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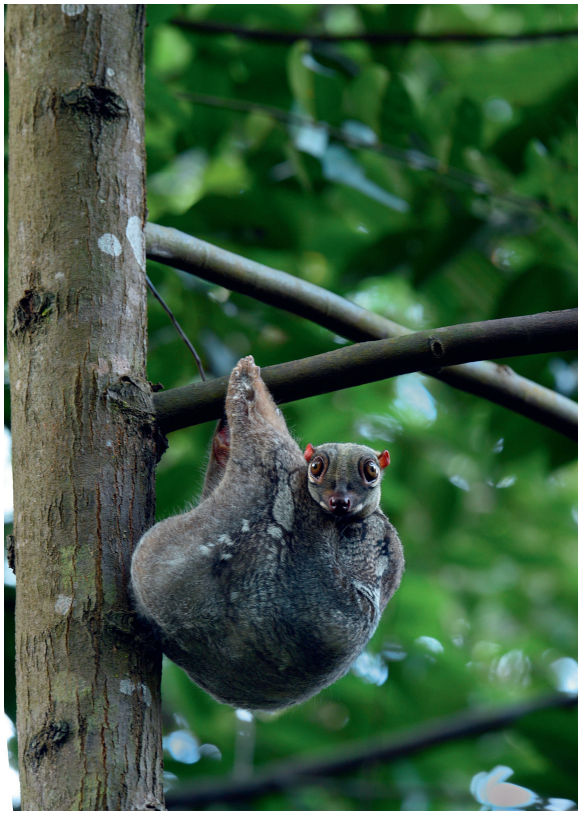

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# Letter from the Editor

**There are many quirks in healthcare**

Contrary to the opinions of many, the dental profession may be more important to health than are other apparently more "health" related professions – let me explain.

I am not about to expound what Peter Hunter, a British surgeon did in the 1920s – the Focal Infection Theory. That theory took the English speaking sphere of medicine through years of needless extraction of teeth that rendered many people toothless and perhaps shorter lived, as it is now recognised that if you have 20 or more teeth at age 60 you live longer than those who have less(correlational evidence).

For some time now, oral health has been associated with a host of medical problems from worsening diabetic control, lower full term birth weight and coronary heart disease. Where might the link be? Why can't researchers put their fingers on the cause and say "aha!"…. There had been many papers published on oral bacteria DNA being found in atheroma plaques in arteries of patients and then it is claimed that the bacteria could come from other than oral sources. The evidence to definitive cause however cannot be found. For definitive causative evidence from epidemiological studies, we need to fulfil the Bradford Hill criteria. (For those interested please type "THE BRADFORD HILL CRITERIA: THE FORGOTTEN PREDICATE" in the search engine Bing. The PDF file is available free online).

Whether dental health is causal or not to other general health problems should not be important to dentists however. What is important is that they realise that their convictions to rendering their patients' mouth healthy helps their patients in many ways aiding their patients to maintain in good general health.

I would like to draw your attention to two articles that I thought you should be aware of.

**1. N Engl J Med. 2007 Mar 1;356(9):911-20**

In that paper intensive periodontal treatment was reported to result in acute, short-term (48 h) systemic inflammation and endothelial dysfunction. However, 6 months after therapy, the benefits in oral health were associated (correlational evidence) with improvement in endothelial function. Patients in the treatment group had a higher percentage blood vessel dilatation when given nitroglycerine than the control group. This means that for patients who have angina and have been given nitroglycerin in case they get chest pain, a good scaling and root surface debridement will make them more responsive to the nitroglycerin tablets.

This paper makes us realise the importance of our work. We have to take the simple task of scaling and root surface debridement seriously. The second realisation should be – When should scaling be done for a patient who is being hospitalised for surgery? Surely you do not want to do scaling today and then go for heart surgery tomorrow and risk the effects of endothelium dysfunction affecting the outcome? Perhaps then, for all patients considering surgery, for whatever reason, should have scaling at least 48 h before being admitted to surgery. To read the full paper, please go online to PubMed and search the reference given above. The paper is available without charge.

**2. The Journal of the Royal Society Interface**

J. R. Soc. Interface 2016 13 20160539; DOI: 10.1098/rsif.2016.0539.

Again the paper is available at no charge online. Use the search engine "Bing" and use the search terms "LPS AND blood coagulation AND royal society" and the appropriate article will be first on the list. The title of the paper is "Acute induction of anomalous and amyloidogenic blood clotting by molecular amplification of highly substoichiometric levels of bacterial lipopolysaccharide".

I quote from this paper: "addition of tiny concentrations ($0.2\ \mathrm{ng\,l^{-1}}$) of bacterial LPS to both whole blood and platelet-poor plasma of normal, healthy donors leads to marked changes in the nature of the fibrin fibres so formed, as observed by ultrastructural and fluorescence microscopy (the latter implying that the fibrin is actually in an amyloid $\beta$-sheet-rich form that on stoichiometric grounds must occur autocatalytically). They resemble those seen in a number of inflammatory (and also amyloid) diseases, consistent with an involvement of LPS in their aetiology."

The message important to us is that LPS from bacteria contributes to quick coagulation of blood and also to amyloid diseases. Amyloid protein is formed in a variety of chronic degenerative ailments. One well known amyloid disease is Alzheimer's disease.

Remember that the paper does not prove that LPS causes Alzheimer's disease or heart disease. It shows directly that very little LPS is required to cause blood coagulation and formation of amyloid. Accumulation of LPS in the body can thus contribute to coagulation of blood and formation of amyloid protein.

Scaling using ultrasonic instrumentation, which generates cavitation around the working tip, disrupt biofilms around dental pockets as well as help remove LPS from the root surfaces.

Many people now feel that they too want to be dentists – they feel that there is such a large component of artistry and cosmetics in our work – being a dentist earn good bucks! We have to know our own worth. We offer a value for service that may have wider implications on health than most people may realise – it is not about money. We have to give our own profession enough self-respect so that we can contribute actively to our patients understanding of the value of our service.

Do you remember when it was, that you last instructed your patients on the correct method of toothbrushing?

*Editor*
*Sum Chee Peng*

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Scientific article

# Differences in willingness to pay for an extraction, a filling, and cleaning teeth at various levels of oral health-related quality of life, as measured by oral impacts on daily performance, among older adults in Singapore

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*Keywords:*
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ABSTRACT

*Objective:* To examine the differences in Willingness to pay (WTP) for an extraction, a filling, and cleaning of teeth among older adults with varying levels of Oral Health-related Quality of Life (OHQoL).

*Background:* OHQoL has been used extensively to measure utilities as reported by individuals of interest. Currently there are no reports that examine the WTP of individuals at various levels of OHQoL.

*Methods:* A convenience sample of adults 60 years or older were recruited. Besides other domains, questionnaires were used to assess WTP (extraction, filling, and cleaning of teeth), OHQoL (using Oral Impacts on Daily Performance-OIDP), McArthur scale, and access to care.

*Results:* Tamil ethnicity was related to higher WTP for an extraction (mean ratio, 1.63–3.98; 95% Confidence Interval [CI]), increase of age in years was related to lower WTP for extraction (mean ratio, 0.96–1.00 [95%CI]) and increasing OIDP score was related to lower WTP for extractions (mean ratio, 0.80–0.99 [95%CI]). Tamil ethnicity was associated with higher WTP for fillings (mean ratio, 2.69–6.44 [95%CI]); higher age in years was associated with lower WTP for fillings (mean ratio, 0.94–0.99 [95%CI]), and higher OIDP scores was trending to be associated to lower WTP for filling (mean ratio, 0.80–1.00 [95%CI]). Tamil Ethnicity was also associated with higher WTP for cleaning (mean ratio, 2.14–7.19 [95%CI]), higher age in years was also associated with cleaning (mean ratio, 0.94–0.99 [95%CI]).

*Conclusion:* Individuals with higher OIDP scores tended to have lower WTP for extraction, filling and cleaning; with significant differences reported for extraction.

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## Introduction

A major global phenomena and demographic trend carrying over from the late 20th century into the 21st century is the high growth rate (2.3% annually) of the proportion of the population age 65 years and over; with the population of adults aged 60 years and over expected to double from 600 million by 2025 [1,2]. In the coming decades, this demographic shift in Singapore is projected to be faster than in most other countries. The Singapore Department of Statistics reported that the proportion of Singaporean elderly (age 65 year and over) almost doubled from 4.9% in 1980 (118,281) to 8.5% in 2007 (390,031) [3]. The Committee on Aging Issues (Singapore) has forecast the number of residents age 65 and over to reach 900,000 (20% of the total population) by 2030 [4]. The number of Singaporeans 80 years or older is expected to increase by 10 times from 2000 to 2050 [2]. One of the challenges faced by the Singapore government is ensuring that the health needs of the elderly, including their oral health needs are provided for.

In addition to private dental services, Singaporean elderly adults can access public dental care from 18 polyclinics and 7 tertiary care hospitals [5]. The Ministry of Health in partnership with the private sector also provides subsidies for basic dental care under the Community Health Assist Scheme (CHAS) [6]. CHAS is aimed to improve the accessibility and affordability of dental care for qualifying citizens over the age of 40 years or disabled and who have a monthly per-capita income less than 1800 Singapore Dollars (SGD); and provide higher subsidies for those with per-capita household income less than 1100 SGD. The net effect of these programs should result in an improvement in the Oral Health-related Quality of Life (OHQoL) of the individuals who are targeted by this program.

OHQoL measures such as the Oral Impacts of Daily Performances (OIDP) assess the impact of oral health on the functioning and social and psychological well-being of elderly populations. Besides lending validity for overall oral health, they have been developed to examine disease-specific outcomes. OIDP has exhibited criterion validity with treatments and treatment needs. It provides a way to measure the ultimate impacts that affect oral health from the various disease conditions and is unique in providing frequency and severity of impacts [7,8]. It was found to be valid and reliable in Singapore as well [9]. Quality of life measures are also used for measuring the intensity of preferences. Common OHQoL measures, though proven in their usefulness and validity, may be less patient based, due to its expert driven domains and it may not include all aspects of preference that are desired by the target group [10].

Willingness to pay (WTP) has been used in cost-benefit analyses [11]. By measuring WTP, similar to quality of life measures, it may also be possible to get a measure of the intensity of preferences of target individuals. Due to its expert driven domains, quality of life measures may be less patient based, and may not include aspects of preferences that are desired by the target group [10]. WTP may be able to incorporate health outcomes, and non-use values of healthcare, as they are driven by the population under study [11]. By measuring WTP, it may also be possible to obtain a good measure of preference intensity of target individuals, especially from a resource allocation perspective. To avoid some common pitfalls of using WTP, recommendations for best practices for its use were given and it outlines several factors that could affect the amount elicited for WTP [12].

Studies in dentistry have analyzed WTP for services and products. A study in Japan, examining the use of WTP for dental screening found that it was related to select age-groups ($p<0.01$) and gender ($p<0.01$); and income was not related to the WTP [13]. Another study conducted on the WTP for implants in Saudi Arabia found relationships between income ($p=0.01$) and gender ($p=0.03$); however, there was no analysis for WTP and age [14]. While analyzing WTP for caries preventive strategies researchers found housing ($p<0.01$) and risk-group ($p=0.03$) to be associated significantly among a group of 19 year-olds in Sweden [15]. Gender ($p<0.01$), being a student ($p<0.01$), income ($p<0.01$), and current need ($p<0.01$) were associated with WTP for unexpected dental expenses among a group of Finnish adults [16]. In this case, willingness and ability to pay were linked to each other. Analyzing WTP for sealants and fillings for Thai children, as reported by their parents, income ($p=0.04$), age ($p=0.03$), education ($p=0.03$) and past fillings ($p<0.01$) were significantly associated with WTP [17]. Income was also significantly related to the provision of fillings to children as reported by their parents [18].

Current review of the literature did not reveal any studies in dentistry that have examined the relationship between any measure of OHQoL and WTP. An understanding of the changes in WTP for three basic services as reported by individuals in various levels of OHQoL, would give insight to the variation in preferences for these services by individuals. In this study we analyzed the relationship between OIDP and Willingness to pay (WTP) for dental extraction, filling, and cleaning.

## Materials and methods

For this study, a sample of community dwelling elderly were recruited after informed consent was obtained. Participants 60 years or older were recruited from community centers at Housing Development Board sites and assisted living centers between 2010 and 2013. The participants were also part of a larger study that aimed at validating the OIDP questionnaires for Singapore. The Housing Development Board provides housing for over 80% of the resident population, and all the participants were residents of Singapore. Ethical approval to conduct this research was received from the National University of Singapore Institutional Review Board, Reference Code 10-155.

All the questionnaires were developed in English and translated into Chinese, Malay and Tamil by translators proficient in the English and the respective languages and then back translated to English by separate translators who were blinded to the English version. The differences were settled in a meeting and a final translation was prepared. This version was tested for understanding on the target group and edits were made where necessary and this final version was used for the study. Four trained interviewers conducted

interviews in Chinese, Malay, Tamil and English. All questionnaires were interviewer administered.

The questionnaires collected information related to demographics including socio-economic status, and WTP for an extraction (of a tooth), a filling, and cleaning teeth. Besides these; OIDP, global ratings of QOL, self-reported medical conditions, self-reported oral conditions, use of oral care products, oral functioning, perceptions about dental visits, beliefs related to oral health, questions related to access to care, and assessment of Xerostomia were also ascertained through the questionnaires.

Willingness to pay for extraction, filling and cleaning of teeth were considered, as these three treatments were deemed to be the most basic care needed by elderly Singaporeans. A bidding game was utilized to measure stated preference [18,19]. The starting bids were the usual rates used at the public hospitals in Singapore which were set at 50 SGD for an extraction, 80 SGD for a composite restoration (filling), and 80 SGD for scaling and polishing (cleaning). A slightly higher amount than the usual charges for basic cleaning (70 SGD) was used, as many participants were not expected to have regular care.

