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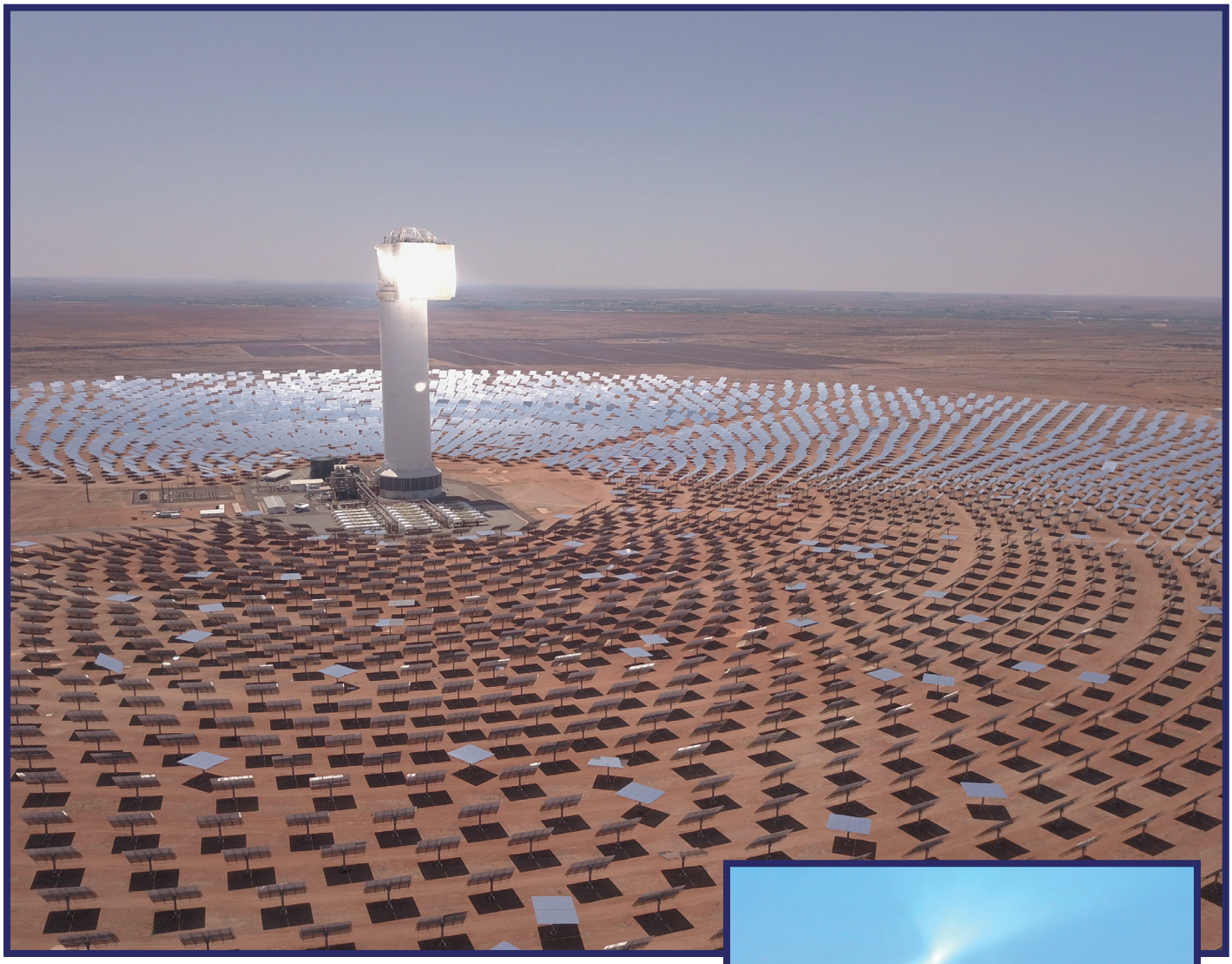

The future of power technology

Khi Solar One (KSO), in Upington in the Northern Cape, is Africa's first concentrated solar power thermal power plant. The solar plant is 140 hectares and produces 50 MW of energy through its Molten Salt Thermal Energy Storage System, reducing the country's carbon dioxide emissions by about 138 000 metric tons per year.

Developed by Spanish company Abengoa and financed by Industrial Development Corporation (IDC) and community group, Khi Community Trust, it is the first tower plant to achieve 24 hours of operation with solar energy only and is part of the Department of Energy's project to bring a combination of wind and solar energy to generate 17 800 MW from renewable energy by 2030.

Commissioned in 2016, the thermal energy storage project uses molten salt as its storage technology. The power station includes a facility to store steam, enabling it to generate electricity for two hours when the sun is not shining, and uses dry cooling, which dramatically reduces water consumption by two thirds.

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AGM
Annual General Meeting

NOTICE OF 23rd ANNUAL GENERAL MEETING (AGM) OF The South African Dental Association NPC (SADA)

Notice is hereby given that the 23rd Annual General Meeting of Members (AGM) of The South African Dental Association (SADA) NPC, will be held on 22 June 2023 at 18h00, which will be held via SADA's Zoom virtual meeting

(Due to the virtual meeting, member participation will be facilitated through the Zoom platform of the meeting. To allow for the confirmation of a quorum, members are kindly requested to join the virtual meeting no later than 17h45 to avoid delaying the meeting). The Agenda with any supporting documents for the meeting will be posted on the SADA website and sent electronically to voting members.

SADA is your Association and your voice counts.

KC Makhubele
Chief Executive Officer
February 2023

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The future of power technology

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The impact of loadshedding on dental practice in South Africa

SADJ February 2023, Vol. 78 No.1 p1

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

The COVID-19 pandemic has had a profound impact on many industries and sectors across the world, and South Africa is no exception. The economic effects of the pandemic have been particularly severe in South Africa. In this context, the recent announcement of sustained, widespread electricity loadshedding in South Africa raises serious concerns about the impact on dentistry within the South African economy.

Loadshedding refers to the deliberate switching off of electricity supply to certain areas in order to prevent widespread blackouts and system failures. This has now become a common practice in South Africa when demand for electricity exceeds supply. While loadshedding can help to prevent widespread blackouts, it also has serious implications for businesses and industries that rely on a continuous electricity supply. Loadshedding can be particularly disruptive to the dental practice. Dental procedures often require the use of specialized equipment, such as dental chairs, lights, and radiographic equipment. These pieces of equipment are designed to work with a constant supply of electricity, and interruptions in the electricity supply can have a significant impact on the quality and safety of dental treatments, with the added potential to damaging the expensive equipment due to power surges when electricity is switched back on.

During a power outage, dental chairs may become inoperable, which can lead to patient discomfort and inconvenience. Radiographic equipment may also become non-functional, which can prevent dentists from taking necessary radiographs that are required for diagnosing and treating oral health problems. Interruptions in the electricity supply can also affect the sterilization of dental instruments, which can increase the risk of infections and cross-contamination.

The impact of loadshedding on dentistry can also have broader economic implications. For example, interruptions in the electricity supply can cause appointments to be rescheduled or cancelled, which can result in a loss of income for dentists and their staff. It can also reduce the overall demand for dental services, as patients may be less likely to seek dental care when they know that loadshedding is likely to occur.

The impact of loadshedding on dentistry can also be compounded by other economic challenges in South Africa, such as high unemployment rates and low levels of disposable income. For example, people with low incomes or who are unemployed may be more likely to put off dental appointments during times of loadshedding, which can lead to more serious oral health problems in the long run.

Despite these challenges, there are steps that dentists and the dental industry can take to mitigate the impact of loadshedding. For example, dental clinics can invest in backup power systems, such as generators, that can provide a constant supply of electricity during outages. Additionally, clinics can take steps to ensure that their equipment and instruments are properly maintained, which can reduce the risk of malfunctions and breakdowns during outages. There is also a growing interest in using technology to improve access to dental care in South Africa, even during times of loadshedding. For example, telemedicine and telehealth services can allow patients to receive dental care from the comfort of their own homes, without the need for a constant supply of electricity. There are also efforts underway to develop new and innovative approaches to dental treatments, such as the use of 3D printing and robotics, which can help to improve the accuracy and efficiency of dental treatments.

I believe that it is our responsibility to raise awareness of the impact of loadshedding on dentistry within the South African economy, and to work together to find solutions. We can do this by encouraging research into these issues and by sharing best practices and success stories. We can also work to improve access to dental care by partnering with organizations that are working to advocate for better infrastructure and policies to support the growth and development of the dental industry, as well as providing education and training to dentists and dental students on how to effectively manage the impact of loadshedding.

In conclusion, while the impact of loadshedding on dentistry in South Africa is a serious concern, it is not an insurmountable challenge. With the right tools and resources, the dental industry can continue to thrive and provide high-quality care to patients, even during difficult economic times. It is my hope that through our collective efforts, we can overcome these challenges and ensure a bright future for dentistry in South Africa.

We present you with the first issue of the 2023 SADJ. We look forward to receiving your continued inputs and support.

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From 2023, SADA Members can purchase amalgam separators at discounted prices

SADJ February 2023, Vol. 78 No.1 p2

Mr KC Makhubele: CEO, SADA

At SADA we constantly and consistently seek ways to add value for the health practitioner and where possible save them money. The following is just but one example of many such actions. With the looming implementation of amalgam handling in South Africa, SADA is pleased to announce that it has entered into a collaboration with Dental Recycling International (DRI), through which SADA members will be eligible to receive a free amalgam separator beginning in November 2022.

Members interested in signing up can do so by signing on to the SADA website with their username and password and then selecting "Order your amalgam separator" from the "Clinical and Legal" menu. The member will then be forwarded to the DRI SA website to fill out an application. Your application will not be complete until we have confirmed your SADA membership. Everything in the list below is part of the deal.

All SADA members who sign a 3–5-year service agreement with DRI will be entitled to the following benefits:

- A FREE amalgam separator unit valued at approximately R17000 with an annual amalgam recycling service
- Special introductory pricing of R6520 per annum if the agreement is signed by 31st December 2023 including amalgam recycling costs and transportation fees for the standard BU10 unit, or R12185 per annum for the BU1030 unit.
- A FREE sustainable development CE course as part of an ongoing development to support members with issues and concerns around future regulatory development, which includes a "how to" guide on SMART amalgam removal i.e., Safe Mercury Amalgam Removal Technique.
- Each year after recycling has been completed, members will receive a certificate of reclamation demonstrating the wastes have been properly recycled.

Instalment fees are the only out-of-pocket expense for members, and those are paid directly to Wright-Milners. The Department of Forestry, Fisheries, and the Environment have not yet confirmed the regulations' effective date, so we recommend that members take the initiative to get their separators well in advance of those days.

CPD questionnaire on page 52

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

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Analysis of the Mental Foramen and Inferior Alveolar Canal pattern based on CBCT data

SADJ February 2023, Vol. 78 No.1 p3-9

N Verma[1], M Kaushik[2], S Elkanti[3], N Mehra[4], A George[5]

ABSTRACT

Introduction

The mental foramen is located in a position where certain dental procedures may cause inadvertent damage to the mental nerve and lead to disorders of sensory functions such as altered sensa¬tion, complete numbness, and neuropathic pain, which are uncommon but severe treatment complications with significant medico-legal implications. Hence thorough knowledge of its anatomical relation to its surrounding structures is critical while undertaking dental procedures.

Aim and objective

To investigate the size, shape, and position of the mental foramen (MF), its distance from adjacent teeth and mandibular borders, and the pattern of the inferior alveolar canal using CBCT in the Indian subpopulation.

Design

This was a retrospective, cross-sectional study

Methods

The study evaluated 310 CBCT scans (179 males, 131 females) in axial, sagittal, and coronal planes. CBCT scans were evaluated, mapped and measured for all the parameters listed above based on age and sex. Data were analyzed using ANOVA, independent't-test, and chi-square test.

Results and Conclusion

The size of MF is independent of age and sex; the most frequent shape of MF was Type III (round); location was below the apex of the second premolar ($p>0.05$). The distance of MF from the nearest root apex decreased with an increase in age and more in females than males ($p>0.05$). Inferior Alveolar Nerve Canal (IAC) pattern was perpendicular, and linear patterns of exit at MF were more common than anterior loops in all age groups.

Keywords

Anterior loop, CBCT, Mental Foramen, Pattern, Position

INTRODUCTION

The inferior alveolar nerve is the largest branch of the mandibular nerve, which traverses via the mandibular canal along with the inferior alveolar artery and terminates into the mental nerve (MN) and incisive nerve. The mental nerve, along with the mental artery and vein, exists through the mental foramen (MF), at the anterolateral surface of the body of the mandible. [2] It provides sensory innervation to the soft tissues of the chin, lower lip, labial mucosa, lower canines, and incisors. [2-5]

The IAN exits at the mental canal (MeC), and splits into the incisive nerve and the MN. The exit path at the MF is seen in three different patterns; linear or straight, perpendicular or vertical, and anterior loop (AL). [6, 7]

The usual location of the MF is between the apices of the first and second premolars or just below the apex of the second premolar.[3, 4] The accurate identification of the MF is essential for diagnostic, clinical, and surgical procedures of the mandible. To untrained eyes, the MF may be mistaken for radiolucent lesions around the apices of the mandibular premolars and lead to misdiagnosis and incorrect interventions.[6] Dental procedures like regional anesthesia, flap elevation, osteotomy,

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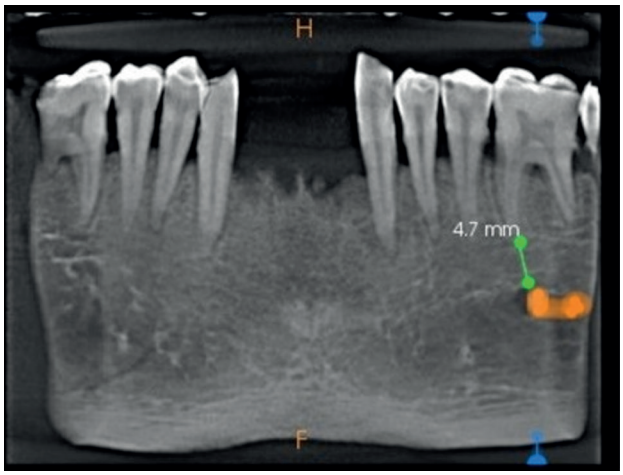

Figure 1 – Sagittal view: Anteroposterior position of MF.

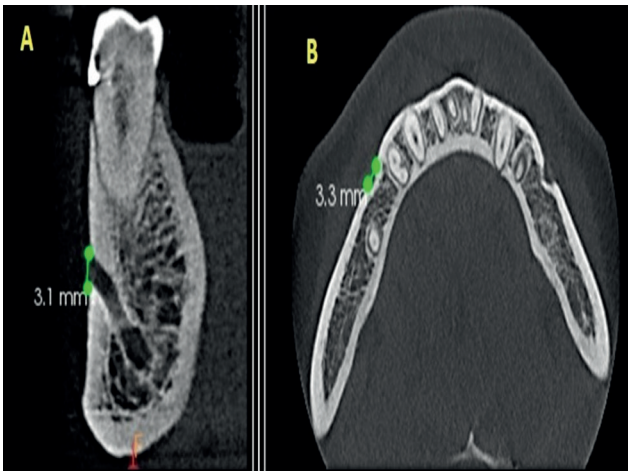

Figure 2 – (A) Coronal view - the vertical [V] diameter and (B) Axial view: horizontal [H] diameter.

insertion of dental implants, surgical removal of roots, teeth, cysts, tumour or orthognathic surgeries, fixation of bone fractures procedures, non-surgical and surgical endodontic procedures require the operator to have thorough knowledge about the MF, the exit pattern of the nerve and its relation to the surrounding area.[2,4,6,8]

Endodontic procedures such as cleaning and shaping may lead to over instrumentation, inadvertent extrusion of medicament, irrigants, or chemicals used for root canal treatment can lead to complications from pain and swelling to mental nerve paraesthesia.[14] Gutta percha though an inert root filling material, can generate paraesthesia due to thermal irritation and nerve compression by overfilling thermoplastic guttapercha.[15]

The mental nerve is a sensory nerve, and because its anatomic location, any invasive procedure performed in this region may damage the neurovascular bundles[2], causing altered sensa¬tion, complete numbness, and even neuropathic pain. These complications interference with speech, eating, drinking, shaving, or make-up applica¬tion and have medico-legal implications.[16]

Therefore, the knowledge of the presence and location of the mental foramen is essential for all dental procedures in the mandibular premolar area. This study aimed to investigate the size, shape, and position of the mental foramen, its distance from adjacent teeth and mandibular borders, and the pattern of the inferior alveolar canal using cone-beam computed tomography (CBCT) data in an Indian subpopulation.

MATERIALS AND METHODS

Exempt status was obtained for the study by the Institutional Review Board (ACDS/IRB/13/JAN/2021). The study was a retrospective analysis, and 402 CBCT scans were retrieved. All the scans were shot at a voxel size of 150µm ×150 µm ×150 µm and exposure settings of and 90 kV, 15 mA, 14s with Care stream C S 8100 (CS 3D version suite 3.10.8.0) (Care Stream Dental LLC, Atlanta, GA). The scan centre takes a blanket consent from all patients to use their data for scientific purposes.

Inclusion criteria for the CBCT scans were: South Indian ethnicity (verified by surname), visibility of MF, presence of permanent mandibular premolars and first mandibular molars, age group 20 years or more, lack of lesion in the apical area of premolars, and MF, and lack of bone resorption. Exclusion criteria: patients under 20 years, with mixed dentition, supernumerary teeth in the mental foramen region, and CBCT scans with poor film quality, errors, and artifacts concealing visibility of structures in the mandible.

As this is an observational study, from a CBCT center in Secunderabad, where the ethnicity of the paients is South Indian. The sample size determined was based on previous studies.[2, 6]

All the scans were assessed for eligibility against selection criteria by a single observer to reduce bias. A total of 310 scans fulfilling the inclusion and exclusion criteria were included in the study and categorized into three age groups 20-45 years, 46-60 years, and more than 60 years.

The CBCT scans were screened in sagittal, coronal, and axial views, and various measurements and observations were recorded.

In the sagittal view (Figure 1), the anteroposterior position of MF was recorded as the following (Tebo and Telford:

(a) Below 1st premolar
(b) Between 1st and 2nd premolar
(c) Below 2nd premolar
(d) Between 2nd premolar and 1st molar
(e) Below 1st molar

The distance between the superior margin of MF and the root apex of the nearest tooth (either premolar or mesial root of the mandibular first molar) was measured and recorded.

In the coronal view and axial view (Figure 2), the vertical [V] and horizontal [H] diameters of the MF were determined, respectively. The ratio (H: V) was used to classify the form of MF into three types based on previous studies [2, 12, 13 -]

1. Oval horizontal form (Type I, H: V > 1.24)
2. Oval vertical form (Type II, H: V < 0.76)
3. Round form (Type III, when 0.76 ≤ H: V ≥ 1.24)

The distance from the superior margin of MF to the cementoenamel junction (CEJ) and distance from the inferior margin of MF to the lower border of the mandible was measured in the coronal view (Figure 3).

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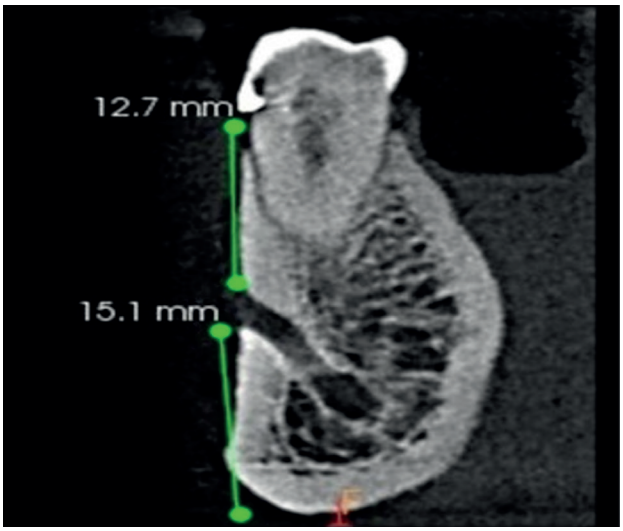

Figure 3 - Distance from the superior margin of MF to the cementoenamel junction (CEJ) and distance from the inferior margin of MF to the lower border of the mandible.

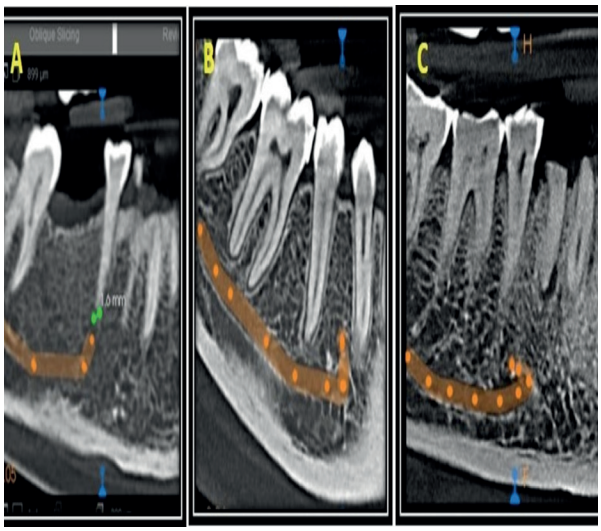

Figure 4 - Inferior alveolar canal patterns: (A) Linear pattern (B) Perpendicular pattern (C) Anterior Loop.

The inferior alveolar nerve canal (IAC) is classified based on its exit path into three patterns: linear, perpendicular, and anterior loop (Figure 4). The linear or straight pattern with the mental canal (MeC) shows a slight curve opening directly through the mental foramen.7 The perpendicular or vertical patterns with the mental canal bends (MeC) perpendicularly to the mental foramen.[8] The anterior loop is an extension of the inferior alveolar nerve, anterior to the mental foramen, before exiting the canal, traversing inferiorly and anteriorly to it. [9-11]

All the data was tabulated and recorded in an excel sheet (MS Office 2010).

STATISTICAL ANALYSIS

The data were subjected to analysis using Statistical Package for the Social Sciences (SPSS-20.0) software package (IBM, Chicago, USA). Results showing p< 0.05 as statistically significant.

One-way ANOVA test and Independent t-test were applied to compare the mental foramen size, the distance of MF from the nearest root apex, and distance from the lower mandibular border with age and sex. A Chi-square test was applied to compare the mental foramen type (based on its shape), the position of the mental foramen, and the prevalence of the Inferior Alveolar Canal pattern.

RESULTS

Descriptive analysis of the demographic data revealed the study participants as 179 male and 131 female. The distribution consisted of ages 20- 45 years, 46-60 years, and more than 60 years, with 228, 62, and 20 scans, respectively.

The size of the mental foramen in terms of its horizontal and vertical diameter varied with different age groups and sex. One-way ANOVA test and independent 't-test showed no significant differences (p>0.05) in values of the horizontal and vertical diameters as well as the H: V ratio (Table I) on both sides with the age and sex of participants. The shape of the MF was Type III (round) irrespective of age and sex (Table II).

The most common position of mental foramen apropos the adjacent teeth on the left and right side of the mandible was found to be below the second premolar irrespective of age and sex. (p>0.05) (Table III and Table IV).

Table I: Comparison of Mental Foramen size based on Age and sex

Sub-group		Left Side			Right Side		
		Mean ± SD Horizontal Diameter (mm)	Mean ± SD Vertical Diameter (mm)	Mean ± SD H:V	Mean ± SD Horizontal Diameter (mm)	Mean ± SD Vertical Diameter (mm)	Mean ± SD H:V
Age (in years)	20-45	2.61 ± 0.53	2.72 ± 0.56	0.98 ± 0.17	2.61 ± 0.52	2.75 ± 0.52	0.97 ± 0.21
	46-60	2.46 ± 0.45	2.62 ± 0.60	0.96 ± 0.16	2.73 ± 0.60	2.75 ± 0.46	1.01 ± 0.26
	>60	2.56 ± 0.43	2.52 ± 0.49	1.03 ± 0.17	2.61 ± 0.43	2.81 ± 0.43	0.94 ± 0.14
	p value	0.140	0.185	0.275	0.267	0.882	0.280
sex	Male	2.56 ± 0.50	2.69 ± 0.57	0.97 ± 0.17	2.65 ± 0.56	2.78 ± 0.51	0.97 ± 0.23
	Female	2.60 ± 0.53	2.69 ± 0.57	0.99 ± 0.17	2.61 ± 0.49	2.71 ± 0.49	0.98 ± 0.20
	p value	0.505	0.955	0.465	0.554	0.189	0.610

One way ANOVA test; Independent samples t test

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Table II: Comparison of Mental Foramen type in the studied subjects

		Left Side			Right Side		
		I Oval horizontal form n (%)	II Oval vertical form n (%)	III Round n (%)	I Oval horizontal form n (%)	II Oval vertical form n (%)	III Round n (%)
Age	**20-45**	9 (3.9)	34 (14.9)	185 (81.1)	10 (4.4)	39 (17.1)	179 (78.5)
	46-60	2 (3.2)	10 (16.1)	50 (80.6)	2 (3.2)	8 (12.9)	52 (83.9)
	>60	2 (10.0)	1 (5.0)	17 (85.0)	0 (0.0)	2 (10.0)	18 (90.0)
	p value	0.525	0.659				
sex	**Male**	7 (3.9)	26 (14.5)	146 (81.6)	7 (3.9)	31 (17.3)	141 (78.8)
	Female	6 (4.6)	19 (14.5)	106 (80.9)	5 (3.8)	18 (13.7)	108 (82.4)
	p value	0.958			0.690		

One way ANOVA test; Independent samples t test; p> 0.05 (not significant)

The distance of MF from CEJ with side or sex did not significantly differ. However, its distance to the lower border of the mandibular showed a statistically significant difference on the right side concerning age (p< 0.05 and sex r (p<0.05) (Table V). The distance of MF from adjacent teeth decreased with age and more in females than males, the results were marginally different (p>0.05).

The most commonly observed IAC pattern was perpendicular in the age group 20-45 years, linear in 46-60 years, and for the age group >60 years, linear on the left side and perpendicular on the right side.

The anterior loop pattern was the least prevalent. These results were significant on the left side regarding age (p-value <0.05). Based on sex, the most common pattern in males and females on both sides was perpendicular, followed by a linear pattern with no statistically significant difference (Table VI).

DISCUSSION

The accurate identification of the MF is essential for diagnostic, clinical, and surgical procedures of the mandible. The analysis of the mental foramen and inferior alveolar canal can be done using techniques like manual palpation, direct visualization during surgery, cadaveric dissection, panoramic radiographs, periapical radiographs, magnetic resonance imaging (MRI), computed tomography (CT), ultrasound, and cone-beam computed tomography (CBCT). 17 Most techniques have limitations such as accuracy, cost, radiation exposure, and magnification.[2]

High-resolution CBCT is a promising and accurate technology for quantitatively determining the position of MF and the presence of AL. CBCT has the advantage of providing high-quality three-dimensional images without distortion and serves with a precise evaluation of the anatomical variations at much lesser radiation exposure than CT.9 For evaluation of the MF's location, size, and shape, a CBCT gives accurate estimates compared to an Orthopantogram.

