



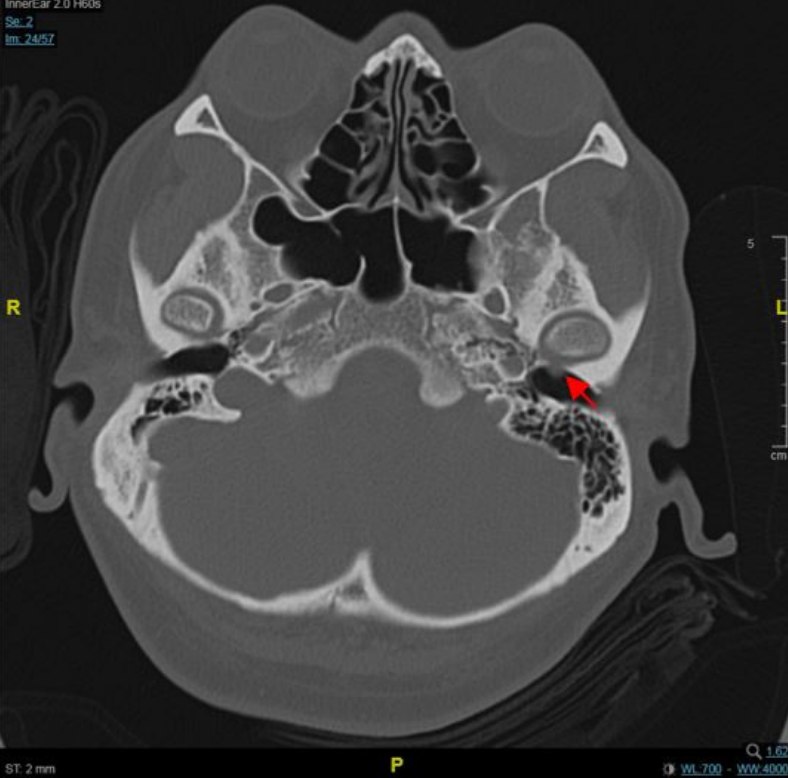
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IIUM Journal of Orofacial and Health Sciences (IJOHS) is a peer reviewed biannual international journal dedicated to publish high quality of scientific research in the field of orofacial sciences, health sciences and interdisciplinary fields, including basic, applied and clinical research. The journal welcomes review articles, original research, case reports and letters to the editor. Areas that are covered include but are not limited to dental sciences, oral microbiology and immunology, oral maxillofacial and craniofacial surgery and imaging, dental stem cells and regenerative medicine, dental biomaterial, oral maxillofacial genetic and craniofacial deformities.

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Scientific research misconducts: An overview

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Introduction

Research misconduct is defined as fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results (Anderson, 2013; Breen, 2016; Resnik, 2019). It can occur at many stages of the research process. These include during proposal preparation, data collection, analysis and publication (Amin *et al.*, 2012). The previous studies reported that 2,047 articles were retracted from PubMed in May 2012, with 67% of the articles due to misconduct (Dal-Ré *et al.*, 2020). Besides, the percentage of retracted papers in the year of 2012 were reported to increase by 10-fold compared to the total articles retracted in 1975 (Fang *et al.*, 2012). According to Liu and Chen (2018), the data from Retraction Watch on the 31st July 2017 revealed that the US, China, Germany, Japan and India were the top six countries that had articles retracted.

Types of misconducts

Fabrication of data is a process of creating results and reporting them as real (Chau *et al.*, 2018; Pratt *et al.*, 2019). The example of fabrication is when the researcher

manipulated the original data and presented as two different data sets (Chau *et al.*, 2018). Meanwhile, falsification is defined as modifying research materials such as changing, omitting or replacing the data to improve the results, which is no longer representing the original (All European Academies, 2011; Chau *et al.*, 2018). One example is when the researcher falsifies the data obtained to increase the significance of the published results.

Plagiarism is an act of using other people's work including ideas, processes, results, texts, or specific terms without crediting the source (Olesen *et al.*, 2017; Chau *et al.*, 2018; Dal-Ré *et al.*, 2020). Direct plagiarism, mosaic plagiarism and uncited plagiarism are among the most common type of plagiarisms made by the researcher (Chau *et al.*, 2018). Direct plagiarism is the plagiarism of word-to-word which the whole text is copied verbatim without a proper citation. Meanwhile, mosaic plagiarism is a substitution of the original word with a synonym from the sourced text without a proper citation. On the other hand, the uncited phrase occurs when the information is sufficiently paraphrased; however, no citation is made from the source (Chau *et al.*, 2018).

Reasons for misconducts

There are various reasons for misconduct. A study conducted at three Chinese Tertiary Hospitals revealed that the factors that led to misconduct are pressure from individual morality, the competition of colleagues, promotion, funding, recognition and publishing papers (Yu *et al.*, 2020). Surprisingly, more than 15% of the respondents admitted having committed at least once in fabrication, falsification or plagiarism, with the most common scientific misconduct is inappropriate authorship (Yu *et al.*, 2020).

According to Olesen *et al.* (2018) plagiarism and authorship disputes are the most common misconducts. Authorship disputes include gift authorship, ghost-writer, coercion authorship and admiration authorship. These misconducts were suggested due to the priority given on the publication records over other qualifications. The study also reported that the authorship dispute has become common, especially when the academics are pressured to publish or face delays in the promotion (Olesen *et al.*, 2018). Besides, situational factors, such as when researchers aim for monetary incentives given to those who can publish a paper in Q1 and Q2 articles, can also lead to misconduct.

The organisational factor such as lack of communication between researchers, management and faculty members, and lack of mentoring could also lead to misconduct (Olesen *et al.*, 2018). The study also revealed that the workload, competition and evaluation set to an academic also contributed to a researcher's misconduct. Further, the pressure of 'publish or perish' lead to a hostile working environment thus enhancing misconduct since the researchers will only focus on their individual work rather than teamwork (Olesen *et al.*, 2018). Nevertheless, other study also revealed that an individual with high moral values and integrity would have less tendency to engage in misconduct (Bülow and Helgesson, 2019).

Conclusion

In conclusion, researchers must avoid misconduct to ensure the validity of the data produced, particularly in health science research. More study is also needed to comprehend other underlying factors and identify the prevention measures that can avoid research misconduct.

References

- All European Academies (2017). The European code of conduct for research integrity. Retrieved from https://allea.org/wp-content/uploads/2015/07/Code_Conduct_ResearchIntegrity.pdf
- Amin, L., Zainal, S. Z., Hassan, Z., & Haji Ibrahim, M. (2012). Factor contributing to research misconduct. *The Social Sciences*, 7(2), 283-288.
- Anderson, M. S., Shaw, M. A., Steneck, N. H., Konkle, E., & Kamata, T. (2013). Research integrity and misconduct in the academic profession. *Higher education: Handbook of theory and research*, 217-261.
- Breen, K. J. (2016). Research misconduct: time for a re-think? *Internal Medicine Journal*, 46(6), 728-733.
- Bülow, W., & Helgesson, G. (2019). Criminalisation of scientific misconduct. *Medicine, Health Care and Philosophy*, 22(2), 245-252.
- Chau, D. M., Chai, L. C., & Veerakumarasivam, A. (2018). Malaysian Educational Module on Responsible Conduct of Research. Academy of Sciences Malaysia.
- Dal-Ré, R., Bouter, L. M., Cuijpers, P., Glud, C., & Holm, S. (2020). Should research misconduct be criminalised? *Research Ethics*, 16(1-2), 1-12.
- Fang FC, Steen RG and Casadevall A (2012) Misconduct accounts for the majority of retracted scientific publications. *Proceedings of the National Academic of Sciences USA*, 109(42): 17028-17033.
- Liu, X., & Chen, X. (2018). Journal retractions: some unique features of research misconduct in China. *Journal of Scholarly Publishing*, 49(3), 305-319.
- Olesen, A. P., Amin, L., & Mahadi, Z. (2018). In their own words: research misconduct from the perspective of researchers in Malaysian universities. *Science and Engineering Ethics*, 24(6), 1755-1776.
- Pratt, T. C., Reisig, M. D., Holtfreter, K., & Golladay, K. A. (2019). Scholars' preferred solutions for research misconduct: results from a survey of faculty members at America's top 100 research universities. *Ethics and Behavior*, 29(7), 510-530.
- Resnik, D. B., Neal, T., Raymond, A., & Kissling, G. E. (2015). Research misconduct definitions adopted by US research institutions. *Accountability in Research*, 22(1), 14-21.

Yu, L., Miao, M., Liu, W., Zhang, B., & Zhang, P. (2020).
Scientific misconduct and associated factors: A

survey of researchers in three Chinese tertiary
hospitals. *Accountability in Research*, 1-20.

Current concept of oral health and its potential implications for policy and practice of dental health coverage and insurance: Post COVID-19 measurement

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Abstract

This review paper aims to succinctly discuss the current concept and definition of general and oral-health and its potential implications on policy and practice in regards to the dental health coverage/insurance post COVID-19 pandemic. In general, dental policies and coverage are treatment-oriented, largely focus on curative procedures with some portion for preventive care despite most of dental diseases being largely preventable. There is however still no universal consensus definition of health, leading to mixed-feeling in setting-up priorities and direction for health policy. The FDI-World Dental Federation has then published a new definition of oral-health, highlighting the broader determinants of oral-health and envisioning a discussion on the implications of this definition and, in particular, how to transform the new oral health framework into a policy and practice agenda. In Malaysia, it is predicted there will be increasing demand for public dental coverage post COVID-19, however the government is yet to be ready in fulfilling those needs, leading to worsening oral-health inequalities. The lack of healthcare expenditure with no health social-insurance model reduces the affordability and accessibility of patients to private services. Moreover, such narrow definition of oral-health, as influenced by the previous policies led to a limited coverage for common dental diseases, including oral health-related deformities linked to oral cancer and injuries. These are the major challenges for Malaysia. The government should therefore working in partnership, start subsidising dental fees of private health insurance, focus and integrate disease prevention and health promotion in order to achieve WHO-goal of universal health coverage.

Keywords: *definition, oral health, perception, dental coverage, COVID-19, Malaysia*

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Global concept and definition of health

There are numerous definitions and conceptual models developed to provide a holistic description of health, including psycho-social, ecological and biomedical concepts (Huber *et al.*, 2011). However, there is still no universally accepted definition of health (Huber *et al.*, 2011; Saracci, 1997). Commonly, health professionals and researchers have largely focused on the treatment of diseases through the perspectives of the biomedical model (Glick *et al.*, 2012). Such concern nevertheless has created a narrow focus on the management of health and diseases (Glick & Meyer, 2014; Huber *et al.*, 2011). Nonetheless, over the years, the concept of health, including oral health, has evolved from the body's capacity to function into the mental, social, spiritual, emotional, and societal distinctive of health (Glick & Meyer, 2014; Huber *et al.*, 2011; Saracci, 1997). Addressing determinant for health is pivotal to reduce health inequalities within and across the countries (Marmot *et al.*, 2012; Marmot *et al.*, 2013).

At present, the World Health Organisation (WHO) defines health as the extent of an individual's or group's capacity to realise the aspirations and satisfy one's needs as well as to cope with the ever-changing environment. Thus, health is considered as a life necessity, rather than a resource and the present concept of health emphasises the importance of social and individual resources, along with physical capacities (WHO, 1984).

The way health is defined and interpreted by the public could be said to determine the nature and types of health services they need from the health practitioners (Glick *et al.*, 2016; Lee *et al.*, 2017). Several studies have found that there is higher public interest towards health and the public has become more aware on their health and well-being (Che Musa *et al.*, 2020; Gallagher & Wilson, 2009), and as a result they would like to participate in decision making over the treatment options offered to them (Watt *et*

al., 2013). Nevertheless, their perception and interpretation of health needs as a layperson may differ from the view of professional evaluation that necessitates careful interpretation (Sheiham & Tsakos, 2007); especially when planning and determining types of care could be provided and focused under the health insurance schemes and plans to improve patients' accessibility and affordability in seeking healthcare. Moreover, there is also an increasing awareness over the importance of social, general and oral health in a broader term to perform their daily routine and social activities without restriction, lead to better quality of life (Marmot *et al.*, 2012; Watt, 2012). All of these have significant impact on health policy, research and service provision (Gallagher & Eaton, 2015; Lee *et al.*, 2017). Those increasing demand for health mainly due to high public expectation towards dental care and trend of the ageing population that associated with complex and chronic diseases, as well as general and oral health problems (Marcenes *et al.*, 2013), need to be well-encountered given they may have special and complicated dental procedures (Ghezzi *et al.*, 2017). As such various methods to assess healthcare should not be limited to the capability and capacity of health care provided by government only, but also from other payment mechanism such as health coverage and insurance. Moreover, out of pocket payment for even simple health procedures can often be quite expensive and limit their accessibility to better and high quality of care (Garla *et al.*, 2014).

It is also widely recognized that demand on health care systems will always be greater than the resources available to meet these needs (Daly *et al.*, 2013). It can be seen there exists health inequalities across and within both developed and developing countries. Inequalities are more significant in countries with a lower probability of unmet needs due to the lower public coverage for care provided by the government (OECD, 2020). Accessing for quality of medical care have undeniably played a significant role in determining health status in both rich and poor countries (Chin & Mohd Noor, 2014; WHO and Commission on Social

Determinants of Health, 2008); regardless of their economic status (Marmot, 2005; Wilkinson & Marmot, 2003).

Therefore, the availability, affordability, accessibility, acceptability and accommodation to healthcare are a crucial and important factor to address health inequalities (Daly *et al.*, 2013; Marmot, 2005). Understanding social and economic conditions, and other new trends of health determinants, as well as how the health is defined and interpreted is crucial to inform policy and practice, which could lead to better population health.

Oral health definition and understanding

Similarly, there seems to be a contradictory interpretation and understanding the concept and definition of oral health; especially towards the prevention and promotion of oral health among and between dental professionals and the public, including among dental stakeholders (Glick *et al.*, 2016; Lee *et al.*, 2017). As oral health is also a fundamental human right and has been recognised as an essential element for well-being in this millennia (Glick & Meyer, 2014; Petersen, 2008), a universally accepted definition of oral health should reflect what oral health encompasses and how such definition may implicate the policies, research, education and clinical practices; in a way to improve people's quality of life (Lee *et al.*, 2017; Patrick, 2017). Consequently, researchers and policymakers have used, modified, and developed several definitions of oral health based on the underlying and current concepts of general health.

Sheiham and Spencer (1997) described that oral health does not only reflects one's physical ability to painlessly and comfortably chew, taste and eat different foods, speak clearly, and have a fresh breathe, it also encompasses having a socially acceptable smile and dento-facial profile. This interpretation highly stressed those importance of social and oral health (Watt, 2012). In recent years, a broader bio-

psychosocial model of health has emerged that states that interactions between biological, psychological, and social factors in determining the cause, manifestation, and outcome of wellness and diseases, which also significantly influenced policy, clinical practice and research (Huber *et al.*, 2011).

In 2016, the FDI World Dental Federation has recognised the limitation of the previous interpretations and proposed their definition for oral health (Glick *et al.*, 2016). The narrow definition of health and oral care has led to limited coverage on service provision and dental insurance, which subsequently leads to accessibility issues among population with greatest needs, or presented with complex health problems, especially oral health-related deformities linked to oral cancer and injuries, which has significant effects on patients' quality of life.

Glick and his colleagues (2016) summarised that FDI defined oral health as *"a multi-faceted concept comprising of one's ability to taste, smell, smile, speak, touch, swallow and chew as well as the ability to confidently and painlessly show different emotions through facial expressions without any discomfort and craniofacial deformity. Oral health is also an important aspect of physical and mental well-being influenced by individual and societal values and attitudes of individuals and communities; [it] reflects the physiologic, social, and psychological attributes that are essential to quality of life; [it] is influenced by the individual's changing experiences, perceptions, expectations and ability to adapt to circumstances."* In this light, widespread discussions and research are necessary if those dental components are to be useful and translatable into practice and policy of dental health coverage/insurance in order to improve patients' accessibility, lead to better care management of patients with complex dental health care needs.

The proposed framework of the FDI definition is deemed as a more comprehensive framework and it should help to move oral health into the mainstream and strengthen the effectiveness of advocacy for better oral health and oral health equity. By recognising the importance of tackling

social and economic condition; and shared common risk factors (Watt, 2012), as advocated by current concept and definition of health. It also places oral health at the centre of strategies to address the both the global burden of non-communicable and oral diseases (Glick *et al.*, 2016). Such development has opened the opportunity to discuss the impact of such definitions to oral health and how to translate the new oral health framework into practice. In addressing health inequalities in dentistry, public and private sector need to work together in recognising those shared social determinants and common risk factors (Watt, 2012), to improve accessibility and affordability for dental care through the provision of an alternative payment system as part of the dental health coverage and insurance.

COVID-19 and dental insurance

With the COVID-19 pandemic, it had a strong influence on the utilization of dental services (Guo *et al.*, 2020; Passarelli *et al.*, 2020). As employees lose their jobs due to COVID-19, many is expected to lose their employer-sponsored dental insurance; thus, their access to dental care. It is more pronounced in states that have not expanded medical scheme insurance or do not even offer dental benefits for adults (Choi *et al.*, 2021).

With these predictable changes in dental insurance coverage, there will be expected changes in types of dental procedures performed at dental practices following the COVID-19 pandemic (Choi *et al.*, 2021); as it had a strong influence on the utilization especially for emergency dental services (Guo *et al.*, 2020). In general, fewer patients visited the dental for both urgency and non-urgency cases at the beginning of the COVID-19 pandemic than before (Ahmadi *et al.*, 2020; Choi *et al.*, 2021; Passarelli *et al.*, 2020). Whereas, in the US, it was reported that the average dental practice would experience decreases in routine check-up visits but increases in tooth extraction, a procedure that is greatly used by uninsured patients or through publicly insured (Choi *et al.*, 2021). This could be explained due to the evidence that the proportion of dental and

oral infection were reported to raise from pre to during COVID-19 (Guo *et al.*, 2020). As such, regularly refining the fundamental of dental health insurance policy is critically needed wider discussion among key policymakers to improve the affordability and accessibility of patients towards the dental care.

Insurance principles and dental care

Inherently, global oral health care is mostly provided by private dental practitioners and the treatment cost is high. A total increase in general health expenditure was reported across OECD countries, specifically for private health expenditure, (OECD, 2017, 2020). For dentistry, the use of dental care is low and it is relative to the existing need mainly because of the high cost of dental services (Bommireddy *et al.*, 2014; Brennan *et al.*, 2008). Hence, dental prepayment programmes or insurance schemes are considered an effective mechanism for extending dental services to more people (Garla *et al.*, 2014; Gnanamanickam *et al.*, 2018).

Insurance has grown in prominence and evolved over time from pay-for-service as the main method of payment to an alternative form of payment, which is private health insurance (Gnanamanickam *et al.*, 2018). Private insurance transfers the cost risk to the insurer company through scheme applied and chosen by the patients. Thus, such third-party payment for dental services is made to the dentist by an agency, rather than directly by the patient. The third party could be referred to as a private carrier such as an insurance company, or also the government as part of the public financing of dental care (Garla *et al.*, 2014). Insurance cover for dental services is typically provided under general treatment cover which can be purchased separately, or as part of a combined health policy with hospital cover. Nevertheless, cash payment of service fees is still the dominant form of payment in many developing countries and it is preferred in many instances since the payment is made immediately (Garla *et al.*, 2014).

Private health insurance plays a key role in financing dental care in certain countries. Adult dental care in countries such as Australia, United States, Canada and New Zealand, are mainly based on private health insurance and not part of the basic package of public care insurance, although some care is provided for individuals with disabilities, low-income and underprivileged groups. Whereas, other countries such as the UK and Nordic countries provide public dental care particularly to children and underprivileged groups. Meanwhile, in other countries, prevention and treatment are covered under the private insurance and the cost is shared among the patients. As such, low-income groups without insured face difficulties in accessing dental care (OECD, 2011, 2015), and therefore require support from the government.

The provision of private dental insurance has been associated with higher levels of access to dental care, more frequent check-up visits and receiving a favourable quality of services (Garla *et al.*, 2014). There is a positive association between dental insurance and frequent dental visits. Adults with dental insurance in Australia are likely to have more regular access to dental care and have a more favourable pattern of service uses than those uninsured (Gnanamanickam *et al.*, 2018). Having dental coverage and insurance leads to more consistent dental care. As access to dental care is important to general health, the government could subsidise some of the payment for the private health insurance (Garla *et al.*, 2014). In a nutshell, dental care insurance should focus on providing more access to essential preventive care, lowering costs for other procedures, and maintaining patients' overall wellbeing (Stancil *et al.*, 2005); as well as ensuring universal health coverage (UHC) of its people. UHC does not mean free coverage for all possible health interventions, regardless of the cost, as there is no country can provide all services free of charge on a sustainable basis. UHC should encompass all components of the health system such as service delivery systems, the health workforce, health facilities and communications networks, health technologies, information systems, quality

assurance mechanisms, and governance and legislation (DGHS, 2017; WHO, 2015).

Situation of Malaysia

In general, Malaysia relatively has not practiced dental health insurance systems as overall (Che Musa *et al.*, 2019). Adult and elderly groups who choose dental care in private practices need to pay using their own pocket-money. Out of pocket payment for even simple dental procedures can often be quite expensive and very few insurers will inevitably embrace dental coverage as part of the benefits in their plans. Furthermore, only a limited number of private organisations (employers) provide basic dental coverage that subsidise dental care as part of their employee benefit often for routine care such as annual tooth cleaning and fillings; whereas serious dental problems usually remain the responsibility of the individual to pay for (Che Musa *et al.*, 2018; Ministry of Health Malaysia, 2013; Oral Health Division Malaysia, 2005).

They are few notable insurers for dental coverage in Malaysia provided by few companies such as by Allianz Care, Tune-Protect in collaboration with Universal MediDent Sdn Bhd (UMDSB) and Malaysia Dental Health Insurance. Nevertheless, their existence is unknown locally and unattractive probably due to some of the schemes being offered are yet comprehensive enough to offer holistic dental benefits or dental protection in Malaysia. Hence, the prevention of dental diseases, such as common and complex dental diseases such as dental caries and periodontium diseases, and oral health related deformities linked to oral cancer and injuries are commonly missed from the health insurance coverage.

This is probably the available policies are restricted and determined and interpreted differently by non-health groups or general health professionals, instead of oral health experts. As a result, oral health is defined and translated into private health scheme in a very rigid way. Narrow interpretation of oral health description among oral health practitioners also could further restricting

the dimensions of those private health insurance policy.

The oral healthcare system in Malaysia involves both public and private agencies and organisations (Oral Health Division Malaysia, 2006). The Oral Health Programme (OHP), under the Ministry of Health (MOH) is the leading public agency responsible for providing health and oral care to the Malaysian population through its primary, specialist, and community oral healthcare programmes (Oral Health Division Malaysia, 2005, 2006). All Malaysians are eligible to receive publicly funded dental services, which provide highly subsidised basic dental treatments like fillings, extractions, low-cost dentures, and emergency care. The target groups for public dental services are toddlers, preschool children, primary and secondary school students, antenatal mothers, adults and elderly people, as well as special care groups who are mentally, physically or economically disadvantaged. All school children aged 18 years and below will receive dental treatment provided by dental therapists under the School Dental Programme, which offers free dental check-ups and treatment, with parental consent (Malaysian Dental Council, 2018; Oral Health Division Malaysia, 2005). Whilst the oral health planning is widely considered across targeted groups, nevertheless only 23.7% of the total Malaysian population utilised the dental service in 2019; majority of them visited public sector and 15.0% have never received dental care (Ministry of Health Malaysia, 2020); indicating poor accessibility of Malaysian population to dental care and services.

As a middle-income country with a growing and ageing population (Department of Statistics Malaysia, 2011), Malaysia has recorded significant levels of oral diseases such as dental caries and periodontal disease, even though there are indications that dental caries is declining in certain age-groups (Dental Service Division Malaysia, 1990; Oral Health Division Malaysia, 2004, 2013). With increasing need and demand for inexpensive, curative public funded dental care, there is evidence that the dental

waiting list for subsidised dental care in Malaysia has increased over time (Malaysian Dental Council, 2014). The situation seemed to get worst during the COVID-19 pandemic as only non-generating aerosol dental procedure was allowed in adherence to medical/dental recommendations (Clarkson *et al.*, 2020). Moreover, many patients only visit dental facilities on an emergency basis or when they experience pain due to cost issues (Locker, 1989; Watt, 2007, 2012). Adults and the elderly may choose private dental care need to pay using their own money as there is a long waitlist to access public dental care.

In addition, private health insurance providers should provide wider coverage for oral cancer and trauma cases. General cancer cases are on the rise and this is reflected in the higher number of insurance claims in the country (Abdul Karim, 2016). There is less or none evidence whether this claim including oral cancer cases. In Malaysia, malignant neoplasms account for 10.6% of deaths at government hospitals (Omar *et al.*, 2006); and Indians ethnicity were reported to be at the highest risk of oral cancer, followed by the Indigenous people of East Malaysia (Zain *et al.*, 1997). As mentioned, oral cancer can seriously affect the quality of life of its sufferers. Due to the important functional and social role of the oral cavity and its related structures, oral cancer can be even more debilitating than other forms of cancer (Johnson, 2001). In this regard, the most difficult challenge in managing oral cancer is creating the delicate balance between arresting disease progression and not compromising the patient's quality of life (Bjordan *et al.*, 1994). Patients are often willing to accept a reduced lifespan, rather than compromise their quality of life drastically, as oral cancer will affect how they speak, eat, and swallow (Meek *et al.*, 2000). This message is clear and could not be ignored by insurance policymakers. Therefore, understanding the functional, socio-psychological and physical effects of oral cancer through inputs from the medical and dental specialists would assist them in appreciating the value that sufferers attach to different aspects of their health-related quality of life. Subsequently, more insurance

company should offer cancer protection plans that also account for oral cancer, or even evolving and broadening their coverage to more types and stages of cancer. It is also worth to know that Malaysians indeed are underinsured and inadequately protected which about only 22% have medical insurance and critical illness coverage (Abdul Karim, 2016).