The participants were asked about separate problems that would lead to an extraction, a filling, and a cleaning of teeth. Such problems included pain, discomfort, holes in teeth, broken teeth or 'shaky teeth'. If those conditions occurred, were they willing to pay the usual amount. If they were not willing for the usual amount then a bid for half the usual amount was made, and this continued for three rounds. If they agreed to one of the bids or if they disagreed to all of them, then they were asked on how much they would be willing to pay for the treatment in order to assess the exact amount of their willingness to pay. The amount was noted for all the three treatments separately.

The McArthur Scale using a picture of the 10 step ladder was used to determine subjective social status [20]. Perceptions related to dental visits were recorded from 13 questions. Beliefs related to teeth were collected from 4 questions and beliefs relating to dental visits were elicited from 4 other questions.

## Data analysis

The questions that enquired of the beliefs relating to the importance of oral health and access to care were tested for internal consistency before they were combined and a composite was created. Variables relating to willingness to pay were the dependent variables. Non parametric analysis was used for bivariate analysis, due to the distribution of the variables and the tests included Mann–Whitney U, Kruskal–Wallis, and Spearman Correlation.

Negative binomial regression was used to assess the relationship between the predictor variables and variables connected to willingness to pay. Variables that had a $p$-value less than 0.15 or were deemed important from the literature review were entered into the model. Statistical significance (alpha) was set at 5%.

## Results

A total of 83 participants with some extent of natural dentition were included in the analysis. All the participants were able to answer the questions connected to WTP. Of the questions that were asked, one participant could not answer questions regarding satisfaction with the dental office and access to care. There were 46 females and 37 males; with 29 Chinese, 23 Malay and 31 Tamil participants. Sixteen participants (about 20%) did not have any formal education and another 65 (about 60%) had some extent of primary school education. No one had higher than secondary education.

Age ranged from 60 to 91 years with a mean age of 73 years. Eighty percent of the participants ($n=67$) did not report any impacts as indicated by their OIDP scores. The rest of the participants had an average score of 5.08, with scores ranging from 0.4 to 12. About half of the participants ($n=40$) reported having no income, and another 40 reported up to 999 SGD every month. Only 3 participants reported having monthly earnings of 1000 SGD or higher. Subjective social status as measured using McArthur scale showed the participants reporting all levels ranging from 1 to 10, with an average score of 5.88, with 9 participants reporting a level of 1, and 10 participants reporting a level of 10.

No one exceeded the starting bid, while 5 participants were willing to pay the initial bid for extraction and filling, and only one participant was willing to pay the initial bid for cleaning. There were 15 participants who were not willing to pay any money for extractions and fillings, and 16 for fillings. Only two participants reported going to the dentist for regular check-ups.

Beliefs relating to the importance of oral health and age were significantly correlated with all three items for WTP (Table 1). Increasing age was related to lower willingness to pay and increasing levels of beliefs connected to importance of oral health was related to increased willingness to pay. OIDP approached statistical significance for correlation with WTP for extraction, where lower OIDP was related to higher WTP for extraction. While comparing the overall trends of correlations between OIPD and the three WTP measures, cleaning appears to be less correlated than extractions and fillings.

Women were willing to pay significantly higher amounts than men (Table 2). Those who were currently married were also more likely to be willing to pay higher amounts for all three treatments. The median WTP for fillings was double among those who lived with a partner or alone versus those who lived in a group or with family. Among the three ethnicities, Tamil Indians were willing to pay significantly higher amounts for all three procedures.

Multi-variable negative binomial regression analysis was performed for the three items relating to willingness to pay and the mean ratios were calculated for the willingness to pay for the categorical and continuous variables (Table 3). The mean ratios calculated show the change in adjusted mean values of WTP per category of the independent variables. Among the three ethnicities that were sampled, the participants who identified themselves as Tamil reported 2.5 times higher mean WTP when compared to the Chinese

**Table 1 – Correlation between the continuous independent variables with willingness to pay (WTP) for extraction, fillings and cleaning.**

| Independent variable | WTP for extraction | | WTP for filling | | WTP for cleaning | |
|---|---|---|---|---|---|---|
| | Correlation coefficient[a] | P-Value | Correlation coefficient[a] | P-Value | Correlation coefficient[a] | P-Value |
| Age (years) | −0.31 | 0.004 | −0.34 | 0.002 | −0.25 | 0.001 |
| Beliefs related to importance of oral health | 0.25 | <0.001 | 0.25 | <0.001 | 0.21 | <0.001 |
| Dental visit is worthwhile | 0.18 | 0.1 | 0.17 | 0.13 | 0.14 | 0.2 |
| McArthur scale | 0.18 | 0.11 | 0.19 | 0.09 | 0.16 | 0.14 |
| Access to dental care | 0.09 | 0.44 | 0.08 | 0.46 | 0.32 | 0.11 |
| OIDP | −0.19 | 0.09 | −0.16 | 0.16 | −0.1 | 0.37 |

[a] Spearman Correlation coefficient.

**Table 2 – Association of demographic factors with WTP for extraction, filling, and cleaning.**

| Independent variable | Categories | N | WTP for an extraction | | WTP for filling | | WTP for cleaning | |
|---|---|---|---|---|---|---|---|---|
| | | | Median | P-Value | Median | P-Value | Median | P-Value |
| Gender | Female | 46 | 20 | 0.03* | 20 | 0.01* | 20 | 0.01* |
| | Male | 37 | 10 | | 5 | | 5 | |
| Any education | Yes | 67 | 7.5 | 0.20* | 10 | 0.50* | 7.5 | 0.27 |
| | No | 16 | 12 | | 10 | | 10 | |
| Currently married | Yes | 49 | 20 | 0.002* | 20 | 0.001* | 20 | 0.002* |
| | No | 34 | 10 | | 5 | | 5 | |
| Living with | Partner or alone | 27 | 20 | 0.18* | 20 | 0.04* | 20 | 0.07* |
| | Family or group | 56 | 10 | | 10 | | 10 | |
| Ethnicity | Chinese | 29 | 10 | <0.001[a] | 5 | <0.001[a] | 5 | <0.001[a] |
| | Malay | 23 | 10 | | 10 | | 10 | |
| | Indian | 31 | 20 | | 30 | | 30 | |

* Mann Whitney U.
[a] Kruskal Wallis.

participants. There were no significant differences between the Malay and Chinese or the male and female participants in their WTP for any of the three WTP items.

Age was significantly related to all three items for WTP, with lower average WTP with increasing age (in years). With each year of increase in age there was a decrease of mean WTP by 2% for extractions and 4% for both fillings, and cleaning. OIDP scores were significantly related to WTP for fillings and cleaning. An increase in a point on the score for OIDP lead to a decrease of mean WTP for extractions by 11% and 10% for fillings. Subjective social status, as reported using McArthur scale, and beliefs connected with the importance of oral health were not significantly related to willingness to pay.

## Discussion

A majority of the participants (96%) reported monthly earnings less than a 1000.00 SGD. The median monthly income for all the citizens and permanent residents in Singapore was 2925 SGD and 3000 SGD for the years 2011 and 2012 respectively [21]. The elderly are expected to earn less than other groups in Singapore due to retirement and/or reduced working hours. However, in this study monthly earnings was especially lower among the participants with almost half ($n=40$) not reporting any income. Level of education was also low and similar across the group with close to 86% of the participants completing only primary school or less. The sampling was done from state subsidized housing used by about 81% of the citizens and permanent residents in Singapore in 2007 [22]. The participants were similar based on income and housing for socio-economic stratifications, so use of The MacArthur Scale of Subjective Social Status seemed appropriate and it gave an adequate spread of scores.

Sixteen participants (about 20%) in this study had impacts due to oral conditions, as reported using OIDP. This percentage was lower than groups in other Asian studies for older individuals, but similar to select groups in Great Britain and Mexico [23,24]. It may be a function of similar expectations and access in these groups that have led to the similarity in the percentage with impacts.

WTP gives the respondents a chance to evaluate services based on their preferences, which could include “use-values” and “non-use” or “passive-use” values [12]. This may be an advantage, when compared to the expert driven domains of many QOL measures in dentistry [10]. In healthcare, WTP analysis for many of the procedures have shown or was assumed to have higher WTP for procedures while suffering from a disease that could be relieved by the procedure in

**Table 3 – Multivariable Negative binomial regression analysing factors affecting Willingness To pay (WTP) for extraction, filling and cleaning.**

| Dependent variable | Independent variable | Categories | Mean Ratio | 95% CI | P-Value |
|---|---|---|---|---|---|
| Willingness to pay for extraction of a tooth | Gender | Female | 1.00 | | |
| | | Male | 1.06 | 0.71–1.57 | 0.79 |
| | Ethnicity | Chinese | 1.00 | | |
| | | Malay | 0.98 | 0.63–1.54 | 0.93 |
| | | Tamil | 2.54 | 1.63–3.98 | <0.001 |
| | Age | In years | 0.98 | 0.96–1.00 | 0.05 |
| | OIDP score | Range: 0 to 100 | 0.89 | 0.80–0.99 | 0.04 |
| | Beliefs related to oral health | Range: 4 to 20 | 1.01 | 0.98–1.03 | 0.60 |
| | McArthur scale | Range: 1 to 10 | 1.04 | 0.98–1.10 | 0.20 |
| Willingness to pay for a filling | Gender | Female | 1.00 | | |
| | | Male | 1.18 | 0.83–1.74 | 0.31 |
| | Ethnicity | Chinese | 1.00 | | |
| | | Malay | 1.40 | 0.91–2.15 | 0.13 |
| | | Tamil | 4.16 | 2.69–6.44 | <0.001 |
| | Age | In years | 0.96 | 0.94–0.99 | <0.001 |
| | OIDP score | Range: 0–100 | 0.90 | 0.80–1.00 | 0.05 |
| | Beliefs related to oral health | Range: 4–20 | 1.00 | 0.98–1.02 | 0.80 |
| | McArthur scale | Range: 1–10 | 1.04 | 0.98–1.11 | 0.17 |
| Willingness to pay for cleaning | Gender | Female | 1.00 | | |
| | | Male | 1.15 | 0.77–1.71 | 0.51 |
| | Ethnicity | Chinese | 1.00 | | |
| | | Malay | 1.35 | 0.86–2.11 | 0.19 |
| | | Tamil | 4.60 | 2.94–7.19 | <0.001 |
| | Age | In years | 0.96 | 0.94–0.99 | <0.001 |
| | OIDP score | Range: 0–100 | 0.91 | 0.82–1.02 | 0.11 |
| | Beliefs related to oral health | Range: 4–20 | 1.01 | 0.99–1.03 | 0.52 |
| | McArthur scale | Range: 1–10 | 1.03 | 0.97–1.10 | 2.84 |

question [25–27]. This forms the basis for the commonly used incremental cost-effectiveness, where at lower QOL, there is increased WTP.

Among the participants, there were very few ($n=5$) who were willing to pay the initial bid for extraction and filling, whereas only one person was willing to pay the initial bid for cleaning. No one exceeded the initial bid for WTP for the three procedures. It may be expected that there would be fewer people who are willing to pay higher amounts as their incomes were lower than the median income for the country. The expectations connected with oral health and willingness to pay for treatments may also be lower among the older cohorts [16].

The analysis of WTP, examined the participants' assessment of how much they thought each of the treatments were worth spending on, based on their ability to spend. The scenario that was given was based on the past experiences of the participants and their future expectations, as all had some past tooth loss and carious (cavities) experience. Only those with some natural dentition were included to ensure the temporal relevance of the questions that were being asked. The high prevalence of dental diseases distinguishes it from some of the other conditions studied elsewhere, where the incremental cost-effectiveness analysis measures were made to compare those with disease experience versus those who didn't have the same [28].

In the multivariable negative binomial regression analysis, OIDP was significantly related to WTP for extraction ($p=0.04$), and approaching statistical significance with fillings at ($p=0.05$), while not being significantly related to WTP for cleaning teeth. WTP was adjusted for demographic variables, McArthur Scale, and a variable constructed to measure the beliefs gauging the importance of oral health. Lower OIDP scores (indicating better patient outcomes) tended to have higher WTP for all three procedures. This was different from results reported for other conditions, where worse quality of life (QOL) was linked to higher WTP [25,27]. The difference could be due to the less severe impacts on QOL, the chronic nature of many dental diseases, high prevalence, low dental expectations, and lower health literacy among older cohorts. These would be useful to test in the future.

In all three models, ethnicity was significantly related to WTP, where Tamil adults were willing to pay higher amounts than Chinese (reference group), with no difference between Malay and Chinese ethnicities. With a lack of published material on socio-economic status in the Singaporean population, the reason for the effect could not be explained. Perhaps a larger sample may reduce this large difference.

Mean WTP for filling and cleaning reduced by about 4% for each year, and the mean WTP for extraction was reduced by 2% for each year of age. This may indicate a higher priority for extraction with increasing age when compared to filling and cleaning. This was similar to a previous study where age and

gender were related to WTP for regular dental check-ups and income was not related to it [13].

Our study may be limited by sample-size, as with a larger sample-size statistical significance (at 5%) for the WTP for filling and extraction may have been achievable. There is a need to replicate the study, as the results were unexpected, but consistent through our analysis. There are several limitations to the measurement of willingness to pay measurements and the method of elicitation used here. This includes, a slightly higher WTP possible from the bidding method used here versus other methods [29]. The starting amount given here was estimated based on the cost of the procedures charged by general dental practitioners in the hospital. This could be higher than the ability to pay of the lower income individuals and may have starting point bias, with higher reported WTP. Despite these, the reported WTP was very low across the board.

## Conclusion

Individuals with higher OIDP scores (lower OHQoL) tended to have lower WTP for extraction, filling and cleaning; with significant differences reported for extraction.