In the present study, mental foramen has been studied in terms of its size, shape, position, distance from adjacent teeth and mandibular borders, and pattern of the inferior alveolar canal using CBCT. A lot of research is focussed on reading the MF and its relation to its size, anatomical position and IAN exit.[2,3,4,6,7,9]

However, this study is the first one to study the MF on CBCT and read the exit pattern; in the Indian Subpopulation (South Indian).

Horizontal diameter and vertical diameter values on the right side were higher in males as compared to the values observed in females. There was a marginal difference difference in the size of the MF with age and sex on both the left and right sides. These results are consistent with those found by Ewa Zmyslowska-Polakowska *et al.,*[2]

Table III: Position of Mental Foramen w.r.t. Age and sex on left side

		Left Side						
		Below apex of 1st premolar (n)	Between 1st and 2nd premolar (n)	Below apex of 2nd premolar (n)	Between 1st molar and 2nd premolar (n)	Below apex of 1st molar (n)	Total	p value
Age (in years)	**20-45**	6 (2.6%)	55 (24.1%)	147 (64.5)	11 (4.8)	9 (3.9)	228 (100)	0.525
	46-60	0 (0.0)	14 (22.6)	40 (64.5)	6 (9.7)	2 (3.2)	62 (100)	
	>60	0 (0.0)	4 (20.0)	20 (80.0)	0 (0.0)	0 (0.0)	20 (100)	
sex	**Male**	4 (2.2)	35 (19.6)	123 (68.7)	8 (4.5)	9 (5.0)	179 (100)	0.128
	Female	2 (1.5)	38 (29.0)	80 (61.1)	9 (6.9)	2 (1.5)	131 (100)	

Chi-square test, p>0.05 (not significant)

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Table IV: Position of Mental Foramen w.r.t. Age and sex on right side

		Right Side						
		Below apex of 1st premolar (n)	Between 1st and 2nd premolar (n)	Below apex of 2nd premolar (n)	Between 1st molar and 2nd premolar (n)	Below apex of 1st molar (n)	Total	p value
Age (in years)	20-45	8 (3.5)	43 (18.9)	156 (68.4)	2 (0.9)	2 (0.9)	228 (100)	0.618
	46-60	1 (1.6)	8 (12.9)	47 (75.8)	6 (9.7)	0 (0.0)	62 (100)	
	>60	1 (5.0)	6 (30.0)	13 (65.0)	0 (0.0)	0 (0.0)	20 (100)	
sex	Male	7 (3.9)	34 (19.0)	124 (69.3)	12 (6.7)	2 (1.1)	179 (100)	0.534
	Female	3 (2.3)	23 (17.6)	92 (70.3)	13 (9.9)	0 (0.0)	131 (100)	

Chi-square test, p>0.05 (not significant)

The value obtained by evaluating the ratio of the two diameters, i.e., horizontal diameter and vertical diameter, was helpful in the assessment of the shape of MF. The most frequent shape was a round shape (Type III), and the least was an oval horizontal (Type I). This was in contrast to the study by Ewa Zmyslowska-Polakowska *et al.,* in the Polish population, where oval horizontal (Type I) was most frequent,[2] and the study by Gershenson on dry mandibles, where the elliptical shape was more frequent.[5]

The results were similar to the CBCT studies reported by Shankar *et al.,* Sekerci *et al.,* and Alam *et al.,* in the Indian, Turkish, and Arabic populations, respectively.[18-20]
Hence, the size and shape of the mental foramen vary among different populations.

The MF was located below the apex of the second premolar, followed by between the first and second premolar. These results were similar to the studies carried out by Ewa Zmyslowska-Polakowska *et al.,* H. Mahlawy *et al.*, Von Arx *et al.,*[2,6,21]

No significant difference was found between the distance between the MF and the apex of the nearest adjacent tooth with age and sex; however, the distance was slightly more on the left side in both males and females.

Distance from the mandibular lower border on the right side is maximum for age group>60 years, followed by 46-60 years, and the least for 20-45 years age group; the difference among these three groups was significant (p-value 0.018). This could be because there is resorption of alveolar bone with age, which places the MF near the superior border of the mandible.[5]

In severe cases of resorption, the MF, and the adjacent part of the mandibular canal are open at the superior margin of the body of the mandible.[22]

Distance from the mandibular lower border on the right side was significantly more in males than females (p-value 0.032). This difference in sex can be due to the lower development rate and bone growth of the craniofacial skeleton in females compared to males, which is governed by sexual hormones and local factors like masticatory forces and muscles, resulting in lesser bone deposition along the basal bone of the mandible. The result was similar to a study conducted by Rani *et al.,*[23] There is no explanation for this observation, however, we did not read the presence or absence of teeth. A study by Pramstraller M Et.al has suggested that mandibular asymmetry as partially edentulous cases could result in resorption of alveolar bone more on one side and display a difference in the distance from the lower border. [24]

The IAC pattern is categorized into linear, perpendicular, and anterior loop patterns. Identifying the anterior loop is essential for preventing neurosensory alterations during various surgical procedures in the MF region.

Table V: Comparison of distance of MF from nearest root apex, CEJ and mandibular lower border based on Age and sex

		Left Side			Right Side		
		Mean ± SD Distance from nearest root apex (mm)	Mean ± SD Distance from CEJ (mm)	Mean ± SD Distance from mandibular lower border (mm)	Mean ± SD Distance from nearest root apex (mm)	Mean ± SD Distance from CEJ (mm)	Mean ± SD Distance from mandibular lower border (mm)
Age (in years)	20-45	2.81 ± 0.78	11.83 ± 2.04	12.20 ± 1.33	2.73 ± 0.79	11.64 ± 1.87	12.07 ± 1.33
	46-60	2.77 ± 0.90	11.53 ± 1.86	12.24 ± 1.43	2.67 ± 0.88	11.97 ± 1.93	12.47 ± 1.62
	>60	2.52 ± 0.74	12.35 ± 1.83	12.03 ± 1.50	2.80 ± 0.75	11.95 ± 1.53	12.82 ± 1.54
	p value	0.297	0.267	0.831	0.781	0.405	0.018*
Sex	Male	2.77 ± 0.76	11.65 ± 1.92	12.15 ± 1.39	2.71 ± 0.80	11.77 ± 1.87	12.35 ± 1.45
	Female	2.79 ± 0.86	12.01 ± 2.11	12.26 ± 1.33	2.73 ± 0.81	11.66 ± 1.87	12.00 ± 1.36
	p value	0.822	0.127	0.499	0.788	0.581	0.032*

One way ANOVA test; Independent samples t test; indicates significant at p≤0.05 (* significant)

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Table VI: Prevalence of inferior alveolar canal pattern

		Left Side			Right Side		
		Linear N (%)	Perpendicular N (%)	AL N (%)	Linear N (%)	Perpendicular N (%)	AL N (%)
Age	**20-45**	92 (40.4)	115 (50.4)	21 (9.2)	98 (43)	113 (49.6)	17 (7.5)
	46-60	34 (54.8)	21 (33.9)	7 (11.3)	30 (48.4)	29 (46.8)	3 (4.8)
	>60	15 (75)	5 (25)	0 (0)	6 (30)	11 (55)	3 (15)
	p value	0.009*	0.473				
sex	**Male**	79 (44.1)	84 (46.9)	16 (8.9)	75 (41.9)	92 (51.4)	12 (6.7)
	Female	57 (43.5)	62 (47.3)	12 (9.2)	59 (45)	61 (46.6)	11 (8.4)
	p value	0.832	0.663				

Chi-square test; * indicates significant at p≤0.05 (significant)

The most common pattern detected in the present study was the perpendicular pattern, followed by a linear pattern irrespective of sex, and the least common was the anterior loop. The incidence of anterior loop pattern was similar to a study conducted by H. Al-Mahalawy *et al.,* in the Saudi population, in contrast with studies by Hu *et al.,* and Apostolakis and Brown. [8,25] Whereas the difference among the three age groups was significant, the visibility of the anterior loop decreases with an increase in age, which may be due to reduced calcification of the cortex, which makes the bone remodeling slower. The increased cortical porosity and Haversian canals show resorption of bone, resulting in the bone marrow space enlargement and arrangement of the trabecular pattern in a disoriented manner, affecting the anterior loop of mental foramen visibility.[26]

Clinical significance of the present study-

1) Taking relevant radiographs for diagnostic and therapeutic procedures is essential.
2) Knowledge of the operator about the size, location, and position of the MF is of great clinical relevance for more accurate prediction of the success or failure of the dental procedures like successful anesthesia during nerve blocks, curettage, and root canal treatment. Misjudgments of the position may lead to paresthesia, bleeding, and inadvertent nerve damage.
3) In the present study, the distance from the superior margin of MF to CEJ provides a stable and reliable reference point in patients with periodontal diseases that may cause resorption at the alveolar crest. This is clinically significant as it aids in avoiding iatrogenic errors while judging the precise position of the MF, which is important in preventing the damage to the neurovascular bundles exiting the MF during periapical surgeries.
4) Regarding the IAC pattern, in the present study, the perpendicular pattern was more common. However, AL has clinical relevance as identifying the anterior loop is important during various surgical procedures in the MF region like periapical surgery, orthognathic surgery, and hemorrhagic complications during the transoperative period of implant placement because individuals with an AL are more likely to suffer from neurosensory alterations. It is recommended to leave a '2mm Safety zone' between the coronal aspect of the nerve and the intended implant.[27]

The limitation of the study was that only one observer evaluated all the CBCT, thus, there could be some bias in the interpretation. However, the observer had a strict fixed parameter for reading and recording.

CONCLUSION

CBCT precisely determined the shape and location of mental foramen with the neighboring anatomical structures in the present study, and it was found that the size of MF varies with age and sex. The most frequent shape of MF was Type III (round), the location was below the apex of the second premolar, and the most common IAC pattern observed was the perpendicular pattern. Hence, knowledge of the anatomic proximity of the MF to adjacent root apices is essential during endodontic treatment and while performing various surgical procedures in the premolar area to avoid any injury or iatrogenic complications and achieve successful dental procedures.

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Surveillance of specific pathogens on mobile phones in aerosol and non-aerosol generating dental clinics during the COVID pandemic

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ABSTRACT

Following COVID-19 protocols implemented globally, it is prudent to extend this to mobile phones, regarded as carriers of microbes, as these are used extensively in clinical settings for learning and patient care.

Aim

Was to determine types of microbes harbored on mobile phones and related hygiene practices whilst using these in aerosol and non-aerosol generating dental settings.

Methodology

This cross-sectional study was conducted in two parts: A laboratory study to determine the prevalence of microbes on mobile phones and a questionnaire survey to determine the related knowledge and behavior of phone users in both aerosol and non-aerosol generating dental clinics. All proper protocols (consent, ethics) were adhered to.

Results

A small percentage (27.2%) of swabs of mobile phones yielded a positive bacterial culture, of these 72% were from the AGP dental setting. Gram positive and negative microorganisms were distinguishable, indicating a diverse group of microbes. Students and staff indicated good mobile phone hygiene practices, but there is place for improvement. Their related knowledge of disinfectants and use were acceptable, but not having mobile phone coverings was problematic.

Conclusion

Faculty protocols for disinfecting mobile phones and standardized guidelines for its use in aerosol or non-aerosol clinics is recommended.

KEYWORDS

Mobile phones in dental clinics; Pathogens on mobile phones; COVID-19 mobile phone protocols; phone clinical use; phone hygiene practices; mobile phone use guidelines.

INTRODUCTION

Electronic devices, such as mobile phones, smartphones and computers have become a necessary addition to the armamentarium of the public, and in the academic setting where it is considered as essential for students and professionals. With the corona virus disease (COVID-19) pandemic, these devices were seen as a lifeline for daily communiqué and to allow continuance of everyday activities, such as remote working. Thus, it has become an essential part of our lifestyle, impacting greatly on those who use it by keeping them connected to work and loved ones. It was therefore recommended as a tracking device by country health authorities during the current COVID-19 pandemic.1 However, by holding these devices, texting, making calls or reading from it in public and sharing devices between people, germs can be transferred onto and from the mobile phone surfaces.

These mobile phones are appreciated as a necessary form of learning and teaching at tertiary educational institutions.[1] These are used to read academic material and do assessments online thus, it must be incorporated as an indispensable tool within the curriculum.[1-2] Some benefits

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Authorship:
SK: Principal Researcher. Contributed to Protocol, Data collection and Analysis and Manuscript preparation and manuscript finalization (45%)
EM: Contributed to Protocol, Data collection and Analysis and Manuscript preparation and manuscript finalization (25%)
NV: Contributed to Protocol, Data Analysis, Manuscript preparation and finalization (15%)
AT: Contributed to Protocol, Data Analysis, Manuscript preparation and finalization (15%)

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The authors declare no conflict of interest

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Data availability statement:
1. The datasets generated during and/or analysed during the current study are available from the corresponding authors on reasonable request.
2. Data generated or analysed during this study are included in this published article

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identified with mobile phone use in academia include better understanding of students' learning pace, encouraging and empowering more proactive learning, improving conversational skills, and greater academic achievements.[1]

In the healthcare environment, professionals use these for work-related activities such as: following health-related news; communicating with colleagues and patients; searching databases for updated guidelines, drug interactions, adverse events and health research; taking pictures of patients oral health conditions; sharing of medical documents; conducting tele-consultations as well as patient-tracking and creating appointments.[3] The self-reported use of mobile phones among healthcare workers ranges from once in every 15min to once every 2hours.[3] Due to its continuous daily use, these devices may be considered as 'hotspots' for carrying and transmission of pathogens, such as corona virus (SARS-COV2).4-6 Mobile phones are thus highly touched surfaces and should be cleansed daily to avoid transmission of identified and unidentified pathogens.[2,5,7]

Constant and widespread use of mobile phones leads to a build-up of pathogenic microbes on the surfaces and can lead to infection and transmission of various diseases.[2] Electronic devices in use heat-up and it's this increase in temperatures that create a favorable environment for microbial growth and survival. In addition, disinfection and regular cleaning of mobile phone surfaces was not common among users at the start of the pandemic, where it's reported that 72% of users never washed or cleansed their devices.[2] Hence mobile phones act as the perfect fomite, meaning a non-living object possessing the ability to transmit infectious microbes across devices and surfaces.[2]

The SARS-COV2 viruses and their variants are transmitted via aerosols, stay on different surfaces (including that of electronic devices) for varied lengths of time (hours and days) and at different locations such as hospitals and may be transferred to people who after surface contact then touch their face, mouth, nose and eyes.[8,9] It thus has the potential to be one of those microbes being transmitted across surfaces including those of electronic devices.[8] Therefore, a person may carry the pathogen on their mobile device and accidentally infect self and others.

Olsen *et al.,* 2020 has identified several groups of microbes (bacterial, viral and fungal types) in different healthcare settings and on hands of individuals.[2] In this same study, where both the public and healthcare target groups were investigated, the findings demonstrated that 7 different microorganisms remained consistent on the surfaces of mobile phones: Escherichia coli, CoNS, Bacillus sp., Klebsiella pneumoniae, Pseudomonas aeruginosa, Staphylococcus aureus, and Methicillin-resistant S. aureus.[2] Another study conducted in Akola, India, found similar bacteria, and isolated a few other types too.10 Hospitals became extra cautious during the pandemic and follow proper evidence-based cleansing protocols in all clinics, including special procedures directly related to patients to prohibit the spread of the SARS-COV2 virus between people and surfaces, but the focus has not been on electronic devices.[6,11]

In the study by Hosseini *et al.,* (2018), they demonstrated that 64% of dental students never disinfected or cleaned their mobile phones.[11] Some health departments and electronics manufacturers, such as the Apple device company, in response to inquiries related to disinfecting mobile phones, have provided a few guidelines. They recommended using cleansing agents such as a 70% isopropyl alcohol wipe or Clorox disinfecting wipes on mobile devices and then allowing the surfaces to dry.[12-14] The type of disinfectant that should be used must be safe enough to avoid damage to the device and to reduce the toxic effects on the users.[15] It could, therefore, be part of a regular daily regimen to clean mobile phones and computers. Recommendations for mobile device hygiene must therefore be shared and more stringently implemented.[16] Implementation of this type of protocol will counter the trajectory of aerosols created in dental clinics which contain biological materials such as saliva, blood and microbes which are able to survive for extended periods of time.[11]

The aim of this surveillance study is therefore to determine prevalence of the different types of microbes/pathogens that

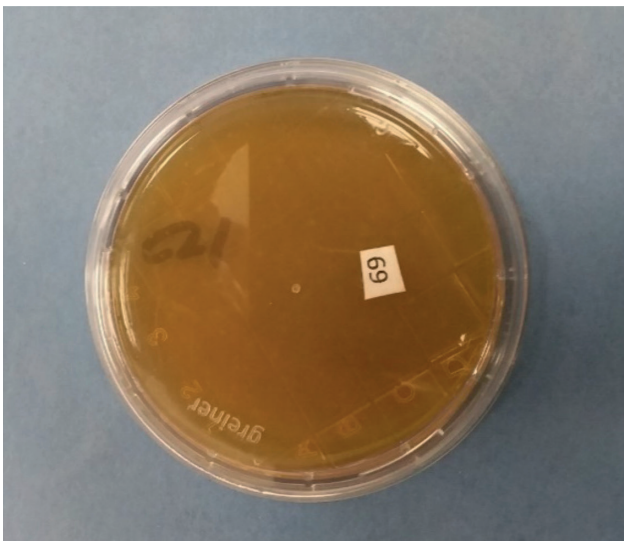

Figure 1: A sample indicating a negative culture with no bacterial colonies

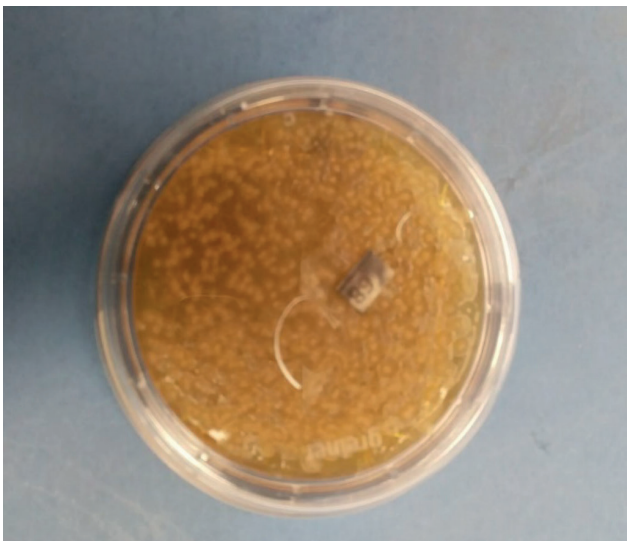
Figure 2: A sample with a positive culture after 24 hours, showing 100s of colonies from the AGP clinic

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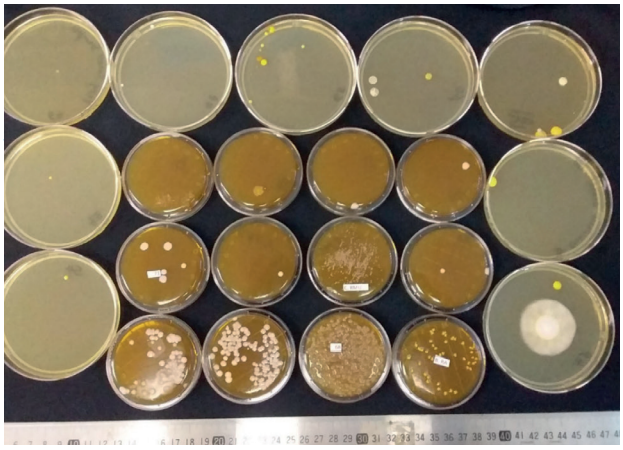

Figure 3: Agar plates of samples that yielded positive for bacterial growth ranging from 0 to 100s of colonies

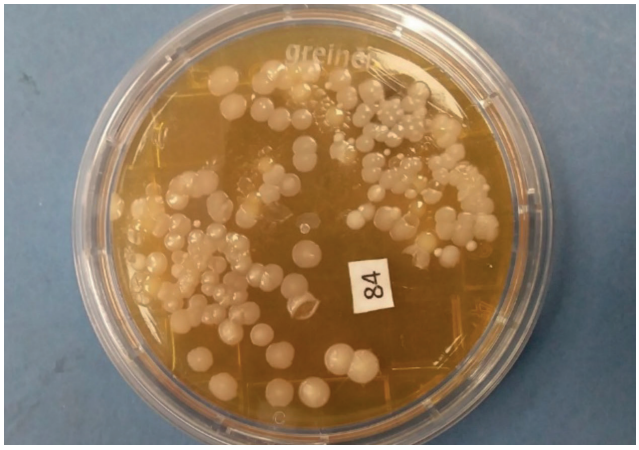

Figure 4: Sample on a CASO agar plate indicating many colonies with more than 1 morphotype from the AGP clinic

are regularly found on mobile, or smartphones used in a dental setting.

MATERIALS AND METHODS

This was a cross-sectional laboratory study and questionnaire survey and related to mobile phones used in the dental setting conducted amongst senior and junior dental students and staff at the University of the Western Cape. Information related to the study was shared with participants and informed consent obtained from the specific cohorts. Due to the 3rd wave of COVID-19 lockdown experienced within the country at the time of this study, data collection was firstly delayed, and when researchers resumed, deviated from the intended protocol by necessity as access to all students were limited due to classes being conducted remotely. For this ongoing study, the 1st data collection stage occurred whilst the city was experiencing winter, where the types of pathogens differ from those found in other seasons. Thus, surveillance of the state of mobile phones regarding types of pathogens was reported as experienced during winter and the 3rd wave of the COVID-19 pandemic only.

Students and staff working in aerosol generating clinics were initially targeted, and their mobile phones swabbed using sterile swabs soaked in hygienic physiological saline. The swabs were rotated over each of the surfaces of mobile phones such as the keys, mouthpiece, and earpiece. These swabs were then transported to the laboratory and were aseptically transferred into appropriate enrichment media, which was then cultured, facilitating DNA or RNA extraction. That is, swabs were vortexed and 100µL was pipetted on to fresh CASO agar plates and these were incubated aerobically at 370C for 48 hours. For the 1st phase of this surveillance study, it was sufficient to assay for the presence or absence of pathogens. The specific pathogens proposed for this mobile phone study belonged to the four primary groups of microbes: Gram positive bacteria, Gram negative bacteria, viruses, and fungi which are grouped below:[17-18]

Group A: **Gram positive bacteria:** *Methicillin-resistant Staphylococcus aureus* (MRSA) and *Streptococcus pneumoniae.*
Group B: **Gram negative bacteria:** *Salmonellae* and *Pseudomonas aeruginosa,*
Group C: **Viruses:** *Human Papilloma virus* (HPV) and *Human Simplex virus* (HSV)

For this current paper, the presence of the different microbes from Groups A and B are reported.

The different types of pathogens harbored on the mobile phones of participants and used daily in the dental clinic, that showed a positive culture after 24 hours, were then exposed to Gram staining to provide a more descriptive identification of the pathogen from either Groups A and/ or B. These were then viewed under a light microscope and a full description is provided.

For the second part of the study, a self-administered questionnaire was emailed to the same students in 3rd and 5th year and to the staff who consented to swabbing of their mobile phones.19 For section A of the questionnaire, the socio-demographic characteristics (age, gender and profession) of each participant was obtained and for section B, a series of questions were posed which related to the use of mobile phones in clinics, mobile phone disinfecting and hygiene habits pre- and during the COVID-19 pandemic, and lastly transmission of pathogens.20 All protocols related to research were followed for this study and these were linked to the guidelines of the Declaration of Helsinki.[19]

RESULTS

A protocol was developed and registered with the institutional ethics committee (Registration No: BM21/4/7) but it was not published. Consent was obtained from all participants according to the Declaration of Helsinki for all aspects of this research.[19-20]

3.1. Swabbing of mobile phones

The total number of mobile phones swabbed for this study (N=92) and included students and staff (N=68) working in aerosol generating (AG) clinics and those (N=24) working in non-aerosol generating (Non-AG) clinics.

3.1.1. Cultured swabs

After careful transfer and storage of swabs, these were vortexed and cultured on media incubated at 370C under aerobic conditions. The swabs were cultured on to fresh CASO agar plates to observe positive bacterial growth. The laboratory technician (EM) completed this phase as a blinded procedure as all swabs were coded using numbers for students and letters for staff. Only the primary reseacher (SK) knew which swab belonged to whom. Twenty five

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samples turned positive for bacterial cultures within 24 hours of incubation: From the AG groups, 16 students and 2 staff members' and from the non-AG groups, only 4 students and 3 staff members'mobile phone swabs yielded positive bacterial cultures, but each looked very different. This could be due to the AG clinic staff being more conscious of cleansing protocols. An example of a negative and positive bacterial culture from mobile phone swabs is shown in Figure 1 and 2 respectively.

3.1.2. Colony Description

Next, the colonies for each of these positive swabs and cultures were estimated to range from 1 to 100s as these were difficult to count individually due to their arrangement over each other (Figure 3). A distinct difference between positively cultured colonies from the swabs of students working in non-AG clinics were mostly cream to white compared to those working in AG clinics which were white, cream, and yellow in color (Figure 3).

The sizes were measured, where possible, using a digital caliper and a description of some of these according to color, shape, size, elevation and/ or margins included (Figures 3, 4, 5, 6): The sizes in diameter of individual bacteria ranged from 0.5 to 7cm, but most were found to be from 3.5cm and above (Figures 4, 5). Different colony morphotypes were observed even on one culture, where their shapes also went from being well rounded and regular to irregular and crenated margins and the surfaces from smooth, raised or flat and dome shaped to being granular (Figures 4, 5, 6 respectively). These differences were seen amongst the bacterial morphotypes between the AG and non AG clinics (Figures 2, 4, 5, 6).

Moreover, most of these colonies were easily spreadable, some were sticky, others were dry and crumbly and difficult to spread. The spreadability of the colonies and lifting the colony with an inoculating loop made it easy to create smears on the glass slide for the next stage of sample evaluation.

3.1.3. Gram Staining

When more than five colony morphotypes were present, the five most prevalent ones were selected, and smears were made by drying and fixing these onto the glass slide. The smears were stained with the Gram staining procedure during this phase. Otherwise, all colony morphotypes were stained (Figure 7).

3.1.4. Morphology of stained pathogens

The staining procedures of the previous phase assisted to determine whether the colony forming units were Gram-positive or negative and to discern their morphologies, that is, in identifying bacteria according to morphology and extracellular and intracellular structures, taking it closer to definitive identification of bacteria in the colonies observed (Figure 8). The descriptions of the intracellular structures obtained from Gram staining viewed under a light microscope indicated that the Gram-positive cocci form chains whereas the Gram-negative appeared like rods and bacilli distinguishing it from the former. Gram-positive yeast-like microorganisms were also observed (Figure 8).

3.2. Questionnaire Results

Due to the COVID pandemic and country lockdown rules experienced during the 3rd wave, not all students received a questionnaire related to mobile phones. It was decided by the principal investigator to rather administer the questionnaires to only those students and staff who were present and had consented to having their mobile phones swabbed.

