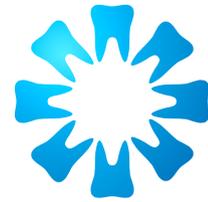


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SADA

THE SOUTH AFRICAN
DENTAL ASSOCIATION

*Johannes Frederick van Reenen
- a doyen of the profession*



Johannes Frederick van Reenen - a doyen of the profession

Johannes Frederick ("Frikkie") van Reenen (20/04/1926 to 8/9/2007) a doyen of the profession who by exemplary example contributed to the advance of Dental Education in South Africa.



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Our Front Cover for this Issue...

The theme for the Front Cover of the South African Dental Journal this year provides for some historical figures, some characters illuminating dental history and some important achievements in South African Dental history. The cover for August looks at a dentists who is considered a doyen of the profession. Read more on page 409.



Johannes Frederick van Reenen - a doyen of the profession
Johannes Frederick ("Frikkie") van Reenen (20/04/1926 to 8/9/2007) ...a doyen of the profession who by exemplary example contributed to the advance of Dental Education in South Africa.

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Professor Johannes Frederick van Reenen ...a doyen of the profession (20/04/1926 to 8/9/2007)



Johannes Frederick ("Frikkie") van Reenen (20/04/1926 to 8/9/2007)

Frikkie Van Reenen qualified BDS (Rand) in 1949, and then spent his first year as a dentist in London before returning to South Africa and opening a private practice in Pretoria. It was there that he began his foray into academia when he was appointed to a post as an honorary lecturer at the Faculty of Dentistry, University of Pretoria.

He remained in that position for some years, during which time he was amongst the first to recognise that combating dental disease requires a sound comprehension of the microbial organisms populating the mouth. Pursuing this passion, he returned to London in 1957 where he read microbiology at the London School of Tropical Medicine and Hygiene.

He then returned to South Africa, and entered into full time academia, introducing the study of microbiology at Wits Dental Hospital and ascending in time to the post of Dean of the Faculty of Dentistry in 1975. As a full Professor he held that position and as Director of the Oral and Dental Hospital for 12 years up until 1987.

He was deeply committed to enhancing dental education and to the advancement of knowledge and acuity in the practice of Dentistry. To this end he served for twenty years as Scientific Editor of the South African Dental Journal. His time in this position was marked by his determination to ensure that the publication played a significant role in the profession. He selected the most contemporary articles that would have the greatest impact, and strived to present these in the most concise and lucid manner.

Frikkie also delved into research in prosthodontics, oral microbiology and anthropology. He contributed to an understanding of the culture of the San people and was noted for his empathy with these much smaller folk, towering over them from his well-over six foot height. Not only was he a great academic, but Professor van Reenen had many interests beyond dentistry including his love of music, in which he became well qualified, holding recognitions including the Licentiate of the Royal School of Music (LRSM), the Licentiate of Trinity College London (LTCL), and the University Teachers Licentiate in Music (UTLM). His appreciation of the aesthetics in life, for he deeply enjoyed art and received regular Monday evening tuition under renowned South African artist Lionel Abrams, gave Frikkie a special sense of how to

combine beauty, health and function into dentistry. That understanding ensured that countless students under his tutelage came to recognise those critical balances in their practice of Dentistry, and enhanced their empathy for their patients. His students recognised his dedication by creating the Professor Van Reenen Award, an accolade to teaching excellence.

In addition to all of these commitments, Professor van Reenen became involved in many of the wider aspects of Dentistry in South Africa. He was a long-time member of the Federal Council of the Association, and held office on the Health Professions Council and the South African Medical Research Council. As a founder member of the Prosthodontic Society of South Africa, Professor van Reenen also was an inspiration in the founding of the Academy of Prosthodontists of South Africa. Elected as a Fellow of the College of Medicine of South Africa, he contributed to the creation of the Faculty of Dentistry at the College.



Frikkie was a very private and reserved person, but at the same time was always open and approachable. A man of impeccable style, dress and demeanour, well into his 70s he was noted to have said that he "longed for the day that he would be old enough to walk with a cane, as he considered this to be very genteel". He never did need that cane, and was in any event already the epitome of a true gentleman.

Prof van Reenen was a steadfast man of unflinching integrity, who throughout his life held himself to the highest ethical principles and endeavoured to ensure that through his teaching, his beloved profession should be an example of ethical commitment and clinical excellence, a noble contribution indeed.

With acknowledgments to Professor Leanne Sykes and Dr Michael Hellig.

Enhancing information distribution through open access publishing

SADJ September 2020, Vol. 75 No. 8 p410

NH Wood
Managing Editor of the SADJ



The South African Dental Journal is steadfastly moving deeper into the open access realm. This brings with it some challenges and concerns that the editorial team need to be aware of and manage accordingly. However, many positives are gained from this position that include improved article distribution and visibility, better knowledge dissemination, and improved manuscript management to name a few.

Academic journal subscriptions became increasingly expensive over a number of years as publishing companies saw that there was profit to be made from charging libraries, scholars and readers with fees to access scientific papers. The cost of this access keeps rising which raises the question: “why is this cost necessary?”.

There are certainly costs to be covered by the journal and publishers in the process from the article submission to the publication thereof, and reasonable fees can be built in through different mechanisms and are justifiable. But is an exorbitantly high cost justified?

Many view this paywall as simply blocking access to scientific material and obstructing scientific progress and the dissemination of knowledge to anyone who needs it for the sake of making money. And those making the money are not the authors, neither the reviewers nor the journal itself. It is therefore not morally acceptable to hold scientific progression at ransom for profit.

Academics and prominent academic institutions globally are making efforts to break down this restrictive paywall. The knowledge revolution is also gaining popularity among scientific funders, many of whom now demand that the research they fund be published as open



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access. It is my view that we must strive to provide the latest scientific developments and information from the knowledge frontier to anyone who seeks it. As such, the SADJ will be hosted on the Khulisa platform which will soon be accessible at <https://journals.assaf.org.za/index.php/sadj>.

There is some concern regarding the endurance of open access journals and papers on the web.¹ There have been instances where journals and/or articles have disappeared off the web, but this was mainly as a result of non-attendance. At the SADJ every effort is made to ensure our material is backed up to protect the SADJ against such information loss with the South African Dental Association also acting as the preservation custodian for the journal. In this way the knowledge contained in the archives of the SADJ will be available to many generations after ours. We once again thank our contributors for the content in this September issue of the South African Dental Journal.

References

1. https://www.theregister.com/AMP/2020/09/10/open_access_journal/.

Clinical management of Sialadenitis

SADJ September 2020, Vol. 75 No. 8 p11- p412

N Kana¹, Z Cassim², S Maharaj³

INTRODUCTION

Within the area of salivary gland pathology, obstructive sialadenitis is the most common inflammatory condition of the salivary glands.¹

It has been well established in the literature that salivary calculi occur most commonly in the submandibular gland, whereas fewer cases are found in the parotid gland, while the sublingual gland and the minor salivary glands form no more than 2% of cases.²

The early treatment of sialadenitis is usually conservative and involves hydration, anti-inflammatory medication in conjunction with antibiotics when a bacterial infection is suspected. However, when initial treatment fails, further intervention is needed.

The traditional external approach is sialadenectomy. However, with this exists the potential for injury to the lingual and facial nerves. Further complications including bleeding, infection and an unsightly scar are also found with this procedure.^{3,4}

Sialendoscopy is a relatively new technique that only became available once optics had improved to the extent that fiber-optic endoscopes could be miniaturized to a diameter of 0.9 mm to 1.6 mm. This has ushered in a new era for the management of sialadenitis, particularly in cases where sialadenitis was caused by salivary duct obstruction.

It must be noted that in South Africa, there are currently no generally accepted guidelines on the management of sialadenitis secondary to salivary ductal obstruction as well as in the role of sialendoscopy within the treatment algorithm.

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1. **Nadir Kana:** Conceptualisation, write up, editing - 40%
2. **Zarreen Cassim:** Write up and editing - 30%
3. **Shivesh Maharaj:** Conceptualisation and write up - 30%

METHODS

Currently sialendoscopy is now the benchmark against which radiological tests are measured. As often happens in clinical medicine, the rather invasive nature of sialadenectomy ushered in the need for an alternative approach.

For the purpose of this communication, the researchers, including two Ear Nose and Throat surgeons, reviewed the trends within the setting of their personal clinical practice, over a period of 12 years, commencing with the year 2008. It must be noted that the researchers' experience with sialendoscopy has not only been positive but appears to be largely supportive of the findings reflected in the international literature. This report involved a review of the clinical experience of two surgeons and reflected an 86% success rate when sialendoscopy was used as a management tool, and a 100% success rate when it was utilized as a diagnostic tool. Thus far, all the cases seen by the authors have been adult patients, with all of the procedures performed under general anaesthesia.

DISCUSSION

The first successful diagnostic sialendoscope was performed by Katz et al. in 1990.⁵ As technology in optics improved it became possible not only to diagnose salivary duct obstructions, but a hollow working channel in the center of the endoscope allowed for the passage of specifically designed tools such as hand drills, stone removal baskets and later, fibre lasers. A further development was the successful use of lithotripsy for the fragmentation of large salivary calculi. However, it must be noted that salivary ductal obstruction does not only occur due to calculi.

Salivary strictures versus calculi occur with approximately a 20/80 ratio split. Short strictures are referred to as stenoses and are more easily dilated via sialendoscopy than their longer counterparts.⁶ Currently, sialendoscopy is the most sensitive diagnostic tool used, in comparison to radiological imaging methods.

The diagnosis of sialolithiasis, stenosis, polyps, recurrent sialadenitis, foreign bodies and sialadenosis are made with ease using the sialendoscope. The advantage of sialendoscopy is its ability to treat ductal obstruction. The passage of the sialendoscope itself through salivary ducts dilates minimally stenosed ducts. In addition to this, high-pressure saline solution aids in the dilatory process. The need for sialendoscopy was largely due to the complications associated with invasive and open procedures such as the sialadenectomy, which resulted in the presence of a visible scar.

Furthermore with the submandibulectomy procedure there are potential complications including dysgeusia, partial tongue paralysis and marginal mandibular nerve palsy (although this is more often a temporary paresis). Parotidectomy is associated with higher risks such as facial nerve injury which is the foremost risk, followed by Frey's Syndrome.⁷ Sialendoscopy itself is minimally invasive, however, it is not entirely complication free, and can rarely be associated with duct avulsion especially during active sialadenitis. Thus acute sialadenitis is a universally accepted contraindication to Sialendoscopy.

Other complications include failed extraction of a salivary calculus, and excessive bleeding leading to abandonment of the procedure. In some cases, the procedure would be repeated but in others a decision to proceed to open adenectomy may be taken.

A further variation of the procedure is a combined external/sialendoscopic procedure which is indicated particularly in cases where the calculi are unusually large. The basic sialendoscopy procedure falls into three steps: the first of which involves the papillary dilation, followed by the passing of the sialendoscope, diagnosis, and lastly, the treatment of the obstruction. The papilla is more readily located using a microscope or magnifying loupes. Furthermore the papilla can be exposed by massaging the gland to initiate salivary flow.

A sialagogue such may aid this technique, for example, the use of lemon juice. The diameter of the undilated papilla is about 0.5 mm necessitating the use of ductal dilation in order to accommodate a working channel. This is as a therapeutic scope has a diameter of 1.3mm to 1.6mm. The "classic technique" to dilate the papilla is with the use of salivary probes. These are similar to lacrimal dilators. A conical dilator that is less traumatic to the ductal lumen can also be used instead of salivary probes. This is possible only when the papilla opening is large and clearly visible.

The "guided puncture technique" begins with the introduction of probes of increasing size followed by a guidewire. A conical dilator is 'railroaded' over this guide to expand the papilla. The dilator is then removed and the endoscope working channel is once again 'railroaded' over the guidewire.

The guide is removed when a ductal image is correctly obtained. In cases where the submandibular duct papilla is difficult to find, a more invasive "surgical" technique can be useful. An incision is made parallel to the course of the duct. The duct is then identified and incised by 1 mm to allow the insertion of the endoscope. In terms of the location of stones, for mobile stones less than 5 mm located in the distal duct/papilla, sialendoscopy with calculus retrieval via stone basket may be attempted. If located in the proximal duct/hilum, in the case of small, mobile calculi less than 5 mm, retrieval of the calculus with a wire basket or grasping forceps is indicated. In the case of calculi that are greater than 7 mm which are palpable, the stones can be fragmented using laser, lithotripsy or a transoral incision of the duct can be performed. Intraparenchymal, mobile stones less than 7 mm can

be removed using the sialendoscope. With impacted calculi greater than 7mm up to 10mm, fragmentation is recommended, thus allowing for endoscopic removal. With regards to the use of the basket, there are various retrieval baskets that are now available to remove calculi. Since the advent of the stone basket, less damage to the ducts and glandular parenchyma have been reported. When a laser is used, the main limiting factor for sialendoscopy in sialolithiasis is the size of calculi. The different techniques described for calculus fragmentation include external lithotripsy, electrohydraulic, piezoelectric, electromagnetic and pneumoblastic lithotripsy and holmium: YAG lithotripsy.

CONCLUSION

Based on the information presented above, it can be seen that within a clinical context, sialendoscopy can be used dynamically by practitioners not only as a diagnostic tool, but as a therapeutic measure. In the management of salivary duct obstructions specifically, endoscopes with working channels allow for concomitant use of instrumentation to assist in sialolith removal or stricture dilation. In some centres, lithotripsy may be used to facilitate stone fragmentation prior to removal. For stones not amenable to endoluminal removal, a combined approach using a limited incision in conjunction with sialendoscopy to localize and stabilize the stone can provide minimal surgical morbidity, as is the case for complex strictures/dilatations of the duct.^{4,5}

The success rates of sialendoscopy vary between 85% and 95% which has resulted in a drastic reduction in the need for invasive procedures such as sialadenectomy.⁶ Thus, sialendoscopy has a major role to play in the diagnosis and management of sialolithiasis and such a field warrants more research, especially due to the success that practitioners have seen with regards to the use of the procedure within clinical practice.

References

1. Strychowsky JE, Sommer DD, Gupta MK, Cohen N, Nahlieli O. Sialendoscopy for the management of obstructive salivary gland disease: a systematic review and meta-analysis. *Arch Otolaryngol Head Neck Surg.* 138(6): 541-7.
2. Ianovski I, Morton RP, Ahmad Z. Patient-perceived outcome after sialendoscopy using the Glasgow benefit inventory. *Laryngoscope.* 2014; 124(4): 869-74. doi:10.1002/lary.24343.
3. Kroll T, Finkensieper M, Sharma SJ, Guntinas-Lichius O, Wittekindt C. Short-term outcome and patient satisfaction after sialendoscopy. *Eur Arch Otorhinolaryngol.* 2013; 270(11): 2939-45.
4. Marchal F, Dulguerov P. Sialolithiasis management: the state of the art. *Arch Otolaryngol Head Neck Surg.* 2003; 129: 951-6.
5. Nahlieli O, Nakar LH, Nazarian Y, Turner MD. Sialoendoscopy: a new approach to salivary gland obstructive pathology. *J Am Dent Assoc.* 2006; 137(10): 1394-400.
6. Katz P. Endoscopy of the salivary glands. *Ann Radiol (Paris)* [cited 2018 Oct 6]. 1991; 34(1-2): 110-3. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/1897843>.
7. Singh PP, Gupta V. Sialendoscopy: introduction, indications and technique. *Indian J Otolaryngol Head Neck Surg.* 2014; 66: 74-8.
8. Nahlieli O. Complications of sialendoscopy: personal experience, literature analysis, and suggestions. *J Oral Maxillofac Surg.* 2015; 73.

The SADA dental mediation (free and going online)

SADJ September 2020, Vol. 75 No. 8 p413 - p414

KC Makhubele
CEO of SADA



The South African Dental Association offers a **free** and **voluntary** “complaints resolution” service available to members of the public and Oral Health Care Practitioners (OHCP) when a dispute arises. The service follows a non-adversarial approach and uses the principles of mediation to find a solution or outcome acceptable to both parties.

The structured process is impartial, confidential and without prejudice. The Public and Professionals (includes non-SADA members) have access to a Mediation Process in the event of a dispute. The Dental Mediator will in an ethical and non-partisan manner:

- Mediate in any disputes arising out of the supply of clinical and professional treatment by practitioners to patients.
- Promote and ensure ethical practice by the dental profession.
- Assist with the education of the dental profession with regard to appropriate risk management processes.

About mediation

Mediation is the most spoken about word in the current national healthcare litigation crisis. It has been advocated by various institutions and even government as a possible solution to drive down the costs of negligence claims and professional indemnity.



Members will be delighted to know that SADA has been pro-active in this regard by offering a “complaint resolution and mediation service” to its members and their patients since 2013. The service was spearheaded by the late Dr A Rademeyer in 2013, with Dr J Barnard taking over the responsibilities two years later.

The service offers a solution for both patients and dentists looking to resolve conflicts and concerns, in a non-adversarial environment, without the involvement of the HPCSA or medical litigation lawyers.

Mediation differs from the process of arbitration, counselling or negotiation in that participants, with the assistance of a neutral person, can systematically isolate issues to develop options, consider alternatives and reach a consensual settlement that will accommodate their unique needs. Currently, all patient complaints received by SADA are automatically referred to the Dental Mediator.

Oral Health Professionals can also contact the Mediator directly for assistance with a patient complaint. Currently, all referrals must be in writing to dentalmediator@sada.co.za. We are very excited that in October 2020, we will be digitising our process making it easy for users to submit their cases online 24/7 and have the ability to check on the progress of their cases.

The mediation service:

- Is free to Oral Health Professional and their patients; no fees are payable.
- Is voluntary and confidential and participants are free to abandon the process at any time.
- Is impartial and neutral.
- Encourages self-determination by ensuring both par-

ties recognise their differences and take ownership to resolve the conflict.

- Is not aimed at achieving absolute justice, but to develop options and find the most workable and timeous solution.

Recognising disappointment and identifying solutions are not easy where conflict exists. Some dentists find it extremely difficult to objectively view a complaint and the mediation service offers patients and dentists a solution where a normal complaint handling process does not exist or fails to function effectively.



The mediation process follows the following steps:

The Dental Mediator receives a complaint for mediation from either the OHCP or a member of the public.

1. **Self-Resolution:** Members of the public are encouraged to formalise their complaint and expectations in writing to the treating practitioner before involving any third parties. It is essential that the treating practitioner is aware of the patient's concerns and is given an opportunity to resolve the matters first. The majority of disputes can be resolved through good

communication between the member of the dental patient and OHCP.

2. If the "self-resolution" efforts between parties have been unsuccessful and a complaint is subsequently lodged, the Dental Mediator would contact both parties to inform them about the complaint and establish their willingness to participate in a mediation process.
3. If both parties agree to participate in the mediation process, the Mediator will analyse the information at hand. The Mediator may call for further information in any manner he/she deems necessary from any person who, in his opinion, may assist in the mediation to resolve the matter. It may include requesting the OHCP to respond to the complaint or seek expert advice from his/her indemnifier or other relevant parties such as an expert in the field.
4. Once the Dental Mediator is satisfied with the information received, he/she will assist the parties to generate solution options through self-determination to meet the needs and concerns of both parties. Participants are free to leave the mediation process at any time during the process.
5. Once an outcome acceptable to both parties is agreed on, the arrangement will be formalised in an agreement, and the process becomes binding.
6. If the participants, with the help of the mediator, fails to find an outcome acceptable to both parties, the process mediation fails, and parties have to resort to alternative forms of "dispute resolution".

We would like to encourage our members to explore the service, and trust that it will prove to benefit those who make use of it.



Lip height estimation in a southern African sample

SADJ September 2020, Vol. 75 No. 8 p415 - p424

Tobias MR Houlton¹, Nicolene Jooste², Andre Uys³, Maryna Steyn⁴

ABSTRACT

Introduction

The South African Police Service frequently relies on craniofacial approximation and superimposition to assist in identifying unknown deceased individuals. Standards to estimate lip height are however limited. Findings from this study share medical applications.

Aims and objectives:

Establish reliable standards for estimating lip height using dentoskeletal measurements.

Methods

Cone-beam CTs comprising 124 black and 39 white southern African adults were assessed. A series of dimensions were recorded using a DICOM viewer with an in-built measuring tool. Relationships between hard tissue structures (maxillary, mandibular and total central incisor heights, their corresponding root lengths, face height (N-Gn), and nose height (N-Sn)) and respective overlying soft tissues (upper, lower and total lip heights) were evaluated.

Results and conclusions

Statistically significant differences were observed between population, sex and age groups. A selection of regression equations to estimate lip height was calculated that included population, sex and approximate age

(20-39 and 40+ years) for improved goodness-of-fit (r^2 -value). Regression models using face height produced the strongest multiple correlation (r -value) and goodness-of-fit (r^2 -value). Validation testing indicated that regression models often improved upon mean measurements, while offering a degree of individuality that mean values do not.

Keywords

Facial anthropology, craniofacial identification, craniofacial approximation, craniofacial reconstruction, craniofacial superimposition, mouth morphology.

INTRODUCTION

High rates of violent deaths, illegal immigration and internal migration, including a shortage of identification documents, result in a high incidence of unidentified deceased in the South African medico-legal system. Furthermore, families may be unaware of missing or dead loved ones due to infrequent communication in poorer communities. The unidentified deceased presents a growing humanitarian and legal strain on the country, as only after formal identification can a police inquest or criminal case progress, family be notified, and other legal, religious and cultural requirements be addressed.¹

Limited dental and DNA records are available for comparison, leading the South African Police Service (SAPS) to rely on craniofacial approximation (CFA) and craniofacial superimposition to assist in identifying possible matches. CFA recreates the likeness of an individual's face from the features of their skull.²⁻⁴ Craniofacial superimposition overlays a number of antemortem images of a missing person with an unidentified skull, to assess their structural similarity.⁵⁻⁷

Although this paper focusses on forensic applications of the relationship between the skull and the overlying soft tissues, this relationship is relevant to several medical fields. Insight from reference data about hard and soft tissue associations could benefit surgeons and orthodontists treating dentofacial deformities; for whom obtaining harmonious facial characteristics and functionality are important considerations during diagnosis and treatment.⁸⁻¹⁰

There is an absence of appropriate standards for estimating lip height for southern African or even Sub-Saharan African individuals. Generally, little is known

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3. André Uys: Assisted with data acquisition - 10%
4. Maryna Steyn: Performed the interobserver repeatability and assisted with the write up - 20%

about the placement of the mouth and lips during CFA, and yet they play a key role in the evaluation and recognition of the craniofacial complex. Previous anthropometric research on the mouth originated predominantly from the fields of dentistry and maxillofacial surgery.^{8,11-15} None of these studies were, however, performed in South Africa.

Lip height and mouth width dimensions were measured by Farkas et al.¹² using sliding callipers on a North American white sample, and Ferrario et al.¹⁵ using optoelectric equipment on a North Italian sample. They identified that males generally have greater oral dimensions than females, which is in agreement with three-dimensional studies on Czech, German, North American white and North American Latino individuals.¹³⁻¹⁴ However, no sexual dimorphism was identified by Wilkinson et al.⁴ on a European and Indian subcontinent population using direct caliper and photographic measurements, or by Ferrario et al.¹¹ on a North Italian population using photographic measurements.

Lip height alters with age and can vary between population groups.^{4,16} In a study using a white Italian sample, Sforza et al. found that the vermilion surface area and height of the upper and lower lips progressively increased during juvenile development until late adolescence, and then decreased with ageing.⁸ The vermilion height to mouth width ratio was larger in females than in males, and decreased with age; the total lip height and lip volumes were however significantly larger in males than in females. In a study on an adult South African male sample by Schmidlin et al.¹⁷, the upper and lower lip dimensions was found to similarly reduce with age, but the lip height dimensions were consistently greater than in Sforza et al.'s⁸ European sample.

Research focussing on the direct relationship between the lips and skull has been previously performed. Early observations by Gerasimov¹⁶ related lip height to the projection of the maxillary and mandibular incisors and their corresponding alveolar sockets. He associated small straight teeth to thin lips and orthognathism, and big prominent teeth to thick lips and prognathism. Angel¹⁸ agreed that lip height depended on the projection of the teeth, emphasising the impact of ancestry, and the strength of the incisive and buccinator muscles.

Gerasimov¹⁶, Gatliff and Snow¹⁹ and Taylor²⁰ all directly affiliated the vertical thickness of the mouth (referring to the thickest, pigmented part in the middle portion of the lips) to be equal to the vertical distance of the central incisors (from the upper cemento-enamel junction to the lower cemento-enamel junction).

George²¹, however, alternatively indicated that the upper lip is positioned parallel to the upper quarter mark of the maxillary central incisor, and the lower lip positioned parallel to the lower three-quarter mark of the mandibular central incisor. These existing methods for estimating lip height were, however, based on a predominantly European sample.

Wilkinson et al.⁴ constructed the only existing equation for calculating lip height using maximum height mea-

surements of central incisors, with independent equations for European and Indian subcontinent individuals. These methods of lip height estimation (by Wilkinson et al.⁴, Taylor²⁰ and George²¹), have subsequently been tested on a central European sample by Mala and Veleminska.²² Wilkinson et al.'s⁴ equations offered the most accurate result for estimating upper and lower lip height (1.3mm and 1.8mm mean absolute error for upper and lower lip estimation, respectively). George²¹ was the most accurate for determining total lip thickness (3.4mm mean absolute error).

This study aimed to develop reliable standards for estimating lip height using dentoskeletal measurements taken from a southern African sample. Statistical differences were assessed between population, sex and age groups, in order to determine whether universal or specific formulae should be used.

Relationships between dentoskeletal measurements and lip height were determined. The goodness-of-fit achieved using the available dentoskeletal measurements as compared to a mean model were also assessed.

MATERIALS AND METHODS

This study was retrospective, using clinical cone-beam computerised tomography (CBCT) scans of 124 black (72 male, 52 female; mean age 35 years) and 39 white (19 males, 20 females; mean age 36 years) southern African adults. Data were collected from the University of Pretoria, Oral and Dental Hospital (ethics clearance number: 212/2016).

Subjects were aged between 20 and 87 years, displayed neutral facial expressions and moderate bodyweight. Subjects with the following characteristics were excluded from the study: intrusive craniofacial trauma, congenital anomalies, extensive tooth loss, or surgery impeding the basic craniofacial appearance, particularly of the mouth.

Comparative hard and soft tissue dimensions were collected in OsiriX (DICOM viewer) (Figure 1, Table 1). Measurements included upper, lower and total lip vermilion height (1-3); maxillary, mandibular and total height of the central incisor crowns (A-C); corresponding root lengths of the incisors (D-E); skeletal nose height (N-Sn; F) and face height (N-Gn; G). Lateral dimensions (i.e. central incisor heights and root lengths) were taken from both left and right views.

One hundred subjects underwent three intra-observer repeat measurements following 7-day intervals, and 30 individuals were remeasured by another observer. Repeat measurements utilised the original set of CBCT scans, thus purely representing observer measurement error.

Detecting possible technological and biological variables/errors using repeat scanning techniques was not feasible due to the retrospective nature and ethical considerations of this study. We are also conscious of the limited white sample, which is representative to the frequency of white patients visiting the dental hospital. The white data were maintained in this study to form a descriptive comparison for black and white southern Africans.

Repeatability was calculated using technical error of measurement (TEM) and relative TEM (r-TEM), using Microsoft Excel 2011 version 14.4.1. TEM was performed according to Dahlberg²³ and Perini et al.²⁴ for interobserver tests incorporating two observational repeats, and Langley et al.²⁵ for intra-observer tests incorporating three observational repeat measurements.

The statistical package SPSS version 25 was used to analyse all other results. Wilcoxon signed rank tests were conducted to identify whether significant differences exist between the left and right maxillary and mandibular central incisors, and corresponding roots.

The Wilcoxon signed rank test was also used to compare the central incisors and corresponding lip heights (to investigate Gerasimov¹⁶, Gatliff and Snow¹⁹ and Taylor's²⁰ theory for lip height estimation); the upper and lower lip heights were similarly compared. Differences between population and sex groups for the various dimensions were studied using Mann-Whitney U tests.

Age variation was investigated using both Kruskal Wallis H tests (assessing age groups by decades; 20-29 years, 30-39 years, etc.) and Mann-Whitney U tests (assessing two distinctly different age groups, as determined by the Kruskal Wallis H test). The influence of ancestry on the sample size and distribution was assessed by comparing both total and equal sample sizes for each test.

To determine if the collected hard tissue measurements can predict the associated soft tissue measurements, regression analyses were conducted. The independent variables (i.e. skeletal measurements, sex, age and population) that may contribute to the regression models were checked for inter-correlation with one another, using Spearman's rank and point-biserial correlation tests.