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## REFERENCES

[1] World Health Organization, Regional Office for South-East Asia, Strategic Directions for Strengthening Active and Healthy Ageing: Report of A Workshop on Active and Healthy Ageing for Mega Countries, New Delhi, 30 September–2 October 1999, WHO Regional Office for South-East Asia, New Delhi, 2000, p. 16.
[2] United Nations, Department of Economic and Social Affairs, Population Division, World Population Ageing, 1950–2050, United Nations, New York, 2002, xlix, p. 483.
[3] Singapore, Dept. of Statistics, Population Trends, Dept. of Statistics, Singapore, 2008. v. p.
[4] Ministry of Community Development YaS, Singapore, Report on the Ageing Population, MCYS, Singapore, 2006.
[5] Ministry of Health S, Hospital Services, 2013. ⟨http://www.moh.gov.sg/content/moh_web/home/our_healthcare_system/Healthcare_Services/Hospitals.html⟩. (accessed 2013).
[6] Ministry of Health S, Community Health Assisst Scheme. ⟨http://www.moh.gov.sg/content/moh_web/home/costs_and_financing/schemes_subsidies/Community_Health_Assist_Scheme.html⟩, 2013.
[7] G.D. Slade, Measuring oral health and quality of life. in: G.D. Slade (Ed.), Department of Dental Ecology, School od Dentistry, University of North Carolina, 1997.
[8] S. Adulyanon, J. Vourapukjaru, A. Sheiham, Oral impacts affecting daily performance in a low dental disease Thai population, Community Dent. Oral Epidemiol. 24 (6) (1996) 385–389.
[9] R. Nair, G. Tsakos, R. Yee Ting Fai, Testing reliability and validity of oral impacts on daily performances for Chinese-speaking elderly Singaporeans, Gerodontology (2015).
[10] D. Locker, F. Allen, What do measures of 'oral health-related quality of life' measure?, Community Dent. Oral Epidemiol. 35 (6) (2007) 401–411.
[11] J.A. Olsen, R.D. Smith, Theory versus practice: a review of 'willingness-to-pay' in health and health care, Health Econ. 10 (1) (2001) 39–52.
[12] K. Arrow, R. Solow, Report of the NOAA Panel on Contingent Valuation, National Oceanic and Atmospheric Administration, Washington, DC, 1993.
[13] Y. Tamaki, Y. Nomura, K. Teraoka, F. Nishikahara, M. Motegi, A. Tsurumoto, N. Hanada, Characteristics and willingness of patients to pay for regular dental check-ups in Japan, J. Oral Sci. 46 (2) (2004) 127–133.
[14] B. Al Garni, S.C. Pani, A. Almaaz, E. Al Qeshtaini, H. Abu-Haimed, K. Al Sharif, Factors affecting the willingness to pay for implants: a study of patients in Riyadh, Saudi Arabia, Dent. Res. J. 9 (6) (2012) 719–724.
[15] N. Oscarson, L. Lindholm, C. Kallestal, The value of caries preventive care among 19-year olds using the contingent valuation method within a cost-benefit approach, Community Dent. Oral Epidemiol. 35 (2) (2007) 109–117.
[16] E. Widstrom, T. Seppala, Willingness and ability to pay for unexpected dental expenses by Finnish adults, BMC Oral Health 12 (2012) 35.
[17] S. Tianviwat, V. Chongsuvivatwong, S. Birch, Prevention versus cure: measuring parental preferences for sealants and fillings as treatments for childhood caries in Southern Thailand, Health Policy 86 (1) (2008) 64–71.
[18] S. Tianviwat, V. Chongsuvivatwong, S. Birch, Different dental care setting: does income matter?, Health Econ. 17 (1) (2008) 109–118.
[19] B. O'Brien, J.L. Viramontes, Willingness to pay: a valid and reliable measure of health state preference?, Med. Decis. Mak. 14 (3) (1994) 289–297.
[20] N.E. Adler, E.S. Epel, G. Castellazzo, J.R. Ickovics, Relationship of subjective and objective social status with psychological and physiological functioning: preliminary data in healthy white women, Health Psychol. 19 (6) (2000) 586–592.
[21] Manpower Mo, Gross Monthly Income From Work, 16 January 2013. ⟨http://www.mom.gov.sg/statistics-publications/national-labour-market-information/statistics/Pages/earnings-wages.aspx⟩. (accessed 16.01.16).
[22] Housing Development Board S, Statistics and Charts, HDB Annual Report 2007/2008. Singapore, 2008.
[23] A. Sheiham, J.G. Steele, W. Marcenes, G. Tsakos, S. Finch, A. W. Walls, Prevalence of impacts of dental and oral disorders and their effects on eating among older people; a national survey in Great Britain, Community Dent. Oral Epidemiol. 29 (3) (2001) 195–203.
[24] S. Sanchez-Garcia, T. Juarez-Cedillo, H. Reyes-Morales, J. de la Fuente-Hernandez, F. Solorzano-Santos, C. Garcia-Pena, State of dentition and its impact on the capacity of elders to perform daily activities, Salud Publica Mex. 49 (3) (2007) 173–181.
[25] D.Y. Oh, B. Crawford, S.B. Kim, H.C. Chung, J. McDonald, S.Y. Lee, S.K. Ko, J. Ro, Evaluation of the willingness-to-pay for cancer treatment in Korean metastatic breast cancer patients: a multicenter, cross-sectional study, Asia Pac. J. Clin. Oncol. 8 (3) (2012) 282–291.
[26] J. Svensson, O. Ghatnekar, A. Lindgren, O. Lindvall, B. Norrving, U. Persson, Z. Kokaia, Societal value of stem cell therapy in stroke – a modeling study, Cerebrovasc. Dis. 33 (6) (2012) 532–539.

[27] J.D. Stein, P.A. Newman-Casey, T. Mrinalini, P.P. Lee, D.W. Hutton, Cost-effectiveness of bevacizumab and ranibizumab for newly diagnosed neovascular macular degeneration (an American ophthalmological society thesis), Trans. Am. Ophthalmol. Soc. 111 (2013) 56–69.

[28] T. Vos, A.D. Flaxman, M. Naghavi, R. Lozano, C. Michaud, M. Ezzati, K. Shibuya, J.A. Salomon, S. Abdalla, V. Aboyans, et al., Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990–2010: a systematic analysis for the global burden of disease study 2010, Lancet 380 (9859) (2012) 2163–2196.

[29] M. Ryan, D.A. Scott, C. Donaldson, Valuing health care using willingness to pay: a comparison of the payment card and dichotomous choice methods, J. Health Econ. 23 (2) (2004) 237–258.

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Scientific article

# Is periodontitis an independent risk factor for subclinical atherosclerosis?

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ABSTRACT

*Objectives:* The aim of this study was to assess the interrelationship between periodontitis and atherosclerosis by comparing the ultrasound and clinical markers of atherosclerosis in systemically healthy patients with and without periodontitis and whether periodontitis can be an independent risk factor for atherosclerosis.

*Materials and methods:* Total 40 subjects, of same socioeconomic status, belonging to age group of 35–65 years, were recruited and divided into two groups - Group I (Chronic Generalised Periodontitis without any systemic disease: CP-SH), Group II (Normal healthy patients without periodontitis and any systemic disease - SH). Clinical measurements and ultrasound examinations were carried out. Qualitative variables were analyzed using Chi square test and qualitative variables using Unpaired Student t test. Statistical significance was accepted for $p \leq 0.05$.

*Results:* Carotid ultrasound revealed right and left intima media thickness (IMT) of $0.626 \pm 0.016$ mm and $0.715 \pm 0.037$ mm respectively in cases versus $0.495 \pm 0.009$ mm and $0.518 \pm 0.009$ mm respectively in controls, with the difference being statistically significant. In cases, mean diastolic blood pressure (DBP) was $83.45 \pm 4.07$ mmHg versus $79.25 \pm 3.63$ mmHg in controls, with the difference being statistically significant.

*Conclusion:* In this study, we found statistically significant differences in carotid IMT and DBP values between cases and controls. These findings suggest independent role of periodontal disease in subclinical atherosclerosis.

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## Introduction

Periodontitis is a chronic inflammatory disease of tissues surrounding the teeth caused by specific anaerobic pathogens. The destructive process of periodontitis is thought to begin with the accumulation of biofilms which contain significant bacterial masses on the tooth surface at or below the gingival margin. Periodontal destruction is thought to occur as a result of the host inflammatory response against these bacteria and from release of toxic products from the pathogenic plaque. The potential impact of many systemic disorders on the periodontium is well-documented. Also, evidence suggests that periodontal infection may significantly enhance the risk for **certain systemic diseases or alter the natural course** of systemic conditions [1]. Conditions in which the influences of periodontal infection are documented include coronary heart disease (CHD) and CHD-related events such as angina and myocardial infarction, atherosclerosis, stroke, diabetes mellitus, preterm labor, low birthweight delivery, and respiratory conditions.

Cardiovascular diseases (CVD), which globally rank first in the list of morbidity and mortality, are common in many adult populations. Over the last 15 years, several studies have reported epidemiological associations between periodontitis and cardiovascular diseases [2,3]. Chronic inflammation plays a role in atherosclerosis by influencing the risk, manifestation, and progression of vascular events. Periodontitis has been associated with CVD, although causality still needs to be confirmed. Atherosclerosis is the main underlying vascular disease responsible for cardiovascular and cerebrovascular mortality and morbidity. The progression of atherosclerosis and the triggering of cardiovascular events involves the intervention of a series of risk factors, such as age, smoking, hypertension, diabetes and hypercholesterolemia.

The intima-media thickness (IMT) of the carotid artery is a histopathologically validated measure or marker of atherosclerosis [4]. Measurement of this parameter is strongly correlated to disease of the coronary arteries as well as to disease of the cerebral arteries and thus represents a good predictor of both cardiovascular and cerebrovascular ischemic event. **B-mode ultrasonography** is a non-invasive, less time consuming and highly reliable tool for assessing the early stages of atherosclerosis by measuring IMT.

A direct relationship between the levels of subgingival periodontal bacteria and systolic blood pressure (SBP) and diastolic blood pressure (DBP) as well as hypertension prevalence has been described in subjects with no history of stroke or myocardial infarction.

Therefore, the aim of the study was to assess the interrelationship between periodontitis and atherosclerosis by comparing the ultrasound and clinical markers of atherosclerosis in systemically healthy patients with and without periodontitis and also to assess whether periodontitis can be an independent risk factor for atherosclerosis.

## Materials & methods

For this study, total 40 subjects, of same socioeconomic status, belonging to age group of 35–65 years, were recruited from patients visiting **Department of Periodontology, Rishiraj College of Dental Sciences and Research Centre, Bhopal.** The patients were grouped accordingly -

1. Group I: 20 cases of Chronic Generalised Periodontitis without any systemic disease **(CP-SH)**
2. Group II: 20 normal healthy patients (control) without periodontitis and any systemic disease **(SH).**

Inclusion criteria - CP-SH group **(AAP, 1999)** [5]**:** number of teeth $\geq 16$, presence of $\geq 5$ mm probing pocket depth (PPD) in more than 30% sites, presence of $\geq 3$ mm clinical attachment loss (CAL) in more than 30% sites and radiographic evidence of bone loss. SH group: number of teeth $\geq 20$ teeth, presence of PPD $\leq 3$ mm, no clinical attachment loss and no radiographic sign of alveolar bone loss.

Exclusion criteria - patients with history of diabetes mellitus, hypertension or any other systemic diseases and conditions, history of/family history of cardiovascular diseases, obese (BMI$>$30) patients, pregnant or lactating females, smokers and alcoholics, patients who had undergone periodontal therapy during last 6 months and patients who had taken any antibiotics/anti inflammatory/hormonal drugs in past 3months.

This study was carried out over a period of 1 year. Ethical clearance was obtained from the Ethical Committee of Rishiraj College of Dental Sciences and Research Centre, Bhopal. Written informed consent was obtained from the subjects, according to Declaration of Helsinki, before starting the study. Through an interview process, an extensive medical history was compiled for each patient. BMI values were calculated from the anthropometric data (weight [in kilograms] divided by height squared [square meters]); patients exceeding 29.9 kg/m$^2$ were considered obese.

### *Clinical measurements*

Clinical periodontal recordings were performed using William's graduated periodontal probe (Hu-Friedy, Chicago, IL) on all the teeth, with the exception of the third molars. All measurements were performed by a single trained expert in periodontitis. Full mouth gingival bleeding index, PPD and CAL were recorded. Orthopantamographs (OPGs) of patients in CP-SH group were taken to show the radiographic evidence of bone loss. The diagnosis of periodontitis was defined by the percentage of sites with CAL $>3$ mm: 1% to 32%= mild; 33% to 66% = moderate; and 67% to 100% = severe [6].

### *Diastolic blood pressure*

Diastolic blood pressure was measured in right antecubital fossa using calibrated mercurial sphygmomanometer (Diamond, Industrial Electronic & Allied Products, Pune) and

stethoscope. Two readings were taken and the average of two measurements was recorded. Hypertension was defined by patient-reported history of diagnosed hypertension or use of antihypertensive medications or by mean systolic blood pressure $\geq 140$ mmHg or mean diastolic blood pressure $\geq 90$ mmHg. Systolic blood pressure $>120$ mmHg and $\leq 139$ mmHg and Diastolic blood pressure $> 80$ mmHg and $\leq 90$ mmHg were considered as prehypertension [7].

### *Ultrasound examination*

**Intima Media Thickness (IMT)** measurements were obtained from **Right and Left common carotid artery (CCA)**, by a trained radiologist using B mode ultrasonography by **Wipro GE Logiq P5** linear high resolution probe of 7–12 MHz (GE Medical Systems, Wisconson, USA) in the Department of Radiology, J.K Medical Hospital, Bhopal. The radiologist was blinded to the periodontal status of the patient. The patients were examined in the supine position with the head slightly hyperextended and tilted 45° to the left/right. For IMT measurements, optimal longitudinal images were obtained of the right and left CCA, and measurements were made on the far (posterior) wall of the vessel along a 1-cm section proximal to the bifurcation. IMT was defined as the distance from the leading edge of the lumen–intima interface to the leading edge of the media–adventitia interface [8]. Three measurements were taken in the selected carotid segment, and the measurement corresponding to the maximum IMT was recorded [8]. Presence of **carotid plaque (if any)**, which is defined by the appearance of the largest focal lesion, was also evaluated.