3.2.1. Questionnaire response rates

Of the 92 students and staff who consented to mobile phone swabbing, and to whom the questionnaire was emailed, the following responses were received:

From the total number of questionnaires administered (N=92), a 53% response rate was achieved. Regarding the responses from participants from the different clinics, a total response rate of 54% from the AG clinics with 54% of students and 55% of staff having returned questionnaires at the time of this analysis. Similarly, for responses from the non AG clinic, a total response rate of 50% was observed, with 44% of students and 67% staff who emailed their questionnaires to the researcher.

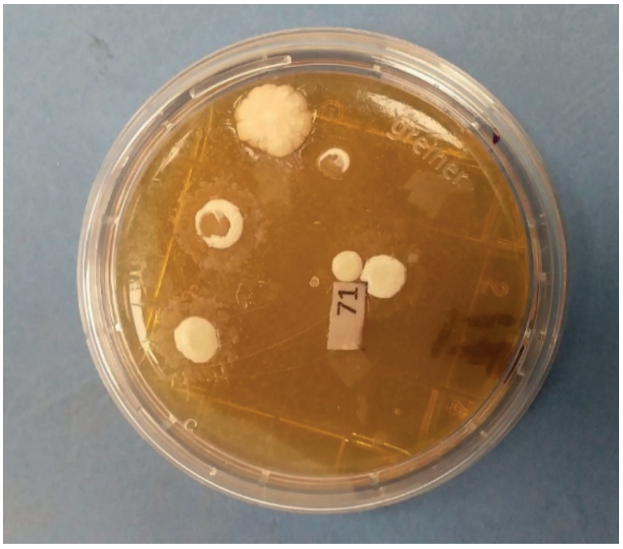

Figure 5: A sample showing growth on a CASO agar plate with 3 different morphotypes from the AGP clinic

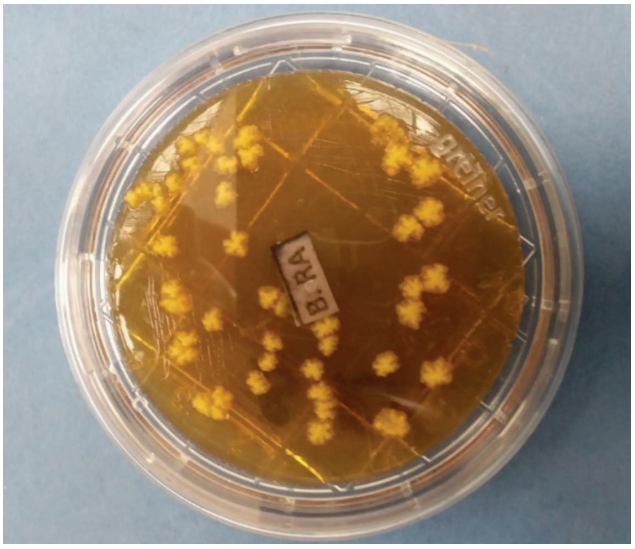

Figure 6: A unique sample of granular colonies cultured from the non-AGP clinic on a CASO plate

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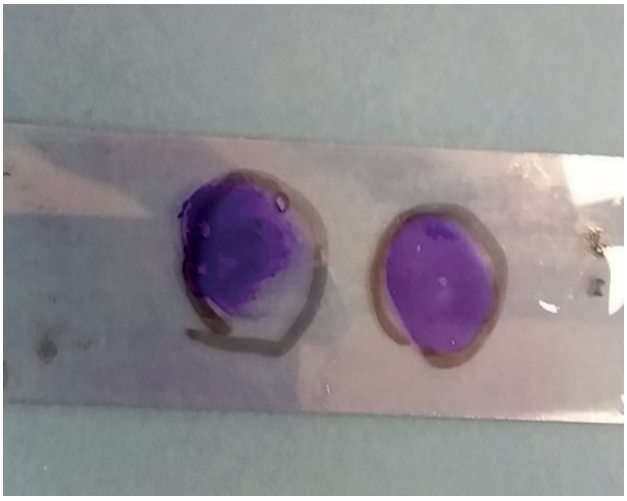

Figure 7: Sample smeared on a slide indicating it is Gram positive

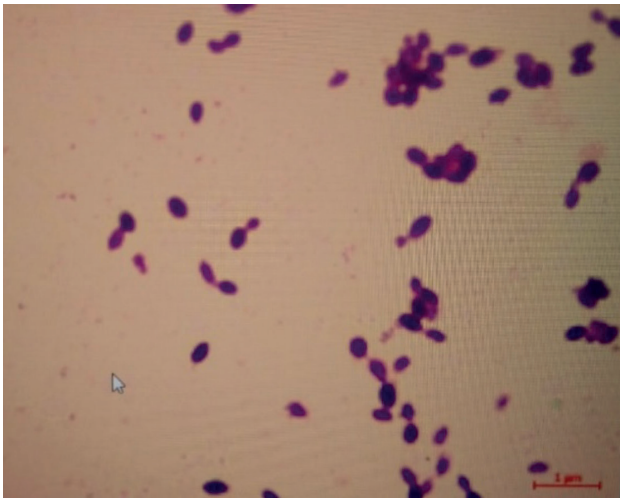

Figure 8: A Gram-positive yeast with numerous budding cells

3.2.2. Questionnaire responses

The following section focuses on the questions posed to participants, but the responses were grouped and are highlighted under the following themes:

• Behavior regarding mobile phone use in clinics

Students indicated that their mobile phones are used daily in clinics to search for information, learning and booking of patients. However, many of them indicated not consciously including a hand hygiene protocol after using their mobile phones in the clinics. And the majority in both AG (80%) and non-AG (77.8%) clinics reported not having special phone coverings for preventing transmission of pathogens (Figure 9). However, 83.3% of participants agreed that the faculty should develop guidelines for phone use in clinics especially during the COVID-19 pandemic (Table 1).

• Disinfectants used on mobile phones

Most students from both AG (80%) and non-AG (77.8%) clinics use 70% alcohol to cleanse their mobile phones (Figure 10). Many of them (56% and 66.7% respectively) do include a personal phone cleansing protocol (Figure 10). However, 93.4% of participants indicated they would appreciate the faculty extend the current COVID-19 protocols to include a mobile phone disinfecting protocol (Table 1).

• Pathogen transmission

As expected, their knowledge related to transmission of microbes between different surfaces, for example, phones and hands and other surfaces, is sound, therefore they started their own special cleansing protocols for phones with appropriate disinfecting solutions. Unfortunately, they have not yet used special coverings on their mobile phones.

DISCUSSION

The mobile phones of most of the students and staff indicated a negative culture for the microbes suspected of being present in the dental setting. There were, however, staff and students (28%) whose mobile phones indicated a positive culture for bacterial microbes within 24 hours of it being cultured, implying that not all participants' mobile phones were clear of any pathogens. Nonetheless, this does not mean they did not institute a cleansing protocol, it does create more questions related to the clinical workspace they find themselves in.[9] Transmission of microbes could be from other surfaces, the environment, different dental procedures they busy with, from patients on whom they work and from each other or just the extended time of using their mobile phones.[3-6, 9]

These outcomes are no different to other studies published on this matter, though a difference was expected due to the strict protocols that most healthcare facilities included during the COVID-19 pandemic the world was experiencing.[6, 17] It was also recommended that the COVID-19 protocols should be strictly adhered to within these healthcare settings especially, because that would ensure the safety of all patients, staff and students.[16] The results of this study deviated from the literature in that most students in both the AG and non-AG clinics included their own mobile phone cleansing protocols regularly, therefore the number of positive cultures were lower than expected.[11]

The diversity of the microbes and their presentation, however, were unexpected but this could be purely seasonal, though many different types were seen in other studies too.[2,10,17,18]

Table 1.
Responses to questions related to protocol development for mobile phone disinfecting and usage in clinics

Questions	Strongly Agree	Agree	Neither Agree/ Disagree	Strongly Disagree
Faculty disinfecting protocol to be extended to mobile phones	66.7%	26.7%	6.7%	
Special Guidelines to be developed for use of mobile phones in clinics	50%	23.3%	23.3%	3.3%

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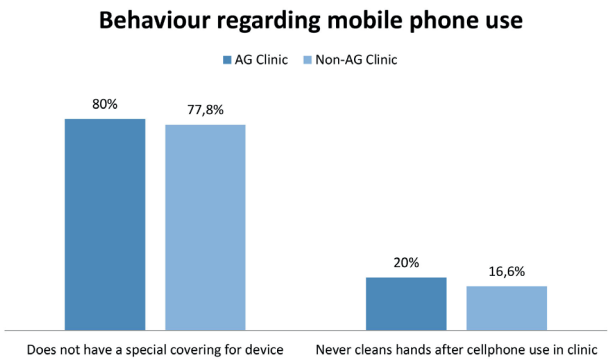

Figure 9: Behavior regarding mobile phone use in clinics

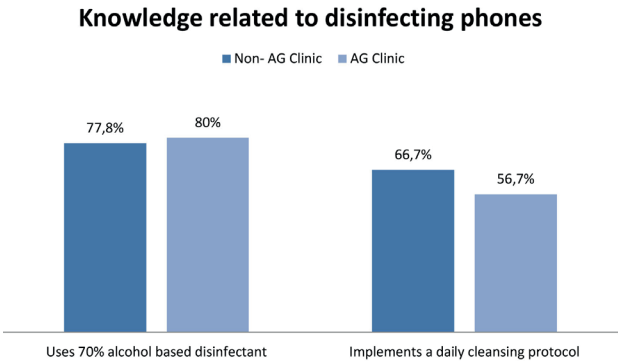

Figure 10: Knowledge related to disinfecting mobile phone in the dental setting

And the students and staff in this study have clearly read the literature related to types of disinfectant to be used that would not damage their mobile phones, as the companies at the start of the pandemic were hesitant to use anything on the surfaces.[12-13]

Due to these differences, it would be wise to test the acquired samples for a more definitive microbe identification, as this could be an indication of how institutional protocols may have to change. As stated before, seasonal changes could have a bearing on the types of microbes observed in this current study outcome. It would be advisable to swab mobile phones during the summer months to ascertain the types of microbes in our environment. And with the 4th wave of the COVID-19 pandemic experienced and the different strains observed then, this should be the next step including engaging faculty on implementing a change to the previously instituted COVID-19 protocol.

All current cleansing and disinfecting protocols noted, however, a stricter and detailed protocol for mobile phone disinfecting and guidelines for using these phones in the dental clinical setting would ensure greater compliance from students and staff. In fact, it would make patients more aware of the transmission of infections, including COVID-19, which may be combated, keeping all who work in this high-risk environment, those exposed to saliva and water sprays and blood spatter, safer.[11]

From the results obtained for the questionnaires and swabs, indication of students' awareness and knowledge related to mobile phone use in a clinical setting was acceptable, but this should not be encouraged while no associated protocol has been developed yet. Moreover, researchers should use the outcomes of this study to develop such a detailed phone use protocol, even its limited use, for both AG and non-AG clinics and for both students and staff. Here, the inclusion of phone coverings to combat the spread of microbes should be stressed and promoted especially when the necessity for its use cannot be ignored. What this study did was create an awareness of behavior related to phone use in these clinics and maybe subconsciously limited its use for the safety of all present. What is required is the formalization of faculty guidelines for mobile phone use within AG and non-AG clinics.

In addition, the consciousness of disinfecting devices, including mobile phones was present and students and staff were implementing these even though none of the COVID 19 protocols was extended to include these mobile phones. Also, the literature and companies have clarified this position and indicated what could be used without damaging the devices.[12-15] Results thus showed that participants also tried to implement some of the appropriate actions related to cleansing and disinfecting of mobile phones in the clinical setting. Again, they would probably be more compliant to appropriate actions if formalized evidence-based protocols and guidelines for disinfecting of mobile phones in the dental setting are included in the current Faculty COVID-19 protocols as well.

Both evidence-based guidelines for mobile phone use and a faculty protocol for its disinfection, including compulsory phone coverings can help prohibit transmission of any type of pathogen irrespective what season is experienced. The students and staff are scientists and transmission of infections in different settings is what they know well, as seen with the study outcomes. They would thus not hesitate to adhere to protocols preventing the transmission of germs or microbes during or post the pandemic.

Post this study, the strain of the COVID related virus mutated and the country experienced a 4th wave of the pandemic (with the omicron virus taking center stage). Moreover, many participants who were diagnosed positively with COVID-19 infections also experienced what is called long COVID where patients experienced symptoms for longer than 5 months.21 Swabbing their mobile phones maybe indicate a different set of microbes.[21] Therefore, this type of surveillance study is very important as the changes experienced impacted on data collection for the survey and swabbing of mobile phones. Also, not all microbes were tested for yet, thus the microbes from Group C will be determined using polymerase chain reaction (PCR) at a later stage.

CONCLUSIONS

A diverse group of microbes was found on the mobile phones of participants from both aerosol and non-aerosol generating clinics who perhaps do not follow an appropriate and/or regular cleansing and disinfecting protocol. Thus, it would be advisable for the faculty to develop guidelines for mobile phone use in clinics and a standard disinfecting phone protocol as well.

CLINICAL IMPLICATIONS

Mobile phones are regularly used by students and staff in clinics for learning and patient work. These mobile phones are hubs for the growth of microbes and with the COVID-19 pandemic experienced globally and with all the different strains observed, transmission of these may occur which could have been avoided. The guidelines for use of mobile

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phones in clinics and clinical settings must be very concise and clear to ensure users remain compliant. From the results, appropriate cleansing protocols after use are also not always adhered to, thus, the guidelines must ensure these are included too. Moreover, regular, and standard disinfecting procedures and media should also be available for mobile phone users. It would also be advisable to expand the institutional COVID-19 protocols to include disinfecting of mobile phones as well.

RECOMMENDATIONS FOR CONTINUING THE STUDY

Gauging from the outcomes and results of this study, surveillance may continue under the following circumstances: temperature changes (winter to summer months); increase in patient treatments/ traffic (due to more students treating more patients/ or at the end of the year when it is quieter when students are away); pandemic conditions (with the 4th and possibly a 5th wave experience or a change or halt of the pandemic) and lastly, different pathotypes of the different microbes that may emerge, including different corona virus strains.

CONFLICT OF INTEREST

The authors declare no conflict of interest

FUNDING

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Research was presented at the IADR-SA, but no funding was requested.

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CPD questionnaire on page 52

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

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The prevalence and associations of radiographic diagnostic signs indicating possible pre-eruptive canine ectopia: The results of a mixed dentition radiographic survey

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APG Hudson[1], L Johan[2], AMP Harris[3], N Mohamed[4]

ABSTRACT

Maxillary canine ectopia is an anomaly of the mixed dentition which can and should be diagnosed early and treated interceptively wherever possible. Various radiographic markers have been associated with canine ectopia, and these are significant aids to a thorough clinical examination, in order to diagnose ectopia.

Methodology

A cross sectional study was carried out on a sample of 465 mixed dentition panoramic radiographs in order to establish the prevalence of maxillary canine ectopia according to a set of radiographic markers. The sample of radiographs included patients with dental ages between 10 and 12 years of age.

Results

404 radiographs displayed signs of canine ectopia according to the markers studied. Non- resorption of the root of the primary canine was the most common marker (63%) found. This was followed by overlap in 25.2% of cases, whilst increased angulation of the developing canine was the least prevalent (4.7%). Non-resorption showed a statistically significant association with distal overlap and overlap over the pulp chamber. Increased angulation was significantly associated with non-resorption in all degrees of overlap. Unilateral increased size of the mandibular canine showed a significant association with cases displaying a mesial overlap (p= 0.027).

Conclusion

Dental age is an important aspect of predicting canine ectopia. Non-resorption of the roots of the primary canine must be viewed with caution at the dental age of 10 years. Enlargement of the mandibular canine maybe viewed as a potential early warning sign for maxillary canine ectopia.

INTRODUCTION

It is not uncommon to encounter maxillary canine ectopia when managing paediatric patients.[1] Maxillary canine ectopia may present either pre-eruptively or post-eruptively. Pre-eruptive ectopia occurs due to the tooth germ being displaced, which then causes the tooth to erupt along the wrong path.[2] Post-eruptive ectopia refers to a tooth that has erupted into the mouth but is out of its normal position.[3] There are important considerations that need to be accounted for when assessing the developing canines during the mixed dentition. The most critical of these is whether or not the buccal bulge resulting from the developing canine is present. This should be clinically palpable from a dental age of 10 years. In the absence of this buccal bulge, a radiographic investigation is considered to be the preferred practice in order to verify whether the developing canine is ectopic or not.[1] These have been identified as:[1]

- The amount of overlap between the crown tip of the developing canine and the root of the lateral incisor

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Dental age; Nolla stage 9, Canine ectopia; Maxillary canines; Interceptive orthodontics, Mixed dentition, Panoramic radiographs, non-resorption of primary canine roots

Author contributions:

Dr A Hudson: Writing article	20%
Dr L Johan: Principal researcher	40%
Prof A Harris: Writing article, clinical input	20%
Prof N Mohamed: Writing article, editing	20%

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None

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- The angulation of the long axis of the developing canine to the mid sagittal plane
- Resorption or non-resorption of the roots of the primary canines and
- The size of the developing canine when compared to the contralateral canine.

On a pantomogram, a visible overlap between the cusp tip of the erupting maxillary canine and the permanent maxillary lateral incisor root may be considered normal, prior to the maxillary lateral incisor reaching Nolla's root development stage 9. At this stage, the lateral incisor roots have developed to full length but still have open apices, and half the root of the permanent maxillary canine has formed but active eruption has not yet started.[4,5] Nolla stage 9 coincides with a dental age of 10 years.[4] However, after Nolla stage 9, the degree of overlap of the permanent maxillary canine cusp tip and maxillary lateral incisor root is considered to be a significantly accurate indicator of potential pre-eruptive maxillary canine ectopia.[6,7]

Ericson and Kurol (1988a)[8] evaluated the degree of overlap of the permanent maxillary canine cusp tip with the root of the maxillary lateral incisor. The amount of overlap between lateral incisor root and canine tip was grouped as follows:

- Group 1 displayed no overlap,
- Group 2 displayed an overlap where the cusp tip was located distal to the pulp chamber of the lateral incisor.
- Group 3 displayed an overlap where the cusp tip was located directly over the pulp chamber of the lateral incisor.
- Group 4 applied to all instances where the overlap of the cusp tip was located mesial to the pulp chamber of the lateral incisor.

Warford *et al.,* (2003)[6] used this method to gauge maxillary canine displacement and predict the non-eruption of the maxillary canine and they found that groups 3 and 4 had the highest odds of non-eruption of the maxillary canine. Lindauer *et al.,* (1992)[9] found that 78% of cases with non-erupted maxillary canines exhibited an overlap as described in groups 2, 3 and 4, above. The amount of overlap after the dental age of 10 determines the prognosis of the interceptive treatment. A positive outcome of interceptive treatment decreases if the erupting maxillary canine overlaps more than half of the root of the maxillary lateral incisor at dental age 11.[10,11] A clinical study by Ericson and Kurol (1988)[10] showed that 91% of cases respond favourably to interceptive treatment when the canine crown-lateral root overlap is distal to the midline of the lateral incisor. This success rate drops significantly to 64% should the canine overlap be mesial to the midline of the lateral incisor.

Baccetti *et al.,* (2008)[12] modified Ericson and Kurol's classification (1988a)[10] and measured the medial crown position of the maxillary canine through sectors 1 to 5:

- Sector 1 corresponded to the primary maxillary canine (present or absent).
- Sector 2 was the area from the distal aspect of the maxillary lateral incisor to the midline of the maxillary lateral incisor.
- Sector 3 was the area from the midline of the maxillary lateral incisor to the distal aspect of the maxillary central incisor.
- Sector 4 corresponded to the area from the distal side of the maxillary central incisor to the midline of the central incisor.
- Sector 5 was designated to the area from the midline of the central incisor to the midline of the maxillary arch.

This modification showed a high rate of reproducibility (0.94) with both methods giving accurate results.[12]

Angulation of the maxillary canines to the mid-sagittal plane appears to be less significant than the amount of overlap between the cusp tip of the maxillary canine and the root of the maxillary lateral incisor.[6] A favourable inclination for the maxillary canine in the arch is no more than 30° to the mid-sagittal plane.[11] The angle is measured between the long axis of the maxillary canine and the midline.[8] Landmarks on the panoramic radiograph such as the intermaxillary suture, anterior nasal spine, nasal septum and internasal suture, demarcates the midline.[13] When the developing maxillary canine (after the dental age of 10 years) has an angulation greater than 30°, it suggests that the maxillary canine has a greater tendency to become impacted.[11]

External root resorption of the primary canines associated with the erupting permanent canines occurs in the apical area of the root, causing a smooth resorption pattern which results in blunting of the root apex.[4,5] When external root resorption involves the lateral aspect of roots, it causes an irregular resorption pattern where one side is resorbed more than the other.[14] This can occur unilaterally or bilaterally.[15] Resorption of primary maxillary canines should have begun by dental age 10 and be completed by dental age 12.[16]

Lappin (1951)[17] put forward non-resorption of the root of the primary maxillary canine as a possible cause for maxillary canine ectopia. In support of Lappin's (1951)[17] theory, various studies have shown the subsequent eruption of the displaced maxillary canines, following the extraction of non-resorbed primary maxillary canines.[18,8,9,11]

Ericson *et al.,* (2002)[19] however, suggested that root resorption of the primary maxillary canines was merely a consequence of maxillary canine ectopia rather than a cause of it. As part of the eruptive mechanism of the permanent maxillary canine, the active pressure exerted causes various cellular changes which, together with the actual physical contact between the adjacent primary teeth and the permanent maxillary canine, brings about root resorption of the primary maxillary canine. Becker (1998)[2] suggested that the erupting permanent maxillary canine provides the stimulus for the resorption of the roots of the primary maxillary canine. A portion of the root far from the permanent canine may be unaffected by this process, thus bringing about non-resorption of the primary maxillary canine.

An enlarged radiographic image of a maxillary/ mandibular canine in comparison to its opposite number and surrounding teeth, indicates palatal positioning of the tooth on the panoramic radiograph.[20,21,5] Palatally displaced maxillary canines have been studied by several authors, where the palatally positioned maxillary canines were verified both clinically and radiographically.[22,23,24,25,26,27,8,15]

A mandibular canine that is situated lingually may be as a result of spontaneous early loss of a primary mandibular canine, an unfavourable sequence of permanent tooth eruption in the mandible or eruption anomalies. These may be determined radiographically and clinically where an early warning sign may be crowded mandibular incisors.[28]

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This lingual ectopia of mandibular canines may cause a lingual collapse of the mandibular incisors which can impact on the maxillary incisors by diminishing the space available for normal eruption of the maxillary canines, thus forcing them into an ectopic position.[28]

METHODOLOGY

An analytical, descriptive, cross-sectional study was carried out to establish the radiographic prevalence of potential maxillary canine ectopia visible on mixed dentition panoramic radiographs between the dental ages of 10 and 12 years as described by Proffit *et al.,* (2007).[4]

A sequential sample consisting of 465 radiographs from UWC's Paediatric Dentistry department at the Tygerberg campus, were used for this study. The radiographs were taken between 2011 and 2014. The data was recorded according to the presence of one or more of the four canine ectopia prediction markers as described by Hudson *et al.,* (2010).[1] These markers have been identified as:

- The amount of overlap between the crown tip of the developing canine and the root of the lateral incisor.
- The angulation of the developing canine to the mid sagittal plane.
- Resorption or non-resorption of the roots of the primary canines.
- The size of the developing canine when compared to the contralateral canine. The size of both the maxillary and mandibular canines were assessed in order to establish the probability of any relationship between mandibular canine ectopia and maxillary canine ectopia.

Inclusion criteria

1. Patients with no previous history of orthodontic treatment.
2. Only good quality dental panoramic radiographs were used.

Exclusion criteria

1. Patients with cleft lip and palate.
2. Patients with syndromes.
3. Panoramic radiographs with only primary or only permanent dentitions.

Data processing and analysis

Pearson's correlation coefficient was used to determine the degree to which two variables were associated. For a correlation coefficient to show a statistically significant association, its absolute value must exceed 0.0834. The Chi-square test of independence and Fishers exact test were also used to determine whether two categorical variables were dependent or independent. A p-value of less than 0.05 indicates that the variables have a statistically significant association.

RESULTS

Of the 465 mixed dentition panoramic radiographs of children between dental ages 10-12 years, 404 displayed potentially ectopic maxillary canines according to the markers studied.

Non-resorption of the primary maxillary canines showed a statistically significant association with overlap:

- Distal overlap ($p < 0.001$)
- Overlap over the pulp chamber ($p = 0.003$)

The probability test showed that:

- Non-resorption of the primary canines was 63% more likely to occur when distal overlap was present.
- There was a 76% chance of non-resorption in cases where the overlap was over the pulp chamber.
- In cases where non-resorption of the primary canine existed, there was 19.8% chance for distal overlap or only a 6% chance for overlap over the pulp chamber to occur.

With angulation greater than 300 as the primary marker, a statistically significant association was found with distal overlap ($p < 0.001$). The probability test showed that:

- Maxillary canines angulated greater than 300 were 39% more likely to cause the maxillary canine cusp tip to have a distal overlap with the root of the maxillary lateral incisor.
- In cases where there was an existing distal overlap, angulation of the maxillary canine had an 11% chance that the angulation would become greater than 300.

Angulation greater than 300 also showed a statistically significant association with overlap over the pulp chamber of the maxillary lateral incisor root ($p= 0.014$). The probability test showed that:

- There was a 13% chance for the maxillary canine cusp tip to overlap the pulp chamber of the root of the maxillary lateral incisor.
- When an overlap existed over the pulp chamber, the probability for the maxillary canines to have an angulation greater than 300 was 14%.

Maxillary canines angulated greater than 300 also showed a statistically significant association ($p= 0.015$) with an overlap that was mesial to the pulp chamber. The probability test showed that:

- There was a small chance (8.7%) for the maxillary canine cusp tip to be positioned mesial to the maxillary lateral incisor root.
- The probability of the maxillary canine to have an angulation greater than 300 doubled to 18% when a mesial overlap existed.

With increased angulation as the primary marker, a statistically significant association with non-resorption of primary maxillary canines ($p = 0.004$) was found. The probability test showed that:

- Non-resorption of the primary canines was 74% more likely to occur when the maxillary canines had an angulation greater than 300.
- When non-resorption of the primary canine existed, there was only a 7% chance for the angulation of the maxillary canines to be greater than 300.

When maxillary canine enlargement was the primary marker, non-resorbed primary maxillary canines occurred 48.1% of the time and 57.1% of the time when enlarged mandibular canines was the primary marker (Table 5). Maxillary canine enlargement ($p = 0.32$) and mandibular canine enlargement ($p = 0.65$) did not show a statistically significant association with non-resorption of primary maxillary canines.

Mandibular canine enlargement as the primary marker showed no statistically significant association with distal

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Table 1: Dental age vs. the prevalence of potentially ectopic maxillary canines.