CBCT scans have been proven to relate to the craniofacial complex with a high level of accuracy, thus the generated regression models did not require any subsequent adjustment to represent reality.^{26,27}

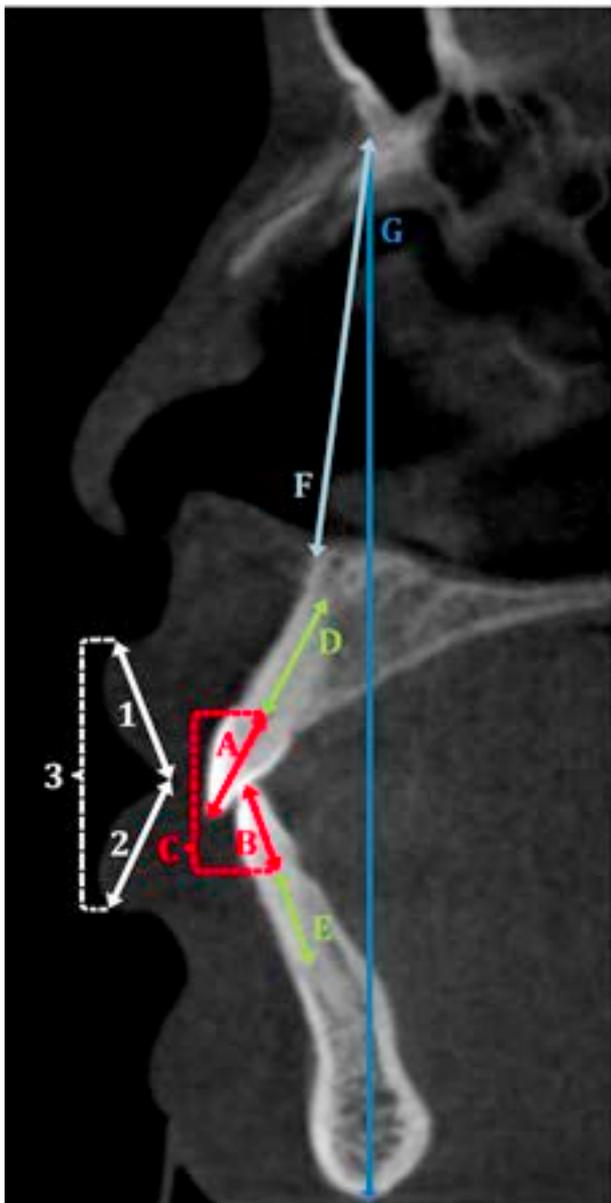


Figure 1. Comparative hard and soft tissue dimensions taken for investigation:

1. Upper lip height.
2. Lower lip height.
3. Total occluded lips height.
- A. Maxillary central incisor crown height.
- B. Mandibular central incisor crown height.
- C. Total occluded central incisors height.
- D. Maxillary central incisor root length.
- E. Mandibular central incisor root length.
- F. Nose height.
- G. Face height.

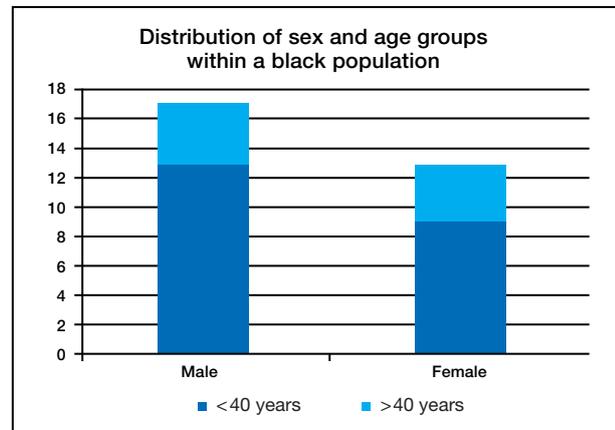


Figure 2. Distribution of sex and age groups within a black population - specific hold-out sample used for validation testing. Sample sizes vary according to the different dimensions obtainable within available scans.

Regression models underwent validation testing using an independent hold-out sample comprising 30 cases. The composition of the hold-out sample is shown in Figure 2. Validation testing was only performed with a black sample, due to a shortage of available white individuals. The available sample was also weighted towards males and younger individuals.

Although limited samples were available, we still found it necessary to check the efficacy of our research using a completely independent set of data; this has been proven to offer the most rigorous method of testing.^{28,29} We encourage more independent validation testing in the future. Regression models were compared to the mean heights of upper, lower and total lips; population, sex and age were considered for all models and mean heights.

RESULTS

Adequate repeatability was obtained from intra- and inter-observer tests (Table 2). Mean intra-observer r-TEM was 1.85%; ranging from 0.69% (for nose height) and 0.70% (face height) to 2.76/3.03% (left/right mandibular central incisor root lengths).

Mean inter-observer r-TEM was 2.26%; ranging from 0.73% (nose height) and 0.74% (face height) to 4.05/4.06% (left/right mandibular central incisor root lengths).

The r-TEM percentages represent the level of deviation experienced between measurements, with the ideal result being zero. The given results could be a consequence of the relative size difference experienced between face height and nose height, in contrast to root length (i.e. 1 mm makes less difference to the greater dimensions experienced in face/nose height, compared to the smaller dimensions witnessed for root length). The comparatively limited reliability witnessed for root length measurements was however expected, due to the challenges experienced when attempting to distinguish the deep margins of the root in CBCT scans.

Table 1. Definitions of measurements taken.

Measurement	Description
Upper lip vermilion height	Taken from the point denoting the vermilion border of the upper lip in the midsagittal plane, to the most anterior point of contact between the upper and lower lips. (Upper lip - Stomion, Ls-St)
Lower lip vermilion height	Taken from the most anterior point of contact between the upper and lower lips to the point denoting the vermilion border of the lower lip in the midsagittal plane. (Stomion - Lower lip, St-Li)
Total lip vermilion height	Taken from the point denoting the vermilion border of the upper lip and lower lip in the midsagittal plane. (Upper lip - Lower lip, Ls-Li)
Maxillary central incisor crown height	Longest apicocoronal distance, parallel to the long axis, between the most apical point of the cementoenamel junction and most incisal point of the anatomical crown, of the maxillary central incisor.
Mandibular central incisor crown height	Longest apicocoronal distance, parallel to the long axis, between the most apical point of the cementoenamel junction and most incisal point of the anatomical crown, of the mandibular central incisor.
Total central incisor crown height	Longest apicocoronal distance, parallel to the long axis, between the most apical point of the maxillary cementoenamel junction to the most apical point of the mandibular cementoenamel junction.
Maxillary central incisor root length	Taken from the border of the maxillary alveolar junction to the distal root apex point.
Mandibular central incisor root length	Taken from the border of the mandibular alveolar junction to the distal root apex point.
Face height	Taken from the midline bony depression between the eyes and just below the glabella, where the frontal and two nasal bones meet, to the midpoint of the lower border of the mandible. (Nasion - Gnathion, N-Gn)
Nose height	Taken from the midline bony depression between the eyes and just below the glabella, where the frontal and two nasal bones meet, to the midline point at the base of the nasal spine. (Nasion - Subnasale, N-Sn)

Table 2. Intra- and inter-observer errors for FSTT measured in this study.

Dimensions	Intra-observer (n = 100; n* = 65, 3 repeat measurements)			Inter-observer (n = 30, 2 repeat measurements)		
	TEM (mm)	r-TEM (%)	Reliability	TEM (mm)	r-TEM (%)	Reliability
Upper Lip Height	0.29	2.14	0.98	0.30	2.16	0.98
Lower Lip Height	0.28	2.21	0.98	0.34	2.65	0.97
Total Lip Height	0.55	2.20	0.98	0.57	2.21	0.98
Maxillary Incisor Height (left)	0.13	1.23	0.98	0.15	1.34	0.98
Maxillary Incisor Height (right)	0.14	1.35	0.98	0.16	1.46	0.97
Mandibular Incisor Height (left)	0.13	1.50	0.98	0.15	1.71	0.97
Mandibular Incisor Height (right)	0.13	1.52	0.98	0.19	2.09	0.96
Total Occluded Teeth Height	0.35	1.86	0.98	0.47	2.45	0.97
Maxillary central incisor root length (left)	0.26	2.34	0.95	0.32	2.67	0.92
Maxillary central incisor root length (right)	0.27	2.43	0.94	0.39	3.31	0.89
Mandibular central incisor root length (left)	0.25	2.76	0.95	0.39	4.05	0.93
Mandibular central incisor root length (right)	0.28	3.03	0.94	0.39	4.06	0.91
Face Height*	0.84	0.70	0.99	0.87	0.73	0.98
Nose Height*	0.35	0.69	0.99	0.37	0.74	0.99
Minimum	0.13	0.69	0.94	0.15	0.73	0.89
Maximum	0.84	3.03	0.99	0.87	4.06	0.99
Mean	0.30	1.85	0.97	0.36	2.26	0.96

The performance was however acceptable for a cautious continuation of the investigation.

No significant differences between the left and right central maxillary/mandibular incisors/roots heights were found, and therefore only bony dimensions from the left side were used for further analyses. Utilising measurements taken from the left side is furthermore supported by the moderately improved performance of repeat measurements taken between the left and right aspects.

The calculated mean and standard deviation (SD) values for the retained dimensions are shown in Table 3.

Mann-Whitney U tests (Table 4) identified significant population differences in all soft tissue measurements.

Black individuals on average presented with a greater mean upper lip, lower lip, and total lip height compared to the white individuals. White individuals, however, had a significantly greater hard tissue nose height compared

Table 3. Mean (standard deviation) values for recorded lips, central incisors, roots, face (N-Gn) and nose (N-Sn) height dimensions, in a black and white southern African sample.

	n	Mean age (years)	Upper lip (mm)	Lower lip (mm)	Maxillary central incisor (left) (mm)	Mandibular central incisor (left) (mm)	Maxillary root (left) (mm)	Mandibular root (left) (mm)	
Black	Total	124	35 (12)	13.35 (2.28)	12.63 (2.20)	10.75 (1.11)	8.76 (0.82)	11.17 (1.33)	9.13 (1.13)
	Male	72	34 (10)	13.77 (2.21)	12.99 (2.07)	11.06 (1.05)	8.93 (0.87)	11.49 (1.34)	9.14 (1.05)
	Female	52	37 (14)	12.78 (2.26)	12.13 (2.30)	10.32 (1.05)	8.52 (0.67)	10.72 (1.19)	9.10 (1.25)
	<40 years	91	29 (5)	13.85 (2.06)	13.16 (1.76)	10.93 (1.04)	8.89 (0.81)	11.40 (1.25)	9.36 (1.02)
	≥40 years	33	52 (10)	11.99 (2.33)	11.15 (2.63)	10.26 (1.17)	8.38 (0.71)	10.53 (1.35)	8.48 (1.20)
	Male <40 years	56	29 (5)	14.16 (2.08)	13.33 (1.86)	11.22 (0.97)	9.03 (0.87)	11.66 (1.28)	9.30 (0.97)
	Male ≥40 years	16	50 (6)	12.39 (2.19)	11.80 (2.40)	10.50 (1.19)	8.58 (0.79)	10.88 (1.43)	8.59 (1.19)
	Female <40 years	35	29 (6)	13.34 (1.96)	12.90 (1.59)	10.46 (0.99)	8.67 (0.67)	10.98 (1.10)	9.46 (1.10)
	Female ≥40 years	17	53 (13)	11.62 (2.45)	10.55 (2.76)	10.03 (1.13)	8.20 (0.59)	10.20 (1.22)	8.39 (1.24)
White	Total	39	36 (12)	8.20 (1.62)	7.78 (2.06)	10.54 (0.96)	8.51 (0.91)	11.22 (1.49)	9.80 (1.52)
	Male	19	37 (11)	7.87 (1.93)	7.72 (2.38)	10.65 (1.24)	8.65 (1.15)	11.39 (1.51)	10.15 (1.84)
	Female	20	36 (13)	8.51 (1.23)	7.84 (1.76)	10.44 (0.60)	8.37 (0.62)	11.05 (1.50)	9.48 (1.09)
	<40 years	24	28 (6)	8.59 (1.77)	8.72 (1.86)	10.64 (0.60)	8.71 (0.77)	10.99 (1.45)	9.87 (1.59)
	≥40 years	15	49 (7)	7.56 (1.12)	6.28 (1.39)	10.39 (1.36)	8.19 (1.05)	11.59 (1.54)	9.70 (1.45)
	Male <40 years	11	29 (5)	8.47 (2.23)	8.80 (2.32)	10.81 (0.59)	8.95 (0.95)	11.22 (1.19)	10.20 (2.02)
	Male ≥40 years	8	48 (7)	7.05 (1.04)	6.23 (1.59)	10.43 (1.83)	8.24 (1.32)	11.63 (1.92)	10.08 (1.69)
	Female <40 years	13	27 (6)	8.70 (1.35)	8.65 (1.46)	10.50 (0.59)	8.50 (0.54)	10.79 (1.65)	9.58 (1.12)
	Female ≥40 years	7	51 (7)	8.14 (0.95)	6.34 (1.24)	10.34 (0.66)	8.13 (0.71)	11.53 (1.12)	9.28 (1.08)
	n	Mean age (years)	Total lips (mm)	Total occluded incisors (mm)	Total incisors (maxillary+mandibular) (mm)	Total roots (maxillary+mandibular) (mm)			
Black	Total	100	35 (12)	24.86 (4.07)	18.40 (2.49)	19.31 (1.79)	20.14 (1.97)		
	Male	58	35 (11)	25.61 (3.83)	18.89 (2.39)	19.92 (1.78)	20.33 (1.97)		
	Female	42	36 (13)	23.82 (4.20)	17.73 (2.49)	18.48 (1.44)	19.85 (1.97)		
	<40 years	72	29 (5)	25.78 (3.40)	18.89 (2.47)	19.58 (1.77)	20.33 (1.79)		
	≥40 years	28	51 (8)	22.48 (4.69)	17.15 (2.08)	18.63 (1.66)	19.64 (2.34)		
	Male <40 years	43	30 (5)	26.35 (3.27)	19.30 (2.32)	20.13 (1.76)	20.50 (1.87)		
	Male ≥40 years	15	51 (6)	23.48 (4.58)	17.72 (2.25)	19.30 (1.75)	19.85 (2.21)		
	Female <40 years	29	29 (6)	24.94 (3.48)	18.28 (2.61)	18.75 (1.47)	20.07 (1.64)		
	Female ≥40 years	13	51 (10)	21.33 (4.74)	16.49 (1.72)	17.86 (1.20)	19.40 (2.55)		
White	Total	39	36 (12)	13.67 (3.32)	17.30 (2.43)	19.05 (1.70)	21.02 (2.68)		
	Male	19	37 (11)	13.08 (3.97)	17.86 (2.99)	19.30 (2.19)	21.55 (2.95)		
	Female	20	36 (13)	14.24 (2.53)	16.77 (1.67)	18.81 (1.06)	20.52 (2.36)		
	<40 years	24	28 (6)	15.07 (3.10)	17.73 (2.70)	19.35 (1.22)	20.85 (2.72)		
	≥40 years	15	49 (7)	11.44 (2.32)	16.62 (1.81)	18.58 (2.24)	21.29 (2.68)		
	Male <40 years	11	29 (5)	15.04 (3.95)	18.46 (3.45)	19.76 (1.37)	21.43 (2.88)		
	Male ≥40 years	16	48 (7)	10.38 (1.99)	17.04 (2.15)	18.67 (2.98)	21.71 (3.24)		
	Female <40 years	13	27 (6)	15.10 (2.33)	17.11 (1.78)	19.00 (1.01)	20.37 (2.59)		
	Female ≥40 years	7	51 (7)	12.64 (2.19)	16.14 (1.34)	18.47 (1.14)	20.81 (2.01)		
	n	Mean age (years)	Face height	Nose height (mm)					
Black	Total	65	36 (12)	119.99 (7.45)	50.63 (3.63)				
	Male	42	35 (11)	122.76 (5.32)	51.80 (3.05)				
	Female	23	38 (13)	114.95 (8.22)	48.50 (3.70)				
	<40 years	46	29 (6)	119.87 (7.77)	50.64 (3.87)				
	≥40 years	19	52 (9)	120.31 (6.80)	50.61 (3.06)				
	Male <40 years	32	29 (6)	122.96 (5.07)	51.93 (3.16)				
	Male ≥40 years	10	52 (6)	122.10 (6.28)	51.39 (2.75)				
	Female <40 years	14	29 (6)	112.79 (8.36)	47.70 (3.83)				
	Female ≥40 years	9	51 (11)	118.31 (7.15)	49.75 (3.31)				
White	Total	39	36 (12)	117.01 (8.05)	53.69 (3.40)				
	Male	19	37 (11)	121.75 (7.50)	55.49 (3.26)				
	Female	20	36 (13)	112.50 (5.68)	51.99 (2.61)				
	<40 years	24	28 (6)	115.96 (8.50)	53.20 (3.00)				
	≥40 years	15	49 (7)	118.68 (7.22)	54.48 (3.94)				
	Male <40 years	11	29 (5)	120.50 (9.35)	54.65 (2.92)				
	Male ≥40 years	8	48 (7)	123.48 (3.74)	56.64 (3.54)				
	Female <40 years	13	27 (6)	112.12 (5.56)	51.97 (2.58)				
	Female ≥40 years	7	51 (7)	113.19 (6.29)	52.01 (2.87)				

to black individuals. The central incisors, roots, and bony face height measurements showed no significant differences between the two population groups.

Sexual dimorphism was more evident in black individuals than in white individuals (Tables 3 and 4). Black males had significantly greater mean dimensions compared to black females in the soft tissue structures (upper lip and total lip height) and hard tissues (maxillary and mandibular central incisor heights, maxillary central incisor root length). White males only presented a significantly greater face height and nose height compared to white females. The lips, incisors and roots were found to differ between the age groups 20-39 years (<40 years) and 40 years

and above (≥40 years), with a notable decline in their dimensions with the progression in age (Table 5). The effect of age was most evident in the black sample, especially affecting black females (Tables 3 and 5).

The sample composition that included greater age variation for older black females (≥40 group mean age= 53 years, 13 years SD) compared to black males (≥40 group mean age=50 years, 6 years SD) could have influenced this result. Black individuals typically presented with much greater lip heights than white individuals, but there was a similar decline in their dimension with age. Upper lip heights in the ≥40 years category were, on average, 1.86mm and 1.03mm thinner in black indi-

Table 4. Mann-Whitney U results comparing, central incisors, roots, face (N-Gn) and nose (N-Sn) height dimensions in the various population and sex groups. The "Total" column presents results using all available data; the "Equal" column tests a uniform sample size.

	Population		Sex		Black Sex		White Sex	
	Total	Equal	Total	Equal	Total	Equal	Total	Equal
n	B:124, W:39	B:39, W:39	M:91, F:72	M:72, F:72	M:72, F:52	M:52, F:52	M:19, F:20	M:19, F:19
Upper lip	199.0**	106.0**	2628.0*	2190.0	1435.0*	1017.0*	232.5	227.0
Lower lip	278.0**	127.0**	2714.0	2210.0	1578.0	1092.5	205.0	204.0
Maxillary incisor	2116.0	807.5	2033.0**	1486.0**	1096.0**	711.5**	148.5	142.5
Mandibular incisor	2002.0	704.0	2224.0**	1658.5**	1244.0**	842.0**	151.5	140.5
Maxillary root	2362.0	712.5	2317.5**	1829.5**	1203.0**	912.0**	171.0	155.0
Mandibular root	2977.0*	947.5	3132.0	2355.5	1794.0	1293.5	159.0	152.5
n	B:100, W:39	B:39, W:39	M:77, F:62	M:62, F:62	M:58, F:42	M:42, F:42	M:19, F:20	M:19, F:19
Total lips	75.0**	34.0**	1947.0	1620.0	940.0	621.0*	232.0	229.0
Total occluded incisors	1388.5**	597.0	1660.0**	1429.0*	853.5*	677.5	142.5	138.5
Total incisors (Max. + Man.)	1806.0	704.5	1354.0**	1130.5**	621.5**	487.5**	141.0	133.0
Total roots (Max. + Man.)	2226.0	916.5	1998.0	1638.5	1003.5	779.0	159.0	147.0
n	B:65, W:39	B:39, W:39	M:61, F:43	M:43, F:43	M:42, F:23	M:23, F:23	M:19, F:20	M:19, F:19
Face height	968.0*	623.0	482.5**	322.5**	218.0**	109.0**	62.5**	59.5**
Nose height	1844.0**	1150.0**	771.5**	477.5**	225.5**	133.0**	73.0**	71.0**

Key: B = Black, W = White, M = Male, F = Female, Max. + Man. = Maxillary + Mandibular
 * value is significant at the 95% significance level (p < 0.05)
 ** value is significant at the 99% significance level (p < 0.01)

Table 5. Significant Mann-Whitney U (and test statistic) results, comparing individuals aged <40 years and ≥40years, for height dimensions specific to lips, central incisors and roots. The "Total" column presents results using all available data; the "Equal" column tests a uniform sample size.

	All		Black		White		Male		Female	
	Total	Equal	Total	Equal	Total	Equal	Total	Equal	Total	Equal
n	<40y:115 ≥40y:48	<40y:48 ≥40y:48	<40y:91 ≥40y:33	<40y:33 ≥40y:33	<40y:24 ≥40y:15	<40y:15 ≥40y:15	<40y:67 ≥40y:24	<40y:24 ≥40y:24	<40y:48 ≥40y:24	<40y:24 ≥40y:24
Upper lip	1653.0**	908.0	851.0**	381.5*	109.0*	82.0	433.5**	235.0	412.5	232.0
Lower lip	1419.5**	726.5**	763.5**	293.5**	47.0**	43.0**	405.0**	198.0	300.5**	163.5**
Maxillary incisor	1898.5**	742.5**	975.5**	312.0**	139.5	90.0	547.0*	198.0	428.0	166.0*
Mandibular incisor	1812.0**	762.0**	963.5**	348.0*	130.0	78.0	576.5*	209.0	342.5**	167.5*
Maxillary root	2236.5	909.5	981.5**	328.0**	217.0	133.5	648.5	226.5	508.0	232.0
Mandibular root	1890.5**	708.0**	786.5**	268.0**	168.0	92.5	627.0	217.0	341.5**	134.5**
n	<40y:96 ≥40y:43	<40y:43 ≥40y:43	<40y:72 ≥40y:28	<40y:28 ≥40y:28	<40y:24 ≥40y:15	<40y:15 ≥40y:15	<40y:54 ≥40y:23	<40y:23 ≥40y:23	<40y:42 ≥40y:20	<40y:20 ≥40y:20
Total lips	1267.5**	639.5*	611.0**	213.0**	50.5**	44.5**	363.0**	190.0	275.5*	136.5
Total occluded incisors	1294.0**	585.0**	615.5**	251.5*	131.0	63.5*	432.5*	177.5	221.5**	104.0**
Total incisors (Max. + Man.)	1537.5*	773.0	735.0*	325.0	140.0	93.5	486.0	234.5	284.5*	137.5
	Black Males		Black Females		White Males		White Females			
	Total	Equal	Total	Equal	Total	Equal	Total	Equal		
n	<40y:56 ≥40y:16	<40y:16 ≥40y:16	<40y:35 ≥40y:17	<40y:17 ≥40y:17	<40y:11 ≥40y:8	<40y:8 ≥40y:8	<40y:13 ≥40y:7	<40y:7 ≥40y:7		
Upper lip	251.0**	96.0	190.5*	103.0	24.5	23.0	36.0	23.0		
Lower lip	243.0**	79.0	144.5**	69.5**	17.0*	15.0	6.0**	6.0*		
Maxillary incisor	286.5*	74.0*	218.0	76.0*	35.5	27.5	33.5	17.0		
Mandibular incisor	319.5	81.0	170.5*	87.5*	31.0	23.0	31.0	15.0		
Maxillary root	311.0	80.0	194.0*	81.5*	47.5	34.5	61.5	34.0		
Mandibular root	252.0**	75.0*	149.0**	58.0**	43.0	30.0	37.5	15.5		
n	<40y:43 ≥40y:15	<40y:15 ≥40y:15	<40y:29 ≥40y:13	<40y:13 ≥40y:13	<40y:11 ≥40y:8	<40y:8 ≥40y:8	<40y:13 ≥40y:7	<40y:7 ≥40y:7		
Total lips	198.0*	68.0	116.0*	46.0*	11.0**	11.0*	14.5*	10.5		
Total occluded incisors	228.5	67.5	95.5**	55.0	34.0	24.0	27.5	7.0*		
Total incisors (Max. + Man.)	246.0	89.0	126.0	61.0	37.0	32.5	32.0	15.0		

Key: Max. + Man. = Maxillary + Mandibular
 *value is significant to the 95% significance level (p<0.05)
 ** value is significant to the 99% significance level (p<0.01)

viduals and white individuals respectively. Similarly, lower lip heights in the ≥40 category were, on average, 2.01 mm and 2.44 mm thinner in black and white individuals respectively. There were also moderately similar trends in central incisor height reduction.

Maxillary incisor heights in the ≥40 category were, on average, smaller by 0.67 mm and 0.25 mm in black and white individuals respectively, and mandibular incisor heights, by 0.51 mm and 0.52 mm in black and white individuals respectively. Changes in root lengths were

Table 6. Best performing multiple linear regression equations for estimating upper, lower and total lip height (ordered according to their statistical strength), with validation test results (absolute mean inaccuracy represents the average result for the hold-out sample tested, maximum inaccuracy is the greatest inaccuracy demonstrated for a single individual).

Multiple linear regression							Validation testing			
Upper lip height	Regression sample (n)	F statistic, P-value	r-value	r ² -value	Adjusted r ² -value-Total	SEE (mm)	Test sample (n)	Inaccuracy (mm)		
								Bias	Mean	Max
= 5.49 + (0.12 x Face Height) - (4.98 x Population) + (0.92 x Sex) - (1.96 x Age Group)	104	F(4,99) = 71.159, p<0.001	0.861	0.742	0.732	1.70	30	0.34	1.65	5.44
= 20.22 + (0.02 x Nose Height) - (5.22 x Population) - (1.78 x Age Group)	104	F(3, 100) = 73.427, p<0.001	0.829	0.688	0.678	1.86	30	0.44	1.79	4.91
= 15.16 + (0.45 x Maxillary Incisor Height) - (4.90 x Population) - (1.38 x Age Group)	163	F(3, 159) = 78.848, p<0.001	0.773	0.598	0.590	1.96	30	1.05	1.95	5.67
= 16.70 + (0.32 x Maxillary Root Length) - (5.00 x Population) - (1.48 x Age Group)	163	F(3, 159) = 77.514, p<0.001	0.771	0.594	0.586	1.97	30	0.95	1.91	5.51
Upper lip height	Regression sample (n)	F statistic, P-value	r-value	r ² -value	Adjusted r ² -value-Total	SEE (mm)	Test sample (n)	Inaccuracy (mm)		
								Bias	Mean	Max
= 12.06 + (0.07 x Face Height) - (4.36 x Population) - (2.63 x Age Group)	104	F(3,100) = 74.236, p<0.001	0.831	0.690	0.681	1.81	30	0.24	1.42	4.41
= 19.06 + (0.03 x Nose Height) - (4.63 x Population) - (2.57 x Age Group)	104	F(3, 100) = 66.354, p<0.001	0.816	0.666	0.656	1.88	30	0.51	1.56	4.23
= 15.96 + (0.41 x Mandibular Incisor Height) - (4.52 x Population) - (1.92 x Age Group)	163	F(3, 159) = 77.851, p<0.001	0.771	0.595	0.587	1.93	30	0.25	1.60	4.17
= 19.36 + (0.06 x Mandibular Root Length) - (4.64 x Population) - (2.09 x Age Group)	163	F(3, 158) = 73.444, p<0.001	0.763	0.582	0.574	1.96	30	0.18	1.63	4.08
Upper lip height	Regression sample (n)	F statistic, P-value	r-value	r ² -value	Adjusted r ² -value-Total	SEE (mm)	Test sample (n)	Inaccuracy (mm)		
								Bias	Mean	Max
= 18.55 + (0.17 x Face Height) - (10.66 x Population) + (1.59 x Sex) - (4.45 x Age Group)	104	F(4, 98) = 99.299, p<0.001	0.896	0.802	0.794	3.01	30	0.09	3.26	7.69
= 41.75 - (0.01 x Nose Height) - (10.93 x Population) - (4.10 x Age Group)	104	F(3, 99) = 113.263, p<0.001	0.880	0.774	0.768	3.20	30	-0.31	3.28	7.09
= 31.89 + (0.38 x Total Occluded Incisors Height) - (10.47 x Population) - (2.81 x Age Group)	139	F(3, 135) = 111.178, p<0.001	0.844	0.712	0.705	3.45	30	-0.41	2.78	8.17
= 30.21 + (0.48 x Total Incisors Height) - (10.75 x Population) - (2.98 x Age Group)	139	F(3, 135) = 109.192, p<0.001	0.842	0.708	0.702	3.47	30	-0.68	2.73	6.71
= 35.80 + (0.22 x Total Roots Height) - (11.04 x Population) - (3.35 x Age Group)	139	F(3, 134) = 103.059, p<0.001	0.835	0.698	0.691	3.54	30	-0.50	2.48	6.45

Key: Population (Black = 1, White = 2), Sex (Male = 1, Female = 2), Age Group (<40 years = 1, ≥40 years = 2)
 Total Incisors Height (combined maxillary + mandibular central incisors height),
 Total Roots Height (combined maxillary + mandibular central roots height)
 SEE = Standard Error of Estimate

Table 7. Calculated upper, lower and total lip height mean measurements and validation test results.

Multiple linear regression		Validation testing			
Description	Mean (mm)	Test sample (n)	Inaccuracy (mm)		
			Bias	Mean	Max
Black (n=124)	13.35	30	0.98	1.89	5.85
Black Male (n=72)	13.77	17	1.56	2.10	5.43
Black Female (n=52)	12.78	13	0.26	1.37	3.23
Black <40 years (n=91)	13.85	22	0.47	1.83	5.35
Black ≥40 years (n=33)	11.99	8	2.38	2.40	5.81
Description	Mean (mm)	Test sample (n)	Inaccuracy (mm)		
			Bias	Mean	Max
Black (n=124)	12.63	30	0.18	1.59	3.18
Black Male (n=72)	12.99	17	0.05	1.62	3.54
Black Female (n=52)	12.13	13	0.37	1.54	3.62
Black <40 years (n=91)	13.16	22	-0.20	1.56	3.71
Black ≥40 years (n=33)	11.15	8	1.22	1.79	3.96
Description	Mean (mm)	Test sample (n)	Inaccuracy (mm)		
			Bias	Mean	Max
Black (n=100)	24.86	30	-0.38	3.34	6.98
Black Male (n=58)	25.61	18	-0.98	3.63	7.01
Black Female (n=42)	23.82	12	0.45	2.90	6.44
Black <40 years (n=72)	25.78	22	-0.09	2.78	6.43
Black ≥40 years (n=28)	22.48	8	-1.32	2.73	5.15

Table 8. Wilcoxon signed rank results comparing lip height to incisor height, including upper lip height to lower lip height.