### *Statistical analysis*

Data analysis was done using SPSS software version 15.1. A descriptive study was made of each variable. The associations among the different qualitative variables were studied using the Chi square test. Unpaired Student *t*-test was used for studying association between two independent samples in application to quantitative variables, in each case determining whether the variances were homogeneous. Statistical significance was accepted for $p \leq 0.05$.

## Results

The mean age of the cases (CP-SH) was $39.75 \pm 5.37$ years and controls (SH) was $39.55 \pm 3.68$ years. CP-SH group had 8 males and 12 females and SH group had 10 males and 10 females. In CP-SH group, bleeding index was $78.54 \pm 11.47\%$ versus $24.22 \pm 14.71\%$ in SH group, the difference being statistically significant. Mean PPD and CAL was $4.53 \pm 1.12$ mm and $4.39 \pm 0.56$ mm respectively in CP-SH group. CP-SH group had 8 patients with moderate periodontitis and 12 with severe periodontitis, depending on number of sites with CAL $\geq 3$ mm. Demographic characteristics and periodontal parameters measured are shown in Table 1.

Carotid ultrasound revealed right and left IMT of $0.626 \pm 0.016$ mm and $0.715 \pm 0.037$ mm respectively in CP-SH group versus $0.495 \pm 0.009$ mm and $0.518 \pm 0.009$ mm respectively in SH group, with the difference being statistically significant. Carotid atheroma plaques were not found in any of the patients in periodontitis or control group. In CP-SH group, mean DBP was $83.45 \pm 4.07$ mmHg versus $79.25 \pm 3.63$ mmHg in SH group, with the difference being statistically significant (Table 2).

## Discussion

The classic risk factors for CVD do not explain the etiology of this disease to the fullest of its extent. Thus, efforts are being made to identify other modifiable risk factors that play a role in the etiology of CVD. There is a growing body of evidence showing that chronic infections, local (periodontitis) and/or systemic inflammation and possibly autoimmunity play a role in the pathogenesis of atherosclerosis, which is

**Table 1 – Comparison of groups by demographic characteristics and periodontal parameters.**

| S. No | Characteristics | Periodontal disease group (Cases) | Control group | *p* value |
|---|---|---|---|---|
| 1. | **Age, mean ± SD** | **39.75 ± 5.37** | **39.55 ± 3.68** | **0.891** |
| 2. | **Sex, *n*(%)** | | | **0.525** |
| | **Male** | **8 (44.4%)** | **10 (45.5%)** | |
| | **Female** | **12 (54.5%)** | **10 (55.6%)** | |
| 3. | **BMI (kg/m$^2$), mean ± SD** | **25.13 ± 2.91** | **24.76 ± 3.07** | **0.696** |
| 4. | **Regular Physical activity, *n*(%)** | | | **1** |
| | **Yes** | **17 (50%)** | **17 (50%)** | |
| | **No** | **3(50%)** | **3(50%)** | |
| 5. | **Number of teeth, mean ± SD** | **26.3 ± 2.0002** | **27.8 ± 0.696** | **0.003** |
| 6. | **Bleeding index, mean ± SD** | **78.54 ± 11.47** | **24.22 ± 14.707** | **<0.0001** |
| 7. | **CAL (mm), mean ± SD** | **4.39 ± 0.56** | **–** | **–** |
| 8. | **PPD (mm), mean ± SD** | **4.53 ± 1.12** | **–** | **–** |
| 9. | **Number of sites with CAL ≥ 3 mm, mean ± SD** | **66.17 ± 18.32** | **–** | **–** |
| 10. | **Periodontal disease, *n*(%)** | | **–** | **–** |
| | **Mild** | | | |
| | **Moderate** | **8 (40%)** | | |
| | **Severe** | **12 (60%)** | | |

**Table 2 – Comparison of groups by ultrasound characteristics and diastolic blood pressure.**

| S. No | Characteristics | Periodontal disease group (Cases) | Control group | *p* value |
|---|---|---|---|---|
| 1. | **Right IMT (mm), mean±SD** | **0.626±0.016** | **0.495±0.009** | **0.003** |
| 2. | **Left IMT (mm), mean±SD** | **0.715±0.037** | **0.518±0.009** | **0.026** |
| 3. | **Carotid plaques, *n*(%)** | | | |
| | **Yes** | | | |
| | **No** | **20 (50%)** | **20 (50%)** | **1** |
| 4. | **Diastolic Blood Pressure (mmHg), mean±SD** | **83.45±4.07** | **79.25±3.63** | **0.001** |

considered to be the major risk factor associated with coronary artery disease (CAD).

This case-control study was designed to examine whether periodontal disease is an independent risk factor for atherosclerosis. In view of the significant role of confounding factors in establishing a link between periodontitis and cardiovascular diseases, this study excluded smoking, alcohol consumption, obesity, diabetes mellitus and other systemic diseases, as suggested by Ashraf et al. [9].

The right and left carotid IMT in CP-SH and SH groups were found to be well below the critical value of increased cardiovascular risk (IMT $\geq 0.82$ mm). But, there was a statistically significant difference between carotid IMT in cases and controls, with values in CP-SH group being on a higher quartile.

Beck et al. [10], in a population-based study involving 6017 individuals with an average age of 62 years, found that severe periodontitis is associated with 1.31 times the odds of IMT $>1$ mm compared with the absence of periodontitis. Similarly, Soder and Yakob [11], in a study on women, found significantly higher values of carotid IMT in patients with periodontal disease than in controls.

In contrast to these, Lopez et al. [12] found no statistically significant difference between carotid IMT in test and control groups ($p=0.538$). However, there was significant difference in the presence of carotid atheroma plaques and the severity of periodontitis ($p=0.003$). Thus, the severity of periodontitis was seen to influence the presence of carotid atheroma plaques. It is considered that IMT of the carotid artery is more of an early sign of the atherosclerotic process than plaque formation in younger patients. In elderly patients, there is possibility that patients prone to developing atherosclerosis have already reached a more advanced stage of the disease, thus relationship with IMT may/may not be seen, whereas presence of carotid plaque may be seen. Similarly, Holmund and Lind [13], investigated whether number of teeth (NT) were related to the carotid IMT and to atherosclerotic plaque in elderly population and found a significant inverse relationship between the NT and presence of plaque. But, self reported NT cannot be considered as a validated marker of periodontal disease, as there are various reasons of tooth loss.

Hypertension is a consistent and modifiable cause of cardiovascular disease. It is considered to be one of the classical risk factors for atherosclerosis. Increasing evidence also supports the view that, like atherosclerosis itself, inflammation may participate in hypertension providing a pathophysiological link between these two diseases. In our study, the DBP levels were found to be 83.45±4.07 mmHg in CP-SH group versus 79.25±3.63 mmHg (prehypertension) [7] in SH group, with the difference being statistically significant.

Periodontitis has been linked to endothelial dysfunction, with blood pressure elevation and increased mortality risk in hypertensive patients. This ill-effect is due to elevation of systemic inflammatory biomarkers (CRP and IL-6), worsening the lipid profile, increased production of vascular superoxide radicals and reduction of vascular nitric oxide synthase-3 expression.

Holmund et al. [14] investigated how the severity of periodontal disease and number of remaining teeth relate to myocardial infarction (MI) and hypertension (HT) and found that severity of periodontitis was significantly associated with HT (prevalence 16%; $p<0.0005$) and MI (prevalence 1.7%, $p<0.03$), but in middle-aged subjects only. Desvarieux et al. [15] found a direct relationship between the levels of subgingival periodontal bacteria and SBP/DBP.

In contrast to this, Lopez et al. [10], in their study, did not find any difference in SBP/DBP levels between the cases and controls. They used aneroid sphygmomanometer in contrast to our study, whereas we used mercurial.

Logistic regression analysis was not carried out in our study, as strict criteria for patient selection was followed, to rule out the effect of confounding factors on the outcome of the studied parameters.

In this study, we found statistically significant differences in carotid IMT and DBP values between cases and controls. These findings suggest the role of periodontal disease (chronic inflammation) in subclinical atherosclerosis.

## Conclusion

From the above study, we can conclude that there is an association between chronic periodontitis and subclinical atherosclerosis. Further Randomized Controlled Trials (RCTs), interventional trials and prospective studies with larger sample size and microbiological assessment of periodontal disease, establishing the causal relationship between periodontal and cardiovascular diseases, are required to vindicate the above drawn conclusions and establish periodontitis as an independent risk factor for atherosclerosis.

## REFERENCES

[1] B.L. Mealey, Influence of periodontal infections on systemic health, Periodontology 2000 21 (1999) 197.
[2] J.H. Muerman, M. Sanz, S. Janket, Oral health, atherosclerosis and cardiovascular disease, Crit. Rev. Oral. Biol. Med. 15 (2004) 403–413.
[3] P.M. Ridker, J.D. Silvertown, Inflammation, C-reactive protein, and atherothrombosis, J. Periodontol. 79 (Suppl. 8) (2008) S1544–S1551.
[4] P. Pignoli, E. Tremoli, A. Poli, P. Oreste, R. Paoletti, Intimal plus medial thickness of the arterial wall: a direct measurement with ultrasound imaging, Circulation 74 (1986) 1399–1406.

[5] G.C. Armitage, Development of a classification system for periodontal diseases and conditions, Ann. Periodontol. 4 (1) (1999).
[6] A. Cueto, F. Mesa, M. Bravo, R. Ocana-Riola, Periodontitis as risk factor for acute myocardial infarction. A case control study of Spanish adults, J. Periodontal Res. 40 (2005) 36–42.
[7] A.I. Qureshi, M.F.K. Suri, J.F. Kirmani, A.A. Divani, Y. Mohammad, Is prehypertension a risk factor for cardiovascular diseases? Stroke 36 (2005) 1859–1863.
[8] F. Velazquez, J.D. Berna, J.L. Abellan, L. Serrano, A. Escribano, M. Canteras, Reproducibility of sonographic measurements of carotid intima-media thickness, Acta Radiol. 49 (2008) 1162–1166.
[9] J. Ashraf, S.A. Bokhari, S. Manzoor, A.A. Khan, Poor oral health and coronary artery disease: a case-control study, J. Periodontol. 83 (2012) 1382–1387.
[10] J.D. Beck, P. Eke, D. Lin, P. Madianos, D. Couper, K. Moss, et al., Associations between IgG antibody to oral organisms and carotid intima-medial thickness in community-dwelling adults, Atherosclerosis 183 (2005) 342–348.
[11] B. Soder, M. Yakob, Risk for the development of atherosclerosis in women with a high level of dental plaque and severe gingival inflammation, Int. J. Dent. Hyg. 5 (2007) 133–138.
[12] P. Lopez-Jornet, J.D. Berna-Mestre, J.D. Berna-Serna, Camacho-Alonso, S. Fernandez-Millan, M. Reus-Pintado, Measurement of atherosclerosis markers in patients with periodontitis: a case control study, J. Periodontol. 83 (2012) 690–698.
[13] A. Holmlund, L. Lind, Number of teeth is related to atherosclerotic plaque in the carotid arteries in an elderly population, J. Periodontol. 83 (2012) 287–291.
[14] A. Holmund, G. Holm, L. Lind, Severity of periodontal disease and number of remaining teeth are related to the prevalence of myocardial infarction and hypertension in a study based on 4254 subjects, J. Periodontol. 77 (2006) 1173–1178.
[15] M. Desvarieux, R.T. Demmer, D.R. Jacobs Jr., T. Rundek, Boden-Albala, Rl Sacco, et al., Periodontal bacteria and hypertension: the oral infections and vascular disease epidemiology study (INVEST), J. Hypertens. 28 (2010) 1413–1421.

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Scientific article

# Viral serological and molecular data on possible involvement of herpes viruses in periodontal disease

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ABSTRACT

*Background:* Recent studies have suggested that latent herpes virus infections can be associated with chronic periodontal sites that exhibit a predisposition to disease progression.

The aim of this study was to identify the possible relationship between infections with CMV and EBV and the severity of periodontal disease.

*Materials and methods:* Fifty two patients aged between 27 and 70 years, diagnosed with periodontal disease were enrolled in the study after giving informed consent. Quantitative immunoenzymatic assays were used to determine the concentration of anti CMV and EBV antibodies. The presence of CMV and EBV DNA was tested in biopsies from periodontal tissues using an in-house PCR adapted after a method described previously.

*Results and conclusions:* Higher titers of the anti CMV antibodies appear to be correlated with the severity of the periodontal lesions ( $p<0$, 05). These correlations have not been found for anti EBV antibodies. Higher titers of specific anti CMV and EBV antibodies were correlated with a history of periodontal treatment ($p<0$, 05). Only two samples were positive for the viral genome. Both samples were collected from female patients diagnosed with very advanced forms of periodontal disease.

Although the molecular biology data from the present study do not support the pathogenic involvement of EBV or CMV in the development of chronic periodontitis lesions, the serological data might be important markers for the evolution and severity of the periodontal disease

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## Introduction

Periodontal disease represents a group of clinical entities of uncertain etiology, characterized by the periodontal junction breakdown, loss of alveolar substance up to teeth loss. Various factors can promote the onset and evolution of this disease (environmental, behavioral, and genetic risk factors). The possible involvement of viral infections, especially with herpes viruses, in the pathogenesis of periodontal disease has been reported in recent studies [1–4].

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Herpes viruses produce systemic infections following the reactivation of latent infections especially during immunosuppression, inflammatory disorders or after a trauma and have been isolated from saliva and gingival tissues in patients affected by periodontal disease [5–9]. Socioeconomic status, racial and educational factors may be contributing to the seroprevalence of herpes viruses infection and its impact on the evolution of the periodontal disease [5].

Recent studies [9] have suggested that latent herpesvirus infections (especially cytomegalovirus– CMV and Epstein Barr virus- EBV) can be associated with chronic periodontal sites that exhibit a predisposition to disease progression [9]. A large number of copies of the DNA genomes of both CMV and EBV were isolated from some cases of progressive marginal periodontitis, a fact that has important implications in understanding the disease etiology.