Dental Age	n (%)	Total N (%)
10	211 (52.3)	
11	133 (32.9)	404 (100%)
12	60 (14.8)	

Table 2: Maxillary lateral incisors that reached Nolla Stage 9 vs dental age.

Dental Age (n)	Nolla stage 9 reached - n (%)
10 (211)	151 (71.6)
11 (133)	125 (93.98)
12 (60)	57 (95)

overlap or overlap over the pulp chamber of the root of the maxillary lateral incisor ($p > 0.05$). However, there was a statistically significant association with those cases displaying a mesial overlap ($p= 0.027$). The probability test showed:

- A 6% chance of a mesial overlap in cases with enlarged mandiular canines.
- It was 27% more likely for the mandibular canine to be lingually displaced when the maxillary canine displayed a mesial overlap.

DISCUSSION

This study showed that radiographic evidence of potentially ectopic maxillary canines seems to become less prevalent as the dental age increases from 10 to 12 years (Tables 1 and Table 3). The timing of normal eruption of the maxillary canine should coincide with a dental age of 12 years.[4]

Thilander and Jakobsson (1968)[29] examined dental casts and radiographs and recorded an ectopia prevalence of 37% for unerupted maxillary canines at the initial examination in cases with a mean chronological age of 11.5 years. In the present study, the prevalence of potentially ectopic maxillary canines at dental age 12 was 14.8% (Table 1). The differences in the findings may be because Thilander and Jakobsson (1968)[29] had access to the models and did not use all the radiographic markers used in this study, but more importantly, the present study used dental age and not chronological age. Studies have shown that dental age can differ by between 4 to 5 years from the actual chronological age.30,31 Davidson and Rodd (2001)[32] found that the difference between dental age and chronological age was most evident in 8 to 12-year-old children.

If a clinical examination had been conducted in the present study and it was found that the maxillary canine buccal bulge was palpable and/ or the primary canine was mobile, the 404 radiographs showing potential ectopia may have been judged to be displaying normal canine development.

Any overlap of the permanent maxillary canine is to be considered normal prior to the permanent maxillary lateral incisor reaching Nolla Stage 9.[7] Table 2 shows the dental age distribution of the maxillary lateral incisor at Nolla Stage 9. In three cases at dental age 12, the maxillary lateral incisors did not reach Nolla stage 9 but were close to reaching this stage (Table 2).

Using the Erickson and Kurol (1988a)[8] overlap classification, 25% of the potentially ectopic maxillary canine cases presented with an overlap, the prevalence of which is shown in each age group in Table 3. Chalakkal *et al.,* (2011)[33] found that overlap displayed a prevalence of 73%. The difference seen was due to variations in criteria in the sample selection. Children between the chronological ages of 10 and 12 years were selected. These cases were clinically examined and only cases with unilaterally palpable maxillary canine bulges were included in the study. In the present study, 2.6% of the potentially ectopic maxillary canines overlapped the root of the lateral incisor mesial to the pulp chamber (Table 4). Chalakkal *et al.,* (2011)[33] found that 30% of the maxillary canines were positioned mesial to the root of the maxillary lateral incisors between the chronological ages of 10 and 12 years. In this study non-resorption of primary canines did not show a statistically significant association with mesial overlap ($p = 0.21$). This may have resulted due to the dental age at which mesial overlap is being identified. If non-resorption of primary canines and mesial overlap were studied in an older age group, the results may have been different. Mesial overlap is perhaps an extreme situation at dental ages 8-12 years but this needs to be further investigated.

Proffit *et al.,* (2007)[4] and Duterloo (1991)[5] suggested that resorption of the apical third of the root of the primary maxillary canines should have taken place at dental age 10. The high prevalence (83%) of non-resorption of primary canines at dental age 10 (Table 3) suggests one of two conclusions:

- A potentially ectopic maxillary canine is present and has not resorbed the root of the primary canine.
- The minor resorption of the primary maxillary canine was not clearly visible from the panoramic radiograph.

Between the dental ages of 10 and 12 years, there is a decline in the prevalence of non-resorbed primary canines (Table 3). As the permanent maxillary canine actively erupts during dental age groups of 10 to 12 years, the resorption of the root of the primary maxillary canine should occur at the same time.[4,5] Duterloo (1991)[5] also stated that resorption of the primary maxillary canine should take place at this age. It is therefore normal to find a decline in the number of non-resorbed primary maxillary canines from dental age 10 to 12 years as shown in Table 3.

Table 3: Prevalence of the radiographic markers, as seen at various dental ages, out of the cases deemed potentially ectopic.

Dental Age	Total n	Overlap (%)	Non-resorption of primary canines (%)	Angulated maxillary canines (%)	Mx. Enlarged (%)	Md Enlarged (%)
10	211	56 (26.5)	176 (83.4)	9 (4.3)	28 (13.2)	20 (9.5)
11	133	33 (24.8)	72 (54.1)	8 (6)	18 (13.5)	16 (12)
12	60	14 (23.3)	10 (16.7)	2 (3.3)	6 (10)	6 (10)
Total	404	103 (25.2)	258 (63)	19 (4.7)	52 (12.9)	42 (10.4)

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Table 4: Extent of overlap of the maxillary canine cusp tip over the root of the maxillary lateral incisor at ≥ 10 years (Total n=404).

n (%)									
No Overlap	**Distal to pulp chamber (distal overlap)**			**On the pulp chamber**			**Mesial to pulp chamber (mesial overlap)**		
	RHS	**LHS**	**BOTH**	**RHS**	**LHS**	**BOTH**	**RHS**	**LHS**	**BOTH**
301 (74.5)	32 (7.9)	25 (6.2)	14 (3.5)	12 (2.97)	7 (1.7)	2 (0.49)	5 (1.2)	5 (1.2)	1 (0.2)
Total n (%)				**103 (25.5)**					

The present study had one marker (non-resorption of primary maxillary canines) in common with the study conducted by Thilander and Jakobsson (1968).[29] The present study showed a prevalence of non-resorption of 16.7% at dental age 12 years (Table 3) compared to Thilander and Jakobsson (1968)[29] who recorded non-resorption of primary maxillary canines as 67% at chronological age of 12 years.

The fundamental problem is that early stages of root resorption are difficult to detect on a panoramic radiograph as it is two-dimensional and root resorption in the 3rd dimension may only be identified at a later stage or not at all.[21,34] Furthermore, the fact that overlap, particularly of the first premolars and the root of the primary canine at dental age of 10 years, is a complicating factor.[35]

This study showed 25.9% of the cases displayed an overlap (all types), when non-resorbed primary maxillary canines was viewed as the primary marker while 65% had non-resorption of primary canines when overlap (all types) was viewed as the primary marker (Table 5). The probability test findings suggest that non-resorption of the primary canines is more a consequence of potentially ectopic maxillary canines rather than a cause, thus concurring with the work of Ericson *et al.,* [19].

Warford *et al.,* (2003)[6] found a degree of overlap to be a significant predictor of maxillary canine impaction when compared to angulation of the maxillary canine. This was only possible because they had the impaction status of the maxillary canines, allowing them to run a logistic regression test between the two predictive markers. Since the present study could not determine the impaction status of the maxillary canines, their statement could not be verified. However, as the severity of overlap increased, potentially ectopic maxillary canines became less prevalent (Table 3). This suggests that an absence of the buccal canine bulge upon clinical examination (dental age ≥ 10 years) and identifying the degree of overlap on the panoramic radiograph could act as a good predictor of ectopic maxillary canines.

Although increased angulation showed a statistically significant association with overlap (all types), the statistical results above suggest that the marker did not add significantly to the prediction of ectopic maxillary canines when compared to overlap as a marker. Most of the maxillary canines positioned over the pulp chamber or mesial to the root of the maxillary lateral incisor will become impacted. Hence, the small increase that angulation contributes is not clinically significant. Angulation would only have significance in predicting impaction for the maxillary canines positioned distal to the root of the maxillary lateral incisor, confirming the work of Warford *et al.,* (2003).[6]

When non-resorption of the primary maxillary canine was the primary marker 6.6% of the cases had angulated maxillary canines greater than 300. When angulated maxillary canines greater than 300 was the primary marker (Table 5), 89.5% of the cases displayed non-resorption of primary canines. The probability tests in this study suggest that non-resorption of the primary maxillary canines is caused by an ectopically erupting maxillary canine and is not a cause of it thus confirming the work of Warford.

Maxillary canine enlargement was detected in 12.9% (52/404) of the radiographs studied (Table 3). When overlap was the primary marker, enlargement occurred in 15.5% of the cases. When enlargement was the primary marker overlap (all types) occurred 30.8% of the cases (Table 5). Maxillary canine enlargement resulted in no statistically significant association with distal overlap (p= 0.21), overlap over the pulp chamber (p= 0.64), and/ or mesial overlap (p= 0.45).

Other studies are yet to examine the relationship between these two radiographic markers. This study however, suggests that when the maxillary canine is palatally displaced and the maxillary canine bulge is not palpable by dental age 10, the maxillary canine is likely to overlap the root of the adjacent maxillary lateral incisor to some extent. As the dental age of the patient increases, the extent of the overlap may worsen.

Table 5: Occurrence of the other radiographic markers when the primary marker (grey block) already exists (n=404).

Non-resorption of primary canines	Overlap maxillary canines	Angulated	Mx. Enlarged	Md. Enlarged
258 (63.9)	67 (25.97)*	17 (6.6)	25 (9.7)	24 (9.3)
67 (65)*	103 (25.5)	13 (12.6)	16 (15.5)	10 (9.7)
17 (89.5)*	13 (68.4)*	19 (4.7)	0	0
25 (48.1)	16 (30.8)	0	52 (12.9)	25 (48.1)
24 (57.1)	10 (23.8)*	0	25 (59.5)	42 (10.4)

* indicates a statistically significant relationship with the primary marker (grey block)

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This result of this study suggests that if there is an ectopically positioned mandibular canine, there is a chance that an ectopic maxillary canine also exists (Table 5). Further investigations are needed to reveal any clear link between mandibular canine ectopia and maxillary canine ectopia.
Both maxillary canine enlargement and mandibular canine enlargement were identified in approximately 9% of cases when non-resorbed primary maxillary canine was the primary marker (Table 5). Non-resorbed primary maxillary canines occurred 48.1% of the time when maxillary canine enlargement was the primary marker and 57.1% of the time when enlarged mandibular canine was the primary marker (Table 5). Maxillary canine enlargement ($p = 0.32$) and mandibular canine enlargement ($p = 0.65$) did not show a statistically significant association with non-resorption of primary maxillary canines. This result could not be compared since no other studies have examined the relationship of these anomalies.

CONCLUSIONS

Dental age is an important aspect in the diagnosis of canine ectopia, as there is little correlation between dental and chronologic age.

From the dental age of 10 years, regular thorough clinical examinations, buccal bulge palpations and primary canine mobility assessments are vital to the monitoring of the developing canine. In patients with dental age greater than 10 years, the absence of the buccal canine bulge on clinical examination and identifying the degree of overlap on the panoramic radiograph, could be valuable indicators of maxillary canine ectopia.

Non-resorption of the apical third of the root of the maxillary canines at dental age 10 years should be interpreted with caution, as the early stages of root resorption can be difficult to detect on panoramic radiographs and overlap may be present between the first premolar and the root of the primary canine. The findings of this study suggest that non-resorption of the primary canines may more likely be a consequence of potentially ectopic maxillary canines rather than the cause of it.

Canines positioned over the pulp chamber or mesial to the root of the maxillary lateral incisor will most likely become impacted. Angulation would only be a significant predictor of ectopia for canines positioned distal to the root of the maxillary lateral incisor.

Clinicians who detect an enlarged mandibular canine on a panoramic radiograph i.e. a lingually displaced mandibular canine, should be aware of the possibility for the maxillary canine to also become ectopic as it should erupt a year after the mandibular canine. Since mandibular canines develop earlier than the maxillary canines, clinicians can take timeous interceptive measures if needs be.

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The oral presentation of secondary syphilis among men: the evolving interplay between and prophylactic strategies

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ABSTRACT

Syphilis has been intricately linked with HIV because of shared transmission pathways and because these infections promote each other's transmission. In addition, HIV infection may change the clinical presentation and management of syphilis lesions.

Initially, the HIV epidemic had improved safe sex practices among men who have sex with men (MSM), but subsequent effective treatment and prophylaxis strategies, have resulted in behavioural disinhibition and a resurgence of syphilis.

Aims and objectives

Here, we report on three cases of oral secondary syphilis and explore the relationship between oral syphilis and sexual practices, HIV and prophylactic measures that MSM employ.

Design/Methods

Three men, who presented to the University of Pretoria Oral Health Centre (UPOHC), complaining of oral lesions, were diagnosed by histopathology with secondary syphilis. The clinical appearance of the lesions, HIV status, treatment and prophylaxis employed by the men were documented.

Results

The clinical presentation, sexual practices, HIV status and prophylactic measures among these men differed and demonstrate the complexity of oral secondary syphilis diagnosis and management.

Conclusions

Syphilis presents variably in the oral cavity, and this may be linked to the sexual practices and HIV status of the patient.

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Author contribution:
Dr J Fourie: abstract, introduction, epidemiology, concept design and execution of the research paper (60%).
Dr L Mukucha: aetiopathogenesis, oral presentation, case 2 and 3 (20%).
Dr L Masuka: diagnosis and special investigations, treatment and measuring response to treatment, social strategies, case 1 (20%).

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INTRODUCTION

Syphilis is a sexually transmitted disease (STD) caused by the spirochete bacterium *Treponema pallidum,* subspecies *pallidum*.[1]

Genital syphilitic lesions significantly increase the risk of HIV transmission.[2-3] This resulted in an initial curb in syphilis prevalence, especially among men who have sex with men (MSM), due to safer sex practices.[4-5] However, oral sex may wrongly be considered a 'safe sex' practice, and subsequently, result in the oral transmission of other sexually transmitted diseases, such as syphilis. Barrier protection remains the most effective way to reduce the sexual transmission of diseases. And although pre-exposure prophylaxis (PrEP) is now offered as an additional precaution against HIV transmission, it may inadvertently result in behavioural disinhibition or riskier sexual practices.[6]

When syphilis is acquired through oral sex, a painless ulcer, known as a chancre, may develop at the site of inoculation. However, due to its short-lived and painless nature, the primary infection often goes unreported.[1] The secondary stage, however, has a varied clinical presentation and duration,[7] during which patients may search for treatment from dental clinicians.[7-8] Oral lesions of secondary syphilis have frequently been reported in the literature.[9-12] The variation in clinical presentation makes it difficult to make a clinical diagnosis,[12] and we therefore have to rely on histology and serology to reach a final diagnosis.[13-14] It is possible that concurrent HIV infection may further alter the oral presentation and management of secondary syphilis.[15]

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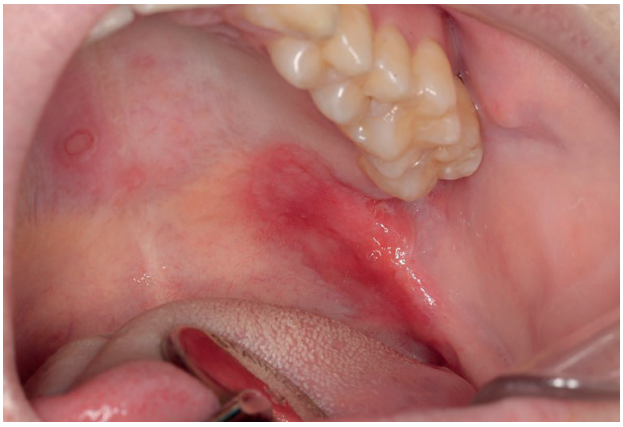
Figure 1: Palatal erosions in patient 1

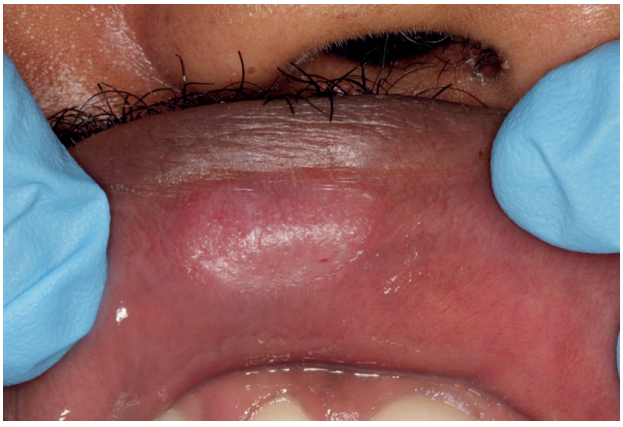
Figure 2: Mucous patch of the upper labial mucosa in patient 2

Here, we report on three cases of oral secondary syphilis and explore the relationship between oral syphilis and sexual practices, HIV and prophylactic measures that may be employed.

CASE PRESENTATIONS

Patients and methods: three male patients with oral secondary syphilis were identified at the Oral Medicine Clinic of the University of Pretoria Oral Health Centre (UPOHC) in 2021. The Research Ethics Committee granted a waiver of the need for written informed consent (University of Pretoria, Faculty of Health Sciences, Research Ethics Committee clearance number 379 2022). The data were anonymized at the stage of extraction from the patient charts.[4]

Case 1

A 26-year-old, white male presented with a complaint of an intra-oral 'rash' that had been present for the past four weeks. A saltwater rinse has helped to alleviate some of the sensitivity associated with the lesion. During the anamnesis, the patient reported being healthy, only smoking hubbly-bubbly and consuming alcohol socially. The patient practices sex with other men. Besides the palpable, rubbery, left submandibular lymph node, there were no other extra-oral abnormalities detected or reported by the patient. Intra-orally a large and irregularly shaped erythematous erosion was present on the left soft palate, with other, smaller and circular lesions starting to develop on the hard palate (Figure 1).

A differential diagnosis of an aphthous ulcer was considered, but the new lesions that started to occur on the hard palate, as well as the absence of a true break in the epithelium, discredited this differential diagnosis. Other possibilities, such as a deep fungal infection such as histoplasmosis or bacterial infection, such as tuberculosis, or oral syphilis, were also considered.

An incisional biopsy was performed on the lesion in the soft palate and the histopathological examination revealed hyperplastic stratified squamous epithelium with extensive neutrophilic exocytosis. Parts of the epithelium were ulcerated and covered by a fibrinopurulent membrane. The lamina propria consisted of a deep and dense plasmacytic infiltrate. Special stains with PAS did not demonstrate any fungal elements, and the Warthin-Starry stain showed isolated spirochetes at the basement membrane. Immunohistochemistry (IHC) for *T. pallidum* showed numerous spirochetes intra-epithelially as well as at the basement membrane. Overall, the features were in keeping with a syphilitic ulcer. The patient elected to have further laboratory investigations and treatment performed by his private medical doctor.

Case 2

A 29-year-old, African male complained of a lesion that moves around his mouth. Similar, painless, lesions developed 3 months earlier. These have all regressed with only the lesion of the upper lip remaining. The patient only experienced a tingling sensation associated with the lesion. The patient reports being completely healthy and occasionally consuming alcohol and smokes cigarettes. The patient has sex with men and had only a single recent sexual partner. He uses PrEP due to his concern for HIV infection.

No extra-oral abnormalities were noted or reported, and only a solitary, regular, and well-defined white plaque was noticed on the upper right labial mucosa (Figure 2).

Differential diagnoses for a white plaque such as discoid lupus, leukoplakia, chemical burn and a mucous patch of secondary syphilis were considered.

An incisional biopsy was performed and the histopathological examination revealed the presence of a mucosa surfaced by hyperplastic parakeratinising stratified squamous epithelium with marked acanthosis and severe inflammatory exocytosis. Dense lymphoplasmacytic inflammation was present in the lamina propria, which extended deeper around vascular channels. IHC staining for *T. pallidum* demonstrated the corkscrew-like spirochetes within the epithelium and the adjacent connective tissue and was therefore deemed representative of a mucous patch of secondary syphilis.

Subsequent serology (ELISA) confirmed that the patient is HIV naïve, while serology for syphilis confirmed the diagnosis with a Rapid Plasma Reagin titre of 16:1. Treatment was initiated with a single IM dose of 2.4 million units of Benzathine penicillin G (BPG).

Case 3

The third patient was a 46-year-old, African male who was referred by his local clinic. The patient complained about painful 'blisters' of his tongue that limited his tongue movement and had been present for more than a year. He

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believed this disease may have been sexually transmitted or due to his broken-down dentition. He practices sex with women and has many different partners. Earlier treatment with antifungal agents at his local clinic was not successful. The patient is HIV positive and on treatment with ART (absolute CD4 count = 878 cells/μL). He smokes cigarettes and consumes alcohol occasionally.

No extra-oral abnormalities were noted. Multiple intra-oral lesions were present which could all be characterised as white plaques, which varied in regularity and definition, and were sometimes bordered by a red rim (Figure 3).

Based upon the clinical presentation of numerous white plaques, differential diagnoses such as human papilloma virus associated lesions, leukoplakia, oral squamous cell carcinoma (especially of the irregular plaque of the left buccal mucosa), hyperplastic candidiasis and a mucous patch of secondary syphilis were considered.

An incisional biopsy was performed of the lower labial mucosa and the left buccal mucosa. The histopathological examination revealed that both specimens had similar histological features consisting of hyperplastic stratified squamous epithelium with extensive neutrophilic exocytosis. The lamina propria contained a dense and deep plasmacytic infiltrate. Special stains with PAS did not demonstrate any fungal elements, while the Warthin-Starry stain showed isolated spirochetes at the basement membrane. IHC for *T. pallidum* showed numerous spirochetes intra-epithelially as well as at the lamina propria, confirming the diagnosis of syphilis infection.
The patient was lost to recall, and serological confirmation could not be obtained, as the patient refused further management.

LITERATURE REVIEW AND DISCUSSION

History of syphilis

Syphilis has always been a stigmatized, contemptible disease. Countries have blamed other countries, as has been done with COVID-19, for outbreaks.[16] At first, syphilis behaved more aggressively, spread more rapidly, and evolved atypically, frequently resulting in death. But, over time, as immunity in the community grew, and certain strains of *T. pallidum* evolved, the disease became milder and more predictable.[16]

Syphilis was first recognised as a separate disease to other sexually transmitted infections (STIs) in 1831, and the bacterial aetiology established in 1905. Direct identification of the bacterium was made possible through dark-field microscopy shortly thereafter. The first serologic test, the *T. pallidum* immobilization test (TPI), only became available in 1949.[16]

Epidemiology

The epidemiology of syphilis and HIV is intricately linked by shared transmission pathways and risk factors. Particularly in MSM, patients with multiple sexual partners, sex workers, intravenous (IV) drug users and patients with a previous history of STIs.[3] So that HIV status became a significant predictor of syphilis prevalence.[17]

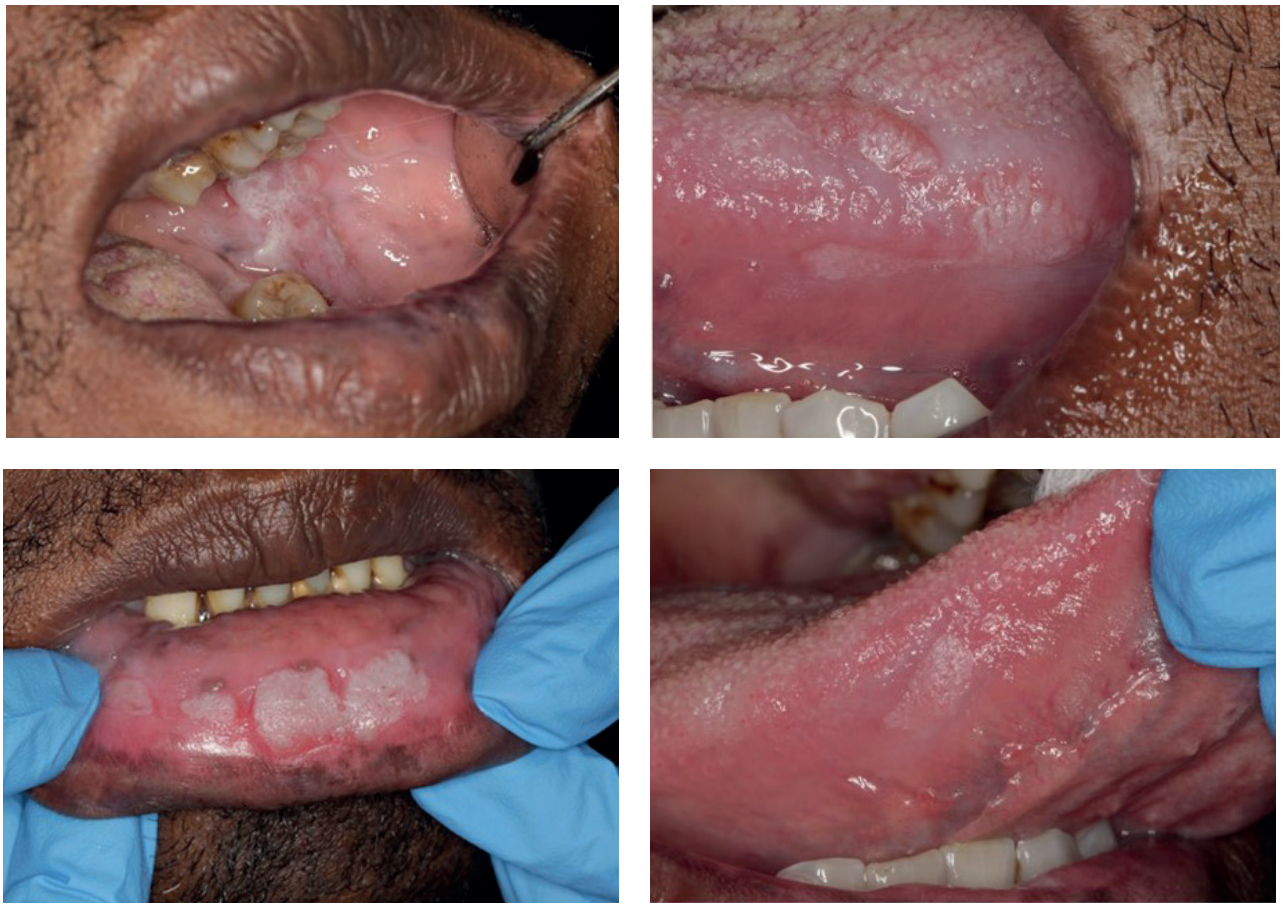

Figure 3 White plaques distributed over the lateral border of the tongue, buccal mucosa and lower labial mucosa in patient 3

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South Africa continues to see some of the highest rates of STIs. The adult population prevalence of syphilis has declined since 1990, likely due to improved treatment coverage, and was estimated at 0.50% for women and 0.97% for men in South Africa in 2017.[18] While the estimated overall HIV prevalence rate is approximately 13,0%, with the total number of people living with HIV estimated at approximately 7,8 million in 2020. For adults aged 15–49 years, an estimated 18,7% of the population is HIV positive.[19]

In England, Germany and the USA, the HIV epidemic resulted in a reduced prevalence of syphilis between 1980 and 2000, as MSM changed their sexual behaviour.[5, 4,20] However, a sudden and significant increase was subsequently seen from the beginning of 2000 with infection rates among MSM almost doubling.[5,4,20-21] The incidence of syphilis increased drastically among HIV infected MSM,[3] resulting in a 45.5% prevalence of syphilis, compared to only 8.8% of HIV infected men who have sex with women.[20] Furthermore, in a recent review of patients with secondary syphilis, 98% of patients were MSM, and almost a third of the population were co-infected with HIV.[12]

The increase in syphilis among MSM has been attributed to reduced condom use, more effective treatment of HIV and more recently, the use of PrEP, which have all resulted in riskier sexual behaviour.[22]

PrEP consists of a once-daily dose of tenofovir (TDF), with or without emtricitabine (FTC),[6] but can also be taken as an 'event-driven' approach.[23] PrEP has significantly reduced the incidence of HIV among MSM. However, by reducing the use of other primary prevention methods,[6,23] it may increase the risk of other STIs.[24] Therefore, it is imperative that MSM who start PrEP routinely (3 monthly) be tested for STIs.[6, 25, 22] In fact, bacterial STIs in MSM have reached almost the same numbers as was seen before HIV infection appeared in the late 1970s.[25] These infections can be addressed by the prophylactic use of doxycycline.[26, 27] Although PrEP does not necessarily result in risk compensation and is usually not the only preventive method employed, a gradual decline in condom use has been noted,[23] resulting in a subsequent increase in STIs.[24-25] Therefore, individuals using PrEP should receive ongoing education and counselling to emphasize the importance of condom use and safe sexual behaviour to ensure that risk compensation does not occur.[6] Pre-treatment, as well as continuous HIV screening, is essential during PrEP use, because undiagnosed infection may result in the development of drug resistance mutations, placing the cornerstone of ART at risk.[27]

Aetiopathogenesis and transmission

T. pallidum is an obligate human pathogen and spreads via infected blood, predominantly, through all means of sexual contact (vaginal, anal, and oral) when mucocutaneous lesions are present, but may also spread from mother to child.[1,28]

At the site of inoculation, *T. pallidum* replicates and enters the circulation, to disseminate systemically, resulting in three stages of infection: primary, secondary, and tertiary.[1,28] Syphilis is only transmissible during the first few years of infection, with sexual transmission being rare after 2 to 3 years of infection.[1] Syphilis infection is the result of unsafe sexual practices among both MSM and heterosexual individuals, suggesting either a lack of knowledge about transmission risks or that individuals have become complacent about the risk of acquiring STIs.[5]

HIV and syphilis are both acquired infections and often appear together as a co-infection. Besides the epidemiological relationship between HIV and syphilis mentioned earlier, there is also a plausible mechanistic relationship whereby these two infections increase the transmission of each other. Syphilis, because of its ulcerative nature which disrupts the barrier provided by the skin and mucous membranes, will increase the portal of entry and exit for HIV and therefore increase the chances of contracting HIV.[2-3,29] In addition, there is an influx of immune cells at the site of a syphilitic lesion, especially CD4+ cells, which increases the target cells for HIV.3,[30-31] *T. pallidum* itself increases the expression of HIV co-receptors on macrophages and other dendritic cells (CCR5) allowing efficient entry of HIV into target cells.[32] Syphilis may also change the course of HIV disease by inducing a decrease in the CD4 cell count and an increase in the HIV viral load in HIV infected patients.[33, 3]

Screening for HIV and other STIs should be done at the time of syphilis diagnosis as well as 3 months later, while HIV-infected patients should undergo regular screening for syphilis.[3,5,34-35] Although syphilis may be transmitted through oral intercourse,[36-37] oral sex is generally considered a low-risk sexual activity for contracting HIV, and therefore usually not protected through barrier use.[38] Yet, HIV can be transmitted through receptive oral intercourse,[39-40] and should therefore be included in safer sex counselling.[41] The risk of HIV transmission is increased when the oral mucosa is compromised by dental procedures, allergies, pharyngitis, chemotherapy or periodontal disease.[42]

Subsequently, and because high-risk sexual practices are normally not isolated,[42] patients may choose to take PrEP against HIV, yet, unwittingly expose themselves to other STIs, such as syphilis.

