaw movements at all? This is important, and the answer is, not to the degree of perfection that studies revealing the ICRs would require (or at least, not yet). From a clinical point of view, we have to find as repeatable a position as we can, and we can actually observe what looks like a hinge movement, even if we know it is not really a hinge. It is most useful when a patient has no teeth, as it can be repeated (though with some difficulty in some patients) so at some point in its path you *can* decide where to put the teeth. This point in space is then referred to as the vertical dimension of occlusion.
- If the teeth are not together but the jaw is at rest, in space, this is called the vertical dimension of rest, or the rest position. As you can imagine, it varies a lot, but usually only in a small range of a millimetre or two.
- This 'hinge' movement of the mandible, useful as it is if we can repeat it, has also been responsible for a great deal of confusing terminology. And we can blame the invention of X-rays for that. Back in the day, when ethical research was, well, unethical, some patients were subjected to lots of X-rays of the TMJ and dentistry became obsessed with the position of the condyle in the glenoid fossa. Mostly of course, these were 2-dimensional images but now we have the magic of MRI and something called videofluoroscopy, which allows us to see everything whilst the jaw is moving (though it's not so easy to interpret).[17]
- But the early (and for some, still) obsession with condyle position has not helped. The American Academy of Prosthodontics has published fairly regularly, since 1956, a Glossary of Prosthodontic Terms (GPT) and is currently on its 9th edition, published in 2017.[18] In a recent history of this,[19] describing the latest revision, is stated: *"The most contentious term in the entire revision process was "centric relation"".*
- Here's the 1956 version: *"The most retruded relation of the mandible to the maxillae when the condyles are in the most posterior unstrained position in the glenoid fossae from which lateral movements can be made, at any given degree of jaw separation".*
- And here is the latest version: *"A maxillomandibular relationship, independent of tooth contact, in which the condyles articulate in the anterior-superior position against the posterior slopes of the articular eminences; in this position, the mandible is restricted to a purely rotary movement; from this unstrained, physiologic, maxillomandibular relationship, the patient can make vertical, lateral or protrusive movements; it is a clinically useful, repeatable reference position".*
- Phew! Does that make sense to you? No, nor to me. Unstrained? How do you tell? And of course you can make *"vertical, lateral or protrusive movements"* from any position, because of the anatomical nature of the joint itself, which the American Academy seems to have ignored. But what they have said, in line with what is in the previous bullets here, is that it is a position restricted to *"a purely rotary movement"* and therefore a *"repeatable reference position"*. Well, as we have seen, there is no such thing as a purely rotary movement.[15,16]
- And of course they don't define the *"reference position".* But does it really matter where the condyles are? Surely it is the observed movement that is important so it ought to called an *observed repeatable movement.* And you can then decide at what point during this movement to have the teeth come together. And you can call that centric relation occlusion if you want.
- No-one really knows where the condyles of the mandible are when the jaw is at rest but the teeth are not in contact. When the teeth are in contact, that is what has been referred to as centric occlusion rather than just being in occlusion. I have no idea why the word *"centric"* was used as it comes from the Greek kentrikos "*pertaining to a centre*". What centre? Same with centric relation.
- And the Glossary makes it worse. Centric occlusion is *"the occlusion of opposing teeth when the mandible is in centric relation; this may or may not coincide with the maximal intercuspal position".* Which is ridiculous, because it ignores their own definition of centric relation!
- This may be why centric occlusion is often confused with *maximum intercuspation*, or maximum *intercuspal position.* However, as we shall see later, what if you don't have cusps, or enough of them to intercuspate?
- So, the terminology around occlusion is really confusing. My advice is to use whatever helps you understand from a *functional* point of view, because it was the study of the static relationships of the teeth when for example, casts are put together, that gave rise to all sorts of dogmas for which there turned out to be no evidence.[20]
- Mandibular movement is complex, simply because it is held in a sling, and is influenced by the muscles carrying out whatever action you are doing, be it speaking, talking, chewing, doing nothing, or sleeping. The jaw never moves in a straight line, anywhere. That is why no mechanical instrument can ever reproduce jaw movement. It is also why the digital virtual world may hold great promise to reproduce jaw movements (some claim it does already, but we haven't got there, yet – see Part 7).
- This doesn't mean articulators have no use, because even an approximation is better than nothing. It just means you need to know what they are approximating, in other words, their limitations and why, for example, some types should never be used. This will be dealt with in Part 6.

Having written all this, I fear it may not seem so simple after all! But, if you think about all these points and try to contextualise them with what you may have been taught, and what you may have read, I am confident you will be able to sort the wheat from the chaff, and understand the terminology, and the nonsense around terms like centric relation. It's what happens when the teeth come together functionally that is important. And they don't come together that often, unless you are clenching your teeth all day. Teeth *'occlude'* when they come together but when chewing that is only fleeting, and they move across and over each other and need to be able to do that without interrupting the pattern of chewing. The teeth and the joint need to allow this to happen. That is what you need to know about occlusion!

Now, before we get to solutions, we need to look at how we as *Homo Sapiens Sapiens,* ended up with the teeth and the jaws and the joint we have. I am confident this will further help you to understand the functional aspects of occlusion and articulation. Part 2 will therefore look at the evolution of teeth and the temporomandibular joint.

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

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1. Assessing vaccine hesitancy in the population using a generalized vaccine hesitancy survey instrument

From a scientific perspective, the benefits of vaccination have long been demonstrated with rigorous empirical research[1]. To the individual being vaccinated, vaccines provide almost invaluable protection against serious infections, but high coverage levels can also create an additional benefit emerging at the population level. This public good of 'herd immunity', i.e. heavily reduced transmission of a pathogen in the population because of low numbers of susceptible hosts in the population, is an important layer of protection for those individuals who cannot receive vaccination themselves, those with a dysfunctional immune system, and those whose protection has waned.[1] It is mainly for the latter reason that many ethicists believe that vaccination is not merely a matter of personal choice but that it can also be a social obligation.[1]

Despite the demonstrated effectiveness of vaccination programs, there is evidence that in many parts of the world, substantial numbers of people are questioning the need to become vaccinated, seek alternative vaccination schedules, delay or refuse vaccination. The concept of 'vaccine hesitancy' was suggested and defined as broader and less judgmental than skepticism or refusal.[1] So, rather than a set of general anti-vaccine opinions, the concept of vaccine hesitancy is thereby defined as a vaccine and context-specific, behavioral phenomenon that needs to be understood against an expectation of reaching a specific coverage goal, and this under circumstances of sufficient access to vaccination.[1]

Several measurement scales have been developed in order to tap into the core of hesitant vac- cine attitudes. In 2015, the WHO-SAGE Working Group on Vaccine hesitancy developed a scale, called the 'Vaccine Hesitancy Scale' (VHS) that aimed to unify existing research on the many determinants of vaccine hesitancy in a workable framework and to standardize the measurement of vaccine attitude. The VHS allows comparing parental levels of hesitancy across regions as well as to map evolutions of hesitancy over time, and can be linked to socio-demographics in order to identify priority groups.