Black individuals	Frequency (%)	Statistical Significance
Upper Lip greater than Maxillary Incisor	89	p < 0.001; 8.580
Lower Lip greater than Mandibular Incisor	97	p < 0.001; 9.598
Total Lips greater than Total Occluded Incisors	96	p < 0.001; 8.489
Upper Lip greater than Lower Lip	68	p < 0.001; 4.038
White individuals	Frequency (%)	Statistical Significance
Upper Lip smaller than Maxillary Incisor	92	p < 0.001; 5.243
Lower Lip smaller than Mandibular Incisor	62	p = 0.037; 2.081
Total Lips smaller than Total Occluded Incisors	82	p < 0.001; 4.648
Upper Lip greater than Lower Lip	54	p = 0.240; 1.175

slightly more variable. The average maxillary root length in the ≥ 40 years category was 0.87mm and 0.6mm shorter in black and white individuals respectively, and the average mandibular root length was 0.88mm and 0.17mm shorter in black and white individuals respectively. This large variation between the population groups could partially be attributed to differences in sample sizes. Curve estimation, prior to regression analysis, confirmed all data had a linear relationship. All necessary assumptions for regression analysis were tested and met. Multiple linear regression that included population, sex and age group variables, significantly improved the goodness-of-fit for equations estimating upper, lower and total lip heights; without the demographic variables' inclusion, the r^2 -values of generated equations were exceptionally weak, often below 0.100.

Table 6 lists a selection of equations with the best goodness-of-fit (r^2 -values) and validation test results for estimated lip heights; the equations independently utilise face height, nose height, central incisor height, and root length measurements. Notably, all independent variables used were not intercorrelated with one another.

For comparison, **Table 7** presents the validation results for a mean model approach to estimating upper, lower and total lip height.

Equations estimating upper lip height presented an r^2 -value ranging 0.594 to 0.742, with a standard error of the estimate (SEE) ranging from 1.70mm to 1.97mm; the equation utilising face height (including population and age group variables) performed best. This was evident in validation tests, with face height presenting an absolute mean inaccuracy of 1.65mm, outperforming other tested equations (mean absolute inaccuracy ranging from 1.79mm to 1.95mm) and the calculated upper lip mean model value for black individuals (mean absolute inaccuracy, 1.89mm).

The mean model value for black female upper lips, however, outperformed the regression equations during validation testing, with a 1.37mm mean absolute inaccuracy (**Table 7**). In validation tests, the equations and mean models for upper lip height furthermore presented a consistent positive bias (calculated as the actual value minus estimated value), thus always underestimating the actual value.

Equations estimating lower lip height presented an r^2 -value ranging 0.582 to 0.690, with a SEE ranging from 1.81mm to 1.96mm. The equation utilising face height (including population and age group variables) performed best (mean absolute inaccuracy, 1.42mm) against other tested equations (mean absolute inaccuracy ranging from 1.56mm to 1.63mm) and the generated lower lip mean model values for black individuals (mean absolute inaccuracy, 1.59mm). During the validation testing of lower lip equations and mean models, results tended to demonstrate a positive bias, thus often underestimating the actual value.

Equations estimating total lip height presented an r^2 -value ranging 0.698 to 0.802, with quite a high SEE ranging from 3.01mm to 3.54mm. According to r^2 and SEE

results, the equation utilising face height (including population, sex and age group variables) performed the best. However, validation tests identified the face height equation (that includes population, sex and age group variables) provided the most inaccurate results compared to all other equations (mean absolute inaccuracy, 3.26mm).

The calculated maxillary plus mandibular root length equation (total roots length) utilising population and age group variables performed best (mean absolute inaccuracy, 2.48mm). All tested equations outperformed the total lip mean model for black individuals in general (mean absolute inaccuracy, 3.34mm).

Contrastingly, when considering sex and age, only the equation using total root length outperformed the mean models (**Table 6**, **Table 7**). A negative bias during validation testing was often presented for equations and mean models, thus they tended to overestimate the actual value.

General lip patterns identified, include the fact that black individuals tended to present a significantly greater upper, lower and total lip height relative to maxillary, mandibular and total incisor height, respectively. The upper lip also tended to be significantly greater than the lower lip (**Table 8**). In white individuals, the upper, lower and total lip height tended to be significantly smaller relative to the maxillary, mandibular and total incisor height, respectively. The upper lip also tended to be greater than the lower lip, but it was not statistically significant (**Table 8**).

DISCUSSION

Black southern African individuals notably presented statistically significant thicker lip heights in comparison to white southern African individuals of European origin.

This was similarly identified by Schmidlin et al.¹⁷ when investigating facial ageing patterns in black South African males, and comparing results to an Italian sample taken from Sforza et al.⁸. It is generally agreed that the prognathism typical to individuals of Sub-Saharan African origin is accompanied by thicker lips^{16,30}, but the exact relationship between prognathism and lip thickness is not clear.

Thus, we cannot necessarily consider the correlation between these two variables as causal, as the correlation can likely be attributed to the fact that both features are commonly found in individuals of African origin. The suggestion by Gerasimov¹⁶ that big prominent teeth are related to thicker lips and vice versa is, however, not supported by this study, as incisor heights were similar across the black and white population samples.

The weak relationship between incisor and lip heights also suggested that the canon employed by Gerasimov¹⁶, Gatliff and Snow¹⁹ and Taylor²⁰ is unreliable, and is especially inaccurate for individuals of Sub-Saharan African origin.

Thus, lip thickness cannot be assumed to be the same as the incisor enamel height or the gum line to gum line thickness. Wilkinson et al.⁴ similarly identified this when investigating incisor and lip height patterns in European

and Indian subcontinent groups; stating that factors such as population, prognathism, and age, can all play equally determinant roles in lip thickness - as similarly indicated in other existing research.^{13,15,17,18}

Differences between the sexes in the black population included greater lip heights, central incisor heights and root lengths in males, which is comparable to several previous studies on other population groups.¹²⁻¹⁵ White males and females did not differ significantly regarding lip heights, central incisor heights and root lengths, which was similarly identified in only two existing studies.^{4,11} A clearer pattern of sex differences in white southern Africans might be detected using a larger sample size.

Age-related lip thinning and dental wear is well recognised.^{4,8,16,17,30-32} Similar to Schmidlin et al's study,¹⁷ this study observed a similar decrease in lip heights for both black and white individuals. Thus, even though both groups experienced lip thinning with age, black individuals maintained considerably thicker lip heights compared to white individuals. Soft tissue changes are attributed to a reduction in skin elasticity, muscle tone and volume, which invariably causes the lips to thin and the prominence of the vermilion border to decrease.^{8,30,31}

The observed dental wear is attributed to three factors: attrition, abrasion and erosion.^{30,32} Attrition is caused by mastication or grinding between opposing teeth. The effect of attrition can be exacerbated in those who eat a particularly fibrous diet, or habitually clench and grind their teeth. Abrasion is caused by food and foreign body contact (e.g. tooth brushing). Lastly, acid-based leaching and dissolution cause erosion. This can often be the result of frequent high-acidity fluid consumption (carbonated drinks, fruit juices).

The statistically significant reduction in root length is likely the result of root resorption, due to inflammation and/or orthodontic tooth movement over a lifespan.³³⁻³⁵ It is, however, possible that the age-related changes observed might be equally influenced by a degree of human variation accentuated by the sample composition.

This study was retrospective, with all CBCT scans on the hospital database being intended for orthodontic investigation and procedures. Many scans were thus localised (not complete craniofacial scans). Cases with clear pathology or trauma had to be excluded. Older individuals were also of limited representation. Thus obtaining adequate sample sizes and distributions was challenging.

If more scans were to become available, it would be ideal to test an equally representative sample (equal age, sex and population groups) to offer more informative results. This could, however, take an extensive timeframe to accumulate.

In direct response to concerns voiced by the SAPS, with regard to the lack of CFA standards for individuals of southern African or even Sub-Saharan African origin, this study provides a series of potential equations for estimating upper, lower and total lip height, which expands on the equations offered by Wilkinson et al.⁴ The equations utilising face height were statistically the strongest (ac-

ording to r-values, r²-values, and SEE), and thus the height of the facial skeleton gives the best prediction of lip height. In the validation tests, however, utilising the total roots length (maxillary plus mandibular root lengths) equation with population and age group variables demonstrated a better solution to total lip height estimation.

Due to the weakened intra- and inter-observer reliability of root length measurements, it is, however, recommended that the total lip height regression equation be used as a secondary option to the independent lip height equations available. Maximum absolute errors accounted, which consider worst individual performance during validation tests, were quite large (Table 6 and 7), thus all methods of prediction need to be used with caution. The generated equations incorporate both a black and white southern African sample. The limited sample sizes available for the white population, with validation tests only being performed on a black sample, indicates the equations are best suited to black southern African cases. The validation tests performed using a black sample verified that the equations generated in this study often performed better than the mean models. An exception was the upper lip mean model for black females. We do, however, suggest that equations demonstrate a preferable degree of individuality that mean values do not.

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References

1. Steyn M, L'Abbé EN, Myburgh J. Forensic Anthropology as practiced in South Africa. In: Blau S, Ubelaker DH, editors. Handbook of Forensic Anthropology and Archaeology. 2nd edition. New York: Routledge, Taylor & Francis Group. 2016; 151-65.
2. Gatliff BP. Facial sculpture on the skull for identification. Am J Forensic Med and Path. 1984; 5(4): 327-32.
3. Helmer R, Rohricht S, Petersen D, Mohr F. Assessment of the reliability of facial reconstruction. In: Íscan MY, Helmer RP, editors. Forensic analysis of the skull. New York: Wiley Liss Publications, 1993: 229-34.
4. Wilkinson C, Motwani M, Chiang E. The relationship between the soft tissues and the skeletal detail of the mouth. J Forensic Sci. 2003; 48(4): 728-32.
5. Aulsebrook W, Íscan MY, Slabbert J, Becker PJ. Superimposition and reconstruction in forensic facial identification: A survey. Forensic Sci Int. 1995; 75: 101-20.
6. Stephan CN. Craniofacial identification: Techniques of facial approximation and craniofacial superimposition. In: Blau S, Ubelaker DH, editors. Handbook of forensic anthropology and archaeology. California: Left Coast Press, 2009: 304-21.
7. Huete MI, Ibáñez O, Wilkinson C, Kahana T. Past, present, and future of craniofacial superimposition: Literature and international surveys. Legal Medicine 2015; 17(4): 267-78.
8. Sforza C, Grandi G, Binelli M, Dolci C, De Menezes M, Ferrario VF. Age- and sex- related changes in three-dimensional lip morphology. Forensic Sci Int. 2010; 200: 182e1-e7.

9. Ferrario VF, Sforza C, Tartaglia GM, Sozzi D, Caru A. Three-dimensional lip morphometry in adults operated on for cleft lip and palate. *Plastic Reconstruct Surg* 2003; 111: 2149-56.
10. Sawyer AR, See M, Nduka C. 3D stereophotogrammetry quantitative lip analysis. *Aesthetic Plast Surg*. 2009; 33: 497-504.
11. Ferrario VF, Sforza C, Miani A Jr, Tartaglia G. Craniofacial morphometry by photographic evaluations. *Am J Orthod Dentofac Orthop*. 1993; 103: 327-37.
12. Farkas LG, Hreczko TA, Katic MJ. Craniofacial norms in North American Caucasians from birth to young adulthood. In: Farkas LG, editor. *Anthropometry of the head and face*. 2nd edition. New York: Raven Press, 1994: 241-335.
13. Hajnis K, Farkas LG, Ngim RCK, Lee ST, Venkatadri G. Racial and ethnic morphometric differences in the craniofacial complex. In: Farkas LG, editor. *Anthropometry of the head and face*. 2nd ed. New York: Raven Press, 1994: 201-21.
14. Nanda RS, Ghosh J. Facial soft tissue harmony and growth in orthodontic treatment. *Semin Orthod*. 1995; 1: 67-81.
15. Ferrario VF, Sforza C, Serrao G. A three-dimensional quantitative analysis of lips in normal young adults. *Cleft Palate Craniofacial J*. 2000; 37(1): 48-54.
16. Gerasimov M. *The face finder*. London: Hutchinson & Co, 1971.
17. Schmidlin E, Steyn M, Houlton TMR, Briens N. Facial ageing in South African adult males. *Forensic Sci Int*. 2018; 289: 277-86.
18. Angel JL. Restoration of head and face for identification. In: *Proceedings of the 30th annual meeting of the American Academy of Forensic Sciences*. St. Louis, Missouri. 1978.
19. Gatliff BP, Snow CC. From skull to visage. *J Biocommun*. 1979; 6: 27-30.
20. Taylor KT. *Forensic art and illustration*. New York: CRC Press, 2001.
21. George RM. The lateral craniographic method of facial reconstruction. *J Forensic Sci*. 1987; 32: 1305-30.
22. Mala PZ, Velemínska J. Vertical lip position and thickness in facial reconstruction: A validation of commonly used methods for predicting the position and size of lips. *J Forensic Sci*. 2016; 61(4): 1046-54.
23. Dahlberg G. *Statistical Methods for Medical and Biological Students*. London: George Allen & Unwin, 1940.
24. Perini TA, de Oliveira GL, Ornellas JS, de Oliveira FP. Technical error of measurement in anthropometry. *Rev Bras Med Esporte* 2005; 11: 86-90.
25. Langley NR, Jantz LM, McNulty S, Majjanen H, Ousley SD, Jantz RL. Data for validation of osteometric methods in forensic anthropology. *Data in Brief*. 2018; 19: 21-8.
26. Kamburoglu K, Kolsuz E, Kurt H, Kiliç C, Özen T, Paksoy CS. Accuracy of CBCT measurements of a human skull. *J Digit Imaging* 2011; 24(5): 787-93.
27. García-Sanz V, Bellot-Arcís C, Hernández V, Serrano-Sánchez P, Guarinos J, Paredes-Gallardo V. Accuracy and reliability of cone-beam computed tomography for linear and volumetric mandibular condyle measurements. A human cadaver study. *Sci Rep*. 2017; 7(1): 11993.
28. Klepinger L, Giles E. Clarification or confusion: statistical interpretation in forensic anthropology. In: Reichs KJ (Ed.). *Forensic Osteology: Advances in the Identification of Human Remains*. Charles C Thomas, Springfield. 1998; 427-40.
29. Milner GR, Boldsen JL. Transition analysis: a validation study with known-age modern American skeletons. *Am J Phys Anthropol*. 2012; 148: 98-110.
30. Wilkinson C. *Forensic facial reconstruction*. Cambridge: Cambridge University Press, 2004.
31. Kaur M, Garg RK, Singla S. Analysis of facial soft tissue changes with aging and their effects on facial morphology: A forensic perspective. *Egypt J Forensic Sci*. 2015; 5: 46-56.
32. Sperber GH. Dental Wear: Attrition, Erosion, and Abrasion - A Palaeo-Odontological Approach. *Dent J (Basel)*. 2017; 5(2): 19.
33. Aguilar PE, Aguilar AP, Rolleri MF, Ubios AM. Root resorption in elderly patients. *Acta Odontol Latinoam*. 2001; 14(1-2): 3-8.
34. Consolaro A, Furquim LZ. Extreme root resorption associated with induced tooth movement: A protocol for clinical management. *Dental Press J Orthod*. 2014; 19(5): 19-26.
35. Li Y, Jacox LA, Little SH, Ko CC. Orthodontic tooth movement: The biology and clinical implications. *KJMS*. 2018; 34(4): 207-14.

Skeletal morphologic features of Anterior Open Bite Malocclusion amongst black patients visiting the Medunsa oral health centre

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ABSTRACT

Introduction

Anterior open bite (AOB) malocclusion presents as lack of vertical overlap of anterior teeth. It is viewed to be unaesthetic and may affect speech and mastication.

It develops due to the interaction of hereditary and environmental etiological factors and these usually affect the vertical growth of the face. This study describes the vertical changes of South African black people presenting with AOB.

Aims and objectives:

The aim was to determine skeletal morphological features of patients with AOB malocclusion.

Design

The design was a retrospective, cross-sectional study.

Materials

Archived pre-treatment lateral cephalographs of 181 patients who consulted between 2007 and 2014 were divided into four groups: control group of 62 patients with skeletal Class I pattern without AOB; test groups of patients with AOB (119) divided into 35 Class I, 43 Class II, and 41 Class III malocclusions. Records of each group were divided according to gender. Descriptive statistics, the Pearson correlation coefficient, t-test and

Wilcoxon test were employed to analyze the data, and p values of ≤ 0.05 were considered statistically significant.

Results and conclusions

Patients with AOB had a larger vertical facial pattern in all classes of malocclusion. Males presented with larger Sn-GoGn angles than females. The PFH/AFH ratio was lower across all classes of malocclusion compared to the control group.

INTRODUCTION AND LITERATURE REVIEW

Malocclusion can occur in three planes of space, namely sagittal, transverse and in the vertical plane. The lack of dental occlusion in the oral cavity occurs in the vertical plane as either an open bite in the anterior area, an open bite in the lateral areas, or as a combination of the two.¹

Open bite malocclusion is considered as an abnormality in the vertical relationship of maxillary and mandibular arches. It is characterized by a lack of contact between opposing segments of teeth.^{2,3} The term "open bite" was first introduced by Caravelli in 1842.⁴ The incidence of AOB varies between races and ranges from 1,5% to 11%. Differences also occur with age as some AOB close spontaneously with increasing age.⁵

The clinical and radiological evaluation of AOB is complex and exhibit dental or skeletal components, or a combination of the two in some cases.¹ The dental open bite is associated with a normal craniofacial pattern of growth on the cephalometric radiograph and labial tipping of both upper and lower anterior teeth. The skeletal open bite shows vertical disharmony of craniofacial skeleton on the cephalometric radiograph and over eruption of posterior teeth.

A dental open bite can also affect the alveolus and has also been referred to as dento-alveolar, when there is a change in the vertical growth of the alveolar component. A skeletal open bite has features such as clock-

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wise or downward rotation of the mandible, tipping of the maxilla and diversion of the gonial angle of the mandible and the open bite usually extends to the posterior teeth.

The etiology of AOB is multifactorial with numerous theories such as environmental, genetic and anatomic factors often cited as culprits. Bjork⁹ reported that open bite malocclusion occurs as a result of environmental and genetic factors stimulating the vertical growth of the molar region which is not compensated by condylar growth. Forces that prevent eruption in the incisal region also contribute to the cause of AOB malocclusion.¹⁰

A mouth breathing pattern is a common condition and is due to constriction of the upper airway resulting from the presence of some form of physical obstruction of the airway such as enlarged adenoids and or tonsils, chronic sinusitis, swollen nasal turbinates and deviated nasal septatae.

The acidic air and many circulating allergens are common causative agents of most oronasal tissue infections leading to airway obstruction and subsequent mouth breathing. A prolonged open mouth posture leads to development of the AOB as a result of lack of contact of posterior teeth with resultant over-eruption of these teeth.^{3,5} A deviated nasal septum may impede normal breathing pattern and lead to AOB.

Anatomic factors that contribute to an anterior open bite will include a large tongue and a lower tongue posture at rest due to a mouth breathing habit. Neuromuscular deficiencies such as muscular dystrophy can also lead to anterior open bites due to a decrease in tonic muscle activity and inadequate mouth seal and support. This leads to the mandible rotating downward resulting in increased anterior facial height and posterior growth rotation of the mandible.^{4,5}

Genetic factors also play a role with some families genetically presenting with a vertical craniofacial growth and an AOB. Habits such as digit sucking may lead to AOB depending on the position of the digit, the duration of the habit and the magnitude and direction of the force applied by the digit against the surrounding structures.

A plethora of local factors: trauma to the condyle, osteoarthritis, infection and systemic factors: autoimmune diseases such as rheumatoid arthritis, ankylosing spondylitis, Sjogren syndrome and systemic lupus erythematosus to mention a few also cause AOB.

The classification of AOB is therefore complex and the current trend errs towards reliance on etiological factors. The classification of occlusion and malocclusion by Angle² was mainly directed to horizontal discrepancies of the maxillary and mandibular arches and did not include other planes of AOB.

Many studies have been done and much information obtained regarding the morphologic characteristics and specific areas of skeletal open bite malocclusion in dif-

ferent races.¹¹ Dawjee, Oberholzer and Hlongwa¹² reported that various cephalometric analyses are available to diagnose the morphological features of AOB malocclusion by authors such as Cangialosi.¹³

AIMS AND OBJECTIVES

The aim of this study was to assess the skeletal morphologic features in a black South African population with skeletal AOB malocclusion using cephalometric radiographs of untreated cases.

Studying and analyzing morphological features of this form of malocclusion may shed light on the possible prevention and early treatment strategies of this condition, and might help in establishing a protocol for its management.

DESIGN AND METHODS

The study was approved by the Medunsa Research and Ethics Committee of the University of Limpopo, Medunsa Campus (Project number: MREC/D/379/2014). Following the granting of permission from the hospital authorities, archived lateral cephalograms of untreated black patients in the Department of Orthodontics, University of Limpopo, Medunsa Campus were retrieved and used for the study.

A total of 181 lateral cephalograms (65 males and 116 females) were selected for this study. The criteria for selection were: incisor relationships with AOB of ≥ 1 mm; no history of orthodontic treatment or orthognathic surgery; lateral cephalometric radiographs of good quality according to acceptable standards that had been taken with the patient biting in centric occlusion. All patients selected were mature and above the age of 21 to avoid the effect of growth on the craniofacial structures

The analog cephalograms were taken with the Siemens, Orthopantomograph 10®, whereas the digital radiographs were obtained using the Kodak 8000C® X-ray machine. The analog cephalograms were digitized using the Vidar Sierra Advantage® X-ray film digitizer. The calibrations on the ruler served as a reference to enable adjustment for magnification of the image.

Dolphin Imaging 11.5 Premium® cephalometric analysis computer software was used to trace and analyze the cephalograms. The Nahoum¹⁴ analysis was utilized to confirm the magnitude of AOB malocclusion of the selected radiographs. The incisal edges of the maxillary and mandibular incisors were projected perpendicularly onto the facial plane (N-Me). The vertical distance between points **A** and **B** (Figure 1) was measured digitally.

The traced lateral cephalometric radiographs were divided into four groups according to skeletal classification, by using the ANB angle¹⁵, the facial plane angle¹⁶, the Wits analysis¹⁷, and convexity.¹⁸ The control group consisted of 62 lateral cephalometric radiographs of patients with skeletal Class I pattern without AOB.

The test groups consisted of 119 pre-treatment lateral cephalometric radiographs of black South African pa-

tients who presented with AOB malocclusion and were divided into three groups: skeletal Class I, II, and III malocclusions. The records of each group were divided according to gender. All the digitally-traced cephalometric radiographs were stored in a computer folder.

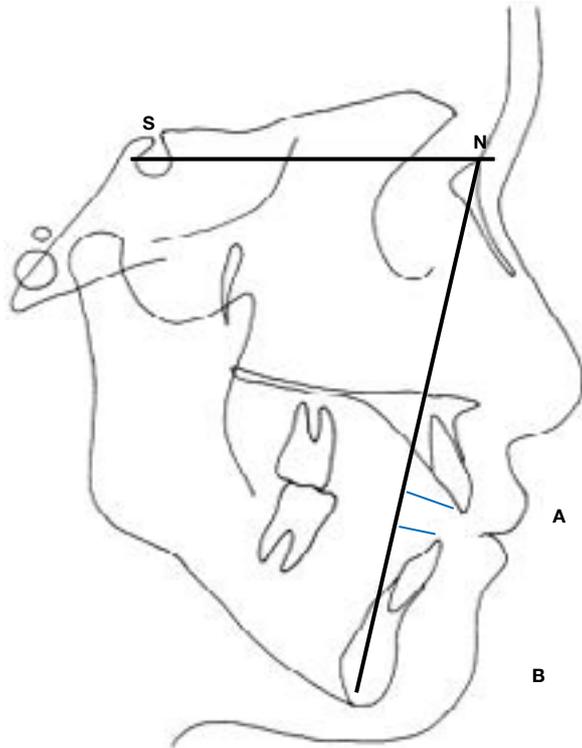


Figure 1. Measurement for AOB malocclusion on a lateral cephalometric radiograph. The incisal edges of the maxillary (A) and mandibular incisors (B) are projected perpendicularly onto the facial plane (N-Me). The vertical distance between points A and B is measured in millimeters.¹⁴

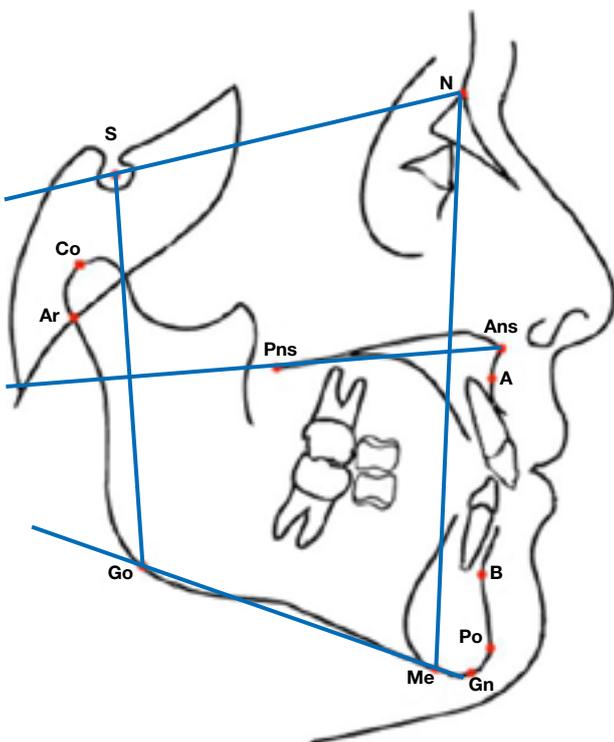


Figure 2. Cephalometric landmarks: sella (S); nasion (N); condylion (Co); articulare (Ar); posterior nasal spine (PNS); anterior nasal spine (ANS); A-point (A); B-point (B); gonion (Go); pogonion (Po); menton (Me); gnathion (Gn).¹⁷

Selection of landmarks and cephalometric measurements

Measurements according to skeletal relationships

The cephalometric radiographic angular and linear measurements used to verify and classify patients according to their skeletal relationships are as follows:

- **SNA angle:** angle formed by SN plane and NA line.²⁰
- **SNB angle:** angle formed by SN plane and NB line.²⁰
- **ANB angle:** difference between SNB angle and SNA angle.²⁰
- **Wits appraisal:** linear measurement taken on the occlusal plane (OP) from a perpendicular line drawn from point A and point B.²¹
- **Facial plane angle:** formed by FH plane and N-Pog line; represents the position of the chin.²⁰
- **Convexity:** linear measurement from point A to line N-Pog.²²

Measurements according to radiographic skeletal morphological features

The measurements used to characterize the radiographic skeletal morphological features of the selected radiographs are the following eight angular measurements and one linear measurement (refer to Figure 2), as per the study by Cangialosi:¹⁷

- **Posterior facial height (PFH):** from sella to gonion.
- **Anterior facial height (AFH):** from nasion to menton.
- **Upper facial height (UFH):** from nasion to the palatal plane.
- **Lower facial height (LFH):** from palatal plane to menton.
- **Sn-GoGn:** angle formed by sella nasion line and mandibular plane.
- **Gonial angle:** angle formed by posterior border of the ramus of the mandible and mandibular plane.
- **SN-PP:** angle formed by nasion line and palatal plane.
- **PP-GoGn:** angle formed by palatal plane and mandibular plane.
- **Open bite:** measured in millimetres.

Figure 2 shows the landmarks, linear and angular measurements that were performed. The values obtained were recorded and entered into a computer for statistical analysis.

To determine the errors associated with the identification and measurement of landmarks, ten radiographs were randomly selected, retraced and re-measured by the principal investigator (intra-examiner reliability) as well as the supervisor (inter-examiner reliability). The Pearson correlation coefficient test was performed to determine intra- and inter-examiner reliability. Arithmetical mean and standard deviations were calculated for all the variables. A Shapiro-Wilk test was carried out to objectively assess the normality of distribution of measured variables.

The mean values for male and female were compared by a two-sample t-test to determine if there were any differences in skeletal features. The mean values obtained from the sample for all nine variables of test groups were compared with the nine variables of the control

group by a one-sample t-test to evaluate any significant variations that characterized skeletal morphology in the open bite malocclusions, according to skeletal relationship.

The level of significance was set at $p \leq 0.05$. All statistical analyses were performed using the statistical analysis system (SAS) 9.2 computer software programme.

RESULTS

The Shapiro-Wilk test revealed that >90% of the variables were normally distributed ($p \geq 0.05$). The intra- and inter-reliability tests showed the correlation coefficient exceeded 0.8, indicating that the method of measurement was reliable and reproducible.

Comparison between male and female control sample

There was no statistically significant difference between the mean values of male and female samples. There was a trend of an insignificantly larger gonial angle in males compared to females.