Oral presentation

Acquired oral syphilis presents as primary, secondary and tertiary infections, most commonly among men (78,9%) in the 3rd and 4th decades of life, favouring in order of frequency the tongue, palate, lips, buccal mucosa, labial commissure and gingiva,[8,43] similar to our patients.

The chancre is the hallmark feature of primary syphilis, appearing 2-3 weeks after exposure at the site of inoculation and healing within 2 - 10 weeks.[1,37] The oral cavity is the most common extra-genital site to be affected,[10-11] and then mostly affects the tongue, lips, and palate.[44] The oral sites of involvement used to show a gender predilection according to the sexual acts performed,[9] but sexual orientation has changed this arbitrary association.

Given its painless and self-limiting nature, chancres are often not reported by patients, or may even go unnoticed.[1,45] Yet, with its deep, red, purple or brown base and the irregularly raised border, oral squamous cell carcinoma and traumatic ulcers should be excluded.[9] Neither of our patients reported the original ulcer and did not even recall it upon questioning.

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The secondary stage of syphilis is characterised by systemic symptoms such as pharyngitis, myalgia, arthralgia, lassitude, headache and generalised lymphadenopathy, but these are only variably present.[10] It is mostly the secondary stage of syphilis that is associated with oral mucosal lesions[7-8] where it may be seen in up to 30% of patients and it may even be the sole manifestation.[9-12]

The literature paints varied pictures of the oral lesions of secondary syphilis and the terminology is not uniformly applied. Essentially, there may either be a sensitive white plaque known as a mucous patch (note the dichotomy of terms by naming a plaque as a patch), which may ulcerate, or papillary to nodular lesions which resemble viral papillomas and have therefore been named 'condyloma lata'.[9,45-46] The hyperplastic epithelium of condyloma lata may be mistaken for condyloma acuminatum and other papillomatous lesions,[45] but these are much more frequently found on the skin than the oral mucosa.[47]

The traditional snail track pattern is created by the merging of adjacent mucous patches. When necrosis and sloughing of the epithelium from a mucous patch occurs, the underlying, red, connective tissue is exposed[7,9] leaving a clean based, non-purulent ulcer as in our first patient.[37] This appearance is sometimes known as a 'syphilitic rosette', is generally painless, well defined and commonly involves the tongue, gingiva, soft palate and lips.[37] Some authors wish to separate the ulcerative aspect from the plaque-like aspect of mucous patches because these are so dissimilar.[15]

Mucous patches may also take on a 'leukoplakia-like' or 'leukokeratotic' appearance, which appears as a well-defined, corrugated, and non-homogenous plaque as seen in our second and third cases.[7,12,48-49] Other, less frequently encountered oral lesions include *plaques en prairie fauchée* (shallow, painful, round to oval erosions/ depapillation on a background of a whitish, non-removable hyperkeratotic thickening of the posterior dorsal aspect of the tongue) as well as *fausse perlèche* when a mucous patch creates a painful split papule a the angle of the mouth.[11]

Although lesions are not usually symptomatic, [8,12,37] when the tongue is involved, the patient may complain of an altered taste sensation as well as a burning sensation of the tongue.[11]

The oral mucosal lesions of secondary syphilis often mimic other diseases and have therefore become known as the "great imitator",[1,7] from mimicking oral herpes infection[8,50] to lymphoma.[46] This varied clinical appearance makes a clinical diagnosis challenging, especially for clinicians who do not frequently encounter the disease. Differential diagnoses that may be considered for secondary lesions of oral syphilis will vary depending on the clinical characteristics (Table I);[43] but syphilis should always be considered in the presence of non-specific oral ulcers and erosions, where there is a discrepancy between clinical and histological findings, and especially when the systemic symptoms and social history are suspicious.[4,8] However, in a high-risk population of HIV+ MSM, the oral lesions are often conspicuous enough to make a diagnosis.[4,15]

It is not infrequent that patients will have been treated by different clinicians and by various means before a final diagnosis is established,[10-12,45,53] especially when only isolated oral lesions are present.[12] The diagnostic delay increases the risk of transmission from these highly contagious lesions because of the high number of spirochetes.[4,28] However, even in the absence of an accurate diagnosis and successful therapy, the lesions will eventually resolve, committing the patient to a latent, non-infective state, until the tertiary stage is reached.[53]

The relative prevalence of the different oral lesions of secondary syphilis varies in the literature. Among an HIV+ population, mucous patches accounted for 85.5% of lesions.[15] However, others found that ulcerative lesions are seen slightly more frequently[10,12] and that when oral lesions were the sole presentation, 86% of lesions were erosive or ulcerative.[12] Nodular (10%) and leukokeratotic lesions (5%) of the tongue are seen much less frequently.[12]

Tertiary syphilis is the most serious of all the stages of syphilis as it may involve the central nervous system and cardiovascular system.[1] Oral features of tertiary syphilis include gumma, atrophic luetic glossitis and syphilitic leukoplakia.[8] The opportunity to successfully diagnose and treat a patient during the secondary and last clinically evident phase of the disease, should therefore not be missed.

Some authors have suggested that the clinical manifestations of syphilis, and response to treatment, may differ in people living with HIV.[1,15] Yet, it appears that for genital lesions, at least, there are only minor differences: the primary infection may be accompanied by multiple ulcers and the secondary infection with a greater likelihood of concomitant genital ulcers.[54] When oral lesions were the sole manifestation of syphilis, the prevalence of individual lesions was similar between HIV-infected and uninfected individuals.[12] Yet, it is not clear from this study if the distribution or number of lesions differed between these populations. Among our patients, the third patient who was HIV positive, presented with a wider variety and distribution of lesions, as well as a

Table I: Differential diagnoses to consider for oral lesions of secondary syphilis [48,4,51,8,15,52]

Clinical presentation	Differential diagnosis
White plaques	Oral hairy leukoplakia (lateral border of tongue) Leukoplakia Oral lichen planus Hyperplastic candidiasis
Ulcerative	Secondary herpetic infection (hard palate) Recurrent aphthous ulcers (soft palate) Granulomatous infections Mucous membrane pemphigoid Adenocarcinoma Necrotising sialometaplasia Kaposi sarcoma
Red macular and papular lesions	Erythematous candidiasis Erythroplakia Lupus erythematosus
Nodular lesions	Viral papillomas Mesenchymal neoplasms Lymphoma
Serpentine pattern	Benign migratory mucositis

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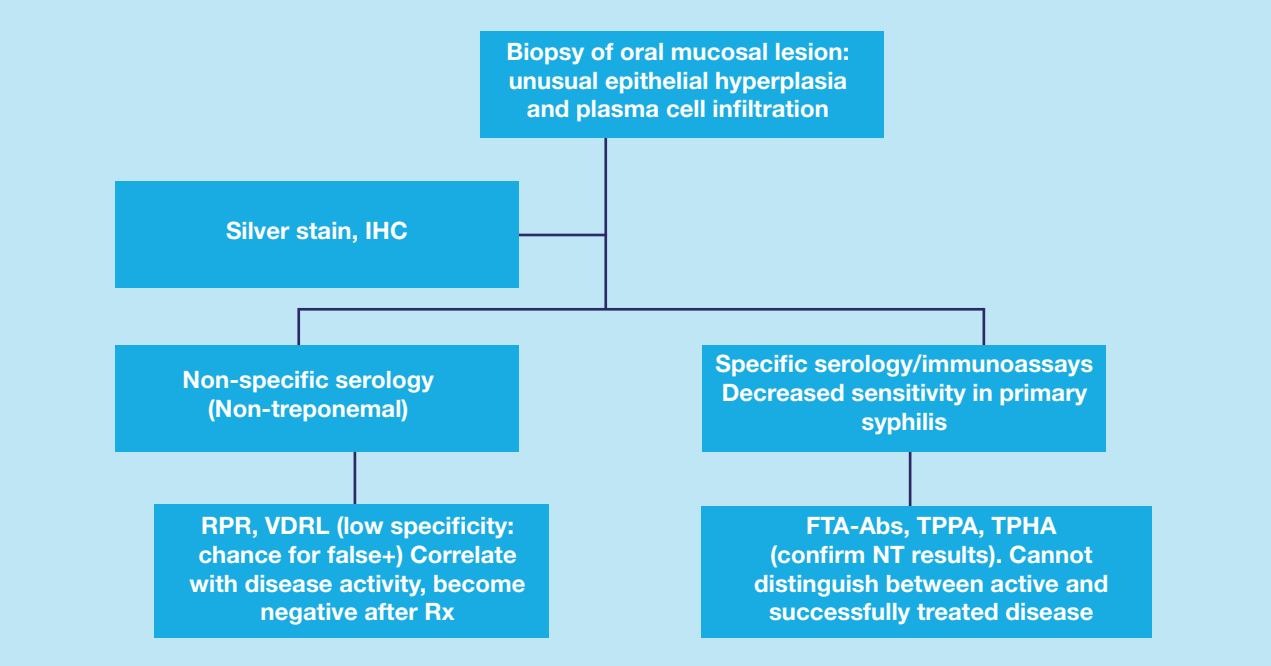

Figure 4: Flow diagram of diagnostic processes following an incisional biopsy

much longer duration of lesions. However, given his sexual history, repeated re-infection may have been responsible for his persistent disease.

Diagnosis and special investigations

As oral medicine clinicians, and given the relatively infrequent and varied presentation of oral syphilis, our first instinct had been to perform biopsies for histopathological analysis.[10,12-13,43] This strategy allowed for the identification of the spirochete through immunohistochemistry (IHC) and/or a silver stain (Warthin-Starry). Which in all instances still required serological confirmation. However, histology is not a primary requirement in the diagnoses of oral secondary syphilis lesions, as a more astute clinician can make the diagnoses through clinical findings, sexual history,[5] and serology alone.[15,43]

T. pallidum, cannot be cultivated in the laboratory, therefore other laboratory investigations are necessary.[14,55] These may be through the direct identification of the spirochete in tissue samples or, indirectly, by measuring the host's immune response to the organism or its components.[14] Yet, there is no single test with adequate sensitivity or specificity that can diagnose syphilis with 100% accuracy during all stages of the disease.[55]

Darkfield microscopy (DFM) can demonstrate the presence of spirochetes in lesion exudate, which makes it most suitable for primary lesions,[56-57] but it is hardly used for oral lesions due to the risk of nosocomial infection and confusion with other oral treponemes.[9] A histology specimen allows for the direct identification of the tissue spirochetes. This is usually done through silver staining of specimens but this technique is difficult and non-specific due to the presence of non-treponemal spirochetes in the oral cavity, has low sensitivity, and is time-consuming.[9,13-14] In fact, a recent review estimated silver staining to have a sensitivity as low as 0-41%.[55] The oral cavity harbours a multitude of spirochetes, the most common of which is *Treponema denticola*, known for its association with periodontal disease.[58] The oral, non-pathologic spirochetes, should only be demonstrated on the surface of the epithelium and should not be seen invading the mucosa,[45] while *T. pallidum* can be seen in the superficial epithelium, next to blood vessels, macrophages and endothelial cells.[9,13] Direct fluorescent anti-*T.pallidum* antibodies (DFA) and PCR can also be used, with immunohistochemistry (IHC) having improved upon the sensitivity and specificity of silver staining, locating the spirochete in the precise location in the lesion.[14,55] PCR has the greatest sensitivity when the sample was obtained from the primary lesion exudate (75-95%).[55] These direct detection methods were developed to address the shortcomings of serological assays, particularly for the diagnosis of primary disease.[55]

The histologic features of syphilis lesions are mostly non-specific but one hallmark of primary and secondary syphilis is plasma cell infiltration.[9-10,13] While this is a common occurrence in oral mucosal biopsies when this infiltrate extends more deeply and in a band-like distribution into the submucosa, syphilis should be suspected (Barrett 2004).[13] The plasma cells may even infiltrate the walls of blood vessels and nerve bundles, consistent with plasma cell arteritis, peri-arteritis, and plasma cell neuritis, and should be considered pathognomonic of oral syphilitic lesions.[10]

Intra-epithelial micro-abscesses and unusual epithelial hyperplasia[7,10] may also be seen. These histological features may be sufficient to direct the clinician in performing a serologic syphilis screen.[10] If special stains are not performed due to stronger consideration being given to other clinical diagnoses, histopathology may not be sufficient to make a diagnosis.[7]

Besides the difficulty of distinguishing other oral spirochetes from *T pallidum* when direct detection methods like DFM and silver stains are used,[14,57] three other pathogenic spirochetes can cause human treponemal diseases so that even serology is not entirely specific for syphilis.[1] The bacterial family members cannot be distinguished from one

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another, either by morphological, chemical or immunological means.[16]

The indirect detection methods have excellent sensitivity during secondary and later stages of the disease (>95%) but are very unreliable during primary infection,[9,59] with false-negative results obtained in up to 46% of patients.[55]

Serologic tests are divided into treponemal and non-treponemal tests. Non-treponemal tests are non-specific and are often used for screening purposes, these include the Venereal Disease Research Laboratory (VDRL) and more commonly, the Rapid Plasma Reagin (RPR) tests which detect IgG and IgM antibodies against synthetic cardiolipin, cholesterol, and lecithin antigen complexes.[14,28,60] But because these antibodies are not specific for syphilis, the results need to be confirmed with a treponemal test.[59] Non-treponemal test reactivity regresses after successful treatment of syphilis,[55,60] although false positives may sometimes be seen after successful treatment.[55] It is less likely for HIV naïve patients to have false-negative titers, while HIV infected patients are more likely to have false-positive RPR results[34] – yet, the impact of HIV on serologic titers probably has minimal clinical significance.[3] Serologic tests remain accurate and reliable for diagnosing and monitoring the response to treatment, in patients with HIV.[34] Refer to Figure 4 for a flow diagram of diagnostic procedures that are followed to confirm a syphilis diagnosis after performing a biopsy.

Treponemal tests include *T. pallidum* particle agglutination (TPPA), fluorescent treponemal antibody absorption test (FTA-ABS), and *T. pallidum* hemagglutination assay (TPHA) which detects IgG and IgM antibodies against *T. pallidum* or their proteins.[14] Treponemal tests become reactive shortly after a new infection and remain reactive regardless of treatment.[9,60]

While traditionally, the non-treponemal tests have been used for screening purposes, recently, with the increasing availability of immunoassays, a reverse algorithm has been suggested whereby screening is performed by treponemal immunoassay and then confirmed by non-treponemal or treponemal serology. The benefit is that immunoassays are more sensitive than non-treponemal tests during secondary and tertiary syphilis and eliminate the risk of biological false positives of anti-cardiolipin antibodies from other diseases.[59]

Treponema, point-of-care tests for syphilis are now available and recommended in resource-limited settings, providing results in 15 – 20 minutes, and are more cost-effective in screening and treating syphilis than laboratory-based methods, such as RPR. However, as with other treponemal tests, it is not possible to distinguish between current and past infections. Dual syphilis and HIV infection point-of-care tests can be used in populations at high risk of dual infection, hopefully paving the way towards home-based self-testing.[25]

Treatment and measuring response to treatment

The treatment of syphilis has evolved from the earliest use of purgatives to mercury, and finally, since its introduction in the 1940s, penicillin, which continues to be the treatment of choice.[16]

The treatment of syphilis depends on the stage of the disease,[62] either early or late (including unknown) stage syphilis (Table II). Cefixime, a 3rd generation cephalosporin, has shown promising results in an HIV+ population when given a dose of 400mg twice daily for 10 days during early-stage disease.[63] But evolving resistance to the macrolide antibiotics, makes this a dubious choice among penicillin-allergic patients.[64] The extended protocols of late-stage syphilis are suggested due to the probable slower replication rate of *T pallidum.*[34]

Clinical and serological evaluation should be performed at 6 and 12 months after treatment, or more frequently (3 monthly) if re-infection is a concern, especially among patients with HIV.[34] Re-infection is particularly likely if clinical signs and symptoms persist or when there is a fourfold increase in non-treponemal test titre.[34] Successful treatment should result in a 4 fold decline in RPR and VDLR titres,[34-35] failure of which will require additional clinical and serological follow-up and screening for HIV infection.[34]

Initially, it was believed that the dose and duration of treatment of syphilis should be adjusted among HIV-infected patients.[5] Some report that serological failure is more likely, and that serological success may take twice as long to reach within an HIV-infected population[65-66] but that it does not affect the cure of lesions.[66]

Yet, the CDC recommends that the same treatment of early syphilis be employed in both HIV-infected and uninfected populations,[34] admittedly, even though some feel that the evidence for this strategy is not optimal nor found in objective data.[67-68]

Neither increasing the single dose of BPG, to 3 weekly doses nor the addition of a 10-day course of amoxicillin with probenecid, improves serological outcomes beyond what is achieved with a single dose[35,66,69-70] regardless of the CD4 count.[35] Although a faster serological response has been reported in patients with higher pretreatment titres

Table II: WHO and CDC recommended treatment of syphilis [34,61]

Early syphilis of less than 2 years duration				Late, or unknown stage of syphilis
	Dose	Administration	Duration	
Benzathine penicillin G	2.4 million units	IM	Single-dose	3 weekly doses
Penicillin allergy				
Doxycycline	100 mg	oral	Twice daily, 10-14 days	30 days
Ceftriaxone	1 g	IM	10 – 14 days	
Azithromycin	2 g	oral	Single-dose	

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and CD4 counts.[70] Serological failure may be attributed to re-infection,[35] necessitating serological monitoring and retreatment if a failure occurs.[67]

Partner notification or contact tracing is essential for the management of syphilis.[5,71] Health care providers should routinely obtain sexual histories from patients to address risk reduction and offer to counsel as needed.[34,72] Clinicians should continue to encourage safe sexual practices and the use of condoms by those having sex with unknown partners.[5]

Case-control management is an integral part of an STI control strategy because early treatment can disrupt onward transmission if treatment and partner notification are successful. Most patients are willing to self-notify partners of STIs.[25] However, the sex partners of persons with syphilis who are deemed at risk of infection, especially within the first year of diagnosis, may confidentially be notified, and pre-emptively treated if deemed necessary.[34]

CONCLUSION

The three presented cases not only highlight the diversity of oral lesions associated with syphilis, but also the diverse male population that it affects. From the naïve patient who unwittingly puts himself at risk by having sex with men, to the HIV naïve patient who conscientiously uses PrEP, but inadvertently exposes himself to other STIs, and the HIV-infected patient who knowingly participates in high-risk sexual behaviours. This historic disease continues to burden men with high-risk sexual behaviours. Despite the earlier decline in syphilis numbers that the risk of HIV has caused, the successful prevention and management of HIV have resulted in a behavioural disassociation, even though the risk of STIs remains. The use of barrier protection remains essential in the prevention of STIs.

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Adverse drug reactions, a guide for dentists

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ABSTRACT

Adverse drug reactions (ADRs) are unintended or harmful effects due to the use of a medicine. Antibiotics and analgesics, which incidentally, are commonly prescribed by dentists, result in most of the ADRs globally. As with most healthcare professionals, dentists do not report on ADRs regularly. Therefore, the aim of the review was to explore the drugs most used in dental practice in South Africa (SA), their associated ADRs and the ADR reporting channels.

The study undertook a literature review that focused on studies of adverse drug reactions specifically in dental practices. An electronic search was done on EBSCO host to source articles published from 2000 to 2022. There was a plethora of ADRs that were found to occur with the medicines that are prescribed by dentists that ranged from minor to serious. Although all medicines have a risk of ADRs, amoxicillin can result in gastrointestinal disturbances and anaphylactic reactions, while clindamycin has a risk of Clostridium difficile infection.

Patients need to be alerted to the risk of a disulfiram reaction with metronidazole and alcohol. Hepatic failure can occur with paracetamol use especially in patients with underlying liver disease, an alcoholic or in an overdose. Ibuprofen, caution in patients with underlying ulcers as gastrointestinal bleeding is a risk. Local anesthetics pose a high threat of severe reactions such as tissue necrosis and direct neurotoxicity while anterograde amnesia, respiratory depression and thrombosis can occur with benzodiazepines.

Dentists can prevent ADRs by having a good knowledge of their prescribed drugs, monitoring their patients and by being judicious in their prescribing habits.

Keywords

Adverse drug reactions, dentists, adverse drug reaction reporting, SAHPRA

INTRODUCTION

Adverse drug reactions (ADRs) are unintended or harmful effects attributed to the use of a drug. Unrecognized ADRs may have significant financial consequences for the patient. Globally, studies show that antibiotics and analgesics are among the leading causes of ADRs and coincidentally are also commonly prescribed by dentists.[1,2]

Although, most of these reactions are dose-dependent and predictable, reactions like allergic and idiosyncratic reactions can occur and are unrelated to the normal pharmacological action. ADRs may be compounded (aggravated) by drug-drug interactions, drug- food interactions, drug-physiology interactions and underlying comorbidities of the patient.[3]

Recognizing, managing, and reporting ADRs or any other complications is critical to medication adherence, improving clinical outcomes, and the patients' overall health. The patient's medical history should be evaluated, and the patient counselled on possible adverse effects, before prescribing medications to reduce the risks of ADRs, and increase compliance.[7] As in medical practice, underreporting of ADRs among dental professionals is a common phenomenon.[4-6] Therefore, this study explores the drugs most commonly used in dental practice in South Africa (SA), their associated ADRs, the importance of ADR reporting, and the ADR reporting channels.