In this context, the aim of this study was to identify the possible relationship between infections with CMV and EBV and the severity of periodontal disease by causing the specific immune responses and the viral replication in the periodontal lesions.

## Materials and methods

Fifty two patients aged between 27 and 70 years, diagnosed with periodontal disease, undergoing treatment in different dental clinics were enrolled in the study after giving informed consent. The eligibility criteria were: age over 18 years, suggestive clinical manifestations of periodontitis (gingival inflammation, gingival bleeding and mobility or loss of dental units), without subtotal dentition, absence of antibiotics or periodontal treatments during the last 6 months, without any uncompensated serious systemic disease, and without major modifications in terms of diet or lifestyle.

A data sheet was prepared for the registered patients, which included their personal data and personal history. Intraoral clinical examination was carried out by inspection and palpation, the appearance of the oral mucosa, changes in the gum aspect, the oral hygiene index (OHI)(Green and Vermillion 1960), the papillary bleeding index, gingival retraction, tooth mobility, existing periodontal pockets depth (21 with depth >5 mm) were noted. The study was approved by the local Ethics Committee. Venous blood samples and biopsies from the affected periodontal tissue were collected during the same visit.

Quantitative immnunoenzymatic assays (DIA.PRO, Italy) were used to determine the concentration of anti CMV IgG and IgM antibodies and of anti VCA IgM, anti VCA IgG and anti-EBNA IgG specific antibodies. The presence of CMV and EBV DNA was tested in biopsies from periodontal tissues using an in-house PCR adapted after the method described previously (Jankovic) [10]. Briefly, the total cellular DNA was isolated from periodontal tissue in maximum two days after harvest, using a High Pure PCR template preparation commercial kit (Roche, Germany). The integrity of the isolated DNA's was verified by amplification of a 110 bp β -globin gene fragment using specific primers synthetized by Invitrogen. Amplification of a specific fragments of 264 bp and 256 bp were performed using CMV primers: (Fw: 5′-GAGCGCGTCCACAAAGTCTA-3′; R: 5′-GTGATCCGACTGGGCGAAAA-3′) and EBV primers (Fw: 5′-AGGGATGCCTGGACACAAGA-3′; R: 5′-GCCTCGGTTGTGACAGAG-3′) PCR products were detected following electrophoresis in a 1.5% agarose gel containing 0.5 mg/ml ethidium bromide.

## Results

The socio-demographic and epidemiological characteristics of patients are shown in Table 1. Half of the patients (26/52, 50%) had one or more risk factors for periodontal disease, the most common being: poor dental hygiene, local causes (overflowing fillings, prosthodontic bridges or crowns which have lost their adaptation, family factors, smoking); 56% of the subjects did not experience any periodontal treatment. Out of 52 patients, 27 (52%) were diagnosed with deep chronic marginal periodontitis (PMCP), of whom 78% (21/27 patients), experienced periodontal pockets with depth >5 mm and 96%

**Table 1 – Studied patients characteristics.**

| | Chronic periodontitis N=27 | Gingivitis N=25 |
|---|---|---|
| Sex ratio M:F | 9/18 | 11/14 |
| Mean age ±SD | 51,81(±13,28) | 35,84(±13,22) |
| Urban vs rural medium | 21/6 | 24/1 |
| Education highschool vs University | 18/9 | 9/16 |
| Comorbidities *n*(%) | 12 (45) | 0 |
| Smoking *n*(%) | 9 (33) | 5 (20) |
| Poor dental hygiene *n*(%) (OHI Average) | 20 (74)(3,27) | 10(40)(2,94) |

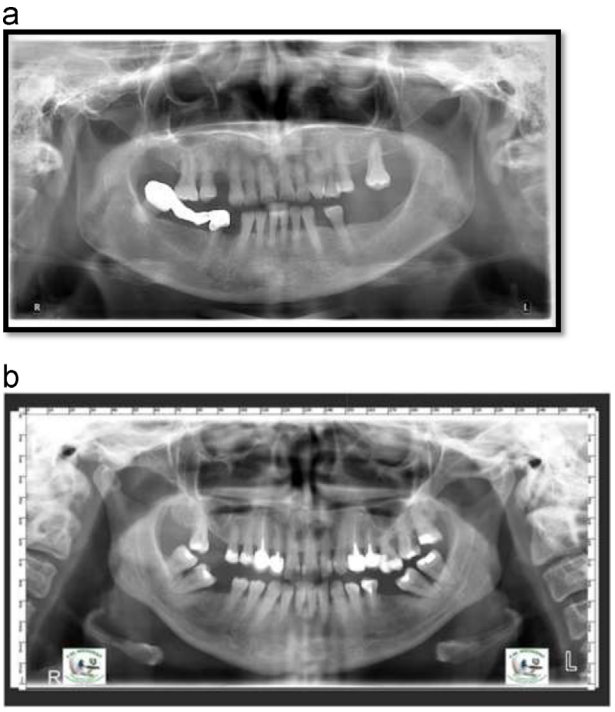


**Fig. 1 – a. Panoramic radiograph of a patient aged 70 with chronic periodontitis. b. Panoramic radiograph of a patient aged 45 years with chronic periodontitis.**

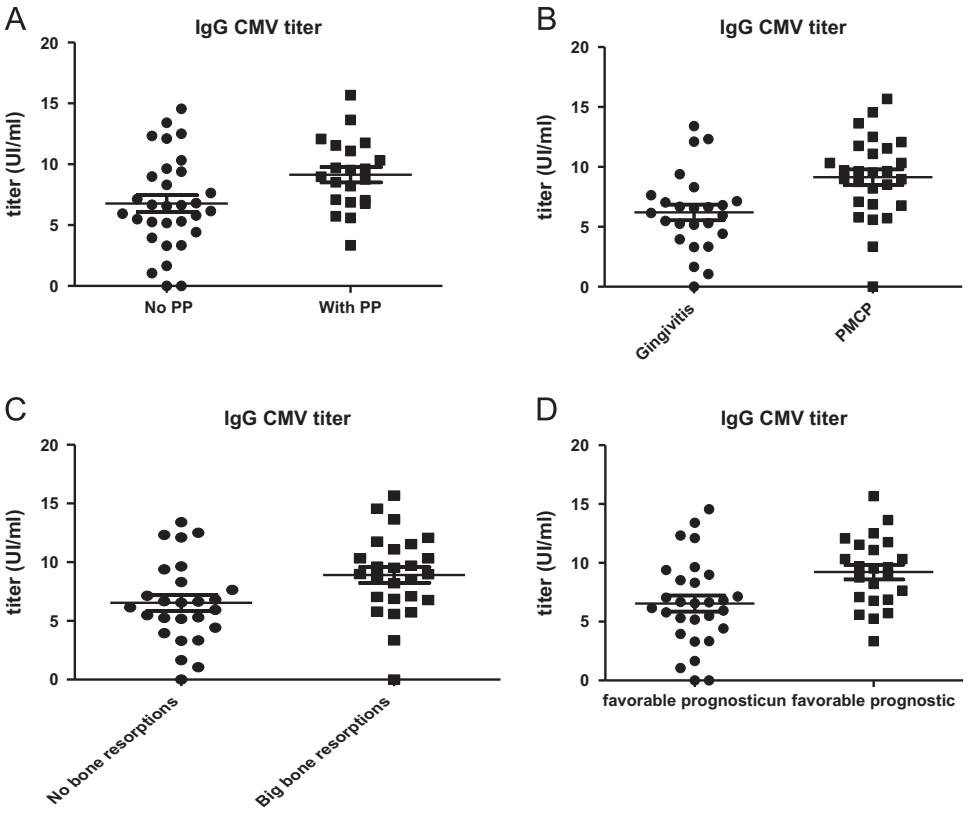


**Fig. 2 – Correlations between the concentration of anti CMV antibodies and the severity of clinical disease: a. Gingivitis versus PMCP; b. Presence of deep periodontal pockets (PP); c. High Bone loss; d. Clinical evolution.**

(26/27 patients) had deep bone resorption (Fig. 1a and b). Gingivitis was diagnosed in 48% of the subjects. Most of the patients had a history of clinically symptomatic oral or facial herpes simplex 1 infections and frequent reactivation.

### *The seroprevalence of herpesvirus infections*

Anti CMV IgG antibodies were present in 96% of the patients, with a mean concentration of 7,72 UI/ml; 46% of those had concentrations above the average. Only one patient diagnosed with gingivitis had anti CMV IgM antibodies (sign of a recent infection). All patients had anti EBV VCA IgG antibodies, with a mean concentration of 79.60 Uarb / ml (46% having values above this average) and 94% of the patients had also anti EBNA IgG with an average concentration of 108.97 Uarb /ml (56% having values above this value). Anti VCA IgM antibodies were present in only three cases, a patient diagnosed with gingivitis and two patients diagnosed with chronic periodontitis).

Higher titers of the anti CMV antibodies appear to be correlated with the severity of the periodontal lesions; higher percentages of the patients with anti CMV concentrations above the mean value were diagnosed with chronic periodontitis (x versus y, $P=0$, 0027), had deep periodontal pockets (x versus y, $p=0{,}017$) and high bone loss (x versus Y, $p=0{,}011$) and, an unfavorable clinic evolution (X versus y, $p=0$, 0068) (Fig. 2). These correlations have not been found for anti EBV antibodies (t-Test).

Higher titers of specific anti CMV and EBV antibodies were correlated with a history of periodontal treatment (Fig. 3). Anti VCA EBV antibodies (x versus y, $P=0{,}027$); Anti CMV (x versus y, $P=0$, 0024); Anti EBNA EBV antibodies (x versus y, $P=0$, 0326).

### *Identification of CMV and EBV genomes in periodontal biopsies*

Only two samples were positive for the viral genome (one for CMV, another from EBV). Both samples were collected from female patients diagnosed with very advanced forms of periodontal disease (pockets > 5 mm, large bone resorption, high mobility) with a poor prognosis (Figs. 4 and 5).

## Discussion

These results are supported by other recent data that indicate an association between periodontal disease and herpes virus infections [11]. A direct association between the CMV IgG antibody titers and several chronic diseases has been already reported. Elevated titers of anti CMV antibodies have been correlated with a premature onset of subclinical atherosclerosis and an elevated risk of cardiovascular disease in both immunocompetent and immunosupressed patients. [12,13].

An increased concentration of specific anti CMV antibodies can be explained by more frequent reactivations of the latent virus due to a loss of T cell-mediated control of viral

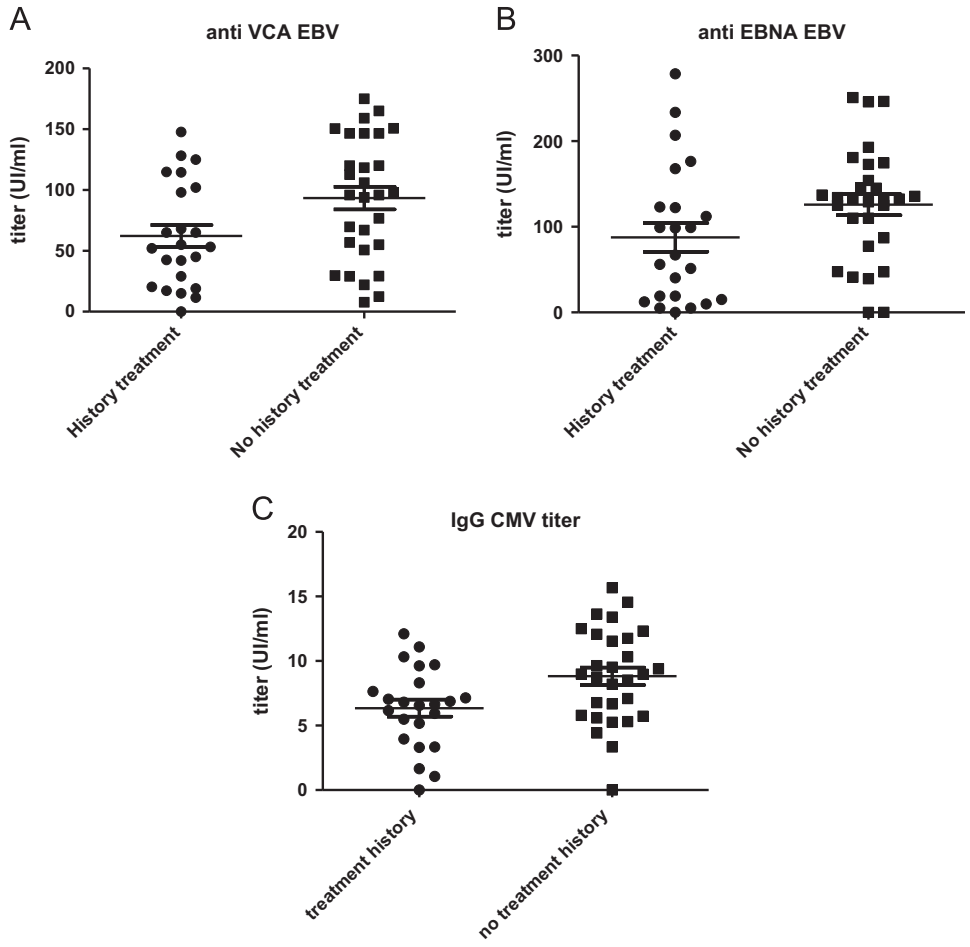


**Fig. 3 – Correlation between the concentration of specific anti CMV and EBV antibodies and a current or past history of periodontal treatment.**

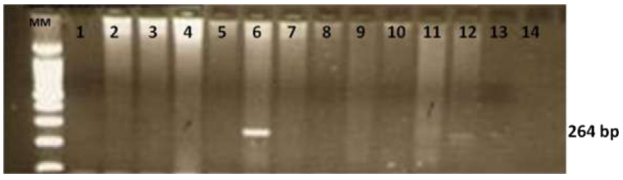


**Fig. 4 – CMV- MM= molecular Marker; 1–11= samples( 6= positive sample) 12= positive control; 14= negative control.**

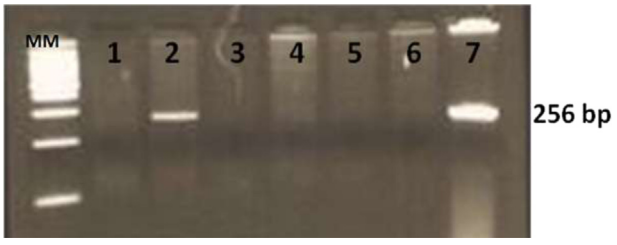


**Fig. 5 – EBV- MM= molecular Marker; 1–5= samples ( 2= positive sample); 6= negative control; 7= positive control.**

replication. This, in turn, can stimulate an inflammatory response that might be responsible for the already reported increase in all-cause mortality as well as in the risk of cardiovascular death in older patients.

