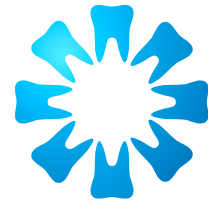


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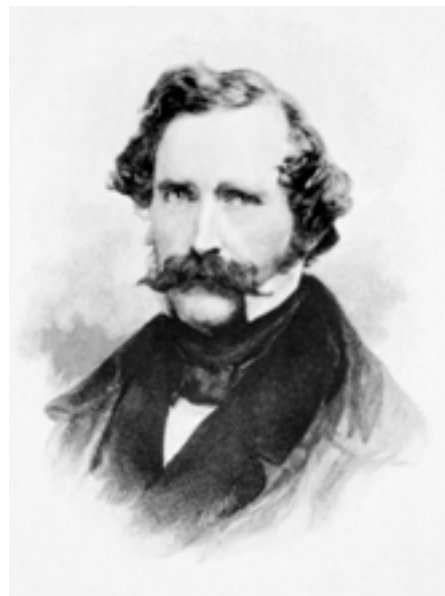
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*Horace Wells and William TG Morton
Pioneers of anaesthesia*



Horace Wells (1815 - 1848) and William TG Morton (1819 - 1868):

Anaesthesia pioneers Well and Morton, both dentists in the USA, are recognised as having first introduced anaesthetic agents to clinical practice. Sadly both had somewhat erratic careers after their initial inspired discoveries, Wells using nitrous oxide, Morton using ether.

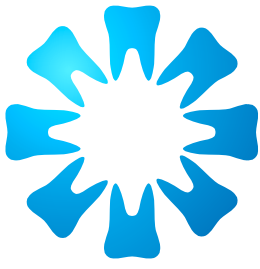


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Our Front Cover for this Issue...

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 March issue draws focus to two dentists recognised as pioneers in anaesthesiology. Read more on page 63.

**Horace Wells (1815 - 1848)****and William TG Morton (1819 - 1868):**

Anaesthesia pioneers Well and Morton, both dentists in the USA, are recognised as having first introduced anaesthetic agents to clinical practice. Sadly both had somewhat erratic careers after their initial inspired discoveries, Wells using nitrous oxide, Morton using ether.



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THE SOUTH AFRICAN
DENTAL ASSOCIATION

Horace Wells (1815 - 1848) and William TG Morton (1819 - 1868) ...pioneers in anaesthesiology

To recount the story of the introduction of anaesthesia into clinical practice is to realise just how influential were the efforts of two dentists who were among the first to realise that pain-free surgery could indeed be accomplished.

William Morton, who was apprenticed to Wells, focused on ether as an anaesthetic agent. In September 1846 he performed a painless extraction and the next month administered ether to a patient from whom a tumour in the neck was painlessly removed.



Horace Wells (1815 - 1848)



TG Morton (1819 - 1868)



A sceptic may argue that it was because dentistry was so severely painful that it was inevitable that dentists would try any remedy to render their treatments more comfortable! Thus it was that in December 1844 a dentist, Horace Wells, attended a public demonstration on the effects of inhaling nitrous oxide.

He observed that a participant under the influence of the Laughing Gas did not apparently feel any pain when he forcefully kicked a wooden bench. Intrigued by the potential, Wells the very next day inhaled nitrous oxide and had his assistant, Dr Riggs, extract a tooth ...painlessly!

Wells gave a public demonstration of the technique to medical students at Massachusetts General Hospital in Boston on 20th January, 1845. The patient did cry out during the extraction, although he later explained he had not experienced any pain. The students jeered and Wells departed forlornly back to Hartford, where he was in practice, with William Morton as his apprentice.

This was in fact the start of a decline for Wells: he closed his dental office nine times and relocated six times between 1836 and 1847. He withdrew from dentistry in 1845 and became a shower-bath salesman.

After moving to New York in 1848, he became addicted to chloroform and under the influence threw sulphuric acid over two prostitutes. In jail for the offence, he slit his femoral artery with a razor and died.

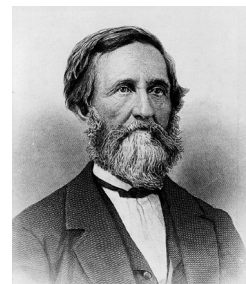
In 1864 the American Dental Association named Wells as the discoverer of modern anaesthesia and he was also recognised by the Parisian Medical Society and the American Medical Association.

Morton then tried to claim a patent for the use of ether. identified in the application as "letheon". The profession decried the approach suggesting it was not professionally justified. Morton persisted with these attempts and also made applications to the United States Government for recompense to the tune of \$100.000. All these approaches failed.

He did perform valuable service in the Army of the Potomac when he was able to administer ether to more than two thousand wounded soldiers, who would be deeply grateful for the relief obtained.

Morton died of a cerebrovascular accident in 1868, and it is recorded that the attending surgeon remarked to his class: "Young gentlemen, you see before you a man who has done more for humanity and for the relief of suffering, than any man who has ever lived."

Now to a disclosure: the contributions of the two dentists notwithstanding, but in 1842, a medical practitioner, Crawford Williamson Long, employed ether as an anaesthetic, preceding our champions! He published only in 1849 although he had demonstrated the technique several times to surgeons.



Whoever may take the credit finally, all dentists are indebted to these pioneers who have made the burden of Dentistry a little easier to bear.

With thanks to Prof Bill Evans

Dealing with COVID-19

SADJ March 2020, Vol. 75 No. 2 p64

NH Wood



We are now facing several cases of COVID-19 (atypical pneumonia) in our country's borders. This disease is caused by the SARS-CoV-2 virus¹, a large RNA virus in the order Nidovirales, family Coronaviridae, subfamily Coronavirinae.² Due to its newly-emergent status, there is currently no targeted treatment against SARS-CoV-2.

Although the disease burden in South Africa is quite different from other countries, the infection control and hygiene measures advocated to limit spread of the SARS-CoV-2 virus can still be applied effectively to prevent a spectrum of infectious diseases from spreading.

These are some key points that need to be taken into consideration when dealing with COVID-19:

Physical contact and droplet spread are the main modes for transmission of SARS-CoV-2. Therefore, avoidance of physical contact is the first line of defence.¹ Close proximity to a person showing signs of disease should also be avoided, and the World Health Organization (WHO) recommends a 1 meter minimum distance.³ However, once present on the skin, the virus still requires entry into the body to infect cells and cause disease.

Regular and thorough hand-washing is strongly recommended: The SARS-CoV-2 virus has a lipid bilayer which it obtains from budding from the host cell's endoplasmic reticulum and golgi-complex.²

This lipid bilayer is susceptible to competitive amphiphiles found in soap.⁴ Soap manipulates the solvent interaction with the lipid bilayer, disrupting the normal architecture and inducing micelle formation. Once the viral membrane is compromised, the structure is no longer viable and therefore not infectious.

Limiting the spread of droplets during coughing or sneezing is another important hygiene practice to limit spread of infectious organisms. The use of face-masks is not only to prevent the dispersion of large droplets, but also to prevent the user from touching the face.⁵ Another WHO recommendation is not to touch your face, especially when you have not yet washed your hands.³

Should the virus gain entry into the body via mucosal surfaces or otherwise, it requires receptor-activation for cellular uptake. Angiotensin-converting enzyme 2 (ACE2) is expressed in the lower respiratory tract, and is a receptor used by the virus to gain entry into the cell. In other sites such as the lungs, liver and small intes-



tine, a protein found on the host cell surface called furin interacts with viral membrane proteins and is the necessary first step for infection.⁶ These receptor interactions are therapeutic targets currently under investigation, and vaccine development is also ongoing.

Finally, be aware of the signs and symptoms that indicate a possible case of COVID-19. These include onset symptoms such as fever, a dry cough, and fatigue which may progress to acute respiratory distress syndrome.⁷ Have yourself checked out if at any point you suspect you may have been exposed.

A sincere word of thanks to our contributors for the stimulating content for this month's edition. We invite you to join us for the 2020 SADA congress taking place in Johannesburg on the 28th-30th August, and look forward to productively engage with you.

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SADA Head Office - Key issues discussed with the Ministry of Health

SADJ March 2020, Vol. 75 No. 2 p65 - p66

KC Makhubele



On the 28th January a SADA delegation made of Prof P Moipolai (*President*), Dr N Osman (*Vice Chairperson*), Mr KC Makhubele (*CEO*) and Mr P Govan (*Head of Legal & Corporate Governance*), had the privilege to meet the Ministry of Health: Hon. Dr. Zweli Mkhize (*Minister of Health*), Hon. Dr. Joe Phaahla (*Deputy Minister of Health*) and Sibusisiwe Magubane-Zulu (*Chief of Staff*).

Some of the key issues that were discussed included the following:

National Health Insurance (NHI)

1. It was reinforced that SADA and the other stakeholders in oral healthcare were committed to contributing meaningfully to the aims and objectives of NHI. Although SADA fully supported and expressed commitment to the proposed NHI, we were concerned that the Green Paper, White Paper and even the NHI Bill (2019) made little or no mention of oral health.
2. SADA, together with professional associations representing dental therapists, oral hygienists, dental assistants, and dental technicians advised the meeting that a joint submission together with the academic institutions was made on the proposed contribution that key oral health players are able to make to NHI.
3. The role of the dentist and dental specialist in the NHI environment was highlighted, and we made a point that this required further discussion. The role of the dentist in the public service provision was also highlighted, and was reinforced by indicating that that early detection and prevention in oral healthcare contributes to overall health.
4. SADA would like to see proper integration of dentists in primary healthcare systems and facilities as envisaged in the NHI. To this end we are willing to assist in the formulation of clinical protocols and guidelines with the Benefit Advisory Committee. Keeping this in mind, SADA also raised key concerns around the Certificate of Need.
5. It was appreciated that key information and details would be made available in the regulations and when the work of the establishment of the Fund was completed.

6. The Hon. Minister expressed his encouragement by our support and urged SADA to continue to make submissions and contribute to protocols and guidelines when called upon to do so. In addition, he suggested that SADA reinforce its support for NHI on television interviews and radio slots.
7. We indicated the need for the decision- and policy-makers to properly engage our profession with the need for formal meetings with the minister. The Hon. Minister responded by saying that he would like SADA to engage with the Ministry on all matters relating to oral health, and that he is committed to ensure the obviating of the feeling that Oral health is neglected by the ministry and sub-structures.

He indicated that, as he meets with SAMA, he wants to have a similar relationship with SADA, and expressed appreciation that we have taken the step to meet and engage with the ministry.



Invitation to 2020 SADA Congress

1. During our meeting it was mentioned that the Deputy Director General for Health, Dr Anban Pillay, was kind enough to attend the 2019 Congress and present on the NHI which was most useful.
2. The CEO extended an invitation to the Minister of Health to attend the 2020 Congress, which will only serve to infuse and encourage oral health care workers and the industry.
3. The Hon. Minister indicated a commitment, with time willing, to attend, or at least to send a delegate from the Department of Health. The CEO undertook to send a formal invitation for the Minister's office to diarise.

Challenges facing Community Service for dentists

1. The present difficulties of dental graduates in finding community service posts was highlighted as a pressing issue. In addition, many of the facilities that these dentists were assigned to, did not have proper equipment or materials and, as a result, they were carrying out extractions predominantly without providing restorative or rehabilitative services.
2. In some cases, these community service members were unsupervised. As these dentists were carrying out limited procedures there was a loss of clinical skills and dexterity.

SADA proposed that the Department consider permitting community service to be performed in private establishments in addition to the public sector. That a similar project is presently run by the Pharmacy Council.

3. The Hon. Minister was encouraged by these proposals but express concerns about access of the public to these services, remuneration, and materials.
4. The Hon. Minister showed concern about the lack of funded posts and suggested that an urgent submission must be made to him, with concrete proposals and suggestions to remedy the current state of affairs. That this issue then be brought up for urgent discussion to find a solution to this problem.



Challenges created by the Radiation Licensing and Testing regulations

1. SADA highlighted the present problems experienced by dentists who require licensing of their radiographic and imaging equipment. Although a lack of personnel is a factor, this is exacerbated when new practices are opened or when equipment is being replaced, when due to these licensing delays, practitioners are prejudiced and compromised in the treatment of their patients.
2. It was also highlighted that the legal process followed when introducing regulations for compulsory testing of radiographic and imaging equipment owned and operated by dental professionals was flawed, as the radiation doses were minimal and was not considered by those drafting these regulations.

3. SADA would like the ministry to regularly engage the profession and reevaluate the need for such regulatory provision with an intent to set aside and if need be re-starting the process.
4. The Minister was not aware of this and suggested that proposals be presented.



The motivation for a separate Regulatory Council

1. The CEO touched on the Commission (Ministerial Task Team) investigating the HPCSA and the efficiency of the regulatory body in its mandate of guiding the profession.
2. We also mentioned that discussions were held with the former Minister and SAMA when proposals were made for the Ministry to consider establishment of a separate regulatory council for doctors and dentists.

The Hon. Minister indicated he was aware of this matter. He indicated that SADA and SAMA should submit a joint proposal for him to evaluate. SADA indicated that their stance is to support the recommendation made by the Ministerial Task Team for a separate council looking after the needs of dentists and medics.

3. SADA indicated that, together with SAMA, we would seek another meeting to discuss the issue of the separate Council.

We are expecting further meetings with the ministry in the future and will communicate our progress and any further developments in these matters to you, our members, timeously.

Examining the relationship between Dental Technology students' learning styles and their performance in entrance tests

SADJ March 2020, Vol. 75 No. 2 p67 - p71

A Vahed¹, F Ally²

ABSTRACT

Introduction

Selection tests provide early indications of prospective students' competencies, skills and knowledge.

Knowledge of students' learning styles and their correlation to entrance tests can contribute to the debate on student retention and attrition rates in higher education, which have been dominant research focus areas in the past decade.

Aim and objectives

To investigate the relationship between Dental Technology students' learning styles and their performance in entrance tests at the Durban University of Technology.

Design

A retrospective cohort study design within a quantitative framework was used.

Methods

The 2019 first year students completed the VARK® questionnaire, which was used to determine their learning styles. The VARK results were compared against the data obtained from entrance tests. Cross tabulations and Fisher's Exact tests ($p < 0.05$) were used to analyse the data.

Results

Despite there being no correlation between students' performances in entrance tests and their preferred

learning styles, the most dominant learning styles among Dental Technology first year students were unimodal (kinaesthetic) and quadrimodal (VARK).

Conclusions

This evidence-based data is critical in developing more appropriate student selection and placement tests for the Bachelor of Health Sciences in Dental Technology, and other similar programmes.

Keywords

VARK, learning styles, Dental Technology, selection tests.

INTRODUCTION

Dental Technology is characterised as a region^{1,2} as it hinges at the interface between disciplinary knowledge and the field of professional practice. The teaching, learning and assessment of Dental Technology should facilitate connecting the discipline-specific theory to laboratory based practice in order to design and fabricate intra-oral prostheses.³⁻⁷ Dental Technology students therefore require both knowledge and skills, and are generally selected for this profession possessing both attributes.

Awareness of students' learning styles and its correlation to entrance tests can therefore contribute to the debate on low student retention and increased attrition rates in higher education, which have been dominant research focus areas in the past decade.⁸⁻¹¹

James, D'Amore and Thomas defined learning styles as the habitual manner of gaining knowledge, skills or attitudes through study and experience.¹² Fleming and Mills' "Visual, Aural, Read/Write and Kinaesthetic" (VARK) model is a meta-strategy to understand undergraduate student learning preferences, particularly as a way of improving student retention rates.¹³

Visual learners prefer to see information and use visual aids. Aural learners, by contrast, prefer to listen and speak before reading and writing. Read/write and kinaesthetic learners tend to continually read and write the information and learn by doing and performing tasks respectively.^{14,15}

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1. **Anisa Vahed:** Conception and design, data analysis and interpretation, drafting and revising of paper. - 55%
2. **Fazila Ally:** Data collection, data interpretation, drafting and revising of paper - 45%

Importantly, several other authors have argued that understanding the learning styles of students, especially when they enter higher education, can enable both lecturers and students to reach the desired outcomes of the curriculum.¹⁶⁻¹⁹

This is pertinent in Dental Technology as prospective first year students are required to complete a set of entrance test comprising of manual dexterity and the Standardised Assessment Test for Access and Placement (SATAP) tests.

Ultimately, knowledge of learning styles could be used to increase the self-awareness of students and lecturers whilst potentially alerting them to their weaknesses and strengths.¹⁷

Using a retrospective cohort study design within a quantitative framework, this study aimed to investigate the relationship between Dental Technology students' learning styles and their performance in entrance tests at the Durban University of Technology.

The evidence-based data will assist the Dental Sciences department to develop improved selection and placement tests for the Bachelor of Health Sciences in Dental Technology programme, which is to be implemented in 2021.

OBJECTIVES OF THE STUDY

- To ascertain the learning styles of first year Dental Technology students using the VARK questionnaire.
- To compare and evaluate the VARK results against student performances in the entrance test in order to improve the student selection process and academic teaching practices.

METHODOLOGY

Study design and sampling

A retrospective cohort design within a quantitative framework was used to examine the relationship between dental technology students' learning styles and their performances in entrance tests. Creswell defined a quantitative method as a process of collecting, analysing, interpreting and writing the results of a study.²⁰

The study followed a positivist paradigm. A positivist approach enables one to present the discipline sufficiently and rigorously as scientific experts, providing the platform to make strong claims on reliability and objectivity.²¹

A purposeful sampling technique was used. The target population was the 2019 first year Dental Technology students (n=47) from the first year Dental Technology extended curriculum (n=29) and mainstream (n=18) programmes at the Durban University of Technology (DUT). Vahed and Cruickshank clarified that there are two entry routes into the Dental Technology programme, that is, through the mainstream programme and through the extended curriculum programme (ECP).²²

Consequently, the minimum time for completion of the National Diploma qualification is three years for mainstream students and four years for ECP, as their first year of study extends over two years.

In light of this, it must be noted that there were 10 ECP Level 1 students who had applied for the Dental Technology programme in 2018. The 19 ECP Level 2 students were the 2017 applicants and were part of the 2019 main-stream class.

Ethical considerations

Ethical clearance and permission to conduct the study was obtained from DUTs Institutional Research Ethics Committee (IREC153/16). Permission to conduct the questionnaires was obtained from the Academic Head of Dental Sciences. Informed consent was sought from the participants.

Data collection and analyses

The VARK® (Version 7.8) questionnaire, which consists of 16 multiple choice questions, was administered to the students.

Each question has four options that correspond to the four sensory modality preferences (i.e. Visual, Aural, Read/Write and Kinaesthetic), which determines students' learning styles. As noted by several authors students can select one or more choices based on the sensory modalities they prefer when learning.^{15,19,23}

This was clarified to the Dental Technology students during data collection, who were encouraged to choose the option(s) that best suited them. The VARK questionnaire scoring sheet was used to calculate the learning style scores.