DRUGS USED IN DENTAL PRACTICE

Dentists most commonly use antimicrobials (antibiotics, antifungals, antiviral agents), analgesics (non-steroidal anti-inflammatory drugs (NSAIDs), paracetamol and opioids), local anaesthetics (lidocaine, articaine, lignocaine, mepivacaine), sedatives and general anaesthetics (nitrous oxide, midazolam). Systemic and topical corticosteroids may also be used to manage post-operative inflammation and treat oral immune-mediated diseases.[8]

ANTIMICROBIALS

Antibiotics

Antibiotics are prescribed for the treatment of bacterial infections, most commonly of pulpal and periodontal origin. However, it may also be used to prevent cardiac and joint complications due to bacteremia in high-risk patients and local complications following surgery.[9,10] They are used

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Neelaveni Padayachee conceptualised and drafted the idea for the paper. She contributed to researching and writing part the sections on the policy of the paper. She also edited and reviewed the paper for language and content

Deborah Matesun researched and wrote about the drugs involved in dental practice and assisted with the referencing of the article

Mafora Matlala assisted with the language editing and content review for the paper

Rajesh vagiri assisted with language editing, researching and writing the introduction and conclusion for the paper

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Table I: Commonly used antimicrobials in dentistry and their Adverse Drug Reactions[27]

Drug Category	Examples	Adverse Drug Reactions	Frequency/ Severity	Special Warnings/ Precautions
Antibiotics	Amoxicillin	Gastrointestinal symptoms Opportunistic infections (mucocutaneous candidiasis, clostridium difficile diarrhoea) Cutaneous symptoms (urticaria, pruritus, flushing, angioedema)	Common; mild Common; severe[28] Common; severe[29]	In cases of any hypersensitivity skin reactions, treatment should be discontinued.
	Amoxicillin/ clavulanic acid	Hypersensitivity (Same as for amoxicillin) Hepatotoxicity (marked elevations in AST and ALT)	5-10%; severe[30] Rare; moderate	
	Metronidazole	Gastrointestinal symptoms Nervous system reactions such as seizure Altered taste Disulphiram type reactions; flushing, Headaches, cardiac palpitations[31]	Very common; mild Rare; potentially severe Common; mild Rare; severe (potentially life threatening)	Patients should avoid alcohol intake for at least 3 days after completing full treatment course
	Clindamycin	Gastrointestinal effects (diarrhoea is most common)[32] *Clostridium difficile* infection Eosinophilia, skin rash, redness Rheumatoid arthritis, hypotension, renal changes (proteinuria or azotemia)[33] Hematological reactions (neutropenia, agranulocytosis)	Very common; mostly mild Common; severe (life threatening) Rare; mild Rare	High risk of *clostridium difficile* infections in patients taking clindamycin compared to other antibiotics. In cases of prolonged diarrhoea with fever, blood in stool or urine, patients should be advised to contact clinician for prompt evaluation of clostridium difficile infection
	Azithromycin[34]	Gastrointestinal symptoms Clostridium difficile infections Cardiovascular reactions (QTC prolongation in the cardiac cycle) Nervous system reactions (altered taste, dizziness, and somnolence)	Common; mild Common; severe life-threatening Common; severe	Azithromycin should be used with caution with other medications such as antipsychotics and antidepressants which can cause QTC prolongation
Antifungals	Topical Miconazole, nystatin and clotrimazole	Nausea, dry mouth, tongue discolouration, taste abnormalities.	Common; mild	
	Systemic Fluconazole	Gastrointestinal symptoms Neurologic effects; dizziness, headache, dysgeusia Pruritus, rashes, angioedema, exfoliative cutaneous reactions, insomnia, seizures Hepatotoxicity	Common; mild Common; mild Uncommon; severe Severe	

either empirically based on the anticipated microbiology of odontogenic infections, or based on antimicrobial susceptibility testing.[11,12] Short courses of antibiotics (3-7 days) are effective in managing dental infections. In SA, the most prescribed antibiotic in dental practices is amoxicillin.[13,14] Azithromycin, a macrolide antibiotic, is not suggested as first-line treatment, but may be considered as an alternative for the patient with suspected or confirmed penicillin allergy.[15,16]

Amoxicillin, a penicillin-like antibiotic is bactericidal and acts by inhibiting cell wall synthesis in susceptible organisms.[17] It is s the first drug of choice in treating odontogenic infections.[18,19] A combination of amoxicillin and clavulanic acid, a beta lactamase inhibitor, is also commonly administered due to its lower level of bacterial resistance, extended spectrum of activity and convenient dosing characteristics.[20] Amoxicillin is relatively safe in non-allergic patients and has the lowest reported rate of ADRs compared to other antibiotics.[19]

Metronidazole inhibits nucleic acid synthesis with intracellular macromolecules. It is prescribed as an adjunct to penicillin in severe infections such as severe periodontitis. Additionally, it can be used to treat cases of predominantly anaerobic infections. Metronidazole and alcohol should not be used in combination due to a disulfiram reaction. Metronidazole causes an increase in acetaldehyde because it inhibits the enzyme acetaldehyde dehydrogenase in the ethanol degradation pathway. Patients present with flushing, headache, nausea, and cardiac palpitations and alcohol must be avoided for 3 days after use of metronidazole.[17,21]

Clindamycin is a lincosamide antibiotic which inhibits protein synthesis by reversibly binding to 50S ribosomal subunits and a good choice for penicillin sensitive patients.[22] It is known for its good oral absorption (low incidence of bacterial resistance and high antibiotic concentrations reached in tissues, including bone.[23] Nevertheless, there is a greater risk

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of *Clostridium difficile* infections reported with clindamycin compared with other antibiotics prescribed in dentistry.[24] The anaerobic gram-positive bacteria, *Clostridium difficile* is transmitted via the fecal-oral route in humans and the usage of ampicillin, amoxicillin, cephalosporins and clindamycin are commonly associated with an increased risk of *C. difficile* infection. Watery diarrhea, fever, nausea, abdominal pain, nausea, vomiting, weakness, and loss of appetite are common features of *C. difficile.*[25,26]

ANTIFUNGALS

Oral candidiasis, caused by *Candida albicans*, is managed topically (using miconazole or nystatin) or systemically with fluconazole and itraconazole. Topical antifungals such as nystatin have few and mild adverse effects because of their limited absorption. However, patient compliance to topical formulations such as nystatin oral suspension may be compromised by unpleasant taste, frequent application, and lengthy use and its prolonged treatment pattern.

In general, the principal risks associated with antibiotics are opportunistic infections, especially oral candidiasis, and gastrointestinal disturbances such as nausea, vomiting and diarrhea, often due to the disruption of the gut flora.[27] A summary of the commonly used antimicrobials and their adverse reactions are provided in Table I.

ANALGESICS

Dentists most commonly prescribe two types of analgesics: non-narcotic analgesics (paracetamol and non-steroidal anti-inflammatory drugs) and narcotic analgesics (opioids). Paracetamol is used for treating mild dental pain when NSAIDs are contraindicated. It is one of the safest analgesics when administered to healthy individuals in usual therapeutic doses.[35] However, hepatotoxicity may be a concern due to the buildup of N-acetyl-p-benzoquinone imine, a potentially toxic metabolite, in individuals with compromised liver function (such as alcoholics) or in cases of overdosage.[36] The commonly accepted maximum dosage of acetaminophen in a healthy individual is 4 g per day. However, the Food and Drug Administration recommends a maximum dose to 3 g per day to reduce the risk of severe liver injury.[37]

NSAIDs are the first line of analgesics in treating dental pain, with ibuprofen prescribed most for mild odontogenic pain. It is usually prescribed either alone and in combination with paracetamol.[38] Occasionally, maxillofacial surgeons also prescribe etoricoxib and celecoxib, a selective COX-2 inhibitor as short-term treatment for mild to moderate pain associated with dental surgery.[39] Due to its selectivity, etoricoxib and celecoxib is usually considered in patients at risk of gastric ulceration or those taking blood thinners such as warfarin.[40]

Opioids produce analgesia by activation of opioid receptors and are used for managing moderate or severe dental pain. When NSAIDs combined with paracetamol, does not yield sufficient pain relief, a weak opioid analgesic such as tramadol, may be added. However, a short course of a strong opioid, such as oxycodone, may be used in patients suffering from insomnia due to severe pain.[41] These patients should be closely monitored due to the high risk of ADR such as constipation. Table II highlights ADR of commonly used analgesics in dentistry.

LOCAL ANAESTHETICS AND THEIR VASOCONSTRICTORS

Local anesthesia is commonly used in invasive dental procedures, and include lidocaine, articaine, prilocaine, lignocaine and mepivacaine. These can be applied topically (not all are available as topical preparations) or injected for local infiltration or nerve blocks. Local anaesthetics (LA) are often combined with a vasoconstrictor such as epinephrine, to retain the LA to increase the duration of action, and limit systemic absorption .[42]

Local anaesthetics are generally considered safe but can cause systemic and local toxicity due to the irritating nature of the solution, pressure from large volumes, or vasoconstriction.[43] The dose and concentration should be

Table II: Commonly used analgesics in dentistry and their Adverse Drug Reactions[17]

Drug	Name	Adverse Drug Reactions	Frequency/Severity	Special Warnings/Precautions
Non-narcotic drugs	Paracetamol[36]	Gastrointestinal reactions Non-narcotic drugs Hepatotoxicity Pruritus, erythematous skin rashes Blood dyscrasias	Common; mild Uncommon; severe Rare; mild Uncommon; severe Rare; mild	In cases of compromised liver function, overdoses, individuals with high alcohol intake or patients taking enzyme-inducing drugs (e.g., anti-epileptics and rifampicin), hepatotoxicity is a major concern.
	NSAIDS Ibuprofen	Gastrointestinal ulceration and bleeding Bronchospasm Renal dysfunction/ cardiovascular events (elevated blood pressure) Nervous reactions (dizziness)	Common; severe Rare; severe Rare Common; severe	Caution is required in patients with a history of hypertension and/or heart failure as fluid retention and oedema have been reported. Risk of gastrointestinal bleeding is higher with increasing doses. NSAIDs should be used at the lowest effective dose for the shortest duration.
Narcotic drugs/ opioids	Opioids	Dose-dependent respiratory depression sedation Gastrointestinal upset, including constipation and emesis Mood alterations (euphoria or dysphoria) Opioid abuse and addiction	Common; severe Common; mild to severe Common Common	

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tailored towards each patient to prevent potential adverse reactions. Table III details the adverse reactions relating to local anaesthetics and their vasoconstrictors.

SEDATIVES AND GENERAL ANAESTHETIC AGENTS

Sedatives and general anaesthetics are classes of drugs which induce sedation, altered consciousness, and reduces anxiety during major dental procedures. They are broadly classified into three categories: oral sedation (diazepam), inhalation sedation (nitrous oxide) and intravenous sedation (propofol, midazolam). Commonly reported ADRs to this class include nausea, vomiting, headache, slurred speech, dry mouth, dizziness, chills, and lockjaw.[46] Respiratory depression is a major ADR following the administration of sedatives and general anaesthetic agents[47](Table IV). Most adverse reactions to these drugs are dependent on the level of sedation and the number of agents being administered, with more severe effects occurring at high doses and combination therapy.

SYSTEMIC AND ORAL CORTICOSTEROIDS

Both oral and topical corticosteroids have a wide range of uses in dentistry. For example, oral cortisones are used to reduce pulpal inflammation or for post operative inflammation while topical steroids are used for the treatment of lichen planus. However, although useful, corticosteroids pose risks which are dependent on the route of delivery (topical, oral, inhaled, intranasal or intravenous), the length of time that was taken, the type and strength of the cortisone, dosing schedule and systemic other factors. A low dose cortisone is 10mg or less, while a moderate dose is 15-40mg and high dose is over 40mg. Increases in blood sugar and behavioral changes are potential concerns with short-term use of cortisones, while osteoporosis, oral candidiasis, cataracts, glaucoma, arthritis, hypertension, myopathy, Cushing's disease and adrenal suppression can occur after long-term use.[50]

REPORTING ADRS

As per regulation 40 of the Medicines and Related Substances Act, 1965 (Act 101 of 1965) as amended, a healthcare professional, veterinarian or any other person should inform the South African Health Products Regulatory Authority (SAHPRA), of any suspected ADRs; or any new or existing safety, quality, or effectiveness concerns, occurring because of the use of any medicine or scheduled substance (Medicines Act). Although clinical trials identify ADRs, they are limited due to the number of participants in the trial; the timeframe of the trial as drugs may act differently over a longer period; and also, may exclude high risk individuals such as the elderly or pregnant women. For these reasons, post marketing surveillance is crucial in identifying ADRs and thus informing better prescribing practices which ensures the safety and efficacy of medicines. A spontaneous report, which is a common method of reporting a suspected ADR, is not generated from a controlled study (active surveillance). Spontaneous reports can generate a signal which is 'reported information on a possible causal relationship between an adverse event and a medicine, the relationship being unknown or incompletely documented previously'. More than one ADR report is needed to generate a signal depending on the seriousness.[51] For this reason, reporting any ADR is important in identifying signals whereby the necessary course of action can be taken.

The South African adverse drug reaction monitoring system is managed by the regulatory pharmacovigilance unit at SAHPRA. Healthcare professionals including dentists are required to report all suspected adverse reactions to medicines by completing the eReporting link available on the SAHPRA website or completing the Adverse Drug Reaction (ADR)/Product Quality Problem Report form on the SAHPRA website and emailing it to adr@sahpra.org.za.[51] Additionally, SAHPRA has launched a MedSafety App, which is a platform whereby both healthcare professionals and the public can report ADRs.

For a report to be considered valid, the following minimum requirements should be included in the report: information about the patient, suspect medicine, suspected reaction, and information about the reporter.

CONCLUSION

Medicines are essential for improving the quality of life of patients, yet they do come with risks. Dentists should consider their patients' comorbidities and current drug use, to select the appropriate drug and dose, which will limit the risk of ADRs. Although dentists have a fair knowledge on ADRs, it is likely that dentists, just like other healthcare professionals, under report these events. To effectively manage the dental patient, dentists need to understand the risks associated with the medicines they prescribe and the importance of reporting ADRs.

Table III: Local anaesthetics and their vasoconstrictors and their adverse reactions[17]

Category	Examples	Adverse Drug Reactions	Frequency/ Severity	Special Warnings/ Precautions
Local anaesthetics	Lidocaine, Articaine, Prilocaine, Lignocaine and Mepivacaine	Tissue necrosis and direct neurotoxicity (high concentrations such as 4% articaine)	Common	
		Paraesthesia in higher concentrations	Common; severe (disabling/ incapacitating)	
		CNS depression: seizures, drowsiness, ultimately cardiovascular collapse at high levels in cerebral circulation[44]	Common; mild to severe	
Vasoconstrictors	Epinephrine	Hypertension, tachycardia, and potential cardiovascular emergency at high doses[45]	Common	Dental clinician must be cautious with regards to how much dose is administered
		Anxiety, restlessness, headache, weakness, respiratory difficulties	Common	

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Table IV: Adverse drug reactions associated with sedatives and general anaesthetic agents[48,49]

Adverse drug reaction	Oral sedation		Inhalation sedation	IV sedation
	Benzodiazepines	Opioids	Nitrous oxide	Propofol
Respiratory depression	++	++	++	++
Depress central hypercapnic drive (Depress both tidal volume respiratory rate)		++		++
Depress hypoxemic drive (depress tidal volume while increasing respiratory rate)			++	
Reduction in arterial blood pressure	++	++	++	++
Reduction in heart rate (at doses required for general anaesthesia)	++	++	++	++
Anterograde amnesia (at sedative doses)	++			++
Thrombophlebitis/ thrombosis	++			
Falls/ Ataxia/ Confusion	++			

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The Complexity of Care and the Dunning-Kruger Effect

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ABSTRACT

There appears to be an increase in litigation against general dental practitioners which is increasingly due to clinicians exceeding their competence, because they may not be aware that they lack the required skills: the so-called Dunning-Kruger effect. The purpose of this paper is first, to briefly explain the Dunning-Kruger effect, and second, to propose guidelines for dentists confronted with differing levels of complexity of care, in order to increase practitioners' awareness of their competence, and by extension, their limitations. An example of complexity levels is given using the discipline of Prosthodontics. It is concluded that there needs to be a revision of the scope of practice for dentistry, which currently provides an "anything goes" approach; a revision of Rule 21 of the Health Professions Council of South Africa, whose provisions need to be more precise as they are currently being ignored; and a revision of the system of providing accreditation for CPD courses and in particular for the presenters and content of those courses.

INTRODUCTION

There appears to be an increasing need to protect patients from clinicians who may exceed their capabilities within their training and experience, because they may not be aware that they lack the required skills: the so-called Dunning-Kruger effect. A professional liability company, Dental Protection (a subsidiary of the Medical Protection Society) has expressed concern at the observation that many South African dental practitioners appear to be exceeding their competence. They have identified increasing numbers of cases involving the following (personal communication, McKenzie A):

- Accidental or unplanned re-organised occlusions
- Unethical treatment decisions
- A complete failure to apply correct occlusal principles
- No records, no study casts analysed on a semi-adjustable articulator
- No adequate temporisation
- Irregular lower incisors restored with heavy prep veneers where the final result is aesthetically level and aligned incisor edges but no attention given to the creation of an unplanned anterior guidance and then subsequent failure
- Vertical dimensions increased

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It is proposed here that there is a need for guidelines to help reduce human error, assist with greater consistency of outcome and to improve the overall standards of care provided by general dental practitioners. Such guidelines would not limit dentists who are capable and competent in performing clinical work at higher levels. The purpose of this paper is first, to briefly explain the Dunning-Kruger effect, and second, to propose guidelines for dentists confronted with differing levels of complexity of care.

THE DUNNING-KRUGER EFFECT

This term has evolved from a paper published in 1999 by two psychologists from Cornell University.[1] The first words of its title were "Unskilled and Unaware of it" and it was described as "an exploration into why people tend to hold overly optimistic and mis-calibrated views about themselves". Their hypothesis was that people tend to hold overly favourable views of their abilities in many social and intellectual domains, and those with limited knowledge in a domain suffer what they referred to as a dual burden: they reach mistaken conclusions and make regrettable errors; and they do not realise this precisely because of their lack of knowledge and competence. Put in psychological terms, they lack metacognition, which is the ability to be aware of and understand one's own thought processes.[2,3]

Kruger and Dunning tested their hypothesis that being unable to recognise one's level of ability is related to (in)competence, and that this may be due to a lack of metacognitive skills, by testing individuals in three situations. They asked participants to estimate their ability relative to a set of objective criteria; to recognise their own or others' competence; and to estimate their performance relative to others'. In addition, they tested whether providing metacognitive skills would assist in gaining a better insight into their own competence. This paper will not reproduce all their findings, but will summarise some examples to illustrate their conclusions.

The first example was of participants' perceived ability to recognise humour: the authors drew up a 30-item questionnaire of jokes they described as having "varying comedic value" as determined by professional comedians who rated them from not at all funny to very funny on a 10-point scale. The participants then had to do the same, and were then asked how they thought they did on a percentage basis from 0 (I'm at the very bottom) to 50 (I'm exactly average) to 99 (I'm at the very top). Fig. 1 shows their perceived scores against their actual scores. Congruence is only reached for those who scored correctly, in the top quartile, where they mostly under-estimated their scores. Those who scored poorly were completely oblivious to that fact.

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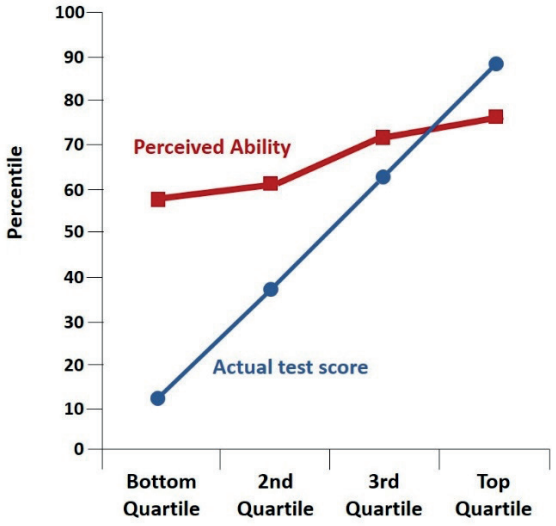

Fig. 1 Perceived ability to recognise humour as a function of actual test performance (redrawn from Kruger and Dunning 1999[1])

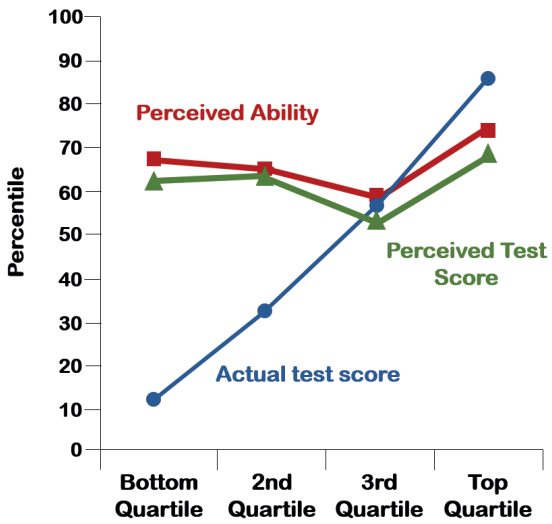

Fig. 2 Perceived logical reasoning ability and test performance as a function of actual test performance (redrawn from Kruger and Dunning 1999[1])

Another example is a test of logical reasoning where this time the participants were asked to score not only their perceived ability but also what percentage score they felt they had achieved in the test. This was again mapped against their actual scores, as shown in Fig. 2.

Since that seminal paper, many others have looked for similar effects, and this phenomenon of not knowing what you don't know has been illustrated in many domains. [4-8] The question of how to overcome this was also addressed by Kruger and Dunning[1] and by others since[7,9,10] with mixed success (and some ironic conclusions). In the original study, Kruger and Dunning[1] found that in a test of logic, the bottom quartile of participants who received training reduced their over-estimation of test performance compared with those who did not receive the training. The authors concluded that this might be that the training improved their metacognition and thus moved them into the competent realm. However, in a study on emotional intelligence, participants after receiving their result were asked if they wanted to purchase a book which would improve their self-knowledge at a 50% discount. Of those in the top quartile, 64% wanted the book, but only 19% of those in the bottom quartile did.[9] So pointing out people's deficits did not necessarily induce them to strive to overcome those limitations. This was confirmed in a study among people with a known bias, which concluded that they were either indifferent or unaware of their own bias, and that if one is to improve, one needs to recognise the need for improvement but that "those who would benefit the most … are the ones who are least likely to do so".[10]

So, if you don't know what you don't know, how will you know when you have exceeded what it was you thought you knew? Despite the somewhat sceptical conclusions of the studies quoted above, I would suggest that there are two ways to increase peoples' awareness of their competence, and by extension, their limitations. One would in fact be to educate them, preferably by their volunteering for such education, and the other, associated way, is by categorising what they do into levels of complexity and insist that further education is required to move from one layer of complexity to another. This in effect, is one of the goals of Continuing Professional Education, but at present its unregulated manner and its lack of linkage to tests of competence (other than the negative effect of litigation) seems to have missed that goal.

Guidelines in the form of a categorisation of treatment need into complexity categories will serve a variety of purposes; they will:

- Protect patients from incompetent or negligent dental practitioners;
- Capacitate dental practitioners to identify / recognise their clinical limitations / skills, thereby enabling them to decide who is the most appropriate and adequately qualified clinician to provide the care for their patients;
- Provide a competency framework against which a dentist's conduct can be evaluated by the regulator, the Health Professions Council of South Africa (HPCSA) and professional experts called on when complaints / claims are made;
- Provide a framework that will help the profession identify where additional training and and/or qualifications are required; and
- Provide a means of identifying a reasonable expected standard of care at each level of complexity.

It must be emphasised, though, that if the profession and the regulator accept these guidelines and complexity levels, they must guard against their possible abuse by third part funders who may abuse the guidelines to restrict some treatments that are currently open to all. This applies also to the National Health Insurance fund and is not the intended use and must be vigorously opposed should this happen.

SCOPE OF PRACTICE: DENTAL PRACTITIONERS CAN DO EVERYTHING

The scope of practice of dental practitioners is defined in the vaguest possible terms by the National Department of Health as set out in Regulation R238 in Government Gazette 31958 of 6 March 2009. The scope is 'defined' as follows:

"The following acts are hereby specified by the board under section 33 as acts which shall, for the purposes of the Act, be deemed to be acts pertaining to the profession of dentistry:

(a) The physical clinical examination of the oral, maxillofacial and related structures of a person;
(b) making a diagnosis of diseases, injuries and conditions

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of the oral, maxillofacial and related structures, including determining the relevance of systemic conditions, and/or giving advice on such conditions;

(c) performing dental procedures and/or prescribing medicines aimed at managing the oral health of a patient, including prevention, treatment and rehabilitation;

(d) performing any procedure on a patient aimed at fitting or supplying a dental prosthesis or appliance; and

(e) performing any aesthetic or cosmetic procedure on a patient pertaining to the oral and peri-oral area."

This creates a huge ethical dilemma, in that there would appear to be no limit to what a dental practitioner can do, as no actual procedures are specified. I would suggest that these regulations need to be urgently revised and that procedures and their complexity rather be specified. In the meantime, it is suggested here that a way around this might be what is presented here as complexities of treatment need.

COMPLEXITY OF TREATMENT NEED

Defining complexity levels is not new. The UK's National Health Service has used this primarily as a means of identifying what types of treatment would be referred into secondary care pathways.[11] It also gave the specialists a framework of referral criteria. However, for South Africa, the need is slightly different, and the emphasis, it is suggested, should rather be to help the clinician identify who is the best person to treat the patient and identify what additional skills are needed to attempt specific procedures or to carry out more complex treatment or treatment involving newer technologies. Therefore the assessment of complexity is related to the credentials of the clinician, and this should guide the determination of whether a practitioner may have exceeded their level of competence.

LEVELS OF COMPETENCE/EXPERIENCE/ TRAINING

The complexity assessment is related to the following levels of experience/training:

Complexity Level 1: A registered dental practitioner with no additional degrees or diplomas or training.

Complexity Level 2: A registered dental practitioner who has undergone training and/or gained experience in the particular discipline or area.

Complexity Level 3: A registered dental specialist.

TRAINING AND EXPERIENCE

Moving from complexity level 1 to level 2 would require further training and/or experience. This of course is very difficult to define, and the only official guideline available is under Rule 21 of the HPCSA. This rule, though, is aimed more at the medical profession and certainly was not made with dentistry in mind, as some of its provisions are impossible to comply with. Rule 21 is the "Performance of Professional Acts": "*A practitioner shall perform, except in an emergency, only a professional act... for which he or she is adequately educated, trained and sufficiently experienced".* In 2014 the Council's Human Rights, Ethics and Professional Practices Committee published an interpretation of Rule 21, which is reproduced in the box.

For example, with reference to clause iii,cc there is no definition of what number of interventions defines proficiency (the same dilemma undergraduate curricula have), and both this and clause ii,ee provide no definition of the "standards and norms considered reasonable". This should be of great concern to the profession and to the Medical and Dental Professions Board of the HPCSA, but appears not to be. Equally important is the question of what constitutes being appropriately educated and credentialed, because the interpretation seems to imply

Box 1: Interpretation of Rule 21 of the of the generic ethical and professional rules of the HPCSA as promulgated in government gazette R717/2006

INTERPRETATION OF RULE 21

i. Emergency intervention

In an emergency, where there was a direct threat to life or limb and there is no immediate access to a more appropriately trained healthcare worker, then the healthcare worker should intervene to the best of his/her ability.

ii. Appropriately educated and credentialed

To qualify as appropriately credentialed, the individual practitioner must have successfully completed a training programme approved and accredited by the Board for registration purposes:

aa. The training entity/institution/hospital needed to be accredited for training in that particular profession or discipline and for that particular competency (in this case, by the Board).

bb. The trainee needed to be evaluated and certified as having met the requirements of the training programme by an entity accredited by the Board (e.g. Colleges of Medicine, Universities).

cc. The duration of under- and postgraduate training was laid down by the Board.

dd. Short courses would only be recognised as enhancing or maintaining skills within the field of practice and category of registration in which the practitioner had already been credentialed and registered by the Board.

ee. The actual scope of the profession was laid down by the Board judged by the standards and norms considered reasonable for the circumstances under which the intervention took place.

iii. Sufficiently experienced

aa. Initial training period under the supervision as defined in clause (b) above, under the supervision of an entity accredited by the Board for such purposes.

bb. Certification of successful completion of such training, as defined.

cc. With any intervention a minimum number of interventions needs to be performed annually to remain proficient, taking into account and judged by the standards and norms considered reasonable for the circumstances under which the intervention took place

dd. The introduction of new interventions within the practitioners' scope of profession was only permissible if the practitioner had undergone further appropriate training as approved by the Board.

iv. Under proper conditions and surroundings

All interventions shall take place under appropriate conditions and surroundings. These are subject to judgement by the Board as to what is considered reasonable for the circumstances and conditions, under which the intervention took place. No practitioner must embark upon an intervention unless he/she feels that it is in the patient's interest, and that it would be considered safe to do so, under the prevailing conditions and surroundings. The practitioner would be judged on what requirements would be reasonable to ensure that patient safety was protected.