Comparison of measured variables between control and Class I anterior open bite male sample

A significant difference was found in the mean value of PFH/AFH ratios. In the linear variables, only the LFH showed a trend of being larger in the Class I group compared to the control group, but it was not significant. The Class I group showed a trend of increased angular measurements, although it was not significant. The PFH/AFH ratio was significantly larger in the control group.

Comparison between control and Class II anterior open bite male group

A significant difference was found in the variables LFH, Sn-GoGn, gonial angle, PP-GoGn and PFH/AFH ratio. They were all significantly larger in the Class II group compared to the control group. There was a trend of larger linear and angular values in the Class II male group compared to the control group, although it was not significant.

Comparison between controls and Class III anterior open bite male group

A statistically significant difference was found in the values of all angular variables, except PP-GoGn. All the linear variables, except PFH, and angular variables were larger in the Class III male group compared to the control group, although it was not significant. The control group showed a significantly larger PFH/AFH ratio compared to the Class III group.

Comparison between control and Class I anterior open bite female sample

Three out of nine variables demonstrated a statistically significant difference. The PFH/AFH ratio was significantly smaller in the Class I open bite group compared to the control group. PP-GoGn and Sn-GoGn were significantly larger in Class I compared to the control group.

Comparison between control and Class II anterior open bite female sample

Six of the nine variables demonstrated a statistically significant difference. The mean values of the linear measurements (AFH, UFH and LFH) of the Class II group were significantly larger compared to the control group.

All angular variables, except the Sn-PP and gonial angle, were significantly larger in Class II than in the control group. The PFH/AFH ratio was significantly larger in the control group compared to the Class II female group.

Comparison between control and Class III anterior open bite female sample

UFH and LFH were significantly different in the two groups. There was a trend of larger linear variables (PFH, AFH, UFH and LFH) and gonial angle in the Class III group compared to the control group, but it was not significant. The PFH/AFH ratio of the control group was larger compared to the Class III group, although it was not significant.

Comparison between male and female Class I open bite sample

There was no statistically significant difference in the values of the Class I groups. The female group showed an insignificantly larger AFH compared to the male group.

Comparison between male and female Class II open bite sample

There was no significant difference between male and female in all measured variables, however, there was an insignificant trend of a larger gonial angle in the Class II male group compared to the Class II female group.

Comparison between male and female Class III open bite sample

With the exception of Sn-GoGn, there was no statistically significant difference between the mean values of the male and female samples. The PFH and the PFH/AFH ratio were insignificantly larger in the female group compared to the male group. There was also an insignificant trend of larger Sn-GoGn and gonial angles in the male group compared to the female group.

DISCUSSION

This study sought to determine the skeletal morphological features of patients with AOB malocclusion. The data obtained in this study showed that there are differences between patients with AOB and those without it. These differences were especially notable in the angular measurements as compared to the linear measurements.

There were more females who presented with AOB compared to males in the study period. This could be because females appear to be more willing to seek and receive orthodontic treatment compared to male subjects. The finding is similar to studies done elsewhere.^{23,24}

The total PFH and AFH were found to be smaller in the Class I open bite samples of male and female groups compared to the male and female control groups. These findings are in agreement with the findings by Cangialosi¹⁷ who reported that such a finding may be an indication of the specific area, or areas, responsible for open bite malocclusion.

The increase in AFH is associated with an increase in the LFH caused by downward tipping of the palatal

plane, and/or mandibular plane. Nielsen²⁶ reported that the increase in AFH is apparently as a result of the eruption of maxillary and mandibular posterior teeth and the amount of sutural lowering of the maxilla.

In this study an increase in AFH was noted in the Class II female group with anterior open bite malocclusion compared to the female control group. These results are contrary to those of Horowitz²⁶ who found that males have a 10% increase in total AFH compared to females,

Table 1. Male control and test groups.

Variable	Mean Males Control n=31	Mean Class I Males AOB n=10	p-values	Mean Class II Males AOB n=13	p-values	Mean Class III Males AOB n=11	p-values
PFH (mm)	81.5 <i>11.64</i>	81.8 <i>12.3</i>	0.9592	85.7 <i>12.31</i>	0.2888	81.7 <i>12.88</i>	0.9694
AFH (mm)	133.7 <i>20.25</i>	132.7 <i>16.51</i>	0.8942	143.1 <i>18.80</i>	0.1570	141.7 <i>16.89</i>	0.2483
UFH (mm)	54.8 <i>7.49</i>	55.2 <i>6.58</i>	0.8865	57.5 <i>7.59</i>	0.2940	58.4 <i>6.88</i>	0.1790
LFH (mm)	79.2 <i>12.91</i>	81.0 <i>10.07</i>	0.6776	88.1 <i>12.58</i>	0.0403	85.4 <i>10.53</i>	0.1599
Sn-GoGn (°)	30.1 <i>6.15</i>	34.6 <i>9.09</i>	0.0794	36.5 <i>7.72</i>	0.0059	36.6 <i>6.74</i>	0.0054
Gonial angle (°)	122.8 <i>7.47</i>	125.1 <i>11.02</i>	0.4447	131.1 <i>7.11</i>	0.0013	128.5 <i>5.66</i>	0.0261
SN-PP (°)	5.1 <i>4.11</i>	6.1 <i>2.97</i>	0.4867	4.7 <i>3.81</i>	0.7629	8.2 <i>4.57</i>	0.0441
PP-GoGn (°)	25.0 <i>6.14</i>	28.5 <i>6.75</i>	0.1347	31.8 <i>6.06</i>	0.0017	28.5 <i>7.00</i>	0.1307
PFH: AFH (%)	67.1 <i>4.55</i>	63.4 <i>5.37</i>	0.0390	62.7 <i>4.16</i>	0.0047	60.8 <i>5.39</i>	0.0006

Means in standard print, standard deviations in italics and control groups shaded in blue p≤0.05 significant.

Table 2. Female control and test groups.

Variable	Mean Females Control n=31	Mean Class I Females AOB n=25	p-values	Mean Class II Females AOB n=30	p-values	Mean Class III Females AOB n=30	p-values
PFH (mm)	83.2 <i>10.03</i>	81.6 <i>12.27</i>	0.5932	84.1 <i>13.26</i>	0.7640	86.5 <i>12.60</i>	0.2617
AFH (mm)	133.5 <i>14.00</i>	136.3 <i>18.43</i>	0.5184	144.3 <i>15.61</i>	0.0062	141.1 <i>19.26</i>	0.0824
UFH (mm)	54.1 <i>3.77</i>	53.5 <i>5.91</i>	0.6813	56.9 <i>5.35</i>	0.0213	57.9 <i>7.84</i>	0.0205
LFH (mm)	77.8 <i>8.38</i>	82.4 <i>12.37</i>	0.1203	87.1 <i>10.70</i>	0.0002	84.6 <i>12.28</i>	0.0154
Sn-GoGn (°)	31.0 <i>4.01</i>	34.7 <i>6.65</i>	0.0198	35.9 <i>7.25</i>	0.0021	31.8 <i>5.73</i>	0.5135
Gonial angle (°)	113.0 <i>40.13</i>	124.4 <i>6.54</i>	0.1295	125.7 <i>9.46</i>	0.0969	125.7 <i>7.85</i>	0.0929
SN-PP (°)	5.5 <i>3.83</i>	4.5 <i>3.85</i>	0.3328	5.7 <i>4.13</i>	0.8685	5.4 <i>3.85</i>	0.9592
PP-GoGn (°)	25.5 <i>4.72</i>	30.2 <i>5.58</i>	0.0012	30.3 <i>6.22</i>	0.0013	26.4 <i>5.24</i>	0.4914
PFH: AFH (%)	65.7 <i>3.28</i>	62.0 <i>4.94</i>	0.0016	61.0 <i>5.33</i>	0.0002	63.8 <i>4.86</i>	0.0841

Means in standard print, standard deviations in italics and control groups shaded in blue p≤0.05 significant.

Table 3. Comparison of measured variables between male and female control groups.

Variable	Controls			Class I (AOB)			Class II (AOB)			Class III (AOB)		
	Male	Female	p-value	Male	Female	p-value	Male	Female	p-value	Male	Female	p-value
PFH (mm)	81.5	83.2	0.5518	81.6	81.8	0.9707	84.1	85.7	0.7051	86.5	81.7	0.2903
AFH (mm)	133.7	133.5	0.9693	136.3	132.7	0.5958	144.3	143.1	0.8352	141.1	141.7	0.9305
UFH (mm)	54.8	54.1	0.6084	53.5	55.2	0.4559	56.9	57.5	0.7597	57.9	58.4	0.8565
LFH (mm)	79.2	77.8	0.6268	82.4	81.0	0.7587	87.1	88.1	0.7807	84.6	85.4	0.8504
Sn-GoGn (°)	30.1	31.0	0.4918	34.7	34.6	0.9868	35.9	36.5	0.8345	31.8	36.6	0.0298
Gonial angle (°)	122.8	113.0	0.1926	124.4	125.1	0.8495	125.7	131.1	0.0697	125.7	128.5	0.2932
SN-PP (°)	5.1	5.5	0.6906	4.5	6.1	0.2490	5.7	4.7	0.4709	5.4	8.2	0.0630
PP-GoGn (°)	25.0	25.5	0.7172	30.2	28.5	0.4448	30.3	31.8	0.4685	26.4	28.5	0.3153
PFH: AFH (%)	67.1	65.7	0.1557	62.0	63.4	0.4579	61.0	62.7	0.3027	63.8	60.8	0.1009

p≤0.05 significant.

although the class of malocclusion was not specified in that study.

The Sn-GoGn in this study was significantly greater for the open bite groups of female Class I and II, and male Class II and III malocclusions compared to controls. This means that these open bite subjects demonstrated a more vertical growth pattern and an increase in the total AFH.

The finding is similar to that of Cangialosi¹⁷ and of Nahoum¹⁴ who found an increase in the total AFH in AOB subjects. The increase in Sn-GoGn in subjects with AOB is expected because most etiological factors, for example habits and chronic upper airway obstructions, encourage vertical facial growth.

Similarly, the gonial angle was significantly larger in male Class II and III with AOB as compared to the normal groups. This finding is an indication that in AOB subjects the lower facial height is increased and the subjects presented with increased vertical facial dimensions. Authors such as Sassouni and Nanda², Subtelny and Sakuda,⁶ and Trouten²⁷ also found similar results in the gonial angle of open bite patients.

Class III AOB male subjects were found to have a significantly larger Sn-PP compared to the control group. This shows that the upper AFH was increased in Class III AOB male subjects. This could be a result of the counter-clockwise rotation of the SN or clockwise rotation of the PP.

The other malocclusion groups showed no significant difference from the control groups, meaning that there was no change in the inclination of the PP or SN planes.

These results are in agreement with those reported by Subtelny and Sakuda⁴ and Cangialosi¹⁷ who concluded that the anterior open bite malocclusion was not due to a change in maxillary inclination, but was mainly due to the clockwise rotation/downward opening of the mandibular plane. This finding is in contrast to that of Nahoum¹⁸ and Lopez-Gavito²⁸ who reported an increase in the palatal plane due to the anterior maxillary rotation. The PP-GoGn angle in this study was found to be significantly greater in Class I and Class II female subjects, as well as Class II male subjects, compared to the control groups. This finding could indicate an upward inclination in palatal plane or downward tipping of the mandibular plane. In this study, Sn-GoGn and PP-GoGn showed similar findings, namely significantly larger angles in female Class I and II, and male Class II patients.

Therefore, one could argue that because the Sn-PP was not significant between malocclusions (except for Class III male and female groups) and controls, the increase in the PP-GoGn angle was due to a downward mandibular rotation. These results are similar to those reported by Nahoum¹⁴ and Cangialosi.¹³

In contrast to these findings, Sassouni and Nanda² found a sharply angulated Sn-PP in open bite subjects, which was also found in the Class III male group of the current study.

There was a significant increase in the LFH in Class II male and female and Class III female groups compared to controls. The increase in the LFH signifies an increase in the lower anterior facial dimension in the mentioned malocclusion groups. Similar findings have been reported in other studies.^{1,2,15,17}

Female subjects with Class II and III AOB demonstrated a significant increase in UFH, which is an indication of excess vertical maxillary growth. Such growth patterns have a tendency of rotating the mandible downward and backward leading to the development of an anterior open bite malocclusion. This is in contrast with the findings by Tsang and Cheung,²⁹ Nahoum,¹⁸ Sassouni and Nanda,² and Richardson²⁶ who did not find any difference in the upper anterior facial height in open bite subjects.

The PFH/AFH ratio was significantly smaller in all groups of malocclusion except Class III females, indicating a smaller posterior facial height in open bite malocclusion subjects. A similar result was confirmed in research by Sassouni and Nanda² and Nahoum.¹⁸ This result is expected because most subjects presented with an increase in the LFH.

Except for the Sn-GoGn, there was no significant difference between the mean values of male and female subjects in all groups. On the other hand, there was a significant increase in Sn-GoGn in males Class III compared to females of the same group. This means that male open bite subjects demonstrated a more vertical growth pattern and increased total anterior facial height.

The finding was similar to that found by Cangialosi¹⁷ and Nahoum¹⁸ who found an increase in the total anterior facial height in open bite subjects even though it was not stratified according to gender. Nahoum¹⁸, Fields, Proffit and Nixon,¹⁵ and Hassanali and Pokhariyal³¹ found a larger total facial height in males who have a larger and greater post-pubertal vertical growth spurt than females.¹⁸ Nanda concurred with these findings reporting that this gender dimorphism becomes apparent from the beginning of the growth spurt when boys are about 14 years of age.³²

CONCLUSIONS

The following conclusions were made from this study:

- The anterior facial height is larger in Class II female subjects with AOB.
- The PFH/AFH ratio is less in subjects with anterior open bite malocclusion.
- The UFH of females with Class II and III AOB is larger.
- The LFH of Class II male and female subjects and Class III female subjects with AOB is larger.
- The mandibular plane angle is increased in females with Class I and II AOB, as well as in males with Class II and III AOB.
- The gonial angle is increased in Class II and III male subjects with AOB.
- The palatal plane angle (PP-GoGn) is larger in female Class I and Class II AOB, as well as in Class II male subjects with AOB.

- The vertical position of the maxilla, as represented by the palatal plane (SN-PP), changed only in Class III males with AOB; therefore, it was only in Class III male subjects where anterior open bite malocclusion was due to a change in the maxillary inclination.
- The difference between male and female subjects with anterior open bite is brought about by the difference in the Sn-GoGn which is larger in male than in female subjects.

Black patients with open bite were found to have greater facial height because of their lower facial dimensions, not their upper facial dimensions. This conclusion is supported by Beane, Reimann, Phillips and Tulloch³³ who arrived at the same conclusion.

References

1. Hapak F. Cephalometric appraisal of the open-bite case. *Angle Orthod* 1964; 34: 65-72.
2. Sassouni V, Nanda S. Analysis of dentofacial vertical proportions. *Am J Orthod* 1964; 50: 801-23.
3. Subtelny JD, Sakuda M. Open-bite: diagnosis and treatment. *Am J Orthod* 1964; 50: 337-58.
4. Lin LH, Huang GW, Chen CS. Etiology and treatment modalities of Anterior Open Bite Malocclusion. *J Exp Clin Med* 2013; 5(1): 1-4.
5. Ngan P, Fields HW. Open bite: a review of etiology and management. *J Pediatr Dent*. 1997; 19: 91-8.
6. Sassouni V. A classification of skeletal facial types. *Am J Orthod*. 1969; 55: 109-24.
7. Parker JH. The interception of the open bite in the early growth period. *Angle Orthod*. 1971; 41: 24-44.
8. English JD. Early treatment of skeletal open bite malocclusions. *AJO DO* 2000; 121(6): 563-5.
9. Tulley WJ. A critical appraisal of tongue-thrusting. *Am J Orthod* 1969; 55: 640-50.
10. Warren JJ, Bishara SM. Duration of nutritive and non-nutritive sucking behaviors and their effects on the dental arches in the primary dentition. *Am J Orthod Dentofac Orthop* 2002; 121: 347-56.
11. Bjork A. The face in profile: an anthropological X-ray investigation on Swedish children and conscripts. *Svenska Tandl Tidshr*. 1947; 40: 124-68.
12. Angle EH. Classification of malocclusion. *Dent Cosmos*. 1899; 41: 248-64.
13. Greenlee GM, Huang GJ, Chen SSH, Chen J, Koepsell T, Hujjoel P. Stability of treatment for anterior open-bite malocclusion: A meta-analysis. *Am J Orthod Dentofacial Orthop*. 2011; 139: 154-69.
14. Ismail IN, Leung YY. Anterior open bite correction by Le Fort I osteotomy with or without anterior segmentation: which one is more stable? *Int J Oral Maxillofac surg*. 2017; 46: 766-73.
15. Fields H, Proffit WR, Nixon WL, Phillips C, Stanek E. Facial pattern differences in long-faced children and adults. *Am J Orthod*. 1984; 85: 217-23.
16. Dawjee SM, Oberholzer TG, Hlongwa P. An introduction of a new cephalometric method and its potential application to open bite deformities. Thesis 2007, University of Limpopo.
17. Cangialosi TJ. Skeletal morphologic features of anterior open bite. *Am J Orthod*. 1984; 85: 28-36.
18. Nahoum HI. Vertical proportions and the palatal plane in anterior open bite. *Am J Orthod*. 1971; 59: 273-82.
19. Steiner CC. Cephalometrics for you and me. *Am J Orthod* 1953; 39: 729-55.
20. Downs WB. Variations in facial relationships: their significance in treatment and prognosis. *Am J Orthod*. 1948; 34: 812-40.
21. Jacobson A. The "Wits" appraisal of jaw disharmony. *Am J Orthod*. 1975; 67: 125-38.
22. Ricketts RM, Bench RW, Gugino CF, Hilgers JJ, Schulhof RJ. The use of superimposition areas to establish treatment design. *Bioprogr Ther*. 1979; 25: 55-69.
23. Gravely JF. A study of need and demand for orthodontic treatment in two contrasting National Health Service regions. *J Orthod*. 1990; 17: 287-92.
24. Gray M, Anderson R. A study of young people's perceptions of their orthodontic need and their experience of orthodontic services. *Prim Dent Care*. 1998; 5: 87-93.
25. Nielsen IL. Vertical malocclusions: etiology, development, diagnosis and some aspects of treatment. *Angle Orthod*. 1991; 61: 247-60.
26. Horowitz HS. A study of occlusal relations in 10 to 12-year-old Caucasian and Negro children. *Int Dent J*. 1970; 20: 593-605.
27. Trouten JC, Enlow DH, Rakine M, Phelps AE, Swedlow I. Morphologic factors in open bite and deep bite. *Angle Orthod*. 1983; 53: 192-211.
28. Lopez-Gavito WL. Anterior open-bite malocclusion. *Am J Orthod*. 1985; 87: 175-86.
29. Tsang WM, Cheung LK, Samman N. Cephalometric characteristics of anterior open bite in a southern Chinese population. *Am J Orthod Dentofac Orthop*. 1998; 113: 165-72.
30. Richardson AR. Dento-alveolar factors in anterior open bite and deep over bite. *Dent Pract Dent Rec*. 1970; 21: 53-7.
31. Hassanali J, Pokhariyal GP. Anterior tooth relations in Kenyan Africans. *Arch Oral Biol*. 1993; 38: 337-42.
32. Nanda SK. Patterns of vertical growth in the face. *Am J Orthod Dentofac Orthop*. 1988; 93: 103-11.
33. Beane RA, Reimann G, Phillips C, Tulloch C. A cephalometric comparison of black open-bite subjects and black normal. *The Angle Orthodontist*. 2003; 73: 294-300.

Development of a radiographic dental implant guide for identification of dental implant types

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L Vermeulen¹, A Speelman², V Daries³, V Philips⁴

ABSTRACT

Introduction

Identification of dental implant types can be a complex process for inexperienced health care professionals. Dental implants can have subtle differences in their morphology, which make it difficult to distinguish them from one another.

The unique appearance of dental anatomy and the placement of custom restorations ensure accurate identification of bodies or human remains when radiographic techniques are correctly applied.

Aims and objectives:

To develop a radiographic dental implant guide for ten common dental implant types currently used in the Western Cape, South Africa; using their morphological characteristics observed on pantomographs.

Design

The methodology considered for this research study was a positivist approach through a quantitative, exploratory, non-experimental research design.

Methods

Ten commonly used dental implants were radiographed at straight tube (ST), off-centre (OC) and severe off-centre (SOC) angles to create a reference instrument.

Two reviewers used the morphologies of the different dental implant types, namely the apex, thread and neck, observed on ante-mortem pantomographs, and compared it to the appearance of the dental implants in the reference instrument to make a positive identification match. The straight tube image of all ten dental implant types in the reference instrument was used as the initial point of reference to positively identify the morphological characteristics of each dental implant type on the pantomographs.

Results

A total of 380 dental implants could be identified on 105 pantomographs reviewed. Of the 380 dental implants, 350 dental implants (91%) were identified as dental implant types listed in the reference instrument while 30 dental implants were identified as another type of dental implant type not listed in the reference instrument.

A total of 208 dental implants (54.2%) could be positively identified on the ante-mortem pantomographs using the straight tube images in the reference instrument. The morphological characteristics of the dental implant types were described using x-ray imaging of dental implants. The ten commonly used dental implants types could be positively identified by two independent reviewers and based on this a radiographic dental implant guide was developed.

Conclusion

Each dental implant type had unique morphological characteristics as well as similarities which enabled distinction between the different dental implant types.

The dental implant guide developed could be used by dentistry and radiography students. The dental implant guide may be useful in the field of forensic dentistry and forensic radiology.

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INTRODUCTION

Implantology has become more popular, accessible and of great value globally, therefore more health care professionals need to appreciate its application to identify different types of dental implants clinically and in forensic dentistry. Clinical and radiographic records of dental implant procedures are becoming widely and increasingly available and used during forensic identification of human remains.¹

Forensic dentistry plays a key role in identifying human remains that cannot be identified visually or by other means; these remains include the victims of violent crime, fires (charred bodies), motor vehicle accidents and accidents on duty. Studies have shown that in cases of single or multiple deaths, scientific identification of human remains utilising forensic dentistry, is often the most successful source of identification.^{2,3} Dental identification of human remains consists of a very complex procedure that makes it necessary during the investigation process to use and compare unique dental identifiers.¹

The different types of dental implants vary in morphology and in conjunction with the unique appearance of dental anatomy, and the placement of custom restorations such as dental implants, has been found to accurately assist in the identification of human remains.¹ Dental implants have unique and overlapping morphological characteristics which for the untrained eye, are difficult to distinguish. The purpose of this study was to develop a dental implant guide using the unique morphological characteristics of the ten most common dental implant types used in the Western Cape, South Africa.

METHODS

The methodology applied during this research study was a positivist approach through a quantitative, exploratory, non-experimental research design. Ten dental implant types (Table 1) were radiographically imaged under non-clinical conditions.

Table 1. List of dental implants radiographically imaged.

	Type of dental implant	Specifications
1.	Bicon	Example dental implant
2.	Biomet	Full Osseotite 3.25mm x 11.5mm
3.	Champion	Example dental implant
4.	Megagen	AnyRidge 4 mm x 10mm
5.	MIS	MIS7 internal hex 6 mm x 10mm
6.	Neodent	Example dental implant
7.	Nobel Biocare	NobelActive®
8.	Southern	IB 3.75 mm x 12 mm
9.	Straumann	Example dental implants (3)
10.	Zimmer	SwissPlus (2)

Prior to the individual imaging of the ten dental implant types, the name of each dental implant type was registered on Carestream (software) on an Asus Pro Windows: laptop with i7 processor that was connected to a digital detector with dimensions: 27.6mm x 37.7mm; resolution: 24lp/mm.

Before the dental implant was placed on the digital detector, the name of the dental implant type (Table 1) was selected on the laptop computer. This ensured that the dental implant being radiographed corresponded with the dental implant type selected on the computer program in order to correctly label the dental implant on the computer system.

The exposure was set at 70kV (dental x-ray units usually operate between 50kV and 90kV), 8 mA and 0.4s (3.2mAs). Dental implants were removed from the plastic enclosure and were individually placed flat on the clean digital detector to be radiographed in 3 positions: straight tube (ST) which was positioned perpendicular to the dental implant, off centre (OC), a 5-degree central ray angulation, and severe off centre (SOC), a 30-degree central ray angulation in the opposite direction (Figure 1A-C).

This method of exposing the dental implants 3 times was to create images of the dental implants that will correspond with the dental implants on the pantomographs. Dental implants on pantomographs may appear in an

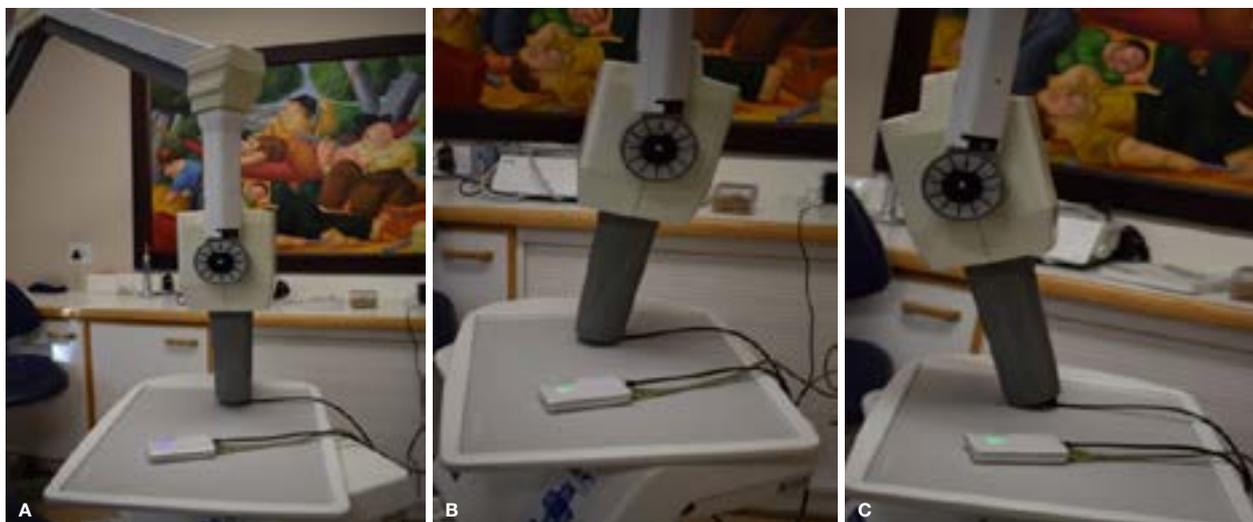


Figure 1A-C. Dental implant imaging representation: A - Straight tube (ST), B - Off centre (OC) 5-degree angulation, C - Severe off centre (SOC) 30-degree angulation in opposite direction.

off centre (or oblique) position due to the position of the dental implant in the occlusion, or due to technique errors during actual radiographic acquisition of the pantomographs.

A total number of 36 images were taken and saved. Afterwards all the images were stored on a personal computer [Mecer Xpression, Model: W251HP, HDMI (High-Definition Multimedia Interface)], and saved in a folder named "Dental implant data".

All 36 images were backed up on a personal external hard drive, saved with the corresponding folder name "Dental implant data". Subsequently, a reference instrument was compiled by using the radiographs of the ten dental implants imaged at ST, OC and SOC angles.

Ethical approval to conduct this research study was obtained from the Research Ethics Committee of the Faculty of Health and Wellness Sciences, Cape Peninsula University of Technology as well as the Dean of the Faculty of Dentistry, University of the Western Cape. The ethical principles of the Declaration of Helsinki⁴ were upheld during this research study.

A total of 223 pantomographs, presenting with dental implants, were retrieved from the computer monitor of the Panorex x-ray unit at the research site. Of the 223 pantomographs, 105 were regarded as suitable for analysis.

Two reviewers (the researcher as radiographer and consultant periodontist) reviewed the dental implants present on the pantomographs; the review process was done independently. Each dental implant on the pantomographs was reviewed using morphological characteristics, namely the shape of the neck, appearance of the thread, and shape of the apex as seen on the reference instrument. Each of the dental implants was also independently compared with the OC image (5-degree central ray angulation) and SOC image (30-degree central ray angulation in opposite direction).

The researcher correlated with a specialist in the field in the few cases where the type of dental implants could not be positively identified. This verification was done after both reviewers had independently reviewed

the dental implants on the pantomographs, using the reference instrument.

RESULTS

A total of 384 dental implants were *in-situ* on the 105 pantomographs analysed. Only nine of the ten different dental implant types radiographed, to create the reference instrument (listed in Table 1), were observed on the pantomographs.

An additional 5 dental implant types were identified on the pantomographs that were not included as part of the reference instrument, while 4 dental implants seen on the pantomographs could not be identified. In the sample of 384 dental implants, 380 dental implants in total were positively identified on the pantomographs as a specific dental implant type.

Frequency analysis was used to analyse the data for this research study. The Cohen's Kappa test was performed in Microsoft Excel to determine inter-observer reliability and to measure the agreement between the two reviewers. The researcher and the consultant periodontist both identified the dental implant types independently to ensure a non-bias and valid outcome of the test. The inter-observer agreement was 86.4% (Table 2).

Table 2. Results of Cohen's Kappa test for inter-observer reliability.

Number of dental implants viewed	384
Number of dental implants identified:	380
- Observer 1 (radiographer)	332
- Observer 2 (consultant periodontist)	380
Cohen's Kappa test %	332/384 = 86.4%

Of the 380 dental implants, 350 dental implants were identified as a dental implant type used for the reference instrument. A total of 208 dental implants (54.2%) from nine dental implant types were identified using corresponding morphological characteristics (i.e. apex and/or thread and/or neck) from the ST image (0-degree central ray angulation) used in the reference instrument. Each of the 208 dental implants was individually compared with the OC image (5-degree central ray angulation) and SOC image (30-degree central ray angulation in opposite direction) as well.