CMV plays an essential role in immunosenescence and oncogenesis, being an important modulator of the k-cell signaling pathways.

Increases in the specific anti CMV antibodies have been reported in different types of cancers and neurocognitive disorders [14,15].

While most of the tissue samples in our study were negative for viral DNA, recent studies have documented the presence of EBV and CMV genomes in periodontal lesions (ref). EBV DNA was found in up to 65% of aggressive periodontal disease cases and up to 49% in chronic lesions whereas CMV was detected in up to 44% of active and chronic cases [16–18]. The radiological aspect shows the loss of hard lamina of the alveolar bone, a sign of aggressive periodontitis, possibly aggravated by active CMV infection [19]. Gingival inflammatory process accentuation, especially in immunocompromised patients may be associated with acute cytomegalovirus infection [20]. The abundance of herpes viruses in individual periodontal lesions is expressed by a high viral load in the entire periodontal tissue in patients with severe and expanded periodontitis.

It has been shown that in untreated sites showing severe periodontal suffering, there is a higher concentration of virus

(viral genomic copies) than in sites which had undergoing treatment [21,22].

## Conclusion

High levels of anti cytomegalovirus antibody were found in patients with advanced stages of periodontal disease and in those without current or past history of periodontal treatments. Although the molecular biology data from the present study do not support the pathogenic involvement of EBV or CMV in the development of chronic periodontitis lesions, the serological data might be important markers for the evolution and severity of the periodontal disease.

## References


[1] R. Sharma, O. Padmalatha, G. Kaarthikeyan, N.D. Jayakumar, S. Varghese, K. Sherif, Comparative analysis of presence of Cytomegalovirus (CMV) and Epsteinbarr virus -1 (EBV-1) in cases of chronic periodontitis and aggressive periodontitis with controls, Indian J. Dent. Res. 23 (4) (2012) 454–458.

[2] S. Das, G. Shobha Prakash Krithiga, S. Gopalakrishnan, Detection of human herpes viruses in patients with chronic and aggressive periodontitis and relationship between viruses and clinical parameters, J Oral. Maxillofac. Pathol. 16 (2) (2012) 203–209.

[3] Z.T. Al-Rassam, M.Y.M. Taha, Detection of human herpesviruses in patients with chronic periodontitis in Mosul- Iraq, Int. J. Adv. Res. 2 (6) (2014) 328–339.

[4] S. Vincent-Bugnas, S. Vitale, C.C. Mouline, W. Khaali, Y. Charbit, P. Mahler, et al., EBV infection is common in gingival epithelial cells of the periodontium and worsens during chronic periodontitis, Plos One 8 (12) (2013).

[5] M. Chalabi, S. Moghim, A. Mogharehabed, F. Najafi, F. Rezaie, EBV and CMV in chronic periodontitis: a prevalence study, Arch. Virol. 153 (2008) 1917–1919.

[6] L.J. Ling, C.C. Ho, C.Y. Wu, Y.T. Chen, S.L. Hung, Association between human herpesviruses and the severity of periodontitis, J. Periodontol. 75 (2004) 1479 1485.

[7] J. Slots, Herpesviruses in periodontal diseases, Periodontol 2000 38 (2005) 33–62.

[8] J. Slots, A. Contreras, Herpesviruses: a unifying causative factor in periodontitis?, Oral. Microbiol Immunol. 15 (2000) 277–280.

[9] M. Ting, A. Contreras, J. Slots, Herpesviruses in localized juvenile periodontitis, J. Periodontal Res. 35 (2000) 17–25.

[10] S. Jankovic, Z. Aleksic, B. Dimitrijevic, V. Lekovic, P. Camargo, B. Kenney, Prevalence of human cytomegalovirus and Epstein-Barr virus in subgingival plaque at peri-implantitis, mucositis and healthy sites. A pilot study, Int. J. Oral. Maxilofac. Surg. 40 (3) (2011) 271–276.

[11] A. Konstantinidis, D. Sakellari, A. Papa, A. Antoniadis, Real-time polymerase chain reaction quantification of Epstein–Barr virus in chronic periodontitis patients, J. Periodontal Res. 40 (4) (2005) 294–298.

[12] R.T. Roberts, M.N. Haan, J. Beam Dowd, A.E. Aiello, Cytomegalovirus antibody levels, inflammation, and mortality among elderly latinos over 9 years of follow-up, Am. J Epidemiol. 172 (2010) 363–371.

[13] C.M. Parrinello, E. Sinclair, A.L. Landay, N. Lurain, A. Richey Sharrett, S.J. Gange, et al., Cytomegalovirus immunoglobulin G antibody is associated with subclinical carotid artery disease among HIV-infected women, J. Infect. Dis. 205 (2012) 1788–1796.

[14] G. Pawelec, E. Derhovanessian, A. Larbi, J. Strindhall, A. Wikby, Cytomegalovirus and human immunosenescence, Rev. Med. Virol. 19 (1) (2009) 47–56.

[15] G. Pawelec, S. Koch, C. Franceschi, Human immunosenescence: does it have an infectious component?, Ann. N Y Acad. Sci. 1067 (2006) 56–65.

[16] B. Kolliyavar, S. Setty, A. Patil, S.L. Thakur, Association of viruses in chronic periodontitis, International, J. Oral. Hyg. Dent. Res. 1 (1) (2013) 1–5.

[17] D.R. Combs, E.A. Reilly, D.R. Dawson III, S.A. Avdiushko, R.J. Danaher, C.S. Miller, Detection of human cytomegalovirus in dental plaque from individual periodontal sites by real-time polymerase chain reaction, Oral. Surg. Oral. Med. Oral. Pathol. Oral. Radiol. Endod. 106 (2008) 840–844.

[18] A.V. Imbronito, O.S. Okuda, N. Maria de Freitas, R.F. Moreira Lotufo, F.D. Nunes, Detection of herpesviruses and periodontal pathogens in subgingival plaque of patients with chronic periodontitis, generalized aggressive periodontitis, or gingivitis, J. Periodontol. 79 (12) (2008) 2313–2321.

[19] J. Slots, Herpes-bacterial interactions in periodontal disease, Periodontology 2000 51 (2009) 1–24.

[20] D. Olczak-Kowalczyk, J. Pawłowska, B. Cukrowska, P. Kluge, E. Witkowska-Vogtt, K. Dzierzanowska-Fangrat, et al., Local presence of cytomegalovirus and Candida species vs oral lesions in liver and kidney transplant recipients, Ann. Transplant. 13 (4) (2008) 28–33.

[21] P.T. Sunde, J. Olsen, M. Enersen, M. Beiske, B. Grinde, Human cytomegalovirus and Epstein–Barr virus in apical and marginal periodontitis: a role in pathology?, J. Med. Virol. 80 (2008) 1007–1011.

[22] H. Khosropanah, M. Karandish, M. Ziaeyan, M. Jamalidoust, Quantification of Epstein-Barr Virus and human cytomegalovirus in chronic periodontal patients, Jundishapur J. Microbiol. 8 (6) (2015) 18691.

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Scientific article

# Knowledge of managing avulsed tooth among general dental practitioners in Malaysia

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ABSTRACT

*Background:* Dental and maxillofacial injuries are one of the areas of concern highlighted in the Malaysian National Oral Health Plan 2011–2020. General dental practitioners (GDPs) have the responsibility of diagnosing and assessing dental trauma and determining the prognosis and outcomes of trauma along with its management. The purpose of this study was to evaluate the knowledge base and preferred methods of general dental practitioners regarding the management of avulsed tooth.

*Methods:* A random convenient sampling methodology was employed for sample selection. A pre-tested 11-item questionnaire was validated on the dental officers. The survey was distributed to 182 GDPs attending the annual Malaysian Dental Association conference in January 2010. The data obtained was statistically analyzed using descriptive analysis and logistic regression was employed to predict the probability of achieving high scores.

*Results:* A total of 182 general dental practitioners participated in the study, with the majority being female ($n=153$, 75%). The place of practice significantly affected the knowledge score. In the group that scored more than 80 points ($n=84$, 46%), 76% of them worked with government hospitals. Age, work duration and number of traumatised teeth previously treated had no significant effect. The odds ratio for place of practice indicates that respondents who work in government hospitals are 3.6 times more likely to score more than 80 points compared to those who worked in private clinics (OR=3.615, $P=0.001$).

*Conclusion:* The knowledge level on the management of avulsed tooth among general dental practitioners in Malaysia needs to be improved. Strategies in improvement of the Malaysian dental educational system, continuous dental educational activities and utilisation of guidelines on trauma management should be recommended to increase the knowledge level of avulsed tooth management to ensure good treatment outcomes.

*Clinical implication:* Trauma prevention and further education regarding the management of avulsed tooth is an essential requirement to improve general dental practitioners knowledge and clinical skills.

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## Introduction

Tooth avulsion is defined as a total displacement of a tooth from its socket [1]. Avulsion of teeth is one of the most serious dental injuries [1], representing about 16% of all dental injuries [2]. Maxillary central incisors are the teeth most commonly prone to avulsion [1]. Da Silva et al. reported that the incidence of dental trauma over one year period of evaluation in Brazil was 15.29%, of which luxation and avulsions were the most frequent injuries [3].

Prevalence of dental injuries to the anterior teeth ranged from 2.6% to 6.1%, as reported by earlier studies conducted in Malaysia [4,5]. Data from the National Oral Health Plan (NOH Plan) 2011–2020 stated that the prevalence of dental injuries in the year 2007 for 12- and 16-year-old patients were 5.4% and 4.4%, respectively [6]. Therefore, the NOH Plan identified dental and maxillofacial injuries as one of the primary areas of concern and strategies are listed in this report to prevent, and improve the management of, dental injuries by dentists [6]. These injuries may be related to increased participation in sports and recreational activities associated with active lifestyles and ignorance of, or disregard for, wearing injury-prevention devices [5]. Based on a recent survey, more than 40% of university athletes in Malaysia claimed they sustained dental injuries while playing sports [7]. When dental trauma occurs, these injuries may have a detrimental psychological effect on the athletes and their colleagues [8].

General dental practitioners (GDPs) have the responsibility of diagnosing and treating dental trauma, as well as to inform both the patient and the parents of the prognosis and outcome of this treatment. It is well established that immediate measures taken at the place of accident after the tooth avulsion occurs are essential to ensuring a good prognosis and treatment outcome of the replantation [1]. As such, it is important that appropriate instructions are given by the dentists to the people at the emergency site for immediate replantation of avulsed tooth. Several studies were carried out to assess the knowledge of oral health professionals in various countries on the emergency management of avulsed tooth and their overall knowledge has been reported to be limited, requiring improvement [9–12]. General dental practitioners should be well educated in this field [12]. However, surveys from other countries indicated that the knowledge level was low. For example, in Kathmandu, 68.6% of dentists thought that primary avulsed tooth should be replanted [13], as opposed to the International Association of Dental Traumatology (IADT) guideline, which states that primary teeth should not be replanted [13]. Hence, there is a need to assess general dental practitioners' knowledge regarding the management of avulsed tooth due to trauma. The purpose of this study was to evaluate the knowledge base of managing tooth avulsion injuries among general dental practitioners in Malaysia.

## Methods

This study was approved by the UKM Faculty of Dentistry Ethical Research Committee. A questionnaire was developed consisting of two parts: Part A – demographic data, and Part B – management of dental trauma. Seven multiple choice questions on knowledge of managing avulsed tooth and four questions on the preferred methods of management of avulsed tooth among general dental practitioners were constructed. The questionnaire was validated and pre-tested on the dental officers in the University Kebangsaan Malaysia before they were distributed to the respondents.

The respondents were recruited from a random convenient sampling of general dental practitioners who attended the Malaysian Dental Association's conference in January 2010. An information sheet was prepared to explain the objective and importance of the study together with a consent form to participate in the proposed study. All respondents gave their written consent before completing the questionnaires. The data was recorded and analyzed using the Statistical Package for the Social Sciences, software version 20.0 for Windows (IBM; SPSS Inc., Chicago, IL, USA). Descriptive analysis was used to describe the percentage of responses and logistic regression analysis was employed to assess the significance of each background variable (gender, age, place of practice, practice duration and number of traumatised teeth previously treated) in predicting the probability of achieving high scores. The level of significance was set at $P<0.05$.

## Results

### *Demographic characteristics*

A total of 182 general dental practitioners participated in this study. The respondents comprised of 75% females ($n=135$) and 25% males ($n=46$). The age of the respondents ranged from 25 to 61 years old, with a mean age of 35.8+8.8 years. The duration of the practice varied from 0.5 to 33 years, with a mean duration of 9.8+8.1 years. Slightly more than half of the respondents ($n=105$; 58%) worked in government dental clinics, while 42% ($n=76$) were private practitioners. The number of avulsed teeth treated in the past 2 months ranged from 0 to 12 teeth, with a mean number of 1+2.4.