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that all training (a) has first to be accredited by the Board (clause ii,aa) and (b) must be evaluated and certified (clause ii,bb). It appears that these provisions have been, and continue to be, ignored by both the profession and the HPCSA, for according to these provisions, all CPD courses must be accredited, evaluated, and certified, and carried out only by an entity/institution/hospital that has been accredited. I know of no such courses other than the postgraduate courses offered by our dental schools that lead to postgraduate Diplomas or Masters degrees. Does this make all CPD courses redundant?

It would appear that currently, the CPD courses offered are largely industry- and/or profit-driven. Furthermore, there has been much discontent among the dental specialist societies about the content of many of these courses, and the credentials of those offering such courses. For example this prompted one such society, the Academy of Prosthodontics of South Africa, to issue a statement in 2018 as reproduced in the second box. Needless to say, the South African Dental Association (SADA) completely ignored this, and the trend is continuing.

AN EXAMPLE OF PROCEDURES AND COMPLEXITY LEVELS: PROSTHODONTICS

The following list is an example of what treatments could be placed in the proposed three levels of complexity for Prosthodontics. It is merely presented here as a polemic and suggestion for further debate. In line with the levels used in the UK, there are also under each discipline, what are referred to as Modifying Factors. These are patient and other factors that may increase the complexity of the treatment such that referral to a higher level is required. These will be listed for each discipline. Generally the referral will be to Level 3 (dental specialist).

BOX 2. APSA position statement on general dental practitioners teaching other dental practitioners (JULY 2018)

There appears to be an increasing trend for CPD courses that are being taught by general dental practitioners, and that often seem to include specialist content. APSA finds this situation unacceptable, unless those teaching the courses have ensured that they are properly credentialed according to the guidelines of the Health Professions Council of South Africa pertaining to Rule 21 of the Ethical Guidelines.

Although we acknowledge that this rule relates to the "Performance of Professional Acts", we believe it should also be applied to those giving training and/or courses, as these almost always include instructions on the performance of clinical procedures; and these are "professional acts". The consequences of this are that general dental practitioners may be provided with incorrect information or inappropriate instructions for treatment which can and will have adverse consequences for their patients.

APSA therefore believes that a person providing training, or courses, should, according to the guidelines, be "Appropriately educated and credentialed" and "Sufficiently experienced" as defined by those guidelines.

Furthermore, it seems that the accreditation bodies are either ignorant of these guidelines or choose to ignore them when awarding CPD points for participation.

APSA therefore calls on SADA, and any other agency providing CPD accreditation, to more strictly apply the Rule 21 guidelines to presenters of courses or training.

REMOVABLE PROSTHODONTICS

Modifying Factors for Removable Prosthodontics: refer to Level 3, dental specialist

- Alteration in the occlusal vertical dimension required
- Significant tooth surface loss
- Hyposalivation, Xerostomia
- Special needs patients
- Maxillofacial prostheses
- Oro-facial dystonias
- Atypical or undiagnosed facial pain
- Limited operating access
- Concurrent mucogingival disease (e.g. Lichen Planus)
- Coordinated medical (e.g. renal, cardiac) and/or dental multi-disciplinary care
- Medical history that significantly affects clinical management:
- Patients requiring IM or IV medication as a component of clinical management.
- Patients with a history of head/neck radiotherapy.
- Patients who are significantly immuno compromised or immuno suppressed.
- Patients with a significant bleeding dyscrasia/disorder.
- Patients with a potential drug interaction.

REMOVABLE PARTIAL DENTURES

Complexity Level 1

Acceptable prostheses with adequate evidence from the literature:

- Removable partial dentures with acrylic bases *and* tooth support
- Removable partial dentures with a metal framework and tooth support (other material such as PEEK for frameworks have insufficient evidence at the time of writing)

Unacceptable prostheses because of evidence from the literature or insufficient evidence:

- Removable partial dentures made from thermoplastic resins
- Removable partial dentures with no tooth support
- Unilateral removable partial dentures

Complexity Level 2

- Removable partial dentures supported in part by implants (such as mandibular distal extension bases)

Complexity Level 3

- The use of extra-coronal restoration to provide retention and support (e.g. milled ceramo-metal or metal restorations, use of precision attachments).
- Dual-path insertion removable partial dentures
- Swing-lock and sectional dentures
- Associated with maxillofacial prosthodontics for cranio-facial defects

COMPLETE DENTURES

Complexity Level 1

- Patients requiring mucosa-borne complete dentures with uncomplicated alveolar resorption patterns
- Patients with a history of successful complete denture wearing

Complexity Level 2

- Patients with Cawood and Howell Class V and VI ridges

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- Patients with Cawood and Howell Class V and VI ridges who have been unable to wear dentures made at Level 1

Complexity Level 3

- Patients who have been unable to wear dentures made at Level 1 or 2
- Tooth and implant-supported overdentures when planned after providing diagnostic dentures and in association with a surgical discipline
- Maxillofacial prosthetic patients requiring complete dentures with obturators, speech bulbs, etc.

FIXED PROSTHODONTICS

Modifying Factors for Fixed Prosthodontics: refer to Level 3, dental specialist

- Reorganisation of the occlusion required
- Alteration in the occlusal vertical dimension required
- Radiographic evidence of 50% reduction in bone support
- Skeletal base alveolar discrepancy that adversely affects the occlusion
- Significant tooth surface loss
- Hyposalivation, Xerostomia
- Special needs patients
- Oro-facial dystonias
- Atypical or undiagnosed facial pain
- Limited operating access
- Concurrent mucogingival disease (e.g. Lichen Planus)
- Coordinated medical (e.g. renal, cardiac) and/or dental multi-disciplinary care
- Medical history that significantly affects clinical management:
  - Patients requiring IM or IV medication as a component of clinical management.
  - Patients with a history of head/neck radiotherapy.
  - Patients who are significantly immuno compromised or immuno suppressed.
  - Patients with a significant bleeding dyscrasia/disorder.
  - Patients with a potential drug interaction.

Complexity Level 1

- Anterior indirect veneers
- Crowns where the external surfaces can be guided by the existing teeth, in shape and form, and to maintain and be in harmony with anterior guidance and where applicable, with the existing excursive tooth contacts
- Posterior intra- and extra-coronal restorations where there are sufficient remaining teeth to guide the occlusal anatomy of the restoration to be in harmony with the existing occlusion.
- Fixed partial dentures (bridges) of a maximum of 4 units (as taught at the undergraduate level).

Complexity Level 2

- Single restorations on an implant
- Three- or 4-unit fixed partial denture on implants
- One- or two-implant-supported overdentures

Complexity Level 3

- All fixed partial dentures (bridges)
- Periodontal-Prosthetic prostheses
- All implant-supported restorations
- Restorations replacing the complete anterior guidance dentition (maxillary or mandibular or both)
- Restorations requiring a re-organised occlusal scheme
- Restorations associated with maxillofacial prostheses

CONCLUSIONS AND RECOMMENDATIONS

There is much that is wrong with the current state of education, training and treatment provision in the profession of dentistry in South Africa at present, as evidenced by increasing litigation which is highlighting treatments being provided by practitioners exceeding their competence yet being unaware or unconvinced that they are doing so.

The scope of practice of dentistry as defined by the National Department of Health is vague and implies an "anything goes" approach. This is somewhat mitigated by ethical rule 21 of the HPCSA pertaining to the "performance of professional acts" but is complicated by further vague and unsubstantiated provisions in the HPCSA's interpretation of that Rule. Further, this has allowed the unregulated accreditation of CPD courses being presented by insufficiently credentialed presenters as defined by that interpretation.

The suggestions made in this admittedly polemic paper are made with a view to improving this unsatisfactory situation and the Dunning-Kruger effect has been used to help illustrate the problems, and provide solutions that will hopefully obviate the observations that some practitioners are indeed exceeding their levels of knowledge and skill.

The following recommendations are therefore made:

1. Levels of care and procedures of increasing complexity should be defined for every discipline (such as in an example given in this paper);
2. The interpretation of Rule 21 should be revised as a matter of urgency, as its provisions need to be more precise and are currently being ignored;
3. The system of providing accreditation for CPD course be urgently reviewed: at present apart from the dental schools, the only accreditor is the South African Dental Association, and as an association largely of and for dental practitioners, this is a clear conflict of interest. The evidence of inappropriate awarding of CPD points is manifest and abundant.

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Phenotypes and Clinical Genotypes of Bruxism Patients: A Systematic Review

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ABSTRACT

Background. Bruxism is a phenomenon where psychological and exogenous biological factors act in greater percentage. Several genetic polymorphisms have been described in GABAA receptors, and some have been associated with motor limitations, such as the rs1805057 polymorphism of the GABRB1 gene (GABAA), which found a haplotype associated with a lower limitation in movement in acute pain processes. The aim to identify the clinical phenotypes in bruxism patients.

Methods

Eligibility criteria were as follows: observational studies, case control studies, odds ratios, bruxism, patients, and a keyword search that included [[bruxism]], OR [[temporomandibular joint disorders]] OR [[sleep bruxism]], OR [[awake bruxism]], OR [[polymorphism]] or [[GABAA]], or [[serotonin]] , using the Boolean operators AND, OR and NOT.

Results

Were included 210 identified records in databases; 50 records from other sources; 117 records were deleted after determining they were duplicates; 42 studies were included in qualitative synthesis ; finally, who met inclusion requirements 5 studies were included in synthesis. The comparison of global DNA methylation profiles in patients with bruxism shows a possible genetic influence on their etiology, indicating that patients with HTR2A rs2770304 alleles are at increased risk.

Conclusion

the HTR2A rs2770304 allele leads to an increased risk of bruxism.

Keywords

bruxism, temporomandibular joint disorders, phenotype, genotype, methylation.

INTRODUCTION

Initial genetic evidence of bruxism is based on questionnaires and surveys, and evidence indicates that 20% to 50% of patients have at least one close family member reporting that there is a genetic relationship.[1] Several genetic polymorphisms have been described in GABAA receptors. Some have been associated with motor limitations, such as the rs1805057 polymorphism of the GABRB1 gene (GABAA), which found a haplotype associated with a lower limitation in movement in acute pain processes[2]; this subunit would act as an endogenous muscle relaxant with a greater inhibitory GABAergic action, reducing muscle spasm and allowing greater movement the chewing muscles.[3] Another case is the rs4906902 polymorphism of the GABRB3 gene (GABAA), which has been associated with the presence of a complex syndrome

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characterized by skeletal muscle pain.[4] Mishra *et al.,* postulated that at least 10–15 genes relate to phenotypes of anxiety. The most studied genes in this regard are serotonin transporter genes (receptors), and their relation to anxious personality ranges. The medium rafe brain serotonin system is related to mood modulation, anxiety, emotions, and cognition. In addition, the serotonergic system has been investigated in molecular genetics relating it to emotional behavior, variations in the SLC6A4 gene of the serotonin receptor (SERT) have been associated with more than twelve different traits of human behavior and other pathologies.[4,5] Bruxism is characterized by biological, psychological, and exogenous factors presenting as frequent clinical signs: repetitive movements of the jaw causing the teeth[6] to squeak, micro trauma to chewing muscles and cervical pain skull mandibular. The prevalence of bruxism was[8] to 31.4%, with the highest percentage in men[7], neuromuscular activity accompanied by teeth grinding with three-dimensional mandibular movements. In 2017, the International Bruxism Assessment Council defined conceptual differences between sleep bruxism and awake bruxism. The new definitions are as follows. Masticatory muscle activity during sleep is characterized as rhythmic (phasic) or non-rhythmic (tonic), not a movement disorder or a sleep disorder, in healthy individuals, which is known as sleep bruxism.[8] Awake bruxism is a masticatory muscle activity during wakefulness that is characterized by repetitive, sustained dental contact and mandibular hypermobility. An etiologically, emerging evidence suggests that psychology, biologic, and exogenous risk indicators have greater involvement than morphologic factors.[9] Having identified the HTR2A rs2770304 allele related to bruxism, a comprehensive evaluation system can be created to facilitate the diagnosis and subsequent clinical management of the patient.[10] Symptomatology found in patients with bruxism include the following: headache, neck pain, TMJ pain, limitation of mouth opening, joint noises, fatigue, and deviation in mouth opening. The following risk factors are considered as predisposing factors: macro and micro trauma[11], skeletal changes of the face, occlusal contact, hyperactivity of chewing or cervical muscles, changes in TMJ[12], hormonal and genetic factors, and psychological factors.[13] The aim to identify the clinical phenotypes in bruxism patients

MATERIALS AND METHODS

This systematic review was registered with PROSPERO with the registration number CRD42020164836.

RESULTS

Table 1: Summary of the risk of bias for in-vitro studies according to Consolidated Standards of Reporting Trials

Item		Oporto G [15] 2018	Oporto G[16] 2016	Hoashi, Y[17] 2017	Oporto G[19] 2018	Cruz , N[21] 2018
1	Abstract	Yes	Yes	Yes	Yes	Yes
2a	Background and objectives	Yes	Yes	Yes	Yes	Yes
2b	Background and objectives	Yes	Yes	Yes	Yes	Yes
3	Intervention	Yes	Yes	Yes	Yes	Yes
4	Outcomes	Yes	Yes	No	No	Yes
5	Sample size	No	No	Yes	No	Yes
6	Randomization: sequence generation	No	No	No	No	No
7	Allocation concealment mechanism	No	No	No	No	No
8	Implementation	No	No	No	No	No
9	Blinding	No	No	No	No	No
10	Statistical methods	Yes	Yes	Yes	No	Yes
11	Results: outcomes and estimation	Yes	Yes	No	Yes	Yes
12	Discussion: limitations	Yes	No	Yes	Yes	Yes
13	Other information: funding	No	No	No	Yes	Yes
14	Protocol	Yes	No	Yes	Yes	Yes

Table 2: Summary of the risk of bias

Item	Oporto G[15] 2018	Oporto G[16] 2016	Hoashi, Y[17] 2017	Oporto G[19] 2018	Cruz , N[21] 2018
Random sequence generation	Low	Low	Low	Low	Unclear
Allocation concealment	Low	Low	Low	Unclear	Unclear
Selective reporting	Low	Low	Low	Low	Low
Blinding (participants and personnel)	High	high	high	High	High
Blinding (outcome assessment)	High	High	High	High	High
Incomplete outcome data	Low	Low	Low	Low	Low

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Table 3: Structural summary Systematic Review

Study (Year)	Object of Research	Intervention	Evaluation methods	Result
Oporto G[15] 2018	Compare global DNA methylation level in patients under bruxism treatment and control group.	SB (32 patients),WB (42),W&SB (42) patients and control group (CTR) (42) individuals	ELISA kit Methyl Flash Methylated DNA Quantification Kit	Significant differences were found in the amounts of methylated DNA in all circadian manifestations of BRX compared with the control group (SB 0.95 % ±) AB 0,87% ± 2.1 % Sleep and awake. = 0.17% ± 0.25%; Control = 1.69% ± 1.6%; Kruskal–Wallis test [p =.0001] followed by Dunn's test [p < .05]).
Oporto G[16] 2016	Evaluate the frequency of genetic polymorphisms in the HTR1A (rs6295), HTR2A (rs1923884, 4941573, 6313 2770304), HTR2C (rs17260565 and SLC6A4, rs 63749047) genes in subjects undergoing BRX treatment	130 patients were the recruited to cases groups. Randomized controlled clinical trial contact areas	Diagnosis of circadian manifestations of BRX was reached using clinical criteria. Criteria in probable awake and/or sleep bruxism. Blood samples were obtained and genomic DNA was extracted from blood leukocytes using a salting out method as describe Genotypes were determined using TaqMan® SNP genotyping assay (Applied Biosystem, USA) 2× TaqMan® SNP genotyping master mix (Applied Biosystem, USA), and using	Suggested that polymorphisms in serotonergic pathways are involved in sleep bruxism. Further research is needed to the understanding of the increase of the physiopathology of BRX
Hoashi, Y[17] 2017	Generate neural cells using SB patient- specific induced pluripotent stem cells (iPSCs) Randomized controlled clinical trial	Two primary SB patients and two age- matched healthy controls were selected from SB and control group .	Four lines of iPSCs, two from SB patients' controls, were established from peripheral and two from blood. The following iPSC clones were selected for detailed analysis: three from patient SB1 (SB1–1, SB1–2, and SB1–10), three from patient SB2 (SB2–2, SB2–7, and SB2–10), three from control 1 (C1-6, C1–12, and C1–18), and three from control 2 (C2–1, C2–2, and C2–4).	Patient-specific iPSCs were successfully differentiated into neurons expressing 5-HT2A.
Oporto G[19] 2018	Evaluate the frequency of single nucleotide polymorphisms (SNPs) in dopaminergic pathway genes (DRD1, DRD2, DRD3, DRD4, DRD5, and MAOB) in patients undergoing bruxism treatment and controls. Cross- sectional study	130 patients nonrelated Chilean patients (41 males and 89 females) were included in case groups	Bruxism diagnosis was reached using clinical Bruxism diagnosis was reached using clinical criteria. Genotypes Bruxism diagnosis was reached using clinical polymerase chain reaction (PCR) of polymorphism rs63749047 (5-HTTLPR) of the SLC6A4 gene was determined using conventional	The G allele of DRD2 rs1800497 SNP was associated with significant risk reduction of awake- sleep bruxism (p = 0.041), while the C allele of DRD3 rs6280 SNP was associated with increased risk of sleep bruxism (p=0.02) and the C allele of DRD5 rs6283 SNP. was associated with decreased risk of awake bruxism (p = 0.01).

Eligibility criteria were as follows: observational studies, case- control studies, odds ratios, bruxism, patients "with temporomandibular disorders , and a keyword search that included [[bruxism]], OR [[sleep bruxism]] , AND [[Sleep Bruxism]], , OR [[chewing]],OR [[oral parafunctional habits]], OR [[oral habits]] OR [[Facial pain]] or [[temporomandibular joint disorders]] AND [[Temporomandibular Joint Dysfunction Syndrome]] OR [[myofascial pain]] OR [[syndromes]] AND [[myalgia]] AND [[osteoarthritis]] OR [[arthralgia]] OR [[orofacial pain]] OR [[TMD]] O [[temporomandibular disorder]] OR[[polymorphism]] OR [[GABAA]],OR [[serotonin]], OR [[Case Control Studies]],OR [[Odds Ratio Studies]] using the Boolean operators AND, OR and NOT. The Scopus, Ebsco, PubMed, Medline Embase, the Cochrane Library, the Web of Science databases were searched; alternate databases that were searched included Scielo, Latindex, and Redalyc. Using the Prisma research protocol, the flowchart sequentially explains the selected information. Complete articles published were included as follows: were included 210 identified records in databases; 50 records from other sources; 117 records were deleted

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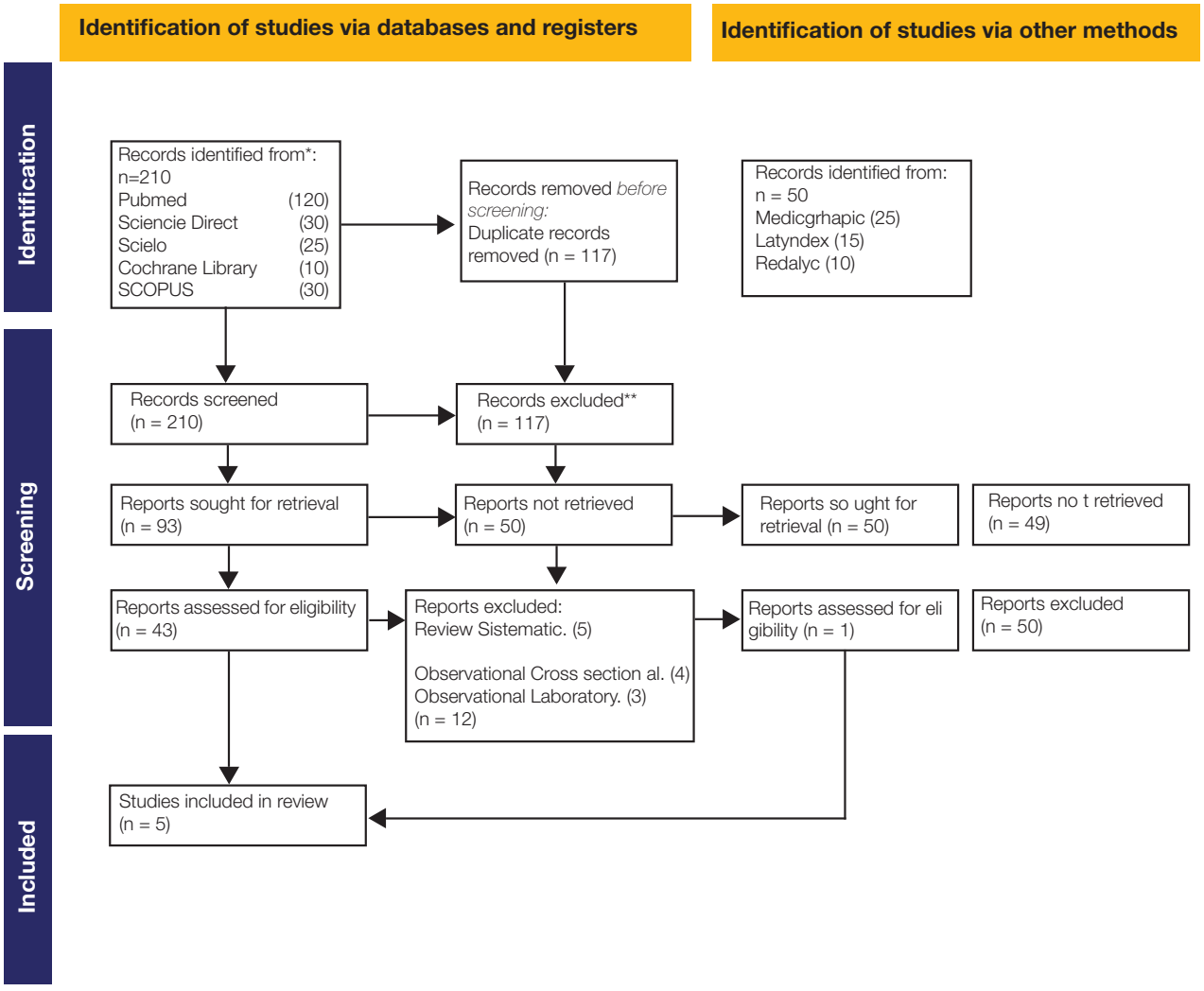
after determining they were duplicates; 42 studies were included in qualitative synthesis ; finally who met inclusion requirements 5 studies were included in synthesis. (Fig. 1) The authors (BVVR, AZ, AU, LCH, BS.) independently selected the titles and summaries, excluded duplicates and irrelevant articles that did not contain keywords or fell within the inclusion criteria and considered only full text articles. The date and names of all authors were included in the final review article. If the articles did not meet the inclusion and exclusion criteria as complete articles, case controls, odds ratio were resolved by the third and fourth evaluator (VC, MR) those who considered the results obtained in the studies and the methodology to confirm or eliminate the articles. The data extraction procedure was evaluated according to the criteria of all authors. Articles are classified by the author/year, study objective, study type, methodology, results (standard mean and deviation) and conclusions.

DISCUSSION

The circadian manifestations of bruxism are associated with characteristic personality traits (stress)[13,14] as well as alterations in neurotransmitters and their pathways.[15]

Therefore, the neurotransmitters of the central nervous system as its genes are related to bruxism[16,18] considering its pathogenesis by serotonin , which is responsible for the circadian rhythm, maintaining arousal, and regulating the response to stress, muscle tone and respiration, the typical manifestations associated with BRX.[19] Abe *et al.,* 20 studied the polymorphisms (HTR1A (rs6295), HTR2A (rs1923884, rs4941573, rs6313, rs2770304) and HTR2C) relating them to serotoninergic transmission produced in sleep bruxism, finding three SNPs within the HTR2A gene (rs6313, rs2770304 and rs4941573) associated with SB in Japanese individuals, but did not explore other circadian manifestations.[21.23] The process of selecting patients with SB included screening, clinical examination, and the nightly use of an electromyography device for masseter muscle We could not determine whether in the study control group people had signs of Bruxism. In the review carried out, evaluations were observed that coincided with the selection process of the SB individuals used, there were some differences in the general diagnostic method.

Patients recruited to participate in the study were referred by physicians and dentists in the community and at the university, with a presumptive diagnosis of bruxism 25 Patients were then evaluated by a specialist in temporomandibular disorders[26, 28] and classified into bruxism circadian manifestations (sleep bruxism, weak up bruxism , and sleep bruxism, weak up bruxism). This examination was performed in the control group as well to exclude the presence of bruxism. [29]



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Therefore, to our knowledge, our work constitutes systematic review study that associated and examined the relationship between all circadian manifestations of bruxism and genetic polymorphisms within the serotonergic system.[30] We found significant differences in the rs27703045 SNP (HTR2A) between the SB group and the control group, where carriers of allele C showed an increased risk of SB compared to the control group. Grigoriadis, A *et al.,*[31] found differences in the rs27703045 SNP but compared genotypes of patients with SB with the control group. The HTR2A gene encodes 5-hydroxytryptamine (5-HT) 2A receptors. This family of receptors coupled with the G protein located in the brain involves physiological functions such as memory, sleep, nociception, eating and rewarding. However, these receptors have also been associated with depression[32] and epilepsy.[33] Serotonin receptors can directly or indirectly, depolarize or hyperpolarize, neurons by changing ion conductance and/or their concentrations within the cell; therefore, it is not surprising that serotonin is able to alter excitability in most serotonergic networks.[34] No information is available regarding the clinical importance of the Rs2770304 SNP, and this variant is known to be within the intrinsic regions of HTR2A. Previous reports have determined that inactivation of 5-HT2A receptors enhances depressive effects[35], and in animal models, inactivation of these receptors increased susceptibility to epileptic chemicals and electrical products.[36, 37]

The findings show that the HTR2A rs6313 SNP was associated with an increased risk of SB in Japanese individuals. Therefore, it is possible that the HTR2A gene plays a role in SB physiopathology as well.[38, 39] HTR2A rs2770304 allele C studies showed an increased risk of patients with SB compared to the control group [40, 41, 42] whereas a decrease in the function of the 5-HT 2A receptor could be associated with depression and epilepsy. 43 Along with the intrinsic location of the rs2770304 SNP, it is noted that carriers of allele C[44, 45] showed receptor expression of 5-HT 2A; the function of receptors can also decrease in these individuals with episodes of BRX during sleep.[46, 47] Future research should be conducted to test this hypothesis, including functional studies and/or gene expression trials, to achieve a better understanding of the genetic basis of BRX circadian manifestations.[48] Although the diagnostic methods used in studies have limitations, they can be improved with the use of polysomnographic (PSG) and electromyography devices. Studies indicate that to recognize SB, the use of PSG is highly recommended by doctors and dentists within the gold standard of diagnostic research. Some authors note that the unstable nature of SB will also be reflected in fluctuations in the result variables of PSG recordings.[49, 50] In most studies, SB patients are asked to spend the night in a sleep monitoring laboratory. This action would detract from the validity of the procedure. The first night the patient will be adapting to, changes in the environment, which can alter the results. The re commendation is to first make a recording of only PSG to inhibit the patient to sleep under experiences and conditions different from their normal conditions. Observations indicate that variables associated with rapid eye movement take longer to stabilize [51,52] which appears to be a process extending to the fourth night. The PSG is described as a technique that is only suitable for small waiting times between diagnostic evaluation that takes between 5 and 6 months in the United States and around the world, with noted limitations for the control policies and ethics committees that each country has. The etiology of bruxism is multifactorial; this SNP is one of the mechanisms in volved in the circadian manifestations of BRX. [53]

CONCLUSION

The clinical phenotype identified by the authors is the HTR2A rs2770304 allele the risk of bruxism patients.