Table 3. Number of dental implants identified from the reference instrument using corresponding morphological characteristics.

Type of dental implant	No. of implants identified from the reference instrument using corresponding morphological characteristics from the Straight tube (ST) image	No. of implants identified from the Off Centre (OC) image	No. of implants identified from the Severe off centre (SOC) image
Bicon	13	13	13
Biomett	12	12	2
Champion	7	7	7
Megagen*	0	0	0
MIS	5	5	5
Neodent	15	11	0
NobelActive	56	56	56
Southern	38	38	38
Straumann	42	42	42
Zimmer	20	20	9
Totals:	208	204	172

*No Megagen dental implants were observed on any of the pantomographs viewed during this research study.

Of the 208 positively identified dental implants using the ST image (used as the point of reference image) in the reference instrument, 204 could be identified from the OC image, and 172 from the SOC image.

The OC and SOC images assisted the reviewers in confirming a positive identification of dental implant types. Unfortunately, four and 36 dental implants could not be

identified from the OC and SOC images respectively. This indicates that the possibility of not identifying a dental implant type (owing to the unavailability of an ST image) may occur.

A total of 142 dental implants were identified as a dental implant type listed in the reference instrument using different variations of three morphological characteristics (apex, thread and neck), and in some cases the abutment was used for identification. These variations were observed by the researcher during the viewing of the pantomographs, and were confirmed by the consultant periodontist as additional information, to aid in the process of positively identifying dental implant types.

A total of 30 dental implants were identified as dental implant types not listed in the reference instrument. After a variation of morphological characteristics was used to analyse the unidentified dental implants, an additional 37% of dental implants were identified by the consultant periodontist as a dental implant type found in the reference instrument.

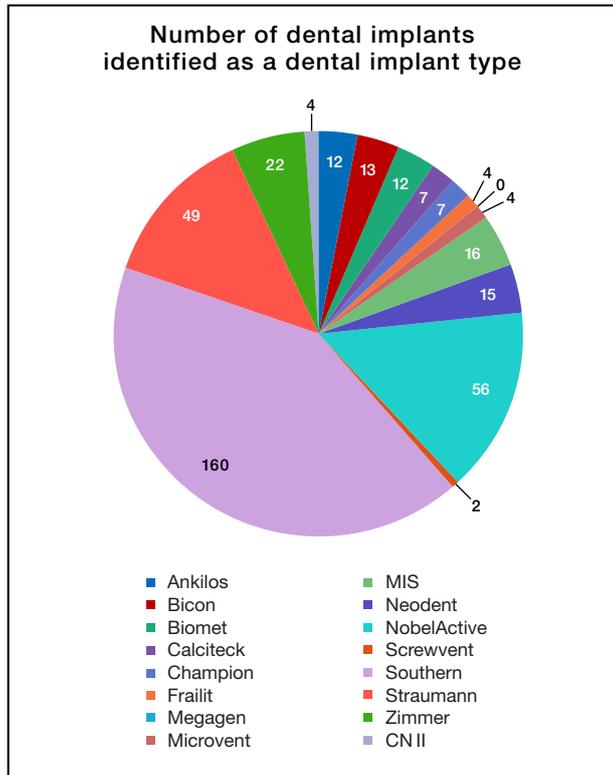


Figure 2. The number of dental implants identified from each dental implant type.

DISCUSSION

Dental implants are widely used to identify human remains by radiographic image recognition and geographic evaluation. If a human body is found and no dental records are available, it can be identified by the radiographic images of the dental implants.

The radiographs of dental implants are used to identify the manufacturers and different types of dental implants. Radiographs of dental implants are therefore useful for the odontologist to identify the victims.⁵

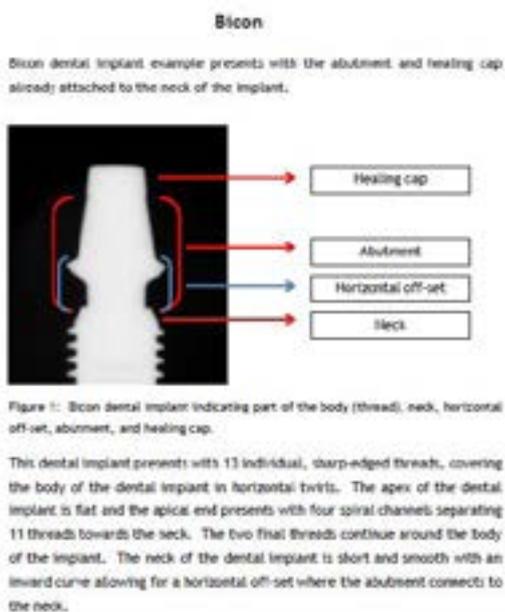


Figure 3. An excerpt from the radiographic dental implant guide presenting the Bicon dental implant.

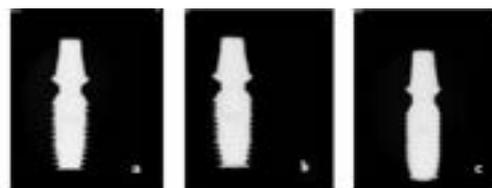


Figure 2: Bicon dental implant example: a - ST, b - OC and c - SOC.

Bicon dental implants are known to be a short dental implant type and have an accentuated horizontal off-set which can also be used as an additional identification morphology (as seen in Figure 1). The threads and apex appear to be round on the SOC image, but corresponding Bicon characteristics can still be observed.

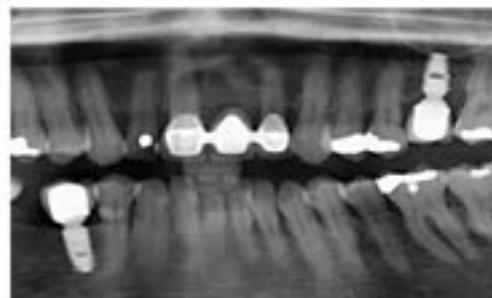


Figure 3: Magnified panoramic radiograph (archival record) presenting with two Bicon dental implants.

The identification of dental implant types remains challenging for inexperienced health care professionals and students. It can be argued that more learning material needs to be made available that can assist with the identification of dental implant types on radiographs. The use of the morphology of different types of dental implants to identify various dental implant systems and human remains is still an unexplored field in South African forensic dentistry.

One of the main objectives of this research study was to describe the radiographic appearance of dental implants based on the morphological characteristics, including the apex, thread and neck of each dental implant type observed. This description was based on the morphology of dental implants and whether they could be positively identified on pantomographs and allowed the researcher to develop a radiographic dental implant guide for the ten dental implant types (Figure 3).

Three publications^{1,6,7} described the use of dental implants during the identification of human remains. The literature indicated that in all three cases dental implants within the occlusion were successfully used to make a positive identification of human remains.

The type of dental implant used in the occlusion can be identified through morphological characteristics such as the connection, length, and diameter of the implant. Radiographic imaging is part of this process when comparisons need to be made between post-mortem and ante mortem images.^{8,9} Morphological features of dental implants depicted on radiographs may be used to develop a dental profile of the individual, and this can narrow the search to a smaller number of individuals, or eliminate certain candidates by taking into account the dental system employed.¹⁰

Dental implants, considering their morphological characteristics that differentiate between different types, give a supplementary layer of evidence during odontological identification, increasing the chances for a positive proof of identity.¹¹ However, it is important that care should be exercised when using dental treatment radiographs for direct comparison against post-mortem radiographs as there are distortion and angulation factors that need to be considered.

This is a slight disadvantage, because if these factors are not considered, a positive identification might not be made.³ In comparison with a study done by Australian researchers¹² where 51.3% of dental implants were identified, 54.2% of dental implants were identified during this research study by using the three morphological characteristics: i.e. apex, thread, and neck.

Previous research studies^{2,8,10,13,14} have indicated that dental implant types can be identified by their unique morphological characteristics. The ST image was used as the point of reference to identify dental implant types, with each positively identified dental implant type compared to the OC and SOC images thereafter.

In cases where there is distortion of dental implants, or where angulation of dental implants may occur owing to

placement in the patient's dentition, it might be necessary to use the OC and/or SOC image to assist in making a positive identification of such dental implant types.

It was possible to develop a radiographic dental implant guide using dental implant types commonly used in the Western Cape, South Africa. During this research study, the reference instrument was compiled by acquiring radiographs of the referenced dental implants at ST, OC and SOC angles. The morphological characteristics of the shape, size and structure of the apex, thread and neck of each dental implant type were identified and used to differentiate between dental implant types; the images of the reference instrument were used and the radiographic dental implant guide was created.

A digital version of the dental implant guide was created (available on request from the principal author), and may be used for the education and training of radiography, dental and medical students to enhance their learning in identifying dental implant types on pantomographs. It is postulated that the dental implant guide may be used as an academic and clinical reference tool. The digital guide may also serve as a user friendly and easy to access guide for identifying different dental implant types in living persons or in the deceased.

The authors are of the opinion that the morphologies of dental implants play an important role during the identification process of unidentified persons. Identification of dental implant types can be a complex process for inexperienced health care professionals.

Dental implants can have subtle differences in their morphology, which make it difficult to distinguish them from one another. Dental records play an important role particularly in the identification of human remains, and this supplementary dental implant guide may support the identification process of unidentified human remains in South Africa.

Limitations

This research study only described the morphological characteristics of one (or in some cases two) dental implants from ten different dental implant types, which was a limitation. Future research studies should involve more dental implant types based on a broader geographical area, unlike this research study that only used dental implant types predominantly used in the Western Cape, South Africa.

The modern and improved technology of dental implant manufacturing companies has led to an increased variety of dental implant types which necessitates use of more varieties. This research study was conducted from a forensic perspective combining the identification of dental implant types as well as the use of dental records in human remains identification.

Very few publications were found using the morphological characteristics of dental implants for human identification purposes, which influenced contextualising the findings. It is recommended that more studies on this topic be conducted.

CONCLUSION

Human remains can be successfully identified if dental implants are present. During any type of investigation where human remains are unidentifiable, forensic dentistry can be a very useful adjunct. Dental implants are still relatively new in the field of dentistry, and as it will become more commonly used, it will necessitate the use of morphological characteristics to identify different types of dental implants, as well as the possibility to identify human remains.

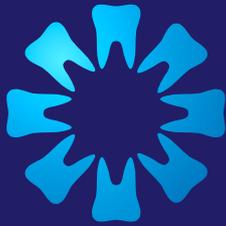
Each dental implant type has unique morphological characteristics as well as similarities which enable differentiation between the different dental implant types. It is important to examine all three characteristics namely the apex, thread, and neck in order to make a positive identification of the dental implant type.

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References

1. Silva R.F, Franco A, Gratão de Castro M, Dumont J.A.V, Garcia R.R, Batista de Souza J. Dental Human Identification using Radiographic Records of Oral Implant Placement - a Case Report. *Austin Journal of Forensic Science and Criminology*. 2014; 1(1): 1-3.
2. Pretty A, Sweet D. A look at forensic dentistry. *British Dental Journal*. 2001; 190: 359.
3. Verma A.K, Kumar S, Rathore S, Pandey A. Role of dental expert in forensic odontology. *National Journal of Maxillo-facial Surgery*. 2014; 5(1): 2-5.
4. World Medical Association (WMA). WMA Declaration of Helsinki - Ethical principles for medical research involving human subjects. 2018. <https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects>.
5. Nuzzolese E, Lusito S, Solarino B, Di Vella G. Radiographic dental implants recognition for geographic evaluation in human identification. *Journal of Forensic Odontostomatol*. 2008; 27: 8-11.
6. De Angelis D, Cattaneo C. Implant Bone Integration Importance in Forensic Identification. *Journal of Forensic Sciences*. 2015; 60(2): 505-8.
7. Berketa J.W, James H, Langlois N.E.I, Richards L.C. A study of osseo-integrated dental implants following cremation. *Australian Dental Journal*. 2014; 59(2): 149.
8. Brown R.M, Devenport J.S. *Forensic Science: Advanced Investigations*. Boston: Cengage Learning. 2012.
9. Berketa J.W, Hirsch R.S, Higgins D, James H. Radiographic Recognition of Dental Implants as an Aid to Identifying the Deceased. *Journal of Forensic Sciences*. 2010; b:55(1): 66.
10. Byraki A, Costea A.V, Curca G.C, Hostiu S. Morphological analysis of dental implants – forensic significance. *Romanian Journal of Legal Medicine*. 2010; 18(3): 207-2012.
11. Dumancic J, Kaic Z, Njemirovskij V, Brkic H, Zecevic D. Dental identification after two mass disasters in Croatia. *Croatia Medical Journal*. 2001; 42: 657-62.
12. Soukoulis, S. Forensic odontology and a dental implant registry. 2016. https://www.linkedin.com/pulse/forensic-odontology-dental-implant-registry-dr-steven-soukoulis?trk=portfolio_article-card_title.
13. Michelinakis G, Sharrock A, Barclay C.W. Identification of dental implants through the use of Implant Recognition Software (IRS). *International Dental Journal*. 2006; 56(4): 203-8.
14. Berketa J, James H, Marino V. Survival of batch numbers within dental implants following incineration as an aid to identification. *Journal of Forensic Odonto-Stomatology*. 2010; a:28(1): 1-4.



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Individual and social determinants of oral health in South Africa in the context of COVID-19

SADJ September 2020, Vol. 75 No. 8 p440 - p444

A Magan

INTRODUCTION

The global pandemic due to infection with the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) causes the disease COVID-19 which is a mild, self-limiting disease in the majority of infected individuals.¹ However, in many individuals, particularly the elderly, or those with comorbidities such as diabetes, pulmonary disease or cardiovascular conditions, infection with SARS-CoV-2 has resulted in more severe symptoms, and has proved fatal.²

Given that COVID-19 is a novel disease and that there is no vaccine or specific pharmacologic treatment for it, it is likely that its impact on an individual's general health will be protracted and is yet to unfold. Oral health is inextricably linked to general health and its neglect may have negative consequences on human and economic capital. The aim of this commentary is, therefore, to highlight the potential impact of SARS-CoV-2 on oral health in South Africa (SA).

Pathogenesis and epidemiology of SARS-CoV-2

The virus SARS-CoV-2, which most likely has a zoonotic origin, is transmissible from person-to-person either through direct contact, or via respiratory droplets produced when coughing or sneezing;¹ thus, the primary portal of entry of the virus into the host is via the mucous membranes of the mouth, nose and eyes.

Entry of the SARS-CoV-2 virus into host cells is mediated by the attachment of its surface spike proteins to angiotensin-converting enzyme 2 (ACE2) receptors³ expressed by epithelial cells of the oral and nasal mucosae, lung, intestine and kidney, and the endothelium of blood vessels.⁴ Epidemiological data of COVID-19 cases in China, Italy, the United Kingdom (UK) and the United States of America (USA) have shown that the most common comorbidities associated with fatality were hypertension, diabetes and obesity.^{2,5,6}

Hypertension and diabetes are commonly treated with ACE2 inhibitors;⁷ therefore, it has been suggested that there is greater expression of ACE2 in these patients which increases their susceptibility to a more fatal form of COVID-19.⁸

Relationship between oral health and non-communicable diseases

Diabetes and hypertension are non-communicable diseases (NCDs) which share modifiable risk factors with dental diseases including dental caries, periodontitis and oral cancers. These oral diseases are among the most common global diseases,⁹ and are caused by a high sugar content diet, tobacco use, and excessive alcohol consumption.

The World Health Organisation reported a rise in these risk factors in Africa,⁹ which in SA has been shown to be associated with an increase in prevalence of NCDs.¹⁰ This was highlighted in a study of 1251 African females from the Birth to Twenty cohort in Soweto, Johannesburg, in whom the prevalence of diabetes, metabolic syndrome (a cluster of cardiovascular diseases, type 2 diabetes and waist circumference), and obesity were 14%, 42.1% and 50.1%, respectively.¹¹

The relationship between diabetes and periodontitis is bidirectional as they share pathophysiologic pathways that include inflammation, altered host responses, and altered tissue homeostasis.¹² In a study of 10 diabetic and 10 non-diabetic patients with periodontal disease, non-surgical periodontal therapy resulted in improved glycaemic control at 3 months and 6 months follow-up.¹² Although this study was limited by its small sample size, and by not having a control group that received no treatment, the findings are consistent with a recent systematic review and meta-analysis which assessed nine randomised clinical trials that included a control group with no periodontal intervention.¹³

The role of periodontal bacteria in the aetiology of hypertension was shown in a robust study of a total of 1056 participants.¹⁴ The subgingival biofilm consisting of *A. actinomycetemcomitans*, *T. Forsythia*, *P. gingivalis*, and *T. denticola*, described as the aetiologic burden, was positively associated with prevalent hypertension. After adjusting for age, body mass index, race, smoking,

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education, diabetes and cholesterol, the highest tertile of aetiologic burden was associated with greater systolic (9 mmHg) and diastolic pressure (5 mmHg) than the lowest tertile.¹⁴

In the context of COVID-19, it has not yet been established whether poor oral hygiene or periodontitis increase the risk of morbidity in patients with NCDs, and these associations need to be tested empirically. It is, however, of concern that given the high prevalence of NCDs in SA, COVID-19 may result in greater morbidity and mortality.

Nutrition and food security

South Africa has a double burden of malnutrition with a high prevalence of both obesity and undernutrition.¹⁵ Steyn and Nel¹⁶ found that fat and energy intake were greater in urban SA women than their rural peers by 13.5% and 4.6%, respectively. In a more recent study of SA children aged between 1 and 8.9 years, the added sugar intakes as a proportion of total energy intake were 10.3% and 7.5% in urban and rural areas, respectively.¹⁷ While a high sugar intake is a low cost source of food energy, it is devoid of micronutrients, and is associated with the development of chronic conditions such as obesity and diabetes.¹⁸ These studies reflect the nutrition transition that has accompanied urbanisation in SA,¹⁹ and which may have adverse consequences on oral health. In addition, it is yet to be determined whether during the current pandemic, due to lack of affordability of nutritious foods, individuals have substituted unhealthy alternative processed foods with a high content of added sugar, salt and fat, and have thereby increased their risk for caries and cardio-metabolic disease.

Social and health problems tend to cluster among impoverished populations²⁰ which is of particular significance in SA, as it has one of the highest rates of income inequity in the world. Approximately 56% of its population live in poverty and 28% in extreme poverty.²¹ In 2017, 6,8 million South Africans experienced hunger with 1,7 million households across the country affected.²² Thus, a high percentage of the population face food insecurity which may lead to malnutrition. Furthermore, the severe lockdown restrictions to contain the spread of SARS-CoV-2 in SA have caused a further downturn in the economy, and exacerbated the problem of food security.

Many children are dependent on school meals to sustain their nutrition; therefore, prolonged closure of schools during the pandemic with school meals no longer available, is likely to worsen the prevalence of malnourishment. Malnourished children are more susceptible to infectious diseases, and show a delay in cognitive development, which negatively impacts on educational outcomes ultimately resulting in lower income in adulthood.²³

Other adverse long-term health effects of malnourishment in infancy and early childhood are stunting,^{15,24} and a greater risk for developing cardiometabolic diseases during the lifecourse.²⁵ The relationship between longi-

tudinal growth and oral health was shown in a recent randomised controlled trial where significantly greater height was found after a 6-month follow-up of SA children who had severe caries treated under general anaesthesia compared to their peers who had no treatment.²⁶ Both direct and indirect (immune, endocrine and metabolic) mechanisms have been proposed to explain the relationship between untreated caries and impaired growth;²⁷ however, these need further investigation in SA children, while considering socioeconomic contexts.

Maternal factors and child oral health

Maternal socioeconomic factors and undernutrition contribute to adverse birth outcomes such as preterm delivery or low birth weight,^{28,29} which have been shown to be associated with enamel hypoplasia of the deciduous and permanent dentition.³⁰ A longitudinal study of Brazilian children aged between 12 and 36 months reported enamel defects, namely opacities and hypoplasia, in children of mothers from economically deprived communities, and suggested that this may affect their oral health related quality of life (OHRQL).³⁰ The odds for enamel defects increased 3.46-fold in neonates who had had poor intrauterine nutrition and as a result were small for gestational age (SGA), and 1.89-fold in infants who had poor postnatal nutrition.³⁰ Maternal malnutrition also negatively impacts on the development of the stomatognathic system;³¹ however, there are conflicting reports in the literature on the associations between maternal malnutrition during pregnancy and the timing of tooth eruption.^{32,33}

While these studies highlight the intergenerational impact of maternal malnutrition on child oral health, the Pelotas longitudinal study showed that poverty at birth and during the life course was correlated with the number of unsound teeth at 24 years of age.³⁴ Early life exposures are therefore critical to an individual's health and well-being through the lifespan.

Antenatal clinics provide the ideal setting for promoting oral health; however, a recent SA study at an urban maternal and child healthcare facility found minimal integration of oral health education with general health, and that a significant number of mothers did not recognise the importance of the primary dentition.³⁵ Interventions are essential to promote attendance of mothers at dental clinics, and to encourage preventative dental care measures once the primary teeth begin to erupt.

Socioeconomic disparities in relation to oral health

Poor oral health may cause pain and impede function. The OHRQL is a tool used to measure how an individual's oral health impacts on their general well-being and ability to function on a physical, social and psychological level.³⁶ In a systematic review of the OHRQL in children in Africa, Malele-Kolisa et al.³⁷ found that individual factors such as children's psyche and oral problems, except for dental caries, were associated with environmental factors such as area of residence and socioeconomic status. Thus, in SA, where there is a strong correlation between low socioeconomic status

and ethnicity,³⁸ sociocultural contexts should be considered when delivering oral health care.

Studies conducted in the USA³⁹ and the UK⁶ have shown that black and Asian individuals with COVID-19 had double the risk of dying than their white peers. The UK cohort study included an analysis of 5683 in-hospital deaths due to COVID-19 during a 12-week period, and found that pre-existing comorbidities or higher deprivation only partly accounted for death.⁶ It was suggested that these ethnic groups may have been over-represented as front-line workers, and therefore at a higher risk of infection, or that other social aspects such as higher household density may have been contributory factors.⁶ Ethnicity as a contributory factor in the spread of the SARS-CoV-2 virus in SA is deeply entrenched in the legacy of Apartheid.

The majority of South African citizens are socioeconomically disadvantaged, have poor and overcrowded living conditions, and limited access to water and sanitation. These conditions render social distancing, and maintaining stringent general and oral hygiene more challenging. Neglect of oral health may also arise due to psychological factors such as fear of entering a high-risk dental environment for treatment. However, a positive outcome of the pandemic is that individuals have become acutely aware of the importance of hygiene and the mode of transmission of infectious diseases.

In children, in particular, the greater awareness that prevails could present an opportunity to promote and reinforce positive oral health behaviour. It is important to target this age group since dental caries can be tracked; that is, the severity of caries in the primary dentition is a predictive of caries in adulthood.⁴⁰ The prevalence and severity of caries in the primary dentition are also strongly related to individual and socioeconomic factors such as family income and maternal education.⁴¹

A significant number of South African households were facing financial challenges even prior to the COVID-19 pandemic due to the high unemployment rate of 30.1%.⁴² The national lockdown has exacerbated the unemployment crisis with permanent closure of businesses and further job losses. A recent survey of 2688 individuals residing in SA found that, at the start of the lockdown, 5.2% of respondents had no income, and that this increased to 15.4% in the subsequent six weeks.⁴³ Almost 75% of the respondents reduced their spending to compensate for the loss of income. For many, this has included downscaling their private medical insurance benefits. Whether this results in an increase in demand for dental care at already constrained public facilities, or that it translates to greater neglect of oral health through lack of affordability of treatment in the private sector, is yet to unfold.

Oral health care workers

The majority of South Africans have inadequate access to oral health care facilities. In SA, there are 0.13 dentists per 1000 individuals, which is fewer than most other middle-income countries.⁴⁴ In addition, there are in-

equities in the distribution of its oral health care workers (OHCW).^{9,44}

While 84-90% of the SA population is reliant on public oral health services, in 2009, only 25% of all South African dentists were employed by the public sector.⁴⁴ The SA National Department of Health has demonstrated that it has the ability to garner resources and undertake intense community screening as it has for SARS-CoV-2. If only such intense mobilisation could be done for the promotion of oral health screening and education in disadvantaged communities. This, together with addressing the shortage of oral hygienists and dental therapists in SA,⁴⁵ could alleviate the burden of oral health care delivery in an already over-burdened environment, and should be considered by health policy advocates.

Of concern is that OHCW themselves are at a higher risk of infection by COVID-19 and may be responsible for amplification of transmission of infections. Routine screening does not identify infected patients who may be asymptomatic, or, patients may not disclose that they are infected. SARS-CoV-2 is highly contagious due to its mode of transmission, and its ability to remain viable in air droplets, and on objects and surfaces for long durations.⁴⁶

There is much controversy regarding the risk posed to OHCW due to the aerosol generated during dental procedures even when treatment is undertaken using protocols such as a pre-procedural mouth rinse, high vacuum evacuation, rubber dam, and adequate personal protective equipment.⁴⁷ It is of paramount importance that further research on airborne transmission of SARS-CoV-2 in the dental setting is undertaken so that evidence-based guidelines can be formulated for the profession.

Currently, the health risk posed to OHCW is compounded by the lack of availability of adequate personal protective equipment. Also, many OHCW in SA are older and may themselves have comorbidities and a high body mass index, and if infected, have a higher risk of suffering from a more severe form of COVID-19. Whether COVID-19 inadvertently forces older, at-risk dentists into early retirement remains to be seen. For now, practitioners have to mitigate risk by implementing additional disinfection measures, which reduces the number of patients that can be treated in a day, and by performing only those procedures which conform to the guidelines published by their professional association. Collectively, these challenges are likely to be financially crippling for many private dental practices, and compromise an already under-resourced sector.

Clinical considerations of COVID-19

There are some clinical considerations for OHCW when treating patients who either currently have or have recovered from COVID-19. Ibuprofen, which is a nonsteroidal anti-inflammatory drug commonly prescribed by OHCW for the treatment of pain, fever, and inflammation may cause an increase in ACE2.⁴⁸ Since many COVID-19 positive individuals are asymptomatic, in the current environment, ibuprofen should be prescribed more ju-

ditionally. Although there are no specific drugs for the treatment of COVID-19, interferon which is known to reduce viral load, and the broad-spectrum antibiotics meropenem and moxifloxacin, are being used in some settings to treat severely ill patients.⁴⁹ Intense pharmacotherapy may result in oral side effects such as xerostomia, stomatitis or candidiasis, which are known to impact on OHRQL.⁵⁰ It is unclear for how long these side-effects persist after full recovery from COVID-19, and prolonged hospitalisation may exacerbate pre-existing dental conditions.

Clinical and epidemiological studies have shown that patients with periodontal disease are at greater risk for developing nosocomial pneumonia, particularly during orotracheal intubation.⁵¹ The proposed mechanisms for the propensity for lung infection include aspiration of pathogenic oral bacteria into the lower respiratory tract, modification of the respiratory mucosa by salivary enzymes which facilitates bacterial colonisation, and the secretion of pro-inflammatory cytokines which promote the adhesion and colonisation of respiratory pathogens to the lung mucosa.⁵¹

Some of the risk factors for nosocomial pneumonia that need to be considered include compromised periodontal health, duration of hospital stay, antibiotic use, inadequate oral care, smoking, alcohol consumption, and advanced age. Thus, it is imperative to maintain a stringent oral hygiene regimen in the face of potential infection by SARS-CoV-2, especially for the elderly who are at greater risk for fatality due to COVID-19.

CONCLUSIONS AND RECOMMENDATIONS

The relationship between COVID-19 and oral health is indirect and multifaceted. There is a need for empirical studies to advance our understanding of the impact of COVID-19 on oral health, particularly in the South African context. The last National Oral Health survey was conducted in the early years of democracy between 1999 and 2002, and showed that approximately 45-60% of children younger than 12 years living in SA require treatment for dental decay.

In light of the nutrition transition and epidemiologic transitions⁵² that have occurred in SA in the last 2 decades, an updated national survey is needed to more accurately reflect the current status of oral health in SA. In addition, prospective quantitative studies are required to determine the risks and outcomes of COVID-19 on OHRQL in SA, while qualitative studies may elucidate behavioural changes that may have occurred in response to the pandemic. Most importantly though, longitudinal studies that track the trajectory of oral health in relation to NCDs are critical, not only for our understanding of the complex relationship between the diseases, but also to understand their impact on human and economic capital.

Given that shared health behaviours are defined by social, environmental and political contexts, further research should be patient-centred and focus on oral health rather than oral disease. Thus, the recently developed Adult Oral Health Standard Set,⁵³ which considers

clinical, social and environmental contexts, is recommended, and would allow for clearer guidance on managing risk, and may better inform policy on delivering more appropriate oral health care and behavioural interventions in SA.