This study sought to broaden the applicability of the VHS by focusing on vaccine hesitancy within the respondents themselves, rather than an exclusive focus on parental attitudes regarding childhood vac cines. This was done by modifying the perspective and wording adopted in the original VHS, without losing its intended conceptual meaning. Using this revised version of the VHS, the researchers sought to examine vaccine hesitancy among a representative sample of the UK population, and to determine the association between vaccine hesitancy and various respondent characteristics.

METHODS

Using a consumer panel database, 9613 random individuals were approached to participate in a scientific study on healthcare resource allocation. Respondents did not know the specific subject of vaccination before deciding to participate. Of these contacted people, 4144 (43%) responded to the invitation and 1950 were recruited via stratified random selection to fulfill predetermined quotas, which provided a representative sample of the UK population in terms of socio-economic strata (indicated by the occupation of the head of the household), gender and urban vs. rural background. Since the primary interest of this study was related to responses in age groups, a concerted effort was made to recruit individuals equally in 5 age categories (20–29, 30–39, 40–49, 50– 59, 60+ years).

An email containing a link to the survey website was sent to participants and by clicking on the link respondents consented to participate, although they were free to stop or close the survey at any point. All respondents received a nominal incentive for study completion. The vaccine hesitancy scale (VHS) was asked before the start of the resource allocation experiment so no order effects are to be expected.

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Participants were asked to answer ten questions related to their confidence in vaccines on a five point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 agree, 5 = strongly agree). Three questions (five, nine and ten) were phrased negatively. In the original VHS, these ten items were targeted at parents to measure attitude towards childhood vaccination. The researchers modified the 10 items so that they could be asked by anyone without reference to children. For instance, the first item was changed from "Childhood vaccines are important for my child's health" to "Vaccines are important for my health". Respondents were asked various socio-demographic questions such as whether they have or had children (and their age) and they self-rated their health status. In addition, their optimistic or pessimistic expectations about the future were measured via the Revised Life Orientation Test (LOT-R). This is a standard instrument to measure 'dispositional optimism', the relatively stable personality trait of anticipating a good or a bad future.

To study the latent dimensions of the VHS, the dataset was randomly and evenly split into a construction and a validation set. Exploratory factor analysis was conducted on the construction set. Factors were extracted using varimax rotation. Subsequently, a confirmatory factor analysis was used on the validation set to con- firm the latent structure that resulted from the exploratory factor analysis. Simple and multiple regression analyses were used to identify significant associations between the identified VHS sub- scales and hypothesized explanatory variables.

RESULTS

Forty-three percent of the contacted panel members were willing to participate in this study and of these, 1950 were selected based on a number of predetermined quota with 1546 participants completing the questionnaire. When asked how difficult the survey was and whether their answers were sufficiently valid to be used for public policy purposes, 47 (2%) indicated that the survey (which included a discrete choice experiment) "was very difficult and I am not sure that I made a valid contribution". In addition, there were 97 (6.5%) 'straightliners' in the sample, i.e. participants who selected the same response category for each of the 10 items. Sixty-four of them consistently. answered the middle category 'neither agree nor disagree'. These 97 respondents were excluded from the analysis, leaving us 1402 respondents for analysis.

One in five respondents disagreed or were undecided whether "vaccines are effective" (question 2), and two in three respondents did not fully reject the claim that "New vaccines carry more risks than older vaccines" (question 5). Also, for the items "I am concerned about serious adverse effects of vaccines" (question 9) and "Vaccines are not needed for diseases that are not common anymore" (question 10) a majority of respondents answered in a hesitant way. The fraction of respondents that clearly opposed was however much smaller, ranging from 4.4% disagreeing that "vaccines are important for the health of others in my community" to 32.7% stating concerns for side effects. Items 5, 9 and 10 were answered differently compared to the other seven items. These three items showed an even distribution around "neither agree nor disagree" compared to a strongly skewed distribution towards "strongly agree" for the others.

On a scale from 1 to 5 (with 5 maximal hesitancy), the average respondent scored 1.99 (SD = 0.80) for the lack of confidence factor and 2.89 (SD = 0.93) for risks, highlighting that the hesitancy of the average person in our sample was driven more by risk perceptions than by lack of confidence in vaccines.

Using regression analysis for the two VHS subscales, the researchers found several variables that were statistically linked to respondents' answers to the clustered 'lack of confidence' and 'risks perception' items. For the first construct, those aged 50–59 year old showed lower lack of confidence than those aged 20–29 year old. People in rural areas showed higher lack of confidence compared to those from urban areas. Women were more confident than men and, as compared to those without children, parents with children aged >20 years were also less confident. There was no significant association between lack of confidence and employment, education, socio-economic status, health state or optimistic or pessimistic expectations for the future. Regarding the second construct, aversion to the risks of side effects, as compared to those without children, people with young children showed greater aversion to risks. The same can be said for those who were optimistic about their future versus more pessimistic individuals.

CONCLUSIONS

This study found that a a substantial percentage of the British population is vaccine hesitant, these views are not clustered in typical demographic features.

Implications for practice: The important similarities and differences across the different age categories provide evidence of the focus areas needed for education initiatives to increase vaccine uptake levels in populations

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2. Is there an association between periodontitis and severity of COVID-19 infection?