### *Percentage distributions of the responses to questions on knowledge of managing avulsed tooth*

Percentage distributions of responses for each question are shown in Table 1. The majority of the respondents correctly answered saliva and milk ($n=156$; 85.7%, and $n=145$; 79.7% respectively) as the appropriate transport medium for an avulsed tooth. A higher percentage of respondents gave the correct response of rinsing the dirty avulsed tooth ($n=153$; 84.1%) and treating the socket with gentle irrigation and aspiration with saline before replantation of an avulsed tooth into the socket ($n=151$; 83%). Regarding the type of splint which was used to stabilise the replanted tooth, 45.6% of respondents gave the correct response of using a flexible splint and 64.8% of them answered correctly of using a splinting duration of 7–10 days. Most respondents answered correctly regarding the possible sequelae of replantation of avulsed tooth, citing resorption ($n=163$; 89.6%), followed by pulpal necrosis ($n=146$; 80.2%) and ankylosis ($n=119$; 65.4%).

**Table 1 – Percentage distributions of the responses to questions on knowledge of managing avulsed teeth by general dental practitioners.**

| Questions on knowledge of managing avulsed teeth | Response | N=182 (n, %) |
|---|---|---|
| 1) What would be an appropriate transport medium for an avulsed tooth? (more than one correct answers) | Saliva | 156 (85.7) |
| | Ice | 2 (1.1) |
| | Saline | 95 (52.2) |
| | Water | 5 (2.7) |
| | Milk | 145 (79.7) |
| | Distilled water | 8 (4.4) |
| 2) If an avulsed tooth is covered with dirt and you would like to replant it, how would you prepare the tooth? | Wash tooth in water | 9 (4.9) |
| | Scrub the tooth gently with a toothbrush | 3 (1.6) |
| | Rinse tooth in saline | 153 (84.1) |
| 3) How would you treat the socket prior to replantation? | Gentle irrigation and aspiration with saline | 151 (83.0) |
| | Removal of coagulum with curettes | 21 (11.5) |
| | No treatment | 10 (5.5) |
| 4) What type of splint would you use to stabilise the replanted tooth? | Rigid splint | 94 (51.6) |
| | Flexible splint | 83 (45.6) |
| | No splinting | 2 (1.1) |
| 5) Please select suitable splinting duration. | 7–10 days | 118 (64.8) |
| | 30 days | 51 (28.0) |
| | 60 days | 9 (4.9) |
| | No splinting | 1 (0.5) |
| 6) If you were to carry out root canal treatment on a replanted tooth, when would you start the treatment? | Immediately after replanting the tooth | 10 (5.6) |
| | 7–10 days after replantation and before splint removal | 71 (39.9) |
| | 6 months after replantation | 97 (54.5) |
| 7) What are the possible sequelae of replantation of avulsed teeth? (more than one correct answers) | Resorption | 163 (89.6) |
| | Pulpal necrosis | 146 (80.2) |
| | Ankylosis | 119 (65.4) |

### *Knowledge scores in the management of avulsed tooth by general dental practitioners*

The overall mean score for knowledge of managing tooth avulsion was 72.7+17.7. Eleven percent of the respondents ($n=20$) achieved the maximum score of 100 points, while 0.5% of the respondents ($n=1$) scored the minimum score of 10 points. The respondents were divided into two groups: those who scored more than 80 out of 100 points from seven multiple choice questions on knowledge in managing avulsed tooth and a second group who scored less than 80 points. Forty-six percent of the respondents ($n=84$) scored more than 80, while 53.8% of the respondents ($n=98$) scored below the benchmark of 80 points (Fig. 1). When comparing the place of practice with the respondents that scored more than 80 points, 76% (n=63) of them worked with government clinics or hospitals, while only 24% (n=21) worked in private practice (Fig. 1). A logistic regression analysis revealed that predictors, such as gender, age, practice duration and number of traumatised teeth previously treated had no significant effect on attaining scores more than 80 points (Table 2). However, the odd ratio for the place of practice indicated that a respondent working in a government clinic was 3.6 times more likely to score more than 80 points when compared to a private practitioner.

**Table 2 – Knowledge scores on management of avulsed teeth: Logistic Regression co-efficient, Wald test and Odds Ratio for each of the predictors.**

| Predictors | B | Wald | P | Odds ratio |
|---|---|---|---|---|
| Gender | −0.264 | 0.494 | 0.482 | 0.768 |
| Place of practice | 1.285 | 11.333 | 0.001[a] | 3.615 |
| Age | −0.097 | 2.007 | 0.157 | 0.908 |
| Practice duration | 0.109 | 2.073 | 0.150 | 1.115 |
| Number of traumatised teeth previously treated | 0.102 | 1.928 | 0.165 | 1.107 |

[a] Statistically significant.

### *Preferred methods of management of dental trauma*

Percentage distributions of responses to each question are shown in Table 3. When being asked for advice, the majority of the respondents ($n=162$; 90%) would prefer to instruct the guardian to place the avulsed tooth in transport medium and to advise to immediately seek care at a dental clinic instead of giving instructions on replanting the avulsed tooth at the emergency site. When a patient arrived with avulsed tooth, the majority of the respondents ($n=153$; 85.5%) elected to replant only the permanent teeth. Fifty-three percent of the respondents ($n=95$) elected to perform root canal treatment only if the patients developed signs and symptoms after replantation of an avulsed tooth. Forty percent of the respondents ($n=73$) would prefer to monitor the replantation of avulsed tooth for a minimum of 5 years by clinical and radiographic examinations.

**Table 3 – Percentage distribution of the responses to questions about preferred methods of management of avulsed teeth by general dental practitioners.**

| Questions on management of avulsed teeth | Response | N=182 (*n* , %) |
|---|---|---|
| 1. You received a call from the worried mother of a child who has just had a fall and avulsed his permanent upper front tooth. What would you do? | Give instructions over the phone | 19 (10.5) |
| | Ask the patients to bring tooth to the nearest clinic | 162 (89.5) |
| 2. Patient arrived with avulsed tooth. Would you replant? | Yes, in all cases | 9 (5.0) |
| | Yes, only for permanent teeth | 153 (5.5) |
| | No | 4 (2.2) |
| | I refer these cases to hospital/specialist | 13 (7.3) |
| 3. Would you carry out root canal treatment (RCT) after replantation of an avulsed permanent tooth? | Yes, if the tooth was immature with an open apex | 18 (10.1) |
| | Yes, if the tooth was fully formed with closed apex | 65 (36.3) |
| | Yes, only after the patient develops signs and symptoms | 95 (53) |
| | No | (1) 0.6 |
| 4. Length of monitoring replanted teeth | Clinical and radiographic examinations up to 1 year | 35 (19.3) |
| | Clinical and radiographic examinations up to 2 years | 67 (37.0) |
| | No monitoring | 6 (3.3) |

## Discussion

This study provided baseline information on the existing knowledge of managing avulsed tooth among general dental practitioners in Malaysia. In our study, 46.2% of the respondents scored 80 points out of a total score of 100. In contrast, 78.5% of dentists in Kuwait showed a high level of knowledge in the emergency management of avulsed tooth [12]. We used a relatively high score of 80 as the benchmark for good knowledge, as the questions we posed were simple and were considered as being part of the core knowledge of an undergraduate curriculum [14]. Nevertheless, the undergraduate training programme in Malaysia places little emphasis on teaching about the prevention, identification, and management of dental trauma [22, 23]. On the other hand, in other countries, like Japan, the Ministry of Education, Culture, Sports, Science and Technology reformed the dental education programme and established a model core curriculum to ensure undergraduate students had sufficient knowledge on the management of dental trauma [15].

When asked about the preferred methods of management of avulsed tooth, the majority of the respondents ($n=162$; 89.5%), when receiving a call from a worried mother of a child who had just suffered an accident involving an avulsed tooth, would prefer to ask the parent to bring the avulsed tooth to the nearest dental clinic instead of giving instructions over the phone on how to replant the avulsed tooth into the socket. Replantation of the avulsed tooth at the accident site may be a difficult process for the parent, justifying the answers of the majority of respondents, who indicated that the patient should seek immediate attendance by a dentist [16].

The place of practice significantly affected the amount of knowledge in managing dental avulsion injuries. About 63 (76%) of respondents who worked with government clinics or hospitals scored 80 points or higher. The odds ratio for place of practice indicated that respondents working in government clinics or hospitals in Malaysia were 3.6 times more likely to score above 80 points as compared to a private practitioner. This could be explained by the policy instituted by the Malaysian Ministry of Health, which emphasised training in the management of dental injuries, especially for the dentists who have to undergo two years of compulsory service immediately following graduation. As part of the compulsory programme, the Ministry introduced continuous professional development requirements for dentists in government clinics or hospitals in Malaysia to provide appropriate long-term skills and knowledge [17]. In addition, most dental trauma cases are managed by general dental practitioners in government clinics, as they are the primary dental care centres and are the most accessible to the public.

A review by Barrett and Kenny reported that a delay in replantation of an avulsed tooth of as little as 8 minutes would decrease the probability of periodontal healing to less than 50% [18]. Treatment guidelines state that if the extraoral dry time of a tooth exceeds 60 min, all periodontal ligament cells become nonviable [1]. If immediate replantation cannot be performed, a suitable storage medium should be used. The majority of respondents ($n=156$; 86%) chose saliva as the transport medium when the teeth cannot be replanted at the site of injury. The same result was also reported by Westphalen et al., who justified their results based on the immediate availability of saliva [11]. Trope suggested that the storage media for avulsed tooth (in order of preference) included Hank's Balanced Salt Solution (HBSS), milk, saline, and saliva (buccal vestibule) [19,20].

After replantation, an avulsed tooth should be splinted. The result from this study was quite unsatisfactory, as 51.6% ($n=94$) of the respondents stated they would use a rigid splint. Berude et al. reported that prolonged rigid splinting of teeth in monkeys would lead to ankylosis [21]. Sixty-four percent of the

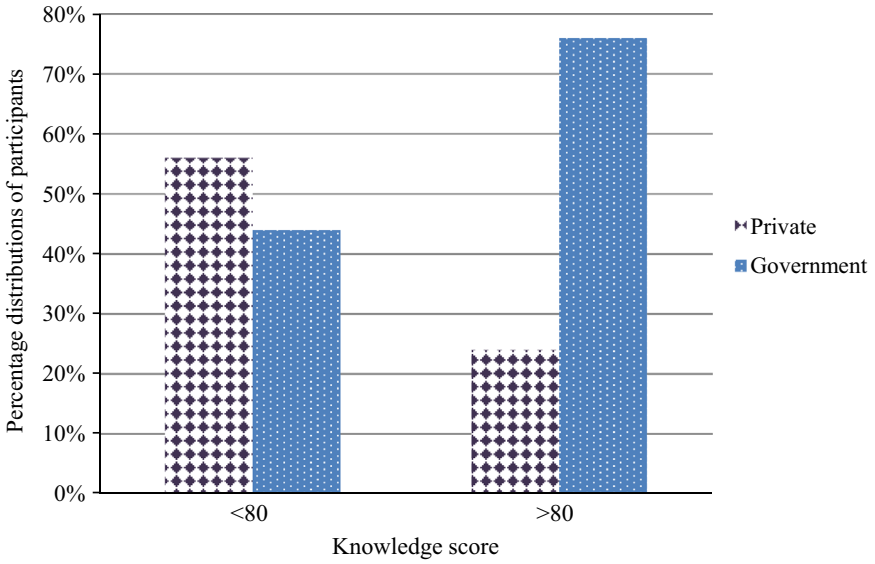


**Fig. 1 – Percentage distributions of respondents with two groups of knowledge scores versus two different places of practice.**

respondents correctly stated that splinting should be performed for 7–10 days. Chappuis et al. proposed a splinting period of 10 days for an avulsed tooth [22]. This suggestion was based on the findings of a one-year follow-up study of replanted teeth, which found teeth with splinting periods of more than 10 days significantly presented with replacement resorption. The International Association for Dental Traumatology (IADT) suggested splinting of an avulsed tooth for up to two weeks to decrease the risk of ankylosis [1].

The IADT also suggested initiation of root canal treatment 7–10 days after replantation of avulsed permanent tooth with closed apex [1]. Barrett and Kenny reported that the timing and nature of endodontic treatment for a replanted tooth was designed to control infection and therefore prevent inflammatory root resorption [18]. In this study, only 36.3% of the respondents stated that they would perform root canal treatment if the tooth was fully formed with a closed apex, while about 40.5% of the respondents would monitor the replanted tooth for a minimum of 5 years by clinical and radiographic examinations. The majority of respondents were aware of the possible sequelae of avulsed tooth, which include resorption, pulpal necrosis and ankylosis.

Based on the findings of this study, there is a need to improve the knowledge of emergency treatment of avulsed tooth among general dental practitioners in Malaysia. Trauma prevention and further education regarding the management of avulsed tooth is an essential requirement of a life-long learning process for improving their knowledge and clinical skills. In addition, the general dental practitioners in Malaysia should utilise the National Clinical Practice Guideline to gain appropriate information regarding the optimal prevention and treatment modalities for avulsed tooth.

## Conclusion

In conclusion, the knowledge level of managing avulsed tooth among general dental practitioners in Malaysia needs to be improved, with only 46% scoring more than 80 points (out of a total of 100). General dental practitioners should use all means available to enhance their existing knowledge of the treatment of avulsed tooth.

## Authors' contributions

All the authors have made substantial contributions to the conception and design, acquisition of data, or analysis and interpretation of data. They were involved in drafting the manuscript or revising it critically for important intellectual content. They gave their final approval of the version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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## Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.sdj.2016.01.001.

## REFERENCES


[1] L. Andersson, J.O. Andreasen, P. Day, G. Heithersay, M. Trope, A.J. Diangelis, D.J. Kenny, A. Sigurdsson, C. Bourguignon, M.T. Flores, et al., International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 2. Avulsion of permanent teeth, Dent. Traumatol. 28 (2) (2012) 88–96.

[2] J.O. Andreasen, F.M. Andersson, Textbook and Colour Atlas of Traumatic Injuries to the Teeth, 3rd edn., Munksgaard, Copenhagen, 1994.

[3] A.C. Da Silva, L.A. Passeri, R. Mazzonetto, M. De Moraes, R.W. Moreira, Incidence of dental trauma associated with facial trauma in Brazil: a 1-year evaluation, Dent. Traumatol. 20 (1) (2004) 6–11.