Besides oral cancer, injuries like a missing front tooth might be considered lightly by the insurance company. Moreover, about 5.4% of 12-year-olds reported injuries to anterior teeth in 2007 (Oral Health Division Malaysia, 2010). In this sense, the front tooth perfects one's smile and presents the first impression of one's facial profile and his ability to speak properly. Therefore, a missing front tooth or a canine tooth as a result of an accident should be considered as an acquired facial deformity and should be covered by the insurance company as it actually affects one's quality of life. In this regard, oral health professional should move from previous non-dynamic oral health definition to accommodate current/contemporary issues on how oral health affects population's quality of life and moves beyond teeth-related definitions to a bigger, more practical and comprehensive definition by including oral health as a true subset of general health.

In the meantime, the lack of government spending on oral healthcare has created concerns over the government's ability to meet the increasing needs of the population. In this light, while the government has constantly called for increasing access to dental care, it has only provided a small allocation for dental health for over 40 years since 1970 (Oral Health Division Malaysia, 2005). The recent data in 2016 reported that only 9.44% of the total national budget has been allocated to the MOH, while the expenditure for healthcare is equivalent to 4.55% of the gross domestic product (GDP) (Ministry of Health Malaysia, 2017). It is projected that such expenses will be incurred until 2030 and this encompasses 4.4% of the GDP (Ministry of Health Malaysia, 2013). While there is uncertainty following unstable political climate at

present, it is hoped that the recent budget tabled and approved is hoped to contribute to positive changes in dental healthcare.

Major challenges for Malaysia

It is expected and predicted that more people will prefer to visit public sector during and post COVID -19 pandemic, however the government is yet to be ready in fulfilling those needs, leading to worsening of health outcome and inequalities in oral health. This is where the role of private is pivotal to support the public oral care in promoting oral health and well-being of the population. However, the lack of government spending on health and dental insurance in the country reduces the affordability and accessibility to private services (Institute for Public Health, 2012). There is some constraint with available options for dental payment mechanism in the country which may limit the opportunity to assess the dental care. As such, there is a slow movement of patients towards the private sector. The privatisation of the future health system is also at stake due to the conflicts between politicians, public, professional expectations and health policies. The proposed change from the subsidised model of healthcare to the health social insurance model may poorly steer the local dental market towards privatisation (Ministry of Health Malaysia, 2013); and it is remained undoubtedly till now. Moreover, such narrow definition of health and oral care, as influenced by the previous policy and politics, has led to a limited coverage on dental diseases, including oral health related deformities linked to oral cancer and injuries. These are the major challenges for Malaysia.

Considering the restrictions on health funding, dental facilities and payment mechanism; prevention of disease and health promotion is necessary. This indicates the needs for stakeholders and health providers to tackle this issue effectively and efficiently. The government should and work across sectors and organisations and start subsidising dental fees charged to private health insurance, including companies involved with the

dental insurance. The focus should be on prevention of common oral diseases and promotion of health, including oral health related deformities linked to oral cancer and injuries in the private health scheme to ensure quality of care, thus achieving and universal health coverage of its people.

Conclusion

This paper illustrates the shift in concept and current understanding of general and oral health; and the implications it has on the policy and practice in regards to dental health insurance/coverage post COVID-19 pandemic. Based on the current understanding on the concept for oral health, it is crucial for key stakeholders working together in recognising the importance of tackling social and economic condition; and shared common risk factors as advocated by the current concept for health. The shift in focus provides an opportunity for oral health care to be placed at the centre of strategies to address not only the dental diseases, but also the global burden of non-communicable diseases in tackling oral health inequalities of its nation. The dental prepayment programmes or insurance schemes should be considered by many countries as an alternative and beneficial mechanism to reduce oral health inequalities and extending dental services to more people, including Malaysia with lower public dental coverage, increasing demands, limited dental facilities and escalating health expenditure. The Malaysian government should therefore consider the possibility of supporting private dental health insurance by allocating and subsidising payment incurred to needy insurers and focusing on prevention oriented-treatment of common dental diseases, as well as covering oral health related deformities linked to oral cancer and dental injuries to ensure and achieve WHO goal of universal health coverage for its nation.

References

Abdul Karim, N. A. (2016). Insurance: Cancer protection plans in Malaysia (Pt 1). *The Edge Malaysia*.

- Ahmadi, H., Ebrahimi, A., Ghorbani, F. (2020). The impact of COVID-19 pandemic on dental practice in Iran: a questionnaire-based report. *BMC Oral Health*, 20(1), 354.
- Bjorndal, K., Kaasa, S., Mastekaasa, A. (1994). Quality of life in patients treated for head and neck cancer: a follow-up study 7 to 11 years after radiotherapy. *International Journal of Radiation Oncology Biology Physics*, 28(4), 847-856.
- Bommireddy, V. S., Pachava, S., Ravoori, S., Sanikommu, S., Talluri, D., Vinnakota, N. R. (2014). Socio-economic Status, Needs, and Utilization of Dental Services among Rural Adults in a Primary Health Center Area in Southern India. *Journal of International Oral Health*, 6(6), 56-60.
- Brennan, D. S., Luzzi, L., Roberts-Thomson, K. F. (2008). Dental service patterns among private and public adult patients in Australia. *BMC Health Services Research*, 8, 1.
- Che Musa, M. F., Bernabe, E., Gallagher, J. E. (2020). The dental workforce in Malaysia: drivers for change from the perspectives of key stakeholders. *International Dental Journal*, 70(5), 360-373.
- Che Musa, M. F., Hassan, Y. F., Sayed Kamar, S. H., Abllah, Z., Supa'at, S., Rahman, F., et al. (2019). Situation, challenges and potential reforms for healthcare systems of Malaysia and Bangladesh: overview of dental counterpart. *Journal of Biotechnology and Strategic Health Research*, 3(3), 225-236.
- Che Musa, M. F., Hassan, Y. R., Rahman, F., Jeenia, F. T. (2018). Provision of Health and Dental Care in Two Middle Income Asian Countries. *Journal of Biotechnology and Strategic Health Research*, 2(3), 182-188.
- Chin, V. Y. W., Mohd Noor, N. A. (2014). Sociocultural determinants of health and illness: A theoretical inquiry. *Malaysian Journal of Society and Space*, 10(1), 49-59.
- Choi, S. E., Simon, L., Riedy, C. A., Barrow, J. R. (2021). Modeling the Impact of COVID-19 on Dental Insurance Coverage and Utilization. *Journal of Dental Research*, 100(1), 50-57.
- Clarkson, J., Ramsay, C., Richards, D., Robertson, C., Aceves-Martins, M. (2020). Aerosol Generating Procedures and their Mitigation in International Dental Guidance Documents - A Rapid Review. *Cochrane Oral Health*.
- Daly, B., Watt, R., Batchelor, P., Treasure, E. T. (2013). *Essential Dental Public Health*. New York: Oxford University press.
- Dental Service Division Malaysia. (1990). *Dental Epidemiological Survey of Adults in Malaysia*. Kuala Lumpur: Ministry of Health Malaysia
- Department of Statistics Malaysia. (2011). *Population Distribution and Basic Demographic Characteristics Report 2010*. Retrieved 1 April 2013, from <http://www.statistics.gov.my>
- DGHS. (2017). *Universal health coverage (UHC); Bangladesh on path to UHC. In: Journey to SDGs 2030 for health*. Dhaka, Bangladesh: Directorate General of Health Services. Retrieved from 21 July 2019, from

- http://www.dghs.gov.bd/images/docs/Publications/JourneytoSDGs2030%20forHealth_Fin_ed2.pdf
- Gallagher, J. E., Eaton, K. A. (2015). Health workforce governance and oral health: Diversity and challenges in Europe. *Health Policy*, 119(12), 1565-1575.
- Gallagher, J. E., Wilson, N. H. F. (2009). The future dental workforce? *British Dental Journal*, 206(4), 195-199.
- Garla, B. K., Satish, G., Divya, K. T. (2014). Dental insurance: A systematic review. *Journal of International Society of Preventive & Community Dentistry*, 4(Suppl 2), S73-77.
- Ghezzi, E. M., Kobayashi, K., Park, D. Y., Srisilapanan, P. (2017). Oral healthcare systems for an ageing population: concepts and challenges. *International Dental Journal*, 67 Suppl 2, 26-33.
- Glick, M., Meyer, D. M. (2014). Defining oral health: a prerequisite for any health policy. *The Journal of the American Dental Association*, 145(6), 519-520.
- Glick, M., Monteiro da Silva, O., Seeberger, G. K., Xu, T., Pucca, G., Williams, D. M., et al. (2012). FDI Vision 2020: Shaping the future of oral health. *International Dental Journal*, 62(6), 278-291.
- Glick, M., Williams, D. M., Kleinman, D. V., Vujicic, M., Watt, R. G., Weyant, R. J. (2016). A new definition for oral health developed by the FDI World Dental Federation opens the door to a universal definition of oral health. *International Dental Journal*, 66(6), 322-324.
- Gnanamanickam, E. S., Teusner, D. N., Arrow, P. G., Brennan, D. S. (2018). Dental insurance, service use and health outcomes in Australia: a systematic review. *Australian Dental Journal*, 63(1), 4-13.
- Guo, H., Zhou, Y., Liu, X., Tan, J. (2020). The impact of the COVID-19 epidemic on the utilization of emergency dental services. *Journal of Dental Sciences*.
- Huber, M., Knottnerus, J. A., Green, L., van der Horst, H., Jadad, A. R., Kromhout, D., et al. (2011). How should we define health? *The British Medical Journal*, 343, d4163.
- Institute for Public Health. (2012). *National Health and Morbidity Survey 2011*. Retrieved 1 December 2014, from http://repository.um.edu.my/22698/1/NHMS2011_research%20team.pdf
- Johnson, N. W. (2001). Global epidemiology. In *Oral Cancer* (pp. 1-30). London: Blackwell Publishing.
- Lee, J. Y., Watt, R. G., Williams, D. M., Giannobile, W. V. (2017). A New Definition for Oral Health: Implications for Clinical Practice, Policy, and Research. *Journal of Dental Research*, 96(2), 125-127.
- Locker, D. (1989). *An introduction to behavioural science in dentistry*. London: Tavistock/Routledge.
- Malaysian Dental Council. (2014). *Malaysian Dental Council Bulletin*. Retrieved from Putrajaya: Malaysian Dental Council. (2018). *Dental Act 2018: Laws of Malaysia*. Putrajaya: MDC. Retrieved 1 October 2020, from http://www.federalgazette.agc.gov.my/outputaktap/aktaBI_20180626_AktaPergigianBI.pdf
- Marcenes, W., Kassebaum, N. J., Bernabe, E., Flaxman, A., Naghavi, M., Lopez, A., et al. (2013). Global burden of oral conditions in 1990-2010: A systematic analysis. *Journal of Dental Research*, 92(7), 592-597.
- Marmot, M. (2005). Social determinants of health inequalities. *Lancet*, 365(9464), 1099-1104.
- Marmot, M., Allen, J., Bell, R., Bloomer, E., Goldblatt, P. (2012). WHO European review of social determinants of health and the health divide. *Lancet*, 380(9846), 1011-1029.
- Marmot, M., Bell, R., Goldblatt, P. (2013). Action on the social determinants of health. *Rev Epidemiol Sante Publique*, 61 Suppl 3, S127-132.
- Meek, P. M., Nail, L. M., Barsevick, A., Schwartz, A. L., Stephen, S., Whitmer, K., et al. (2000). Psychometric testing of fatigue instruments for use with cancer patients. *Nursing Research*, 49(4), 181-190.
- Ministry of Health Malaysia. (2013). *Malaysia Health Care Demand Analysis: Inequalities in Healthcare Demand & Simulation of Trends and Impact of Potential Changes in Healthcare Spending*. Retrieved 1 November 2014, from <http://www.ihp.lk/publications/publication.html?id=933>
- Ministry of Health Malaysia. (2017). *Health Facts 2016*. Retrieved 4 November 2018, from <http://www.moh.gov.my/images/gallery/publications/HEALTH%20FACTS%202017.pdf>
- Ministry of Health Malaysia. (2020). *National Health and Morbidity Survey 2019 (fact Sheet): Non-communicable diseases, healthcare demand and health literacy*. Retrieved 27 November 2020, from <http://iku.moh.gov.my/images/IKU/Document/REPORT/NHMS2019/Fact Sheet NHMS 2019-English.pdf>
- OECD. (2011). *Health at a Glance 2011: OECD Indicators*. In. Retrieved 3 May 2014, from <http://www.oecd.org/els/health-systems/49105858.pdf>
- OECD. (2015). *Health at a Glance 2015: OECD Indicators*. In. Retrieved 3 May 2016, from http://www.keepeek.com/Digital-Asset-Management/oecd/social-issues-migration-health/health-at-a-glance-2015_health_glance-2015-en#page124
- OECD. (2017). *Health at a Glance 2016: OECD Indicators*. Retrieved 29 December 2020, from https://www.oecd-ilibrary.org/social-issues-migration-health/health-at-a-glance-2017_health_glance-2017-en
- OECD. (2020). *Health at a Glance 2019: OECD Indicators*. Retrieved 26 December 2020, from <https://www.oecd-ilibrary.org/docserver/4dd50c09-en.pdf?expires=1608973430&id=id&accna>

- [me=guest&checksum=58749DC36E59ECD487512AD587A49A2E](#)
- Omar, Z. A., Ali, Z. M., Tamin, N. S. I. (2006). *Malaysian Cancer Statistics- Data and Figure Peninsula Malaysia 2006*. Putrajaya: Ministry of Health Malaysia
- Oral Health Division Malaysia. (2004). *National Oral Health Survey of Adults 2000 (NOHSA 2000). Oral health status, impacts and treatment needs of Malaysian adults*. Putrajaya: Ministry of Health Malaysia
- Oral Health Division Malaysia. (2005). *Oral Health Care in Malaysia*. Putrajaya: Ministry of Health Malaysia
- Oral Health Division Malaysia. (2006). *Malaysia's National Oral Health Plan 2010. A lifetime of Healthy Smiles*. Putrajaya: Ministry of Health Malaysia
- Oral Health Division Malaysia. (2010). *National Oral Health Survey of School Children 2007 (NOHSS 2007): 12 year olds*. Putrajaya: Ministry of Health Malaysia
- Oral Health Division Malaysia. (2013). *National Oral Health Survey of Adults 2010 (NOHSA 2010)*. Putrajaya: Ministry of Health Malaysia
- Passarelli, P. C., Rella, E., Manicone, P. F., Garcia-Godoy, F., D'Addona, A. (2020). The impact of the COVID-19 infection in dentistry. *Experimental Biology and Medicine (Maywood)*, 245(11), 940-944.
- Patrick, H. (2017). The New Definition of Oral Health and Relationship between Oral Health and Quality of Life. *Chinese Journal of Dental Research*, 20(4), 189-192.
- Petersen, P. E. (2008). World Health Organization global policy for improvement of oral health-World Health Assembly 2007. *International Dental Journal*, 58(3), 115-121.
- Saracci, R. (1997). The World Health Organisation needs to reconsider its definition of health. *British Medical Journal*, 314(7091), 1409-1410.
- Sheiham, A., Spencer, A. J. (1997). Health needs assessment. In C. Pine (Ed.), *Community Oral Health*. Edinburgh: Elsevier Science Limited.
- Sheiham, A., Tsakos, G. (2007). Oral health needs assessment. In C. Pine & R. Harris (Eds.), *Community Oral Health*. Germany: Quintessence Publishing.
- Stancil, T. R., Li, C. H., Hyman, J. J., Reid, B. C., Reichman, M. E. (2005). Dental insurance and clinical dental outcomes in NHANES III. *Journal of Public Health Dentistry*, 65(4), 189-195.
- Watt, R. G. (2007). From victim blaming to upstream action: tackling the social determinants of oral health inequalities. *Community Dentistry and Oral Epidemiology*, 35(1), 1-11.
- Watt, R. G. (2012). Social determinants of oral health inequalities: implications for action. *Community Dentistry and Oral Epidemiology*, 40 Suppl 2, 44-48.
- Watt, R. G., Steele, J. G., Treasure, E. T., White, D. A., Pitts, N. B., Murray, J. J. (2013). Adult Dental Health Survey 2009: Implications of findings for clinical practice and oral health policy. *British Dental Journal*, 214(2), 71-75.
- WHO. (1984). *Health promotion : a discussion document on the concept and principles : summary report of the Working Group on Concept and Principles of Health Promotion*. Copenhagen
- WHO. (2015). Universal health coverage (UHC)- fact sheets. Retrieved 1 June 2016, from <http://www.who.int/mediacentre/factsheets/fs395/en/>
- WHO and Commission on Social Determinants of Health. (2008). *Closing the gap in a generation*. Retrieved from Geneva, Switzerland:
- Wilkinson, R., Marmot, M. (2003). *Socials Determinants of health: The Solid Facts*. Retrieved from Denmark:
- Zain, R. B., Ikeda, N., Razak, I. A., Axell, T., Majid, Z. A., Gupta, P. C., et al. (1997). A national epidemiological survey of oral mucosal lesions in Malaysia. *Community Dentistry and Oral Epidemiology*, 25(5), 377-383.

The use of bioceramic root canal sealers for obturation of the root canal system: A review

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Abstract

The use of bioceramic root canal sealers in endodontics is a promising approach because of the advantages such as improved flow properties, biocompatible and could promote the formation of hard tissue. Due to the recent technology and limited scientific evidence, the effectiveness of bioceramic root canal sealers remains unclear. This article focuses on the physicochemical properties, biocompatibility, biomineralisation, retreatability, 3D obturation and current practice of using bioceramic root canal sealers. The relevant articles for this review were searched manually from Google Scholar and PubMed using keywords 'bioceramic root filling material AND endodontics', 'bioceramic root canal sealers AND endodontics', 'cytotoxicity AND bioceramic root canal sealers', 'bioceramic root canal sealers AND physicochemical properties', 'biomineralisation AND bioceramic root canal sealers' and 'retreatment efficacy AND bioceramic root filling materials'. Since the clinical data concerning the obturation with bioceramic root canal sealers is lacking, the selection of materials should be made based on the available scientific evidence, individual cases, material availability and operator's preference.

Keywords: *bioceramic root canal sealers, cytotoxicity, biomineralisation, physicochemical properties*

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Introduction

The use of bioceramic root canal sealers for obturation of the root canal system has been a subject of interest in the recent years. However, whether this material can provide an effective sealing of the complex root canal anatomy remains unclear due to the limited scientific evidence. The obturation of root canal system can be performed using a conventional technique with a combination of gutta-percha and root canal sealer, or

thermoplastic technique. The goal standard of root canal sealers for obturating of the root canal system should have low porosity and solubility, adequate setting time and ability to promote hard tissue formation (Gandolfi and Prati, 2010).

Currently, there is a move towards using bioceramic root canal sealers such as MTA Fillapex, GuttaFlow Bioseal, iRoot SP root canal sealer, CeraSeal Bioceramic root canal sealer and others. Generally, the properties

of root canal sealers are determined by the type and ratio of the main components, thus enabling them to function effectively under clinical situations (Zhou *et al.*, 2013). For instance, bioceramic root canal sealers usually contain calcium silicate and/or calcium phosphate, have a higher pH value, chemically stable, lack of shrinkage and biocompatible, making them favourable root canal sealers (Zhou *et al.*, 2013).

In general, bioceramics can be categorised into bioinert, bioactive and bioresorbable based on their interactivity with the surrounding tissues (Best *et al.*, 2008; Wang *et al.*, 2019). Bioinert ceramics such as alumina and zirconia are well-tolerated by the tissue, triggering no toxic response, whereas bioactive ceramics such as ceramics, glasses, glass-ceramics can interact and form a direct bond with the tissue (Best *et al.*, 2008) through the formation of hydroxyapatite layer as the interfacial bonding (De Aza *et al.*, 2007; Vollenweider *et al.*, 2007). This layer has a similar chemical constituent and structure to the inorganic component of bone (De Aza *et al.*, 2007; Best *et al.*, 2008). The bioresorbable ceramics such as tricalcium phosphate and calcium sulphate will be replaced or incorporated into the hard tissue to become part of the structure (Raghavendra *et al.*, 2017).

Mineral trioxide aggregate (MTA) is the first generation of bioceramic (Haapasalo *et al.*, 2015; Assadian *et al.*, 2016; Raghavendra *et al.*, 2017; Song *et al.*, 2020), introduced by Dr. Mahmoud Torabinejad and is composed of tricalcium silicate, tricalcium aluminate, tricalcium oxide, and silicate oxide with the addition of bismuth oxide to make the material radiopaque (Torabinejad *et al.*, 1995). This material is usually used in surgical endodontics, apexification, perforation repairs and pulpotomies (Torabinejad and Chivian, 1999). MTA is known to have excellent properties such as biocompatible, osteoconductive and osteoinductive (Raghavendra *et al.*, 2017), hence making it suitable for various endodontic procedures. The limitations of MTA are its handling characteristics,

discolouration due to the iron compounds and require longer setting time.

Bioceramic root canal sealers are the new generation with the advantages of being well-tolerated by the host tissue, able to promote hard tissue formation and has antimicrobial properties (Raghavendra *et al.*, 2017) but at this stage, robust scientific evidence on this material is limited. The example of bioceramic root canal sealers that have been introduced into the market include EndoSequence BC Sealer (Brasseler, Savannah, GA, USA) or iRoot SP root canal sealer (Innovative BioCreamix Inc, Vancouver, Canada), MTA Fillapex (Angelus, Londrina, Brazil), Endoseal MTA (Maruchi, Wonju, Korea), Tech Biosealer Endo (Isasan, Como, Italy), CeraSeal Bioceramic root canal sealer (Meta Biomed CO. LTD, Korea), Sankin Apatite root canal sealer (Sankin-kogyo, Tokyo, Japan), GuttaFlow Bioseal (Coltène/Whaledent AG, Altstätten, Switzerland), BioRoot™ RCS (Septodont, Saint Maur Des Fosses, France), TotalFill BC sealer (FKG Dentaire, La Chaux-de-Fonds, Switzerland), Sealer Plus BC (MK Life Produtos Medical e Dental, Porto Alegre, Brazil), Smartpaste Bio® (CRD Ltd, Stamford, UK) and others.

Physicochemical properties

The American National Standards Institute/American Dental Association (ANSI/ADA) Specifications number 57 set the standards and tests for the physicochemical properties of root canal sealer. This includes setting time, flowability, solubility, radiopacity, film thickness, and dimensional stability. Some studies on the physicochemical properties of bioceramic root canal sealers have been conducted according to these specifications (Vidotto *et al.*, 2011; Borges *et al.*, 2014; Camargo *et al.*, 2017; Lee *et al.*, 2017; Poggio *et al.*, 2017; Colombo *et al.*, 2018; Khalil *et al.*, 2019), although other researchers have used the International Organisation for Standardisation (ISO) 6876 specifications (Gandolfi and Prati, 2010; de Miranda Candeiro *et al.*, 2012; Vitti *et al.*, 2013; Zhou *et al.*, 2013; Lim *et al.*, 2015; Agarwal and

Nikhil, 2016; Lee *et al.*, 2017; Poggio *et al.*, 2017; Tanomaru-Filho *et al.*, 2017; Colombo *et al.*, 2018; Mendes *et al.*, 2018; Zordan-Bronzel *et al.*, 2019; Kharouf *et al.*, 2020). The ASTM standards C266-07 and C373-88 have also been used to evaluate the setting time and solubility respectively (Gandolfi and Prati, 2010). The summary of physicochemical properties of some bioceramic root canal sealers are shown in Table 1.

Setting time

ANSI/ADA Specifications 57 recommends that all root canal sealers should have a setting time of no greater than 10% of the time determined by the manufacturer. In the studies by (Zhou *et al.*, 2013; Camargo *et al.*, 2017; Lee *et al.*, 2017; Tanomaru-Filho *et al.*, 2017; Zordan-Bronzel *et al.*, 2019), a Gilmore needle was probed onto the surface of root canal sealers and the setting time was recorded when the indenter needle failed to create the indentation. The results revealed that GuttaFlow Bioseal met these specifications (Camargo *et al.*, 2017; Tanomaru-Filho *et al.*, 2017) but in other studies, the TotalFill BC sealer (Zordan-Bronzel *et al.*, 2019), EndoSequence BC Sealer, EndoSeal MTA and MTA Fillapex (Lee *et al.*, 2017) did not fulfil the ISO specifications.

Dimensional stability

ANSI/ADA Specifications 57 recommends that root canal sealers should not exceed 1 % contraction or 0.1 % expansion. In the

studies by (Camargo *et al.*, 2017; Zhou *et al.*, 2013), the percentage of the dimensional alterations was calculated after 30 days following the complete setting of the materials and the results showed that GuttaFlow Bioseal (Camargo *et al.*, 2017) did not meet these specifications. However, the MTA Fillapex and EndoSequence BC Sealer fulfilled the ISO specifications (Zhou *et al.*, 2013).

Solubility

The solubility of material is the percentage of mass loss compared to the initial mass (Borges *et al.*, 2014). ANSI/ADA Specifications 57 and ISO specifications recommend that an ideal root canal sealer should lose not more than 3% of its mass after immersion in water for 24 hours. MTA Fillapex (Vitti *et al.*, 2013; Zhou *et al.*, 2013; Borges *et al.*, 2014; Poggio *et al.*, 2017; Colombo *et al.*, 2018) and GuttaFlow Bioseal (Khalil *et al.*, 2019) fulfilled these specifications. However, BioRoot™ RCS and TotalFill BC sealer did not comply with the ANSI/ADA Specifications 57 and ISO specifications (Poggio *et al.*, 2017; Colombo *et al.*, 2018). Sealer Plus BC (Mendes *et al.*, 2018) and CeraSeal Bioceramic root canal sealer (Kharouf *et al.*, 2020) also did not fulfil the ISO specifications, whereby the solubility of these materials were higher than the recommended values. Although the solubility of the Endosequence BC Sealer fulfilled the ISO 6876 specifications, it approached close to the maximum value for solubility (Zhou *et al.*, 2013).