Most patients with COVID-19 infection usually present with mild symptoms with approximately 14% of confirmed cases developing severe conditions requiring hospitalization and oxygen support, 5% needing admission to intensive care units and around 2% dying.[1] Severe cases are usually complicated by acute respiratory distress syndrome (ARDS), sepsis and septic shock, leading to multi-organ damage and these patients usually have excessive levels of proinflammatory cytokines and widespread tissue damage; the so-called *cytokine storm syndrome*[1]. In fact, COVID-19 mortality has been associated with elevated serum levels of interleukin-6 (IL-6), C Reactive Protein (CRP), D-dimer and ferritin suggesting a clear link between disease severity and a virally driven non-resolving hyperinflammation.

The chronic inflammation associated with severe periodontitis frequently leads to a low degree systemic inflammation and increased levels of cytokines, such as Tumour Necrosis Factor-α (TNF-α), Interleukin (IL)-1β, IL-4, IL-6 and IL-10, as well as CRP and ferritin.[1]

Even though periodontitis and COVID-19 have both been associated with many common comorbidities, there is no evidence of a possible direct association between these two diseases. Marouf and colleagues (2021)[1] reported on a case–control study that sought to estimate the extent to which periodontitis is associated with COVID-19 complications.

METHODS

This study was based in Qatar and every patient with confirmed COVID-19 diagnosis according to the WHO interim guidelines and two subsequent positive PCR test for SARS-CoV-2 were included in a 6 month period from February 2020 to July 2020 provided they mt the following inclusion criteria: - Adults (≥18 years old) discharged or deceased due to COVID-19 before the study end-date (31 August 2020), and with active dental records, with at least one dental appointment during the year preceding the Pandemic (March 2019 to March 2020). Patients with no dental radiographs in the records were excluded because the presence of periodontitis could not be objectively confirmed. Also, patients under the age of 18 were excluded because they are unlikely to develop neither COVID-19 complications nor periodontitis.

This was a case–control study. Cases were defined as patients with registered COVID-19 complications in their records including death, ICU admissions or need of assisted ventilation due to COVID-19. Controls were defined as COVID patients discharged without major complications. No matching for controls was performed as all controls were included for analysis.

The main exposure variable (periodontitis) and covariates (e.g. demographics, medical conditions), and outcomes of COVID-19 were extracted from the electronic health records of included patients. The periodontal status was studied from posterior bitewings and panoramic radiographs in the patient's electronic records, using a dental software program. Interdental bone loss was measured in the posterior sextants using as reference the cement-enamel junction (CEJ) and the total length of the root. The percentage of bone loss was obtained from the most affected tooth using the criteria from the recent classification of periodontal and peri-implant diseases.[1]

Periodontitis was defined when bone loss was detected at two or more non-adjacent teeth, after excluding local factors related to periodontal-endodontic lesions, cracked and fractured roots, caries, restorative factors and impacted third molars. Due to the low sensitivity of panoramic and/or bite wing radiographs for slight bone crestal changes, patients were categorized as follows:

- Periodontally healthy or initial periodontitis (Stages 0–1): Bone loss less than the coronal third of the root length (15%) in OPGs, or ≤2 mm in bitewing radiographs.
- Periodontitis (Stages 2–4): Bone loss more than the coronal third of the root length (>15%) in OPGs, or >2 mm in bitewing radiographs.

Each radiograph was assessed by two blinded investigators. In case of discrepancy, a third blinded investigator reviewed the radiographs, and the majority diagnosis was considered. Information on demographic (sex and age) and other relevant risk factors associated with COVID-19 complications, such as body mass index (BMI, kg/m2), smoking habits, asthma, other chronic respiratory disease, chronic heart disease, diabetes, dermatitis, chronic liver disease, common autoimmune diseases (rheumatoid arthritis, systemic lupus erythematosus or psoriasis), solid organ transplant, peptic ulcer, immunosuppressive conditions, cancer, chronic kidney disease, hypertension, cerebrovascular accident, peptic ulcer and deep vein thrombosis were obtained from patient records.

BMI was categorized as overweight/obese (BMI ≥ 25) and adequate/underweight (BMI < 25), smoking was categorized as current/past, and never smokers, and diabetes as present or absent. For the other chronic conditions, we created a variable “comorbidity” by computing the presence of each of the above condition. The values of this variable ranged from 0 to 7; we further categorized the variable according to number of comorbidity into 0, 1, and ≥2 because of low numbers in some of the categories. Blood parameters relevant to the course of the disease such as concentrations of D-Dimer, CRP, HbA1c, Vitamin D, white blood cells (WBC) and lymphocytes were also collected from the electronic records. Both the initial parameters measured upon diagnosis as well as the latest parameters measured prior to discharge were collected.

RESULTS

From the 1076 patients identified with COVID-19 diagnosis and active dental records, 443 were excluded due to either lack of dental radiographs or relevant medical

information. Furthermore, 65 patients were excluded for being <18 years of age. A total of 568 COVID-19 positive patients were included for the analysis. Among these, 40 experienced COVID complications (cases) and 528 were discharged without any complications (controls).

There was an equal sex distribution among COVID 19 patients with and without complications. As expected, patients with COVID-19 complications were older (mean 53.5 vs 41.5) and had more comorbidities than those without any complication. Similarly, more than 80% of all patients who had COVID-19 complications had periodontitis compared to only 43% of those without COVID-19 complications.

A total of 197 patients had laboratory records for HbA1c, 177 for Vit-D, 96 for D-Dimer, 394 for lymphocytes, 397 for WBC and 310 for CRP. Assessment of the latest laboratory records revealed that the concentrations of D-dimer, WBC and CRP were significantly higher in COVID-19-deceased patients when compared with surviving patients. On the other hand, the concentrations of lymphocytes were significantly lower in the deceased patients. Patients admitted to the ICU as well as patients requiring assisted ventilation also had significantly higher D-dimer, WBC and CRP serum levels than patients that did not enter the ICU or those that did not require assisted ventilation, respectively.