The results from the VARK® questionnaire were compared against the data from the entrance test results, which were extracted from the academic records and programme files located in the Dental Sciences department. These records included:

- Students' manual dexterity scores for four sections, which are drawing, carving, stone block and plasticine. Each section tested students' visual, hand dexterity, listening and communication skills, as well as their ability to follow instructions.
- The SATAP results, which included the scores for Academic Literacy, Mathematics (Maths A and Maths B), Science, and an essay. A point that deserves to be mentioned is that two hour Academic Literacy paper aims to test the ability to use language in an academic context by testing reading, comprehension and writing.

The Maths A section focuses on the numeracy and abstract mathematics content. The Maths B section, by contrast, tests understanding and comprehension of Mathematics. The 1.5 hours Science test assesses the scientific literacies expected of students entering higher education.²⁴

Descriptive statistics (frequency, percentage, mean) and inferential statistics (correlations and cross tabulations) were used to analyse the data (SPSS® Version 25.0). The statistical significance of the results was determined using Fisher's Exact test ($p < 0.05$). Validity and reliability of the VARK questionnaire has been established in previous studies.¹⁹

RESULTS

The students' response rate in this study was 92.2%, which is deemed highly acceptable. There was no significant difference ($p = 0.303$) in the frequencies of students' learning preferences.

From the 47 Dental Technology students (18 males and 29 females) who participated in this study, 17 (36.2%) preferred a unimodal and 30 (63.8%) multimodal learning style. Among the multimodal group of students, 11 (23.4%) were bimodal, 8 (17%) were trimodal and 11 (23.4%) were quadrimodal learners.

Among the unimodal learners, 1 (2.1%) student preferred the visual, 3 (6.4%) preferred the aural, 1 (2.1%) the read/write and 12 (25.5%) preferred the kinaesthetic modes of information processing.

From the students who preferred the bimodal information style of processing, 1 (2.1%) preferred the visual and read/write (VR) style, 4 (8.5%) preferred the visual and kinaesthetic (VK) style, 5 (10.6%) preferred the aural and kinaesthetic (AK) style and 1 (2.1%) preferred the aural and read/write (AR) style.

Of the students who preferred three modes (trimodal) of information processing, 3 (6.4%) preferred the visual, aural and kinaesthetic (VAK) style, 1 (2.1%) preferred the visual, read/write and kinaesthetic (VRK) style, 4 (8.5%) preferred the aural, read/write and kinaesthetic (ARK) style. Eleven (23.4%) students preferred the visual, aural, read/write and kinaesthetic (VARK) modes of information processing.

A significant difference ($p < 0.001$) was noted between the learning styles of first year Dental Technology students.

As presented in **Figure 1**, the most common VARK mode distribution among students was kinaesthetic (26%), followed by visual, aural, read/write and kinaesthetic (VARK) (24%) and then aural and kinaesthetic (AK) (11%).

Of the 47 students surveyed, 24 (52.2%) students attended the entrance test in 2017 which consisted of the SATAP (Academic Literacy, Science, Numeracy) and manual dexterity (Bite block and Plasticine) tests. In 2018, 22 (47.8%) students attended the entrance test, which consisted of the SATAP (Academic literacy, Science, Math A, Math B, Essay) and manual dexterity (Drawing, Stone block and Carving) tests.

The significant difference ($p < 0.001$) in the Academic Literacy section was noted with 20 (43.5%) students achieving above average scores between 60-69%, followed by 17 (37.0%) students who obtained scores between 50-59%, and 1 (2.2%) student achieving a

score between 80-100%. There was a significant difference ($p < 0.001$) for the Science section with 4 (8.7%) students obtaining scores between 70-79%, 26 (56.5%) between 50-59%, while 2 (4.3%) obtained between 30-39%. There was a significant difference ($p < 0.030$) in the Maths A section with 1 (4.5%) student obtaining scores between 70-79% and 9 (40.9%) between 40-49%.

The scores in the SATAP sections were also significantly different ($p < 0.001$) with 1 (2.2%) student scoring between 70-79%, 30 (65.2%) between 50-59% and 13 (28.3%) students between 40-49%. The plasticine section of the entrance test had a significant difference of $p < 0.001$ where 7 (29.2%) students obtained scores between 80-100%, 30 (50%) between 60-69% and 2 (8.3%) between 40-49%.

There was a significant difference ($p < 0.001$) for the stone block section with 5 (22.7%) students obtaining scores between 80-100%, 11 (50%) between 50-59% and 1 (4.5%) between 30-39%. Ultimately, and in considering the total scores achieved in the manual dexterity sections, 11 (23.9%) students obtained the highest scores between 70-79%, 16 (34.8%) between 60-69% and 4 (8.7%) obtained scores between 40-49%.

There was no significant difference however, in the manual dexterity sections ($p = 0.052$) and SATAP tests ($p = 0.148$) against the students' modes of information processing. Notably however, 30 students obtained scores between 50-59% with 8 (17.4%) preferring kinaesthetic, 8 (17.4%) visual, aural, read/write and kinaesthetic (VARK), 3 (6.5%) aural and 3 (6.5%) visual and kinaesthetic (VK) modes of information processing. From the 13 students who scored between 40-49%, 4 (8.7%) preferred kinaesthetic, 3 (6.5%) aural, and kinaesthetic (AK) and 2 (4.3%) aural, read/write and kinaesthetic (ARK) modes of information processing.

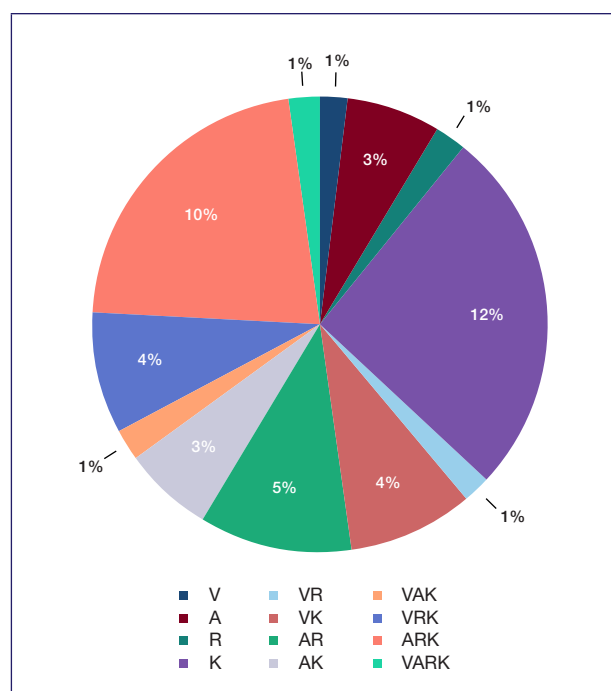


Figure 1. VARK mode distribution among first year Dental Technology students.

The highest score obtained by 1 (12.2%) student was between 70-79%. This student preferred the read/write mode of information processing.

As illustrated in **Table 1**, cross tabulation results between the manual dexterity sections and VARK results revealed that out of the 16 students who scored between 60-69%, 5 (10.9%) preferred kinaesthetic and 5 (10.9%) preferred aural, read/write and kinaesthetic (ARK) modes of information processing.

Table 1. VARK mode distribution in manual dexterity scores among Dental Technology students.

Learning Style	40-49	50-59	60-69	70-79	TOTAL
V	0	0	0	1	1
A	2	1	0	0	3
R	0	1	0	0	1
K	1	4	5	2	12
VR	0	1	0	0	1
VK	0	2	1	1	4
AR	0	1	3	1	5
AK	0	1	2	0	3
VAK	0	0	0	1	1
VRK	0	1	0	3	4
ARK	1	2	5	2	10
VARK	0	1	0	0	1
TOTAL	4	15	16	11	46

Among the 15 students who scored between 50-59%, 4 (8.7%) preferred kinaesthetic and 2 (4.3%) visual and kinaesthetic (VK) modes of information processing. Students scoring between 40-49%, 2 (4.3%) preferred an aural, followed by 1 (2.2%) kinaesthetic and 1 (2.2%) aural, read/write and kinaesthetic (ARK) modes of information processing. From the students who scored between 70-79%, 3 (6.5%) preferred visual, read/write and kinaesthetic (VRK), 2 (4.3%) kinaesthetic and 2 (4.3%) aural, read/write and kinaesthetic (ARK) modes of information processing.

DISCUSSION

There was no significant difference ($p=0.303$) in the frequencies of students' learning preferences, which suggests that there is no distinction between the different learning preferences among the first year Dental Technology students.

A factor contributing to this is the small number of students enrolled in the Dental Technology first year programme. Regardless of this, the results revealed that most Dental Technology students (68%) had multimodal learning styles.

This result correlates with Al-Saud¹⁷ and Marwaha, Bhagat and Kapoor¹⁸, who revealed that the dominant learning preference among undergraduate dental students was multimodal.

The aforementioned predominant mode of information processing aligns with Dental Technology teaching, which mainly focuses on the 'know-how' knowledge of laboratory based practices.

The unimodal kinaesthetic learners, however, may not be stimulated during didactic theory lectures. Resonating with Al-Saud¹⁷ and Cruickshank and Vahed⁷, active teaching and learning strategies therefore need to be considered and varied according to the level and subjects being taught while taking cognisance of the diversity of students.

Discipline-specific games, didactic lectures to group discussions, laboratory demonstrations, problem-based learning and project-based assignments are some exemplars of active learning strategies adopted by academic teachers.^{3-5,7} Ultimately, and in support of Al-Saud's argument, using a range of teaching methods can help students to learn effectively and enable them to adapt to any style a learning situation may require.¹⁷

Despite, there being no significant difference ($p=0.497$) between the manual dexterity sections and VARK results, it can be gathered from **Table 1** that a significant relationship exists between students' kinaesthetic (K) and aural, read/write and kinaesthetic (ARK) modes of information processing and their performance in the manual dexterity sections.

Consistent with several authors, having knowledge of students' modes of information processing enables academic teachers to structure and deliver lectures better by adopting more suitable pedagogies to accommodate their students' learning preferences.^{9,17,18} Importantly, this could improve students' retention rates, an area which dominates the South African higher education debate.^{8,10,11} Conversely, and in corroboration with other authors, students also need to be encouraged to develop more suitable learning strategies to achieve a higher level of academic performance.^{9,17,18} In fact, students may need to adapt to learning modalities that are different from their own preferences because of real-life laboratory constraints.

Limitations

Limitation of this small-scale study must be acknowledged. This study was limited to DUT and had a limited sample size. Hence, the results cannot be generalised to other South African Universities of Technology offering the training of dental technicians.

Another limitation of the study was that the results did not account for confounding factors such as demographics (age and gender), socio-economic and/or first-generation status and ethnic background. The aforementioned limitations therefore point to the future directions of a longitudinal study that seeks to track students from their first to their final year of study.

In particular, to investigate the relationship between students' performance in entrance tests with their overall academic performance and the association to learning styles. The longitudinal study will aim to provide an in-depth analysis of the requirements necessary to encourage constructive learning and students' success in the Bachelor of Health Sciences in Dental Technology, which is to be implemented in 2021.

CONCLUSION

While there is no relationship between students' performances in entrance tests and their preferred learning styles, the most dominant learning styles among Dental Technology students shown in this study were unimodal (kinaesthetic) and quadrimodal (VARK).

The insights from this study provide the impetus for Dental Technology academics to use a diverse range of pedagogical practices to enable unimodal learners to adjust their learning styles such that they can connect the theory and laboratory-based practices.

Students accepted into the Bachelor of Health Sciences in Dental Technology programme should complete the VARK questionnaire at each level of study and prior to lectures commencing so that early interventions to assist them to succeed academically can be implemented and monitored throughout their student career.

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The effect of storage conditions on the deformation patterns of acrylic partial denture bases

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ABSTRACT

Introduction

Incorrect impression-taking techniques and processing errors are known factors contributing to ill-fitting acrylic partial dentures (APDs). Environmental factors such as high temperature and humidity levels can further contribute to the misfits of APDs.

In South Africa, the average summer temperature and humidity level is 21°C and 50%, respectively, which may adversely affect APDs during storage post-manufacture.

Aim

To investigate the effect of storage conditions on the deformation patterns of acrylic partial denture bases.

Methods

Thirty maxillary APD bases were fabricated, and divided into three sample groups, namely: the wet-stored 9-hour cure, dry-stored 9-hour cure, and dry-stored 1½-hour cure. The dimensional fit in the areas of the incisive papilla, maxillary first molars, and the deepest part of the midline posteriorly were measured using a Mitutoyo™ micro-meter.

Results

There were no significant differences in the deformation patterns in the incisal area ($p > 0.42$). Significant differences in the deformation patterns in the maxillary first molar areas ($p < 0.04$) were recorded. The deformation of fit increased as storage time increased.

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2. **Anisa Vahed:** Data analysis and interpretation; drafting and critically revising of paper - 50%

ACRONYMS

APDs: Acrylic Partial Dentures
PMMA: Polymerised Polymethyl Methacrylate

Conclusion

This study confirms that the deformation patterns of APDs are reduced if kept hydrated on storage.

INTRODUCTION

Removable acrylic complete and partial dentures are often selected by patients because of the low cost and acceptable aesthetics.¹⁻⁴ Heat-polymerised polymethyl methacrylate (PMMA), commonly referred to as denture base acrylics, is frequently used to fabricate complete and partial dentures.⁵

A known weakness of PMMA as a denture material is that it is porous in nature. Consequently, water, saliva or any other oral fluids can be absorbed during intraoral use and on storage. This can severely compromise the fit, comfort and stability of the denture base in a patient's mouth.

Acrylic dentures that are not stored in water during periods of disuse can deform and become brittle.^{2,4,6} Deformation of acrylic denture bases stored post-manufacture may also occur in the absence of hydration.

Consani, Monterio and Mesquita et al.¹ reported on the increased distortion of complete denture bases at room temperature over a six-month dry-storage period.

Consistent with them, Kasina, Ajaz, Attali et al.² demonstrated positive correlations do exist between the polymerisation cycles and degree of hydration and dehydration over a 4-week storage period, which resulted in denture misfits.

This was also evident in Lim and Lee's³ recent study, which showed significant linear bilateral posterior buccal flange deformation of complete dentures over a 3-month dry-storage period.

Similarly, South African dental clinicians (Dr Khan and Dr Mohamed, personal communication, March 27, 2015), particularly those who are located in arid areas, have

observed that the dimensional stability of complete and partial dentures were affected over a two-week dry storage period. The above clinicians alluded that distortion of APDs increased with high temperature and low humidity levels.

In particular, the deformation of the 'n' shaped maxillary APDs (Figure 1) were greater compared to the 'w' shaped complete dentures (Figure 2). A point that deserves to be mentioned is that within the context of this study, 'n' and 'w' shapes were used to characterise the deformation patterns between an APD and a complete denture, respectively. Notably, deformation of APDs ('n' shaped) are more likely to be different because of the absence of a buccal flange, which is evident in complete dentures ('w' shaped).

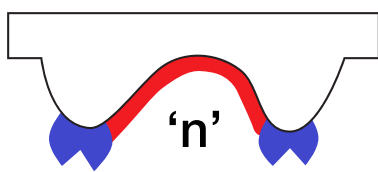


Figure 1. The 'n' shape of a maxillary APD when viewed from the posterior.

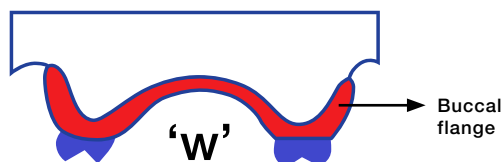


Figure 2. The 'w' shape of maxillary complete denture base when viewed from the posterior.

Despite several studies⁴⁻⁹ reporting on the effect of hydration and dehydration of complete acrylic denture bases with varying results, there is limited evidence on the dehydration and deformation of APDs during storage.

This study aims to analyse the effects of dry- and wet-storage conditions on the deformation patterns of 'n' shape maxillary APD bases. It is anticipated that the results of this study could provide valuable baseline data to dental clinicians in terms of advising patients on denture care and management of APDs during storage.

The hypothesis tested was that there is a significant relationship between dry-storage conditions and deformation of acrylic partial denture bases.

MATERIAL AND METHODS

Preparation of the denture base specimens

A maxillary cast (Figure 3) was duplicated using silicone moulds (Mold Max[®] 30 Smooth-On, Inc. Macungie, East Texas, USA). These moulds facilitated the duplication of 30 yellow stone models (gypsum calcium sulphate α -hemihydrate, Dentsone[™] KD, Saint Gobain, Courbevoie, France).

There were three sample groups, namely: the wet-stored 9-hour cure (Control Group); dry-stored 9-hour cure (Group 1); and dry-stored 1½-hour cure (Group 2). Each sample group had 10 specimens (n=30).

Using the palate area of the model, a maxillary acrylic base plate was subsequently fabricated (Vertex[™] Orthoplast Dental B.V, Netherlands). The acrylic base plate was used as a template (Figure 4) to outline the design on 30 models (Figure 3) prior to fabricating the 30 wax pattern specimens (Kemdent[®], Purton, Swindon, Wiltshire, United Kingdom).

All wax pattern were polymerized, according to the manufacturer's recommendations (Vertex[™]- Dental B.V, Netherlands). It must be noted that the name assigned to each sample group indicates the type of curing method used to fabricate the APD base specimens. All APD base specimens were trimmed, pumiced and polished to 2mm thickness with a high surface lustre.

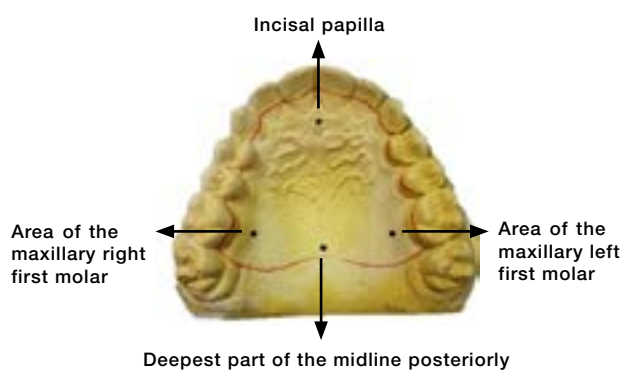


Figure 3. Reference areas on maxillary cast used to gauge the degree of deformation.



Figure 4. Acrylic base plate used as a template to outline the design on 30 models.

Storage of the specimens

In determining the extent of deformation of the APD base specimens by temperature and humidity, the dry-stored 9-hour cure and dry-stored 1½-hour cure were stored in a custom-made incubator for 28 days. The incubator, which was constructed using chipboard (45cm x 35cm x 30cm), consisted of a fan (Cooler Bank[™], Chiefly Choice Limited Company, Shenzhen, Canton, China) to cool the air and two 100w light bulbs to increase the temperature within the incubator.