Table 1. Physicochemical properties of bioceramic root canal sealers

Physicochemical properties	Materials	Specifications	Fulfilment	References
Setting time	GuttaFlow Bioseal	ANSI/ADA Specifications 57, ISO 6876 specifications	Yes	(Camargo <i>et al.</i> , 2017); Tanomaru-Filho <i>et al.</i> , 2017)
	EndoSequence BC Sealer	ISO 6876 specifications	No	(Lee <i>et al.</i> , 2017)
	EndoSeal MTA			
	MTA Fillapex			
	TotalFill BC sealer			(Zordan-Bronzel <i>et al.</i> , 2019)

Table 1 (continued). Physicochemical properties of bioceramic root canal sealers

Physicochemical properties	Materials	Specifications	Fulfilment	References
Dimensional stability	GuttaFlow Bioseal	ANSI/ADA Specifications 57	No	(Camargo <i>et al.</i> , 2017)
	EndoSequence Sealer BC	ISO 6876 specifications	Yes	(Zhou <i>et al.</i> , 2013)
	MTA Fillapex			
Solubility	GuttaFlow Bioseal	ANSI/ADA Specifications 57,	Yes	(Khalil <i>et al.</i> , 2019)
	MTA Fillapex	ISO 6876 specifications	Yes	(Vitti <i>et al.</i> , 2013; Zhou <i>et al.</i> , 2013; Borges <i>et al.</i> , 2014; Poggio <i>et al.</i> , 2017; Colombo <i>et al.</i> , 2018)
	BioRoot™ RCS		No	(Poggio <i>et al.</i> , 2017; Colombo <i>et al.</i> , 2018)
	TotalFill BC sealer		No	(Poggio <i>et al.</i> , 2017; Colombo <i>et al.</i> , 2018; (Zordan-Bronzel <i>et al.</i> , 2019)
	Sealer Plus BC	ISO 6876 specifications	No	(Mendes <i>et al.</i> , 2018)
	Endosequence Sealer BC		Yes	(Zhou <i>et al.</i> , 2013)
	CeraSeal Bioceramic root canal sealer		No	(Kharouf <i>et al.</i> , 2020)
Flowability	GuttaFlow Bioseal	ANSI/ADA Specifications 57	No	(Camargo <i>et al.</i> , 2017)
	MTA Fillapex	ISO 6876 specifications	Yes	(Vitti <i>et al.</i> , 2013; Zhou <i>et al.</i> , 2013; Lee <i>et al.</i> , 2017)
	EndoSequence Sealer BC		Yes	(de Miranda Candeiro <i>et al.</i> , 2012; Zhou <i>et al.</i> , 2013; Agarwal and Nikhil, 2016)
			No	(Lee <i>et al.</i> , 2017)
	BioRoot™ RCS		Yes	(Kharouf <i>et al.</i> , 2020)
	CeraSeal Bioceramic root canal sealer		No	
Radiopacity	GuttaFlow Bioseal	ANSI/ADA Specification 57	Yes	(Camargo <i>et al.</i> , 2017)
		ISO 6876 specifications	Yes	(Tanomaru-Filho <i>et al.</i> , 2017)
	MTA Fillapex	ANSI/ADA Specifications 57	Yes	(Vidotto <i>et al.</i> , 2011; Borges <i>et al.</i> , 2014)
		ISO 6876 specifications		(Lee <i>et al.</i> , 2017)
	TotalFill BC sealer		Yes	(Tanomaru-Filho <i>et al.</i> , 2017; Zordan-Bronzel <i>et al.</i> , 2019)
	EndoSequence Sealer BC			(de Miranda Candeiro <i>et al.</i> , 2012; Agarwal and Nikhil, 2016; Lee <i>et al.</i> , 2017)
	EndoSeal MTA			(Lim <i>et al.</i> , 2015; Lee <i>et al.</i> , 2017)

Flowability

ANSI/ADA Specifications 57 recommends that root canal sealers diameter should be greater than 20 mm. GuttaFlow Bioseal (Camargo *et al.*, 2017) did not meet these specifications. MTA Fillapex (Vitti *et al.*, 2013; Zhou *et al.*, 2013; Lee *et al.*, 2017) and EndoSeal MTA (Lee *et al.*, 2017) both met the ISO specifications. However, EndoSequence BC Sealer showed conflicting results where some studies indicate its diameter to be in accordance with the ISO specifications (de Miranda Candeiro *et al.*, 2012; Zhou *et al.*, 2013; Agarwal and Nikhil, 2016), while a study by (Lee *et al.*, 2017) indicated otherwise.

pH values

High pH values is important for root canal sealers because the release of calcium ions not only stimulates hard tissue formation but also triggers antibacterial activity (Al-Haddad and Che Ab Aziz, 2016) as reported in the studies by (Colombo *et al.*, 2018; Kharouf *et al.*, 2020). BioRoot™ RCS (Colombo *et al.*, 2018; Kharouf *et al.*, 2020) and TotalFill BC sealer (Colombo *et al.*, 2018) exhibited high alkaline pH (up to 11) at 24 hours, similar to the previous studies on EndoSequence BC Sealer, EndoSeal MTA and MTA Fillapex (Lee *et al.*, 2017). High alkalinity of EndoSeal MTA (Lim *et al.*, 2015) and CeraSeal Bioceramic root canal sealer (Kharouf *et al.*, 2020) have also been reported.

Radiopacity

ANSI/ADA Specifications 57 and ISO 6876 specifications recommend that all root canal sealers must have radiopacity greater than or equal to 3 mm Al. GuttaFlow Bioseal (Camargo *et al.*, 2017) complied with the ANSI/ADA Specification 57, as well as the ISO 6876 specifications (Tanomaru-Filho *et al.*, 2017), similar with MTA Fillapex that fulfilled the ANSI/ADA Specifications 57 (Vidotto *et al.*, 2011), (Borges *et al.*, 2014) and ISO 6876 specifications (Lee *et al.*, 2017). TotalFill BC sealer (Tanomaru-Filho *et al.*, 2017), EndoSequence BC Sealer (de Miranda

Candeiro *et al.*, 2012; Agarwal and Nikhil, 2016; Lee *et al.*, 2017) and EndoSeal MTA (Lim *et al.*, 2015; Lee *et al.*, 2017) were also in accordance with the ISO 6876 specifications.

Cytotoxicity

Cytotoxic analysis of bioceramic root canal sealers have been reported by many researchers (Loushine *et al.*, 2011; Mukhtar-Fayyad, 2011; Silva *et al.*, 2013; Yoshino *et al.*, 2013; Chang *et al.*, 2014; Baraba *et al.*, 2016; Candeiro *et al.*, 2016; Silva *et al.*, 2016; Collado-González *et al.*, 2017; Saygili *et al.*, 2017; Victoria-Escandell *et al.*, 2017; Benetti *et al.*, 2019; Rodríguez-Lozano *et al.*, 2019).

The findings on viability of cells observed in their studies was complex, could be associated with multiple factors such as the types of root canal sealers (Loushine *et al.*, 2011; Silva *et al.*, 2013; Candeiro *et al.*, 2016; Baraba *et al.*, 2016; Collado-González *et al.*, 2017; Saygili *et al.*, 2017; Rodríguez-Lozano *et al.*, 2019), incubation periods (Bryan *et al.*, 2010; Loushine *et al.*, 2011; Silva *et al.*, 2013) and concentration of the root canal in the extract solution (Bryan *et al.*, 2010; Mukhtar-Fayyad, 2011; Yoshino *et al.*, 2013; Benetti *et al.*, 2019).

For example, the cytotoxic effects of Endosequence BC Sealer (Baraba *et al.*, 2016; Giacomino *et al.*, 2019) or iRoot SP root canal sealer (Mukhtar-Fayyad, 2011) have been reported but the findings were inconsistent in other study where the iRoot SP root canal sealer and MTA Fillapex showed no cytotoxic effects (Chang *et al.*, 2014). The discrepancy between these findings could be attributed to the different types of cell cultures and methods used for evaluating the viability of cells. Despite this, it is suggested by many researchers that the chemical composition of MTA Fillapex which includes salicylate resin, diluting resin and silica (Silva *et al.*, 2013; Baraba *et al.*, 2016; Silva *et al.*, 2016; Victoria-Escandell *et al.*, 2017; Colombo *et al.*, 2018) that could contribute to the cytotoxic effects.

Another aspect was the high pH value of MTA Fillapex and Endosequence BC Sealer

(Baraba *et al.*, 2016) that was postulated to cause loss of cell viability and membrane integrity (Lee *et al.*, 2017). Bioceramic root canal sealers that exhibit prolonged high pH value (up to 12) before its setting may also cause damage to the periapical tissue. This needs to be carefully considered when choosing bioceramic root canal sealers for obturating the root canal, despite the materials' osteogenic and antimicrobial properties (Lee *et al.*, 2017).

In addition to that, the high solubility of MTA Fillapex that leads to a higher release of the toxic components (Silva *et al.*, 2016) and long setting time of Endosequence BC Sealer (Baraba *et al.*, 2016) can be the contributing factors determining the viability of cells.

Regarding the influence of concentration of the root canal sealers in the extract solution, most concentrated extract leads to more cell damage compared to a more diluted concentration (Mukhtar-Fayyad, 2011; Yoshino *et al.*, 2013; Benetti *et al.*, 2019) and this might occur because of the high pH of the materials that causes damage to the adjacent cells and denatures proteins (Siqueira Jr and Lopes, 1999). For instance, pure extract of MTA Fillapex showed high toxicity levels throughout the incubation periods from 24 to 72 hours as measured by occurrence of cell death and alteration of cell growth rates (Yoshino *et al.*, 2013). However, a decreased cytotoxic levels were observed in diluted MTA Fillapex (Yoshino *et al.*, 2013) and Sealer Plus BC (Benetti *et al.*, 2019). These findings showed that eluents from the root canal sealers were cytotoxic to the cell culture and dependent on its concentration (Bryan *et al.*, 2010).

The incubation period could also be involved in determining the viability of cells. Perhaps, this might explain why the severe cytotoxicity could be observed at 24 hours regardless of any root canal sealers (Bryan *et al.*, 2010; Loushine *et al.*, 2011) but the findings were contradictory to the other study where no cytotoxicity was observed in BioRoot™ RCS and TotalFill BC sealer observed at 24 hours (Colombo *et al.*, 2018). This could be due to the different types of cell cultures that might not response

similarly despite similar incubation periods. Freshly mixed AH Plus root canal sealer was cytotoxic, but the cytotoxicity gradually decreased over time (Bryan *et al.*, 2010; Loushine *et al.*, 2011; Silva *et al.*, 2013). However, the MTA Fillapex exhibited cytotoxicity throughout the incubation periods (Silva *et al.*, 2013; Baraba *et al.*, 2016). Despite no cytotoxic effect in BioRoot™ RCS and TotalFill BC sealer during the early incubation period, mild cytotoxicity was exhibited at later incubation periods (48 hours and 72 hours) (Colombo *et al.*, 2018).

Previous studies on the material cytotoxicity were carried out using *in vitro* cell cultures under specific protocols. However, results from this approach were limited because the cell cultures were monoclonal in origin, not dynamic in nature, had no cell-cell interactions and did not accurately represent the real clinical situation (Loushine *et al.*, 2011). Additionally, the cell culture does not contain mechanisms for removal of the irritants (Bryan *et al.*, 2010). Root canal sealers showed high cytotoxicity in a 2 dimensional (D) cell culture compared to the 3D cell culture due to the absence of cell-cell interactions in the 2D cell culture and a reduced capability of the extracts of root canal sealers to penetrate the 3D cell culture (Silva *et al.*, 2016). Therefore, the findings of *in vitro* studies must be carefully interpreted and the extrapolation to the clinical practice must be made with great caution.

In order to confirm the safety and effectiveness of bioceramic root canal sealers, an alternative approach through an *in vivo* technique using Wistar rats was introduced to assess the histological characteristics of subcutaneous tissues after implantation with the materials (Bueno *et al.*, 2016; Santos *et al.*, 2019). It was found that the GuttaFlow Bioseal triggered low inflammatory reactions during the early and late stages of observation and improved vascular changes during late assessment (Santos *et al.*, 2019). However, mild-to-moderate inflammatory reactions were observed during the initial observation period when using Smartpaste Bio®, but this

subsequently decreased over time (Bueno *et al.*, 2016).

It has been demonstrated that the cytotoxicity of a root canal sealers may decrease with time (Loushine *et al.*, 2011; Silva *et al.*, 2013; Bueno *et al.*, 2016) and later become noncytotoxic, achieved by desorption of the toxic components into the surrounding tissue (Bryan *et al.*, 2010). Although the toxic components may take time to diffuse away from the periapical tissue, their presence may delay the healing process of periapical inflammation (Bryan *et al.*, 2010), therefore, it is essential to understand that this desorption is immune response and can cause ongoing inflammatory process (Giacomino *et al.*, 2019).

Biomineralisation

The osteogenic potential of bioceramic root canal sealers, also known as the biomineralisation have been reported in the previous studies (Gandolfi *et al.*, 2008; Bryan *et al.*, 2010; Han and Okiji, 2013; Chang *et al.*, 2014; Hoikkala *et al.*, 2018; Giacomino *et al.*, 2019). This process begins with the release of calcium ions from the materials followed by the formation of silicate hydroxyl (Si-OH) groups at the material's surface, this will act as an ideal site for nucleation of hydroxyapatite crystal which later precipitates the formation of amorphous layer and becomes crystallised into carbonated hydroxyapatite (Hoikkala *et al.*, 2018). It has been demonstrated that the MTA Fillapex (Chang *et al.*, 2014) Smartpaste Bio® (Bueno *et al.*, 2016), GuttaFlow Bioseal (Hoikkala *et al.*, 2018), iRoot SP (Chang *et al.*, 2014) or EndoSequence BC Sealer (Giacomino *et al.*, 2019; Seo *et al.*, 2019), BioRoot™ RCS (Seo *et al.*, 2019), EndoSeal MTA (Seo *et al.*, 2019) and ProRoot® ES endodontic root canal sealer (Giacomino *et al.*, 2019) showed mineralisation activity in the cultured cell models.

Retreatability

Data on the retreatability of bioceramic root canal sealers has been reported in many studies (Hess *et al.*, 2011; Kim *et al.*, 2015; de Siqueira Zuolo *et al.*, 2016; Oltra *et al.*, 2017; Donnermeyer *et al.*, 2018; Kim *et al.*, 2019; Kontogiannis *et al.*, 2019; Romeiro *et al.*, 2020). Even though there are similarities in some of their findings, other aspects are inconsistent, could be attributed to the use of different retreatment rotary file systems, type of the extracted teeth and bioceramic root canal sealers. Research on retreatability focuses on the amount of remnants and the duration of time required for the procedure.

For instance, after the removal of root canal sealer from the root canal, MTA Fillapex (Uzunoglu *et al.*, 2015), iRoot SP (Uzunoglu *et al.*, 2015) or EndoSequence BC Sealer was demonstrated to leave more remnants (de Siqueira Zuolo *et al.*, 2016; Oltra *et al.*, 2017; Kim *et al.*, 2019) and require longer retreatment time (Hess *et al.*, 2011; de Siqueira Zuolo *et al.*, 2016; Kim *et al.*, 2019; Romeiro *et al.*, 2020) compared to the conventional root canal sealer. The presence of remnants can result in blockage of the apical foramen, leading to loss of apical patency in some cases (Hess *et al.*, 2011). Conflicting evidence on MTA Fillapex exists in which the amount of remnants was reported to be more (Kim *et al.*, 2019), similar (Kontogiannis *et al.*, 2019) and less (Neelakantan *et al.*, 2013) if compared to the conventional root canal sealer. Regarding the retreatment time, the removal of MTA Fillapex requires shorter (Uzunoglu *et al.*, 2015), (Donnermeyer *et al.*, 2018) and longer (Kim *et al.*, 2019) duration compared to other root canal sealers. The shorter retreatment time in MTA Fillapex can be related to its lower bond strength to the root dentine (Neelakantan *et al.*, 2013; Uzunoglu *et al.*, 2015) and questionable mineralisation activity (Neelakantan *et al.*, 2013). Loss of apical patency and more remnants of root canal sealer were also reported when using TotalFill BC Sealer (Kontogiannis *et al.*, 2019). However, when using EndoSequence BC Sealer (Kim *et al.*, 2015) and Endoseal MTA (Kim *et al.*, 2019), the remnants of root canal sealer and retreatment time were equivalent to AH Plus root canal sealer. BioRoot™ RCS showed less remnants and

shorter retreatment times compared to AH Plus root canal sealer (Donnermeyer *et al.*, 2018).

To date, research on the retreatability of bioceramic root canal sealers is increasing but there is still insufficient evidence to draw robust conclusion pertaining to the most effective material that can facilitate retreatment procedure.

3D obturation

The goal of obturation is to create a 3D seal of the root canal system to prevent the recurrence of bacterial infection (Schilder, 1967). 3D obturation seals not only the main canal but also the eccentricities in the root canal system (Schilder, 1967). The use of heat softens the gutta-percha and allows it to be adapted to the root canal wall with the intention to seal the exits to periodontal tissues. This technique requires careful handling of the heat source, clinical skills and more time consuming to achieve effective sealing. A modified version of this technique has been introduced such as continuous and interrupted waves of vertical compaction to achieve similar 3D obturation (Tomson *et al.*, 2014) which is also technique-sensitive procedure. Without proper handling and skill, 3D obturation would not be possible.

Studies have shown that thermoplastic gutta-percha provides good adaptation to the root canal wall (Gençoğlu *et al.*, 1993; Gulabivala *et al.*, 1998; Venturi and Breschi, 2004; Withworth, 2005), but leakage in thermoplastic and cold lateral compaction obturation techniques have also been highlighted (Vizgirda *et al.*, 2004). Despite contradicting findings, thermoplastic gutta-percha has been shown to adapt uniformly to the root canal wall with only minor voids (Torabinejad *et al.*, 1978).

Comparative studies on the ability to provide 3D obturation between bioceramic root canal sealers and other obturation techniques have not been reported because of the recent technology in endodontics. Future research works comparing various obturation techniques with bioceramic root canal sealers should be done to provide an

insight into this aspect, thus can help the profession in the decision-making process with respect to the most effective materials for obturation of the root canal system.

Current practice

The obturation techniques have improved since the introduction of bioceramic root canal sealers. These developments facilitate easier methods of obturation and provide alternative to conventional obturation techniques (Topçuoğlu *et al.*, 2013).

When obturating the root canal system, the root canal sealer is used to seal the gap that is present within the root filling materials and root canal wall. To date, the monocone obturation technique is the commonly practiced because of its ease of delivery and less time-consuming, however, the quality of obturation, apical seal and bacterial penetration when using this technique are questionable (Pereira *et al.*, 2012). Due to the greater volume of sealer that can be present in the complex root canal system, this technique has been considered less effective (Pereira *et al.*, 2012; Robberecht *et al.*, 2012). Contradictory to this, some studies have reported similar performance of this technique (Inan *et al.*, 2009; Koçak and Darendeliler-Yaman, 2012; Robberecht *et al.*, 2012; Obeidat and Abdallah, 2014). To overcome the limitations associated with the monocone obturation technique, the role of conventional root canal sealers have gradually been replaced by the bioceramic root canal sealers.

Studies on fracture resistance of teeth obturated with combination of gutta-percha cones and bioceramic root canal sealers have been conducted in the recent years. An increased fracture resistance was seen when using iRoot SP root canal sealer if compared to the conventional root canal sealers (Ghoneim *et al.*, 2011). However, when comparing the fracture resistance of iRoot SP root canal sealer and EndoSequence BC Sealer, it was equivalent (Celikten *et al.*, 2015). The increased fracture resistance in EndoSequence BC Sealer (Topçuoğlu *et al.*, 2013; Hegde and Arora, 2015) or iRoot SP root canal sealer (Ghoneim *et al.*, 2011)

could be due to its chemical bonding through the formation of hydroxyapatite crystals during setting when the material is in contact with moisture (Ghoneim *et al.*, 2011). Obturation of the root canal system using iRoot SP root canal sealer (Wang *et al.*, 2018) or EndoSequence BC Sealer (Celikten *et al.*, 2016), MTA Fillapex (Al-Haddad *et al.*, 2015) and Smartpaste Bio[®] (Celikten *et al.*, 2016) provided equivalent obturation quality as of AH Plus root canal sealer, as determined by the microscopic evaluation of the presence of voids and marginal gaps. Conversely, the EndoSequence BC Sealer (Al-Haddad *et al.*, 2015) and MTA Fillapex (Polineni *et al.*, 2016) exhibited more marginal gaps when compared to resin-based root canal sealers. These opposite findings could be associated with the different obturation techniques used in their studies. On the other hand, iRoot SP root canal sealer (Zhang *et al.*, 2009; Ersahan and Aydin, 2013) and TotalFill BC sealer (Hasnain *et al.*, 2017) were equivalent to AH Plus root canal sealer in apical sealing ability, as determined by dye penetration method (Hasnain *et al.*, 2017) and fluid filtration analysis (Zhang *et al.*, 2009; Ersahan and Aydin, 2013).

In general, regardless of any obturation techniques and root canal sealers, the presence of voids and marginal gaps is inevitable (Nabavizadeh *et al.*, 2013; Samadi *et al.*, 2014; Adhikari and Jain, 2018; Jain and Adhikari, 2018; Wang *et al.*, 2018).

Conclusion

To date, robust scientific evidence on the obturation of the root canal system with bioceramic root canal sealers is limited, therefore, its use in clinical practice must be considered with great caution, taking into consideration the physicochemical properties, biocompatibility, biomineralisation as well as retreatability of each material. Since the clinical data concerning obturation with bioceramic root canal sealers is lacking, the selection of materials should be made based on the available scientific evidence, individual cases, material availability and operator's preference.

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Conflict of interest

None

References

- Adhikari, H. D., Jain, S. (2018). Scanning electron microscopic evaluation of marginal adaptation of AH-Plus, guttaflow, and realseal at apical one-third of root canals - Part II: Core-sealer interface. *Journal of Conservative Dentistry*, 21(1), 90-94.
- Agarwal, R., Nikhil, V. (2016). The comparison of physicochemical properties of new and established root canal sealers. *Endodontology*, 28(2), 97-101.
- Al-Haddad, A., Abu Kasim, N. H., Che Ab Aziz, Z. A. (2015). Interfacial adaptation and thickness of bioceramic-based root canal sealers. *Dental Materials Journal*, 34(4), 516-521.
- Al-Haddad, A., Che Ab Aziz, Z. A. (2016). Bioceramic-based root canal sealers: A review. *International Journal of Biomaterials*, 2016.
- Assadian, H., Hamzelouei Moghaddam, E., Amini, A., Nazari Moghaddam, K., Hashemzahi, M. (2016). A review of endodontic bioceramics. *Journal of Islamic Dental Association of Iran*, 28(1), 20-33
- Baraba, A., Pezelj-Ribarić, S., Roguljić, M., Miletić, I. (2016). Cytotoxicity of two bioactive root canal sealers. *Acta Stomatologica Croatia*, 50(1), 8-13.
- Benetti, F., Queiroz, Í. O. A., Oliveira, P. H. C., Conti, L. C., Azuma, M. M., Oliveira, S. H. P. *et al.* (2019). Cytotoxicity and biocompatibility of a new bioceramic endodontic sealer containing calcium hydroxide. *Brazilian Oral Research*, 33, e042.
- Best, S. M., Porter, A. E., Thian, E. S., Huang, J. (2008). Bioceramics: Past, present and for the future. *Journal of the European Ceramic Society*, 28(7), 1319-1327.
- Borges, Á. H., Orçati Dorileo, M. C., Dalla Villa, R., Borba, A. M., Semenoff, T. A., Guedes, O. A. *et al.* (2014). Physicochemical properties and surfaces morphologies evaluation of MTA FillApex and AH plus. *The Scientific World Journal*, 2014.
- Bryan, T. E., Khechen, K., Brackett, M. G., Messer, R. L., El-Awady, A., Primus, C. M. *et al.* (2010). In vitro osteogenic potential of an experimental calcium silicate-based root canal sealer. *Journal of Endodontics*, 36(7), 1163-1169.
- Bueno, C. R. E., Valentim, D., Marques, V. A. S., Gomes-Filho, J. E., Cintra, L. T., Jacinto, R. C. *et al.* (2016). Biocompatibility and biomineralization assessment of bioceramic-, epoxy-, and calcium hydroxide-based sealers. *Brazilian Oral Research*, 30(1), e81.
- Camargo, R. V. D., Silva-Sousa, Y. T. C., Rosa, R. P. F. D., Mazzi-Chaves, J. F., Lopes, F. C., Steier, L. *et al.*