Out of the 568 patients included in our study, a 258 presented periodontitis. Among the patients who presented periodontitis, 33 experienced complications, while only 7 of the 310 patients without periodontitis presented COVID-19 complications. The risk of having COVID-19 complications among patients with periodontitis was OR 6.34 (95% CI 2.79–14.61) for any complications, OR 17.5 (95% CI 2.27–134.8) for death, OR 5.57 (95% CI 2.40–12.9) for ICU admission and OR 7.31 (95% CI 2.21–26.3) for need for assisted ventilation. After adjusting for possible confounders such as age, sex, smoking behaviour and comorbidities, the multivariable analysis showed an adjusted OR of 3.67 (95% CI 1.46–9.27) for all COVID-19 complications, 8.81 (95% CI 1.00–77.7) for death, 3.54 (95% CI 1.39–9.05) for ICU admission and 4.57 (95% CI 1.19–17.4) for need of assisted ventilation.

The association between periodontal status and the surrogate laboratory biomarkers studied (HbA1c, WBC and CRP blood levels) were significantly higher in COVID-19 patients with periodontal disease than in those without periodontal disease.

CONCLUSION

Periodontitis was significantly associated with a higher risk of complications from COVID-19, including ICU admission, need for assisted ventilation and death and increased blood levels of markers linked worse COVID-19 outcome such as D-dimer, WBC and CRP.

Implications for practice: This paper provides further evidence of the link between poor oral health and negative general health outcomes for major diseases or infections that affect other parts of the body.

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C Smit[1], A Uys[2]

HYPERPNEUMATISATION OF THE SKULL BONES

CASE

A healthy,12-year-old female patient, presented with an anterior open bite requesting orthodontic treatment. A panoramic radiograph was requested for treatment planning (Figure 1). An incidental finding of well-defined multilocular radiolucencies were detected superimposed over the right ramus and middle cranial fossa region. The patient was asymptomatic with no clinical signs of facial asymmetry. A cone-beam computerised tomography (CBCT) scan was requested to exclude any occult pathology (Figure 2).

Figure 1. Panoramic radiograph

INTERPRETATION

The CBCT images showed multiple air-filled spaces that are continuous with the mastoid air cells, affecting the temporal and sphenoidal bones (Figure 2 A-D). The airspaces were limited to the right side and were associated with areas of mild expansion, best visualised in the lateral and medial pterygoid plates (Figure 2C). Pneumatisation is the process of airspace formation within the bones of the cranium. Pneumatisation or enlargement of the paranasal sinuses, as well as the extension of mastoid air cells anteriorly to involve the temporomandibular joint complex, are commonly reported.[1] However hyperpneumatisation involving the temporal, occipital and parietal bones are rare with a reported prevalence of 0.0003%.[2,3] The aetiology is due to a combination of congenital and environmental factors, including increased pressure within the middle ear.[3]

These entities are often asymptomatic with infrequent reports of tinnitus or headaches. Radiologically they present with a multilocular/ honeycomb appearance with minimal expansion. Recognition of this entity is important as the structural integrity of the bone is affected with an increased risk of fracture after minor trauma.[2] Additionally, it should be differentiated from other pathological entities such as aneurysmal bone cysts or intrabony vascular malformations.

Valsalva manoeuvres in an attempt to relieve the tinnitus are discouraged in these patients as this can lead to damage to the tympanic membrane.[3] Placement of pressure-equalisation tubes can assist in the alleviation of symptoms.[3]

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C Smit: 70%
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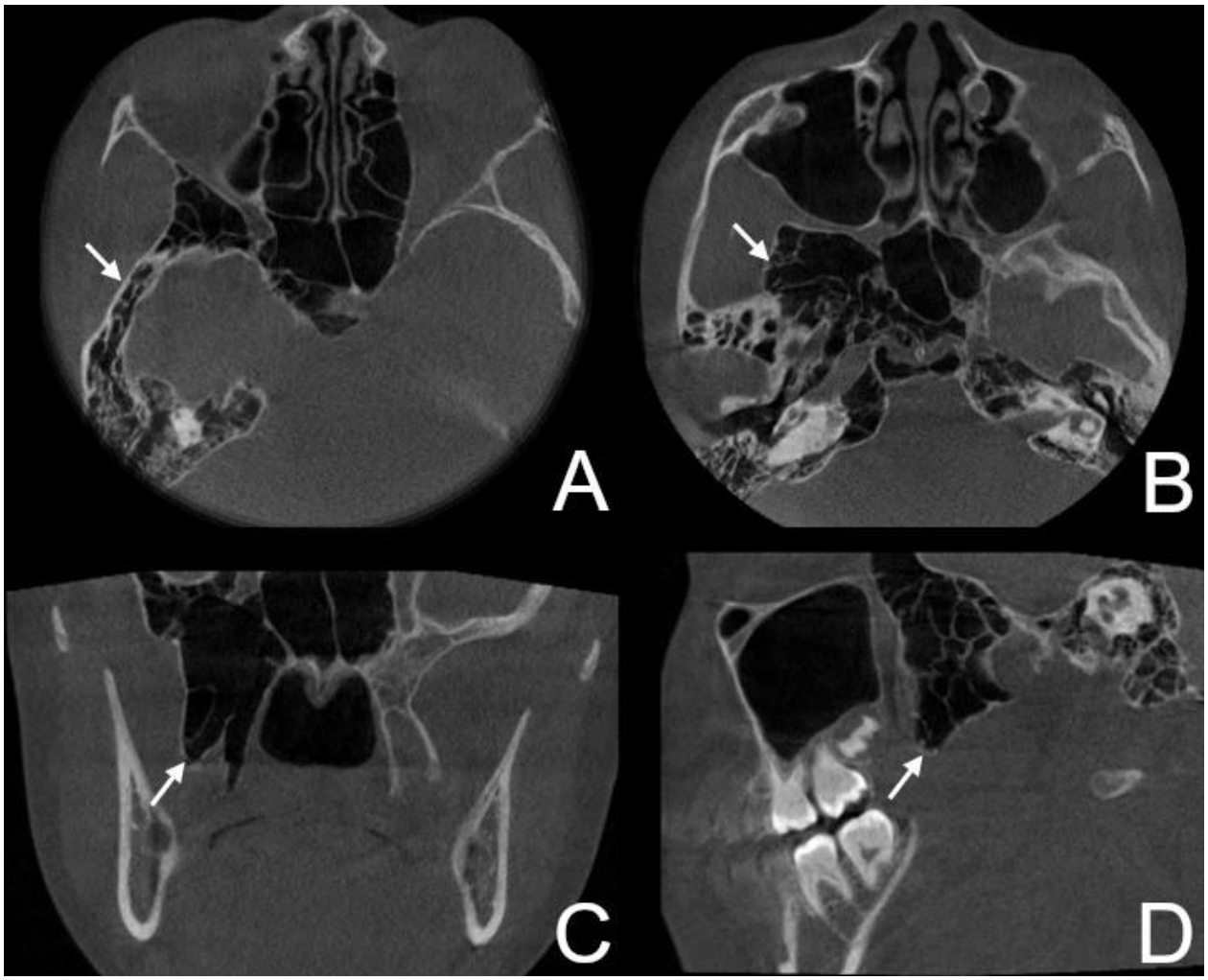
Figure 2. (A,B) Axial, (C) coronal and (D) sagittal CBCT images



Cone beam computed tomography is an accessible modality which can be used for detailed assessment and measurement of air space volumes and surgical planning in these cases.