The Relative Humidity (RH) within the unit was controlled using 245g of silica gels (Mystify[®] dehumidifier, Shoprite Checkers Limited, Brackenfell, South Africa). Using a thermostat (Carel[™] s90 Tp1, Padova, Italy) the temperature in the unit was regulated to 21°C and kept at 40% humidity. It must be noted that the temperature and humidity levels of the various South African regions were considered, however the average temperature and humidity levels of arid regions with lower humidity were used.¹⁰

A Thermo-Hygrometer (Flus® FL-201, Shenzhen Flus® Technology, China) was also used to monitor the relative humidity within the unit.

The wet-stored 9-hour cure APD base specimens were stored in a water bath (Mestra® M-18, Talleres Mestraitua S.L. Spain) at 37°C for 28 days. The conditions of the experiment were monitored daily and the micro meter was calibrated at the beginning of every storage interval.

Measuring the fit of the acrylic partial denture base specimens

The degree of the deformations of the APD base specimens were measured following the silicone wafer method used by Ghani et al.¹¹ The process entailed mixing 100g of Part A Silicone (Mold Max® 30; Smooth-On, Inc. Macungie, East Texas, USA) to 10g of Part B liquid (Fast cat®; Smooth-On, Inc. Macungie, East Texas, USA) for three minutes.

The mixture was then poured onto the palatal surface of the maxillary cast and the APD base specimens were fitted onto the cast using finger pressure. Subsequently, a scalpel (Size 23 stainless steel; Omnisurge, Meadowdale Johannesburg, South Africa) was used to trim the excess silicone and the APD base specimens were carefully removed from the cast.

The thickness of the silicone layer was measured in millimetres using a micrometer (Mitutoyo® S293, America Corporation, Illinois, United States of America) at four reference areas.

As illustrated in Figure 3, these reference areas were the incisive papilla, maxillary first molars (16 and 26), and the deepest part of the midline posteriorly.

The fit of the APD base specimens were measured immediately after fabrication (day 1) and subsequently on days 2, 7, 14, 21 and 28 of the storage period. Consequently, the degree of deformation of the three APD sample groups was recorded.

Statistical analysis

Using Graph Pad® Prism Version 5 (GraphPad Software Inc. California, USA) a slope test was used to compare the deformation trends of each sample group ($p=0.05$).

As outlined by Motulsky¹², laboratory and clinical researchers frequently used Graph Pad® Prism nonlinear regression analysis to fit a straight-line model, and to test whether the best-fit value of the slope differs significantly from 1.0 (or any other value) with 90% confidence limits.

A noteworthy point is that while the r^2 provides an estimate of the strength of the relationship between the observed values and the predicted values, it does not provide a formal hypothesis for this relationship.

The F-test ($p<0.05$) determines whether this relationship is statistically significant.

RESULTS

The degree of deformation of the APDs, specifically at the four reference areas is outlined below.

Incisal area of the acrylic partial denture base

As shown in Table 1, the slope test results of the incisal area of the wet-stored (28 days) APD bases revealed a low r^2 value (0.001452). In contrast to the low r^2 value of the wet-stored APD bases, the slope test results of the incisal region of the dry-stored APD bases revealed high r^2 results of 0.9646 (9-hour cure) and 0.8385 (1½-hour cure).

Table 1. Slope test results in the incisal area.

Slope Test (Goodness of Fit)	Hydrated (Control)	Dry-stored (9-Hour Cure)	Dry-stored (1½-hour Cure)
r^2	0.001452	0.9646	0.8385
P value	0.9515	0.0029	0.0290
Deviation from zero	Not Significant	Significant	Significant

The slope test further revealed that the slopes for the dry-stored APD bases were significantly different ($p<0.05$). There were no significant differences ($p>0.05$) for the wet-stored APD bases. Figure 5, which is a time series plot of the measure of deformation immediately after fabrication (Day 1) to each storage interval, further supports this. The F-test used to determine if the slopes were equal showed no significant difference ($p=0.51$). The F-test for elevation testing ($p<0.05$) also revealed no significant differences ($p=0.42$).

Deepest part of the midline posteriorly

As presented in Table 2, the slope test results of the deepest part of the midline area of the APD bases posteriorly revealed high r^2 results, namely, 0.9919 (wet-stored 9-hour cure), 0.6852 (dry-stored 9-hour cure) and 0.7730 (dry-stored 1½-hour cure).

Table 2. Slope test results of the deepest part of the midline area posteriorly.

Slope Test (Goodness of Fit)	Hydrated (Control)	Dry-stored (9-Hour Cure)	Dry-stored (1½-hour Cure)
r^2	0.9919	0.6852	0.7730
P value	0.0003	0.0836	0.0495
Deviation from zero	Significant	Not Significant	Significant

There were significant differences in the wet-stored 9-hour cure and the dry-stored 1½-hour cure ($p<0.05$). Figure 6 further supports this. Overall, the F-test used to determine if the slopes were equal showed no significant difference ($p=0.15$). A point that deserves to be mentioned is that the F-test for elevation testing (y intercepts) showed significant differences across the three groups ($p=0.00$). This indicates that deformation across the three groups are similar and increased over time.

Area of the maxillary right first molar

As shown in Table 3, the slope test results of the APD bases in the maxillary right first molar area reveal-

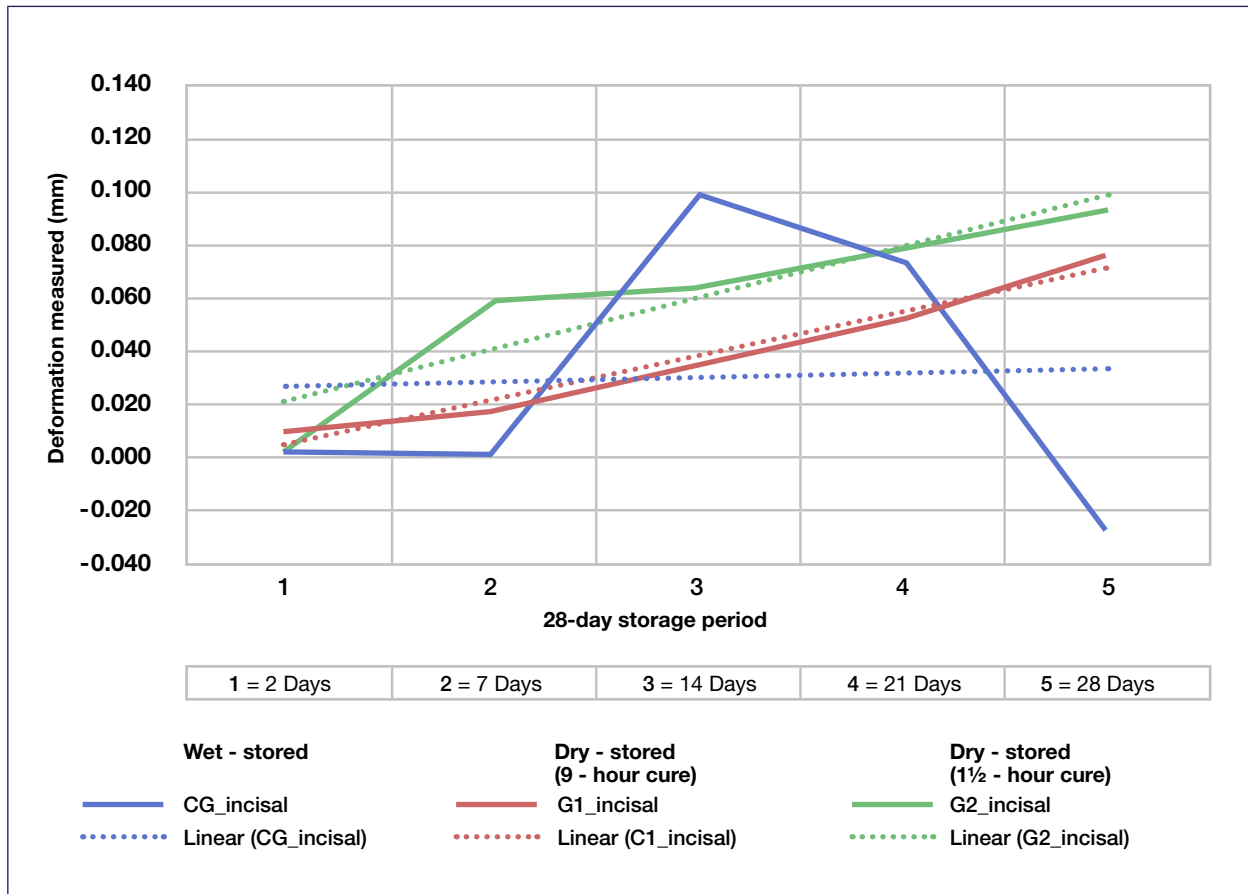


Figure 5. Deformation patterns in the incisal area.

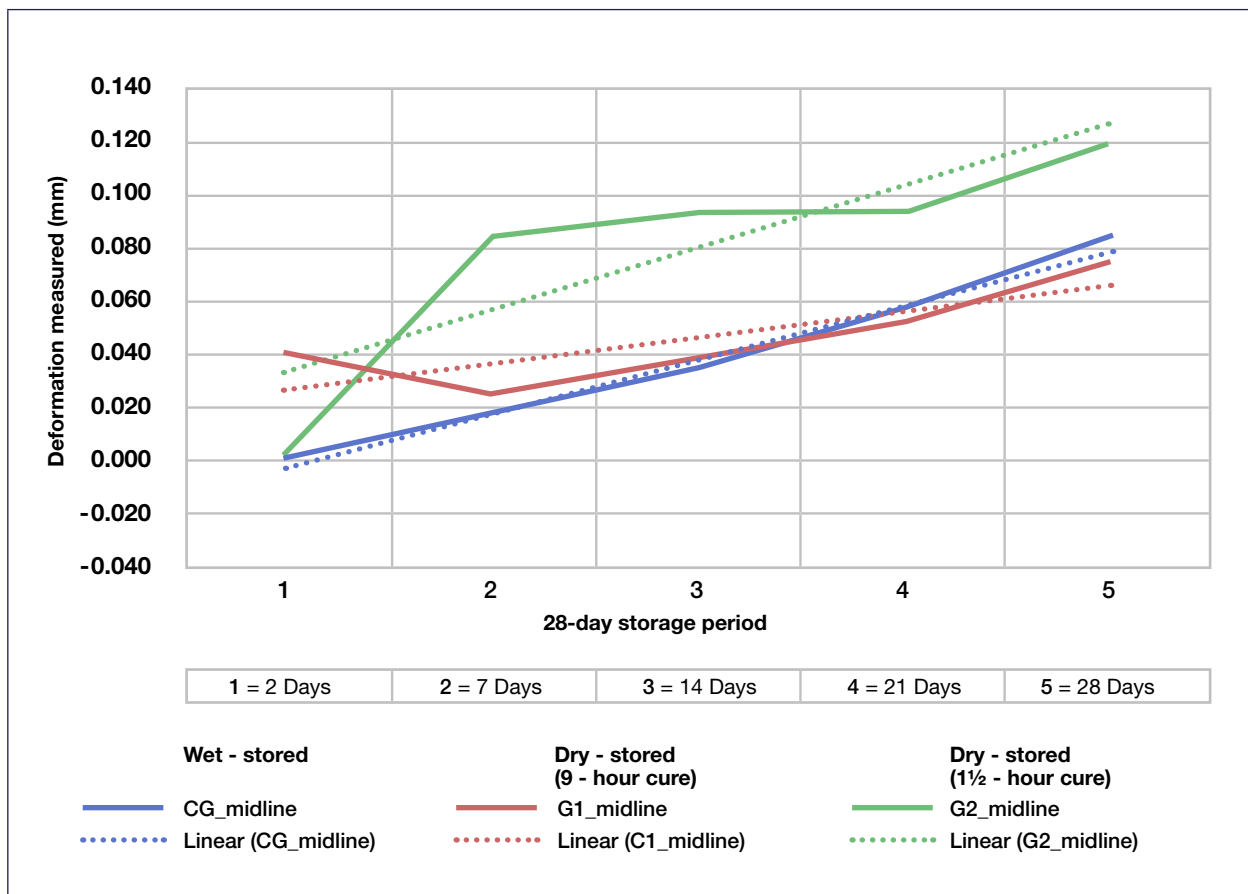


Figure 6. Deformation patterns in the deepest part of the midline area posteriorly.

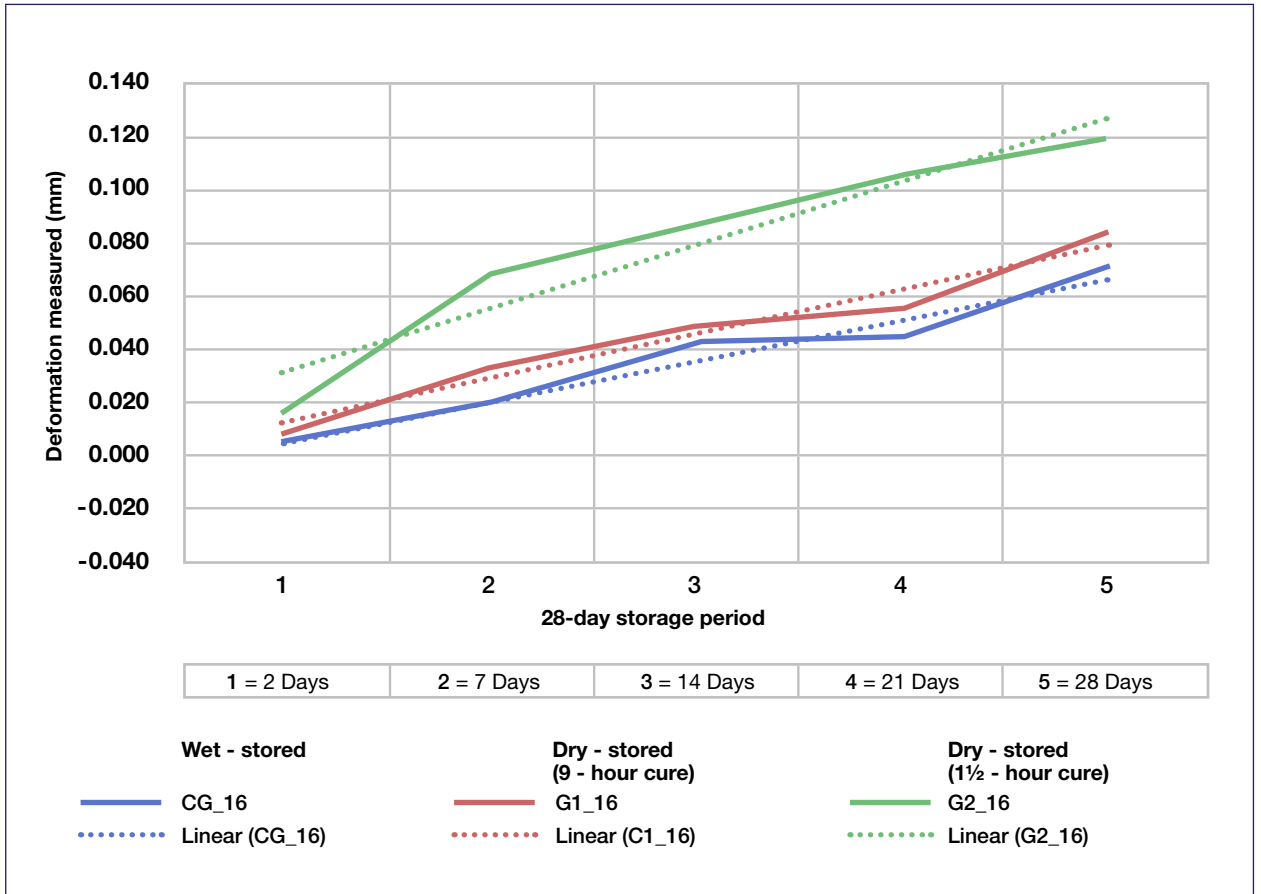


Figure 7. Deformation patterns in the maxillary right first molar area.

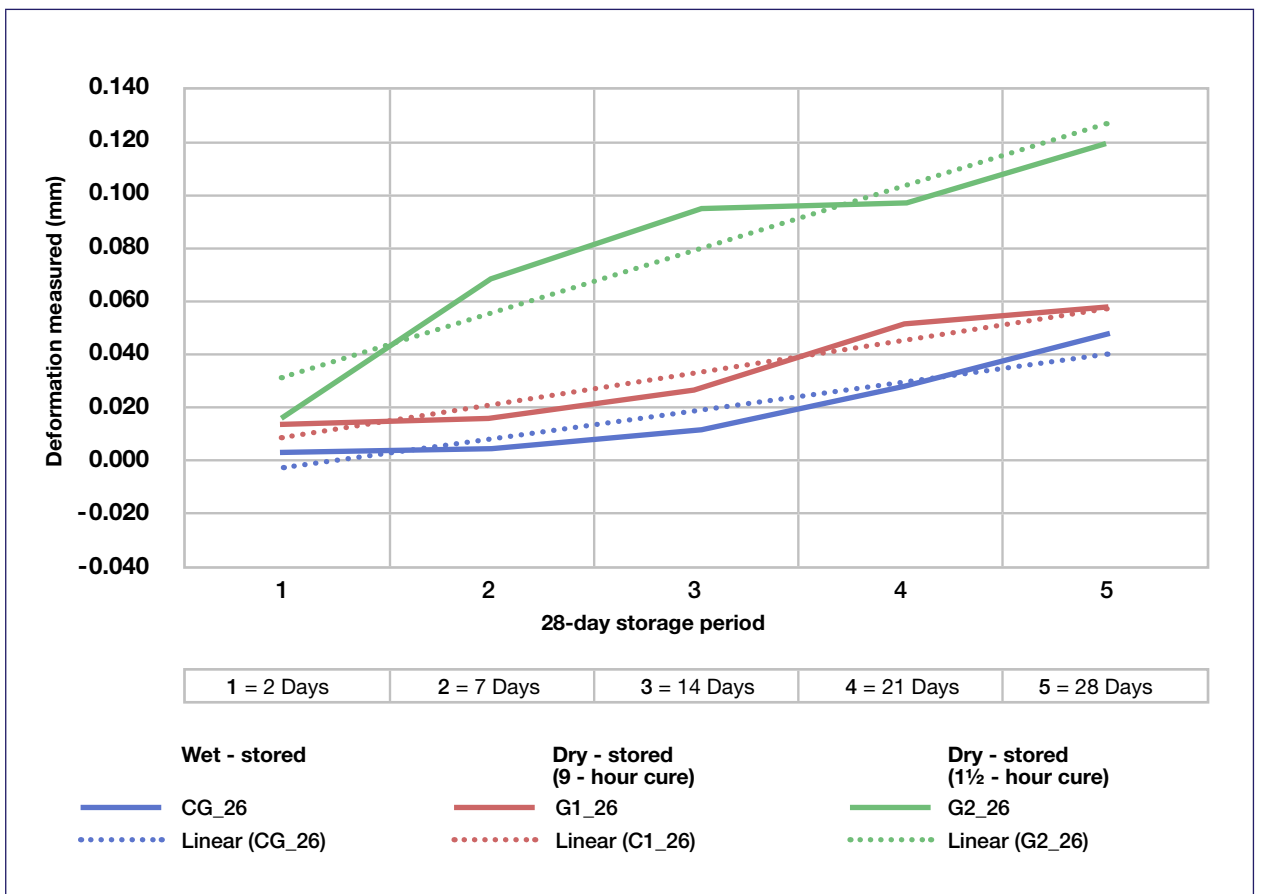


Figure 8. Deformation patterns in the maxillary left first molar area.

ed high r^2 values of 0.9507 (wet-stored 9-hour cure), 0.9654 (dry-stored 9-hour cure) and 0.9167 (dry-stored 1½-hour cure).