- (2017). Evaluation of the physicochemical properties of silicone- and epoxy resin-based root canal sealers. *Brazilian Oral Research*, 31, e72.
- Candeiro, G. T. M., Moura-Netto, C., D'Almeida-Couto, R. S., Azambuja-Júnior, N., Marques, M. M., Cai, S. *et al.* (2016). Cytotoxicity, genotoxicity and antibacterial effectiveness of a bioceramic endodontic sealer. *International Endodontic Journal*, 49(9), 858-864.
- Celikten, B., Uzuntas, C. F., Gulsahi, K. (2015). Resistance to fracture of dental roots obturated with different materials. *BioMed Research International*, 2015.
- Celikten, B., Uzuntas, C. F., Orhan, A. I., Orhan, K., Tufenkci, P., Kursun, S. *et al.* (2016). Evaluation of root canal sealer filling quality using a single-cone technique in oval shaped canals: An in vitro micro-CT study. *Scanning*, 38(2), 133-140.
- Chang, S. W., Lee, S. Y., Kang, S. K., Kum, K. Y., Kim, E. C. (2014). In vitro biocompatibility, inflammatory response, and osteogenic potential of 4 root canal sealers: Sealapex, sankin apatite root sealer, MTA fillapex, and iRoot SP root canal sealer. *Journal of Endodontics*, 40(10), 1642-1648.
- Collado-González, M., Tomás-Catalá, C. J., Oñate-Sánchez, R. E., Moraleda, J. M., Rodríguez-Lozano, F. J. (2017). Cytotoxicity of GuttaFlow bioseal, GuttaFlow2, MTA fillapex, and AH plus on human periodontal ligament stem cells. *Journal of Endodontics*, 43(5), 816-822.
- Colombo, M., Poggio, C., Dagna, A., Meravini, M. V., Riva, P., Trovati, F. *et al.* (2018). Biological and physicochemical properties of new root canal sealers. *Journal of Clinical and Experimental Dentistry*, 10(2), e120.
- De Aza, P. N., De Aza A. H., Pena, P., De Aza, S. (2007). Bioactive glasses and glass-ceramics. *Boletín-Sociedad Espanola De Ceramica Y Vidrio*, 46(2), 45-55.
- De Miranda Candeiro, G. T., Correia, F. C., Duarte, M. A. H., Ribeiro-Siqueira, D. C., Gavini, G. (2012). Evaluation of radiopacity, pH, release of calcium ions, and flow of a bioceramic root canal sealer. *Journal of Endodontics*, 38(6), 842-845.
- De Siqueira Zuolo, A., Zuolo, M. L., Da Silveira Bueno, C. E., Chu, R., Cunha, R. S. (2016). Evaluation of the efficacy of TRUShape and reciproc file systems in the removal of root filling material: An ex vivo micro-computed tomographic study. *Journal of Endodontics*, 42(2), 315-319.
- Donnermeyer, D., Bunne, C., Schäfer, E., Dammaschke, T. (2018). Retreatability of three calcium silicate-containing sealers and one epoxy resin-based root canal sealer with four different root canal instruments. *Clinical Oral Investigations*, 22(2), 811-817.
- Ersahan, S., Aydin, C. (2013). Solubility and apical sealing characteristics of a new calcium silicate-based root canal sealer in comparison to calcium hydroxide-, methacrylate resin- and epoxy resin-based sealers. *Acta Odontologica Scandinavica*, 71(3-4), 857-862.
- Gandolfi, M. G., Pagani, S., Perut, F., Ciapetti, G., Baldini, N., Mongiorgi, R. *et al.* (2008). Innovative silicate-based cements for endodontics: a study of osteoblast-like cell response. *Journal of Biomedical Materials Research Part A: An Official Journal of The Society for Biomaterials, The Japanese Society for Biomaterials, and The Australian Society for Biomaterials, and The Korean Society for Biomaterials*, 87(2), 477-486.
- Gandolfi, M. G., Prati, C. (2010). MTA and F-doped MTA cements used as sealers with warm gutta-percha. Long-term study of sealing ability. *International Endodontic Journal*, 43(10), 889-901.
- Gençoğlu, N., Samani, S., Gunday, M. (1993). Dentinal wall adaptation of thermoplasticized gutta-percha in the absence or presence of smear layer: a scanning electron microscopic study. *Journal of Endodontics*, 19(11), 558-562.
- Ghoneim, A. G., Lutfy, R. A., Sabet, N. E., Fayyad, D. M. (2011). Resistance to fracture of roots obturated with novel canal-filling systems. *Journal of Endodontics*, 37(11), 1590-1592.
- Giacomino, C. M., Wealleans, J. A., Kuhn, N., Diogenes, A. (2019). Comparative biocompatibility and osteogenic potential of two bioceramic sealers. *Journal of Endodontics*, 45(1), 51-56.
- Gulabivala, K., Holt, R., Long, B. (1998). An in vitro comparison of thermoplasticised gutta-percha obturation techniques with cold lateral condensation. *Endodontics and Dental Traumatology*, 14(6), 262-269.
- Haapasalo, M., Parhar, M., Huang, X., Wei, X., Lin, J., Shen, Y. (2015). Clinical use of bioceramic materials. *Endodontic Topics*, 32(1), 97-117.
- Han, L., Okiji, T. (2013). Bioactivity evaluation of three calcium silicate-based endodontic materials. *International Endodontic Journal*, 46(9), 808-814.
- Hasnain, M., Bansal, P., Nikhil, V. (2017). An in vitro comparative analysis of sealing ability of bioceramic-based, methacrylate-based, and epoxy resin-based sealers. *Endodontology*, 29(2), 146-150.
- Hegde, V., Arora, S. (2015). Fracture resistance of roots obturated with novel hydrophilic obturation systems. *Journal of Conservative Dentistry*, 18(3), 261-264.
- Hess, D., Solomon, E., Spears, R., He, J. (2011). Retreatability of a bioceramic root canal sealing material. *Journal of Endodontics*, 37(11), 1547-1549.
- Hoikkala, N. J., Wang, X., Hupa, L., Smatt, J. H., Peltonen, J., Vallittu, P. K. (2018). Dissolution and mineralization characterization of bioactive glass ceramic containing endodontic sealer guttaflow bioseal. *Dental Materials Journal*, 37(6), 988-994.
- Inan, U., Aydin, C., Tunca, Y. M., Basak, F. (2009). In vitro evaluation of matched-taper single-cone obturation with a fluid filtration method. *Journal of the Canadian Dental Association*, 75(2), 123.
- Jain, S., Adhikari, H. D. (2018). Scanning electron microscopic evaluation of marginal adaptation of AH-plus, guttaFlow, and realSeal at apical one-third of root canals - Part I: Dentin-sealer interface. *Journal of Conservative Dentistry*, 21(1), 85-89.
- Khalil, M. M., Abdelrahman, M. H., El-Mallah, S. (2019). Bond strength and solubility of a novel polydimethylsiloxane-gutta-percha calcium silicate-containing root canal sealer. *Dental and Medical Problems*, 56(2), 161-165.

- Kharouf, N., Arntz, Y., Eid, A., Zghal, J., Sauro, S., Haikel, Y. *et al.* (2020). Physicochemical and antibacterial properties of novel, premixed calcium silicate-based sealer compared to powder-liquid bioceramic sealer. *Journal of Clinical Medicine*, 9(10), 3096.
- Kim, H., Kim, E., Lee, S. J., Shin, S. J. (2015). Comparisons of the retreatment efficacy of calcium silicate and epoxy resin-based sealers and residual sealer in dentinal tubules. *Journal of Endodontics*, 41(12), 2025-2030.
- Kim, S. R., Kwak, S. W., Lee, J. K., Goo, H. J., Ha, J. H., Kim, H. C. (2019). Efficacy and retrievability of root canal filling using calcium silicate-based and epoxy resin-based root canal sealers with matched obturation techniques. *Australian Endodontic Journal*, 45(3), 337-345.
- Koçak, M. M., Darendeliler-Yaman, S. (2012). Sealing ability of lateral compaction and tapered single cone gutta-percha techniques in root canals prepared with stainless steel and rotary nickel titanium instruments. *Journal of Clinical and Experimental Dentistry*, 4(3), e156.
- Kontogiannis, T., Kerezoudis, N., Kozyrakis, K., Farmakis, E. (2019). Removal ability of MTA-, bioceramic-, and resin-based sealers from obturated root canals, following XP-endo® Finisher R file: An ex vivo study. *Saudi Endodontic Journal*, 9(1), 8-13.
- Lee, J. K., Kwak, S. W., Ha, J. H., Lee, W., Kim, H. C. (2017). Physicochemical properties of epoxy resin-based and bioceramic-based root canal sealers. *Bioinorganic Chemistry and Applications*, 2017.
- Lim, E. S., Park, Y. B., Kwon, Y. S., Shon, W. J., Lee, K. W., Min, K. S. (2015). Physical properties and biocompatibility of an injectable calcium-silicate-based root canal sealer: in vitro and in vivo study. *BMC Oral Health*, 15(1), 1-7.
- Loushine, B. A., Bryan, T. E., Looney, S. W., Gillen, B. M., Loushine, R. J., Weller, R. N. *et al.* (2011). Setting properties and cytotoxicity evaluation of a premixed bioceramic root canal sealer. *Journal of Endodontics*, 37(5), 673-677.
- Mendes, A. T., Silva, P. B. D., Só, B. B., Hashizume, L. N., Vivan, R. R., Rosa, R. A. D. *et al.* (2018). Evaluation of physicochemical properties of new calcium silicate-based sealer. *Brazilian Dental Journal*, 29(6), 536-540.
- Mukhtar-Fayyad, D. (2011). Cytocompatibility of new bioceramic-based materials on human fibroblast cells (MRC-5). *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 112(6), e137-e142.
- Nabavizadeh, M. R., Moazami, F., Sedigh Shamsi, M., Emami, Z. (2013). Comparison of the percentage of voids following root canal obturation with gutta percha and AH26 sealer using four different sealer placement techniques *Journal of Islamic Dental Association of Iran*, 25(3), 199-203.
- Neelakantan, P., Grotra, D., Sharma, S. (2013). Retreatability of 2 mineral trioxide aggregate-based root canal sealers: a cone-beam computed tomography analysis. *Journal of Endodontics*, 39(7), 893-896.
- Obeidat, R., Abdallah, H. (2014). Radiographic evaluation of the quality of root canal obturation of single-matched cone gutta-percha root canal filling versus hot lateral technique. *Saudi Endodontic Journal*, 4(2), 58-63.
- Oltra, E., Cox, T. C., Lacourse, M. R., Johnson, J. D., Paranjpe, A. (2017). Retreatability of two endodontic sealers, endosequence BC sealer and AH Plus: a micro-computed tomographic comparison. *Restorative Dentistry & Endodontics*, 42(1), 19-26.
- Pereira, A. C., Nishiyama, C. K., de Castro Pinto, L. (2012). Single-cone obturation technique: a literature review. *RSBO Revista Sul-Brasileira de Odontologia*, 9(4), 442-447.
- Poggio, C., Dagna, A., Ceci, M., Meravini, M. -V., Colombo, M., Pietrocola, G. (2017). Solubility and pH of bioceramic root canal sealers: A comparative study. *Journal of Clinical and Experimental Dentistry*, 9(10), e1189.
- Polineni, S., Bolla, N., Mandava, P., Vemuri, S., Mallela, M., Gandham, V. M. (2016). Marginal adaptation of newer root canal sealers to dentin: A SEM study. *Journal of Conservative Dentistry*, 19(4), 360-363.
- Raghavendra, S. S., Jadhav, G. R., Gathani, K. M., Kotadia, P. (2017). Bioceramics in endodontics - a review. *Journal of Istanbul University Faculty of Dentistry*, 51(3 Suppl 1), S128.
- Robberecht, L., Colard, T., Claisse-Crinquette, A. (2012). Qualitative evaluation of two endodontic obturation techniques: tapered single-cone method versus warm vertical condensation and injection system: an in vitro study. *Journal of Oral Science*, 54(1), 99-104.
- Rodríguez-Lozano, F. J., Collado-González, M., Tomás-Catalá, C. J., García-Bernal, D., López, S., Oñate-Sánchez, R. E. *et al.* (2019). GuttaFlow bioseal promotes spontaneous differentiation of human periodontal ligament stem cells into cementoblast-like cells. *Dental Materials*, 35(1), 114-124.
- Romeiro, K., Almeida, A., Cassimiro, M., Gominho, L., Dantas, E., Chagas, N. *et al.* (2020). Reciproc and Reciproc Blue in the removal of bioceramic and resin-based sealers in retreatment procedures. *Clinical Oral Investigations*, 24, 1-12.
- Samadi, F., Jaiswal, J., Saha, S., Garg, N., Chowdhary, S., Samadi, F. *et al.* (2014). A Comparative evaluation of efficacy of different obturation techniques used in root Canal treatment of anterior teeth: An in vitro Study. *International Journal of Clinical Pediatric Dentistry*, 7(1), 1.
- Santos, J. M., Pereira, S., Sequeira, D. B., Messias, A. L., Martins, J. B., Cunha, H. *et al.* (2019). Biocompatibility of a bioceramic silicone-based sealer in subcutaneous tissue. *Journal of Oral Science*, 61(1), 171-177.
- Saygili, G., Saygili, S., Tuglu, I., Davut Capar, I. (2017). In vitro cytotoxicity of guttaflow bioseal, guttaflow 2, AH-plus and MTA fillapex. *Iranian Endodontic Journal*, 12(3), 354-359.
- Schilder, H. (1967). Filling root canals in three dimensions. *Dental Clinics of North America*, 723-744.
- Seo, D. G., Lee, D., Kim, Y. M., Song, D., Kim, S. Y. (2019). Biocompatibility and mineralization activity of three calcium silicate-based root canal sealers compared to conventional resin-based sealer in

- human dental pulp stem cells. *Materials*, 12(15), 2482.
- Silva, E. J. N. L., Carvalho, N. K. D., Ronconi, C. T., De-Deus, G., Zuolo, M. L., Zaia, A. A. (2016). Cytotoxicity Profile of Endodontic Sealers Provided by 3D Cell Culture Experimental Model. *Brazilian Dental Journal*, 27(6), 652-656.
- Silva, E. J., Rosa, T. P., Herrera, D. R., Jacinto, R. C., Gomes, B. P., Zaia, A. A. (2013). Evaluation of cytotoxicity and physicochemical properties of calcium silicate-based endodontic sealer MTA Fillapex. *Journal of Endodontics*, 39(2), 274-277.
- Siqueira Jr, J. F., Lopes, H. P. (1999). Mechanisms of antimicrobial activity of calcium hydroxide: a critical review. *International Endodontic Journal*, 32(5), 361-369.
- Song, W., Sun, W., Chen, L., Yuan, Z. (2020). In vivo biocompatibility and bioactivity of calcium silicate-based bioceramics in Endodontics. *Frontiers in Bioengineering and Biotechnology*, 8, 1113.
- Tanomaru-Filho, M., Torres, F. F. E., Chávez-Andrade, G. M., de Almeida, M., Navarro, L. G., Steier, L. *et al.* (2017). Physicochemical properties and volumetric change of silicone/bioactive glass and calcium silicate-based endodontic sealers. *Journal of Endodontics*, 43(12), 2097-2101.
- Tomson, R. M., Polycarpou, N., Tomson, P. L. (2014). Contemporary obturation of the root canal system. *British Dental Journal*, 216(6), 315-322.
- Topçuoğlu, H. S., Tuncay, Ö., Karataş, E., Arslan, H., Yeter, K. (2013). In vitro fracture resistance of roots obturated with epoxy resin-based, mineral trioxide aggregate-based, and bioceramic root canal sealers. *Journal of Endodontics*, 39(12), 1630-1633.
- Torabinejad, M., Chivian, N. (1999). Clinical applications of mineral trioxide aggregate. *Journal of Endodontics*, 25(3), 197-205.
- Torabinejad, M., Hong, C. U., McDonald, F., Pitt Ford, T. R. (1995). Physical and chemical properties of a new root-end filling material. *Journal of Endodontics*, 21(7), 349-353.
- Torabinejad, M., Skobe, Z., Trombly, P. L., Krakow, A. A., Grøn, P., Marlin, J. (1978). Scanning electron microscopic study of root canal obturation using thermoplasticized gutta-percha. *Journal of Endodontics*, 4, 245-250.
- Uzunoglu, E., Yilmaz, Z., Sungur, D. D., Altundasar, E. (2015). Retreatability of root canals obturated using gutta-percha with bioceramic, MTA and resin-based sealers. *Iranian Endodontic Journal*, 10(2), 93-98.
- Venturi, M., Breschi, L. (2004). Evaluation of apical filling after warm vertical gutta-percha compaction using different procedures. *Journal of Endodontics*, 30(6), 436-440.
- Victoria-Escandell, A., Ibañez-Cabellos, J. S., de Cutanda, S. B. S., Berenguer-Pascual, E., Beltrán-García, J., García-López, E. *et al.* (2017). Cellular responses in human dental pulp stem cells treated with three endodontic materials. *Stem Cells International*, 2017.
- Vidotto, A. P. M., Cunha, R. S., Zeferino, E. G., Rocha, D. G. P., De Martin, A. S., Bueno, C. E. D. S. (2011). Comparison of MTA fillapex radiopacity with five root canal sealers. *RSBO Revista Sul-Brasileira de Odontologia*, 8(4), 404-409.
- Vitti, R. P., Prati, C., Silva, E. J. N. L., Sinhoreti, M. A. C., Zanchi, C. H., e Silva, M. G. D. S. *et al.* (2013). Physical properties of MTA fillapex sealer. *Journal of Endodontics*, 39(7), 915-918.
- Vizgirda, P. J., Liewehr, F. R., Patton, W. R., Mcpherson, J. C., Buxton, T. B. (2004). A comparison of laterally condensed gutta-percha, thermoplasticized gutta-percha, and mineral trioxide aggregate as root canal filling materials. *Journal of Endodontics*, 30(2), 103-106.
- Vollenweider, M., Brunner, T. J., Knecht, S., Grass, R. N., Zehnder, M., Imfeld, T. *et al.* (2007). Remineralization of human dentin using ultrafine bioactive glass particles. *Acta Biomaterialia*, 3(6), 936-943.
- Wang, M., Guo, L., Sun, H. (2019). Manufacture of biomaterials. *Reference Module in Biomedical Sciences: Encyclopedia of Biomedical Engineering*.
- Wang, Y., Liu, S., Dong, Y. (2018). In vitro study of dentinal tubule penetration and filling quality of bioceramic sealer. *PLoS One*, 13(2), e0192248.
- Withworth, J. (2005). Methods of filling root canals: principles and practices. *Endodontic Topics*, 12, 2-24.
- Yoshino, P., Nishiyama, C. K., Modena, K. C. D. S., Santos, C. F., Sipert, C. R. (2013). In vitro cytotoxicity of white MTA, MTA fillapex(R) and portland cement on human periodontal ligament fibroblasts. *Brazilian Dental Journal*, 24(2), 111-116.
- Zhang, W., Li, Z., Peng, B. (2009). Assessment of a new root canal sealer's apical sealing ability. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 107(6), e79-82.
- Zhou, H. M., Shen, Y., Zheng, W., Li, L., Zheng, Y. F., Haapasalo, M. (2013). Physical properties of 5 root canal sealers. *Journal of Endodontics*, 39(10), 1281-1286.
- Zordan-Bronzel, C. L., Esteves Torres, F. F., Tanomaru-Filho, M., Chávez-Andrade, G. M., Bosso-Martelo, R., Guerreiro-Tanomaru, J. M. (2019). Evaluation of Physicochemical Properties of a New Calcium Silicate-based Sealer, Bio-C Sealer. *Journal of Endodontics*, 45(10), 1248-1252.

Oral health knowledge and behaviour among patient in supportive periodontal care in Sarawak

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Abstract

After completing the active phase of periodontal therapy, supportive periodontal care is required to maintain periodontal health. Patient knowledge and awareness are key to periodontal therapy's success, and the study aims to provide baseline data among supportive periodontal care patients in Sarawak. Questionnaires were distributed among patients at two periodontal clinics. Out of 80 responses, 31.3% of respondents believed they had a good-excellent level of periodontal health. 41.3% felt satisfied with their current periodontal condition. 81.3% understood what dental plaque was, 92.5% knew its role in the aetiology of gingival disease, and 93.8% knew it can be controlled with good oral hygiene care. 91.3% of them were aware that; gingival bleeding indicated the presence of periodontal disease, the disease can cause mobile teeth if untreated, and it can be prevented by having regular maintenance. Only 45% were aware that the disease is not 'curable.' Concerning behaviour, 98.8% brushed teeth at least twice daily and used dental floss (43.7%), interdental brush (65%), and mouthwash (52.5%). In the case of gingival bleeding, 70% will continue brushing their teeth, and 36.3% will only use a mouth rinse. 37.5% will attend the appointment if pain arises, and 38.8% believed that a general dentist can sufficiently provide supportive periodontal care. In conclusion, there was inadequate knowledge of periodontitis's curative nature and a lack of understanding of the importance of specialist care's regular follow-up. It is important to reinforce oral health education at SPC.

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Introduction

Periodontal disease is defined by pathologic loss of the periodontal ligament and alveolar bone (Slots, 2017). It is one of the main reasons for tooth loss in adults and is linked to systemic diseases such as atherosclerosis, cerebral ischemia, and diabetes (Linden *et al.*, 2013). Advanced periodontal disease

with deep pockets of 6 mm or more, affected about 10% to 15% of adults worldwide and described that it contributes significantly to the global burden of oral disease (Petersen & Ogawa, 2005). In Malaysia, we observed a rise in advanced periodontitis prevalence, with only 6% in 1990 up to 18.2% in 2010 (Mohd Dom *et al.*, 2016).

In general, periodontal treatment can be divided into three phases: non-surgical, surgical, and maintenance or supportive periodontal care (SPC). The first two phases (non-surgical and surgical) aim to reduce the bacterial load through debridement and correction of the soft and hard tissue defect of tooth-supporting structures that will enable the patient to perform better oral hygiene care. Once the condition has improved and stabilised, the patient will be shifted into the last phase (SPC) to maintain the state of healthy and stable periodontal tissue (Tonetti *et al.*, 1998). Under SPC, patients are required to attend a specialist clinic between 3 to 6 months annually, depending on the complexity of their periodontal status (Axelsson *et al.*, 2004). Typically SPC includes an update of the medical and dental histories, dental and periodontal evaluation, removal of bacterial plaque and calculus supra and subgingivally, debridement if indicated, and a review of the patient's plaque removal efficacy (Leavy & Robertson, 2018). Within that gap of 3 to 6 months, it is crucial for the patient to self-maintain their oral hygiene care at home to prevent the disease's recurrence. Self-maintaining care, such as tooth brushing twice a day, with interdental cleaning, has been shown to effectively reduce plaque and gingival inflammation (Yaacob *et al.*, 2014). Regular interdental cleaning has also been shown to improve periodontal health (Jackson *et al.*, 2006).

However, studies have shown that the degree of compliance with SPC has been insufficient (Delatola *et al.*, 2014; Ojima *et al.*, 2001). Patient compliance with SPC is a complex issue, and one of these factors is the patient's knowledge and awareness (Kopp *et al.*, 2017). A study done by (Fardal, 2006) identified other reasons for non-compliance: patients were seeing a general dentist for SPC while not being compliant with the appointments at the specialist clinic. This may be due to the lack of awareness and knowledge of the patient and the general dentist regarding the importance of specialist care for maintenance post-periodontal active therapy. There is evidence that patients who, after completing a course of periodontal therapy return to the

care of general dentists, do not do as well in terms of periodontal stability as the patients who continue with a specialist maintenance programme (Axelsson & Lindhe, 1981; Cohen *et al.*, 2003; Leavy & Robertson, 2018). Similarly, several studies have also reported non-compliance with oral self-health-care recommendations (Macgregor *et al.*, 1998; Mohd-Dom *et al.*, 2009).

To our knowledge, no studies in these areas have focused on a periodontal patient under the SPC. Most studies were only targeting the general population or a periodontal patient during the active phase of treatment (Martensson *et al.*, 2013; Raman, 2012). There is no apparent reason for this, but we can speculate that it may be because we perceive patients who have been under specialist care to be adequately motivated and to possess an adequate level of knowledge. However, from previous studies, it has been shown that a high percentage of patients who were treated in a specialist clinic failed to follow the recommendation by the specialist (Delatola *et al.*, 2014; Ojima *et al.*, 2001). We assumed this was related to the patient's level of knowledge and awareness, which declines over time once they enter the SPC, or maybe the information given to the patient was not sufficient or specific enough according to their periodontal problem. Therefore, this study aims to investigate the baseline knowledge and behaviour of periodontal patients under SPC concerning their periodontal health.

Methods

Study location and data collection

The study was based on a self-response questionnaire. The questionnaire consisted of three domains and 19-items developed and modified based on questions drawn from a review of literatures (Ahmad N.A. *et al.*, 2018; Mohd-Dom *et al.*, 2009; Raman, 2012; Varela-Centelles *et al.*, 2016). The domains include items related to periodontal and oral health perception, periodontal knowledge, and behaviours. Four questions were used to evaluate the patient's perception of their periodontal

health. Seven statements were used for assessing the knowledge of periodontitis, focusing on aetiology, symptoms, treatment, and maintenance. The last section of the questionnaire was on oral health behaviour, consisting of the frequency of tooth brushing, frequency of interdental cleaning, the type of interdental cleaning aid used, and other oral cleaning aid. Also, four statements were used to evaluate the patient's thoughts on their current oral health practices.

The questions were initially written in English and later translated by a local interpreter to ensure the questionnaire's validity. It was then successively translated back to English by a second interpreter to avoid interpretation mistakes. The questionnaire was reviewed for content validity by two dental experts (periodontist A.A and senior dentist C.H.L), using a 4-points Likert scale. Verbal comments and recommendations were made to improve the relevance of the items. Based on the content validation calculation, all 19-items had achieved a satisfactory level, with a universal agreement index (S-CVI/UA) and an average index (S-CVI/AG) of 1.0 for all three domains. Pre-tested for face-validity was conducted on 20 patients. For each question, the patient may only choose one answer (except for the first part of the behaviour section) from all possible responses provided in the questionnaire. The scale of 1-5 indicates; *No (1-2)*, *Don't know or neutral (3)*, and *Yes (4-5)*. An answer will be scored as incorrect when none of the correct responses or neutral (scale 3) was chosen. Assistance was rendered if they could not read due to vision impairment or for any clarification during the questionnaire's completion. Due to a small study population, the sample size was calculated using a formula of $n = N z^2 p(1-p) / [d^2(N-1) + z^2 p(1-p)]$ where (N is the population size of 100 based on 2018 data of two periodontic clinics in Sarawak), (z values is 1.96 as the confidence level is 95%), (p is the prevalence which is 50%), and (d is the proportion of sampling error of 0.05), which is at least 80 participants.

The questionnaire was distributed to all adult patients diagnosed with periodontitis

(Armitage, 1999) who have just completed active periodontal therapy and were under SPC in 2019. The survey was conducted at two different periodontology clinics, one in Kuching (Unit Pakar Periodontik Jalan Masjid) and another in Sibu (Unit Pakar Periodontik Sibu Jaya) during the period from June to December 2019. The patients were given written information about the study, how the sample was selected, and how they could be given further details. Written consent was obtained from all participants in this study. The study was registered with the National Medical Research Register, Ministry of Health Malaysia -NMRR-18-3844-43984 (IIR) and approved by the Medical Research & Ethics Committee (MREC), Ministry of Health Malaysia.

Data analysis

Data were analysed using IBM SPSS Statistics for Window, version 23 (IBM Corp., Armonk, N.Y., USA). Frequency distribution and percentage to analyse the level of periodontal health knowledge and behaviour of patients.

Results

A total of 80 questionnaires were completed from the Periodontal Specialist Units of Jalan Masjid and Sibu Jaya. As shown in Table 1, the majority of them were >50 years old. More female (61.2%) respondents when compared to male (38.8%). For the educational level, the majority of them were from the tertiary level (56.2%). There were more respondents who needed to travel ≥ 10 km (47.5%), followed by 5 – 9km (31.3%) and ≤ 4 km (21.2%).

More than half of the respondents rated their general health as good-excellent (68.8%), but 55% of them believed that their oral health was in a poor-fair condition. In terms of periodontal health, only 31.3% of adults believed that they had a good-excellent level of periodontal health, and 41.3% of them felt satisfied with their current periodontal condition (Table 2).

The majority of participants correctly defined the meaning of dental plaque (81.3%) and did know its role in the aetiology of the gingival disease (92.5%). They were aware that gingival bleeding indicated the presence of periodontal disease (91.3%), which can lead to mobile teeth if untreated (91.3%), and that it can be prevented by having good oral hygiene (93.8%). They were also aware of the importance of regular maintenance therapy to prevent periodontal disease recurrence (91.3%). However, less than half (45%) of the participants were aware that the disease is not 'curable.' (Table 3).