Authors declaration

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Conflict of Interest: The authors declare that they have no conflict of interest.

Ethics approval: This study was approved by the University of Pretoria, Faculty of Health Sciences Research Ethics Committee (Reference no.: 423/2021). All procedures followed the ethical standards of the Helsinki Declaration of 1975, as revised in 2008.

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CPD questionnaire on page 43

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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Survivorship bias and its implications in dental research and literature

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ABSTRACT

What does the Texan sharpshooter, the World War 2 American air force, The Taj Mahal, cherry farming, and dentistry have in common? They have all been the subject of Survivorship bias. This paper will discuss the concept of survivorship bias in research by using examples of flaws in study designs or interpretation of data. It aims to serve as a caution to practitioners of the need to be aware and critical when reading literature and manufacturers' reports before making decisions regarding materials choices and treatment protocols to follow.

BACKGROUND

New developments in the field of dental materials and techniques have always, and continue to advance at an incredibly fast rate. In keeping with this, both manufacturers and clinicians need to play a part in monitoring the latest products to assess their laboratory and clinical performance, durability, and longevity. These characteristics then need to be compared to those currently in use before one can be replaced with the other. The literature is replete with studies investigating success rates and survival rates of different materials, components, and procedures. However, a recurring problem with comparative studies is the lack of standardization in experimental design, measurements, and scoring criteria. Numerous authors have published papers on standardized guides to utilise when assessing clinical success and survival, most notably in the field of dental implantology. These were developed to help formulate a way of making quantitative and qualitative comparisons that could be substantiated with statistical evidence. This paper will present a brief description and definition of common terms and calculations used in success and survival studies. It will then illustrate examples of inherent flaws in study designs or interpretation of data. This aims to caution practitioners of the need to be particularly critical when reading literature and manufacturers' reports.

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Literature review

1. Success, Survival, and Failure

In restorative material studies different criteria, definitions and types of statistics may be used for reporting on performance. Some papers refer to percent success and percent survival.[1] In these Success is taken as the "number of restorations that survive without any adverse effects", while Survival relates to "the number of restorations that survive even though they may have exhibited some form of damage which has not adversely affected their function or aesthetics".[1,2] Others report on success and survival in terms of probabilities over set periods. They generally consider restorations and prostheses as a success if they have performed as expected for 5 or more years. Success and survival have at times been combined into one definition as "the intact survival of a prosthesis with acceptable surface quality, anatomical contour and function, and where applicable, with acceptable aesthetics".[2]

Restorations would be considered **Failures** if they "had to be replaced during this time for reasons such as secondary caries, irreversible pulpitis, excessive wear of opposing tooth surfaces, excessive erosion and roughening of their surface, ditching of the cement margin, unacceptable aesthetics, cracking, chipping, fracture or bulk fracture".[2] However, there is no standardization in the criteria used to measure these indicators or the parameters reported across different studies or with differing materials. For example are repairable fractures considered failures or technical complications? And should data collection and reporting encompass clinical prosthesis failures, technical complications, and biological side effects?[1] In addition, there needs to be a clear distinction between in vitro studies and data and those from clinical performance studies.

In implant dentistry, a whole gamut of different benchmarks has been postulated for determining implant as well as restoration success and survival. Not only do these indices differ between researchers, specialties, and implant companies, but the measures are constantly being revised to account for extraneous factors such as patient profiles, surgical techniques used, occlusal considerations, implant design, and newer consensus opinions. This makes the comparisons of results on implant success rates far more complex and adds to the difficulty many clinicians have when deciding on which is the best to use for each specific patient.[3]

To further illustrate these difficulties consider how the parameters used for assessing implants changed within the first ten years of reporting. The first set of implant success criteria were developed by a group of experts in 1979.[4] The standards included that "the implant should display mobility less than 1mm in any direction; there should be no bone loss

larger than one third of the vertical height of the bone; there should be no symptoms, infection, nor damage to adjacent teeth; there should be no paraesthesia and no damage to the mandibular canal, maxillary sinus, as well as the nasal floor; and that the implant should function in the patient's mouth for five years in seventy-five percent of all patients".[4] In 1982, the criteria was expanded upon to include that implants "must have been present in the oral cavity for sixty months or more; that there should be a definitive lack of mobility; there should be no evidence of radiolucency on the radiograph in the cervical region of implants; the implant should be free of haemorrhage; the patient should display no pain or percussion sensitivity from the implant; and intraorally, there should be no pericervical granulomatosis, gingival hyperplasia, or widening of the peri-implant space on the radiograph".[5] In 1984, additional success criteria were then added as "subjective and objective indices".[6] "The subjective measures included proper function, absence of discomfort and/or pain, and the patients' belief that the implant had resulted in improvement of their aesthetics, as well as their emotional and psychological attitude". The objective criteria "included good occlusal balance and vertical dimension, maintenance of healthy collagenous tissue, and no polymorphonuclear infiltration".[7]

2. Accuracy, Precision, Validity, and Reliability

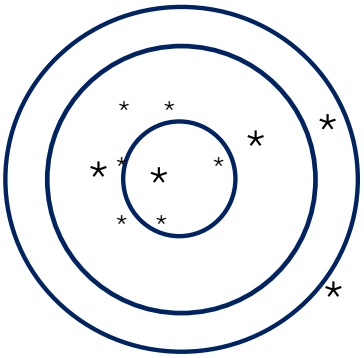
- Accuracy is an indicator of how close measurements are to the true value
- Precision refers to the degree to which repeated measurements will produce the same result. It also relates to how close repeated measurements are to each other
- Validity shows how appropriate and adequate a test is for that specific purpose, as well as how correctly the results have been interpreted and subsequently used.
- Reliability is a measure of consistency and shows the degree to which a method produces the same results when used at different times, under different circumstances, by the same or other observers.