Table 3. Slope test results in the maxillary right first molar area.

Slope Test (Goodness of Fit)	Hydrated (Control)	Dry-stored (9-Hour Cure)	Dry-stored (1½-hour Cure)
r^2	0.9507	0.9654	0.9167
P value	0.0047	0.0028	0.0105
Deviation from zero	Significant	Significant	Significant

As illustrated in Figure 7, the slope test results further indicated that the slopes for all three groups were significantly different ($p < 0.05$).

From Figure 7, the slope pattern for the dry-stored (1½-hour cure) APD bases is higher than the wet-stored and dry-stored (9-hour cure) APD bases. The slope pattern for the wet-stored 9-hour cure APD bases is the lowest from the three groups. Although the F-test used to determine if the slopes were equal showed no significant difference ($p = 0.16$), the F-test for elevation testing revealed significant differences across the three groups ($p = 0.00$).

Area of the maxillary left first molar

Table 4 shows that the slope test results of the APD bases in the maxillary left first molar area had high r^2 values of 0.8871 (wet-stored 9-hour cure), 0.9312 (dry-stored 9-hour cure) and 0.8891 (dry-stored 1½-hour cure). The slope test revealed significant differences across all groups.

Table 4. Slope test results in the maxillary left first molar area.

Slope Test (Goodness of Fit)	Hydrated (Control)	Dry-stored (9-Hour Cure)	Dry-stored (1½-hour Cure)
Y-intercept when $X = 0.0$	-0.0140 ± 0.007514	-0.003600 ± 0.006454	0.008500 ± 0.01602
r^2	0.8871	0.9312	0.8891
P value	0.0167	0.0078	0.0162
Deviation from zero	Significant	Significant	Significant

This is further supported by Figure 8, which shows a positive linear relationship for the wet-stored, dry-stored (9-hour cure) and dry-stored (1½-hour cure) APD bases. The slope pattern for the dry-stored (1½-hour cure) APD base is higher than the wet-stored and dry-stored (9-hour cure) APD bases.

The F-test used to determine whether the slopes were equal showed significant differences between the slopes ($p = 0.04$). Table 4 further shows that the dry-stored (1½-hour cure) APD bases had the highest elevation (0.008500 ± 0.01602). The wet-stored APD bases, by contrast, had the lowest elevation (-0.0140 ± 0.007514).

DISCUSSION

The present study examined the effects of dry- and wet-storage conditions on the dimensional fit of APD bases. As seen in Figure 5, the slope pattern of the wet-stored APD bases increases from days 2-14 and decreases from days 14-28. The irregular slope pat-

tern could be attributed to the affinity of APD bases absorbing water and subsequently expanding.

A critical point that deserves to be mentioned is that within the context of this research expansion of the APD base is a measure of a decrease in the gap (mm) between the APD base and maxillary cast. Conversely, contraction is the measure of an increase in the gap (mm) between the APD base and maxillary cast.

It can therefore be inferred that expansion of the APD bases occurred from days 14-28. This is consistent with the study conducted by Rimple, Gupta, Kamra et al.¹³ and Hamouda, El-Sharkawi, Gomaa et al.¹⁴

They showed that the highest expansion of complete dentures stored in water occurred in the first month of the 3-month storage period. Another noteworthy point is that the dry-stored 9-hour cure APD bases in this study also showed visible changes in dimensional stability across all reference areas.

The results of this study supports the work of Miessi, Goaito, Santos et al.⁷ as the loss of water and incomplete polymerisation affects the dimensional fit of APD bases, especially when the dentures are dry stored.

In contrast to Lim and Lee,³ who reported that the degree of deformation over a one month dry storage period was low, the results of this study showed that the highest deformation occurred on day 28 of the wet- and dry-storage periods. In particular, the deformation across the four reference areas was higher for the dry-stored 1½-hour cure than the wet-stored and dry-stored 9-hour cure APD bases.

The wet-stored 9-hour cure APD bases had the lowest deformation. This corroborates with the advice given by Anusavice, Shen and Rawls⁹ that a 9-hour polymerisation cycle helps to reduce polymerisation shrinkage thereby achieving dimensionally stable denture bases. This must be considered in conjunction with the recommendation given by several other authors¹⁵⁻¹⁸ that dentures are to be stored in water for at least 24-hours post manufacture in order to compensate for polymerisation shrinkage.

While the results of the slope test for the APD bases revealed no significant difference incisally, there were significant differences posteriorly. This is consistent with the findings of Lim and Lee,³ Consani, Domitti and Consani¹⁵ and Arora, Khindaria, Garg et al.¹⁸, who showed deformation in the posterior palatal areas of maxillary complete dentures during dry-storage. The hypothesis tested that is there is a significant relationship between dry-storage conditions and deformation of acrylic partial denture bases was therefore accepted.

The prominent features of this study showed that low humidity affected the posterior areas of the APD bases on dry-storage, specifically confirming the highest deformation recorded was in the maxillary first molar areas.

This study conclusively showed that the deformation patterns of APDs were reduced if kept hydrated on storage.

Limitation

Although the silicone wafer method provided valuable baseline data on the deformation of APDs, the integrity of the silicon wafer could have been affected during the measuring of mis-fits over the 28-days storage period. Future studies should therefore consider using advanced technology such as surface matching software and 3D scanners for scanning impressions and casts.

Acknowledgements

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Do the CPD questionnaire on page 104

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.

Death of a child due to dog bites - a bite mark analysis

SADJ March 2020, Vol. 75 No. 2 p79 - p80

VM Phillips

CASE REPORT

I was requested by Dr DA of the Department of Forensic Pathology in Paarl Western Cape, to examine bite marks inflicted by dogs on a deceased child at Paarl Forensic Pathology Laboratory. The deceased was a male child of approximately 7 years of age who was attacked by a male and a female Pit Bull Terrier.

It was alleged that these dogs leapt over the wall and attacked the child outside the property of the owner. Examination of the victim showed numerous lacerations and deep puncture wounds on the neck, arms, legs, back and buttocks.

Photographs were taken of the entire body of the victim to record the anatomical location of the lesions. Some of the lesions were scratch marks from the claws of the dogs. The puncture wounds were due to the dog teeth. Several puncture wounds had deep lacerations and were not suitable for bite mark analysis. Photographs were taken of the puncture wound that represented dog bite marks.

The puncture wound on the right shoulder of the victim was considered to be the best example of a dog bite and was photographed with an ABFO millimetre scale *in situ* (Fig. 1).



Figure 1. The puncture wound on the right shoulder of the victim with the ABFO mm scale *in situ*. Several smaller puncture wounds are present in this area.

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ACRONYM

ABFO: American Board of Forensic Odontology

Two deceased adult dogs, a male and a female Pit Bull Terrier, were presented for examination of their teeth and possible matching with the bite marks on the victim. Photographs were taken of the front teeth of the male dog and then dental impressions were taken of the upper and lower front teeth.

The female dog was frozen and had to be defrosted overnight before the mouth could be opened for examination. The dentition of the female dog was examined the following day and photographed. Dental impressions were taken of the upper and lower front teeth of this dog. Plaster of Paris study models were cast from the dental impressions of the upper and lower teeth of each dog for bite mark analysis (Figs. 3 & 4).



Figure 2. Deep puncture wound on the left shoulder of the victim due to the dog bite. The deep puncture wounds are due to the canine teeth (arrows). The wounds show tearing of the tissues. The other lesions are due to the dog's incisor teeth. The distance between the deep puncture wounds is 45 mm (white line) ABFO mm scale *in situ*.

Bite mark analysis

The analysis of a human bite mark is undertaken by matching the biting patterns of the upper and lower teeth of the perpetrator with the bite mark. A tracing of the biting pattern is superimposed over a photograph of the bite mark. This bite mark by a dog was a unique experience for the author.

The most distinctive bite mark for analysis was situated on the right shoulder of the victim (Fig. 1). The two deep puncture wounds were produced by the canine teeth of the dog. The distance between the centres of each puncture wound was 45mm (Fig. 2).



Figure 3. The relationship between the upper canine teeth of the male (left) and female (right) dog with the puncture wounds showed the inter-canine distance in both dogs was 45mm.

Comparison between the upper canine teeth of the male and female dogs presented for examination showed that either of these dogs could have inflicted the bite on the right shoulder of the child.

Declaration

No conflict of interest is declared.

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DISCUSSION

The puncture wounds showed distortion due to tearing of the tissues; thus showing a discrepancy in the sizes of the left and right puncture wounds.

The distance between the centres of the puncture wounds was found to be 45mm (Fig. 2). The inter-canine distance in both dogs was measured at 45mm. This was surprising as the male dog is usually more robust than the female.

The taking of the dental impressions of the dog's teeth was challenging because the standard dental impression tray does not compensate for long canines. The impression trays had to be modified.

In retrospect it was unnecessary to take dental impressions as the inter-canine distances could have been measured *in situ* for each dog. No distinct biting pattern for the incisor teeth was discernible as these teeth are much smaller than the canines (Figs. 2 & 3).

Bite marks due to dogs result in deep puncture wounds due to the canine teeth with possible minor wounds due to the adjacent incisor teeth. The wounds inflicted by dog bites may be distorted due to the tearing of the tissues as a result of the shaking of the head of the dog while inflicting the bite. The numerous deep scratch marks by the claws of the dogs caused masking of some of the bites and complicated the analysis.

CONCLUSION

Numerous bite marks and lacerations were present on the body of the victim. The lesion on the right shoulder of the victim was determined to have been caused by a dog bite.

A combined therapeutic approach to treating a challenging case of Dens Invaginatus

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CH Jonker¹, P van der Vyver², S Arnold³, NH Wood⁴

ABSTRACT

Background and objectives

Dens Invaginatus is a rare dental anomaly. The case presentation illustrates a combined endodontic and surgical approach of a maxillary lateral incisor that presented with a Type III Dens Invaginatus.

Methods

The complex root canal system was prepared during phase 1 after proper disinfection; the canals were obturated with a combination of techniques.

An appointment was scheduled for four weeks later for the surgical phase. During this visit, a full muco-periosteal flap was raised, the failed retrograde restoration was removed and MTA was placed.

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1. **Casper H Jonker:** Introduction (25%), report on treated case and procedures (80%), discussion and literature review (25%), conclusion (25%), changes and formulation of drafts (30%).
2. **Peet J van der Vyver:** Introduction (25%), discussion and literature review (25%), conclusion (25%), changes and formulation of drafts (30%).
3. **Samantha Arnold:** Introduction (25%), discussion and literature review (25%), conclusion (25%), changes and formulation of drafts (20%).
4. **Neil H Wood:** Introduction (25%), report on treated case and procedures (20%), discussion and literature review (25%), conclusion (25%), changes and formulation of drafts (20%).

ACRONYMS

DI:	Dens Invaginatus
DFDBA:	Deminerized Freeze-Dried Bone Allograft
SLA:	Straight Line Access

Results

The patient was seen for follow-up visits after the procedure and satisfactory healing was observed.

Conclusion

The case report illustrates a novel approach to treating a unique case of *dens in dente*.

INTRODUCTION

Dens Invaginatus (DI) is a rare dental anomaly in which invagination of the enamel organ into the dental papilla occurs before tooth calcification. The invagination may originate in the crown region of the affected tooth, often extending into the root before calcification of tooth structure occurs.¹

Various other terms can be found for this phenomenon: "dens in dente", "dilated composite odontome", "gestant odontoma", "dentinoid in dente" or "telescopic tooth".² Teeth affected by this anomaly may show a great variety of sizes, shapes and forms.³ Salter gave a very accurate description of this anomaly in a very early statement in 1855, in which it was named "a tooth within a tooth",⁴ and was also the first to describe DI in a human tooth.³

Once the diagnosis of a DI is confirmed, treatment can pose a formidable challenge to the treating clinician and modern clinical techniques and equipment may be required for successful management. Radical approaches in treatment, including endodontics, are needed, and often the affected tooth has to be extracted.^{3,4,5} These teeth may pose challenges concerning aesthetics and occlusion, a higher risk of caries, pulp necrosis and finally tooth impaction.⁵

The following case presentation demonstrates an endodontic and surgical approach to treating a challenging case of DI.

CASE REPORT

Conventional root canal treatment

A 29-year-old male patient with an uncomplicated medical history was referred to the Department of Operative Dentistry at the Oral Health Centre, Sefako Makgatho Health Sciences University for endodontic treatment on his maxillary right second incisor. According to the patient, a root canal treatment had been attempted during a previous visit to the hospital.

On clinical examination a discoloured maxillary right lateral incisor with a slight class I mobility was seen. A periapical radiograph of the area revealed a complex root canal configuration with a large retrograde amalgam restoration at the apex of the root (Figure 1).

Small fragments of the retrograde amalgam were scattered around the root apex and surrounding tissues.

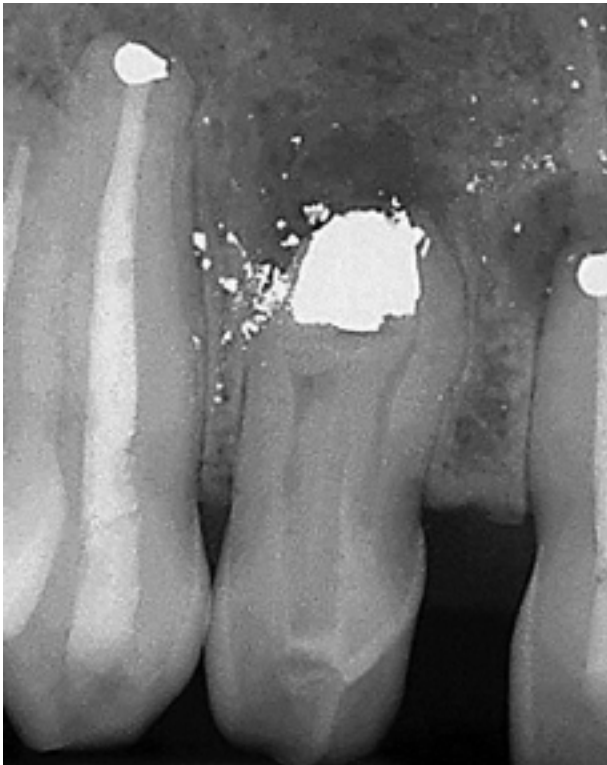


Figure 1. Pre-operative radiograph revealing the complex anatomy of the root canal system and failed treatment with a large retrograde restoration and restorative particles visible in the apical area of the right maxillary lateral incisor.

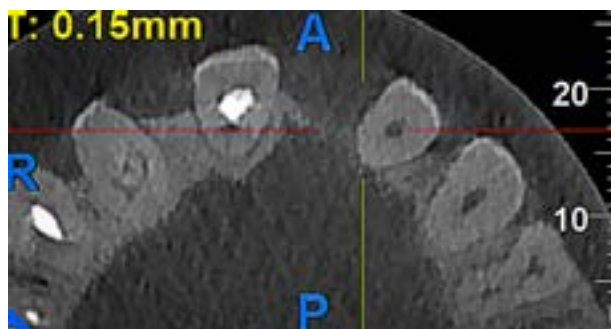


Figure 2. Axial slice of CBCT scan confirming the central root with root canal enclosed by a C-shaped root canal space of the right maxillary lateral incisor.

There was also an apical radiolucency around the apex of the root, and evidence of previous endodontic treatment was visible. The right central incisor and canine had been treated previously by means of conventional endodontic treatment with retrograde amalgam restorations. A periapical radiolucency was visible around the apex of the maxillary right central incisor.

A DI Type III was diagnosed and the decision was made to take a cone beam computed tomography (CBCT) scan. The CBCT images confirmed the complexity of the canal systems, in which the central root canal was enclosed by another C-shaped pulp chamber (Figure 2).

After discussion with the patient and obtaining his consent for treatment, the tooth was anaesthetised, a rubber dam placed, the temporary restoration removed and straight line access (SLA) achieved. The main central root canal system was identified under high magnification using the Dental Operating Microscope (DOM) (Carl Zeiss, Oberkochen, Germany). The complex root canal configuration was scouted with manual K-files (Dentsply-Sirona, Ballaigues, Switzerland) (Figure 3) but no patency was achieved due to the retrograde restoration.

Working length was determined by using a size 0.8 K-file and confirmed radiographically. In the central root canal, glide path preparation was initiated with a size 10 K-file and the glide path was expanded with the Proglider (Dentsply Sirona), a single rotating glide path file.

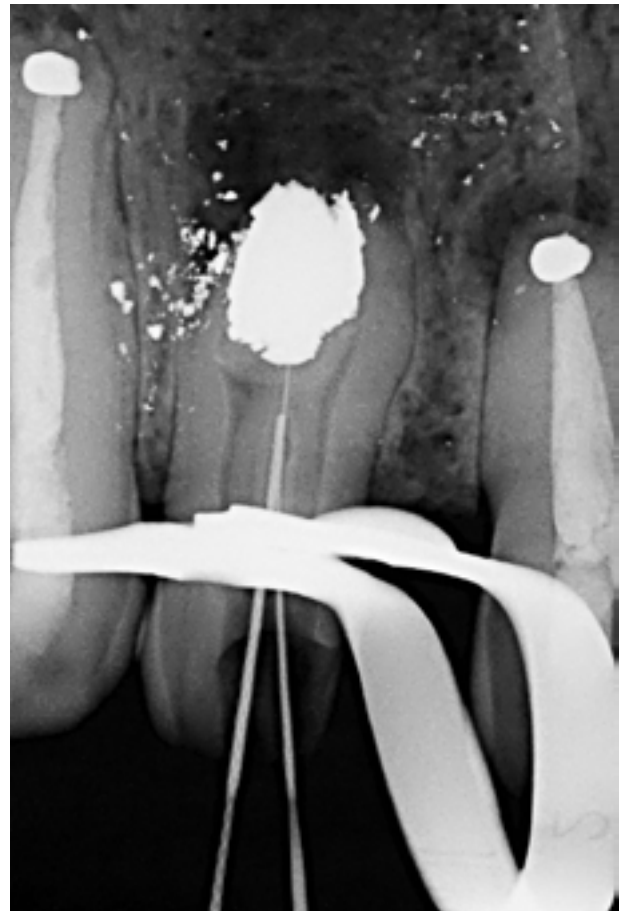


Figure 3. Scouting of the root canal configuration using K-files. Instruments were not able to achieve apical patency.