98.8% of the respondents brushed their teeth at least twice a day. Only 43.7% of the respondents regularly used dental floss, but more of them used an interdental brush (65%), and 52.5% of them used a mouth rinse as part of their oral care regime (Table 4).

For gingival bleeding, 70% of them disagreed with avoiding brushing, and 63.7% disagreed with using an only mouth rinse. 62.5% of the participants agreed not to skip a periodontal appointment, even if they had no pain symptoms, with 38.8% who believed that periodontal maintenance could be solely provided by a general dentist (Table 5).

Table 1. Socio-demographic profiles of the participants.

Demographic categories		n (%)
Age	< 20 years	0 (0)
	20 – 30 years	4 (5)
	31 – 40 years	20 (25)
	41 – 50 years	17 (21.3)
	> 50 years	39 (48.7)
Gender	Male	31 (38.8)
	Female	49 (61.2)
Education level	No formal education	2 (2.5)
	Primary	2 (2.5)
	Secondary	31 (38.8)
	Tertiary	45 (56.2)
Distance from the specialist clinic	≤ 4km	17 (21.2)
	5 – 9 km	25 (31.3)
	≥ 10 km	38 (47.5)

Table 2. Percentage distributions of the respondents on the general and periodontal health perception.

	Good-Excellent (%)	Poor-Fair (%)
1. How would you rate your general health condition?	55 (68.8)	25 (31.2)
2. How would you rate your oral health condition?	36 (45.0)	44 (55.0)
3. How would you rate your gum health condition?	25 (31.3)	55 (68.7)
4. Are you satisfied with your gum health?	33 (41.3)	47 (58.7)

Table 3. Percentage distributions of the respondents on the level of periodontal knowledge.

	Correct answer (%)	Incorrect Answer (%)
1. Dental plaque means soft debris on the teeth.	65 (81.3)	15 (18.7)
2. Dental plaque can lead to gum disease.	74 (92.5)	6 (7.5)
3. Gum bleeding is an early sign of gum disease.	73 (91.3)	7 (8.7)
4. Untreated gum disease may cause teeth to become loose.	73 (91.3)	7 (8.7)
5. Proper oral hygiene can control dental plaque formation.	75 (93.8)	5 (6.2)
6. Periodontitis (severe gum disease) is not curable.	36 (45.0)	44 (55.0)
7. Regular check-up for maintenance therapy can prevent recurrence of gum disease.	73 (91.3)	7 (8.7)

Table 4. Percentage distributions of the respondents on oral health practices.

	1/day (%)	2-3/day (%)	When needed (%)	Don't use (%)	Don't know (%)
Toothbrush	1 (1.2)	79 (98.8)	0 (0.0)	0 (0.0)	0 (0.0)
Dental Floss	22 (27.4)	13 (16.3)	27 (33.8)	16 (20.0)	2 (2.5)
Interdental brush	38 (47.5)	14 (17.5)	16 (20.0)	10 (12.5)	2 (2.5)
Mouth wash	42 (52.5)	0 (0.0)	0 (0.0)	38 (47.5)	0 (0.0)

Table 5. Percentage distributions on the beliefs the respondents had concerning their current periodontal practices.

	Agree (%)	Disagree (%)
1. I avoid brushing when my gums bleed.	24 (30.0)	56 (70.0)
2. I use only mouth rinse if my gums bleed.	29 (36.3)	51 (63.7)
3. I skip my appointment with the gum specialist if there is no pain.	30 (37.5)	50 (62.5)
4. I think I can just visit any general dentist for my gum maintenance therapy.	31 (38.8)	49 (61.2)

Discussion

This study found that less than half (41.3%) of the respondents were satisfied with their current periodontal condition, with only 31.3% rated as having good to an excellent level of oral health. As most of the periodontal referral cases to the specialist clinic were at the advanced stage of severity, it was expected. Several studies have shown that the greater the severity of the disease, the greater the impact on the quality of life of an individual (Graziani & Tsakos, 2020; Masood *et al.*, 2019). Therefore, the importance of early detection and referral for periodontal treatment at the moderate stage should be emphasised among dentists at primary care.

Although periodontal disease can be controlled by proper treatment, more than half (55%) of the respondents were not aware that it 'uncurable'. Such findings may be real or might be related to interpretation errors in this survey. For example, respondents may think that their periodontal condition has been cured as they are not experiencing any significant symptoms of periodontitis such as bleeding, swelling, or pain as they are now under the maintenance phase. However, what they are having right now is a stable stage, which may recur at any time, especially with poor home and professional maintenance care. This misconception or false belief resulting from a lack of knowledge is a significant barrier in the way of proper management of

periodontitis (Deinzer *et al.*, 2009). The majority of respondents answered the rest of the knowledge questions correctly.

Knowledge of periodontal disease may influence patients' behaviour and practices (Deinzer *et al.*, 2009). However, the link between these two was not evaluated in this study. Still, some behaviour and oral health practices among respondents seemed to correlate with their knowledge level. 98.8% of the respondents reported a toothbrushing frequency of twice or more per day. The use of interdental brush was also found to be encouraging at 65%. This is very high compared to other studies, whereby their studies reported 6.9% and 20.4% of their respondents with interdental brush usage, respectively (Badiah, 2015; Lee *et al.*, 2019). This can be due to the advice given on interdental brush instead of floss, as more spacing between teeth can be found in periodontitis cases. It was found that both periodontal specialist clinics in Kuching and Sibu did provide interdental brush to their patients. Surprisingly, 30% of the respondents gave up tooth brushing when they experienced gingival bleeding, and 36.3% will replace tooth brushing with mouth rinses. This information indicates a lack of correlation between knowledge and behaviour in gingivitis, which requires further reemphasising among periodontal patients at the SPC.

The periodontal health stability is related to the balance between oral hygiene performed

by the patient at home and professional cleaning provided at regular follow-up during SPC (Axelsson *et al.*, 2004; Tonetti *et al.*, 1998). The majority of the respondents agreed that regular check-ups at SPC could prevent periodontitis's recurrence (91.3%). However, 37.5% of the respondents stated that they would only visit the periodontal clinic when having a pain symptom. Some of the respondents (38.8%) believed that the general dentist could carry out adequate SPC. These may contribute to the non-compliance attendance at SPC, leading to disease recurrence (Fardal, 2006). This suggests that the respondents may need further information regarding the importance of regular visits for SPC.

There are several limitations in this present study. Evidence showed that the longer the duration of periodontal maintenance could result in poor attendance and compliance for SPC due to low motivation level (Demetriou *et al.*, 1995). The motivation usually links with the knowledge and awareness status of the patient (Shiva *et al.*, 2017). But, this association cannot be evaluated because no assessment was done on the duration of SPC among respondents in this study. However, (De Carvalho V.F. *et al.*, 2010) found a significant improvement in compliance toward SPC for a patient with poor attendance after reinforcing the knowledge of periodontitis. Another limitation is the small sample size, which may affect the reliability of the results. Moreover, the results were based on two periodontal clinics within the State of Sarawak, which may possess socioeconomic and cultural differences from other states in Malaysia. The questions are also done among patients diagnosed with either chronic or aggressive periodontitis, which cannot be generalised to the different types of periodontal diseases or conditions.

Conclusion

Within the limitation of this study, it can be concluded that a high level in periodontal knowledge and behaviour was found among periodontal patients in SPC. However, the respondents showed a low level of knowledge of periodontitis's curative nature

and a low level of desired behaviour in practising when they experienced with bleeding gingiva. As some of the respondents lack understanding of the importance of regular follow-ups provided by specialist care, this may further contribute to the risk of non-compliance. It is important to reinforcing oral health education to boost patient motivation toward maintaining good periodontal health at SPC. Further study is required to explore any correlation between the level of knowledge and behaviour towards SPC compliance. A multi-centre study should be considered, so a larger sample size can be obtained involving other states in Malaysia to get a more significant result.

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Conflict of interest

The authors declare no conflict of interest.

References

- Ahmad N.A., Naime Z., Maling T.H. , Lo, J. Y. Y. (2018). The beliefs and oral health practices amongst indigenous people in bario, sarawak (unpublished manuscript). *University of Malaya*, Malaysia.
- Armitage, G. C. (1999). Development of a classification system for periodontal diseases and conditions. *Annals of Periodontology*, 4(1), 1-6.
- Axelsson, P. , Lindhe, J. (1981). Effect of controlled oral hygiene procedures on caries and periodontal disease in adults. Results after 6 years. *Journal of Clinical Periodontology*, 8(3), 239-248.
- Axelsson, P., Nystrom, B. , Lindhe, J. (2004). The long-term effect of a plaque control program on tooth mortality, caries and periodontal disease in adults. Results after 30 years of maintenance. *Journal of Clinical Periodontology*, 31(9), 749-757.
- Badiah, H. (2015). A preliminary survey on awareness of periodontal risk and oral health practices among diabetic patients in hospital kuala. *Malaysian Dental Journal*, 34(1), 1-7.

- Cohen, R. E., Research, Science Therapy Committee , American Academy of Periodontology. (2003). Position paper: Periodontal maintenance. *Journal of Periodontology*, 74(9), 1395-1401.
- de Carvalho V.F., Okuda O.S., Bernardo C.C., Pannuti C.M., Georgetti M.A., De Micheli G., *et al.* (2010). Compliance improvement in periodontal maintenance. *Journal of Applied Oral Science*, 18(3), 215-219.
- Deinzer, R., Micheelis, W., Granrath, N. , Hoffmann, T. (2009). More to learn about: Periodontitis-related knowledge and its relationship with periodontal health behaviour. *Journal of Clinical Periodontology*, 36(9), 756-764.
- Delatola, C., Adonogianaki, E. , Ioannidou, E. (2014). Non-surgical and supportive periodontal therapy: Predictors of compliance. *Journal of Clinical Periodontology*, 41(8), 791-796.
- Demetriou, N., Tsami-Pandi, A. , Parashis, A. (1995). Compliance with supportive periodontal treatment in private periodontal practice. A 14-year retrospective study. *Journal of Periodontology*, 66(2), 145-149.
- Fardal, O. (2006). Interviews and assessments of returning non-compliant periodontal maintenance patients. *Journal of Clinical Periodontology*, 33(3), 216-220.
- Graziani, F. , Tsakos, G. (2020). Patient-based outcomes and quality of life. *Periodontology 2000*, 83(1), 277-294.
- Jackson, M. A., Kellett, M., Worthington, H. V. , Clerehugh, V. (2006). Comparison of interdental cleaning methods: A randomized controlled trial. *Journal of Periodontology*, 77(8), 1421-1429.
- Kopp, S. L., Ramseier, C. A., Ratka-Kruger, P. , Woelber, J. P. (2017). Motivational interviewing as an adjunct to periodontal therapy-a systematic review. *Frontiers in Psychology*, 2017(8), 279.
- Leavy, P. G. , Robertson, D. P. (2018). Periodontal maintenance following active specialist treatment: Should patients stay put or return to primary dental care for continuing care? A comparison of outcomes based on the literature. *International Journal of Dental Hygiene*, 16(1), 68-77.
- Lee, J. Y., Park, H. J., Lee, H. J. , Cho, H. J. (2019). The use of an interdental brush mitigates periodontal health inequalities: The Korean national health and nutrition examination survey (KNHANES). *BMC Oral Health*, 19(1), 168.
- Linden, G. J., Lyons, A. , Scannapieco, F. A. (2013). Periodontal systemic associations: Review of the evidence. *Journal of Periodontology*, 84(4 Suppl), S8-S19.
- Macgregor, I. D., Balding, J. W. , Regis, D. (1998). Flossing behaviour in English adolescents. *Journal of Clinical Periodontology*, 25(4), 291-296.
- Martensson, C., Soderfeldt, B., Axtelius, B. , Andersson, P. (2013). Knowledge of periodontitis and self-perceived oral health: A survey of periodontal specialist patients. *Swedish Dental Journal* 37(1), 49-58.
- Masood, M., Younis, L. T., Masood, Y., Bakri, N. N. , Christian, B. (2019). Relationship of periodontal disease and domains of oral health-related quality of life. *Journal of Clinical Periodontology*, 46(2), 170-180.
- Mohd Dom, T. N., Ayob, R., Abd Muttalib, K. , Aljunid, S. M. (2016). National economic burden associated with management of periodontitis in Malaysia. *International Journal of Dentistry*, 2016(1891074), 1-6.
- Mohd-Dom, T. N., S. M. Said , Abidin, Z. Z. (2009). Dental knowledge and self-reported oral care practices among medical, pharmacy and nursing students *Malaysian Journal of Health Science*, 7(1), 13-23.
- Ojima, M., Hanioka, T. , Shizukuishi, S. (2001). Survival analysis for degree of compliance with supportive periodontal therapy. *Journal of Clinical Periodontology*, 28(12), 1091-1095.
- Petersen, P. E. , Ogawa, H. (2005). Strengthening the prevention of periodontal disease: The WHO approach. *Journal of Periodontology*, 76(12), 2187-2193.
- Raman, R. W., Woon, T. K.; Mamat, M.; Ishak, A.; Khan, A. R. (2012). Oral health awareness, behaviour and status among Malaysian 16-year-old school students in Penang. *Malaysian Dental Journal*, 34 (2), 45-53.
- Shiva, C. Y. K., Mukta, V. S. , Vinay, K. M. (2017). Patient education and motivation. *Advances in Dentistry & Oral Health*, 7(1), 28-33.
- Slots, J. (2017). Periodontitis: Facts, fallacies and the future. *Periodontology 2000*, 75(1), 7-23.
- Tonetti, M. S., Muller-Campanile, V. , Lang, N. P. (1998). Changes in the prevalence of residual pockets and tooth loss in treated periodontal patients during a supportive maintenance care program. *Journal of Clinical Periodontology*, 25(12), 1008-1016.
- Varela-Centelles, P., Diz-Iglesias, P., Estany-Gestal, A., Seoane-Romero, J. M., Bugarin-Gonzalez, R. , Seoane, J. (2016). Periodontitis awareness amongst the general public: A critical systematic review to identify gaps of knowledge. *Journal of Periodontology*, 87(4), 403-415.
- Yaacob, M., Worthington, H. V., Deacon, S. A., Deery, C., Walmsley, A. D., Robinson, P. G., *et al.* (2014). Powered versus manual toothbrushing for oral health. *Cochrane Database of Systematic Reviews*, 2014(6), Art. No. CD002281.

Comparison between patients' and parents' satisfaction level towards cleft management using Cleft Evaluation Profile

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Abstract

Cleft lip and palate (CLP) are common birth defects that occur in approximately 1 out of every 611 newborn in Malaysia. Cleft Evaluation Profile (CEP) is a well-established method used to evaluate the patient's level of satisfaction with the CLP treatment that they received. This study aimed to compare the level of satisfaction of cleft patients and their parents towards cleft management in Kelantan, Malaysia. The results showed that the mean scores of CEP for the parents were between 2.04 and 3.00, whilst the patient's mean score ranged from 2.01 to 3.04. In general, nose is the most dissatisfied feature for both patients and parents with the mean score of 3.04 for patients and 3.00 for parents. Teeth was the second highest (2.97) mean scores rated by parents but it was the third highest (2.84) mean score from the patients. Lip feature scored the third highest mean score for parents, and it was the second-highest mean score for patients. Hearing was the lowest mean score for both parents and patients. Both parties were aware of the features of their facial and nose appearance. From the weighted Kappa statistic, both the parent and patient pairs demonstrated good to very good agreement for their satisfaction towards the clinical outcome. In conclusion, features related to facial appearance (nose, teeth, lip and facial profiles) require more attention and improvement during the treatment process.

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Introduction

Cleft lip and/or palate (CLP) are common facial birth defects that occur among the children and adults (Noor *et al.*, 2007). The occurrence of CLP was reported to be approximately 1 in 700 live births in Europe (Ali & Sahito, 2015). Meanwhile, 1 in 611 children in Malaysia was born with CLP in 2007 (NOHSS, 2007). A recent study revealed that Asians are more commonly

affected with this cranio-facial abnormality compared to Caucasians (Natsume & Kawai, 1986).

Previous study in Malaysia found that the incidence of oral cleft alone was higher in females (56.7%) than males (43.3%) (Ali & Sahito, 2015). On the other hand, from a recent study in Italy revealed that CLP was found significantly more common in males (67.6%) than females (Gatti *et al.*, 2017).

CLP patients generally require a multidisciplinary team management approach, a proper set of diagnosis, and stage-wise treatment planning protocols to identify and manage a full spectrum of complexities associated with the congenital deformities. This service of multidisciplinary care should start from infancy and continues into early adulthood as long-term treatment planning with proper standardized surgical protocols can improve the overall desired quality of esthetic and functional treatment outcome significantly (Oosterkamp *et al.*, 2007).

For the past two decades, numerous studies have been conducted to assess the level of satisfaction of individuals with CLP and their parents concerning the esthetics and speech features in cleft management and treatment outcomes (Luyten *et al.*, 2013; Noor *et al.*, 2007 & Oosterkamp *et al.*, 2007). From earlier studies, a high level of satisfaction in cleft care and surgical outcomes was observed from the CLP patients and their parents and they were less satisfied with the cleft related subunit in the nasolabial region, particularly teeth (Luyten *et al.*, 2013). On the other hand, a disappointing level of satisfaction from CLP patient and their parents was confirmed from a survey from the Clinical Standards Advisory Group investigation (CSAG) in the United Kingdom (Williams *et al.*, 1993). Twenty years later, after centralization of the cleft care with regards to CSAG in UK, another similar study was conducted and it showed that there was improvement in overall patient and parental satisfaction levels (Sell *et al.*, 2015).

In a recent study, significant differences in the levels of satisfaction were found between the parents from Asian and western countries. Chinese parents from China generally shows a higher level of satisfaction level in the lip and facial profile and a lower level of satisfaction level in the nose and teeth features (Ha *et al.*, 2016). Another local study from Universiti Sains Malaysia Hospital (HUSM) revealed a higher parental satisfaction level in hearing and lower satisfaction level in teeth, lips and nose features (Noor *et al.*, 2007). On the other hand, Italian parents were satisfied with the

surgical outcomes in the nose and occlusal features, but were less dissatisfied with the breathing (Gatti *et al.*, 2017). Ugandan parents were satisfied with the hearing, face and lip and less satisfied with the speech, teeth, and nose (Luyten *et al.*, 2013).

To date, there is no study to compare the level of satisfaction between patients and parents towards cleft management in the CCC that was established over the past nineteen years. This study aimed to compare the level of satisfaction of cleft patients and their parents towards cleft management in Kelantan, Malaysia.

Methods

Study participants

This observational research study involved CLP patients and their parents who visited the Orthodontic Unit in the Combined Cleft Clinic (CCC), Kota Bharu, Kelantan from January 2017 to September 2017. Under a confidence level of 95%, with study power set to 80%, and alpha value of 5%, a sample size of 27 patient-parent pairs was needed for this study. By considering the 10% drop out cases, the final sample size of this study was 30 patient-parent pairs. The age range for patients was 17 to 25 years, whilst for parents was 18 to 65 years. The mean age of patients and parents was 17.2 and 39.8, respectively. Subjects with craniofacial syndrome, hearing or neurological impairment, and intellectual disabilities as well as subjects who were unable to answer the questionnaire were excluded from the study. The cleft patients in this study are still undergoing treatment and review appointments. 100% response rate was attained.

Ethical approval was obtained by following the guidelines stated in National Institutes of Health (NIH) under the Ministry of Health (MOH) Malaysia (NMRR-15-2497-28426). The ethical review was appraised and approved by the NIH Research Review Panel (JPP-NIH) and Medical Research and Ethics Committee (MREC) prior to data collection.

Semi-structured questionnaires

Semi-structured self-administrated questionnaires were adopted from previous work of (Noor *et al.*, 2007). Both English and Malay language versions of the questionnaire were made available for the correspondents. One of the parents who attended the CCC along with the CLP patients was asked to answer the parent questionnaire. The cleft patients were answered the CEP themselves. Full confidentiality for every subject was assured, by emphasizing and making clear that the participation in this study was not related to the child cleft care management before parent started answering the questionnaire. Informed consent was taken from parents (Questionnaire & CEP) and the CLP patient (CEP). Before proceeding to the more specific questions related to the generic information, the questionnaire was designed to make the participants to be more comfortable by starting with a set of identical questions related to superfluous topics, for example, “How long does it take for you to travel from home to clinic?”. The overall satisfaction towards cleft management was evaluated by using forced response questions, including:

“Overall how satisfied are you with the care and attention that you have received from the cleft team?”

very satisfied	(CODED)
satisfied	(CODED)
reasonably satisfied	(CODED)
dissatisfied	(CODED)
very dissatisfied	(CODED)

Cleft Evaluation Profile

The Cleft Evaluation Profile (CEP) is a well-established approach originating from the Royal College of Surgeons Cleft Lip and Palate Audit Group, used to investigate the level of satisfaction for individual features in the cleft management (Turner *et al.*, 1997). There are eight individual items within the CEP including speech, hearing, appearance of teeth, appearance of lip, appearance of nose, breathing through the nose, profile of

the face, and bite. Each item was paired with a 7-point Likert scale, where the subjects were requested to rate their level of satisfaction from very satisfactory (a rank of 1) to very unsatisfactory (a rank of 7) (Table 1). Besides, it was a valid and valuable assessment tool to evaluate cleft patients’ level of satisfaction for the treatment received (Noor *et al.*, 2007). In this study, the CEP was distributed to both parents and patients to evaluate their level of satisfaction with regards to the quality of cleft treatment provided.

Statistical analysis

Data was analysed by using Statistical Package for Social Sciences (SPSS) software program version 18.0 (IBM Corporation, Armonk, NY, USA). The weighted kappa statistic was used to assess the degree of agreement in the level of satisfaction perceived between parent and patient pairs regarding the CEP for the cleft management outcome. The evaluation method used for the analysis of the level of agreement was adopted from the recommended classification by Altman (1999) (Table 2).

Results

Out of the total 69 parents and 69 patients, 14 parents and 23 patients were male, whilst 55 parents and 46 patients were female. Vast majority of our subjects were Malay (n=65; 94.2%), followed by 3 Chinese (4.3%) and 1 Indian (1.4%). The mean age of the parents and patient groups were 39.8 and 17.2, respectively. The sociodemographic and economic characteristics of the subjects were summarized in Table 3 and 4.

Two-thirds of the parents attended only primary school (n=8; 11.6%) and secondary school (n=39, 56.5%). More than half of them had gross household income of less than RM 2999 (n=45, 65.2%) per month. Most of the parents were working in private sectors (n=33, 47.8%), followed by government servants (n=29, 42.0%) and labourers (n=7, 10.2%).

Table 1. Cleft Evaluation Profile

Please circle the number that is closest to how things are for you (patient)/ your child (parent) now.							Office Use
A. Speech							A.
Very satisfactory				Very unsatisfactory			<input type="text"/>
1	2	3	4	5	6	7	
B. Hearing							B.
Very satisfactory				Very unsatisfactory			<input type="text"/>
1	2	3	4	5	6	7	
C. Appearance of the teeth							C.
Very satisfactory				Very unsatisfactory			<input type="text"/>
1	2		4	5	6	7	
D. Appearance of the lip							D.
Very satisfactory				Very unsatisfactory			<input type="text"/>
1	2	3	4	5	6	7	
E. Appearance of the nose							E.
Very satisfactory				Very unsatisfactory			<input type="text"/>
1	2	3	4	5	6	7	
F. Breathing through the nose							F.
Very satisfactory				Very unsatisfactory			<input type="text"/>
1	2	3	4	5	6	7	
G. Profile of the face							G.
Very satisfactory				Very unsatisfactory			<input type="text"/>
1	2	3	4	5	6	7	
H. Bite							H.
Very satisfactory				Very unsatisfactory			<input type="text"/>
1	2	3	4	5	6	7	

Table 2. Interpretation of strength of agreement for the kappa statistic

Value of kappa (k)	Strength of agreement
<0.20	Poor
0.21-0.40	Fair
0.41-0.60	Moderate
0.61-0.80	Good
0.81-1.00	Very good

Table 3. Sociodemographic characteristics of parents and patients

Variables	No. of parents n (%)	No. of patients n (%)
Sex		
Male	14 (20.3)	23 (33.3)
Female	55 (79.7)	46 (66.6)
Ethnicity		
Malay	65 (94.2)	65 (94.2)
Chinese	3 (4.3)	3 (4.3)
Indian	1 (1.4)	1 (1.4)

Table 4. Sociodemographic and economic characteristics of parents

Variables	n (%)
Level of education	
Primary school	8 (11.6)
Secondary school	39 (56.5)
College/ University	22 (31.9)
Gross household income per month	
< RM 1000	21 (30.4)
RM 1000-2999	24 (34.8)
RM 3000-4999	9 (13.1)
RM 5000-9999	12 (17.4)
> RM 10000	3 (4.3)
Employment	
Government servant	29 (42.0)
Private sector	33 (47.8)
Laborer	7 (10.2)

* RM – Ringgit Malaysia, the Malaysian currency

Interaction with cleft team

More than half of the parents felt at ease (64.2%) when attending CCC. About one-fourth felt very relaxed (25.9%) and only 3.1% felt nervous when attending the clinic. Nearly half of the parents (48.8%) preferred to discuss the child's treatment with the whole team together, whilst only one-third (35.8%) preferred to meet each specialist separately.

Families' contributions to decisions involving treatment

More than half of the parents (58.7%) were very much involved in making decisions about their child's treatment and 32.1% of them felt they were usually involved in their child's treatment. Only 9.2% felt that they were occasionally involved in the decision making.

Overall satisfaction with cleft care

Half of the parents (50.7%) were very pleased with the operation outcome whilst about one-quarter of them were pleased (26.1%) with the outcome and another 23.2% were just satisfied. More than half (59.4%) of the parents were very pleased with the

cleft care services from the specialists, 36.2% were satisfied, 3.0% were least satisfied and the remaining (1.4%) were not satisfied. Parent's satisfaction level towards cleft management in Kelantan were summarized in Table 5.

Cleft Evaluation Profile

The mean scores of CEP for the parents were between 2.04 and 3.00, whilst the patient's mean score ranged from 2.01 to 3.04. Nose feature has the highest mean score item of CEP for parents (3.00) and patients (3.04). Teeth was the second highest (2.97) mean scores rated by parents but it was the third highest (2.84) mean score from the patients. Lip feature scored the third highest mean score for parents, and it was the second-highest mean score for patients. Hearing was the lowest mean score for both parents and patients. The results were shown in Figure 1.