References

1. Rothan HA, Byrareddy SN. The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. *J Autoimmun.* 2020; 109: 102433.
2. Porcheddu R, Serra C, Kelvin D, Kelvin N, Rubino S. Similarity in Case Fatality Rates (CFR) of COVID-19/SARS-COV-2 in Italy and China. *J Infect Dev Ctries.* 2020; 14(2): 125-8.
3. Shang J, Ye G, Shi K, Wan Y, Luo C, Aihara H, et al. Structural basis of receptor recognition by SARS-CoV-2. *Nature.* 2020; 581(7807): 221-4.
4. Hamming I, Timens W, Bulthuis ML, Lely AT, Navis G, van Goor H. Tissue distribution of ACE2 protein, the functional receptor for SARS coronavirus. A first step in understanding SARS pathogenesis. *J Pathol.* 2004; 203(2): 631-7.
5. Richardson S, Hirsch JS, Narasimhan M, Crawford JM, McGinn T, Davidson KW, et al. Presenting characteristics, comorbidities, and outcomes among 5700 patients hospitalized with COVID-19 in the New York City area. *JAMA.* 2020.
6. Williamson E, Walker AJ, Bhaskaran KJ, Bacon S, Bates C, Morton CE, et al. OpenSAFELY: factors associated with COVID-19-related hospital death in the linked electronic health records of 17 million adult NHS patients. *medRxiv.* 2020: 2020.05.06.20092999.
7. Ramos-Nino ME, Blumen SR. Benefits of ACE inhibitors in diabetes. *Clin Med Therap.* 2009; 1: 1041-51.
8. Fang L, Karakiulakis G, Roth M. Are patients with hypertension and diabetes mellitus at increased risk for COVID-19 infection? *Lancet Respir Med.* 2020; 8(4): e21.
9. WHO. Promoting oral health in Africa. 2016: 1-126.
10. Shisana O. The South African National Health and Nutrition Examination Survey, 2012: SANHANES-1: the health and nutritional status of the nation. 2014.
11. Crowther NJ, Norris SA. The current waist circumference cut point used for the diagnosis of metabolic syndrome in sub-Saharan African women is not appropriate. *PLoS One.* 2012;7(11):e48883.
12. Navarro-Sanchez AB, Faria-Almeida R, Bascones-Martinez A. Effect of non-surgical periodontal therapy on clinical and immunological response and glycaemic control in type 2 diabetic patients with moderate periodontitis. *J Clin Periodontol.* 2007; 34(10): 835-43.
13. Baeza M, Morales A, Cisterna C, Cavalla F, Jara G, Isamitt Y, et al. Effect of periodontal treatment in patients with periodontitis and diabetes: systematic review and meta-analysis. *J Appl Oral Sci.* 2020; 28: e20190248.
14. Desvarieux M, Demmer RT, Jacobs DR, Jr., Rundek T, Boden-Albala B, Sacco RL, et al. Periodontal bacteria and hypertension: the oral infections and vascular disease epidemiology study (INVEST). *J Hypertens.* 2010; 28(7): 1413-21.
15. Norris SA, Wrottesley S, Mohamed RS, Micklesfield LK. Africa in transition: growth trends in children and implications for nutrition. *Ann Nutr Metab.* 2014; 64 Suppl 2: 8-13.
16. Steyn N, Nel J. Dietary intake of adult women in South Africa and Nigeria with a focus on the use of spreads. *Tygerberg: South African Medical Research Council.* 2006.
17. Maunder EM, Nel JH, Steyn NP, Kruger HS, Labadarios D. Added sugar, macro- and micronutrient intakes and anthropometry of children in a developing world context. *PLoS One.* 2015; 10(11): e0142059.
18. Steyn NP, Temple NJ. Evidence to support a food-based dietary guideline on sugar consumption in South Africa. *BMC Public Health.* 2012; 12(1): 502.
19. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. *Nutr Rev.* 2012; 70(1): 3-21.

20. Mendenhall E. Syndemic suffering in Soweto: violence and inequality at the nexus of health transition in South Africa. *Ann Anthropol Pract.* 2014; 38(2): 300-16.
21. StatsSA. Poverty trends in South Africa. An examination of absolute poverty between 2006 and 2015 2017; Report No. 03-10-062015.
22. StatsSA. Towards measuring food security in South Africa: An examination of hunger and food inadequacy. 2019; Report: 03-00-14.
23. Stein AD, Wang M, Martorell R, Norris SA, Adair LS, Bas I, et al. Growth patterns in early childhood and final attained stature: data from five birth cohorts from low- and middle-income countries. *Am J Hum Biol.* 2010; 22(3): 353-9.
24. Said-Mohamed R, Micklesfield LK, Pettifor JM, Norris SA. Has the prevalence of stunting in South African children changed in 40 years? A systematic review. *BMC Public Health.* 2015; 15: 534.
25. Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, et al. Maternal and child undernutrition: consequences for adult health and human capital. *Lancet.* 2008; 371(9609): 340-57.
26. Yengopal V. The effect of dental treatment on weight gain in children in South Africa [PhD]: University of the Western Cape; 2017.
27. Duijster D, Sheiham A, Hobdell MH, Itchon G, Monse B. Associations between oral health-related impacts and rate of weight gain after extraction of pulpally involved teeth in underweight preschool Filipino children. *BMC Public Health.* 2013; 13(1): 533.
28. Lee AC, Katz J, Blencowe H, Cousens S, Kozuki N, Vogel JP, et al. National and regional estimates of term and preterm babies born small for gestational age in 138 low-income and middle-income countries in 2010. *Lancet Glob Health.* 2013; 1(1): e26-36.
29. Ngandu CB, Momberg D, Magan A, Chola L, Norris SA, Said-Mohamed R. The association between household socio-economic status, maternal socio-demographic characteristics and adverse birth and infant growth outcomes in sub-Saharan Africa: a systematic review. *J Dev Orig Hlth Dis.* 2019.
30. Chaves A, Rosenblatt A, Oliveira O. Enamel defects and its relation to life course events in primary dentition of Brazilian children: a longitudinal study. *Community Dent Health.* 2007; 24(1): 31.
31. Ferraz-Pereira KN, Toscano AE, Manhaes-de-Castro R. Effect of early undernutrition on masticatory morphophysiology: review of the literature. *Arch Oral Biol.* 2013; 58(11): 1735-43.
32. Elamin F, Liversidge HM. Malnutrition has no effect on the timing of human tooth formation. *PLoS One.* 2013; 8(8): e72274-e.
33. Mobley CC, Reifsnider E. Pregnancy, Child Nutrition, and Oral Health. In: Touger-Decker R, Sirois DA, Mobley CC, editors. *Nutrition and Oral Medicine.* Totowa, NJ: Humana Press; 2005; 17-30.
34. Peres MA, Peres KG, Thomson WM, Broadbent JM, Gigante DP, Horta BL. The influence of family income trajectories from birth to adulthood on adult oral health: findings from the 1982 Pelotas birth cohort. *Am J Public Health.* 2011; 101(4): 730-6.
35. Kolisa Y. Assessment of oral health promotion services offered as part of maternal and child health services in the Tshwane Health District, Pretoria, South Africa. *Afr J Prim Health Care Fam Med.* 2016;8:1-8.
36. Locker D, Allen F. What do measures of 'oral health-related quality of life' measure? *Comm Dent Oral Epidemiol.* 2007; 35(6): 401-11.
37. Malele-Kolisa Y, Yengopal V, Igumbor J, Nqobco CB, Ralephenya TRD. Systematic review of factors influencing oral health-related quality of life in children in Africa. *Afr J Prim Health Care Fam Med.* 2019; 11(1): e1-e12.
38. Myburgh NG, Solanki GC, Smith MJ, Lalloo R. Patient satisfaction with health care providers in South Africa: the influences of race and socioeconomic status. *Int J Qual Health Care.* 2005; 17(6): 473-7.
39. Webb Hooper M, Napoles AM, Perez-Stable EJ. COVID-19 and racial/ethnic disparities. *JAMA.* 2020.
40. Sheiham A, Sabbah W. Using universal patterns of caries for planning and evaluating dental care. *Caries Res.* 2010; 44(2): 141-50.
41. Heilmann A, Tsakos G, Watt RG. Oral Health Over the Life Course. In: Burton-Jeangros C, Cullati S, Sacker A, Blane D, editors. *A Life Course Perspective on Health Trajectories and Transitions.* Cham (CH): Springer, 2015; 39-59.
42. StatsSA. South Africa unemployment rate 2000-2020 data. 2020.
43. StatsSA. Results from Wave 2 survey on the impact of the COVID-19 pandemic on employment and income in South Africa. 2020; Report-00-80-03.
44. Strachan B, Zabow T, van der Spuy Z. More doctors and dentists are needed in South Africa. *S Afr Med J.* 2011; 101(8): 523-8.
45. Bhayat A, Chikte U. Human resources for oral health care in South Africa: A 2018 update. *Int J Environ Res Public Health.* 2019; 16(10).
46. Van Doremalen N, Bushmaker T, Morris DH, Holbrook MG, Gamble A, Williamson BN, et al. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. *New Engl J Med.* 2020; 382(16): 1564-7.
47. Mair AD, Korne PH. Decoding dental aerosols. *Emerg Infect Dis.* 2020; submitted.
48. Day M. Covid-19: ibuprofen should not be used for managing symptoms, say doctors and scientists. *BMJ Publishing Group;* 2020.
49. Dziedzic A, Wojtyczka R. The impact of coronavirus infectious disease 19 (COVID-19) on oral health. *Oral Dis.* 2020.
50. Thomson WM, Lawrence HP, Broadbent JM, Poulton R. The impact of xerostomia on oral-health-related quality of life among younger adults. *Health Qual Life Outcomes.* 2006; 4(1): 86.
51. Gomes-Filho IS, Passos JS, Seixas da Cruz S. Respiratory disease and the role of oral bacteria. *J Oral Microbiol.* 2010; 2(1): 5811.
52. Kabudula CW, Houle B, Collinson MA, Kahn K, Gómez-Olivé FX, Clark SJ, et al. Progression of the epidemiological transition in a rural South African setting: findings from population surveillance in Agincourt, 1993–2013. *BMC Public Health.* 2017; 17(1): 424.
53. Ni Riordain R, Glick M, Al Mashhadani SSA, Aravamudhan K, Barrow J, Cole D, et al. Developing a standard set of patient-centred outcomes for adult oral health - an international, cross-disciplinary consensus. *Int Dent J.* 2020.

The case of three burials

- A forensic case book

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CASE REPORT

The details of this case have been omitted in order to maintain anonymity.

An elderly male was reported missing from his home by his family. Initially, an inquiry and missing person's docket was opened. On investigation, several suspicious findings, along with other emerging evidence led to the case being changed into one of kidnapping.

Unbeknown to the investigating officers, around the same time a body had been found buried in a shallow grave about 200 kilometers from the missing person's home (*First burial*). The body had been taken to the state mortuary where a post-mortem was performed. At that stage there was no connection made to the missing person's case and after the body remained unclaimed, the corpse was given a pauper's funeral (*Second burial*).

Later, during the police investigation, a suspect admitted to having kidnapped and murdered the victim and led the police to the area where he had buried the body. They found no body present at the burial site, but did discover two chrome cobalt partial dentures (Figures 1-2) and a single maxillary molar tooth (Figure 3).

Ante-mortem dental records (Figure 4) and radiographs of the suspected missing person were obtained from his dentist. These documents, along with the chrome cobalt dentures and molar tooth, were submitted to the

forensic odontology unit at the University of Pretoria for examination and comparative analysis.



Figure 1. Maxillary chrome cobalt partial denture.



Figure 2. Mandibular chrome cobalt partial denture.



Figure 3. Single maxillary molar tooth.

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3. **Herman Bernitz:** Forensic report and advisor - 30%

DENTAL FINDINGS IN PERMANENT TEETH (Notify temporary teeth specifically)			
11		PFM crown	21
12		4 surface tooth-coloured; Endo Rx	22
13		PFM crown; Post & core; Endo Rx	23
14	XLA	XLA	24
15	PFM crown; Post & core; Endo Rx	Missing	25
16	DO tooth-coloured	PFM crown; Post & core; Endo Rx	26
17	Missing	MO tooth-coloured	27
18	Missing	MO tooth-coloured	28

18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
□															
48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38

48	Missing	Missing	38
47	Missing	XLA	37
46	XLA	Missing	36
45	Missing	PFM crown; Post & core; Endo Rx	35
44	XLA	DOB tooth-coloured; Endo Rx	34
43	PFM crown; Post & core; Endo Rx		33
42	4 surface tooth-coloured; Endo Rx	B tooth-coloured	32
41	BI tooth-coloured	BI tooth-coloured	31

Figure 4. Reconstructed ante-mortem odontogram.

The forensic evaluation revealed the following points of dental concordance:

- The 3-toothed maxillary chrome cobalt partial denture design corresponded to the missing teeth visible on the supplied antemortem dental radiographs.
- The 6-toothed mandibular chrome cobalt partial denture design corresponded to the missing teeth visible on the supplied antemortem dental radiographs.
- The single maxillary molar tooth had a similar crown pattern and endodontic treatment as the left maxillary first molar tooth in the supplied antemortem radiographs (Figures 5-6).
- The left clasp and occlusal rest of the maxillary chrome cobalt partial denture corresponded to the morphology and rest preparation of the left maxillary first molar tooth (Figures 7-8).

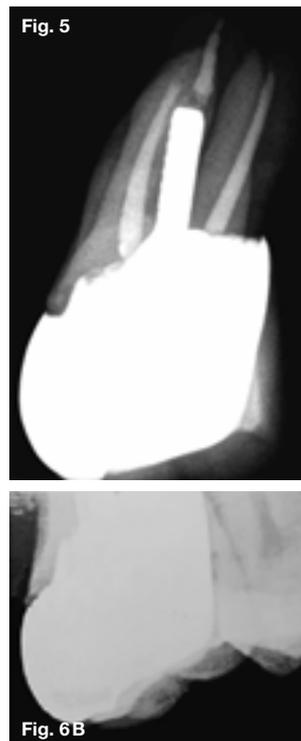


Figure 5. Post-mortem radiograph of the single maxillary molar tooth.

Figure 6. Cropped ante-mortem (A) periapical and (B) bitewing radiographs of the left first maxillary molar tooth.



Figure 7. Occlusal view photograph of the left maxillary first molar tooth in position with the maxillary chrome cobalt denture.



Figure 8. “Buccal” view photograph of the left maxillary first molar tooth in position with the maxillary chrome cobalt partial denture.

Based on the presence of multiple concordant identifiable dental features and no unexplained discrepancies between the antemortem records and the excavated dentures and maxillary molar tooth, it was concluded with absolute certainty that they all belonged to the missing person in question.

Finally, the kidnapping case was closed, and the pauper's body was once again exhumed for a proper burial by his family (*Third burial*).

DISCUSSION

The most common role of a forensic odontologist is the identification of deceased individuals.¹⁻² Dental identification assumes a primary role when post-mortem changes, traumatic tissue injury or a lack of fingerprint records nullifies the use of visual or fingerprint methods.^{1,3}

Teeth not only represent a suitable repository for unique and identifying features, but they also survive most post-

mortem events.² The central principle of dental identification is that post-mortem dental remains can be compared with ante-mortem dental records to confirm identity.¹

In a dentate victim, a forensic odontologist can make use of missing teeth, caries, restorations, partial dentures, onlays, crowns, bridgework and implants.⁴ This method relies on dental professionals recording and storing dental notes, clinical photographs, radiographs and study models.¹⁻² Individuals with numerous complex dental treatments are often easier to identify than those with little or no restorative work.²

Forensic identification based on the assessment of prosthodontic appliances is assuming greater significance, as dental prostheses including crowns, bridge-work, partial or complete dentures, and implants are often made of resilient materials, and can provide additional vital clues for victim identification.⁴

Partial or complete dentures may be discovered in or close to the scene where the body of an unknown individual is found, and can be a useful aid in identification.⁵ Other dental prostheses such as removable orthodontic appliances have also been used successfully for identification purposes.²

Denture identification is an important component of forensic odontology, since it is often more difficult to identify an edentulous person.³ In the absence of marked/labelled dentures, dental identification is problematic and may only be established by well-trained examiners via comparison of bone trabeculation patterns recorded in ante-mortem and post-mortem radiographs.³ Unlabelled dentures recovered from patients can be fitted to casts retained by the treating dentist or laboratory as an identification method.^{2,4}

DNA analysis of material collected from dental prostheses is another useful method of identification. A study by Inoue et al. found that even previously worn acrylic resin dental prostheses that had been left at room temperature for as long as 200 days could be used for DNA extraction and analysis for identification purposes.⁶

However, even in the absence of DNA analysis (which is costly and time consuming), a marked/labelled denture can reveal the identity of a deceased person when all other methods fail to do so.²⁻³ This emphasises the importance of denture marking/labelling for both forensics and other purposes such as:

- To identify unknown denture wearers in cases involving amnesia or senility, psychiatric cases, homicide, suicide, and victims of natural disasters, air disasters or war.
- In cases of lost and found, the denture can be returned to the owner.
- To provide a rapid and accurate method of identification where fingerprinting is not possible, or where other methods could delay a positive identification.
- In dental laboratories and clinical practices where technicians and dentists can easily identify a marked/labelled denture, thus ensuring the correct denture is delivered to the respective patient.^{5,7-8}

In light of these many uses, marking/labelling should not be restricted to acrylic resin dentures, but should also be extended to chrome cobalt partial dentures, orthodontic appliances, maxillo-facial reconstructive prostheses and fixed crowns and bridgework.¹

Many denture marking/labelling methods exist, including:

- a. **Engraving:** This involves marking the models so that the denture carries the identification spots upon fabrication.
- b. **Scribing:** This involves marking the denture after it has been fabricated with either a bur or any other sharp instrument.
- c. **Writing:** This involves slight disking of the posterior flange of the non-tissue-bearing side of the denture in order to write the identification details.
- d. **Inclusion:** This involves replacement of part of the denture material with a clear acrylic and a medium (metallic, non-metallic labels or microchips) from which identification can be obtained.^{1,4-5,8}

More recently, authors have focused their attention on more high-tech methods of denture marking/labelling achieved via the use of radio frequency identification (RFID)-transponders.⁹

Generally, a combination of name and identification number is used inside a denture.⁸ Marking/labelling only the initials of an individual into the prosthesis may delay or lead to misidentification, partially if there are many other fatalities. Chrome cobalt dentures and many fixed restorative prostheses have generally never been marked/labelled because of the hardness of the materials, which makes it virtually impossible to etch, scribe or write on them chairside.⁵ However, given that they resist melting and distortion at far higher temperatures than acrylic resin, they should also be marked/labelled in some durable and inconspicuous manner.

The American Dental Association (ADA) has described guidelines for denture marking/labelling. (These principles can be extended to all forms of dental/facial prostheses and restorations):

1. The strength of the prosthesis must not be jeopardised.
2. It must be easy, efficient and inexpensive to achieve.
3. The markings must be visible and durable.
4. The markings must withstand humidity and fire.
5. The markings must not interfere with any of the fitting or occlusal surfaces of the prosthesis, and not cause any noticeable discomfort to the patient.
6. The identification marks should be cosmetically acceptable to the wearer.^{4,7}

Unfortunately, despite numerous reports in the literature on the benefits of denture marking/labelling, there remains a general sense of apathy and lack of uptake for this in practice. It would appear that this indifference is more on the part of dentists and technicians than the patients.³ This suspicion was confirmed by studies such as that of Borrman and Rene who found that it was the dental profession, rather than the patient, that was responsible for the non-marking of dentures.¹⁰

Furthermore, Cunningham and Hoad-Reddick reported that patients were generally in favour of some form of denture marking/labelling,¹¹ while Richmond and Pretty found the 99% of individuals said they would accept marking/labelling of their dentures.³

Currently, only a few countries in the world adhere to a strict denture marking/labelling regimen, with most having different rules or requirements regarding this process. In Sweden for example, it is mandatory for all dentists to offer and motivate their patients to have dentures marked/labelled, but the actual marking/labelling is not enforced.⁴ In South Africa, a survey of 23 laboratories and 14 dental surgeries showed that no routine denture marking/labelling takes place.⁸ Regardless of legislature, all dentists should inform and motivate their patients about the benefits of denture marking/labelling. Perhaps if this procedure was incorporated into all dental teaching institutions as part of the denture fabrication curriculum for undergraduate students it may gain the importance it deserves.¹²

CONCLUSION

This case report illustrates the value of dental prostheses and restorations in victim identification. However, not all situations will have the benefit of ante-mortem dental records for comparative purposes, making denture identification all the more important.

In light of the numerous additional benefits this procedure has for patients, the profession and the broader community, and given that modern methods exist to achieve this with durable, undiscernible and relatively inexpensive techniques, it should be considered a mandatory requirement of all dental/facial restorations.

References

1. Mishra SK, Mahajan H, Sakorikar R, Jain A. Role of prosthodontist in forensic odontology. A literature review. *J Forensic Dent Sci.* 2014; 6(3):154-9.
2. Pretty IA, Sweet D. A look at forensic dentistry -Part 1: The role of teeth in the determination of human identity. *Br Dent J.* 2001; 190(7): 359-66.
3. Richmond R, Pretty IA. Denture marking-patient preference of various methods. *J Forensic Sci.* 2007; 52(6): 1338-42.
4. Bathala LR, Rachuri NK, Rayapati SR, Kondaka S. Prosthodontics an "arsenal" in forensic dentistry. *J Forensic Dent Sci.* 2016; 8(3): 173.
5. Gosavi S, Gosavi S. Forensic odontology: A prosthodontic view. *J Forensic Dent Sci.* 2012; 4(1): 38-41.
6. Inoue M, Hanaoka Y, Minaguchi K. Personal Identification by DNA Analysis of Samples from Dental Prostheses Made of Acrylic Resin. *The Bulletin of Tokyo Dental College.* 2000; 41(4): 175-85.
7. Chalian VA, Sayoc AM, Ghalichebaf M, Schaeffer L. Identification of removable dental prosthesis. *J Prosthet Dent.* 1986; 56(2): 254-6.
8. Bernitz H, Blignaut J. An inclusion technique for marking dentures. *J Forensic Odontostomatol.* 1998; 16(1): 14-6.
9. Richmond R, Pretty IA. The use of radio-frequency identification tags for labeling dentures-scanning properties. *J Forensic Sci.* 2009; 54(3): 664-8.

10. Borrmann HI, DiZinno JA, Wasen J, Rene N. On denture marking. J Forensic Odontostomatol. 1999; 17(1): 20-6.
11. Cunningham M, Hoad-Reddick G. Attitudes to identification of dentures: the patients' perspective. Quintessence Int. 1993; 24(4): 267-70.
12. Richmond R, Pretty IA. The teaching of denture marking methods in dental schools in the United Kingdom and the United States. J Forensic Sci. 2009; 54(6):1407-10.

Do the CPD questionnaire on page 465

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



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Diffuse gingival enlargement with stromal calcifications occurring in a background of amelogenesis imperfecta - An oral medicine case book

SADJ September 2020, Vol. 75 No. 8 p450 - p453

E Heyl¹, L Robinson², L Kotze³, WFP van Heerden⁴

CASE REPORT

A 12-year-old female patient presented with diffusely enlarged fibrous gingivae, enamel hypoplasia, an anterior or open bite and impacted permanent maxillary canines (Figures 1-4). The patient's mother reported that the child had an unremarkable medical history and was currently not taking any medications. Radiographic examination showed features of amelogenesis imperfecta affecting all erupted teeth and the impacted permanent maxillary canines (Figure 4).

The clinical differential diagnosis included hereditary gingival fibromatosis or diffuse peripheral odontogenic fibromas involving both the maxilla and mandible. Gingivectomies from the anterior maxillary and mandibular regions were performed and submitted for histological assessment.

DIAGNOSIS AND MANAGEMENT

The gingivectomy specimens were submitted in two separate containers. The maxillary gingivectomy consisted of four soft tissue fragments, the largest measuring



Figure 1. Initial clinical presentation. Diffusely enlarged fibrous gingivae obscuring the clinical crowns. Both maxillary central incisors show evidence of enamel hypoplasia.



Figure 2. Maxillary arch. Diffuse gingival enlargement, particularly involving the anterior maxilla. Both permanent first maxillary molars show evidence of enamel hypoplasia.



Figure 3. Mandibular arch. Diffuse gingival enlargement with evidence of enamel hypoplasia involving both permanent first mandibular molars.

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1. **Eric Heyl:** Principle author - 50%
2. **Liam Robinson:** Diagnosis, histological images, advisor - 20%
3. **Leande Kotze:** Clinical case, treatment and follow-up - 15%
4. **Willie FP van Heerden:** Diagnosis, advisor - 15%

7x5x3 mm and the smallest measuring 4x4x2 mm. The mandibular gingivectomy consisted of two soft tissue fragments, the larger measuring 20x5x3 mm and the smaller measuring 10x3x2 mm.

Histological examination of both specimens showed similar features, confirming tissue fragments surfaced by mildly hyperplastic stratified squamous epithelium (Figure 5). The superficial lamina propria consisted of dense fibrous connective tissue with a patchy mixed chronic inflammatory cell infiltrate of moderate intensity.

Additionally, inactive odontogenic epithelial islands with associated irregular and laminated dystrophic calcifications were noted (Figure 5 insert). There was representation of the junctional epithelium with extensive inflammatory cell exocytosis. A Periodic acid-Schiff (PAS) histochemical stain failed to highlight any fungal elements.

Considering the clinical, radiographic and histological features, a diagnosis of diffuse gingival enlargement with stromal calcifications occurring in a background of amelogenesis imperfecta was made. The patient was sche-

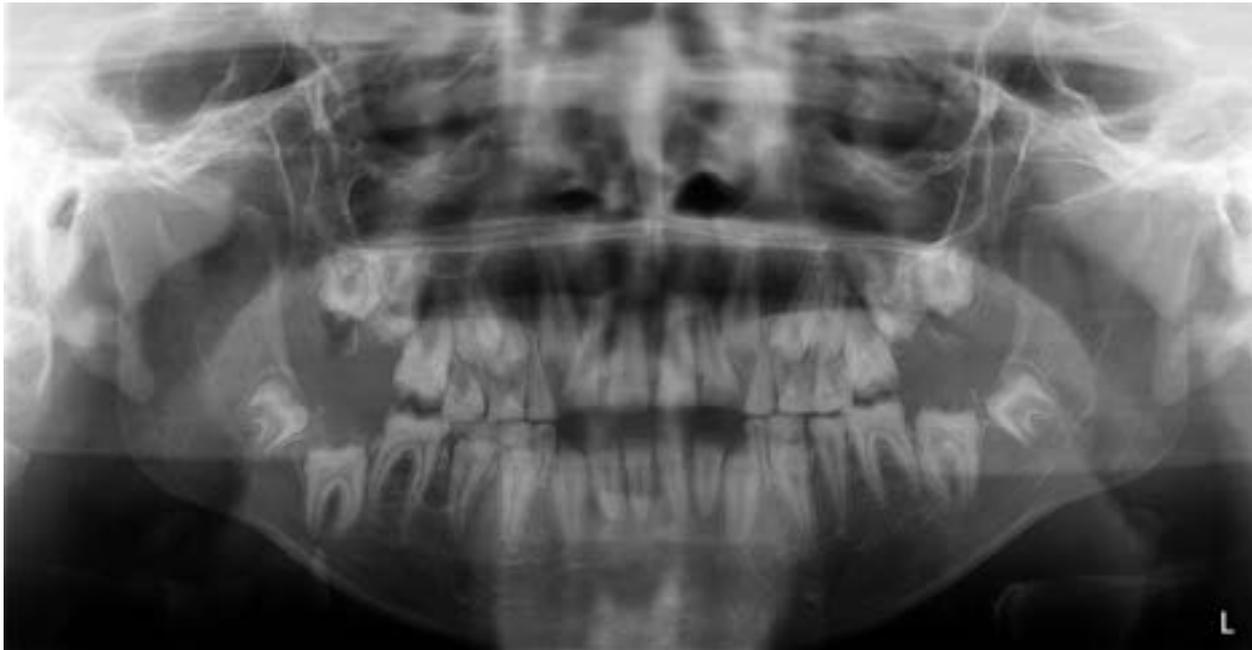


Figure 4. Panoramic radiograph showing diffuse enamel hypoplasia as well as bilateral impacted permanent maxillary canines. An incidental finding of unilocular radiolucency situated between teeth 45 and 46 was noted.

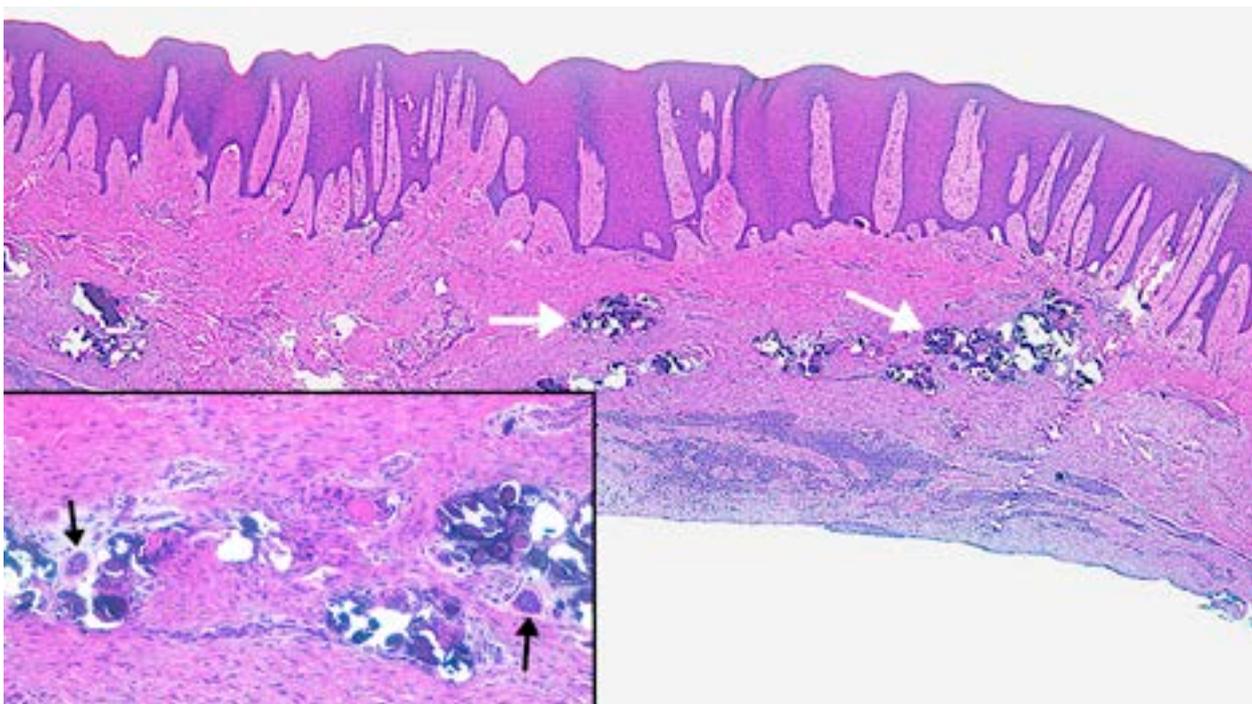


Figure 5. A low-power hematoxylin and eosin (H&E)-stained section showing a tissue fragment surfaced by hyperplastic stratified squamous epithelium with inactive odontogenic epithelial islands with associated irregular and laminated dystrophic calcifications (white arrows) within the lamina propria (original magnification x 40). **Insert:** High-power view of the odontogenic epithelial islands (black arrows) and calcifications (original magnification x 200).

duled for a follow-up appointment one month post periodontal surgery to evaluate healing and to assess for further treatment. The proposed treatment of this patient included dental hard tissue rehabilitation using stainless steel crowns on the posterior teeth and composite strip crowns on the anterior teeth.