Root canal preparation was done with a WaveOne Gold Primary endodontic file (Dentsply Sirona). RC-Prep (Premier Dental, Plymouth Meeting, Pennsylvania) was used as a lubricant, and for irrigation between the instruments 3.5% sodium hypochlorite solution was activated with the EndoActivator (Dentsply Sirona).

Under high magnification, the C-shaped root canal space was investigated for additional root canal orifices or hidden anatomy. An ultrasonic tip, Start-X number 3 (Dentsply Sirona) was used to open root canal space and gain improved access to the C-shaped canal configuration. The WaveOne Gold Primary file was used in a brushing motion on the outstroke in all directions in an effort to shape the C-shaped root canal space. Final root canal irrigation was done with 3.5% sodium hypochlorite solution that was again activated with the EndoActivator (Dentsply Sirona) to improve disinfection in the C-shaped root canal configuration.

The root canal systems were dried with paper points and the canals obturated with WaveOne Gold Primary gutta-percha cones (Dentsply Sirona) and BioRoot RCS endodontic sealer (Septodont, Saint-Maur-des-Fossés, France) using the Calamus Dual Obturation Unit (Dentsply Sirona) (Figure 4). The tooth was restored and an appointment was scheduled for the surgical exploration of the periapical lesion.

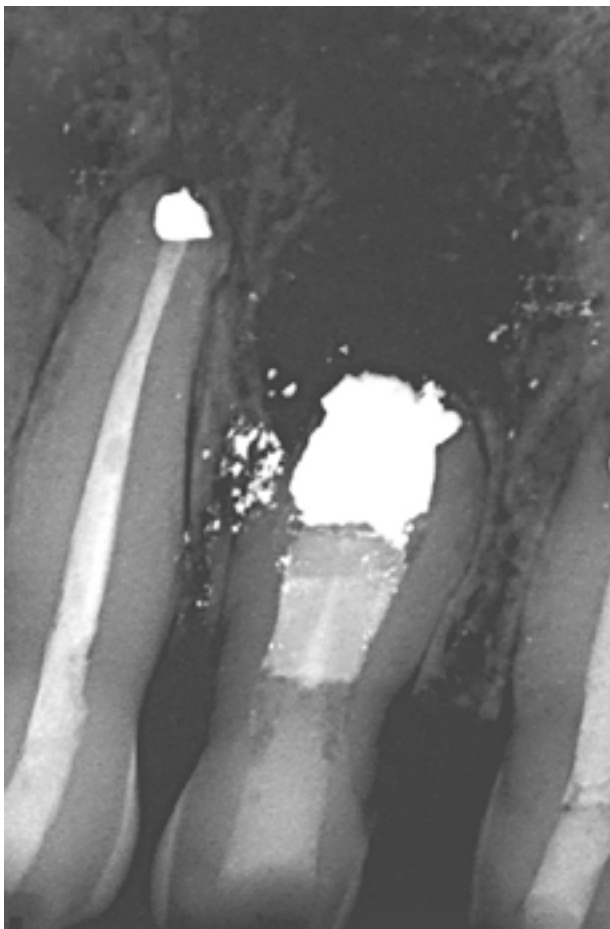


Figure 4. Post-obturation radiograph and restoration completing phase one of the treatment. The obturation was completed on the main central root canal and C-shaped root canal space using a combination of obturation techniques.

Surgical treatment

The patient returned four weeks later for the surgical phase of the treatment. The surgical site was anaesthetised and a full muco-periosteal flap was raised. Bone was removed at a level corresponding to the apical region of the lateral incisor.

The apical region was explored and it was confirmed that a previously placed amalgam retrograde restoration was firmly attached to the apex of the root.

The retrograde amalgam restoration was removed using an ultrasonic tip (Start-X number 3, Dentsply Sirona) and a long diamond burr (Komet Dental, Brasseler, Germany) with constant water cooling.

The remaining apex of the root was observed under magnification to identify all the portals of exit. The decision was made to leave any amalgam scattering *in situ* to avoid possible further damage to apical tissues and root structures. No other portals of exit were identified. Mineral Trioxide Aggregate (MTA) (Dentsply Sirona) was mixed according to the manufacturer's instructions and placed as retrograde restoration.

The apical regions of the canine and central incisor were assessed intra-operatively. No pathology was observed at the canine apex, but granulation tissue was removed around the apex of the central incisor. The integrity of the existing retrograde restorations were intact and, as no signs of leakage were observed, these were not replaced.

Bio-resorbable demineralised freeze-dried bone allograft (DFDBA) (Osseograft TM, Advanced Biotech Products, Chennai, India) was used to fill the bone defects and primary closure of the surgical site was achieved. A follow-up appointment was scheduled for one week later and post-operative instructions were provided.

Follow-up visits

The patient was seen after 12 weeks (Figure 5) for a follow-up visit, reporting no discomfort. The surgical site was inspected and uneventful healing was observed. No mobility of the tooth was detected.

At a 13 month follow-up visit a periapical radiograph revealed satisfactory healing of the periapical pathology around the roots of the central and lateral incisor teeth (Figure 6).

Discussion and literature review

Back in 1957, Oehlers described three types of DI (Figure 7): **Type 1:** minor invagination limited to the crown, not extending beyond the cemento-enamel junction; **Type II:** apical extending invagination not limited to the coronal region, but extending beyond the cemento-enamel junction, forming a blind sac inside the root, which may or may not communicate with the pulp; **Type III:** severe apical extension of the invagination into the root and exiting into the periodontium.⁶

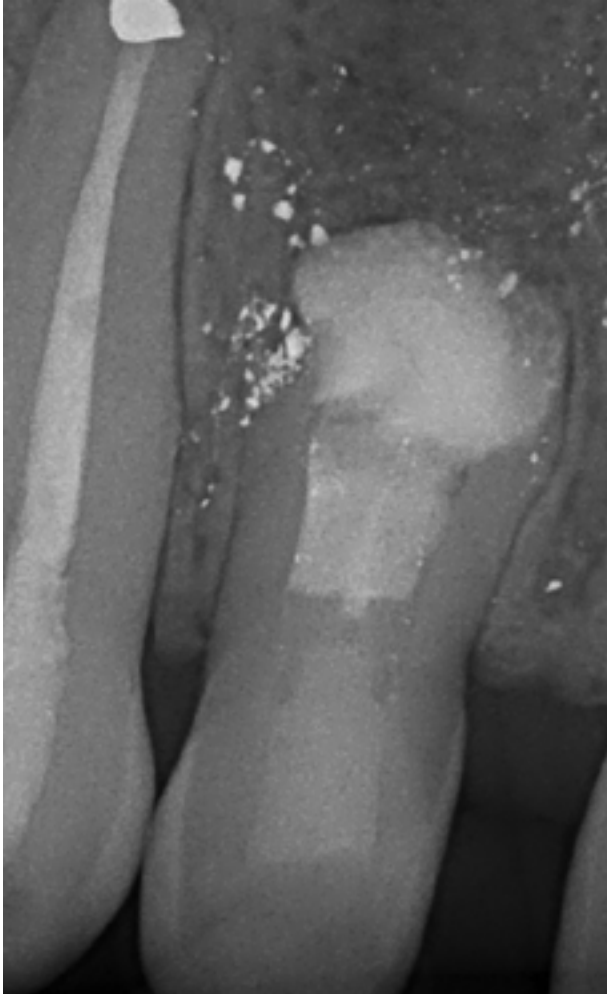


Figure 5. Three-month follow-up periapical radiograph indicating early signs of healing of the apical radiolucency and improved integrity of the apical bone network.

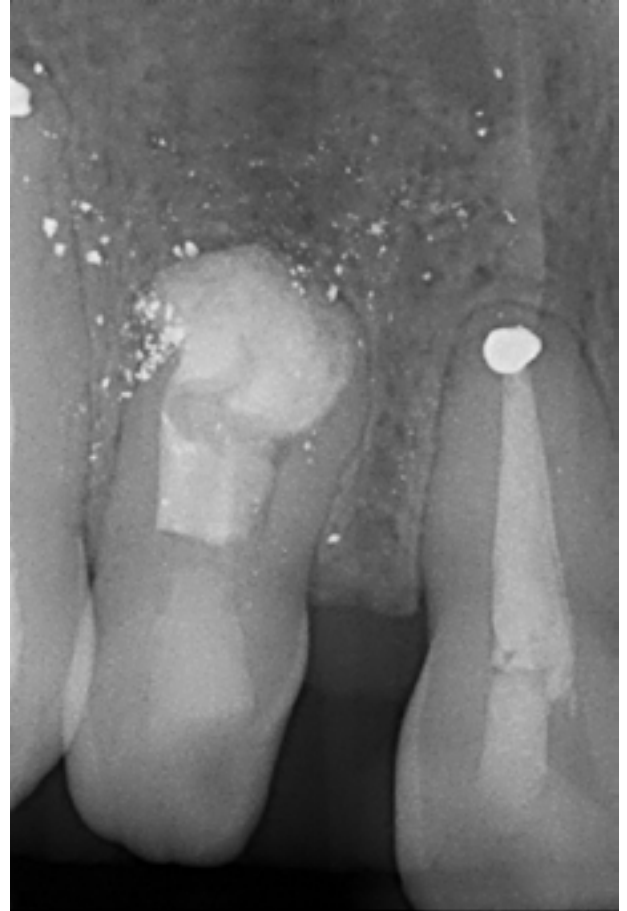


Figure 6. Thirteen-month follow-up images after the surgical phase of treatment: conventional radiograph indicates almost complete healing of the surgical site and apical area.

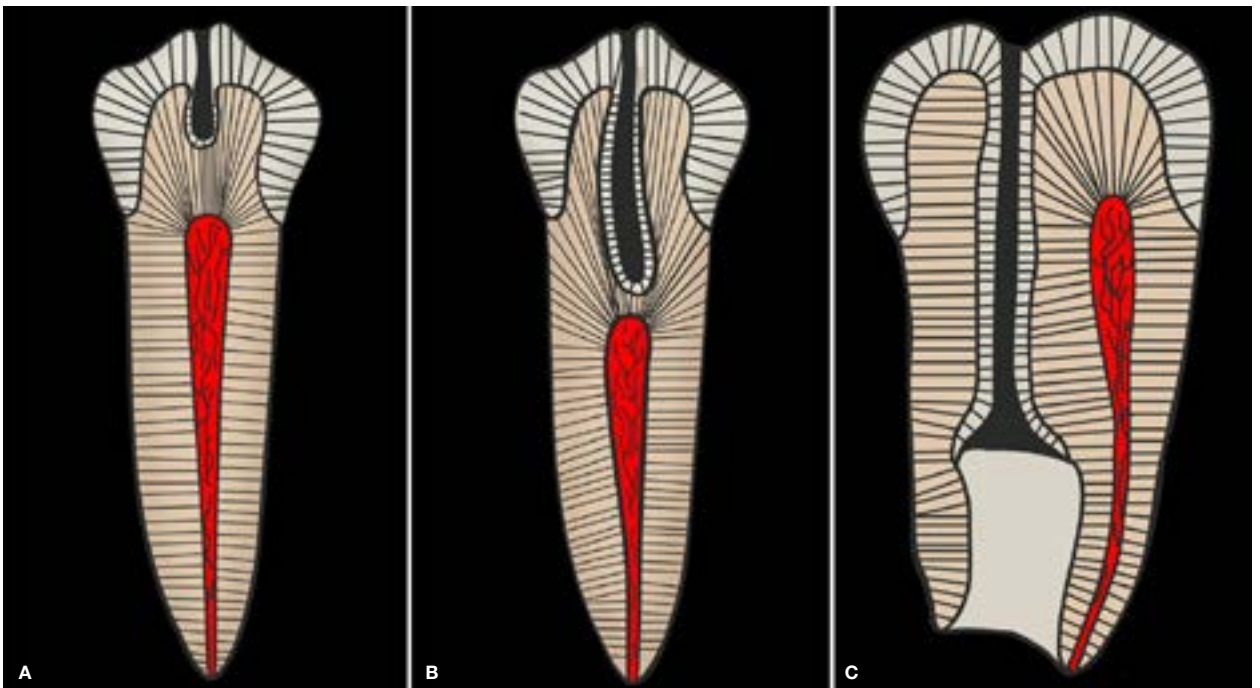


Figure 7. Schematic representation of the different types of dens invaginatus:

(A) Type I: Minor invagination limited to the crown, not extending beyond the cemento-enamel junction;

(B) Type II: Apical extending invagination not limited to the coronal region, but extending beyond the cemento-enamel junction, forming a blind sac inside the root, which may or may not communicate with the pulp;

(C) Type III: Severe apical extension of the invagination into the root and exiting into the periodontium.⁶

Type III can further be divided into Types III a and b. With Type III a, the invagination extends into the root and exits laterally into the periodontal space; pulpal involvement is unlikely.^{7,8} Type III b shows an invagination extending into the root and exiting at the apical foramen into the periodontal space.^{7,8} In rare cases of Type III b, the invagination can be outlined by cementum.⁸ According to the literature, Oehlers' radiographic classification is still used more frequently today than any other.⁹

There is no consensus on the aetiology of this phenomenon. Proposals as to the formation of this "tooth within a tooth" include lateral fusion of two tooth germs, the dental arch imposing constriction within the enamel organ, increased external pressure on the developing tooth germ, restriction of focal growth, individual stimulation of various areas within the tooth bud, crown invagination before calcification of the tooth, infection during the time of tooth development and finally, possible genetic factors.^{10,11,12}

Clinical signs alerting the clinician to the possible presence of the DI are a deviation in normal crown morphology, including dilated, peg-shaped or barrel-shaped crowns.⁷ An enlarged palatal cingula, notching of the incisal edges with palatal grooving, talon cusps and a deep foramen caecum will also raise suspicion.^{7,10} Methylene blue dye can be used to distinguish the normal fissures from the foramen caecum.⁸ Unfortunately, affected teeth can also present with no clinical signs.

The literature records that maxillary lateral incisors are more susceptible to coronal invaginations¹³ than any other tooth in the human dentition. Studies have also confirmed a prevalence in the region of 0.04% to 10% with a female: male ratio of 3:1.^{3,14} Invaginations in posterior teeth are not common, and Hamasha and Al-Omari (2004)¹⁵ found only 6.5% of affected teeth were in the posterior region.

Furthermore, the maxilla is more often affected and DI is also more commonly found in the Caucasian and Asian races. The phenomenon can also be associated with various syndromes: Ekman-Westborg-Julin syndrome, Williams syndrome and Nance Huran syndrome.¹⁶

Clinicians must be encouraged to spend more time on a thorough examination of teeth, especially where deep pits are observed in the region of the foramen caecum. Hypo-mineralisation of the enamel in the region of the dens may be detected, which may make the spread of bacteria easier and faster.⁸ Subsurface caries may develop in the DI because of the tortuous lingual anatomy of the anterior teeth, initially being confined to the internal surface.

The caries could later progress to the external surface or to the pulp through pathways between the dens and the pulp.⁸ With early detection, the need for complex and difficult endodontic treatments at a later stage will be averted.¹⁷ The investigating clinician is also encouraged to thoroughly examine the contra-lateral tooth, as 43% of patients can present with the same anomaly

in this tooth.¹⁸ Patients with a DI can seek dental treatment for acute pain and inflammation, but in general the diagnosis of DI is confirmed during routine examinations, panoramic x rays and CBCT scans. Once the suspicion is raised, a periapical radiograph will confirm the finding.¹¹

The radiological appearance is determined by the severity of the individual case. One case may present with a single deep, narrow pit whilst another may present with an in-folding loop very close to the main root canal. Radiopaque enamel lining is mostly present^{7,8} and the pulp can display a very complex image of anatomy, difficult to follow and interpret.¹⁹ Radiographs can only detect relevant information in the coronal plane of anterior teeth and in the sagittal plane of posterior teeth.¹⁷

Today, the use of CBCT scans in conjunction with traditional radiographs is highly advisable. CBCT provides a non-invasive 3D reconstructed view of external and internal morphological challenges of the DI tooth.^{17,20} Because of the relatively higher dose of radiation involved, the current recommendation is that CBCT scanning should be reserved for selected cases where conventional radiographs fail to provide conclusive information on the complex endodontic configuration.¹⁷

Histologically the enamel of the DI appears hypo-mineralised and may have an altered chemical composition when compared with the external enamel. The dentine of the DI may be regularly or irregularly hypo-mineralised. It may also contain vital connective tissue strains and show intercommunications with the pulp.⁸

Minimal invasive procedures are the aim when treating DI. Conservative restoration of the invagination with fissure sealant or flowable composite is the treatment of choice when the coronal caries are shallow, the pulp tests are vital and periapical lesions are absent.⁷ Periodic follow-ups of clinical and radiographic examinations of these cases are of utmost importance.

DI teeth with vital pulps may present with apical periodontitis, therefore pulp tests are essential for proper pulpal diagnosis, irrespective of what the radiograph presents.⁷ The more extensive the invagination, the more invasive the treatment will be; each case requires a different approach.

The present case describes treatment of a non-vital lateral incisor with a DI Type II and associated periapical pathology. Root canal therapy of both the invagination and the main root canal, together with apical surgery, were needed to resolve the periapical pathosis.

Root canal therapy in DI poses challenges and limitations, as the complex root canal anatomy together with the obstructive invagination limit accessibility and make complete debridement quite difficult.²¹

CONCLUSION

The case report illustrated a novel approach to treating a unique case of dens invaginatus. A conventional endodontic approach was combined with a surgical

approach and at a 13-month follow-up, the tooth and surrounding apical tissue showed adequate signs of healing.

Declaration

The authors declare they have no conflict of interest in the publishing of this manuscript. The manuscript was processed by the outgoing managing editor, Prof Bill Evans.

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Teething symptoms and management during infancy - A narrative review

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ABSTRACT

Even though teething is a normal part of infant development, surprisingly, little is known about the causes and management of its signs and symptoms. Due to the paucity of knowledge in this area, the purpose of this review was to provide clarity on teething symptoms and management options.

A PRISMA flow chart revealed 13 studies that were reviewed which reported on teething symptoms and signs as well as treatment and management options. The databases searched were EMBASE, Medline, PubMed, Google Scholar and the Cochrane Library.

The review showed that although conventional and generic treatment options are constantly in use, there remains no concrete evidence to prove signs and symptoms of teething nor evidence to disprove it. However, in this review, symptoms such as irritability, increased salivation, runny nose, loss of appetite, diarrhoea, rash, sleep disturbance and gum rubbing were most apparent.

Further studies are needed to ascertain these findings objectively and conclusively. Future research is also required to understand and investigate the efficacy of treatment methods and approaches among children with teething symptoms.

Keywords

Teething, infancy, symptoms, treatment, review.