The level of agreement between parents and patients for the satisfaction with the clinical outcomes was ranged from good to very good ($k=0.825$, $p=0.000$). Speech has a very good level of agreement while the other items in CEP scored a good level of agreement ($k=0.691-0.778$) (Table 6).

Table 5. Level of parents' satisfaction towards cleft management in Kelantan.

Variables	Variables	n (%)
Parents' feeling when attending the clinic	Very relaxed	18 (25.9)
	At ease	44 (64.2)
	Reasonably at ease	5 (6.8)
	Nervous	2 (3.1)
Parents' involvement in making decisions about child's treatment	Very involved	41 (58.7)
	Usually involved	22 (32.1)
	Occasionally involved	6 (9.2)
Parents' preference to discuss child's treatment with the whole team or with each specialist separately	Whole team together	34 (48.8)
	Each specialist separately	25 (35.8)
	Don't know	4 (6.1)
	Don't mind	6 (9.2)
Parents' feeling about the outcome of operation	Very pleased	35 (50.7)
	Pleased	18 (26.1)
	Satisfied	16 (23.2)
Parents' feeling about the care and attention received from specialists	Very pleased	41 (59.4)
	Satisfied	25 (36.2)
	Least satisfied	2 (3.0)
	Not satisfied	1 (1.4)
Parents' feeling about the results and outcome of treatment given by specialists	Very satisfied	36 (52.2)
	Satisfied	30 (43.5)
	Least satisfied	2 (2.9)
	Very not satisfied	1 (1.4)

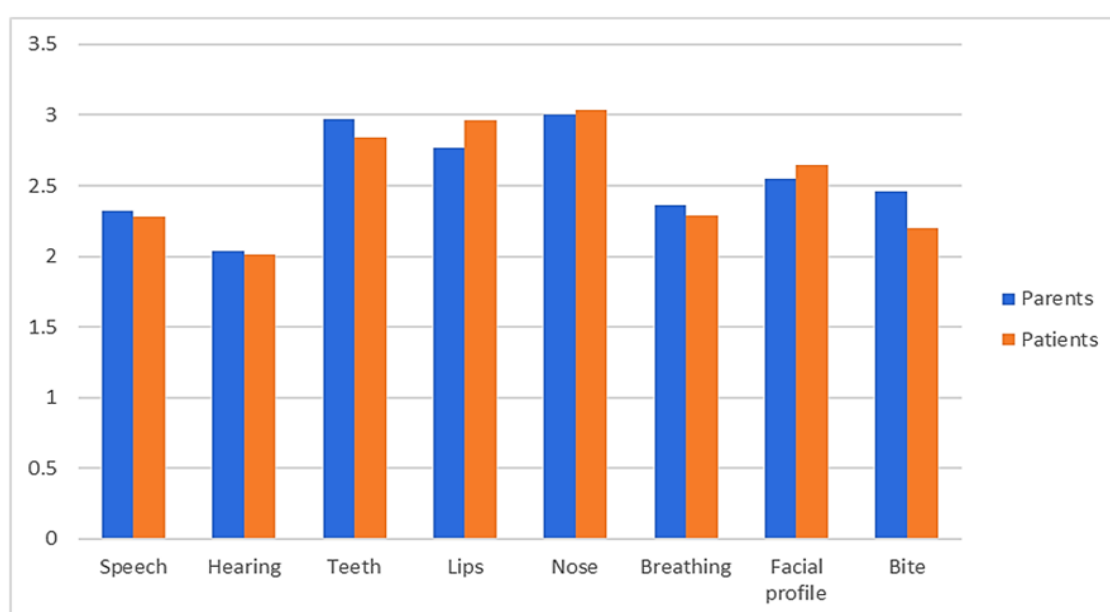


Figure 1. Mean scores of the Cleft Evaluation Profile for the parents and patients

Table 6. Level of agreement between parents and patients for perceived satisfaction with clinical outcome

Features	Kappa Value (k)	Standard Error (kappa)	Probability (p)	Level of agreement
Speech	0.825	0.054	0.000	Very good
Hearing	0.778	0.064	0.000	Good
Teeth	0.713	0.062	0.000	Good
Lip	0.691	0.065	0.000	Good
Nose	0.699	0.063	0.000	Good
Breathing	0.711	0.064	0.000	Good
Face	0.741	0.060	0.000	Good
Bite	0.750	0.061	0.000	Good

Discussion

In this study, the Combined Cleft Clinic (CCC) located at the Main Government Dental Clinic in Kelantan is a referral centre for all cleft cases from all the districts in Kelantan (a northeast state at Peninsular Malaysia). This was established in 1998 and the average number of cleft patients received is about one hundred and fifty per year. The cleft management team consists of plastic surgeons, orthodontists, oral surgeons, dental paediatrician, and speech therapists. The clinical consultation is carried out twice a month on every first and third Tuesday afternoon. However, no study was conducted to compare the level of satisfaction between patients and parents towards cleft management in the CCC that was established over the past nineteen years.

Majority of the parents participated in this study were mother, consistent with another finding from China (Ha *et al.*, 2016). Most of our participants in this study were from a lower socioeconomic status as found in another local study (Noor *et al.*, 2007).

Interaction with cleft team

In our study, majority of the parents felt “at ease” when attending the clinic. This finding was in good agreement with a local study (Noor *et al.*, 2007) in which about 68% of the parents felt “at ease” when they attended the clinic. The main reason is there was a specially allocated clinic for the cleft patients, where in the afternoon only cleft patients been seen. Cleft patients and their parents will be seated in the same waiting room. Thus, when sitting in the waiting room, there

was no feeling of intimidation since every patient was having similar deformity. In addition, the cleft patient’s parents even can share their experience along the journey of having cleft baby or cleft children.

Families’ contributions to decisions involving treatment

More than half of the parents were very much involved in making decision, the findings were contradicted with the previous study (Noor *et al.*, 2007). The main reason could be parents were given the clear comprehensive explanation of the cleft management during the CCC.

Effective communication between specialists and parents is crucial to omit the barrier of parents’ involvement during the clinical discussion. About half of the group in our study were benefited by discussions of their child’s treatment together with the whole cleft care team together. Our findings were consistent with the conclusions of a recent study in the United Kingdom, in which a centralised cleft management services improved the overall outcomes significantly compared to that of uncentralised service 15 years ago (Sell *et al.*, 2015). In contrast, one-third of the parents preferred to have a clinical session with their specialist separately. They claimed that it would be more comfortable for them to discuss their problem and treatment plans in detail. A similar finding was also presented in a local study, in which parents were able to focus on one issue at a time and easier for them to appreciate more on their child’s conditions (Noor *et al.*, 2007).

Overall satisfaction with cleft care

All parents were satisfied with the surgical outcome. Generally more than half of the participants were very satisfied with the care and attention received from the specialists. The reason why patients and parents were satisfied with the overall cleft care at our clinic could be due to the centralisation of cleft services into two hospitals in Kelantan. In that case, surgeons had enough number of cases to practice and to master their skills. Our findings were supported by a recent UK study, in which improved treatment outcomes were obtained after the implementation of cleft care centralisation (Sell *et al.*, 2015).

Cleft Evaluation Profile

In our study, parents and patients gave more attention to the features related to facial appearance - nose, teeth, lip, mastication, and facial profile. These findings were in good agreement with Noar *et al.*, (1991). The findings in our study showed “good to very good” satisfaction agreement which was in contrast to previous local study (Noor *et al.*, 2007). This could be explained by the fact that our cleft care team consists of a multidisciplinary speciality including orthodontists, oral surgeon, plastics surgeon, paediatric dentistry specialists, and speech therapists. Thus, a closer monitoring and consistent follow up might contribute to a more satisfying treatment outcome. Analogous to Noor *et al.*, (1998), both parents and patients were very dissatisfied on the nose feature because most patients are yet to undergo rhinoplasty surgery (mean age is 16.2 years old). The counselling session might help reduce parents' worry and should be conducted with the whole family (Lansdown *et al.*, 1991).

The sample that we collected was from those who has not completed the treatment, so it does not reflect the overall level of satisfaction. For example, cleft patients were concerned about the nose but rhinoplasty was not yet done to correct the deformity. The level of satisfaction that we were assessing was derived from the group of

patients that are still undergoing treatment. Thus, that is not a true level satisfaction for the overall cleft care. On the other hand, future study might be needed to investigate the dissatisfaction sources of the patients and parents in detail. To review the treatment outcomes and cleft care objectively, a more systematic protocol should be implemented to measure the appearance, dento-alveolar arch relationships, oral health, hearing, speech, and psychological aspects. It would be best if the clinical audits can be conducted locally by providing proper training in analysing personal practice (Sell *et al.*, 2015).

A similar study should be conducted on patients who have undergone completed overall cleft treatment including orthognathic surgery and rhinoplasty to assess the overall level of satisfaction perceived for the cleft care and treatment outcomes.

Conclusion

In overall, nose is the most dissatisfied feature for both patients and parents. On the other hand, both parties showed the highest satisfaction towards hearing. Meanwhile, features related to facial appearance (nose, teeth, lip and facial profiles) requires more attention during cleft management.

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References

- Ali, S. Y., Abdul, Z. A., Mirani, S. A., Shaikh, M. I., Khattak, M. N., Sahito M. A. *et al.* (2015). Demographic data on the characterization of oral clefts in malaysia. *Pakistan Oral & Dental Journal*, 35(1), 108-110.
- Altman, D. G. (1999). Practical statistics for medical research. London: Chapman and Hall/ CRC, 403-407.
- Gatti, G. L., Freda, N., Giacomina, A., Montemagni, M., Sisti, A. (2017). Cleft lip and palate repair: our

- experience. *The Journal of Craniofacial Surgery*, 00(00),1-7.
- Joycelyn, L. J., Penko, M. A., Rode, H.L. (1996). Cognition, communication, and hearing in young children with cleft lip and palate and in control children: a longitudinal study. *Journal of Oral Maxillofacial Surgery*, 97, 529-534.
- Lansdown, R., Lloyd, J., Hunter, J. (1991). Facial deformity in childhood: severity and psychological adjustment. *Child: care health and development*, 17(3), 165-71.
- Luyten, A., Evelien, D., Budolfson, D., Hodges, A., Galiwango, G., Vermeersch, H. *et al.* (2013). Parental satisfaction in ugandan children with cleft lip and palate following synchronous lip and palatal repair. *Journal of Communication Disorders*, 46(4), 321-329.
- Natsume, N., Kawai, T. (1986). Incidence of cleft lip and cleft palate in 39,696 japanese babies born during 1983. *International Journal of Oral Maxillofacial Surgery*, 15(5), 565-568.
- Noar, J. H. (1991). Questionnaire survey of attitudes and concerns of patients with cleft lip and palate and their parents. *Cleft Palate-Craniofacial Journal*, 28(3), 279-284.
- Noor, S., Musa, S. (2007) Assessment of patients' level of satisfaction with cleft treatment using the cleft evaluation profile. *Cleft Palate-Craniofacial Journal*, 44(3), 292-303.
- Oral Health Division, Ministry of Health Malaysia. (2009). *National Oral Health Survey of School Children (NOHSS) 2007 6-Year-Olds*. Oral Health Division, Ministry of Health Malaysia. 38-39.
- Oosterkamp, B. C. M., Dijkstra, P. U., Remmelink, H. J., Van, Oort, R. P., Goorhuis-Brouwer, S. M., Sandham, A. *et al.* (2007). Satisfaction with treatment outcome in bilateral cleft lip and palate patients. *International Journal of Oral Maxillofacial Surgery*, 36(10), 890-895.
- P., Ha, C., Li, B., Shi. (2016). Parent satisfaction with primary repair of paediatric cleft lip in southwest china. *International Association of Oral and Maxillofacial Surgeons*, 5-9.
- Sell, D., Mildinhal, S., Albery, L., Wills, A. K., Sandy, J. R., Ness, A. R. *et al.* (2015). The Cleft Care uk study. Part 4: perceptual speech outcomes. *Orthodontics and Craniofacial Research*, 18(2), 36-46.
- Turner, S. R., Thomas, P. W. N., Dowell, T., Rumsey, N., Sandy, J. R. (1997). Psychological outcomes amongst cleft patients and their families. *British Journal of Plastic Surgery*, 50, 1-9.
- Williams, Alison, C., David, B., Sue, M., Terrie, M., Debbie, S. *et al.* (2001). Cleft lip and palate care in the United Kingdom — The clinical standards advisory group (CSAG) Study. Part 2: Dentofacial outcomes and patient satisfaction. *Cleft Palate-Craniofacial Journal*, 38(1), 24-29.

Antibiofilm effect of *Theobroma cacao* (cacao pod) extract on *Aggregatibacter actinomycetemcomitans* biofilm *in vitro*

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Abstract

Successful of periodontal treatment is to eradicate biofilm of bacteria. *Aggregatibacter actinomycetemcomitans* is a Gram-negative bacterium that have been suggested to be the main causes of periodontal disease. *Theobroma cacao* (cacao pod) is a medicinal plant that has a broad range of pharmacological effects. The aim of this study was to assess the antibiofilm effect of cacao pod extract against *A. actinomycetemcomitans* biofilm *in vitro*. *A. actinomycetemcomitans* were cultured in Brain Heart Infusion broth. Crystal-violet staining in biofilm assays were used to evaluate the cacao pod extract effect on *A. actinomycetemcomitans* ATCC 33384 biofilms and 0.2% chlorhexidine-gluconate was used as a positive control. After 24 hours of incubation, the optical density of each well in microtiter plates was measured. The results showed that the biofilm density after incubation with the cacao pod extract was significantly decreased in all concentrations and all incubation times ($p < 0.05$). The most effective concentration for inhibiting biofilm *A. actinomycetemcomitans* was 100% cacao pod extract and 3 hrs of incubation time ($p < 0.05$) with a 98.9% reduction of biofilm compared to negative control. Cacao pod extract is effective in inhibiting the growth of *A. actinomycetemcomitans* biofilm.

Keywords: *Aggregatibacter actinomycetemcomitans*, biofilm, cacao pods

Introduction

According to the World Health Organization (WHO), one of the main health issues in South East Asia is related to oral and dental health (WHO, 2009). The prevalence of oral and dental disease in South East Asia in 2009 was 32-37% (WHO, 2009). The most common oral and dental diseases are dental caries and periodontal disease. In particular, based on the 'Survei Kesehatan Rumah Tangga', the prevalence of periodontal disease in Indonesia is 60% (Badan Penelitian dan Pengembangan Kesehatan RI,

2009). This high prevalence was caused by a low societal awareness of dental and oral hygiene (NL, 2005).

Periodontal disease is a common infectious disease in the periodontal structure and is related to Gram-negative bacteria (Tampubolon, 2006). The most common diseases on periodontal tissue are gingivitis and periodontitis (Haynes *et al.*, 2014). A healthy periodontium tissue includes Gram-positive bacteria, such as *Streptococcus anginosus* and *Actinomyces naeslundii* (Perry, 2014). In poor oral hygiene, Gram-negative

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bacteria, such *Pophyromonas gingivalis*, *Campylobacter* spp., *Tannerella forsythia*, *Treponema denticola* and *A. actinomycetemcomitans*, will increase and contribute to periodontal inflammation (Duerden, 1991; Radita *et al.*, 2019; Widyarman *et al.*, 2018). *A. actinomycetemcomitans* is a main etiology in periodontitis (Mättö *et al.*, 1997) and also an obligate anaerobic Gram-negative bacterium (Fine *et al.*, 2007; Perace *et al.*, 1996).

During a caries activity, the bacterial product interacts with gingival epithelial and penetrates into the fibroblast, periodontal ligament and alveolar bone (Lafaurie *et al.*, 2007; Setiawati, 2012). The bacteria attach to one another on a solid surface coated by the matrix, which consists of polysaccharide, extracellular DNA (eDNA) and protein, known as biofilm (Wei *et al.*, 2013). Biofilm can be a main etiology of virulence factors in tooth damage, periodontal disease and systemic disease because of the pathogenic bacteria in oral biofilm (Li *et al.*, 2000). During a caries activity, the bacterial product interacts with gingival epithelial, this is some examples of the pioneering bacteria that attach to dental surfaces and oral mucosa (Huang *et al.*, 2011).

There are some treatments for controlling oral hygiene, such as diet and plaque control, which balance the normal flora in the oral cavity. Plaque control can be performed mechanically and chemically. Mechanical plaque control can be performed using conventional methods, such as tooth brushing and dental flossing, however these methods are incapable of removing plaque accumulation on certain parts, such as the gingival sulcus (Cobb, 2008). The disadvantages of conventional methods can be overcome by combining them with chemical methods such as mouth wash (Wolf *et al.*, 2005). The chemical materials in mouth rinse are phenol, hexetidine, flour and chlorhexidine. The disadvantages of chemical materials for long-term use are tooth discoloration and allergies (Suhag *et al.*, 2007).

Contemporary society chooses to lead a natural lifestyle. This can be seen in the many uses of plants as medicines, which play an important role in life. WHO exemplifies this “back to nature” concept by recommending the use of traditional medicine to preserve health and prevent disease in society (WHO, 2005). Contemporary society chooses to lead a natural lifestyle. Phytopharmacology is a medicine originally made from natural ingredients, which has a certain utility (Dewoto, 2007).

One phytopharmacological material in Indonesia is cacao (*Theobroma cacao*). Cacao production in Indonesia reaches the third largest in the world (Pusat Penelitian Kopi dan Kakao Indonesia, 2010). Cacao produces seeds and releases 75% of wastes, such as the cacao pod (Figure 1). This large amount of cacao pod waste becomes a problem for the environment (Sartini *et al.*, 2012). Cacao pods consist of flavonoids, such as anthocyanin, catechin and leucoanthocyanidine, which are bioactive compounds that have antibacterial agent (Mulyatni *et al.*, 2012). Moreover, other compounds in the cacao pod are pectin and lignin. These compounds can potentially be developed into alternative medicines, food supplements and even cosmetics (Armiaati *et al.*, 2016; Hii *et al.*, 2009).



Figure 1. *Theobroma cacao*

Previous studies have suggested that antibacterial activity on the cacao pod extract used on *Streptococcus mutans*, *Escherichia coli*, *Bacillus subtilis* and *Staphylococcus aureus* has shown cacao pod extract potential for inhibiting bacterial growth (Monty, 2006). Cytotoxicity test results on cacao pod extract showed that the cacao pod is nontoxic (Yuanita, 2017). Cocoa has significant antibacterial effects against periodontal pathogenic bacteria such as *Porphyromonas gingivalis*, *Fusobacterium nucleatum*, and *Prevotella intermedia* (Hirao *et al.*, 2010). Consuming a cocoa-enriched diet could diminish periodontitis-induced oxidative stress (Tomofuji *et al.*, 2009). A research on cocoa beans (*Theobroma cacao* L) extracted with the ethanol 70% shows a higher antimicrobial activity against *A. actinomycetemcomitans* than with water (Atikah *et al.*, 2016).

There are many studies regarding the antibacterial effectiveness of cacao pod extract towards bacterial growth, but there is no research on the anti-biofilm activity in cacao pod extract towards *A. actinomycetemcomitans*. Therefore, anti-biofilm activity tests of cacao pod extract towards *A. actinomycetemcomitans* (the etiology bacteria in periodontal disease) are needed. Indonesian people are expected to use scientifically tested natural ingredients to prevent periodontal disease. The aim of this research is to analyze the ability of cacao pod extract to inhibit *A. actinomycetemcomitans* biofilm growth *in vitro*.

Materials and methods

Cacao extract preparation

One kilogram of ripe cacao was taken from the tree, and the cacao pod was separated from the seed and placenta. The cacao pod was washed under running water, cut with a knife and dried in the sun. The dried cacao pod was blended and sifted using a 60-mesh strainer until the pod became powder and known as the sample. The purpose of making this cacao pod powder was to destruct the structural cell and tissue, thus the extract

would be easily exposed to the solvent. Cacao pod extraction was performed using the maceration technique. In an Erlenmeyer tube, 40 g of cacao pod powder and 400 ml of 70% ethanol were mixed. The Erlenmeyer tube was inserted into a shaker and shaken at 120 rpm at room temperature for 3 hours and then left for 12–15 hours. Moreover, the solution was filtered with Whatman No. 41 filter paper (Merck, Darmstadt) until filtrate in solid residue form was obtained. Final the filtrate with ethanol was inserted into a rotary evaporator to vaporize the solvent, and the concentrated cacao pod extract was obtained. The concentrated cacao pod extract was diluted in concentrations of 6.25%, 12.5%, 25%, 50% and 100%.

Phytochemical screening

Qualitative phytochemical analysis was to identify active compound of the ethanol extracts of cacao pod. The extracts were tested for the presence of alkaloids, saponins, tannins, phenolics, flavonoids, triterpenoids, steroids, and glycosides. The qualitative results are expressed as (+) for the presence and (-) for the absence of phytochemicals.

Test for alkaloid

For Mayer's test, cacao pod extract was mixed with Mayer's reagent (potassium mercuric iodide solution). The creamish color precipitate was formed, indicate the presence of alkaloids.

Test for saponin

For foam test, 1 g powder was mixed with 5 mL of distilled water and shaken for 10 min, Appearance of foam indicate the presence of saponins.

Test of tannins and phenols

For ferric chloride test, the crude extract was mixed with ferric chloride reagent (FeCl_3), Blue green colour appeared the presence of tannins.

Test flavonoids

For Shinoda test, cacao pod crude extract was mixed with a few of magnesium ribbon and hydrochloric acid. Occurrence of a pink, orange or red coloration indicate the presence of flavonoids.

Test for steroid and triterpenoid

For Liebermann-Burchard test, cacao pod crude extract was mixed with acetic anhydride boiled and cooled, few drops of H₂SO₄ were added down from the side of the test tube. Blue green ring which showed the presence of steroid and the formation red colour indicate the presence of triterpenoids.

Test for glycoside

For Salkowski's Test, cacao pod crude extract was mixed with chloroform, then added concentrated sulfuric acid were added and shaken. Brown red colour indicate the presence of glycosides.

A. *actinomycescomitans* culture

A. actinomycescomitans ATCC 33384 is an obligate anaerobic Gram-negative bacterium. The bacterial culture was performed in an anaerobic atmosphere (5% CO₂) on AaGM (*A. actinomycescomitans* growth medium) in a petri dish and incubated for 24 hours at 37°C.

Biofilm assay

The *A. actinomycescomitans* culture was transferred to 25 ml of Brain Heart Infusion broth (Oxoid, Hampshire, UK) and incubated for 24 hours at 37°C in an anaerobic atmosphere. The culture was then homogenized with a vortexer, and the bacterial colony growth was measured with a 450 nm wavelength. Optical density was measured with a microplate reader (SAFAS MP96, SAFAS, Monaco), and the result was OD 0.132 (1x10⁷ CFU/ml). A 200 µL culture was distributed into 96 well-plate microplates and incubated at 37°C for 48 hours in an anaerobic atmosphere to form the biofilm. The supernatant was removed, and the well was rinsed twice with 200 µL Phosphate Buffered Saline (PBS). 200 µL of

cacao pod extract in different concentrations (100%, 50%, 25%, 12.5% and 6.25%) were distributed into biofilm containing plates. The extract was incubated at 37°C for 15 min, 1 hour, 3 hours, or 6 hours in an anaerobic atmosphere, and the inhibition effect was observed. The supernatant was removed, and the well was rinsed twice with 200 µL PBS. Crystal violet (0.5% w/v) was distributed into the well-plate and incubated for 15 min. The extraction from violet crystal in the well-plate was measured as a biofilm number with the addition of 200 µL of ethanol absolute (Merck, Darmstadt) for 15 min, and the absorbance was measured with 490 nm wavelength. The biofilm without the cacao pod extract was used as a negative control, and 0.2% chlorhexidine was used as a positive control. All treatments were done in triplicate.

Data analysis

The data was analyzed using a parametric test method with the Saphiro-Wilk normality test. An ANOVA one-way statistical test was performed for normally distributed data. A Tukey-HSD test was performed to determine the significant differences. p<0.05 was considered significant.

Results

Preliminary qualitative phytochemical screening analysis

The present study's findings demonstrate that the ethanol extract of cacao pod extract contained alkaloids, saponins, phenolics, flavonoids, triterpenoids, and glycosides, but not tannins or steroids (Table 1).

Table 1. The phytochemicals test result of cacao pod extract

Phytochemical test	Results
Alkaloid	+
Saponin	+
Tanin	-
Phenolics	+
Flavonoid	+
Triterpenoid	+
Steroid	-
Glycosides	+

The inhibitory effects of cacao pod extract against biofilm formation

The results showed that the biofilm density after incubation with the cacao pod extract was significantly decreased in all

concentrations and all incubation times ($p<0.05$). The most effective concentration for inhibiting biofilm *A. actinomycetemcomitans* was 100% cacao pod extract and 3 hours of incubation time ($p<0.05$) with a 98.9% reduction of biofilm compared to negative control (Figure 2-5).