DISCUSSION

Gingival diseases frequently present as gingival enlargement, but have a wide range of presentations that can pose a diagnostic challenge to the clinician. Gingival enlargement can be characterised based on location, size, distribution, and aetiopathogenesis.¹ After detailed examination and exclusion of unlikely differential diagnosis, a final diagnosis can be made in most instances. However, some cases require additional clinical work-up including a biopsy for a definitive histological diagnosis.

There are many causes of diffuse gingival enlargement including poor oral hygiene, systemic medications, genetic conditions, neoplasia, serious systemic illnesses and other specific physiological states.² In some instances the underlying cause of the diffuse enlargement cannot be determined and is therefore considered idiopathic.² Although diffuse gingival enlargement is considered a relatively common finding, it can be a pertinent clinical clue of an underlying serious systemic condition.¹⁻²

Amelogenesis imperfecta (AI) is a hereditary condition of abnormal enamel calcification and formation. The disease encompasses a complicated group of disorders that demonstrate developmental alterations in the structure of enamel, in the absence of a systemic disease or syndrome.³ Although this definition may exclude the association with a syndrome, a number of other dental abnormalities may be seen in patients with AI. These include pulpal calcifications, anterior open bite malocclusion, taurodontism, gingival enlargement and delayed eruption.³ A wide range of hereditary subtypes exist with different patterns of inheritance and an array of clinical manifestations.

Although an ideal classification system for AI has not yet been established, the Witkop classification appears to be the most accepted.⁴ Simplified, AI may be subclassified into four main forms, depending on the type and extent of enamel defects. The presentation may be hypoplastic, hypomaturation, hypocalcified or hypomaturation/hypoplastic with associated taurodontism.³⁻⁴

Several gene mutations have been associated with the development of AI. Diverse and distinctive phenotypic patterns are often created due to variations in individual gene mutations. To date, commonly mutated genes include: *AMELX* associated with the enamel protein amelogenin, *ENAM* associated with the enamel matrix protein enamelin, *MMP-20* which codes for proteinase enamelysin, *KLK4* coding for the protease kallikrein-4, *C4orf26* which encodes extracellular matrix protein in the enamel organ, and *DLX3* which codes for a number of essential enamel proteins. In addition, certain gene mutations have been associated with specific forms of AI. *FAM83H* gene mutations have been associated with autosomal-dominant hypocalcified AI, whereas

WDR72 gene mutations have been associated with autosomal-recessive hypomaturation AI.³⁻⁴

Literature provides reasonable evidence linking amelogenesis imperfecta and diffuse gingival enlargement. A 1992 case report by Peters et al. suggested that there may be an association between AI and hereditary gingival fibromatosis (HGF) on the basis of sibling hereditary patterns, clinical, radiological and histological findings.⁵ Another common trend in the literature postulates that the gingival enlargement associated with AI is attributed to the rough hypoplastic nature of the remaining tooth surface enamel which promotes microscopic bacterial plaque accumulation and retention, leading to a chronic inflammatory host response.⁶ This hypothesis is justified by the inflammatory cell infiltrate, dense fibrous connective tissue and dystrophic calcifications noted histologically, however these findings can also be seen in HGF.⁶

A study by Cherkaoui Jaouad et al. confirmed that mutations in the *FAM20A* gene are responsible for the development of autosomal-recessive AI with concurrent gingival fibromatosis.⁷ This may validate the presence of gingival enlargement in the background of AI from a familial genetic perspective. Further studies are needed to determine the exact mechanism of gingival overgrowth associated with AI, and whether the source of the overgrowth is as a result of fibroblast activity or human growth factors.⁸⁻⁹

The presence of irregular, laminated dystrophic calcifications in the gingiva adjacent to inactive odontogenic epithelial islands in patients with known AI is an uncommon and rarely described phenomenon. In 1995, Günhan et al. described the occurrence of multiple dystrophic calcifications, deposition of amyloid and islands of odontogenic epithelium in the gingiva of three related siblings diagnosed with familial gingival fibromatosis.¹⁰ The calcifications resembled those found in the hyperplastic dental follicles of regional odontodysplasia.¹⁰

A case report by Macedo et al. presented an association between hypoplastic type AI and diffuse gingival enlargement.⁶ In their report, histological examination of the gingival specimen showed dense fibrous connective tissue with a mononuclear inflammatory cell infiltrate and dystrophic calcifications with odontogenic epithelial islands. Rao and Carnelio reported an additional case of gingival enlargement with calcifications in the background of AI in a 12-year-old female presenting with hypoplastic enamel and gingival hyperplasia, without a family history of this condition.¹¹ A diagnosis of autosomal-recessive hypoplastic AI of the rough variant was established based on clinical and radiographic examinations. On histological examination, calcifications with either a concentrically lamellated or globular pattern were present in the hyperplastic gingival specimen. These calcifications, referred to as 'enamelioid conglomerates', have been described in several types of AI and also in regional odontodysplasia.¹¹ The authors further attempted to determine the character of these calcifications via histochemical stains, concluding that they were derived from odontogenic epithelial rests that had undergone dystrophic calcification.¹¹

Regional odontodysplasia (ROD) often shows dystrophic calcifications with laminated or globular morphologies and islands of odontogenic epithelium in the follicular tissue surrounding the crown.¹² ROD is a rare condition defined as nonhereditary amelogenesis imperfecta. It typically affects a focal area of the dentition with an affinity for the anterior teeth, and exhibits no gender or racial predilection.¹² Radiographically, the enamel and dentine appear thin with an enlarged pulp chamber. This radiographic appearance is often termed 'ghost teeth' owing to the lack of enamel-dentine contrast. Delayed eruption, non-inflammatory gingival enlargement and short roots with open apices are common clinical manifestations of ROD. Of the teeth that do erupt, many exhibit discoloured yellow/brown crowns with irregular enamel, rendering them particularly susceptible to dental caries.¹² Diagnosis is usually based on clinical and radiographic examination, with occasional histologic confirmation. Histologically, ROD displays varying degrees of dystrophic pulpal calcifications.^{3,12}

Amelogenesis imperfecta that occurs with gingival enlargement resembling HGF is generally managed via periodontal flap surgery. This has shown relative success in restoring the normal physiology of the gingiva.¹³⁻¹⁴ This is considered an adjunct to the restorative management, which is subdivided into different phases, depending on the eruption status of the patient.¹³⁻¹⁵

The temporary phase is performed during primary and mixed dentitions. In the primary dentition, stainless steel crowns are placed on molars with the purpose of preventing caries while allowing for adequate space maintenance and occlusal vertical dimension (OVD). Direct composite resins can be used on anterior teeth for aesthetic purposes. In the mixed dentition, stainless steel crowns, composite resin restorations or onlays on posterior teeth, and orthodontics are the conservative approach of choice to maintain OVD.¹⁵ Direct or indirect composite resin veneers may be used to improve dental aesthetics. In the mixed dentition, the main goal is to preserve of tooth structure, maintain tooth vitality, reduce tooth sensitivity, maintain the OVD and improve aesthetics.¹⁵

The transitional phase begins when all permanent teeth have erupted and continues till adulthood, whereby the permanent phase begins. In permanent teeth, full mouth rehabilitation with a multidisciplinary approach including prosthodontics, endodontics, periodontics and orthodontics may be necessary.¹⁵

Treatment may also include orthognathic surgery and orthodontic treatment in cases of severe malocclusion. Endodontic treatment may be necessary in cases of pulp exposure due to severe attrition or tooth reduction. Consultation with the appropriate specialists may help in developing a comprehensive treatment plan.¹⁵

CONCLUSION

The aetiology of diffuse gingival enlargement is diverse, including poor oral hygiene, systemic medications, genetic conditions, neoplasia, serious systemic illnesses and other specific physiological states. There is reasonable

evidence linking amelogenesis imperfecta and diffuse gingival enlargement.^{6,11} In these cases, periodontal flap surgery can help restore the normal physiology of the gingiva.¹³⁻¹⁴ Although rare, several case reports describe dystrophic calcifications in gingivectomy specimens of patients with AI additionally presenting with diffuse gingival enlargement.

The restorative management of AI is subdivided into different phases, depending on the eruption status of the patient. The main objective of this treatment is to preserve tooth structure to maintain vitality and improve overall aesthetics.¹⁵ A comprehensive treatment plan, developed via a multidisciplinary approach, is necessary to provide optimal treatment for these patients.

References

1. Agrawal AA. Gingival enlargements: Differential diagnosis and review of literature. *World J Clin Cases*. 2015; 3(9): 779-88.
2. Khara P, Zirwas MJ, English JC. Diffuse gingival enlargement. *J Am Acad Dermatol*. 2005; 52(3 Pt 1): 491-9.
3. Neville BW, Damm DD, Allen CM, Chi AC. *Oral and Maxillofacial Pathology*. Fourth edition. St. Louis, MO: Elsevier; 2016.
4. Witkop CJ, Jr. Amelogenesis imperfecta, dentinogenesis imperfecta and dentin dysplasia revisited: Problems in classification. *J Oral Pathol*. 1988; 17(9-10): 547-53.
5. Peters E, Cohen M, Altini M. Rough hypoplastic amelogenesis imperfecta with follicular hyperplasia. *Oral Surg Oral Med Oral Pathol*. 1992; 74(1): 87-92.
6. Macedo GO, Tunes RS, Motta AC, Passador-Santos F, Grisi MM, Souza SL, et al. Amelogenesis imperfecta and unusual gingival hyperplasia. *J Periodontol*. 2005; 76(9): 1563-6.
7. Cherkaoui Jaouad I, El Alloussi M, Chafai El Alaoui S, Laarabi FZ, Lyahyai J, Sefiani A. Further evidence for causal *FAM20A* mutations and first case of amelogenesis imperfecta and gingival hyperplasia syndrome in Morocco: a case report. *BMC Oral Health*. 2015; 15: 14.
8. Gokce K, Canpolat C, Ozel E. Restoring function and esthetics in a patient with amelogenesis imperfecta: A case report. *J Contemp Dent Pract*. 2007; 8(4): 95-101.
9. Akin H, Tasveren S, Yeler DY. Interdisciplinary approach to treating a patient with amelogenesis imperfecta: A clinical report. *J Esthet Restor Dent*. 2007; 19(3): 131-5; discussion 6.
10. Gunhan O, Gardner DG, Bostanci H, Gunhan M. Familial gingival fibromatosis with unusual histologic findings. *J Periodontol*. 1995; 66(11): 1008-11.
11. Rao N, Carnelio S. Amelogenesis imperfecta with gingival calcification: A rare presentation. *Brazilian Journal of Oral Sciences*. 2015; 4(15): 932-5.
12. Kappadi D, Ramasetty PA, Rai KK, Rahim AM. Regional odontodysplasia: An unusual case report. *J Oral Maxillofac Pathol*. 2009; 13(2): 62-6.
13. Brennan MT, O'Connell BC, Rams TE, O'Connell AC. Management of gingival overgrowth associated with generalized enamel defects in a child. *J Clin Pediatr Dent*. 1999; 23(2): 97-101.
14. Yaprak E, Subasi MG, Avunduk M, Aykent F. Amelogenesis imperfecta and generalized gingival overgrowth resembling hereditary gingival fibromatosis in siblings: A case report. *Case Rep Dent*. 2012; 2012: 428423.
15. Chen CF, Hu JC, Bresciani E, Peters MC, Estrella MR. Treatment considerations for patient with amelogenesis imperfecta: A review. *Braz Dent Sci*. 2013; 16(4): 7-18.

What's new for the clinician?

- Excerpts from and summaries of recently published papers

SADJ September 2020, Vol. 75 No. 8 p454 - p458

Compiled and edited by V Yengopal

1. Conservative therapies to treat pain and anxiety associated with temporomandibular disorders - a randomized clinical trial

RA Melo, CM de Resende, CR Rêgo, et al. Conservative therapies to treat pain and anxiety associated with temporomandibular disorders: a randomized clinical trial. *International Dental Journal* 2020; 70: 245-53.

INTRODUCTION

Temporomandibular joint dysfunction (TMD) is a term used for disorders affecting the muscles of mastication and the temporomandibular joints (TMJ), including the mandibular condyles, fossa of the temporal bone, TMJ capsule and the articular disc.¹ TMD is characterized by pain in the TMJ and periauricular region, and/or the muscles of mastication.

Signs and symptoms include limited mouth opening, restricted/asymmetric mandibular movement, and TMJ noise.¹ TMD can cause a clicking/popping noise emanating from the TMJ when mandibular movement occurs and the condyle crosses the rear margin of the articular disc. It is estimated that the prevalence of TMD in the world population is between 5% and 12%, although only about 2% require some intervention or treatment.

The aetiology of TMDs is complex and multifactorial.¹ Among the factors that increase the risk of the disease, starting or even accentuating the progression of the pain are: physical factors such as trauma, sources of deep pain, parafunctional habits, occlusal condition, postural characteristics, muscular hyperactivity; neuromuscular factors; and psychosocial factors, such as socioeconomic conditions, sleep disturbances, anxiety and depression. Patients with temporomandibular disorders, especially those with chronic pain, may present secondary psychiatric disorders such as anxiety, depression, social phobia, reduced capacity to work, as well as isolation, and suffering from loss of concentration and self-confidence.¹

Due to the multiplicity of factors associated with TMD, many treatment options have been proposed but it is widely agreed that initial treatment should be conservative and reversible, aimed primarily at pain relief, restoration of normal function, and the patient's physical and mental well-being.¹

Conservative treatment options include using an occlusal splint (OS) which has been widely used to restore neuromuscular balance through the return of balanced occlusal contacts, repositioning of the condyle and muscle relaxation. This consists of a removable device made of thermo-polymerisable acrylic resin that can be used during the day or at night depending on the clinical situation. Manual therapy (MT) has also been used to restore normal range of motion, reduce local ischaemia, stimulate proprioception, break fibrous adhesions, stimulate synovial fluid production, and reduce pain.¹ Individualised counselling (CS) is another option that has been shown to significantly improve signs and symptoms of TMD.

Melo and colleagues (2020)¹ reported on a trial that sought to evaluate the effectiveness of treatments with occlusal splint (OS), Manual therapy (MT), Individualised counselling (CS), and the association of OS with CS (OSCS) within the pain and anxiety variables in TMD patients after 1 month of treatment. The expected hypotheses were that, irrespective of the treated group, there would be a reduction in pain and anxiety with 1 month of treatment, and that patients treated with CS associated with OS would present less pain and anxiety when compared with patients who received single therapies.

MATERIALS AND METHODS

A blinded randomised clinical trial was conducted in which the evaluating investigator was not aware of the therapy to which the patient was submitted. Initially, 300

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patients were screened, but 188 patients were excluded because they did not meet the inclusion criteria and 23 patients withdrew. Thus, the convenience sample consisted of 89 patients diagnosed with TMD. Thus, after some sample losses and non-completion of the questionnaires by all patients, 89 patients were evaluated using TMJ diagnostic criteria (RDC), 85 patients by VAS, 83 patients by Hospital Anxiety and Depression Scale (HADS), 88 patients by Beck Anxiety Inventory (BAI), and 87 and 89 by STAI-trait and state, respectively.

The sample was randomly divided into four groups: OS; MT; OSCS; and CS and patients were evaluated after one month. Individuals who abandoned the selected treatment or did not follow guidelines and recommendations, such as inadequate use of OS, absence of the MT sessions or even having taken any measurement that could influence therapy outcomes were excluded from the study. Patients who did not improve and were unable to remain in the initial group went through a waiting period of 3 months without receiving treatment, followed by a change to a new therapy.

The study included patients with a diagnosis of TMD who had not received any treatment for TMD in the last 3 months, had a report of pain in the orofacial region in the last 3 months, and who were between 18 and 65 years of age. Patients who were identified with some impairment of cognitive ability were excluded, as they were unable to understand the questions in the questionnaires; a history of head trauma that is related to the aetiology of orofacial pain; patients with intracranial disorders or headache; use of medications in the last 3 months that could interfere with the effect of tested therapies, such as muscle relaxants, anti-inflammatory medication, anticonvulsants, antidepressants and anxiolytics; use of medication to treat TMD or muscle pain during the research period; other causes of orofacial pain such as caries, periodontal diseases, or neuropathies and fibromyalgia.

The occlusal splints were made from thermo-polymerisable acrylic resin. At the appointment to deliver the splint, adjustments were made before patient was sent away with instructions on how long to use splints (either during the day or night or both). The first return occurred 15 days after the installation, for verification of the adaptation of the splint, adjustments and reinforcement of the advice, for the association group (OSCS). After 30 days of installation, the splints were readjusted, if necessary. At this evaluation, the diagnostic criteria for TMD and the questionnaires were administered.

The Manual Therapy (MT) applied in this study was based on the use of thermal agents (heat and cryotherapy) and therapeutic exercises that were performed clinically by a trained researcher. The therapeutic regimen consisted of 40-min sessions, performed twice a week for 4 weeks. Patients were also instructed to repeat at home, on a daily basis, all the procedures that were applied during the sessions, as noted below.

All treated patients, regardless of their diagnoses, were instructed to apply a gel packet at temperatures be-

tween 40°C and 50°C for 20 min, three times a day during the 4 weeks of treatment. The compresses were applied in the masseter, temporal and TMJ regions.

The therapeutic exercises used were masseter and temporal massage and stretching exercises for the jaw muscles. For counselling (CS), an investigation was made into habits and other factors that might be responsible for the aetiology of the patient's dysfunction, and then a series of orientated guidelines for each case were developed that individualize treatment according to personal needs.

In addition, general characteristics about the disease were clarified, so that patients understood their condition and felt able to manage it themselves. At the end of the consultation, the patient received a written booklet with dietary guidelines, physical exercises, deleterious habits, instructions on correct mandibular function, posture and sleep hygiene. After 15 days, a new appointment was arranged for reinforcement of the CS.

The instruments used to measure the variables were TMD diagnostic criteria (RDC/TMD), visual analogue pain scale (VAS), HADS, BAI and State-Trait Anxiety Inventory (STAI). These instruments were administered at baseline and after 1 month of treatment.

The VAS consisted of a graded visual scale from 0 to 10, where 0 means no pain at the moment and 10 is the worst pain imaginable. The HADS consisted of 14 questions about how the patient felt in the last week. Of these, seven include characteristics focused on anxiety symptoms and seven assess symptoms of depression. For each question there are four possible answers, which have a score from 0 to 3, totalling a maximum score of 21 points for each component of the questionnaire. Scoring classifies anxiety as normal (0-7) or mild to severe (8-21).

The BAI consists of 21 items and has questions that can be answered on a scale of 0 to 3 (absolutely not; lightly; moderately and severely). The score is given by the sum of the items and classifies anxiety into the following: minimum anxiety (0-7); mild to severe anxiety (8-63).

The STAI consists of two self-administered questionnaires that separately evaluate trait anxiety, which is considered a personality trait of the individual; and state anxiety, which occurs momentarily in the face of some specific stimulus. The results of the questionnaire responses are classified as mild anxiety (20-0), moderate anxiety (31-49), and severe anxiety (50-80).

RESULTS

Of the 89 participants, 5.61% had muscular TMD, while 6.73% patients had joint TMD, and 87.62% had mixed TMD.

In relation to the diagnosis of TMD at the 30-day evaluation, three patients from the OS group, three from MT and three from OSCS were diagnosed without TMD, whereas only one patient from the CS group

reached this result. In addition, from the 43 patients diagnosed with the worst prognosis (mixed TMD - both muscular and joint), only 18 remained with this condition.

There was a significant reduction in the pain variable, measured by the VAS, for all groups after 1 month of treatment. When comparing the different groups there was no significant difference between treatments in regard to reduction of pain. Thus, no group was better than another group in improving pain ($p=0.260$).

The evaluation of anxiety using the Hospital Anxiety and Depression Scale (HADS) questionnaire showed that there was a reduction in anxiety symptoms for all groups, but no statistical difference was observed between them ($p=0.260$). However, over time, all treatments resulted in a significant reduction of anxiety ($p<0.001$).

The BAI questionnaire assessing anxiety showed that all four treatment groups achieved a significant reduction in anxiety symptoms over time ($p<0.001$), comparing baseline time with 1 month of treatment. In addition, all groups presented similar therapeutic results in BAI-measured anxiety; therefore, there was no significant statistical difference between the four therapies groups ($p=0.532$). Thus, no group was better than another group in improving anxiety.

Similarly, in the evaluation of the state-trait anxiety measured by the STAI, there was a significant reduction in scores for all treatment groups; however, no significant statistical difference was found between the different groups ($p=0.546$).

CONCLUSION

All of the conservative therapies used were effective in reducing pain and anxiety in patients diagnosed with TMD. However, no treatment was superior to the other in reducing the studied variables.

Implications for practice

TMD treatment and management has a number of conservative non-surgical options that appear to be effective. Clinicians should consider these treatment options before more radical approaches are considered for the management of TMD.

Reference

1. Melo RA, de Resende CM, Rêgo CR, Bispo AD, Barbosa GA, de Almeida EO. Conservative therapies to treat pain and anxiety associated with temporomandibular disorders: a randomized clinical trial. *International Dental Journal*. 2020; 70: 245-53.

2. The effects of vaping electronic cigarettes on periodontitis

F Karaaslan, A Dikilitaş, U Yiğit. The effects of vaping electronic cigarettes on periodontitis. *Australian Dental Journal*. 2020; 65: 143-9.

INTRODUCTION

Periodontitis is a group of inflammatory diseases that affect the connective tissue attachment and supporting bone around the teeth.¹ It is widely accepted that the initiation and the progression of periodontitis are dependent on the presence of virulent microorganisms capable of causing disease. Although the bacteria are initiating agents in periodontitis, the host response to the pathogenic infection is critical to disease progression.

Cytokines are defined as low molecular weight proteins produced by one cell acting on another cell within the same perimeter.¹ Cytokines underpin the immune cells and periodontal tissue cells for orchestrating periodontitis and propagating the inflammatory process after bacterial invasion.¹ Interleukin-8 (IL-8) and tumour necrosis factor- α (TNF- α) are important cytokines reported to have higher gingival crevicular fluid (GCF) levels in periodontitis patients.¹

Oxidative stress is an inflammatory process defined as an imbalance between excessive reactive oxygen species production and antioxidant mechanisms.¹ Increased oxidative stress has been associated with the pathogenesis of periodontitis in a rapidly growing body of

research. The most commonly-used stable product for evaluating oxidative DNA damage is 8-hydroxydeoxyguanosine (8-OHdG), and its relationship to periodontitis has been shown.¹ Glutathione peroxidase (GSH-Px) also has an important role in human defence against oxidative stress, which has been reported in the GCF of periodontitis patients.¹

Smoking traditional cigarettes (T-cigs) is well-established as a major risk factor for periodontitis, increasing the risk two to fivefold. It is well-accepted that smoking changes the host's immune response through mechanisms that include the disruption of cytokine and inflammatory mediator production, impairment of gingival vascular function and creating a source of oxidative stress.¹

In recent years, inhaling the vapours of electronic cigarettes (E-cigs) has been gaining popularity among individuals who want to reduce or stop tobacco smoking. Although the use of E-cigs is escalating, there is limited information available regarding the impact of vaping E-cigs on periodontal health. Karaaslan and colleagues reported on a clinical trial that sought to compare the effects of smoking T-cigs, vaping E-cigs and smoking

cessation on GCF levels of and tumour necrosis factor- α (TNF- α), Interleukin-8 (IL-8), 8-hydroxydeoxyguanosine (8-OHdG), Glutathione peroxidase (GSH-Px) and clinical periodontal parameters in patients with periodontitis. It was hypothesized that vaping E-cigs produces fewer harmful effects on clinical and biochemical parameters of periodontitis, compared with smoking tobacco.

MATERIALS AND METHODS

The study consisted of two parts: a clinical examination and gingival crevicular fluid (GCF) sampling of a total of 57 individuals aged between 29 and 39 years.

For enrolment, participants met the following inclusion criteria:

- i). Individuals diagnosed with periodontitis.
- ii). T-cig smokers: those who had smoked for at least 10 years and a minimum of 10 cigarettes per day.
- iii). E-cig vapers: participants who were ex-smokers having smoked more than 10 T-cigs/day for at least 10 years, and had been vaping E-cigs for at least 12 months.
- iv). Former smokers: those who had smoked more than 10 T-cigs/day for at least 10 years in their lifetime and who currently had not been smoking for at least 12 months.

Exclusion criteria included:

- i). Dual-smoking patients (use of both T-cigs and E-cigs). Cigar, pipe and waterpipe smokers.
- ii). Diabetics.
- iii). Non-smokers.
- iv). Patients with any disease that can affect periodontal health.
- v). Patients who had received any periodontal treatment in the last 6 months.
- vi). Alcohol consumers.
- vii). Patients who had taken any drugs which can affect periodontal tissues, such as antibiotics and non-steroidal anti-inflammatory drugs, within the past 6 months.

Participants included according to the above criteria were divided into three groups:

Group I: T-cig smoker periodontitis group consisted of 19 patients.

Group II: E-cig vaping periodontitis group consisted of 19 vaper patients.

Group III: Former smoker periodontitis group consisted of 19 individuals who had quit smoking at least 12 months previously.

The clinical examination of patients assessed plaque index (PI), gingival index (GI), probing depth (PD) and clinical attachment loss (AL). All clinical parameters were measured with a Williams periodontal probe (Hu-Friedy).

Clinical periodontal measurements were obtained from six points around each tooth except third molars. The patients were diagnosed as having periodontitis under these criteria: their interdental AL was detectable at ≥ 2 non-adjacent teeth; their buccal or oral AL

was ≥ 3 mm with pocketing > 3 mm detectable at ≥ 2 teeth and the observed AL could not be attributed to non-periodontitis causes.

Gingival crevicular fluid (GCF) samples were collected one day after the periodontal clinical measurements. Samples were taken from the two deepest pockets in each quadrant, including four maxilla and four mandibular sites, using paper strips (Periopaper) at a similar time of day for each patient.

These strips were inserted into the crevice, not more than 1-2 mm, for 30 s. Strips contaminated with blood were discarded. GCF volume was determined by a calibrated Periotron 8000, and readings were converted to an actual volume (μ L) by reference to a standard curve. The samples were stored in a micro-centrifuge tube for further analysis.

Samples were assessed in duplicate wells and concentrations were estimated. The mean concentration of each marker was calculated, adjusted to GCF volume and expressed as picograms per millilitre. All clinical and biochemical parameters were compared using one-way ANOVA test.

RESULTS

A total of 57 patients, 39 (68.4%) male and 18 (31.6%) female, were included in the study. The mean age of all participants was 35.19 ± 2.23 years ranging from 29 to 39.

In Group I, the mean number of T-cigs smoked per day was 13.68 ± 3.67 and the mean years of smoking T-cigs was 13.95 ± 3.01 . In Group II, the mean years of vaping E-cigs was 2.32 ± 0.75 , the mean years of smoking T-cigs before changing to E-cigs was 12.11 ± 1.52 , and the mean number of T-cigs smoked per day before changing to vaping E-cigs was 12.89 ± 2.54 . In Group III, the mean years of non-smoking was 2.41 ± 0.95 , the mean years of smoking T-cigs before quitting was 12.11 ± 1.70 , and the mean number of T-cigs smoked per day before quitting was 12.11 ± 2.54 .

When comparing the mean number of T-cigs smoked per day between Group I, Group II (when smoking T-cigs before changing to E-cigs), and Group III (T-cigs smoked before quitting), no statistically significant difference was found ($p > 0.05$).

Although there was no statistically significant difference between Group II and Group III, in terms of mean years of smoking T-cigs before vaping and before quitting, respectively, the mean years of smoking T-cigs of Group I was statistically higher than Groups II and III ($p < 0.05$). In addition, there was no significant difference between mean years of vaping E-cigs (Group II) and mean years of non-smoking (Group III) ($p > 0.05$).

Although there were no significant differences among the groups for mean attachment loss (AL), probing depth (PD), and plaque index (PI) ($p > 0.05$), the mean (gingival index (GI) score of Group I (1.53 ± 0.29) was

significantly lower than in both Groups II (1.81 ± 0.30) and III (2.08 ± 0.35), and the mean GI score of Group II was significantly lower than Group III's.