BACKGROUND

The effect of teething on infant health has been debated for at least 5000 years, and traditional beliefs on the issue have still not been entirely supported by scientific literature.¹

It is widely believed that pain and other discomfort associated with tooth eruption among infants should and can be managed by pharmacological and non-pharmacological means, but this has yet to be proven.² The eruption of primary teeth usually begins around 4-8 months of age with the eruption of the lower incisors, and is complete at around 30-36 months of age when second primary molars erupt. However, the timing of tooth eruption varies by as much as six months.^{3,4}

Teething disturbances are transient but may recur repeatedly during 4 to 36 months of age. Evidence regarding teething signs and symptoms are mostly subjective comments from parents, childcare workers and/or health professionals.^{2,5-12}

Generally, studies on teething have been small, retrospective, descriptive and cross-sectional in nature. Studies of larger cohorts¹³ show no causal association between teething and infection, fever, or diarrhoea.² In some children, teething may be associated with increased drooling, sucking of digits and rubbing of gingivae. Nevertheless, more recent prospective studies reveal that most systemic teething signs and symptoms (fever, vomiting, facial rashes, sleep disturbances, stool looseness, decreased appetite for liquids, and cough) are due to other causes.¹⁴⁻¹⁸

Examples of these alternate causes are well documented in the literature,¹⁹⁻²⁴ and include meningitis, bacterial infections, and herpes simplex virus infections. The latter are painful in their own right.²⁰⁻²³

Teething disturbances may also be caused by development changes, including the decline of maternal antibodies,²⁵⁻²⁷ while wakefulness and night crying may be due to separation anxiety from a parent or attention seeking.

AIM

Even though teething is a normal part of infant development, surprisingly, little is known about the causes and management of its signs and symptoms. Due to the paucity of knowledge in this area, the purpose of this review was to provide clarity on teething symptoms and management options.

METHODS

A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.²⁸

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1. **Yunus I Karjiker:** Primary author - 60%
2. **Jean A Morkel:** Secondary author - 40%

Data Sources and searches

While this was not intended to be a formal systematic review, a search strategy was used to identify the relevant literature. The databases searched were EMBASE, Medline, PubMed, Google Scholar and the Cochrane Library with the keyword search of “teething”, “teething symptoms”, “teething signs”, “teething management”, “teething treatment”, and “teething children”.

A preliminary scoping exercise was undertaken. It indicated that the studies available were too heterogeneous to permit a systematic review or meta-analysis of the interventions developed to tackle the number of children who presented with teething symptoms, eruptions or extractions. Therefore, a narrative review of the literature over a 20-year period (1999-2019) was conducted.

Studies were selected that considered child patients only (as teething symptoms mainly occur between six months and three years of age), had a defined intervention and methodology of patients who presented with varied teething symptoms, a treatment measure, management option or a measured outcome.

The titles and/or abstracts were reviewed to exclude any clearly irrelevant studies. The full texts of the remaining studies were then retrieved and read in full independently to determine whether the studies met the inclusion criteria or not.

Inclusion criteria

In the search, both primary sources and systematic reviews were prioritised as these synthesise the evidence and are at the top of the evidence-based literature as well as studies from the local context. As a second strategy, key scholars from the literature review and institutions were identified, and searched for their recent critical publications, as well as new authors citing them, and which references they had used.

Data extraction and synthesis

Using a standardised data extraction sheet, the following information (if available) was extracted and recorded from studies: authors and year of publication; sample size of participants; age or age range; location; symptoms and management or treatment options.

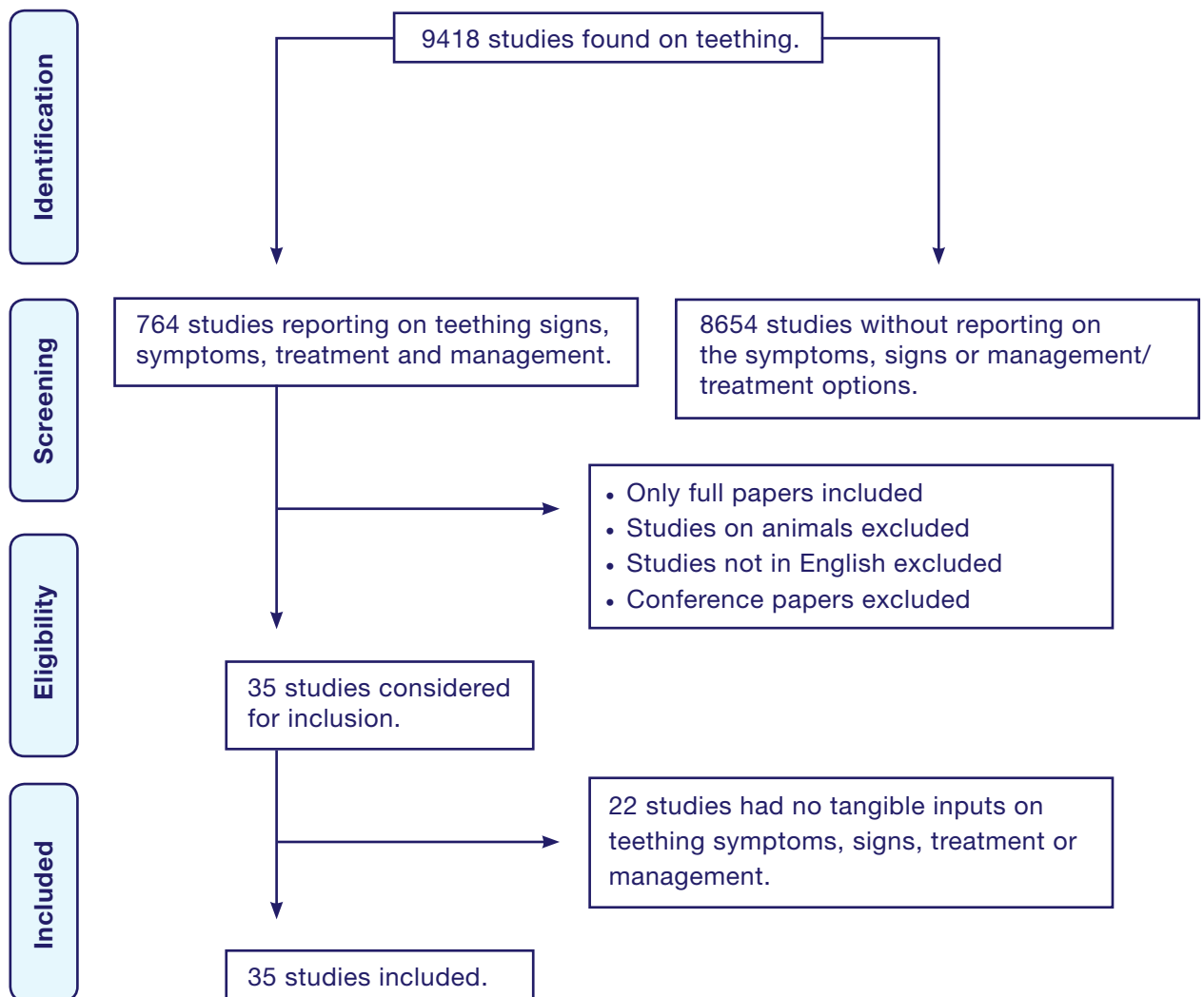


Figure 1. Flowchart of studies included in the narrative review using PRISMA guidelines.

Quality assessment

The PRISMA guidelines were used to examine the quality of the studies. These include adequacy of study design; recruitment of sample; and findings. The quality of the studies was not summarised with a score, as this approach has been criticized for allocating equal weight to different aspects of methodology,²⁹ but a formal assessment of the risk of bias and strength of evidence according to the Agency for Healthcare Research and Quality (AHRQ) guidelines was conducted.³⁰ A study was considered to be of high quality if the study design was prospective in nature, consecutive or a random sampling method was used.

RESULTS

Study selection

The flowchart is shown in Figure 1 for the study selection of which the literature search resulted in 9418 studies. After a review of their titles and abstracts, 764 studies met the inclusion criteria and were retrieved for full text reading.

Of these, 751 studies were excluded from the narrative review as they no longer met the inclusion criteria. A total of 13 studies were included in the review, and the extracted data are summarized in Table 1.

DISCUSSION

This narrative review investigated the available evidence about primary tooth eruption and local and systemic signs and symptoms, along with treatment and management options.

Signs and symptoms

It is now generally accepted that the eruption of the deciduous teeth is accompanied by a number of relatively minor symptoms (Table 1).²⁷ General irritability, disturbed sleep, gum inflammation, drooling, loss of appetite, diarrhoea, circumoral rash, intra-oral ulcers, and increase in body temperature, increased biting, gum-rubbing, sucking, wakefulness and ear-rubbing, have all been identified as being temporally related to teething (Table 1).²⁷

McDonald et al.,¹⁴ described tooth eruption as a physiological process, which does not justify its association with fever and systemic disorders. Fever and respiratory tract infections in this period of life may happen at the same time as eruption but are not associated with it. In the submucosal phase, the number of mast cells is significantly higher than in the intraosseous phase of tooth eruption, and in the submucosa of the normal oral mucosa not associated with teeth. The consequent degranulation and the local release of mediators, such as histamine, leukotrienes, prostaglandins, proteases, cytokines and growth factors, contribute to the understanding of signs and symptoms assigned to tooth eruption, such as itching, inflammation, local redness and sialorrhoea.¹⁴

Macknin et al.,¹ conducted a prospective study that investigated the symptoms associated with infant teething. It was revealed that tooth eruption is associated with a slight temperature elevation, facial rash, sleep disturbance, and ear rubbing. In their study, symptoms of decreased appetite for solid foods, biting, drooling, ear-rubbing, gum rubbing, irritability, rash on face, sucking, abnormal temperature and wakefulness were found to have some association with the teething process.¹

In 2009, Oziegbe et al.,⁹ conducted a cross-sectional study consisting of 1,013 mothers of children between the ages four to 36 months who visited the immunization clinics at the Community Health Centres in Ife Central and Ife East Local Government areas in Nigeria.

A total of 765 mothers (75.5%) reported systemic signs and symptoms in their children. Fever (51.8%), diarrhoea (12.5%), and vomiting (2.9%) were the most prevalent symptoms and signs reported after eruption. However, there was no association between teething and symptoms such as fever or diarrhoea.⁹

In another study, most of the children had one or more signs and symptoms during tooth eruption.³⁴ The most frequent teething symptoms were drooling (92%), sleep disturbances (82.3%) and irritability (75.6%).

These symptoms were more pronounced in low birth weight children.³⁴ Low grade increases in body temperature were observed only on the day of eruption (36.70 ± 0.39 °C), when body temperature was significantly different compared to the day before and on the day.³⁴

Interestingly, in Singapore, significant early-life factors affecting the child's susceptibility to teething-related pain and fever were commonly reported among infants.³⁶ These factors included infants of Chinese ethnicity, who were exposed to tobacco smoke during pregnancy, had childbirth *via* Caesarean section and infants that had elevated levels of prenatal plasma vitamin D.³⁶

Much of the information gathered about teething is based on subjective parental information. According to Shapira et al.,³¹ during the teething period, behavioural problems were observed in 50% of the infants, compared to 16% in the control period ($p < 0.01$); fever was observed in 24% of the infants during tooth eruption and in 8% of the infants during the control period ($p = .04$); and coughing was observed in 12% during tooth eruption compared to 2% ($p = 0.06$) of the infants during the control period. Correlations were also found between high levels of IL-1 β and fever, gastrointestinal disturbances, sleep disturbances, and appetite disturbances.³¹

During the same period, a correlation was observed between high levels of IL-8 and gastrointestinal disturbances. High levels of Tumour Necrosis Factor (TNF) were also correlated with fever and sleep disturbances. The Gingival Crevicular Fluid (GCF) cytokines were correlated to some of the clinical symptoms of teething. IL-1 β and TNF are correlated with fever and sleep disturbances, IL-1 β and IL-8 with gastrointestinal disturbances, and IL-1 β with appetite disturbances.³¹

Table 1. Symptoms and treatment/management options for patients who experienced teething challenges between 1999 and 2019.

Author(s) (year)	n	Age	Location	Symptoms	Treatment / Management
Macknin et al. ¹	125	3 – 5.6 months old	United States	Decreased appetite for solid foods, biting, drooling, ear-rubbing, gum rubbing, irritability, rash on face, sucking, abnormal temperature and wakefulness.	N/A
McIntyre & McIntyre ²⁷	N/A	N/A	Glasgow	Pain inflammation of the mucous membrane overlying the tooth (possibly with small haemorrhages). General irritability/malaise. Disturbed sleep/wakefulness. Facial flushing circumoral rash. Drooling/sialorrhoea, gum rubbing/biting/sucking. Bowel upset (ranging from constipation to loose stools and diarrhoea). Loss of appetite/alteration in volume of fluid intake. Ear rubbing on the same side as the erupting tooth.	A number of supportive measures as well as topical and systemic pharmacological preparations, in addition to alternative holistic therapies can be used to relieve the pain of teething.
Shapira et al. ³¹	16	5-14 months vmonths	Israel	Fever and sleep disturbances, gastrointestinal disturbances, appetite disturbances.	N/A
Oziegbe et al. ⁹	1006	4-36 months	Nigeria	Fever (51.8 %), diarrhoea (12.5%), and vomiting (2.9%).	N/A
Owais et al. ¹⁰	958	0-3 years	Jordan	The desire to bite, gum irritation, increased salivation and loss of appetite were correctly chosen by parents as an association with teething. Almost 75% of the participants attributed fever, diarrhoea and sleep disturbances to teething.	Giving the child a chilled object to bite on, systemic medications and the use of a topical anesthetic.
Ramos-Jorge et al. ³²	47	5 & 15 months Months	Brazil	Irritability, increased salivation, runny nose, loss of appetite, diarrhoea, rash, and sleep disturbance.	N/A
Noor-Mohammed & Basha ³³	1100	4-36 months	India	Fever (16%), drooling (12%), diarrhoea (8%), fever-drooling (15%), fever-diarrhoea (8%), drooling-diarrhoea (6%) and the combination of fever-drooling-diarrhoea was found in 3% of the children.	N/A
Memarpour et al. ³⁴	254	8-36 months	Iran	Drooling (92 %), sleep disturbances (82.3 %) and irritability (75.6 %).	Teething rings, cuddle therapy, rubbing gums.
Elbur et al. ³⁵	493	6 months to about 3 years	Saudi Arabia	Desire to bite 93.1%, fever 87%, gum irritation 84.2%, increased salivation 84% and diarrhoea 83% were the most reported.	About 88 % of parents agreed to the statement “allowing the child to bite on a chilled object will relieve pain associated with teething”, while 346 (70.2 %) preferred the use of systemic analgesics. Teething must be treated in the first instance with an appropriate device which applies local pressure to the gingivae. The use of pharmacological treatment can be limited to certain cases with careful monitoring.
Lam et al. ³⁶	1237	6-18 months	Singapore	Pain 35.5%, fever 49.9%	N/A
El-Gilany et al. ³⁸	457	N/A	Egypt	Correct knowledge related to bite fingers/objects (70.5%) and drooling (60.0%) Inaccurate knowledge was reported as gum rubbing (42.0%), gum swelling diarrhoea (51.0%), fever (83.2%) and weight loss (46.0%).	Mother's false beliefs may interfere with the prompt diagnosis and management of serious illnesses (Kakatkar et al., 2012).
Ip et al. ³⁹	200 pharmacists	N/A	San Francisco	N/A	Almost two-thirds (63.0%) of the pharmacists would incorrectly recommend a benzocaine-containing product, with benzocaine 7.5% gel being the most common product.

Owais et al.,¹⁰ stated that there are side effects from teething, but any real cause-and-effect relationship is doubtful. In addition, it was also postulated that high body temperature (higher than 39°C) should not be attributed to teething and should be further investigated. Plutzer⁴⁰ conducted a randomized controlled trial on how first-time mothers perceive and deal with teething symptoms. It was revealed that teething symptoms, which are at the very root of the problem, are still poorly understood, despite many commendable efforts over the last 10 years to address them.

Their physiological or pathophysiological basis is not in doubt, but what they lead to in terms of discomfort is poorly understood. Partially, this is due to the confusion between the signs and symptoms. Symptoms are what a patient experience, but children getting their first few teeth can only communicate these through signs and signals that their caregivers can interpret.

Memarpour et al.,³⁴ conducted a clinical trial of non-pharmacological remedies with regards to the signs and symptoms associated with primary tooth eruption. It was found that most of the children in the study had one or more signs and symptoms during tooth eruption. The study found that tooth eruption was accompanied by local disturbances such as drooling and the urge to chew on objects.³⁴

An association has also been shown between general objective signs (drooling, fever, and diarrhoea) and the eruption of primary teeth with fever being the most prevalent sign followed by drooling and a fever-drooling combination.³³ It was further stated that most signs appeared during the eruption of the primary incisors.³³ Furthermore, when an infant at teething age has some symptoms, they may be attributed to teething, but other possible causes must be ruled out first.³³

Another study had results that demonstrated associations between teething and sleep disturbance, increased salivation, rash, runny nose, diarrhoea, loss of appetite, irritability, and a slight rise in temperature.³² These associations were significant on the day of eruption and one day after eruption. Therefore, it is not possible to predict eruption through the observation of signs and symptoms because there were no associations on the day before eruption.

The findings of this study contribute towards supporting the concept that teething is not associated with severe signs and symptoms. Therefore, health professionals involved in the care of infants should seek other causes before attributing severe signs and symptoms to teething.³²

Based on the current limited evidence by Massignan et al.,³⁷, there are signs and symptoms during primary tooth eruption. Gingival irritation, irritability, and drooling were the most common.

For body temperature analyses, it was possible to evaluate that eruption of primary teeth is associated with a rise in temperature, but it was not characterized as fever. There are also results which showed a wide gap in knowledge and misconceptions with regards

to the ascribed signs and symptoms and practices used to manage infant teething problems.³⁵

Treatment and management options

Aside from teething signs and symptoms, there has been a number of recommended options suggested for management and treatment.

El-Gilany et al.,³⁸ studied mothers' teething beliefs and treatment practices in Egypt. Their study showed that 13.6% of mothers did not give any treatment for teething problems. Analgesics/antipyretics, pacifiers and antibiotics were the most frequently given treatments (71.3%, 31.3% and 24.3%; respectively).

Relatives, friends and health care workers were the most frequent source of mothers' information about teething problems and their treatments. Deciduous tooth eruption has already been inaccurately associated with several health disorders, such as sleep disruption, ear and cheek itching, primary herpetic gingivostomatitis, cough, croup, bronchitis, diarrhoea, fever, convulsions and (in severe cases) even death.

Objectively, Memarpour et al.,³⁴ presented two main methods - pharmacological and nonpharmacological - which have been recommended as treatments during tooth eruption. Non-pharmacological remedies were used because of the parents' attitudes towards using remedies which do not threaten their child's health. According to their results, some methods such as teething rings, cuddle therapy and rubbing the gums were more effective than others. However, none of the methods was completely effective in dealing with all the teething problems that was reviewed.