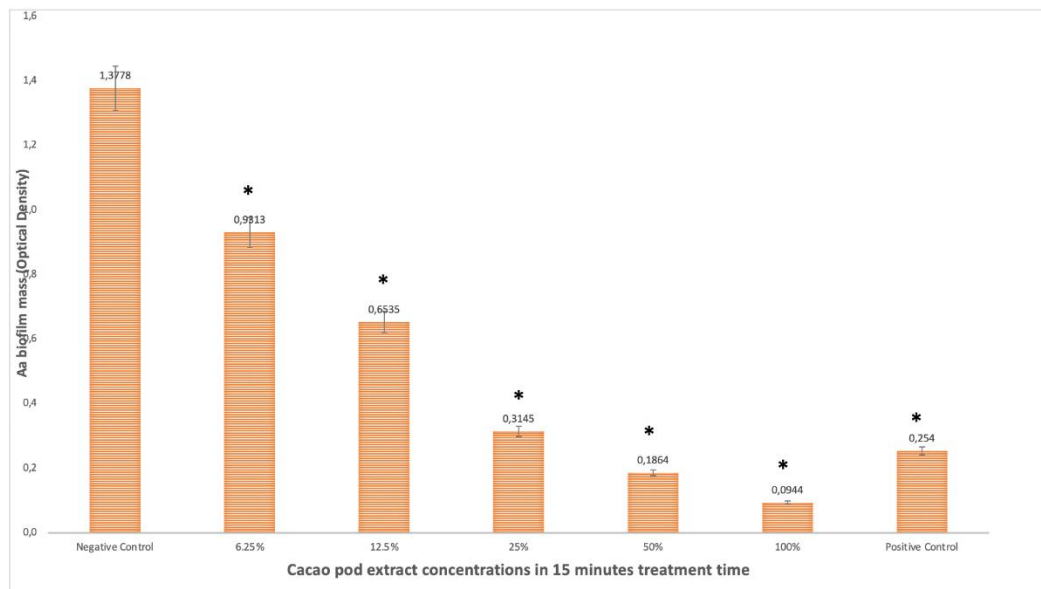


Figure 2. The reduction graphic of *A. actinomycetemcomitans* biofilms (as measured by optical density) after 15 minutes application of cacao pod extract (6.25%, 12.5%, 25%, 50%, 100%), compared to negative and positive controls. Biofilm without treatment was used as a negative control and chlorhexidine gluconate (0.2%) as a positive control. All treatments were done in triplicate. (* $p<0.05$ compared to the negative control)

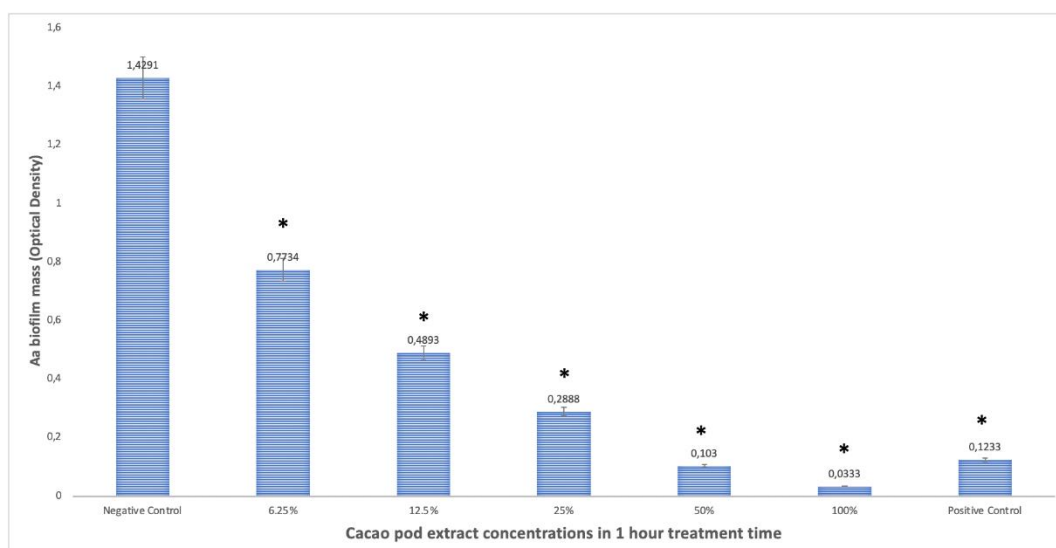


Figure 3. The reduction graphic of *A. actinomycetemcomitans* biofilms (as measured by optical density) after 1-hour application of cacao pod extract (6.25%, 12.5%, 25%, 50%, 100%), compared to negative and positive controls. Biofilm without treatment was used as a negative control and chlorhexidine gluconate (0.2%) as a positive control. All treatments were done in triplicate. (* $p<0.05$ compared to the negative control)

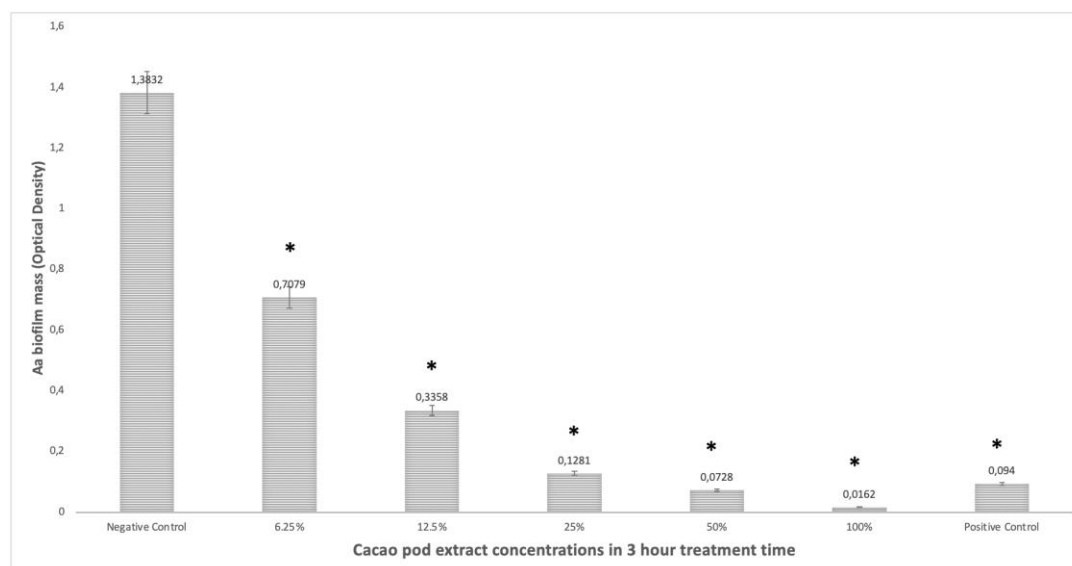


Figure 4. The reduction graphic of *A. actinomycetemcomitans* biofilms (as measured by optical density) after 3-hour application of cacao pod extract (6.25%, 12.5%, 25%, 50%, 100%), compared to negative and positive controls. Biofilm without treatment was used as a negative control and chlorhexidine gluconate (0.2%) as a positive control. All treatments were done in triplicate. (* $p < 0.05$ compared to the negative control)

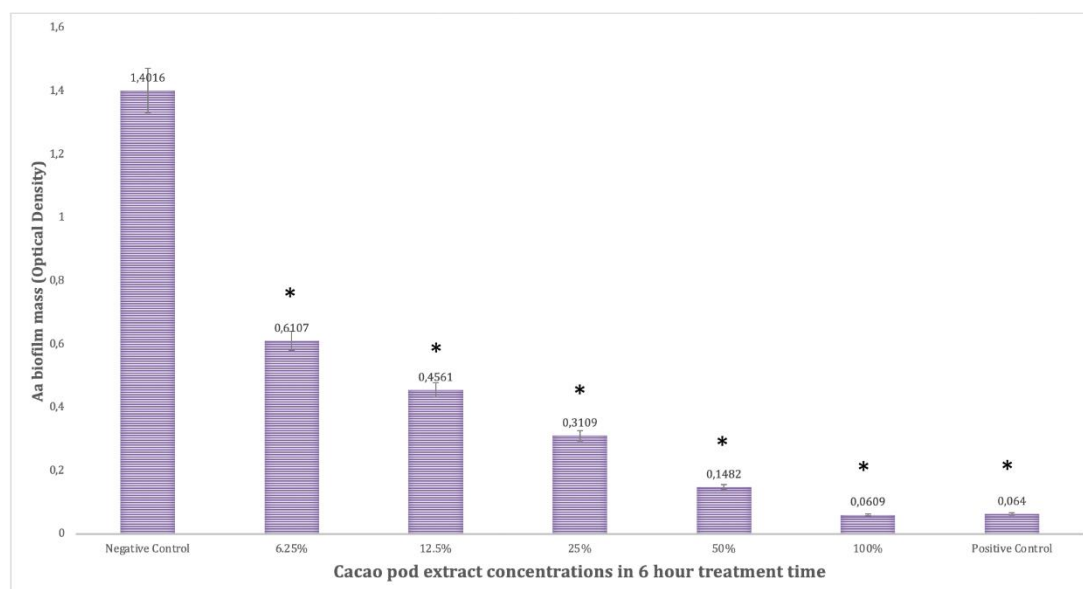


Figure 5. The reduction graphic of *A. actinomycetemcomitans* biofilms (as measured by optical density) after 6-hour application of cacao pod extract (6.25%, 12.5%, 25%, 50%, 100%), compared to negative and positive controls. Biofilm without treatment was used as a negative control and chlorhexidine gluconate (0.2%) as a positive control. All treatments were done in triplicate. (* $p < 0.05$ compared to the negative control)

Discussion

Biofilm-associated periodontitis disease is a major causes of tooth loss in oral cavity dental cases. The primary etiologies factor is bacterial form microcolonies known as biofilm. biofilms were found to protect from to harm environmental and low nutrient

condition (Berezow & Darveau, 2012). Choosing appropriate treatment is the important factor of successful in periodontitis treatment. Beside scaling and root planning as the primary therapy, use antiseptics therapy is the common choice for treating periodontitis.

Many of studies on the efficacy of synthetic medicine such as antiseptics have been established. Antiseptics are often used as adjunctive medicine with scaling and root planing. One of the antiseptics material for periodontitis treatment is chlorhexidine (CHX), CHX has been known as the gold standard of oral antiseptics (Mathur *et al.*, 2011). Studies reported that use of 0.2% chlorhexidine had antibacterial effects on *A. actinomycetemcomitans* (Kadkhoda *et al.*, 2016). CHX was also more effective than minocycline at killing *P. gingivalis* biofilm *in vitro* (Noiri *et al.*, 2003). The mechanism of action of CHX is to destroying bacterial proteins and cell wall. (De Wall *et al.*, 2013). But there are some side effects of CHX, such as discolouration of teeth, tongue (distorted taste), allergic and cytotoxic effect. *In vitro* study of CHX to gingival cells showed that the toxic potency of CHX (Babic *et al.*, 1995). Various allergic reaction due to CHX have been showed such as desquamative gingivitis, dermatitis, urticaria and occupational asthma (Dukes, 1992; Krauthheim, 2004).

Herbal medicines are generally considered to be safe and effective compare to synthetic medicines. About 8% of hospital admission in USA are due to adverse effects of synthetic drugs. At least 100,000 people each year die due to toxicities effect of synthetic drugs (Philomena, 2011). Herbal medicines contain various of active compounds that useful for health such as antioxidant activities, antibacterial, anti-inflammation and anti-cancer (Rafieian-Kopaie *et al.*, 2011; Shirzad *et al.*, 2011). One of the herbal medicines is cacao pod. The cacao pod has anti-inflammatory, antioxidant and antimicrobial material. The antimicrobial compound in cacao pods is flavonoid. The flavonoids in cacao pods are catechin, anthocyanin and leucoanthocyanidine (Mulyatni *et al.*, 2012). Flavonoids are phenolic compounds and the result of phenylpropanoid cycle synthesis as a response against microbial infection. Flavonoids work by reducing the fluidity of the bacterial cell membrane. The flavonoids in the cacao pod have been proven to inhibit *Streptococcus mutans*, *Escherichia coli*, *Bacillus subtilis* and *Staphylococcus aureus*

(Hii *et al.*, 2009). The cacao pod is nontoxic (Armiaati *et al.*, 2016), and other compounds that can be found in the cacao pod include pectin and lignin (Hii *et al.*, 2009).

Biofilm assay will provide information about the quantification of biofilm bacteria. This colorimetric assay is a semi-quantitative method based on dye (crystal violet) uptake by the bacteria cell in a biofilm. The biofilm assay analysis of this research is supported by other research which states that dried ethanol cacao pod extract with a 20% concentration has antibacterial effects against *Escherichia coli*, *Salmonella typhosa*, *Staphylococcus aureus* and *Streptococcus mutans*. The inhibition zones were 8.15 mm, 8.25 mm, 9.15 mm and 8.95 mm, respectively. Other research has shown that the potential of cacao pod extract to inhibit bacterial growth in the urinary tract and that the higher the extract concentration, the larger the inhibition zone against bacterial growth. The largest inhibition zone of *Staphylococcus aureus* and *Escherichia coli* growth was formed at a 64% concentration, and the result was 10 mm and 8.83 mm, respectively (Mulyatni *et al.*, 2012).

Other research has shown that there was a reduction in optical density (OD) in 4 hours and 24 hours of incubation time at a 30% concentration against *Streptococcus mutans*, and this research also showed that cacao pod extract can reduce the acid production of *Streptococcus mutans* (Monty, 2006). Research by Yuanita *et al.* in 2017 stated that cacao pod extract in 100%, 50%, 25%, 12.5%, 6.25% and 3.25 % concentrations was able to reduce the optical density of *Enterococcus faecalis* biofilm; however, a concentration lower than a 3.25% was unable to reduce the density of *Enterococcus faecalis* (Yuanita, 2017).

Based on phytochemical tests at the *Laboratorium Balai Penelitian Tanaman Rempah dan Obat* (BALITRO), cacao pod extract consists of flavonoid, anthocyanin, catechins, saponin, lignin, pectin and triterpenoid. Flavonoid compounds consist of polyphenol with a benzo-y-pyrone chemical structure. Flavonoid has the ability, as an antibacterial, to reduce bacterial

enzymes, interfering with protein transport in the bacterial cell membrane and destructing the bacterial cell membrane (Chandki *et al.*, 2011; Rose *et al.*, 2004).

The glycoside on cacao pod extract is saponin. Saponins are able to destruct the cytoplasm membrane and affect the permeability of the bacterial cell membrane, so the exchange of material inside or outside is uncontrollable. Saponin also has a pharmacological role as a cough suppressant, an anti-inflammatory, a vasoprotective, a hipocolestrolemic, an immune-modulator, an antifungal and an anti-parasite (Ahman, 2017; Podolak *et al.*, 2010). Anthocyanin is a coloring compound in the cacao pod. Catechins are compounds that act as antioxidants, and lignin and pectin are the main components of cell and structural composition in cacao pod tissue (Karatan *et al.*, 2009). Another compound in the cacao pod is triterpenoid, which is a hydrocarbon component (C₅H₈) that gives a distinctive odor to some parts of the plant, such the flower, fruit, leaf and branch. Triterpenoid also has an antimicrobial agent (Sawai *et al.*, 2011).

With these results herbal medicines have potential as antibiofilm agents and many people every year turn to herbal medicines from synthetic medicines because they believe herbal medicines have low side effects (Kazemipoor *et al.*, 2012). Many studies investigated antibiofilm effects of herbal products on bacterial biofilm suggesting their ability as alternative agents for bacterial infection.

Conclusion

Based on this research, it can be concluded that cacao pod extract has an inhibitory effect on the growth of *A. actinomycetemcomitans* biofilm and prevents periodontal disease, especially aggressive periodontitis. The higher the concentration of cacao pod extract, the greater the inhibitory effect on the biofilm viability of *A. actinomycetemcomitans*. Further study to observe cacao pod use as an effective anti-biofilm in the oral cavity is still

needed. *In vivo* research is warranted to observe the side effects of cacao pod use.

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References

- Ahman, S. (2017) Pharmacognosy: Introduction of plant constituents and their tests. *New Delhi: Department of Pharmacognosy and Phytochemistry, Faculty of Pharmacy*. July. p 1-10.
- Armia, Leman, M.A., Waworuntu, O.A. (2016). Uji efek antibakteri ekstrak kulit biji kakao (*Theobroma cacao*) terhadap bakteri *Streptococcus mutans*. *Journal Ilmah Farmasi*, 5:20-24.
- Atikah, A. R., Budi, H. S., Kusumaningsih, T. (2016). Antibacterial effects of 70% ethanol and water extract of cacao beans (*Theobroma cacao* L.) on *Aggregatibacter actinomycetemcomitans*. *Dental Journal*, 49(2), 104-109.
- Babich, H., Wurzbarger, B.J., Rubin, Y.L., Sinensky, M.C., Blau, L.(1995). An *in vitro* study on the cytotoxicity of chlorhexidine digluconate to human gingival cells. *Cell Biology and Toxicology*, 11, 79-88.
- Badan Penelitian dan Pengembangan Kesehatan Kementrian Kesehatan RI. (2009) In: *Laporan SKRT: Studi Morbiditas dan Disabilitas*, 2007. p 32.
- Berezow, A.B., Darveau, R.P. Microbial shift and periodontitis (2011). *Periodontology* 2000, 55(1), 36-47.
- Chandki, R., Banthia, P., Banthia, R. (2011) Biofilms: A microbial home. *Journal of Indian Society of Periodontology*, 15(2), 111-114.
- Cobb, C.M. (2008). Microbes, inflammation, scaling and root planning, and the periodontal condition. *Journal of Dental Hygiene*, 82(Suppl 3),4-9.
- De Waal, Y., Raghoobar, G., Huddleston, S.J., Meijer, H., Winkel, E., van Winkelhoff, A. (2013). Implant decontamination during surgical peri-implantitis treatment: A randomized, double-blind, placebo-controlled trial. *Journal of Clinical Periodontology*, 40,186-195.
- Dewoto, H.R. (2007). Pengembangan obat tradisional Indonesia menjadi fitofarmaka. *Majalah Kedokteran Indonesia*. 57(7), 205-211.
- Duerden, B.I., Drasar, B.S. (1991). *Anaerobes in Human Disease*. Wiley-Liss, New York.
- Dukes, M.N.G. (1992). *Meyler's Side Effects of Drugs: An Encyclopedia of Adverse Reactions and Interactions*. Amsterdam: Elsevier: pp. 576-9.
- Fine, D.H., Markowitz, K., Furgang, D., Fairlie, K., Ferrandiz, J., Nasri, C. *et al.* (2007). *Aggregatibacter actinomycetemcomitans* and its

- relationship to initiation of localized aggressive periodontitis: longitudinal cohort study of initially healthy adolescents. *Journal of Clinical Microbiology*, 45(12), 3859-3869.
- Haynes, W.G., Stanford, C. (2014). Periodontal disease and atherosclerosis: from dental to arterial plaque. *Journal of The American Heart Association*, 23, 1309-1311.
- Hii, C.L., Law, C.L., Suzannah, S., Misnawi, Cloke, M. (2009). Polyphenols in cocoa (*Theobroma cacao*). *Asian Journal of Food and Agro-Industry*, 2, 702-704.
- Hirao, C., Nishimura, E., Kamei, M., Ohshima, T., Maeda, N. (2010). Antibacterial effects of cocoa on periodontal pathogenic bacteria. *Journal of Oral Biosciences*, 52(3), 283-291.
- Huang, R., Li, M., Gregory, R.L. (2011) Bacterial interactions in dental biofilm. *Virulence*, 2(5), 435-444.
- Kadkhoda, Z., Amarlu, Z., Eshraghi, S., Samiei, N. (2016). Antimicrobial effect of chlorhexidine on *Aggregatibacter actinomycetemcomitans* biofilms associated with peri-implantitis. *Journal of Dental Research, Dental Clinic and Dental Prospects*, 10(3), 176-180.
- Karatan, E., Watrick, P. (2009) Signals, regulatory networks, and materials that build and break bacterial biofilms. *Microbiology and Molecular Biology Reviews*, 73(2), 310-347.
- Kazempoor, M., Radzi, C.W., Cordell, G.A., Yaze, I. (2012) Safety, efficacy and metabolism of traditional medicinal plants in the management of obesity: A review. *International Journal of Chemical Engineering*, 4, 288-292.
- Krauthaim, A.B., German, T.H.M., Bircher, A.J. (2004). Chlorhexidine anaphylaxis: case report and review of the literature. *Contact Dermatitis*, 50, 113-116.
- Lafaurie, G.I., Conteras, A., Baron, A., Botero, J., Mayorga-Fayad, I., Jaramillo, A. et al. (2007) demographic, clinical, and microbial aspects of chronic and aggressive periodontitis in Colombia: A multicenter study. *Journal of Periodontology*, 78(4), 629-639.
- Li, X., Kolltveit, K.M., Tronstad, L., Olsen, I. (2000) systemic diseases caused by oral infection. *Clinical Microbiology Review*, 13(4), 547-558.
- Mathur, S., Mathur, T., Srivastava, R., Khatri, R. (2011). Chlorhexidine: The gold standard in chemical plaque control. *National Journal of Physiology, Pharmacy and Pharmacology*, 1, 45-50.
- Mättö, J., Asikainen, S., Vaisanen, M.L., Rautio, M., Saarela, M., Summanen, P., Finegold, S., Jousimies-Somer, H. (1997). Role of *Aggregatibacter actinomycetemcomitans* in extraoral and some odontogenic infections. *Clinical Infection Disease*, 25, S194-S198.
- Monty, S. (2006). The effect of cocoa polyphenols on the growth, metabolism, and biofilm formation by *Streptococcus mutans* and *Streptococcus sanguinis*. *The European Journal of Oral Sciences*, 114(4), 343-8.
- Mulyatni, A.S., Budiani, A., Taniwiryono, D. (2012). Aktivitas antibakteri ekstrak kulit buah kakao (*Theobroma cacao*) terhadap *Streptococcus mutans*, *Escherichia coli*, *Bacillus subtilis*, dan *Staphylococcus aureus*. *Indonesia Journal of Biotechnology Research on Estate Crops*, 80, 77-84.
- Perry, D.A. Periodontal diseases. (2014). In *Periodontology for the Dental Hygienist*. 4th Edition John Dolan. Missouri: Saunders Elsevier. pp. 88-111.
- Noiri, Y., Okami, Y., Narimatsu, M., Takahashi, Y., Kawahara, T., Ebisu, S. (2003). Effects of chlorhexidine, minocycline, and metronidazole on *Porphyromonas gingivalis* strain 381 in biofilms. *Journal of Periodontology*, 74, 1647-1651.
- NL, R. (2005). Oral health and systemic health. *Minnesota Medicine*, 88(8), 46-48.
- Pearce, M.A., Dixon, R.A., Gharbia, S.E., Shah, H.N., Devine, D.A. (1996). Characterization of *Aggregatibacter actinomycetemcomitans* by enzyme production, restriction endonuclease and ribosomal RNA gene restriction analyses. *Oral Microbiology and Immunology*, 11, 135-141.
- Philomena, G. (2011). Concerns regarding the safety and toxicity of medicinal plants - An overview. *Journal of Applied Pharmaceutical Science*, 1(6), 40-44.
- Podolak, I., Galanty, A., Sobolewska, D. (2010) Saponins as cytotoxic agents: A review. *Phytochemistry Review*, 9(3), 425-474.
- Pusat Penelitian Kopi dan Kakao Indonesia. (2010). *Buku Pintar Budi Daya Kakao*, Ed1, Jakarta: Agro Media Pustaka.
- Radita, D.C., Widyarman, A.S. (2019). Mahkota dewa (god's crown) fruit extract inhibits the formation of periodontal pathogen biofilms in vitro. *Journal of Indonesian Dental Association*, 2(2), 57-62.
- Rafieian-Kopaie, M., Baradaran, A. (2013). Plants antioxidants: From laboratory to clinic. *Journal of Nephropathology*, 2(2), 152-153.
- Rose, L.F., Mealey, B., Genco, R., Cohen, D.W. (2004) *Periodontics: Medicine, Surgery, and Implant*. 1st ed USA: Elsevier Mosby.
- Sartini, M., Djide, N., Duma, N. (2012). Pemanfaatan limbah kulit buah kakao sebagai sumber bahan aktif untuk sediaan farmasi. *Jurnal Industri Hasil Perkebunan*, 7(2), 69-73.
- Sawai, S., Saito, K. (2011) Triterpenoid biosynthesis and engineering in plants. *Frontiers in Plant Science*, 2, 25, 1-8.
- Setiawati, E.M. (2012). Crude toxin of *Aggregatibacter actinomycetemcomitans* derotype-B increase PARP-1 expression in gingival epithelium. *Dental Journal*, 45(1), 39-42.
- Shirzad, H., Taji, F., Rafieian-Kopaei, M. (2011). Correlation between antioxidant activity of garlic extracts and WEHI-164 fibrosarcoma tumour growth in BALB/c mice. *Journal of Medicinal Food*, 14(9), 969-974.
- Suhag, A., Dixit, J., Dhan, P. (2007). Role of curcumin as a subgingival irrigant. *PERIO*, 4, 115-121.
- Tampubolon, N.S. (2006) *Dampak penyakit periodontal terhadap kualitas hidup*: Thesis. Universitas Sumatera Utara.

- Tomofuji, T., Ekuni, D., Irie, K., Azuma, T., Endo, Y., Tamaki, N. *et al.* (2009). Preventive effects of a cocoa-enriched diet on gingival oxidative stress in experimental periodontitis. *Journal of Periodontology*, 80(11), 1799-1808.
- Wei, Q., Ma, L.Z. (2013). Biofilm matrix and its regulation in *Pseudomonas aeruginosa*. *International Journal of Molecular Science*, 14, 20983-20984.
- Widyarman, A.S., Suhalim, O.P., Nandary, D., Theodorea, C.F. (2018). Pomegranate juice inhibits periodontal pathogens biofilm *in vitro*. *Scientific Dental Journal*. 28,2(3),101-108.
- Wolf, H.F., Rateitschak, K.H. (2005). Color Atlas of Dental Medicine: Periodontology, Thieme: New York.
- World Health Organization (2005) Traditional Medicine Strategy 2002-2005: Geneva.
- World Health Organization (2009) Oral Health Surveys: Basic Methods. 4th ed. Geneva: ORH/EPID.
- World Health Organization (2009) Formulating Oral Health Strategy for South-East Asia. New Delhi: World Health Organization. Retrieved from WHO <http://www.who.int/iris/handle/10665/205119>
- Yuanita, T. (2017) Antibiofilm power of cocoa bean pod husk extract (*Theobroma Cacao*) against *Enterococcus Faecalis* bacteria (*in vitro*). *International Medical Device and Technology Conference*. 1-11.

CASE REPORT



Anterior teeth rehabilitation with direct resin composite veneer using multiple layering technique: A case report

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Abstract

Cosmetic veneer has become a popular option for patients seeking to improve aesthetic in their smile. The procedure can be done through a direct or indirect technique which differs in term of material used and laboratory involvement. Despite producing a better aesthetic result than its direct technique counterpart, high-cost treatment, multiple visit requirement and invasive nature of tooth preparation are proven to be a stumbling block to the patient in some cases to choose indirect technique. Therefore, direct composite veneer technique can be offered due to its low costing and conservative concept which advocates more tooth structure preservation. This case report is about direct composite veneer for anterior teeth rehabilitation and its simple and conservative protocol.