Both accuracy and precision will affect validity and reliability (Figure 1).[8]

3. Survivorship bias

The Texan Sharpshooter Fallacy is a fictional story that was used to illustrate how misconceptions and false conclusions can arise when differences in data are ignored, while similarities are overemphasized. It relates to a human cognitive phenomenon called the "clustering illusion" where the observer interprets patterns when none exist. Legend has it a Texan fired a series of gunshots at the side of a barn. He then looked for the area where the most holes were clustered and drew a target around these, thus creating the false impression that he was an accurate sharpshooter.

Figure 2. Illustration of The Texan Sharpshooter Fallacy

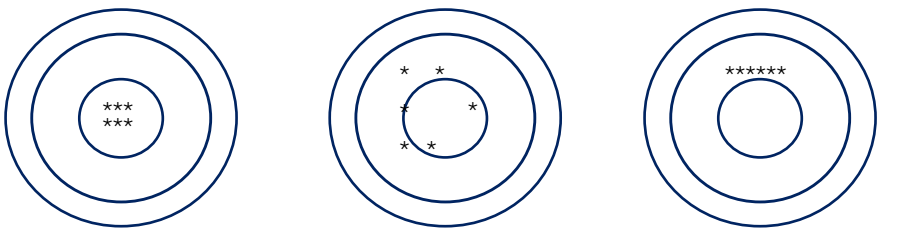


Another famous example of survivorship bias dates back to World War 2. At the time, the American military asked mathematician Abraham Wald to study how best to protect airplanes from being shot down. The military knew that extra armour would help, but it couldn't be used to protect the whole plane as this would make the aircraft far too heavy to fly. Initially, they planned to examine the planes returning from combat, and see where they were worst hit, and then reinforce these areas. They identified the wings, around the tail gunner, and down the center of the body as the worst-hit zones and proposed to reinforce these areas (Figure 3).

But Wald realized they had fallen prey to survivorship bias because their analysis was missing a valuable part of the picture: the planes that were hit but that hadn't made it back. He reasoned that the returning planes surviving the bullet holes they were looking at actually indicated areas that could be hit and still allow the planes to keep flying, whereas those that didn't return must have been hit in "critical" areas. As a result, the military was planning to armour the wrong parts of the planes, the exact areas that didn't need reinforcing.[9]

A type of survivorship bias that can be seen in civil and urban architecture and construction is called "selection bias". This involves the selection of individuals or data in such a way that proper randomisation is not achieved, and the sample is not a true representation of the entire population. For example, commercial development entails that buildings are constantly being torn down and replaced with new structures that may have more modern designs, make better use of the space available, use stronger, more durable, or cost-effective materials, and have improved ergonomics and functionality. Only the most popular, or presumed beautiful, historic buildings

Figure 1. Accuracy versus Precision (Reproduced from Sykes et al.[8])

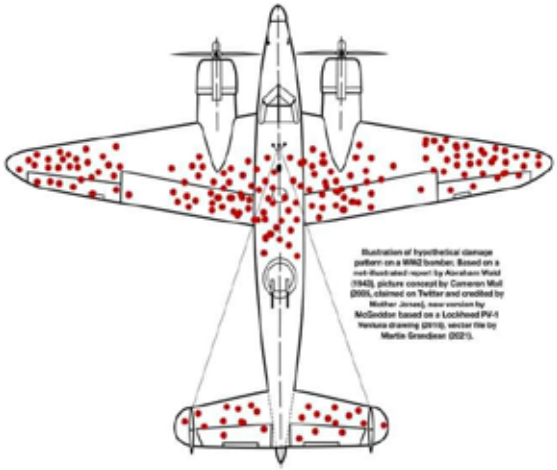


1a. Accurate & Precise
Validity +++
Reliability +++

1b. Not accurate & Not precise
Validity +
Reliability +

1c. Precise but not accurate
Validity +
Reliability +++

Figure 3. American World War 2 aircraft (Reproduced from Mangel and Samaniego al.[9])



tend to be preserved and as such will survive from one generation to the next. Generally, the ugliest and weakest erections tend to have been demolished creating the erroneous impression that all old buildings were more beautiful and better built than modern structures.

Agriculture too has been the victim of "the fallacy of incomplete evidence" or "suppression of evidence". It occurs where only data that conforms to a certain standard or position is considered, while that which does not adhere to these criteria is ignored. For example, one presumes that cherry pickers will only select the ripest and healthiest fruits to send to market. An observer will see their load and erroneously conclude that most of the tree's fruit is likewise as good. This gives them false impressions of the overall quality of all the fruit as they see a mere "snapshot" of the best. (NB do not confuse this with cherry-picking which refers to selecting the most easily accessible fruit/data and ignoring that higher up / more difficult to reach)

Discussion of potential survivorship bias in dentistry

Bias is a systematic error in the design (selection bias) or methodology (information bias) of the study, leading to inacuracies in data or outcomes.[10] Many clinical decisions are based on studies that use success and survival parameters similar to those defined in this paper for dental materials and implantology. However, following the illustrations of survivorship bias, it may be interesting to re-look at both our current clinical practices as well as the literature on which these are based, and scrutinise the data for evidence of these types of errors. Treatment decisions based on clinical experience may be flawed in that happy patients tend to return for follow-up visits, while those who have had complications or treatment failures will often go to a different practitioner. Thus you may never be aware of what went wrong or seek answers as to why, and adjust your practices accordingly in the future. Erroneous conclusions can also be drawn from studies that do not compare "like-with-like" components, procedures, patient profiles, periods, surgical experience, occlusion, or any number of other dissimilar influences. Studies that do not take into account the outliers, or the "lost to follow-up" cases may miss out on valuable evidence, which could contradict the data collected and analysed. Similarly, those that only look at successes and survival rates, or complications associated with the survivors, may never be aware of the number and types of failures. The use of Kaplan–Meier mathematics in statistical analyses is another factor that may have added to survivorship bias. The Kaplan-Meier statistics measures the estimated cumulative survival of a prostheses over time. It looks at a specific time interval and measures the number of failed and at risk prosthesis during this period. The problem with this tool is that the failure number is expressed as a numerator in the equation, but if a failure is not reported (for example if a patient does not return), it will not be registered as a loss and the estimated cumulative survival stays high.[11] Furthermore, in vitro and animal studies have limited use if they cannot mimic the exact human oral conditions where the entity under investigation will need to perform.