Teething rings and rubbing the gums reduced gingival irritation and finger sucking. in the present study.³ The pressure caused by biting teething rings or pacifiers and gingival massage may decrease pain by overwhelming the sensory receptors. Biting or sucking cold or frozen objects including fruits, vegetables or other foods causes localised vasoconstriction and decreases inflammation; in addition, the pressure on the gums reduces pain. However, it is suggested that these remedies should be used only for children who are able to eat solid foods. Also, foods that are very hard should not be used, to avoid pain caused by bruising the gum.⁴ Moreover, parental supervision is needed to prevent choking on small pieces of food.³⁴

In 2018, Ip et al.,³⁹ mentioned that the Food and Drug Administration (FDA) issued a warning to avoid the use of any benzocaine-containing products for infant teething treatment owing to a risk of methaemoglobinemia. Despite the release of this drug safety warning regarding the use of benzocaine-containing products in infant teething treatment, the majority of pharmacists in their study indicated that they would still incorrectly recommend a benzocaine containing product. Further education is warranted to ensure that all pharmacists, health care providers, and consumers are aware to avoid benzocaine, viscous lidocaine, and homeopathic products for infant teething treatment.

Limitations

This study has several limitations. The included studies were not specifically designed to answer prospectively the question as to what tangible symptoms and signs as well as treatment options there are for teething and, therefore, a large diversity in studies, study designs, patient categories with different diagnoses, definitions, subjective insights from parents and severity of teething were combined.

Some studies with a low sample number were also included as it matched the inclusion criteria either for children who presented with signs and symptoms of teething, or where there were adequate options for treatment and management of teething. Due to the limited number of studies included in the review, the findings from this study are not generalizable to a number of population groups and patient settings.

CONCLUSION

This review has shown that although conventional and generic treatment options are constantly in use, there still remains no concrete evidence to prove signs and symptoms of teething nor evidence to disprove it. However, in this review, symptoms such as irritability, increased salivation, runny nose, loss of appetite, diarrhoea, rash, sleep disturbance and gum rubbing were most apparent. Further studies are needed to ascertain these findings objectively and conclusively. Future research is also required to understand and investigate the efficacy of treatment methods and approaches among children with teething symptoms.

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Declaration

Authors have no potential conflict of interest to declare.

Compliance with ethical standards

This research is compliant with ethical research standards.

Ethical approval

Ethical approval for this type of study and formal consent is not required. This article does not contain any studies with humans or animals performed by any of the authors.

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4.

What's new for the clinician?

- excerpts from and summaries of recently published papers

SADJ March 2020, Vol. 75 No. 2 p96 - p99

Compiled and edited by V Yengopal

1. Effectiveness of three different oral moisturizers in palliative care patients

SF Kvalheim, MC Marthinussen, DF Haugen, E Berg, GV Strand, SA Lie.
Randomized controlled trial of the effectiveness of three different oral moisturizers in palliative care patients. *Eur J Oral Sci.* 2019; 127: 523-30.

Saliva is crucial for maintaining optimal oral health. Healthy individuals produce resting (unstimulated) whole saliva at a rate of 0.3-0.4 ml min⁻¹. The subjective feeling of xerostomia is thought to occur when less saliva is secreted than the amount of water lost from the mouth by evaporation and by absorption through the oral mucosa.¹

Mucin-rich resting saliva lubricates mucous membranes and teeth, and stimulated saliva plays an important role in mastication, speech, swallowing, and digestion. Constituents such as lactoferrin, peroxidase, and histatin contribute to salivary antimicrobial, antiviral, and antifungal properties.¹

In individuals with failing salivation, these important properties of saliva in the oral cavity are reduced or absent, causing dry and sore mucous membranes, delayed wound healing, rapid development of caries and erosion, fungal infections of the mouth and throat, discomfort, pain, and problems using dentures.¹ Dry mouth can also lead to swallowing difficulties, speech disturbances, loss of appetite, dehydration, and malnutrition, thus having a negative effect on diseases and contributing to reduced quality of life, particularly in life's final phase.¹

Many patients in palliative care (Palliative care is the active treatment and care for patients with incurable diseases and short life expectancy) have received treatment or medications that may have adverse effects on oral health which commonly manifests as dry mouth or xerostomia. A range of different products are used in an effort to alleviate the symptoms of dry mouth. There are several commercially available mouthwashes and gels.

Kvalheim and colleagues (2019)¹ sought to test the efficacy of three moisturizers [17% watery solution of glycerol, oxygenated glycerol triester (OGT), and a newly developed product (Salient)] was compared] in a randomised clinical trial (RCT).

The trial was designed to answer the following question: Do any of the three agents improve xerostomia, reduce pain and discomfort, and improve ability to talk in palliative care patients? The hypothesis was that there was no difference in efficacy between 17% glycerol, OGT, and Salient.

MATERIALS AND METHODS

The study was designed as an RCT with a crossover design. All patients were treated with three oral-care products.

Thirty patients were recruited from two palliative care units in Norway. Eligibility criteria for participants were: xerostomia (subjective feeling of dry mouth); in institutionalized palliative care; curative treatment of existing diseases completed or terminated; WHO performance status \geq III (corresponding to Karnofsky Performance Status Score of 30%–40% (i.e., only capable of limited self-care, confined to bed or chair more than 50% of wake time); cognitively functioning, capable of and willing to give written consent, capable of giving responses to a limited questionnaire; and expected to remain at the care centre for a minimum of 3 days.

Patients who had previously been treated with chemotherapy and/or radiotherapy to the head and neck region were excluded.

The project leader assigned the participants to the interventions. The intervention was, in general, carried out after morning routine care and breakfast. Each product was applied at the same time of day to avoid the risk that diurnal variation in health status might influence the outcome.

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If the patient agreed to participate, he/she answered a short questionnaire, which contained the primary outcome measures of subjective xerostomia, discomfort and pain, and speech problems.

These measures were recorded on a 5-point ordinal Likert scale at three points in time: before the intervention; immediately after the intervention; and 2h after the intervention. In addition, evaluations of taste and application method of the products used were recorded on a 3-point ordinal scale. After all products had been applied and procedures completed (2h after the last intervention, normally on day 3), patient preference of the three products was recorded on a 4-point nominal scale on the same questionnaire. At the same time, the patients were asked to comment freely on the products and procedures.

The products were presented in neutral containers without labels, ensuring that the patients were blinded as to their content. The dentist who carried out the intervention could not be similarly blinded because of the differences in application methods for the three products. The three products compared in this study were: (i) a 17% watery solution of glycerol, (ii) Oxygenated glycerol triester (OGT) and, (iii) Salient.

The total duration of the intervention was thus normally 3 days. The night following each application was considered a washout period, after which a new product could be applied.

RESULTS

Of the 30 patients, 17 (57%) were female (mean age = 68 yr.) and 13 were male (mean age = 69 yr.). The main diagnosis was cancer in 28 (93%) of the patients; 12 (40%) had WHO performance status III and 18 (60%) had status IV.

Relative to baseline recordings, all products produced improvements immediately after the intervention. At this time, a higher number of respondents treated with glycerol reported no or minimal oral dryness (indicated by the green shades of the columns) compared with respondents treated with OGT.

Two hours after intervention, the effect of glycerol had decreased relative to the other two products (in fact, had reverted to baseline), whereas the effects of OGT and Salient largely persisted.

Relative to baseline recordings, all products impacted significantly in reducing the occurrence of speech problems immediately after intervention. At this time, there were no significant differences between the products. Two hours after the intervention, the effect of glycerol had dropped by a larger amount than that of the two other products and was no longer different from baseline, whereas the effects of OGT and Salient largely persisted.

No statistically significant carry-over effect was discovered for xerostomia, discomfort and pain, or speech problems (smallest $P = 0.13$).

Whereas 22 (73%) of the 30 patients reported that the application method of glycerol was agreeable, only a few felt that about Salient. OGT occupied an intermediate position between glycerol and Salient.

In terms of taste, OGT was disliked by 23 (77%) of 30 patients. For the other products, most respondents reported a neutral taste. The majority of patients (19/30, 63%) preferred glycerol ($P < 0.001$). The corresponding numbers for Salient and OGT were six (20%) of 30 and three (10%) of 30, respectively. Two of the patients preferred not to use any of the three products. There was no association between the preferred product and on which day the preferred product was applied ($P = 0.48$).

All patients commented on the treatment received. The remarks concerning xerostomia, taste, application method, and preferred product mirrored those reported above. The sticky, glutinous consistency of Salient was mentioned by 18 (60%) of 30 patients. In addition, 11 (37%) of 30 patients characterized the taste of OGT as strange, strong, oily, rancid, nauseating, or disgusting.

Others (4/30, 13%) were dissatisfied with the use of a small spoon when dispensing Salient, and an equal number of patients commented that the most important factor for their well-being was oral care in itself; that is, getting help with brushing their teeth and cleaning the mucosa.

CONCLUSION

Within the defined limitations of this study, the researchers conclude that none of the three tested products was found to be clinically completely adequate. The 17% concentration of glycerol had the most positive effect immediately after application, but little or no effect 2 h thereafter.

OGT and Salient had a long-lasting effect, but were nevertheless not preferred by the patients - probably because of the disagreeable taste of the former and the unpleasant, sticky consistency of the latter.

Implications for practice

The glycerol solution was preferred by this group of patients but its effect was short-lived effect. However, this can be compensated for by frequent applications. Additionally, glycerol is relatively cheap and is easily available at most pharmacies without a prescription.

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2. Bisphenol A in human saliva and urine before and after treatment with composite resin restorative materials

TLL Berge, GB Lygre, SA Lie, CH Lindh, L Björkman.

Bisphenol A in human saliva and urine before and after treatment with dental polymer-based restorative materials. *Eur J Oral Sci.* 2019; 127: 435-44.

There is considerable concern among scientists and the public about the hormone-mimicking properties of many chemical components of plastics, including those found in dental composites¹. The commonly used Bis-GMA resin uses one of the most controversial of these, Bisphenol-A (BPA).

Bisphenol A (BPA) is a synthetic chemical substance, produced in large quantities and widely used in the production of polycarbonate plastics, epoxy resins, dental monomers, thermal paper, and numerous other products.¹ Responsible composite manufacturers claim that there is no unreacted BPA in dental resins, and that it takes high temperatures – several hundred degrees – to liberate free BPA. Other critics say that, in fact, the ester bonds in resins are subject to hydrolysis, and BPA can be liberated in measurable quantities.¹

BPA levels in human populations have been associated with reproductive abnormalities, adverse developmental effects, metabolic disease, and breast cancer, among other health conditions.¹ There is wide interest in the sources of BPA exposure. The primary source of human exposure is assumed to be through the diet because BPA can leach into food and beverages from containers made of polycarbonate plastic or lined with epoxy resin coatings.¹ However, results from studies have indicated human exposure also from numerous non-dietary sources, including dust and indoor air, thermal paper, cosmetics, and dental materials.¹

Berge and colleagues (2019)¹ reported on a study that sought to quantify BPA concentrations in saliva and urine, before and after treatment with dental polymer-based restorative materials, to assess if placement of these materials is associated with increased BPA levels in saliva and urine.

MATERIALS AND METHODS

Twenty patients, aged between 16 and 40 years old, without any known diseases or medications at the time of the study and in need of at least one dental restoration, involving two or more tooth surfaces, with a polymer-based restorative material were included.

Individuals with removable dentures, dental splints, and those who currently were undergoing orthodontic treatment, individuals who had received polymer-based dental fillings during the previous 3 months were excluded. Smokers, snuff users, and drug abusers were also excluded.

One dentist recorded the number of tooth surfaces previously filled with tooth-coloured restorative materials. The same dentist also provided the dental treatment.

The treatment was performed according to standardized procedures and materials used at the clinic. The cavities were restored with a widely used filling material (Tetric EvoCeram) which contained Bis-GMA. The bonding procedure and the application of filling material were carried out according to the manufacturers' instructions.

For each participant, a new compule with filling material was used. The material was applied in incremental layers of <2.0 mm, and each layer was cured for 20-30s. Care was taken to avoid application of excessive amounts of material. Any surplus was removed and put back into the compule. Each compule was weighed before and after treatment, using an analytical balance.

The amount (weight in g) of polymer-based material used in each participant was estimated by the difference between the two measurements. The curing lamp emitted 600-700mW cm⁻² light intensity at a range of 440-460 nm. The lamp was controlled prior to each treatment using a hand-held curing radiometer. After curing, the fillings were polished according to standard procedures using polishing diamond burs, polishing disks, and silicone polishers.

The restorations differed in size depending on the tooth size and the extent of the prepared lesion. To adjust for differences, each filling surface was given scores from 1 to 3, depending on its area. Small restorations were given the lowest score of 1. Restorations of intermediate size, typically the approximal or occlusal surfaces of Class II restorations in premolars, were given a score of 2. The highest score, 3, was used for molars to denote restorations extending over the total occlusal fissure pattern or over the approximal surface of Class II restorations.

The scores for all polymer-based filling surfaces treated in each patient were summed and yielded the variable 'filling points'. The tooth surfaces treated and the estimated 'filling points' were recorded.

All treatment sessions were scheduled in the morning before 9 AM. Each participant provided a total of five 2ml saliva samples and four 100ml urine samples. The first saliva and urine samples were collected immediately before treatment, after a 10h fast.

Sampling of a second saliva sample was started 10 min after placement of the polymer-based fillings, and subsequent saliva and urine samples were collected 1 h, 24 h, and 1 wk. after placement of the fillings. On each day of sampling, the participants also answered questions regarding consumption of canned and microwaved food during the previous week and within the previous 24 h.

To reduce exposure from other potential sources of BPA, the participants were instructed to abstain from eating, drinking, and brushing their teeth for at least 10h prior to sampling.

Only tap-water was allowed for drinking. The participants were asked not to use lip balm or lipstick during the same period. To identify possible contamination during sampling, transport, and storage, field blanks were collected using ultra-pure water instead of saliva and urine. The field blanks were treated like the NA, not applicable.

RESULTS

The saliva samples collected 10 min after treatment showed a statistically significant increase in BPA levels compared with the pre-treatment samples. The concentrations remained significantly elevated 1 h, 24 h, and 1 wk. after placement. After the immediate post-treatment increase, the concentration of BPA in saliva decreased exponentially. In saliva, no conjugated BPA was detected. Pre-treatment levels of BPA in saliva were low, and the mean value was estimated to be 0.11 ng ml^{-1} .

Before treatment, 11 (55%) of 20 participants had salivary BPA levels below the limit of detection (0.1 ng ml^{-1}). In one saliva sample collected before treatment, the BPA concentration was more than 100 times higher (11.6 ng ml^{-1}) than the mean value and more than 100 SD from the mean of the remaining 19 samples.

This saliva sample was excluded from the statistical analysis because it was probably contaminated. One participant had breakfast before the sample time point 1 wk. after treatment, and thus the samples collected from this participant at this time point were not included in the statistical analysis.

The levels of BPA concentrations in saliva were confirmed by analysing nine samples in a laboratory. Secondary explorative analysis showed that the number of filling points was associated with the BPA levels in saliva, 24 h ($P = 0.011$) and 1 wk. ($P = 0.029$) after treatment.

However, neither the number of filling surfaces nor the amount (weight) of dental polymer-based material placed was associated with the salivary BPA concentration at any time point (all $P > 0.05$). Moreover, there were no statistically significant associations between the other covariates tested and the salivary BPA levels at the different time points.

Before treatment, 19 (95%) of 20 participants had detectable levels of BPA in their urine. There were no statistically significant differences between urinary BPA levels before and after placement of the dental polymer-based restorations. The BPA levels in the urine samples collected 1 h after treatment did not show a statistically significant association with the BPA level in the saliva samples collected 10 min after treatment.

All field blanks had BPA concentrations below the detection limit.

CONCLUSIONS

The findings in this study confirm that placement of dental polymer-based restorative materials may cause a substantial increase in the concentration of salivary BPA after treatment. The results indicate that exposure to BPA is relatively short and transient. After 1 wk., the concentration of BPA in saliva was only slightly elevated compared with the levels before treatment. This study did not show changes in the BPA concentration in urine after treatment with a dental polymer-based restorative material.

Implications for practice

The findings of this study confirm that composite materials do contribute to raised salivary levels of BPA. This can be of concern if the patient has exposure to BPA from other sources such as plastic bottles, etc.

Reference

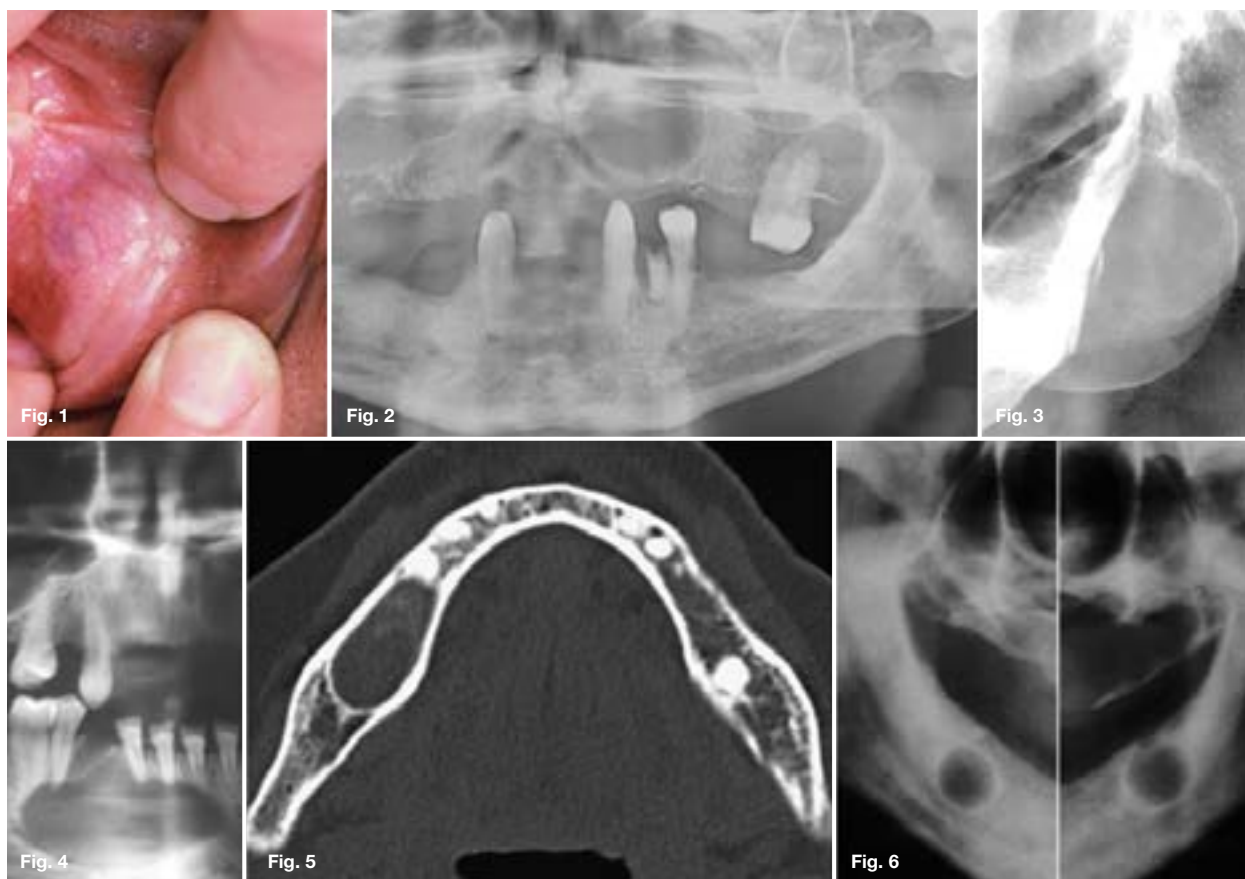
1. Berge, TLL, Lygre, GB, Lie, SA, Lindh, CH, Björkman, L. Bisphenol A in human saliva and urine before and after treatment with dental polymer-based restorative materials. *Eur J Oral Sci.* 2019; 127: 435-44.