AUTHOR CONTRIBUTIONS

BVR, AZR, AUG, and ASA were involved in the conception and design of this study. BVR, LCHB, AMS, MRT were involved in the analysis and interpretation of the data. All authors were involved in drafting the manuscript. All authors reviewed and approved the final manuscript and agree to be held accountable for all aspects of the work

ETHICAL APPROVAL

Approved by the Bioethics committee (CEISHSOLCAQ. OBS.19.125)

FINANCING

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CONFLICT OF INTEREST

The authors have explicitly stated that there are no conflicts of interest in this article.

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CPD questionnaire on page 52

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

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Radiology corner

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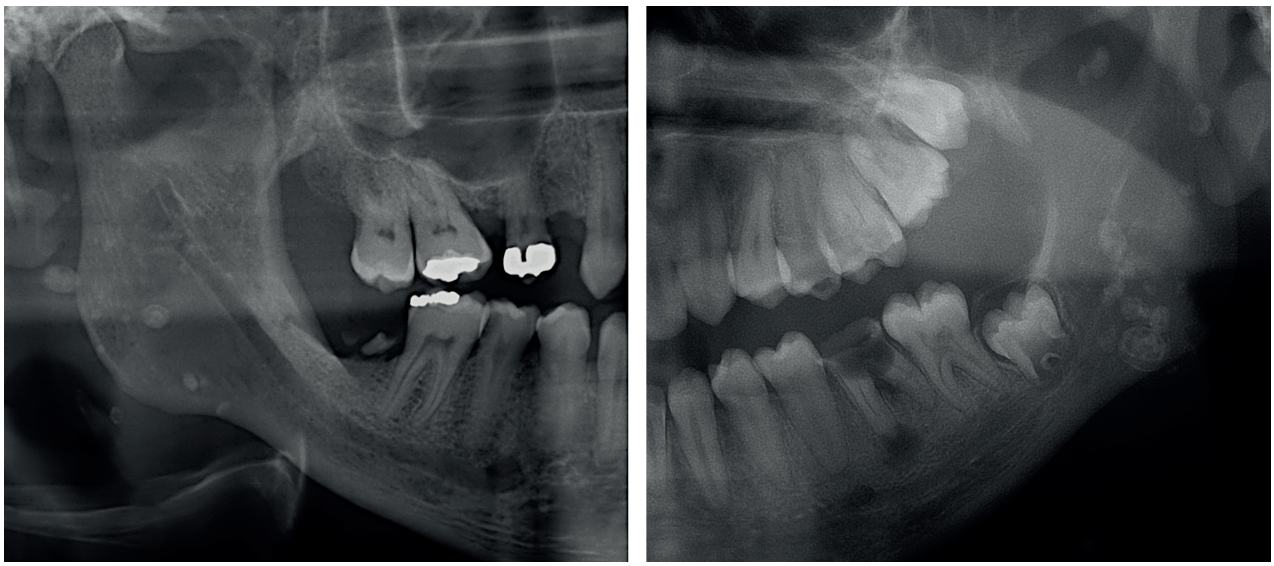

Figure 1: (A) Patient 1: Multiple concentric calcifications involving the right mandibular region.
(B) Patient 2: Similar radiological presentation in a patient with a left facial swelling.

CASES

Two patients presented with multiple concentric calcifications superimposed over the mandibular ramus region. The first patient was a 41-year-old male who presented to the dental clinic requesting a partial denture (Figure 1A). The calcifications were detected incidentally on panoramic radiography. The second patient was a 15-year-old female who presented with a left facial swelling that had been present for 7 years (Figure 1B). What is your diagnostic hypothesis for both patients?

INTERPRETATION

Phleboliths are calcifications that arise from the organisation and mineralisation of intravascular thrombi, typically emanating from the stagnation of blood flow. They are commonly seen in association with haemangiomas and vascular malformations, being detected in 27% of patients with venous malformations.[1,2] Phleboliths are slightly more common in females, however, their true incidence is largely unknown as asymptomatic cases are detected incidentally on routine imaging.[1] In the head and neck, phleboliths are commonly found in the check region.[1] They are usually asymptomatic, but may present with pain as an accompanying symptom in 30% of cases.[1] Radiologically, they present with a target-like appearance with a dense core surrounded by a hypodense rim and/or lamellated periphery.[1-3]

Phleboliths are often multiple and range in size from 2mm to 15 mm in diameter.[1] Due to their location their distinction from sialoliths may be challenging.[2] The target-like appearance and presence of multiple calcifications are more suggestive of phleboliths. Treatment is usually performed in symptomatic cases or patients with aesthetic concerns. This includes removal of the phleboliths, and/or laser and sclerotherapy for the accompanying vascular tumour.[1]

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Ethics approval:
This study was approved by the University of Pretoria, Faculty of Health Sciences Research Ethics Committee (Reference no.: 585/2022). All procedures followed the ethical standards of the Helsinki Declaration of 1975, as revised in 2008.

Authors contribution:

Dr. C Smit	50%
Dr. L Robinson	50%

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Embracing new technology, with caution

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LM Sykes[1], V Bookhan [2]

"The illiterate of the 21st century will not be those who cannot read or write, but those who cannot learn, unlearn and relearn" Alvin Toffler

ABSTRACT

Dental manufacturers frequently present clinicians with new "cutting edge" materials, devices or technology. These usually come with great promise for bettering the *status quo* in their practices, and of putting them ahead of their colleagues in the market place. However before succumbing to the advertorial hype, and abandoning their old practices, materials or equipment, practitioners need to evaluate the new offering against the "gold standard" if one exists. This entails comparing it to "the benchmark" practice / product that is routinely used under reasonable conditions, and answering a number of clinically and scientifically pertinent questions. If they are then confident it has been through extensive trials, the results have been analysed with appropriate tests by independent investigators, and the reporting thereof is accurate, reliable, repeatable, sensitive, specific and clinically applicable, they may consider making practice changes. While it is admirable for clinicians to be open minded and willing to embrace and adapt to modern technology, this should only be done if the change has been proven superior to reliable routine practices. It is incumbent on all practitioners to keep abreast of current trends through the many platforms available. They should also strive towards being life-long learners who are curious, open minded, flexible, willing to learn new skills, and open to adapting their work to embrace advances. This will hopefully lead to practitioners having more fruitful careers, and equip them to provide the best possible service and care to their patients.

INTRODUCTION

How many ways are there to peel an orange and what does this topic have to do with dentistry? The answer to both those questions is "Probably a lot more than you think", as you will discover in this paper where the former will be juxtaposed and compared to the practice of dentistry. Both peeling and orange, and carrying out a dental procedure are tasks with objectives that require physical intervention to result in desired outcomes. Both may be carried out in a number of ways, using different materials and techniques, requiring various skills, having specific time and financial costs, and each with associated advantages, disadvantages, indications for use and operator preferences.

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2. Vinesh Bookhan : Second author 10%

PEELING AN ORANGE

The objectives of peeling an orange are to remove the rind along with as much pith as possible, while at the same time preserving the structure and integrity of the delicate underlying fruit. The conventional hand peeling method has been carried out for centuries, and has remained in use due to its simplicity and reliance on basic skills and equipment (in this case hands). It does however require time, effort, a certain amount of manual dexterity, and follows steps that can vary with each person. It can be messy and may require the peeler to go back over sections to remove small residual remnants of rind or pith. The outcomes are generally satisfactory. However, the procedure also creates debris which differs in amount and size of rind pieces removed, seldom creates a smooth surface finish, and may not produce the most aesthetically pleasing peeled orange. The end result is largely dependant on the type and size of the orange, its condition at the beginning of the procedure and the operator's style and dexterity. It can be a laborious and time consuming process, leaving one to wonder if the effort justifies the outcome (Figure 1).

With time and improved technology, new equipment was introduced to the culinary market. Sharp knives were marketed as multi-purpose gadgets that claimed to save time, be easy to use, be clean and comfortable to work with, remove peels and pith efficiently, and generate less debris. They gained widespread use not only for peeling oranges, but also for a myriad of other domestic purposes. All knives had a basic design of handle and sharp cutting blade and were initially costly to purchase. The expense seemed justified as the procedure was relatively easy and effortless in comparison to hand peeling, didn't take much skill or practice to master, allowed the entire peel and pith to be cut off in a few strips that were easy to discard, and generally saved a lot of time (Figure 2). As their popularity grew so did technology and soon the markets were flooded with knives. The handles and blades came in different materials, colours, sizes and shapes, and were often "custom designed" for specific purposes. Knives looked set to become the "best-practice" orange peelers on the market and many people purchased them. Sadly, with time and use it became evident that the cutting process had certain drawbacks and some unwanted side effects. There was a lot of fluid spillage, many operators sustained finger injuries, they often cut too deeply into the fruit resulting in loss of the valuable fruit substance, and sometimes even damaged the underlying pulp. In addition, many of the early blades corroded from the acidic juices, and both the knife users and the fruit recipients began to complain and to even look for safer options that would also result in less damage.

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Figure 1. A hand-peeled orange

Some innovative thinkers devised a new gadget specifically for peeling oranges and certain other fruits. The idea was to create a utensil that was functional, efficient, corrosion resistant, durable, easy to clean, cheap to manufacture and affordable. The new synthetic gadget had some of the knives features such as a comfortable handle and a slick cutting tip, but did away with the potentially dangerous blade. It was marketed by the manufacturers who did countrywide road shows where they generally gave an introductory talk, a live demonstration, and a short hands-on training session for interested purchasers. Features included a hooked tip to score the fruit a predetermined depth, and to cut down along planned and equally spaced vertical lines, this ensured that all pieces of rind were similarly sized and evenly thick. The curved body portion hugged the contours of the fruit as it gently separated the peel away without causing any damage to the underlying fruit. It resulted in a neat smooth finish, minimal debris, and had an added bonus of vertical grooves along which the orange could be opened (Figure 3). Introductory packages often came at good prices with "additional extras" included to sweeten the deal. These gadgets did indeed serve their intended purpose and at a much reduced price. Results were good, predictable, and the damage and debris much less. However, they had their limitations being designed for only a few specific applications, and it was incumbent of the operator to know when and where to use it.

RELEVANCE TO DENTISTRY

The above scenarios may seem far removed from dentistry, and the reader will be forgiven for asking "What does this topic have to do with me and my practice? The answer to both those questions is "Probably a lot more than you think".

Go back and re-read the narratives, but this time view the orange as a tooth, and the peeling process akin to cutting a crown preparation, where the peel is the enamel, and the fruit is the dentine and pulp. Just as early orange peeling was a slow and laborious task, so too were many early dental procedures. Tooth preparations progressed from being cut with hand instruments to slow foot driven drills, to the super-fast high-speed air turbines and hand pieces in use today. Similarly, the drilling burs evolved in terms of material, strength, size, shape, and cutting efficiency. Nowadays, clinicians can chose form a wide variety of burs each suited to a specific purpose and stage of procedure. They also have a whole gamut of hand pieces, bur kits, dental materials, and adjunctive equipment as part of their daily armamentarium.

In a similar vein to the orange peeling analogy, dental manufacturers frequently present clinicians with new "cutting edge" materials, devices or technology. These usually come with great promise for bettering the *status quo* in their practices, and of putting them ahead of their colleagues in the market place. However before succumbing to the advertorial hype practitioners needs to take time and make an effort to do some basic investigating themselves. They should evaluate the new offering against the "gold standard" if one exists. This entails comparing it to "the benchmark" practice / product that is routinely used under reasonable conditions.[1] It also requires them to "precisely define the question of interest (clinical question), look for relevant information about it from databases, study the research methodology that was used during development and trail periods, including the statistical analysis, critically evaluating the quality of the studies and understand their implications in terms of use and patient care".[2]

Thus when clinicians are presented with any new product they need to critically evaluate the associated literature presented to them by the manufacturers or sales representatives, and ask a number of pertinent questions. This includes inquiring: If the product has been tested in a laboratory? Were tests standardised and carried out according to approved protocols? What were the results of the testing? Is it biologically safe for use in patients? Is it safe for use by clinicians? Were the trials company sponsored as this can lead to an element or researcher bias?[3] Was any conflict of interest declared in the research? Have the results been validated by other independent researchers? Have the results been published in accredited peer reviewed journals and not only in company catalogues and prints? Has the product been subject to human trials? Are there long-term follow up studies? Were there any adverse events? If so,


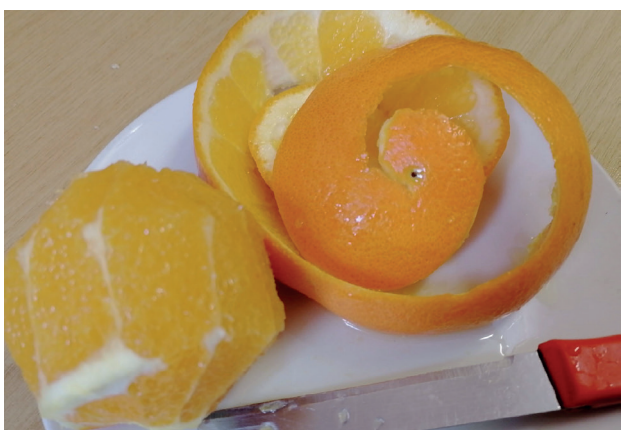
Figure 2. Knife peeled orange with rind removed in 1 long strip

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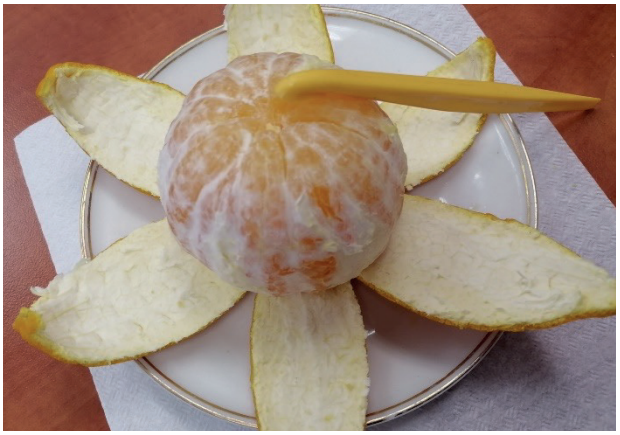
Figure 3. Orange peeled with a custom-designed utensil

have they been reported? What is the cost of the new innovation? Does it have a shelf life and / or how often will it need to be replaced? Does it require training to use? If so, who will provide the training, the company, trained clinicians, or an academic institution? Is there any maintenance plan if equipment is involved and is service easily available after purchase? Only if all of these queries can be satisfactorily answered should the clinician consider replacing the old with the new.

Thereafter, if a practitioner decides to invest in the new product or to make any substantial changes in their routine work, they should proceed with caution. If they see that it is not performing as ideally as promised or anticipated they have a "duty to care" for their patients and to assess the situation in an unbiased manner. This may involve evaluation of the intervention as well as a degree of self- reflection to ensure that the shortcomings are not due to their own inadequacy or lack of training and skills. Thereafter they may need to report their observations to the manufacturers as well as to alert colleagues.

In medical research, Good Clinical Practice (GCP) guidelines have been established to protect patients' rights, and to ensure their safety throughout any clinical trial period, including scheduled follow up evaluation.[5] While "mostly directed towards investigators, pharmaceutical and technological manufacturers, research sponsors, trial participants, research ethics committees, and medicines regulatory authorities", it is also incumbent on practitioners to be part of the process and to monitor newly implemented interventions. They have a moral obligation to report back on their findings if any adverse events or problems are noted.[4-6] This feedback may take place in informal discussions, in small working groups, via correspondence with manufacturers and regulatory bodies, or through publication in dental newsletters and journals. They should also stop using the new regime immediately regardless of how much they have invested in the initial outlay. It would be unethical to continue to use up stock or keep working with the equipment merely to justify its expense. Practitioners may also be afraid to make their observations public in case the manufacturers accuse them of slander. This fear may be allayed if they publish their findings as observations, and ask colleagues to report if they have had any similar experiences.[7] This will alert others to be more vigilant if they are using the new intervention, as the saying goes "You see only what you look for, you recognise only what you know". If the adverse events are too frequent or serious in nature, then the new intervention should be rejected immediately. Furthermore, in the interest of beneficence, and good communication, the dentist may need to alert the patients of potential problems, and offer assistance if they develop complications related to this treatment.

CONCLUSION

Over the years many new products have come onto the dental market promising features such as superior strength, better bonding, reduced tooth sensitivity, enamel remineralisation, multi-purpose uses, easy manipulation, good taste, long shelf life, superior aesthetics, and a range of other desirable features. Some lived up to their promises, others were replaced by updated versions or different products, many ended up in the back of store rooms, or were completely discarded. The latter generally disappeared from sight and use, except perhaps for mention in materials textbooks, (which should be read with the awareness that they become rapidly dated). This paper highlights the need for clinicians to keep abreast of current trends and innovations in dentistry, to read trustworthy scientific literature, and to ensure that before they embark on any new treatment modality they are confident it has been through extensive trials, the results have been analysed with appropriate tests by independent investigators, and the reporting thereof is accurate, reliable, repeatable, sensitive, specific and clinically applicable."[8] While it is admirable for clinicians to be open minded and willing to embrace and adapt to modern technology, this should only be done if the change has been proven superior to reliable routine practices. It is incumbent on all practitioners to spend time reading contemporary literature, attending congresses, participating in study groups, and contributing information based on their own experiences to colleagues in the field. Life-long learning and communication will hopefully lead to practitioners having more fruitful careers, and equip them to provide the best possible service and care to their patients.

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CPD questionnaire

The prevalence and associations of radiographic diagnostic signs indicating possible pre-eruptive canine ectopia: The results of a mixed dentition radiographic survey.

1. Select the CORRECT answer. Which of the following statements are true.

A. During the mixed dentition Dental age and Chronologic age are always coincident.
B. In patients with dental age greater than 10 years, the absence of the buccal canine bulge on clinical examination could be a valuable indicator of maxillary canine ectopia.
C. Resorption of primary maxillary canines should have begun by dental age 8 and be completed by dental age 10
D. Canines positioned over the pulp chamber or mesial to the root of the maxillary lateral incisor will most likely self-correct.
E. An enlarged radiographic image of a maxillary canine in comparison to its opposite number and surrounding teeth, indicates buccal positioning of the tooth on the panoramic radiograph

2. Select the CORRECT statement from the options below

A. An enlarged radiographic image of a maxillary canine in comparison to its opposite number and surrounding teeth, indicates palatal positioning of the tooth on the panoramic radiograph
B. Canines positioned over the pulp chamber or mesial to the root of the maxillary lateral incisor will never self-correct.
C. A pantomogram showing an overlap between the cusp tip of the maxillary canine and the lateral incisor root is definitely abnormal at the dental age of 10 years.
D. All of the above statements are correct

Analysis of the Mental Foramen and Inferior Alveolar Canal pattern based on CBCT data

3. Choose the CORRECT answer. Which of the following are the branches of trigeminal nerve?

A. Optic nerve
B. Lingual nerve
C. Mental nerve
D. Both b and c

4. Select the CORRECT option. Mental foramen is located near the apices of

A. First mandibular premolar
B. Second mandibular premolar
C. First mandibular molar
D. Mandibular canine

5. Which of the following options is CORRECT. The transition between the Inferior alveolar nerve and mental nerve has been classified into the following pattern/s.

A. Linear
B. Perpendicular
C. Anterior Loop (Al)
D. All of the above

6. Select the CORRECT answer, Which of the following are advantages of CBCT

A. Less radiation exposure
B. Cost effective
C. High quality three- dimensional images without distortion
D. Technique sensitive

Surveillance of specific pathogens on mobile phones in aerosol and non-aerosol generating dental clinics during the COVID pandemic

7. Which of the following is CORRECT. Mobile phones are considered hotspots for carrying and transmission of germs when

A. Texting and making calls,
B. Sharing / holding mobile phones and
C. Reading from phones
D. All of the above

8. Choose the CORRECT answer. Electronic devices such as smartphones used in dental clinics are essential for:

A. Patient tracking,
B. Search Literature,
C. Tele-consultations and
D. Communication with colleagues (sharing patient info/ records)
E. All of the above

The oral presentation of secondary syphilis among men: the evolving interplay between syphilis, HIV and prophylactic strategies

9. Select the INCORRECT characteristic. Which of the following lesions are NOT characteristic of oral secondary syphilis?

A. Condyloma acuminatum
B. Condylomata lata
C. Mucous patch
D. Syphilitic rosette

10. Choose the INCORRECT drug. Which of the following treatment strategies are NOT indicated for the treatment of syphilis in a patient allergic to penicillin?

A. Azithromycin
B. Clindamycin
C. Doxycycline
D. Ceftriaxone

Adverse drug reactions, a guide for dentists

11. Select the CORRECT answer. Ibuprofen can cause which of the following adverse drug reaction

A. Gastrointestinal bleeding
B. Itchy skin
C. Sweating
D. Constipation

12. Which of the following is CORRECT. Clostridium difficile is a high risk with which drug?

A. Ibuprofen
B. Clindamycin
C. Paracetamol
D. Celecoxib

13. Choose the CORRECT answer. Alcohol consumption and metronidazole can result in a unpleasant reaction. What is the reaction called?

A. Anaphylactic reaction
B. Immunological reaction
C. Disulfiram reaction
D. Photosensitivity reaction

The Complexity of Care and the Dunning-Kruger Effect

14. Select the CORRECT answer. In the HPCSA's interpretation of Rule 21 is to be found this:

A. The introduction of new interventions within the practitioners' scope of profession was only permissible if the practitioner had undergone further appropriate training as approved by the Board.
B. The actual scope of the profession is defined by the standards and norms considered reasonable for the intervention.
C. With any intervention several interventions need to be performed annually to remain proficient, taking into account the standards and norms considered reasonable for the circumstances under which the intervention took place
D. None of the above interpretations are correct

15. Which of the following statements is CORRECT. One of the motivations for creating complexity levels for treatment need is:

A. Help patients identify competent clinicians
B. Create a framework to identify incompetence
C. Provide a framework to identify where additional training and and/or qualifications are required
D. Obviate the need for professional experts when complaints / claims are made

16. Select the CORRECT answer. The Dunning-Kruger effect can be described as:

A. Being aware of one's limitation
B. Being unskilled and unaware of it
C. Keeping within one's abilities
D. Feelings of inadequacy despite being suitably competent and proficient.

Phenotypes and Clinical Genotypes of Bruxism Patients: A Systematic Review

17. Select the CORRECT statement from the options.

A. Bruxism is characterized by biological, psychological, and exogenous factors.
B. Frequent clinical signs resulting from bruxism include repetitive movements of the jaw causing the teeth to squeak, micro trauma to chewing muscles and cervical pain skull mandibular.
C. The prevalence of bruxism found in this review was 8 to 31.4%, with the highest percentage in men.
D. All of the above are correct.
E. None of the above is correct.

Radiology Corner:

18. Select the CORRECT option. What is the cause of multiple phleboliths?

A. Vascular inflammation
B. Cholesteroleamia
C. Hemangiomas
D. Vascular injury

19. Choose the CORRECT option. What is the radiological appearance of phleboliths?

A. Cauliflower appearance
B. Speck-like
C. Cotton wool
D. Target appearance

20. Select the CORRECT answer. What assists in distinguishing phleboliths from sialoliths

A. Location
B. Size
C. Unilateral vs bilateral
D. Multiple vs singular

Ethics: Embracing new technology, with caution

21. Select the CORRECT statement. Any new material / technique / equipment offered to practitioners should:

A. Be used of it is cheaper or easier to use than those in currently operation
B. Be tried out in order to stay abreast of the latest innovations
C. Be evaluated against those in current use
D. Be avoided as they will need clinicians to change trusted practices
E. Only a) and c) above are correct

22. Which of the following is CORRECT. When clinicians are presented with any new product

A. They should have company representatives train them as they are the experts
B They should be sure it has been tested over a reasonable length of time
C. They should use it if it will save patients time or money
D. They should use it if it is easier to handle than their current product
E. All of the above are correct

23. Which statement is CORRECT. If a practitioner is given free samples of a new but untested product to try out

A. They may use it if they do alert the patient about this
B. The patient should sign consent to them using the product
C. They may use it but should charge the patient less
D. All of the above are correct
E. None of the above are correct

24. Select the CORRECT statement. Good Clinical Practice (GCP) guidelines

A. Relate only to issues concerning patient safety and welfare
B. Were initially established to ensure practitioners safety when using new products
C. Are only relevant during the set period of clinical trial times
D. All of the above are correct
E. None of the above are correct

25. Which option is CORRECT. Conflict of interest may arise where

A. There is company sponsored research
B. Clinicians are offered special introductory rates on new products
C. Patients are offered special introductory rates on new products
D. All of the above are correct
E. Only a) and b) above are correct

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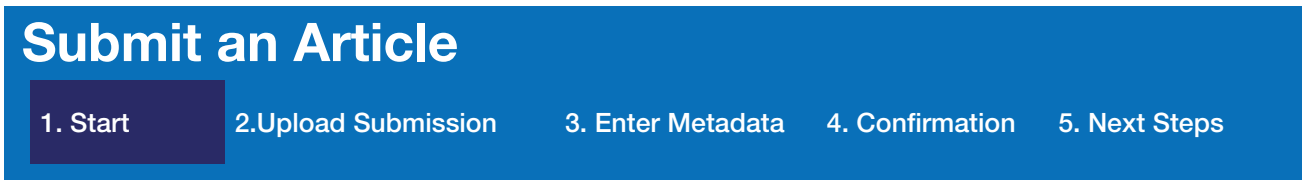

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5. Have you provided all details of the Communicating Author?
6. Have you submitted questions for the CPD section? (four or five multiple choice, one correct answer)?
7. Have you submitted details of the contribution of each author... can be percentage or descriptive... or both?
8. Is the first author under the age of 35 on submission of the article?
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10. Have you submitted questions for the CPD section? (four or five multiple choice, one correct answer)?
11. Are the references quoted according to Journal policy, both in the text and in the list of references?
12. Have all authors signed the Letter of Submission?

NOTES

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