A slightly different, but equally relevant issue to consider when measuring success, is the objective versus the subjective judgment. What the clinician (and literature) deem to be successful in terms of objective outcome measures, may not be the same as the patients' opinions. If a seemingly perfect restoration does not meet the patient's expectations in terms of function, aesthetics, or comfort, should it be considered a success or a failure? And who decides?

CONCLUSIONS

In dentistry, we may make crucial errors in judgment if we base our clinical practice on research or observations of the survivors, the procedures that outperform others, or those things we deem to be successful. Conclusions based only on the successful attributes, without looking more broadly at the whole dataset, including the failures, will constitute survivorship bias. This may blind the dentist to their faults leading to oblivious repetition of the error. While it may be a hard and humbling exercise, clinicians and researchers need to be conscious and courageous enough to scrutinise their failures. They must ask themselves why something didn't work, discuss possible reasons with colleagues or manufacturers, learn from their mistakes, and most importantly share this knowledge with others. This is how real progress is made, and how we avoid survivorship bias.

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GENERAL

Frozen sections in head and neck surgery and the impact of intraoperative analysis on final resection margins: An institutional study

1. Select the CORRECT option. Key information required before performing a frozen section request include:
   A. Reason(s) for the frozen section request
   B. Date and time of surgery
   C. Preoperative diagnosis
   D. All of the above

2. Choose the CORRECT answer. The most common reason for requesting intraoperative frozen section analysis:
   A. Evaluation of sentinel lymph nodes
   B. Evaluation of surgical margins
   C. Viability of tissue for organ transplant
   D. Tumour classification

3. Which of the following is CORRECT. The following tissue is suitable for frozen section analysis:
   A. Bone
   B. Adipose tissue
   C. Muscle
   D. Cartilage

Association between dental and periodontal conditions with chronic kidney disease: A cross-sectional analysis of urban South Africans

4. Which of the following options is CORRECT. Which kidney function estimating equation was used to classify chronic kidney disease?
   A. Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI)
   B. Modification of Diet in Renal Disease (MDRD)
   C. Cockcroft-Gault
   D. Erythrocyte sedimentation rate

5. Choose the CORRECT answer. Which indicators were used to characterize the dental profile of the study population?
   A. Number of teeth
   B. Presence of edentulism
   C. DMFT index
   D. All of the above

6. Which answer is CORRECT. Which component of the DMFT index contributed the most in the study population?
   A. Decay (D) and Filled (F)
   B. Missing (M)
   C. Filled (F)
   D. Decay (D) and Missing (M)

Centering ability and transportation of three analogous reciprocating shaping instruments after glide path preparation.

7. Select the CORRECT option. Which of the following instrument factors has an effect on preservation of root canal anatomy:
   A. Cross-sectional design of the instrument
   B. Instrument kinematics
   C. NiTi Alloy of the instrument
   D. All of the above

8. Which of the following is CORRECT. EdgeOne Fire (primary) file has the following design features
   A. Fixed taper (D1-D3) of 7%
   B. Non-cutting tip
   C. Made from Gold Wire
   D. Triangular cross section

9. Which statement is CORRECT. This study demonstrated:
   A. A significant difference in transportation values between TWOG and TEF ($p < 0.05$) at midroot level
   B. A significant difference in centering ratios between TWOG and TOFG ($p < 0.05$) at coronal and midroot levels
   C. TEF showed significant lower transportation values and centering ratios than TWOG and TOFG ($p < 0.05$) at apical level
   D. All of the above

10. Select the CORRECT answer. The findings of this study could possibly be contributed to:
    A. The flexibility of Gold/Blue heat-treated instruments
    B. The lower residual angle of the EdgeGlide Path file
    C. Operator skill
    D. Kinematics and Tip size (ISO 19) of EdgeGlide Path file

Forensic Dentistry: Will “selfies” solve the identification crisis in lower socio-economic South Africans

11. Which is the CORRECT answer. Selfies are a useful tool in forensic identification as they are:
    A. Easy to use
    B. Low cost
    C. Easily accessible
    D. All of the above

12. Choose the CORRECT option. The most commonly identified dental feature in the study
    A. Missing teeth
    B. Diastema
    C. Dental jewellery
    D. Difference in tooth height

13. Which of the following statements is CORRECT. In forensic identification when comparing the deceased’s dentition to a selfie image
    A. The selfie image does not need to be correlated with the clinical PM examination

B. Mirror images will not have any influence
C. PM photographs need to be taken at multiple angles for comparison
D. Selfie images cannot be used in forensic identification

14. Select the CORRECT answer. Challenges for the identification of unknown individuals in SA include:
A. A lack of DNA reference samples
B. Absence of medical/ dental records
C. Decomposition and carbonisation of fingerprints
D. All of the above

15. Which of the following options is CORRECT. A study by Mckenna *et al.,* showed that
A. 96 % of participants showed at least one unique dental feature
B. No unique dental features were seen
C. Only a small percentage of their photographs were usable
D. All their photographs showed special attributes

Radiology Corner: Hyperpneumatisation of the skull bones

16. Select the CORRECT answer. A common differential diagnosis of hyperpneumatisation of the skull include;
A. Ameloblastoma
B. Odontogenic myxoma
C. Intra bony vascular malformations
D. Mastoiditis

17. Which option is CORRECT. Hyperpneumatisation is important to recognise due to:
A. It being a neoplastic entity
B. It could result in facial asymmetry
C. Increased susceptibility to fractures
D. It can cause the destruction of surrounding structures

Evidence based dentistry

18. Select the CORRECT answer. In the VHS study, the number of participants that completed the study was:
A. 9613
B. 1950
C. 1546
D. 4144

19. Select the CORRECT definition. In the VHS study, "straightliners" were defined as:
A. Participants with narrow views
B. Participants who selected the same response category for all questions
C. Participants who were negative about all the questions
D. Participants who did not want to take the vaccine

20. Select the CORRECT answer. For the Marouf *et al.,* study, the following factors were not significantly associated with periodontitis among COVID-19 patients:
A. Death
B. ICU admissions
C. The need for assisted ventilation
D. Cardiovascular disease.