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Introduction

Aesthetic dentistry as defined by *Mosby's Dental Dictionary* as "the skills and techniques used to improve the art and symmetry of the teeth and face to enhance the appearance as well as the function of the teeth, oral cavity and face" (Elsevier, 2014). Important aesthetic elements like shape or form of tooth, symmetry and proportionality, position and alignment, surface texture, colour and translucency play an important role in producing optimal aesthetic smile in addition to proper function and phonetics (Heymann and Ritter, 2019). Loss or absence of one or more of these elements will possibly from dental caries, trauma, or malformations either congenitally or

acquired will compromise the general appearance of a smile as a whole which can affect a person's self-confidence and motivations.

To rehabilitate and rejuvenate affected smile due to loss of key aesthetic smile elements, there are several treatment options available depending on the clinical considerations, for example, cosmetic contouring, direct composite restoration, dental crown, veneer and micro-abrasion. One of the most common indicated treatment options to restore the aesthetic features of a tooth is dental crowns (Hickel *et al.*, 2004). In dental crown treatment, remaining tooth structure is prepared to receive the crown itself which include the

removal of healthy dental hard tissue to accommodate the physical demand of the restoration. The extensive removal of tooth structure carries the risk of damage to the pulp for vital tooth and surrounding tissue like gingiva (Aristidis and Dimitra, 2002).

Another treatment option that involves less tooth structure removal and achieves a comparable aesthetic result to the conventional dental crown is veneers. Veneer involves the application of a layer of tooth-coloured material on tooth surface particularly labial or buccal surface, to restore localised or generalised defects and intrinsic discolourations (Heymann and Ritter, 2019). Depending on cases, a veneer can be done either through a direct or indirect technique which differs in term of material selection and dental laboratory involvement. A direct veneer technique can be done by application of resin composite on minimally or non-prepared tooth surface and completed chair-side in one appointment. Direct veneer technique or direct composite veneer (DCV) can be considered over indirect technique when the patients are time or financially limited, young patients or a single discoloured tooth (Heymann and Ritter, 2019). There are also some of the reported indications for DCV which include tooth discolouration, rotated teeth, congenital or acquired malformations, diastema, discoloured restorations, palatally positioned teeth, absence of lateral incisors, abrasions and erosions (Hickel *et al.*, 2004).

This case report describes the direct composite veneer technique in aesthetic rehabilitation of anterior teeth in a young adult patient related to the slanted position of teeth, overhanging restorations and secondary caries under old restorations which affect the general aesthetic of a smile.

Case report

A 25-year-old healthy Malay male patient came to dental polyclinic at Kulliyyah of Dentistry, International Islamic University Malaysia (IIUM) in January 2020 with concern regarding the appearance of his upper anterior teeth. His main concerns

were the mismatched colour of previous tooth restoration with the natural tooth and unaesthetic appearance of the incisal edge of the upper incisors. According to the patient's dental history, the teeth were restored due to caries with no complaints or complications afterwards. The patient seeks the replacement of less-than-desirable older restorations and fixes the appearance of the incisors with regard to the overall shape and form of the incisors.

Upon clinical examinations, the existing restoration appears to be discoloured and there is secondary caries detected at the mesial of left maxillary central incisor and over-hanging restoration on the mesial of the right maxillary central incisor. The incisal edge of both maxillary central incisors was also slanted unfavourably to the patient's aesthetic needs (Figure 1). Pulp sensibility and periodontal probing were also done to assess the pulp and periodontal status of the tooth in which all the tooth that need to be restored responded normally to the test and free of periodontal problem. Occlusion between both upper and lower dentition were also assessed to ensure harmonious inter-arch occlusion relationship (Figure 2). The remaining tooth structures were adequate for both teeth to receive dental veneers but due to the limited budget and time constraint, the patient agrees to the DCV method for both teeth instead of indirect veneer technique. The tooth will be restored directly using resin composite by removing previous restorations with minimal preparations for the veneer. Incorporation of proper incisal edges also will be done along with an attempt to recreate natural anatomical features as close as possible.

A diagnostic wax-up was made on the study cast to give an overview of the expected outcomes of the restorations to the patient (Figure 3). Silicone index was also made from the wax-up which include from upper right canine to the left contralateral side to serve as guide in placement of palatal shell. The tooth shade was determined before the commencement of treatment using VITA classical A1-D4® shade guide (VITA Zahnfabrik, Bad Säckingen, Germany) and

matched with the custom resin composite shade guide with Ceram-X® Duo i- Shade (Dentsply Sirona, Konstanz, Germany). In this case, based on the custom resin

composite shade guide, shade E2 was chosen as enamel shade while shade D2 for the dentinal shade of the restoration.



Figure 1. Pre-operative view. Slanted incisal angles of tooth 11 and 21, a visible shadow also noted at mesial of 21 indicated secondary caries under the existing restoration.



Figure 2. Pre-operative view. Inter-arch relationship of both upper and lower anterior dentition.



Figure 3. Diagnostic cast with wax up on tooth 13 until 23. Putty matrix was prepared based on this diagnostic wax-up including from tooth 13 until 23.

Following maxillary infiltration on the respective tooth was done, a rubber dam is placed using multiple isolations from right maxillary canine to the left maxillary canine. Removal of previous restoration and carious tissue was done until caries-free is achieved on all of the teeth with round shaped diamond bur. Affected dentine present at the prepared tooth is left unprepared and covered with glass ionomer cement as a liner (Figure 4). Minimal preparation was made on the labial surface to include beveling and conservative labial reduction of 0.3 mm using diamond chamfer bur. The selective etching was done on the enamel surfaces with 37% phosphoric acid (Eco-Etch® gel,

Ivoclar Vivadent, Liechtenstein) for 15 seconds and rinsed and air-dried. Bonding agent (Prime&Bond® universal, Dentsply Sirona, Konstanz, Germany) was applied thoroughly and light-cured for 20 seconds.

For resin composite placement (ceram.x duo®, Dentsply Sirona, Konstanz, Germany), palatal shell and the proximal wall was first established with enamel shade of E2 guided using silicone index constructed beforehand (Figure 5 & Figure 6). Subsequently, resin composite (ceram.x duo®, Dentsply Sirona, Konstanz, Germany) with shade D2 is used for dentine layering which was done incrementally and light-cured for 20 seconds

on each layer (Figure 7). The final layer of the labial surface is restored with resin composite enamel shade of E2 and light cured for 20 seconds before removal of the rubber dam. Each layering and contouring done using flat end plastic instrument along with silicone sculptor to ensure proper adaptation and smooth transition between restoration and tooth structure.

Finishing of the restoration was done using fine needle diamond bur and abrasive disk (Super Snap, Shofu Inc, Kyoto, Japan) to

contour the surface anatomy. Final finishing is then completed using Enhance® (Dentsply Sirona, Konstanz, Germany) system with polishing paste (Prisma-Gloss®, Dentsply Sirona, Konstanz, Germany). The restoration then polished with PoGo™ polishers (Dentsply Sirona, Konstanz, Germany). Each tooth is restored using the same protocol simulating to the adjacent tooth (Figure 8). After one week, the patient was recalled for review and there was no post-operative sensitivity and aesthetic or functional problem (Figure 9).



Figure 4. Rubber dam placement and removal of previous restoration and carious tissue. Notice the affected dentine was left unprepared and will be covered with liner.



Figure 5. Silicone index fabricated prior to the treatment was used as guide to build up palatal shell and proximal border.



Figure 6. Both palatal shell and proximal wall were built up using ceram.x® duo shade E2, to represent the enamel layer.



Figure 7. Application and layering of dentinal layer using ceram.x® duo shade D2. The procedure was aided by using silicone sculpture brush to ensure proper adaptation and smooth transition for each layering.



Figure 8. Post-operative appearance of the restoration



Figure 9. The restoration at one-week recall shows the optimal blending between restoration and tooth structure.

Discussion

This case report describes the use of resin composite in direct composite veneer technique in rehabilitating the appearance of less-than-desired upper anterior teeth particularly the incisors. The need for affordable and less hassle aesthetic dentistry is gaining popularity in the practice of modern dentistry and direct composite veneer are amongst the treatment of choice offered to the patient. In this case, the patient opted for direct laminate veneer treatment using composite resin although indirect technique

offers more advantages over direct technique (Heymann and Ritter, 2019).

Resin composite materials used in direct veneer technique are known to be associated with long-term discolouration, lower physical strength in term of wear and fracture resistance in indirect technique in addition to the labour-intensive procedure in one appointment for the patient. However, direct composite veneer technique offers a more conservative approach in tooth preparation, low cost in term of material used and elimination of laboratory procedure besides

the whole procedure can be done completely chair-side in one appointment. The versatility of the resin composites itself means it can be repaired and polished intra-orally without the need to remove the existing restorations which then require more tooth structure removal. The success rate of direct composite veneer also has 89% success rate for five years as reported by Peuman *et al.* (1997). With the advancement in dental materials technology, more resin composites material with better handling and physical properties will be produced in the future and soon the gap between both direct and indirect veneer technique will be much closer.

Another point to ponder in this case is the use of silicone index in establishing palatal shell and the proximal wall along with mylar strip. The usage of this technique will reduce the risk of loss proximal contact point and overhung restoration as illustrated in the beginning of this case. Improper adaptation of mylar strip without fixing it with wedges and inability to appreciate proper physiologic contour of the tooth is the main contributing factor the problem stated previously. Therefore, incorporating the use of silicone index in direct composite veneer protocol should be practised whenever possible (Ammannato *et al.*, 2017).

As for the layering technique used in this case, bilaminar layering with natural layering shading was used to utilise the CLOUD shade effect of the resin composite used (ceram.x duo®, Dentsply Sirona, Konstanz, Germany) which has enhanced chameleon blending ability. In this technique, natural tooth layers are used as model and emulated by the resin composite used with single body shade used for both dentine and enamel layering. Resin composite that emulates this concept use combination of universal shading of dentine with single opacity with ranges of chrome and

different tint and translucency for the enamel shade (Dietschi and Fahl, 2016). With much simplified shading and layering, this technique reduces the armamentarium and material needed for the procedure and making it less demanding compared to much more complicated layering technique such as trilaminar and polychromatic approach.

Conclusion

From this case report, it can be concluded that the direct composite veneer technique is a viable treatment option to be offered to the patient seeking rehabilitation of anterior teeth but has certain limitations. With judicious application of resin composite and good appreciation physiologic contour and anatomy of the tooth can made attractive smile achievable with simpler clinical protocol.

References

- Ammannato, R., Ferraris, F., & Allegri, M. (2017). The "index cutback technique": a three-dimensional guided layering approach in direct class IV composite restorations. *The International Journal of Esthetic Dentistry*, 12(4), 450-466.
- Aristidis, G. A., & Dimitra, B. (2002). Five-year clinical performance of porcelain laminate veneers. *Quintessence International*, 33(3), 185-189.
- Dietschi, D., & Fahl, N., Jr. (2016). Shading concepts and layering techniques to master direct anterior composite restorations: an update. *British Dental Journal*, 221(12), 765-771.
- Elsevier, M. (2014). *Mosby's Dental Dictionary - E-Book*, (3rd ed.), Elsevier Inc, 236-237.
- Ritter, A. V. (2017). *Sturdevant's Art & Science of Operative Dentistry - E-Book*, (7th ed.), 264-305.
- Hickel, R., Heidemann, D., Staehle, H. J., Minnig, P., Wilson, N. H., German Scientific Association for Operative Dentistry, & European Federation of Conservative Dentistry (2004). Direct composite restorations: extended use in anterior and posterior situations. *Clinical Oral Investigations*, 8(2), 43-44.
- Peumans, M., Van Meerbeek, B., Lambrechts, P., & Vanherle, G. (1997). The 5-year clinical performance of direct composite additions to correct tooth form and position. I. Esthetic qualities. *Clinical Oral Investigations*, 1(1), 12-18.

CASE REPORT



Soft tissue lesion of the ear canal – now you see it, now you don't

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Abstract

Spontaneous herniation of the temporomandibular joint along a bony defect in the external auditory canal is an uncommon condition that may lead to otologic symptoms. A 43-year-old gentleman presented with otalgia and an external auditory canal soft tissue lesion, which flattens upon opening of the jaw. Computed tomography scan of the temporal region confirmed the presence of a soft tissue lesion that herniated through an external auditory canal wall defect. This condition should be included in the differential diagnoses of an external auditory canal mass, despite infrequently encountered. It is important to inspect the external auditory canal during movement of the jaw when a soft tissue lesion is noted, so as not to miss this diagnosis.

Keywords: temporomandibular joint herniation, otalgia, external auditory canal defect, foramen of Huschke

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Introduction

Spontaneous herniation of the temporomandibular joint (TMJ) through a dehiscence in the wall of the external auditory canal (EAC) is a rare condition. A congenital bony defect known as the patent foramen of Huschke may be one of its causes. Peculiarly, it may present as a soft tissue lesion at the antero-inferior aspect of the EAC, which flattens when the jaw is opened. A careful examination, combined with high resolution computed tomography (CT) scan of the temporal bone, is warranted to achieve the accurate diagnosis.

Case report

A 43-year-old Malay gentleman, without any underlying medical illness; presented with history of left ear pain and fullness for 2 years. It was associated with left intermittent hearing impairment. He had no history of vertigo, ear discharge, tinnitus, or facial asymmetry. There was no history of ear surgery prior to his presentation.

Examination of the ears noted a lesion at the antero-inferior aspect of the left EAC. On palpation, the lesion was hard, and tender to touch. The left tympanic membrane was intact and normal. Upon examining the jaw, there was left temporomandibular joint clicking, while the mouth opening is 4.5cm

with no limitation of jaw movement. Further examination noted that the lesion flattens when the patient opens his jaw (Figure 1).

The lesion was initially thought to be a granuloma or an exostosis of the EAC, and the patient was sent for a high-resolution CT scan of the temporal bone. The scan unveiled a small soft tissue lesion at the antero-inferior aspect of the medial part of the left EAC, measuring about 0.4 x 0.2 cm (AP x W). The lesion was seen herniating through a dehiscence in the EAC wall (Figure 2). No apparent calcification, central hypodensity

or fat streakiness is seen within or around the lesion. The middle and inner ears were normal bilaterally.

After a detailed explanation to the patient regarding his condition and the options of treatment, the patient was not keen to undergo surgery; and was planned for conservative management with non-steroidal anti-inflammatory drugs for his otalgia. During his subsequent visits, his otalgia had reduced. He was advised for follow-up in our clinic regularly for monitoring of his symptoms.

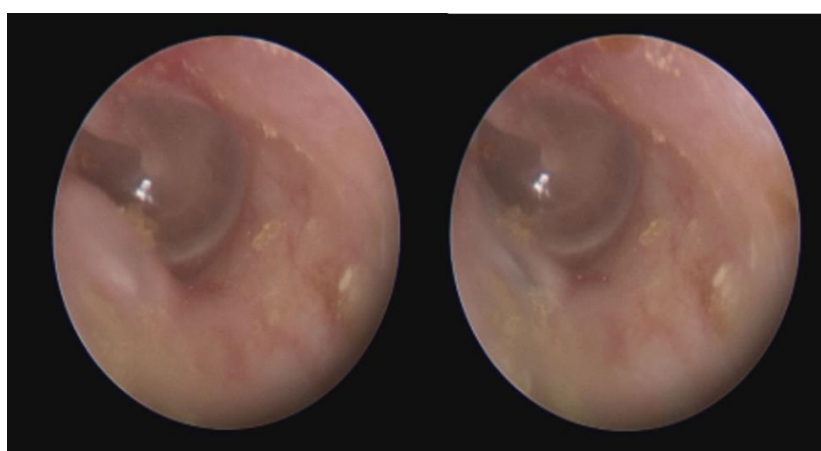


Figure 1. The lesion at the antero-inferior aspect of the left EAC with the jaw closed (left) and flattening of the lesion with the jaw opened (right)

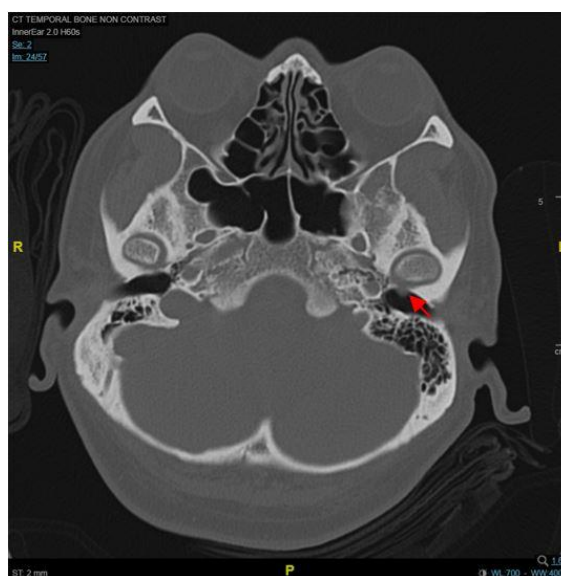


Figure 2. An axial CT temporal bone image at the level of the condylar head of the mandible of the temporomandibular joint. The red arrow depicts the dehiscence in the anterior bony canal wall of the left EAC, with herniation of the soft tissue of the temporomandibular joint (arrow), at the antero-inferior aspect of the medial part of the left EAC measuring 0.4 x 0.2 cm (AP x W).

Discussion

The temporomandibular joint is a type of synovial joint produced by the mandibular condyle and glenoid cavity. The foramen of Huschke (FH), or foramen tympanicum, is a bony defect and anatomical separator between the anterior aspect of the EAC and posterior border of the glenoid cavity (Kayahan *et al.*, 2013). The FH was first described by the German anatomist, Emil Huschke. In 1987, spontaneous herniation of the TMJ into the EAC through the FH was discovered by Hawke (Lacout *et al.*, 2005).

Embryologically, the EAC forms from the first branchial cleft at eight weeks of gestation. In the ninth week, a tympanic ring appears through the fusion of four

ossification centers. From the tympanic ring, the anterior and posterior bony prominences form and continue to grow towards one another. This structure has a U-shaped form and remains incomplete at birth, with the open portion of the structure identified as the notch of Rivinus. During the first year of life, these two prominences will fuse and thus will separate the tympanic ring into the FH inferiorly and external auditory canal superiorly (Figure 3). As the mastoid bone develops, it is displaced downward and forward, resulting in rotation of the ear canal. Therefore, a persistent FH will form a defect at the anterior wall of the EAC. The FH subsequently shortens until its complete closure at five years of age (Figure 4). It is the failure of involution and lack of ossification of the FH that results in an EAC wall defect (Ryu *et al.*, 2017).

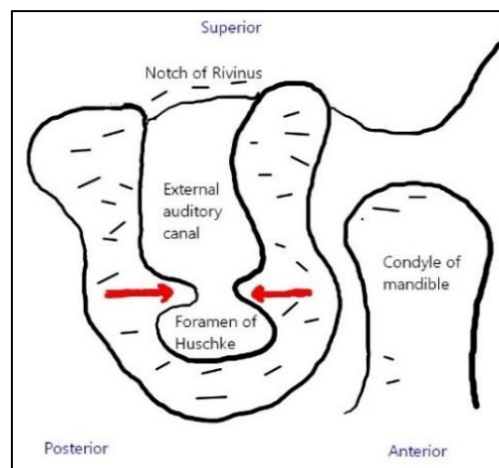


Figure 3. The growth of the tympanic ring, where the red arrows show the anterior and posterior bony prominences growing towards each other

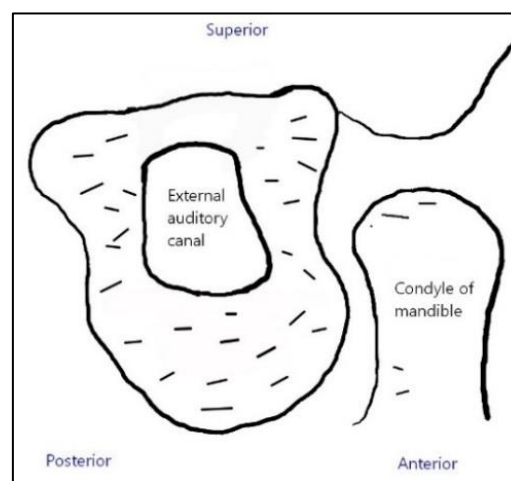


Figure 4. The complete involution & ossification of the Foramen of Huschke

Herniation of the TMJ into the EAC can be due to trauma, malignancy, inflammation, congenital bony defects, or iatrogenic via otologic procedures (O'Brien *et al.*, 2018).

The incidence of FH is about 4.6% in high resolution CT scans of the temporal bone and 7.2% in cadaveric studies. In a study by Park *et al.*, it was reported that TMJ soft tissue herniation was found in only 26% of cases of persistent FH. The sizes of the defect are around 1 mm to 8 mm. There may be a slight female predominance (20%), compared to males (12%); based on one study which looked at 994 Japanese dry skulls (Kim *et al.*, 2013).

Mastication induces mechanical stress, which may cause softening of the tissue between the TMJ and the defect in the temporal bone, subsequently weakening and enlarging the defect, resulting in TMJ herniation into the EAC. This will lead to the occurrence of symptoms over time. Therefore, the mean age of presentation for this condition is about 55 years (Bernstein, 2015).

Spontaneous TMJ herniation into the EAC can cause a myriad of otologic symptoms. Li & Dai reported that, the most common symptoms were otalgia (36%) and clicking tinnitus (36%), followed by otorrhea (32%). The discharge from the ear is specifically watery, odourless and colourless; due to the formation of a fistula leading to the leakage of synovial fluids. The other symptoms include hearing impairment (20%) and aural fullness (10%); while 8% were asymptomatic (Li & Dai, 2015).

Examination reveals a lesion in the antero-inferior segment of the EAC. Special attention must be taken to inspect the EAC during jaw movement, because FH-related TMJ herniation is more pronounced when the jaw is closed and is less prominent when the jaw is opened, due to the negative pressure in the retrodiscal space when the temporomandibular joint is anteriorly translated. In patients who experience a clicking sound as one of the symptoms, this may be heard by placing a stethoscope on the

patient's EAC during jaw movement (Cascone *et al.*, 2015).

This condition can be diagnosed clinically and confirmed radiologically. High-resolution CT scanning is suitable to detect the presence of a bony defect due to their precision and fine millimetric slices. The sagittal and coronal planes are useful in evaluating the size of the defect and its relationship with the mandibular condyle. Using CT scan, TMJ herniation can be differentiated from a true granuloma of the anterior bony canal wall or a salivary fistula. Magnetic resonance imaging (MRI) is helpful to detect the presence and contents of the soft tissue herniation, and the relationship between the existing defect and the parotid gland (Rubio & Vásquez, 2018).

Treatment is based on the severity of the symptoms and patient's choice. Conservative management is usually for patients who are asymptomatic or experience trivial symptoms, the elderly, or patients with multiple co-morbidities. Nevertheless, follow up is essential to control the symptoms and treat any complications that may occur.

Surgical closure of the defect is considered in patients who experience significant symptoms, patients with associated infection, or worsening herniation. There are two usual approaches in managing the defect, which are transcanal and preauricular. For both approaches, a graft is required to close the defect and prevent herniation of the TMJ. It can be in the form of a tragal cartilage, fascia, bone, polyethylene, polypropylene with a titanium miniplate, collagen mesh or titanium mesh. Post operatively, patients are advised to restrict jaw opening for 3 weeks (Singh *et al.*, 2016).

Conclusion

Spontaneous herniation of the TMJ into the EAC is possible due to the presence of a persistent embryological connection between these two structures. We present an interesting finding of such a condition which manifested as a soft tissue lesion that

was prominent when the patient closes his jaw but flattens when the patient opens his jaw. We recommend inspecting the EAC during jaw movement when a soft tissue lesion is noted in the EAC. An anterior wall of EAC soft tissue lesion, which is not cystic, with history of clicking sounds especially during jaw opening; should raise the suspicion of this condition. This is important to ensure that an accurate diagnosis is obtained, and effective treatment is administered to the patient.

References

- Bernstein, J. M. (2015). Spontaneous temporomandibular joint herniation into the external auditory canal through a persistent foramen tympanicum (huschke): Otologic features. *Journal of Otolaryngology-ENT Research*, 2(4), 145 - 147.
- Cascone, P., Ramieri, V., Vellone, V., Angeletti, D., Iannella, G., Magliulo, G. (2015). Temporomandibulare-external auditory canal fistulas treatment: Patient with air into the synovial compartment. *The Journal of Craniofacial Surgery*, 26(6), 530 - 532.
- Kayahan, B., Cabbarzade, C., Bajin, M. D., Gunaydin, R. O., Turan, E. (2013). Spontaneous herniation of temporomandibular joint through the external auditory canal. *Turkish Archives of Otolaryngology*, 52, 145 - 147.
- Kim, T. H., Lee, S. K., Kim, S. J., Byun, J. Y. (2013). A case of spontaneous temporomandibular joint herniation into the external auditory canal with clicking sound. *Korean Journal of Audiology*, 17(2), 90.
- Lacout, A., Marsot-Dupuch, K., Smoker, W. R. K., Lasjaunias, P. (2005). Foramen tympanicum, or foramen of huschke: Pathologic cases and anatomic ct study. *American Journal of Neuroradiology*, 26(6), 1317 - 1323.
- Li, W., Dai, C. (2015). Spontaneous temporomandibular joint herniation into the external auditory canal. *Brazilian Journal of Otorhinolaryngology*, 81(3), 339 - 341.
- O'Brien, D. C., Purpura, K. R., Cassis, A. M. (2018). Bilateral spontaneous temporomandibular joint herniation: A case report and literature review. *Ear, Nose & Throat Journal*, 97(9), E23 - E27.
- Rubio, J. D., Vázquez R. (2018). Dehiscence of the tympanic bone with temporomandibular joint herniation. *SOA Otolaryngology ENT Research*, 1(1), 11 - 13.
- Ryu, K. H., Baek, H. J., Hur, D. G. (2017). Spontaneous temporomandibular joint herniation into the external auditory canal through a patent foramen of huschke: A case report. *Annals of Medicine and Surgery*, 18, 33 - 35.
- Singh, I., Jain, A., Prasad, P., Rajpurohit, P. (2016). Spontaneous temporomandibular joint herniation: A rare case. *Oral and Maxillofacial Surgery*, 21(1), 87 - 90.

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Ahmad, A., Husain, A., Mujeeb, M., Khan, S. A., Najmi, A. K., Siddique, N. A. *et al.* (2013). A review on therapeutic potential of *Nigella sativa*: A miracle herb. *Asian Pacific Journal of Tropical Biomedicine*, 3(5), 337-352.

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