There was a significant difference among the groups for mean GCF volume. Group I's (1.63 ± 0.04) was significantly lower than that of both Group II (1.82 ± 0.03) and Group III (1.95 ± 0.08). In addition, the mean GCF volume of Group II was significantly lower than Group III's.

There was a significant difference among the three groups for mean IL-8 levels. The mean IL-8 level of Group I (70.47 ± 2.76) was significantly lower than those of Group II (77.11 ± 2.38) and Group III (80.11 ± 3.41). The mean IL-8 level of Group II was also significantly lower than that of Group III.

There was a significant difference among the three groups for mean TNF- α level. The mean TNF- α level of Group I (4.20 ± 0.14) was significantly higher than those of Group II (3.41 ± 0.21) and Group III (2.98 ± 0.11), and Group II's level was significantly higher than Group III's.

Although there was no significant difference between Group I (6.41 ± 0.20) and Group II (6.45 ± 0.20) for mean Gash-Px level ($p > 0.05$), the mean level in Group III (6.67 ± 0.21) was significantly higher than those of both Groups I and II.

There was no significant difference among the three groups for mean 8-OHdG level ($p > 0.05$).

CONCLUSIONS

This study demonstrated that both T-cigs and E-cigs had unfavourable effects on markers of oxidative stress and inflammatory cytokines, and that smoking cessation appeared to have a beneficial effect.

Implications for practice

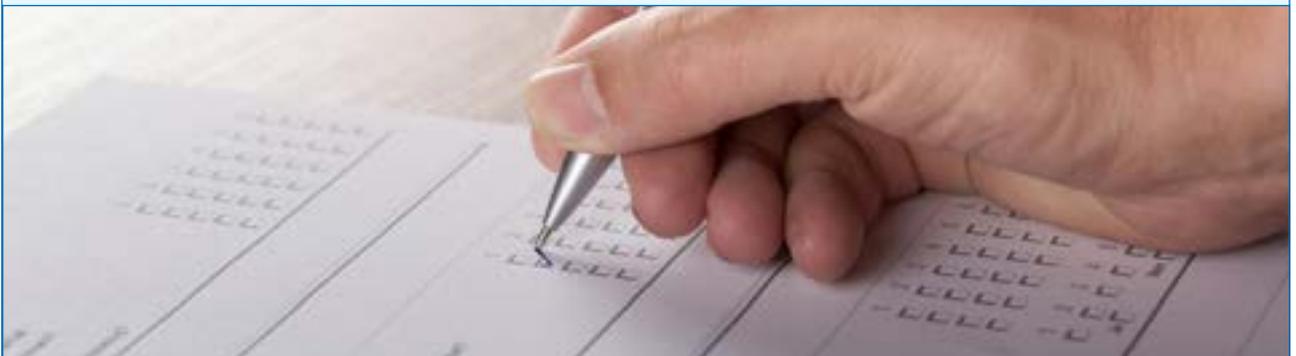
Patients need to be informed that the harmful effect of traditional smoking also applies to new modes of smoking such as Vaping.

Reference

1. Karaaslan F, Dikilitas A, Yigit U. The effects of vaping electronic cigarettes on periodontitis. *Australian Dental Journal*. 2020; 65: 143-9.

Do the CPD questionnaire on page 465

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



Online CPD in 6 Easy Steps

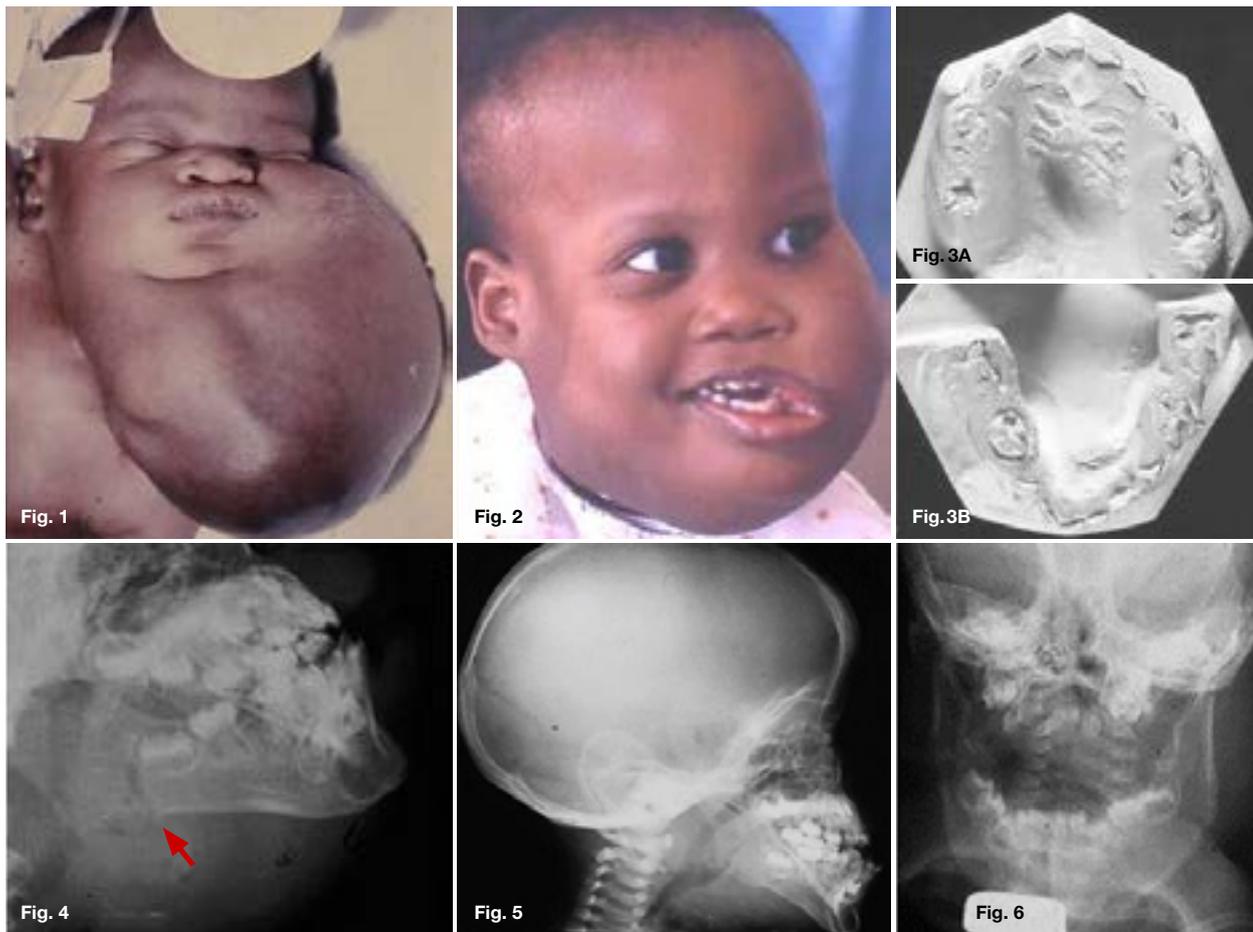
1. Go to the SADA website www.sada.co.za.
2. Log into the 'member only' section with your unique SADA username and password.
3. Select the CPD navigation tab.
4. Select the questionnaire that you wish to complete.
5. Enter your multiple choice answers. Please note that you have two attempts to obtain at least 70%.
6. View and print your CPD certificate.

Maxillofacial Radiology 184

SADJ September 2020, Vol. 75 No. 8 p459

CJ Nortjé

Below are clinical pictures and images of a very rare lesion presenting in the jaws at birth of a female. The patient spend some time in an incubator (Fig.1). Tracheostomy was a lifesaving procedure in this patient. Repeated operations have removed the gross mass hamartomatous tissue but Figure 2 still shows noticeable recurrence of the lesion. Figure 3A and B are study models at two and a half years of age. The jawbones have grown in size. There is a pronounced shift in the midline of both jaws and their dentitions towards the right and away from the lesion. What are the important radiological findings?



INTERPRETATION

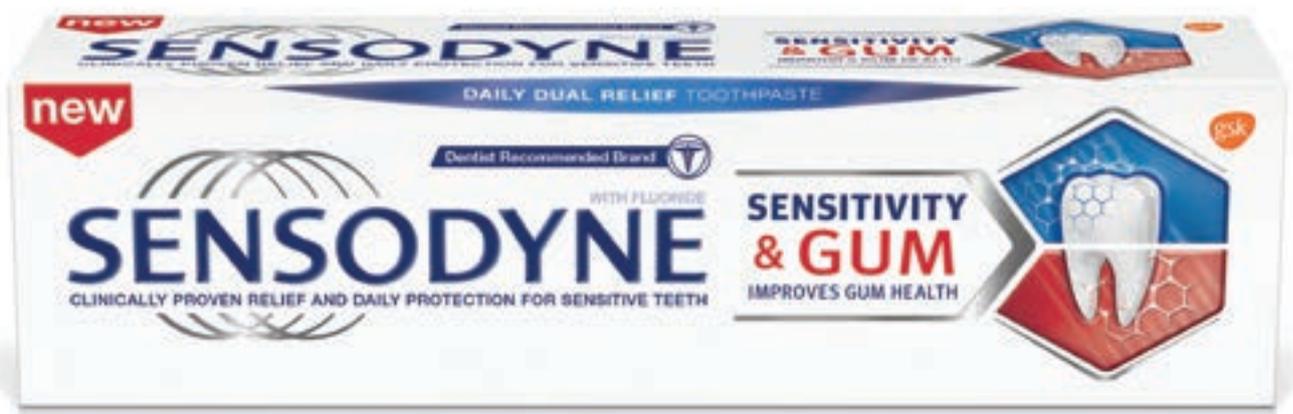
The lateral oblique radiograph (Fig. 4) of the patient shows an irregularity (red arrow) in the outline of the lower border of the mandible just anterior to the angle. The lateral cephalograph (Fig. 5) show that the deciduous molars are in a Class III occlusal relationship, but the patient has a Class II skeletal pattern. The postero-anterior skull radiograph (Fig. 6) of the patient shows that the lesion is much smaller following repeated surgery but the mandibular asymmetry remains without any reduction in intensity or strength. A histological diagnosis of cervical cystic lymphangioma (Cystic Hygroma) was made. The cystic hygroma are one of the most commonly presenting lymphangiomas.

They are benign congenital malformations of the lymphatic drainage system that typically form in the neck, clavicle, and axillary regions. Although several series of cystic hygromas have been reported little is known about the effects this condition has on the mandibulo-facial region. Mal-development of the jaws and consequent dental malocclusion is a possible complication of the condition. In planning the treatment of such patients, maxillofacial surgeons and orthodontists should be consulted at an early stage. Treatment of choice is complete excision, but where vital structures are involved repeated sub-total excisions are advocated.

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Reference

1. Farman AG, Katz, Eloff J, Cywes S. Mandibulo-Facial aspects of the Cervical Cystic Lymphangioma (Cystic Hygroma). British Journal of Oral Surgery. 1978-79; 16: 125-34.



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Consent and confidentiality in children

SADJ September 2020, Vol. 75 No. 8 p462 - p464

LM Sykes¹, E Crafford²

INTRODUCTION

Confidentiality is central to the establishment and preservation of trust between a doctor and their patient, yet is one of the lesser-discussed principles of medical bioethics. A “duty of confidence arises when one person discloses information to another in circumstances where it is reasonable to expect that information to be held in confidence”.¹

Its moral basis is in that it should improve patient welfare, and as such, it is encompassed during all aspects of the treatment process, beginning with the initial consultation where patient autonomy and informed consent are first addressed.

Obtaining consent

Ethically, there are three key elements required for valid consent:

1. Threshold elements entail the patient being sufficiently competent to understand and make a voluntary decision.
2. Information elements relate to the dentist's duty to disclose all relevant information, as well as to recommend an appropriate plan of action.
3. Consent elements refer to the patient's ability to decide for or against the treatment and to authorise it.² Meeting these criteria involves a two way communication process wherein the clinician must first establish the patient's desires, and then provide them with adequate relevant and trustworthy information, in a clear and understandable manner in order for them to make an educated decision.

The General Dental Council (GDC) guidelines state “The clinician must obtain valid consent before starting any treatment or investigation regardless of whether they are the first member of a team to see the patient or involved after other team members have already seen them.



They should find out what the patient wants to know and provide clear answers to these queries, as well as added information on other pertinent issues they think patients should be aware of. This includes treatment options, risks and potential benefits, costs and time involved, the likely prognosis and guarantees, and the consequences of no treatment. They should also recommend the option they deem to be most suitable and in the patient's best interest, and then allow the patient sufficient time for consideration before making their final decision.³

Throughout this process the patient must be guaranteed of full honesty and confidentiality. Practitioners need to be aware that during this interaction they will gain access to personal information that places them in a position of power over their patients. This privilege must never be forgotten or abused by them disclosing any information or confidences without the knowledge and explicit consent of the patient.⁴

While it goes without saying that a patient's privacy and dignity needs to be respected at all times, confidentiality is not absolute. Besides it being an ethical issue, it is also a legal obligation⁵, and as such there are legitimate exceptions where disclosure may be allowed.

These include:

- When the patient has consented.
- When instructed by a court of law.
- When it is in the public's interest.¹
- If they pose a danger to themselves or to others.
- In a deceased patient, with the written consent of his or her next-of-kin or the executor of their estate, and in the case of a minor under the age of 14 years, with the written consent of the parent or guardian.⁴

This last proviso raises a question regarding the rights of children.

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2. **Elmine Crafford:** Second author - 40%

Confidentiality and consent in children

The Childrens' Act of the Medical Dental Protection Society states that "Every child has the right to confidentiality regarding his or her health status, except when maintaining such confidence is not in their own best interest" (MDP act 28).⁵ Thus, in a situation where a child wishes to withhold sensitive information from their parents, this right to confidentiality should be allowed if the child is deemed to be mature enough and it is in their best interest to not disclose.¹

Ethically however, the doctor still has a duty to try and persuade the child to inform their parents or to allow them to do so. However, if they suspect that the child may actually be at risk from their parents, then they have a responsibility to inform the relevant authorities.¹

Note: *there is a distinction between "In the public interest, and what the public is interested in".¹*

Public curiosity is not a justifiable reason to breach confidentiality.

In SA there are laws regarding the age of responsibility, which were drafted to protect minors. The "Bill of Rights" defines a 'child' as 'a person under the age of 18 years'. This allows all people under the age of 18 years to the protection guaranteed by section 28 of the Bill of Rights and the provisions of the Children's Act.⁶

It is also the age below which parental consent is needed for most activities. However, there seems to be duplicity in the legislature on some issues particularly relevant to SA where children below the age of 18 are allowed to make their own decisions.

Examples include:

The age at which a child can consent to an HIV test or his/her own vaccination (12 years), age at which a child can agree to donate his/her body or any specific tissue in the event of his/her death (16 years), age at which a person can consent to donate his/her organs (e.g. kidneys) while alive (18 years), and age at which a male child can consent to being circumcised or a female child can consent to a virginity test (16 years).

In terms of criminality, the age at which a child can be tried and convicted for a criminal act varies depending on the situation and the offence in order to protect them from strict punitive sentences.⁷ "Children under the age of criminal responsibility are not treated as criminals",⁸ although in South Africa *Doli Incapax* is set at the low age of 12 years.⁹

How then is it that a child cannot consent to their own dental treatment, and where does this leave a dentist who has been requested to carry out a specific procedure, but the child explicitly asks that their parents are not informed? Not only do they have to get parental consent legally, but more than likely the parents will also be the ones responsible for paying the accounts. This may result in situations where ethical and legal arguments collide. The following hypothetical case scenario is used to illustrate a debate around an ethico-legal dilemma.

Case scenario

A teenage girl presents for dental treatment and requests that you place 4 anterior veneers on her maxillary incisors. While acknowledging that you are not a trained psychologist, it becomes very clear from the discussion that she has a low self-esteem, which seems to have stemmed from her self-consciousness about her smile.

Despite being clearly distressed and anxious, she presents with a mature understanding about the procedure, including the risks, benefits, and aesthetic limitations. She also explicitly asks you to not inform her parents about your discussion or the proposed treatment. As an ethical practitioner you are obliged to respect both her autonomy and request for confidentiality. However, she is still legally a minor thus in addition to her assent, you still need to obtain parental consent. How will you handle this situation in each of the following, slightly differing, circumstances?

1. In your opinion, the treatment is not necessary from a cosmetic perspective and does not justify preparation and sacrificing of sound enamel on 4 virgin teeth. It would be prudent to refuse treatment, thus also making it easier to avoid any ethical dilemmas about informing the parents and breaching confidentiality.

Best practice would be to acknowledge her aesthetic concerns, but educate her about the procedure, and the unnecessary risks to sound tooth structure. Advise her to wait until she is 18 years old, when she may re-consider her request from a more mature perspective.

2. You agree that the veneers could improve her smile significantly, and are confident that you can carry out the procedure with minimal tooth preparations being needed. However you will need parental consent to commence as well as to ensure they are able and willing to pay for the clinical and laboratory costs?

If you inform them, you will be breaking the patient's trust and going against her strict requests. You fully believe this intervention will be of physical and psychological benefit to her, and are confident that the parents will agree to the proposed treatment. It would be easy to justify this breach in confidentiality by arguing that the potential beneficence outweighs the "indiscretion".

In addition, her autonomy will still have been respected. It would be tempting to argue that despite her initial upset, she will "probably be very happy later". Can you make these assumptions? Does this make it ethically justifiable to disregard her privacy? Should you rather refuse treatment until such time as you are able to gain parental consent?

3. You have the same deliberations as in scenario 2 above and decide to go ahead and speak to her parents. Sadly this time they refuse to give permission despite your persistence that the veneers will have both psychological and aesthetic benefits, and will be minimally invasive. In this situation, she will have endured a broken promise, a breach in confidentiality, and a loss of trust on top of the disappointment of not

being allowed her desired treatment. The patient may react with anger, frustration or rebellion towards the dentist and/or her parents, could become more depressed and self-conscious, or may exhibit any number of other psychologically destructive behaviors. Can you afford to take these risks?

DISCUSSION

This case scenario was merely an example to illustrate the many factors that can come into play when dealing with issues of consent and confidentiality, particularly in minors. However there could be many other instances where an adolescent may request confidentiality such as for bleaching, minor orthodontic tooth movement, extraction of an unaesthetic retained deciduous tooth or a mal-aligned permanent tooth or for closure of diastema.

All of these procedures carry a low risk and are minimally damaging physically, but could have major psychological benefits for the youth. At the same time, they may have already approached their parents about the issue and met with a negative response, or could have been too embarrassed to discuss their concerns out of a fear of being considered vain and self-obsessed.

They may even feel guilty about asking for cosmetic procedures especially if they know it not essential and will have financial implications for their parents. The dentist then finds themselves in the middle of a complex dynamic where they are willing and able to help the child, but at the same time have an obligation and legal duty to obtain parental consent.

A slightly different but related challenge is seen, but not restricted to situations where the parents are divorced, and one agrees to the treatment while the other refuses. The question then arises as to who has the final say? Is it the father, the mother, the parent who has custody or the one who will be paying for the treatment?

According to the South African law, "Minors under the age of fourteen or eighteen years need the consent of their parents or guardians to medical treatment or operations respectively.

In the event of a conflict between the child's father and mother, the father's views settle the matter unless they go against the child's medical interests. Where the parents or guardians have delegated their power to consent to medical interventions upon their children to persons acting in loco parentis, such as relatives or teachers, the latter's consent suffices. The supreme court is also vested, as the ultimate guardian of minors, with the power to authorize the intervention in question".¹⁰

Thus in the situation of elective dental treatment for a minor, if the two parents cannot reach a compromise, the child may become the innocent pawn and be denied help based on the law rather than what would be in their best interest psycho-socially. We as dentists are not trained psychologists, however as health care practitioners we have a duty to consider the child's best interests, and should perhaps refer the family for joint counselling.



CONCLUSION

As is often the case in ethical and legal debates, there are many grey areas. While the law may dictate that a practitioner follows a specific course of action, they may not feel ethically comfortable complying with this. The dilemma revolves around which master to obey. Does acting in the patient's best interest trump adherence to the law?

This paper cannot answer these questions, but seeks to alert practitioner to be cognizant of the complexities within medico-legal ethics. As professionals we should be encouraged to constantly challenge our own thoughts and beliefs, and be modest enough to engage in collegial deliberations with colleagues or other knowledgeable experts whenever we ourselves are unsure.

References

1. Blightman, K, Griffiths SE, Danbury C. Patient confidentiality: when can a breach be justified? Accessed at: <https://academic.oup.com/bjaed/article-abstract/14/2/52/271401>. Accessed on: 28-04-2020.
2. Beauchamps, T and Childress, JF. Principles of Biomedical ethics. 5th edition. Oxford University Press. 2000.
3. General Dental Council. Guidelines for doctors: confidentiality. Accessed at: <https://www.gdc-uk.org/>; Accessed on 26-04-2020.
4. Health Professions Council of South Africa Guidelines for Good Practice in the Health care Professions as promulgated in the Government Gazette R717. 2006; (2nd ed.) B. Booklet 2; Section 13. Professional Confidentiality.
5. Medical Protection Society. Respect for patient confidentiality. Accessed at: www.medicalprotection.org/advise-booklets/respect. Accessed on: 28-04-2020.
6. Bill of Rights of the Constitutional Court of South Africa. Accessed at: <https://www.concourt.org.za/index.php/constitution/your-rights/the-bill-of-rights>. Accessed on: 06-05-2020.
7. Mahery P, Proudlock, P. Legal guide to age thresholds for children and young people. Children's Institute, University of Cape Town: University of Western Cape, 2011.
8. Skelton A, Badenhorst, C. The Criminal Capacity of Children in South Africa. International Developments & Considerations for a Review. The Child Justice Alliance, c/o The Children's Rights Project, Community Law Centre: University of Western Cape. 2011.
9. Cipriani D. Children's Rights and the Minimum Age of Criminal Responsibility. Publishing A, editor. Accessed at <https://books.google.co.za/books?isbn=1409496635>. on 07-07-2015. Ashgate Publishing, Ltd. 2013; 252.
10. Carstens PA. Informed Consent in Medical law. The South African Medico Legal perspectives. Accessed at: new.saml.co.za/node/354. Accessed on 19-02-2020.

CPD questionnaire

This edition is accredited for a total of 3 CEUs: 1 ethical plus 2 general CEUs

GENERAL

Lip height estimation in a southern African sample

- Choose the CORRECT option. What skin changes are NOT attributed to adult facial ageing?
 - Reduction in skin elasticity
 - Reduction in muscle tone and volume
 - Increased skin density
 - Decreased prominence of the vermillion border
- Choose the CORRECT option. What factor would least likely cause dental root resorption?
 - Consuming soft foods
 - Teeth grinding habits
 - Genetics
 - Excessive orthodontic force on the teeth
- Choose the CORRECT option. What is a reliable 3-dimensional scanning technique for bone in a living face?
 - X-ray
 - Cone-beam computerised tomography
 - Laser surface scanning
 - Ultrasound

Skeletal morphologic features of Anterior Open Bite Malocclusion amongst black patients visiting the Medunsa oral health centre

- Choose the CORRECT option. Anterior open bite (AOB) malocclusion is described as:
 - Lack of overlap of anterior teeth in the horizontal dimension
 - Forward positioning of anterior teeth
 - Inability of anterior teeth to make contact in the vertical dimension
 - Upper anterior teeth which bite lingual of the opposing teeth
- Choose the CORRECT answer. The aetiology of AOB:
 - is genetic, environmental and anatomic factors
 - is purely due to environmental factors
 - is due to anatomic factors such as an enlarged tongue
 - is multifactorial and includes all factors mentioned in A, B and C
- Which is the CORRECT statement. Treatment of AOB:
 - is varied and complex and there is no agreed protocol
 - only involves the use of removable appliances
 - only involves surgery to section the two jaws and fixate them together
 - is a combination of B and C methods above

- Select the CORRECT answer. A prolonged mouth breathing pattern:
 - may lead to development of anterior crossbite malocclusion
 - may lead to development of a vertical skeletal growth pattern
 - is the cause of most Class II Div 2 malocclusion
 - may create a severe tooth size arch size discrepancy
- Choose the CORRECT statement. The following were the findings of this study:
 - The Upper Facial Height (UFH) of females with Class II and III AOB is larger
 - Mean values of control samples of male and females differed significantly with males presenting with larger values than females
 - The gonial angle is decreased in Class II and III male subjects with AOB
 - Patients with AOB had a lower vertical facial pattern in all classes of malocclusion.

Development of a radiographic dental implant guide for identification of dental implant types

- Choose the CORRECT statement. Dental implant types can be identified using mainly:
 - The lining of the thread
 - The morphologies of the apex, thread and neck of the dental implant
 - The morphologies of the neck, lining and radiographic appearances
 - None of the above
- Which of the following statements is CORRECT:
 - It is not useful to obtain angulated radiographic images of dental implants to assist in a positive identification of the dental implant type
 - It is not useful to obtain angulated radiographic images of dental implants to provide information on the morphological characteristics
 - It is useful to obtain angulated radiographic images of dental implants to assist in a positive identification of the dental implant type
 - None of the above
- Select the CORRECT answer. Each dental implant was radiographed in an Off Centre (OC) and Severe Off Centre (SOC) position to compensate for:
 - radiographic technique errors that may occur on dental radiographs
 - in-situ* dental implants placed at an angle in the patient's occlusion
 - the possible unavailability of a ST image
 - All of the above

Individual and social determinants of oral health in South Africa in the context of Covid-19

12. Choose the CORRECT statement. Which of the following statements is true?
- The majority of South Africans have adequate access to oral health care
 - There is equitable distribution of dental practitioners in South Africa
 - It is not important to consider sociocultural contexts when delivering oral health care
 - There is minimal integration of oral health with general health at antenatal clinics in SA
13. Choose the CORRECT answer. Which of the following statements are true?
- 56% of South Africans live in poverty and 28% in extreme poverty
 - Social and health problems tend to cluster among impoverished populations
 - Maternal socio-economic factors and undernutrition do not influence the OHRQL of their offspring
 - A and B
14. Choose the CORRECT statement. Which of the following statements is true?
- Infant malnutrition does not affect longitudinal growth of a child
 - Child longitudinal growth is not associated with oral health
 - Treatment of severe caries in children can improve their growth in height
 - Stunting is not associated with later development of cardiometabolic diseases

Diffuse gingival enlargement with stromal calcifications occurring in a background of amelogenesis imperfecta – an oral medicine case book

15. Choose the CORRECT statement. Causes of diffuse gingival enlargement include the following:
- Poor oral hygiene
 - Neoplastic infiltrate
 - Systemic medications
 - Genetic conditions
 - All of the above
16. Choose the INCORRECT statement. All of the following are dental abnormalities that may be seen in patients with amelogenesis imperfecta EXCEPT:
- Malocclusion
 - Diffuse gingival enlargement
 - Pulpal calcifications
 - Sialolithiasis
 - Delayed tooth eruption

Clinical Window: What's new for the clinician?

17. Choose the CORRECT answer. Which one of the following is not an example of a conservative approach to treatment of TMDs?
- Individualized counselling
 - Occlusal splint
 - Surgical treatment
 - Manual therapy

18. Choose the CORRECT answer. In the Melo et al. trial, there was a significant reduction in the pain variable after 1 month of treatment. Select the correct statement below:
- Manual therapy was superior to Individualised counselling
 - Occlusal splinting was superior to Individualised counselling
 - Manual therapy was superior to occlusal splinting
 - No group was better than another group in improving pain
19. Choose the CORRECT statement. In the Karaaslan et al. trial, for clinical measures:
- There were no significant differences among the groups for mean attachment loss (AL), probing depth (PD), and plaque index (PI) and gingival index (GI)
 - There were significant differences among the groups for AL and PD scores but not PI and GI scores
 - There were significant differences among the groups for AL, PD, PI and GI scores
 - There were no significant differences among the groups for mean attachment loss (AL), probing depth (PD), and plaque index (PI)
20. Select the CORRECT statement. The results of the Karaaslan et al. trial, suggest that:
- T-cigs had favourable effects on markers of oxidative stress and inflammatory cytokines
 - E-cigs had favourable effects on markers of oxidative stress and inflammatory cytokines
 - Both T-cigs and E-cigs had unfavourable effects on markers of oxidative stress and inflammatory cytokines, and that smoking cessation appeared to have a beneficial effect
 - T-cigs had improved PD levels

ETHICS

Consent and confidentiality in children

21. Choose the CORRECT option. Consent to dental treatment:
- Must be obtained before any work is commenced
 - Must be re-gained if plans change during the treatment
 - Must take into consideration time and costs of treatment
 - All of the above are correct
22. Choose the CORRECT statement. Laws regarding confidentiality:
- Do not apply to minors
 - Do not apply to deceased persons
 - Do not apply for communications between colleagues
 - Do not apply to issues of public health safety

23. Choose the CORRECT statement. In South Africa, a minor:
- Is anyone under the age of 16 years old
 - Can consent to their own vaccination from the age of 10 years old
 - Can consent to donate an organ from the age of 12 years old
 - May not be tried as a criminal
24. Choose the CORRECT option. Consent to dental treatment:
- Can be waived for minor procedures
 - Depends on the patients having full understanding of the procedures
 - Is not needed if the patient is referred from colleague
 - Is taken as given if the patient requests the treatment themselves
25. Choose the CORRECT answer. Disclosure without consent may be justified if:
- Obtaining consent is undesirable or not possible
 - The individual lacks the capacity to consent
 - The information is being shared with a family member
 - All of the above are correct
 - Only A and B above are correct

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