Ethics: Survivorship bias

21. Choose the CORRECT answer. Problems with many comparative studies are:
A. Different measuring scores used
B. Different techniques or components used
C. Different researchers doing the studies
D. Both A) and B) above
E. All of the above

22. Which of the following statements is CORRECT. Survival refers to:
A. The number of restorations that survive without any adverse effects
B. The number of restorations that survive but have some damage
C. The number of restorations that survive functionally but have compromised aesthetics
D. The number of restorations that survive longer than 10 years with no damage
E. The number of restorations that survive longer than 5 years with no damage

23. Which of the following options is CORRECT. Failures in terms of restorations would include factors such as:
A. Needing to be replaced within a stipulated time frame
B. Needing to be replaced due to secondary caries
C. Needing to be replaced due to patient dissatisfaction
D. All of the above
E. only A) and B) above

24. Select the CORRECT statement. With regards Accuracy, Precision, Validity, and Reliability in research:
A. If repeat measures are accurate, they will also be precise
B. If repeat measures are accurate, they may not always be valid
C. If repeat measures are precise, they will also be reliable
D. If repeat measures are precise, they will also be accurate
E. If repeat measures are accurate, they may not be precise

25. Which of the following statements is CORRECT. Survivorship bias
A. May occur because the analysis is missing some valuable information
B. May occur if a random sample is used rather than the whole population
C. May occur if the sample is not a true representation of the population
D. Only B) and C) above
E. Only A) and C) above

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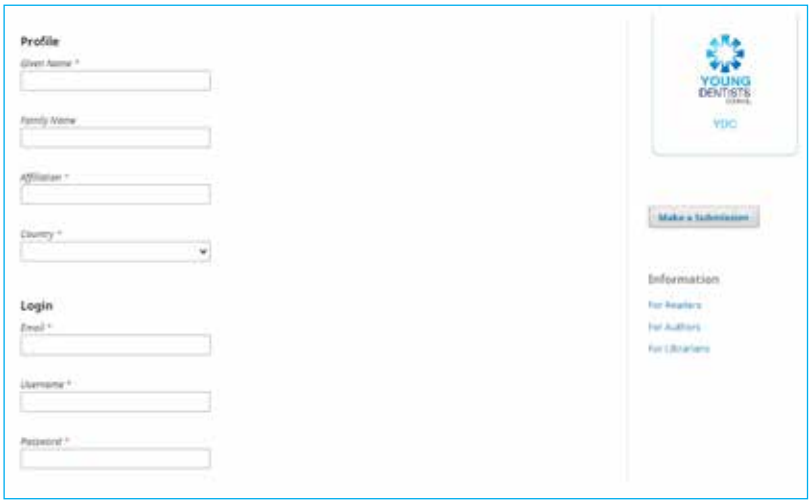

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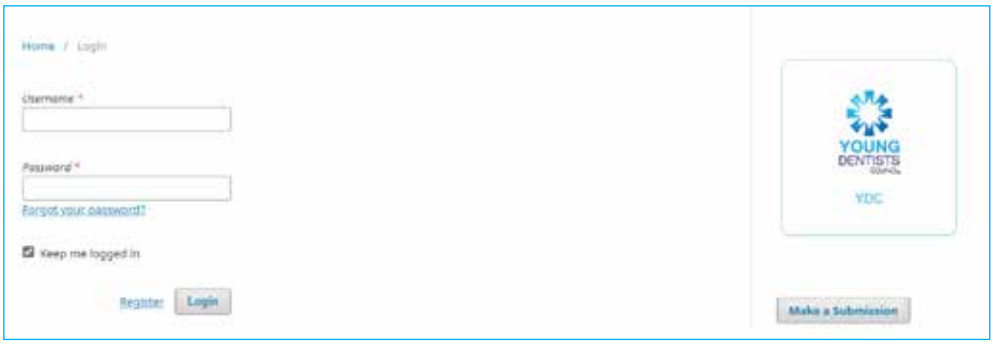

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Have you confirmed the status of your paper in terms of any Conflict of Interest?	☐
Have you submitted the Clearance Certificate number when Ethical permission has been required to undertake research or to publish data?	☐
Does the paper adhere to the format requested in Instructions to Author?	☐
Are the references quoted according to Journal policy, both in the text and in the list of references?	☐
Have all authors signed the Letter of Submission?	☐

Smalls advertising and placement procedure

- All smalls advertisements are restricted to a **maximum 100 words** per advertisement.
- All advertisement requests are required in writing, **submit to abayman@sada.co.za**, with full contact details of the advertiser which should include:
  - the wording of the advertisement as you require it to be published;
  - the members professional number; (will not be published);
  - the members contact details (will not be published).
- Advertisement **lifespan is two weeks** from the date of upload.
- Advertisements to be **repeated follow the same process** as the original placement request.
- All advertisements which **exceed a word count of 100** words will be forwarded to our **publishers E-Doc** for further processing as a potential advertisement to be placed in the SADJ electronically or as website advertising. E-Doc will contact you thereafter regarding your requirements.
- **SADA Members** may place advertisements at no cost providing their annual membership fees are either paid in full at the time of their request of a debit order request has been lodged.
- **Non-SADA Member** advertisers will be charged R25 per word for placement of their advertisements.
- Advertisement must be paid in full prior to uploading on the web platform.
- Invoice may be settled telephonically with the use of a credit card to prevent delay of placement.
- **Telephonically processed** payments will result in uploading of advertisement within **24 hours** of settlement.
- Advertiser remains liable for placement costs should payment be dishonoured and invoice remains unpaid.

Contact details:
Ann Bayman
South African Dental Association
Tel: +27 (0)11 484 5288
Email: marketing@sada.co.za

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THE SOUTH AFRICAN DENTAL ASSOCIATION

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