Maxillofacial Radiology 178

SADJ March 2020, Vol. 75 No. 2 p100

CJ Nortjé

Below are a clinical picture and several radiographic images of a pathological lesion that may present in the maxillofacial region of a patient. Discuss the radiographic features and what is your diagnosis?



INTERPRETATION

The classic radiological appearance of the above lesions is that they are round or ovoid radiolucencies surrounded by a narrow radiopaque margin. A histological diagnosis of residual radicular cyst was made. These cysts are those that are retained after removal of the offending non-vital tooth. There have been a relatively few publications on the subject although it has been estimated that they present 10% of all odontogenic cysts. Figure 6 illustrates two residual radicular cysts on a SS White Panorex taken forty years ago. The histopathological features of the residual cyst are similar to those described for conventional radicular cysts. However, because the cause of the cyst has been removed, residual cysts may progressively become less inflamed so that eventually the cyst wall is composed of uninfamed collagenous fibrous tissue. The epithelial lining may be thin and regular and indistinguishable from a developmental cyst or lateral periodontal cyst. In these cases it is important to establish the relationship of the lesion to the teeth involved.

A few well documented cases have been reported which indicate that squamous carcinoma may occasionally arise from the epithelial lining of radicular and residual radicular cysts. Any number of odontogenic and nonodontogenic cysts and tumours can mimic the appearance of a residual radicular cyst. Calcifications of various kinds are frequently present and are a particular feature of residual radicular cysts that have been present for a long time. These lesions should be excised surgically, even in the absence of symptoms. The residual cysts do not recur after appropriate management, however intraosseous fibrous scars are possible, especially when both cortical plates have been lost; this can give the appearance of a persistent radiolucent lesion. Finally a number of pathologists (Bhaskar, 1972) concluded that the majority of radicular cysts undergo resolution following root canal therapy and do not require surgical intervention.

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Can an ethical question answered with a “Yes, but...” ever be defensible?

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LM Sykes¹, E Crafford², C Bradfield²

INTRODUCTION

This paper will use the issue of sterility of medical equipment as an example, but the points discussed may be extrapolated to a number of other areas in the dental setting.

In 1970 Spaulding suggested that all medical equipment and instruments be grouped into one of three categories according to the risk of infection during their use. He then suggested that they be cleaned and treated accordingly by either “sterilization” or “high-level disinfection” where sterilization refers to “a procedure that inactivates all microorganisms, including resistant bacterial spores, resulting in a device that is free of all living microorganisms”, and high-level disinfection as “a procedure that inactivates all fungi, viruses, and vegetative microorganisms, but not all bacterial spores”.¹ The three categories and protocols to follow are:

Critical equipment

Devices that enter sterile tissues, including the vascular system and which should be cleaned and sterilized between use.

Semicritical equipment

Devices that come into contact with non-intact skin or mucous membranes but do not penetrate them, and should be cleaned and followed by high-level disinfection as a minimum, but preferably sterilized between use.

Noncritical equipment

Devices that touch intact skin and not mucous membranes, or do not directly touch the patient. These should be cleaned and preferably also treated with low-level disinfection.

ACRONYM

CDC: Centers for Disease Control



Image source: by Senior Airman Janiqua P. Robinson (U.S. Air Force photo).

This protocol is logical, simplistic and effective if used correctly. However many studies have revealed that there are still often large gaps between what is recommended and what is practiced clinically.²

Rutala et al. reported on a study where over 50% of medical institutions were correctly cleaning and disinfecting their equipment, but then rinsing them with tap water after processing, and thereby re-exposing them to a variety of waterborne organisms.³

In addition, the CDC Guidelines for environmental control is constantly updating its policies as newer, more effective chemical agents become available, or the efficacy of older regimes deteriorates.⁴ The onus is thus on clinicians to be aware of and use the latest recommended regimes for each class of equipment or instruments.

The necessary information is readily available on internet sites, which makes it unacceptable to try to justify oversights in sterility by pleading unintentional ignorance or adherence to outdated practices. It goes without saying that it is totally indefensible if they are as a result of blatant disregard or neglect.

A complacent attitude and drop in levels of infection control may also develop over time, especially if no serious consequences are ever noticed. It is expected that every effort must be made by a reasonable health-care practitioner to obtain and understand the latest protocols and best practice in this regard.

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1. **Leanne M Sykes:** Primary author - 40%
2. **Elmine Crafford:** Secondary author - 30%
3. **Charles Bradfield:** Registrar - 30%

ETHICAL SCENARIO

A patient's risk of becoming infected from unsterile instruments will depend on a number of factors. These include the procedure being carried out, the type of organisms present, their transferability, infectivity and pathogenicity, as well as the patient's state of immunity.

No clinician can know which of these factors may be at play in any given situation. As such they should always expect, plan and behave according to protocols for the worst risk situation in terms of microorganism pathogenicity, transfer and patient immunity.

This entails strict adherence to the recommended sterilization and disinfection guidelines for all instruments as well as during all stages of clinical treatment. This will also help safeguard theirs and their staff's health and safety.

The above mentioned guidelines are non-negotiable in any reputable dental practice. Furthermore, time constraints and financial justification can never be used as factors to mitigate against following the correct procedures.

The ethical issues to consider will arise when a clinician finds themselves in a less-than-ideal setting, with a limited supply of instruments, insufficient disinfecting agents or inferior sterilizing facilities. This is often the case in rural South African settings, made worse by high volumes of patients seeking treatment. Is it then permissible to treat with instruments that may have only been washed, perhaps disinfected but probably not fully sterilized?



DISCUSSION POINTS

Can and should the dentist go ahead and treat the patients with potentially hazardous equipment? We may debate this question in terms of the four-principles approach to ethics as developed by Beauchamp and Childress in 1983.⁵ These are:

1. **Beneficence** (doing good)
2. **Non-maleficence** (do no harm)
3. **Respect** for patient autonomy
4. **Justice**

When considering beneficence and non-maleficence, the clinician may wish to do good and help the patients, but at the same time feel compelled to refuse treatment because of concerns that the working conditions are not ideal, and the possible harms this may cause.

This will result in them turning away a number of patients who could be in pain, or suffering from serious dental infections. What then will happen to these patients? They may have traveled long distances, taken time off work, spent their hard earned money getting to the clinic, and have no other means of getting treatment. They may develop exacerbated pain or more serious complications and could resort to seeking help from some other, perhaps untrained or even risky and dangerous persons.

If the dentist debates the issue using the principle of respect for autonomy, they may decide to advise the patient about all the limitations and potential problems involved in treatment, and allow them to decide for themselves if they are prepared to take the risk? They could then ask the patient to sign consent for treatment and cover themselves in the event of any adverse events.

That argument seems fair. However, as always in ethics there are more issues to consider. The patient has probably already made sacrifices getting to the dentist and will be reluctant to return home untreated. In addition, if they are in pain, they are considered vulnerable subjects, and would be signing out of desperation.

Others may not fully understand the information nor comprehend the possible implications. While disclosure of information is one of the key elements of consent, there is also the requirements of competence to understand and voluntariness which these patients may not have.

Could the dentist consider carrying out non-sterile procedures with antibiotic cover "just in case"? The appropriate medication may or may not be available and such practices lead to the problems of overprescribing, and antibiotic resistance.

A worse scenario would be if the patient developed and allergic reaction to the medication after the clinician had left. This could have potentially fatal consequences. Who would then be held accountable?

Furthermore antibiotics are often given for bacterial infections, but salivary transmittable viral infections are often overlooked.

Justice refers to fairness and includes consideration of legal, distributive and rights-based justice. Legal issues are complex and generally arise when some form of harm or damage has been inflicted on a patient. However an ethico-legal question is whether a dentist who has the expertise and ability to treat patients can justify turning them away?

In South Africa, a more pertinent discussion revolves around distributive justice. In the public health sector resources are limited and the dentist has to decide on how to distribute these fairly. If all patients are considered equal, how can one determine who is most deserving, in the most pain, or in greatest need.⁶

Rights-based justice may be based on the Batho Pele Principles. In terms of treatment, the principle of Access may be applied. This states that: All citizens have the right to equal access to the services to which they are entitled. This especially applies to disabled people, illiterate people and rural people who may have difficulty accessing government services.

Public servants have a special role to play, to make sure that those who need extra assistance get it.⁷ The ethical, compassionate dentist is often torn between their desire to adhere to these principles, and the harsh reality of not being able to comply due to local economic situation. It's no wonder then that dentistry is considered a stressful occupation!

“Best practice” principles to follow for reprocessing medical equipment and instruments

In the above scenario, if the dentist does treat patients while being fully aware that conditions are compromised, can this not then set a precedent for them to allow latitude in other areas of the practice? How many clinicians can honestly say they have not worked with the same bur on two different patients, re-used single-use items, not washed their hands between gloving, or carried out other “minor” transgressions in sterility?

The trouble is that once a door is opened for small lapses, it becomes all the more easy for others to slip through thereafter, which can potentially compromise the health and safety of their patients and staff.

This paper will not go into detail on the chain of duties, procedures, responsibilities and checklists that should be part of the standard disinfection protocol. However, clinicians need to be cognizant that sterilization and disinfection strategies are constantly changing, and they need to stay current and adjust their regimes accordingly.

Recent guidelines have been added for the inactivation of emerging pathogens, bioterrorist agents, and newly discovered blood-borne pathogens. In addition, other protocols have been altered to address toxicology, environmental and occupational concerns due to exposure to the chemicals.⁸

CONCLUSION

In all endeavors a chain is only as strong as the weakest link. It is futile for a clinician to be fully committed and adherent to evidence based practice in certain areas, but then allow for lapses in others.

Professionalism entails striving to always maintain the highest performance standards for all patients regardless of the circumstances. This is not always practically possible and that is where their integrity and moral values come into play.

We hope that this paper will stimulate a level of introspection as well as some convivial debates between colleagues around controversial issues in dentistry. We once again welcome feedback, comments and advice for others to follow.



Image source: by Senior Airman Brittany Y. Bateman (U.S. Air Force photo).

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CPD questionnaire

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GENERAL

Examining the relationship between Dental Technology students' learning styles and their performance in entrance tests

1. Identify the CORRECT statement. A learning style is defined as:
 - A. the habitual manner of gaining knowledge through study and experience
 - B. the habitual manner of gaining skills through study and experience
 - C. the habitual manner of gaining attitudes through study and experience
 - D. All of the above
2. Identify the CORRECT statement. Visual learners prefer to see information and use visual aids, while Aural learners prefer to:
 - A. continually read and write the information
 - B. learn by doing and performing tasks
 - C. listen and speak before reading and writing
 - D. use diagrams to learn
3. Identify the CORRECT answer. Dental Technology hinges at the interface between disciplinary knowledge and the field of professional practice and is therefore typified as a:
 - A. boundary
 - B. singular
 - C. region
 - D. vocation
4. Identify the CORRECT answer. Most unimodal Dental Technology students preferred to learn:
 - A. aurally
 - B. visually
 - C. kinaesthetically
 - D. writing
5. Identify the CORRECT statement. Cross tabulation results between the manual dexterity sections and VARK results revealed that out of the 16 students who scored between 60-69%, the preferred mode of information processing was:
 - A. kinaesthetic
 - B. aural, read/write and kinaesthetic
 - C. read/write
 - D. visual, aural, read/write and kinaesthetic
6. Identify the CORRECT statement. While there is no correlation between students' performances in entrance tests and their preferred learning styles, the most dominant learning styles among Dental Technology students were:
 - A. unimodal (kinaesthetic) and aural, read/write and kinaesthetic (ARK)
 - B. unimodal (kinaesthetic) and quadri-modal (VARK).
 - C. unimodal (kinaesthetic)
 - D. quadrimodal (VARK)

The effect of storage conditions on the deformation patterns of acrylic partial denture bases

7. Identify the CORRECT answer. Expansion of the wet-stored denture base in the incisal area occurred between which days?
 - A. Day 1 to day 2
 - B. Day 2 to day 7
 - C. Day 14 to day 28
 - D. Day 7 to day 21
 - E. Day 14 to day 21
8. Identify the CORRECT answer. What method was used to measure the degree of deformation?
 - A. Silicone wafer method
 - B. 3D scanner method
 - C. Travelling microscope method
 - D. Micrometer method
 - E. None of the above
9. Identify the CORRECT answer. Which reference area of the denture base showed no significant difference in deformation?
 - A. Incisal area
 - B. Deepest part of the midline area posteriorly
 - C. Area of the maxillary right first molar
 - D. Area of the maxillary left first molar
 - E. None of the above
10. Identify the CORRECT answer. On which days were the dimensional deformation of the acrylic partial denture base specimens measured?
 - A. Immediately after fabrication (day 1) and subsequently on days 4, 8, 12, 21 and 28
 - B. Immediately after fabrication (day 1) and subsequently on days 5, 10, 15, 20 and 25
 - C. Immediately after fabrication (day 1) and subsequently on days 2, 6, 12, 21 and 30
 - D. Immediately after fabrication (day 1) and subsequently on days 3, 6, 12, 21 and 28
 - E. Immediately after fabrication (day 1) and subsequently on days 2, 7, 14, 21 and 28

Death of a child due to dog bites - a bite mark analysis

11. Identify the CORRECT statement.
Which of the following statements regarding dog bites is the most accurate:
- A dog bite mark has the similar pattern of bruises as seen in a human bite mark.
 - The incisor teeth in a dog bite mark produce a distinct curvature of bruises as seen in human bite marks
 - The irregularity in the size and shape of the puncture wounds seen in a dog bite pattern are due to the shaking of the head of the animal while inflicting the bite
 - The analysis of a dog bite mark relies on the matching of the inter-canine distance with the centers of the puncture wounds on the victim

A combined therapeutic approach to treating a challenging case of Dens Invaginatus - a literature review with an illustrative case report

12. Identify the CORRECT answer.
According to the available literature, dens invaginatus teeth may pose challenges concerning which of the following:
- Aesthetics and occlusion
 - Periodontal disease
 - Development of temporomandibular disorders
 - Fractures of opposing teeth
13. Identify the CORRECT answer.
According to available literature, the aetiology of the dens invaginatus phenomenon is:
- genetics
 - smoking
 - diet
 - not clear
14. Identify the CORRECT answer.
The following instrument was used for root canal preparation:
- The WaveOne Gold Large reciprocating instrument
 - The WaveOne Gold Primary reciprocating instrument
 - ProTaper Universal F3 full rotation instrument
 - None of the above
15. Identify the CORRECT answer.
Which ultrasonic tip was used to open root canal space and gain improved access to the C-shaped canal configuration:
- Start-X number 3
 - Start-X number 2
 - Start-X number 5
 - All of the above

Teeth symptoms and management during infancy - a narrative review

16. Identify the CORRECT answer.
What were the most apparent teething signs and symptoms reported:
- Irritability, increased salivation, runny nose, loss of appetite, diarrhoea, rash, sleep disturbance and gum rubbing
 - Fever, Irritability, increased salivation, runny nose, loss of appetite, diarrhoea, rash, sleep disturbance and gum rubbing
 - Fever, diarrhoea, vomiting, stomach cramps, runny nose, flu like symptoms
 - Fever, sleep disturbance, irritability
 - All of the above
17. Identify the CORRECT statement.
Mast cells are significantly higher:
- in normal oral mucosa not associated with teeth
 - in the submucosal phase of tooth eruption
 - in the intraosseous phase of tooth eruption
 - in the saliva at the time of tooth eruption
 - All of the above
18. Identify the CORRECT statement.
Significant early-life factors believed to affect the child's susceptibility to teething-related pain and fever are:
- tobacco smoke exposure
 - childbirth via Caesarean section
 - higher levels of prenatal vitamin D levels
 - ethnicity
 - All of the above

Clinical Windows - What's new for the clinician?

19. Identify the CORRECT answer.
In the Kvalheim et al. study, the following is true:
- Patients used only 1 of the 3 oral moisturizers
 - Patients used only 2 of the 3 oral moisturizers
 - Patients used 3 of the 3 oral moisturizers
 - Patients used none of the 3 oral moisturizers
20. In the Berge et al. trial, the saliva and urine samples collected 10 min after treatment showed a statistically significant increase in BPA levels compared with the pre-treatment samples.
- True
 - False

ETHICS**Can an ethical question answered with a “Yes, but...” ever be defensible?**

21. Identify the CORRECT statement. Which of the following statements regarding dental equipment cleanliness is most accurate:
- High-level disinfection does not inactivate bacterial spores
 - Frequently used dental equipment should be disinfected and then rinsing with clean tap to ensure all remaining chemicals have been removed
 - Rinsing equipment in tap water after disinfecting it is ideal to remove residues
 - Sterilizing items that are indicated for “single use” is acceptable provided the item is metallic
22. Identify the CORRECT statement. Spaulding categorized semi-critical equipment as that which:
- may enter sterile tissues
 - comes into contact with mucous membranes
 - touches intact skin but not mucous membranes
 - has no direct contact with intact skin or mucous membranes
23. Identify the CORRECT statement. Which of the following statements are correct concerning the ethical concerns surrounding patient management and treatment:
- The Batho Pele Principle regarding “Access” states that all citizens have the right to access those services which they can afford
 - Crucial elements of patient consent include disclosure of information, ability of patients to understand, and voluntariness. However these are not necessary for treatment if they are in severe pain
 - Patients who are in pain are considered a vulnerable population and may sign consent out of desperation
 - Full disclosure of information from a practitioner is sufficient in itself to justify informed consent from a patient
24. Identify the CORRECT answer. Which of the following are a valid reason for non-adherence to current sterilization and hygiene protocols?
- A claim of unintentional ignorance
 - Empirical adherence to outdated practices
 - Loadshedding or similar reasons for lack of electrical supply
 - None of the above
25. Which one of the following is NOT a principle in the Beauchamp and Childress approach to ethics:
- Beneficence
 - Respect for patient autonomy
 - Respect for practitioner autonomy
 - Non-maleficence

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