[4] N.N. Nik-Hussein, Traumatic injuries to anterior teeth among schoolchildren in Malaysia, Dent. Traumatol. 17 (4) (2001) 149–152.

[5] R. Esa, I.A. Razak, Traumatised anterior teeth in a sample of 12–13 year-old Malaysian school childrern, Ann. Dent. Univ. Malaya 3 (1996) 5–9.

[6] National Oral Health Plan for Malaysia. ⟨http://ohd.moh.gov.my/v3/images/nohp20112020.pdf⟩, 2011–2020 (accessed 12.12.14).

[7] A. Dalia, W.C.L. Fay, W.A. Wan Noorina, R. Rozytha, T. Siok Peen, K. Selina, Knowledge and use of mouthguards among university athletes in Malaysia, Mov. Health Exerc. Sport J. Minist. Educ. Malays. 2 (2013) 31–40.

[8] C.H. Ferrari, J.M.F. de Medeiros, Dental trauma and level of information: mouthguard use in different contact sports, Dent. Traumatol. 18 (3) (2002) 144–147.

[9] T. Yeng, P. Parashos, Dentists' management of dental injuries and dental trauma in Australia: a review, Dent. Traumatol. 24 (3) (2008) 268–271.

[10] N. Cohenca, J.L. Forrest, I. Rotstein, Knowledge of oral health professionals of treatment of avulsed teeth, Dent. Traumatol. 22 (6) (2006) 296–301.

[11] V.P.D. Westphalen, W.D. Martins, M.D.A. Deonizio, U.X. da Silva, C.B. da Cunha, L.F. Fariniuk, Knowledge of general practitioners dentists about the emergency management of dental avulsion in Curitiba, Brazil, Dent. Traumatol. 23 (1) (2007) 6–8.

[12] M. Abu-Dawoud, B. Al-Enezi, L. Andersson, Knowledge of emergency management of avulsed teeth among young physicians and dentists, Dent. Traumatol. 23 (6) (2007) 348–355.

[13] S. Upadhyay, D. Rokaya, C. Upadhayaya, Knowledge of emergency management of avulsed teeth among general dentists in Kathmandu, Kathmandu Univ. Med. J. 10 (38) (2012) 37–40.

[14] Curriculum & Assessment Framework Guidance 2013–2014. Available at: ⟨https://www.rcseng.ac.uk/fds/courses/documents/GPT%20Curriculum.pdf (accessed 25.01.15).

[15] Y. Fujita, Y. Shiono, K. Maki, Knowledge of emergency management of avulsed tooth among Japanese dental students, BMC Oral Health (2014) 14.

[16] L.G. de Vasconcellos, A.S. Brentel, A.D. Vanderlei, L.M. de Vasconcellos, M.C. Valera, M.A. de Araujo, Knowledge of general dentists in the current guidelines for emergency treatment of avulsed teeth and dental trauma prevention, Dent. Traumatol. 25 (6) (2009) 578–583.

[17] The Oral health division, Ministry of Health Malaysia. Available at: ⟨http://ohd.moh.gov.my/v3/index.php/en⟩ (accessed 09.09.14).

[18] E.J. Barrett, D.J. Kenny, Avulsed permanent teeth: a review of the literature and treatment guidelines, Endod. Dent. Traumatol. 13 (4) (1997) 153–163.

[19] M. Trope, Clinical management of the avulsed tooth, Dent. Clin. N. Am. 39 (1) (1995) 93–112.

[20] M. Trope, Clinical management of the avulsed tooth: present strategies and future directions, Dent. Traumatol. 18 (1) (2002) 1–11.

[21] J.A. Berude, M.L. Hicks, J.J. Sauber, S.H. Li, Resorption after physiological and rigid splinting of replanted permanent incisors in monkeys, J. Endod. 14 (12) (1988) 592–600.

[22] V. Chappuis, T. von Arx, Replantation of 45 avulsed permanent teeth: a 1-year follow-up study, Dent. Traumatol. 21 (5) (2005) 289–296.

[23] Competencies Of New Dental Graduates, Malaysia as approved by the 2012 Malaysian Dental Council, Available at: ⟨http://mdc.moh.gov.my/modules/mastop_publish/?tac=Competencies_of_New_Dental⟩ (accessed 25.01.15).

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Scientific article

# Smart sliding hook as a ready to use auxillary in orthodontist's inventory

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ABSTRACT

Orthodontic treatment often requires extraction or distalization for gaining space. With both treatment modalities, emphasis has always been given to the simplicity and effectiveness of the treatment, time required for each visit, cost and minimum requirement of the inventory. To accomplish this, various appliances and auxiliaries have been designed in the past of which sliding jigs are commonly used. They pose various clinical problems of which time to fabricate them for each patient is one as they cannot be stored in a prefabricated form.

Hence a versatile smart sliding hook is introduced as a ready to use auxillary which is biomechanically efficient, convenient to patients, economical, time saving, easy to fabricate and can be prefabricated making it clinically very helpful for orthodontists in day to day practice.

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## Introduction

During orthodontic treatment, precise diagnosis and consequent correct treatment plan presents a high degree of difficulty and complexity. When defining the treatment plan, a significant percentage of malocclusions, such as discrepancies between tooth and maxillary sizes, and discrepancies between the bony bases either results in extraction therapies or distalization of posterior segments to gain space. Therefore, space closure is a routine procedure in orthodontic practice. Researchers have always been interested in determining efficient methods of retracting canines [1]. One of the biomechanical alternatives for space closure is the retraction of canines with sliding mechanics performed prior to incisor retraction to preserve the anchorage.

A sliding jig is used to apply intra or inter maxillary forces to either distalize or mesialize teeth [2]. The auxiliary should be constructed using a relatively stiff wire, such as $0.457 \times 0.635\ mm^2$ ($0.018" \times 0.025"$) or round 0.508 mm (0.020 in.) [3].

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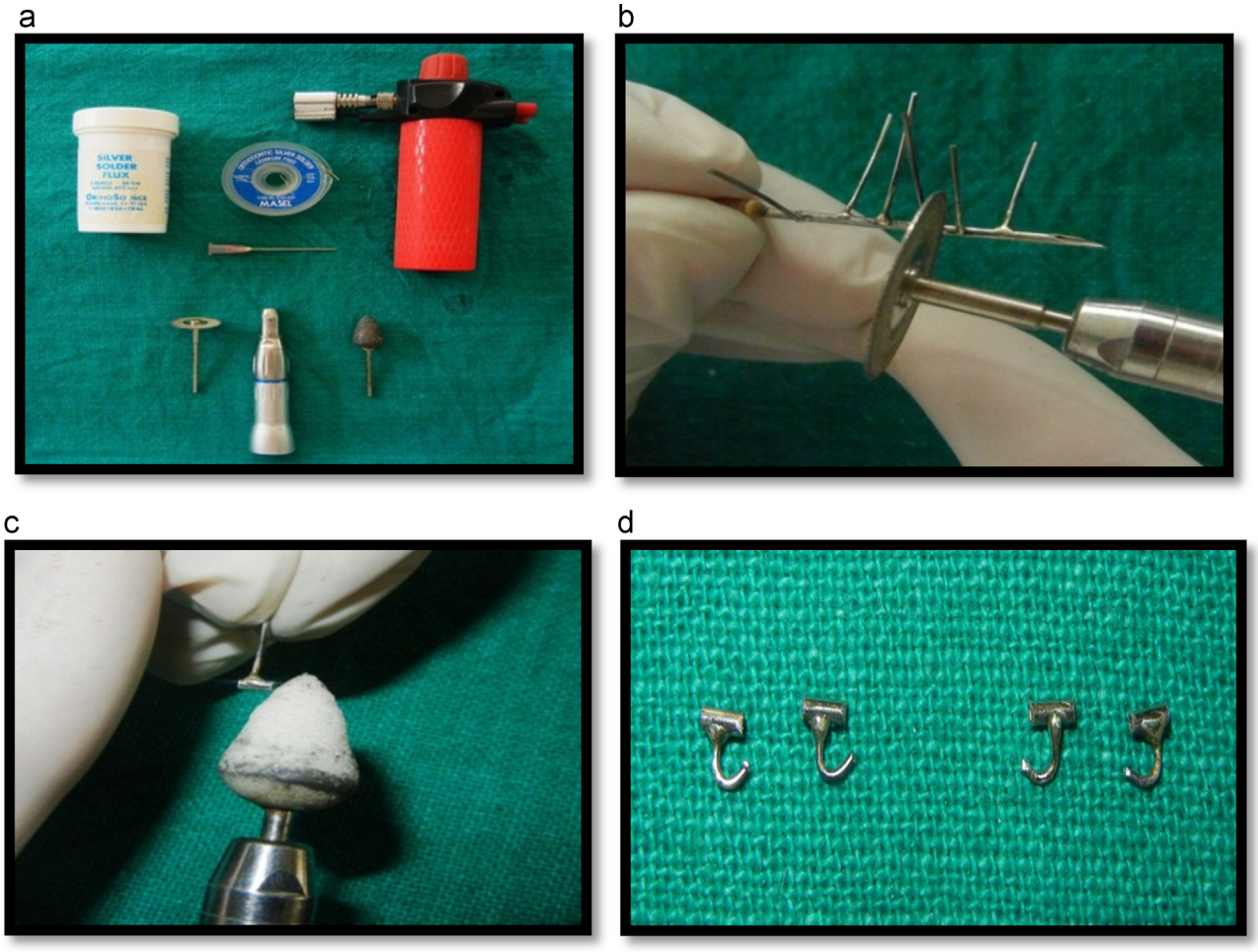


**Fig. 1 – Fabrication of smart sliding hook. (a) Armamentarium used, (b) Hooks cut with the help of diamond cutting disc, (c) Ends of the hook trimmed, sandpapered and polished, and (d) hooks prepared.**

A sliding jig is mainly used for two purposes-

1. Retraction of individual tooth e.g., canine [2]
2. Molar distalization [3]. A quicker response is achieved when sliding-jigs are used, especially in asymmetric Class II cases [4].

With both the treatment modalities emphasis should also be given to the simplicity and effectiveness of the treatment, time required for each visit, cost and minimum requirement of the inventory.

The purpose of this paper is to introduce a new versatile smart sliding hook for canine retraction which is biomechanically efficient, convenient to patient, economical, time saving, easy to fabricate and can be a useful auxiliary for an orthodontist.

## Appliance design and fabrication

A sliding hook is fabricated from a needle of 1.2 mm in diameter and soldered 23 gauge stainless steel wire (0.574 mm) for making the hook as shown in Fig. 1.

## Procedure

A 1.20 × 38 $mm^2$ needle is taken, to which a 23 gauge stainless steel wire is soldered. Then by using a diamond cutting disc, needle is cut 2.5 mm apart and the ends are smoothened with bur, sandpapered and polished [Fig. 1(b and c)]. The 23 gauge wire extension is then bent into the shape of a hook [Fig. 1(d)].

## Smart sliding hook for retraction by sliding mechanics

The Smart sliding hook is placed over the main archwire and is activated for separate canine retraction from the mesially placed hook. This can be used when relieving crowding or when maximum anchorage is needed.

In minimum anchorage cases or when anchorage is reinforced such as crowding cases where it is mandatory to partially retract canine, the hook can be activated by intramaxillary (class I) elastics, elastomeric chain, closed coil spring or by active tie back as shown in Fig. 2

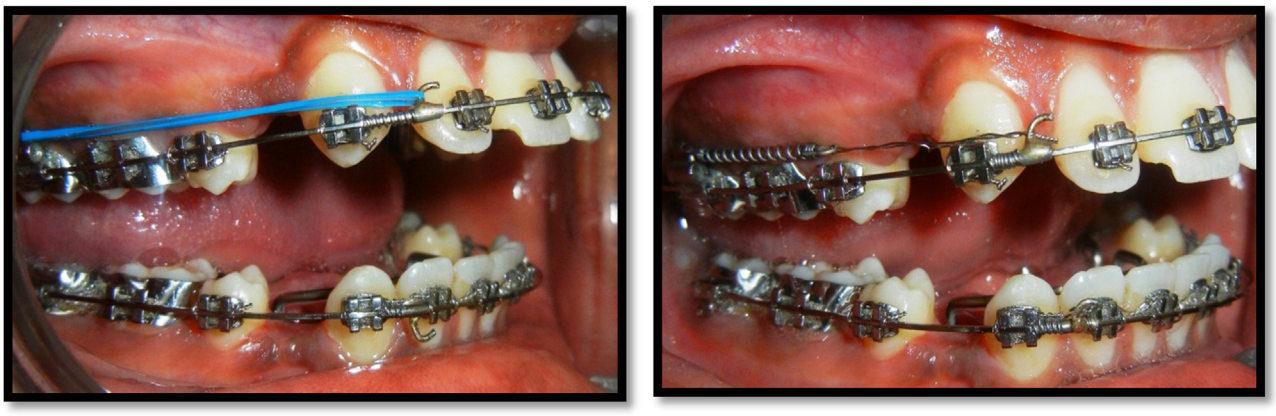

**Fig. 2 – Use of class I elastics and NiTi closed coil spring for canine retraction. Transpalatal arch is given in the upper arch for anchorage reinforcement.**

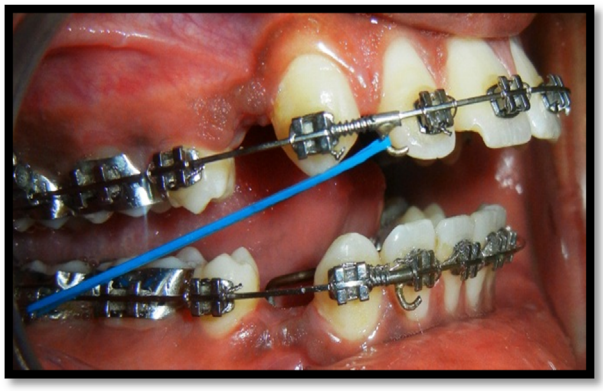

**Fig. 3 – Light Class II elastics (3.5 Oz) given for canine retraction Note that during mouth open position, the hook does not rotate outward.**

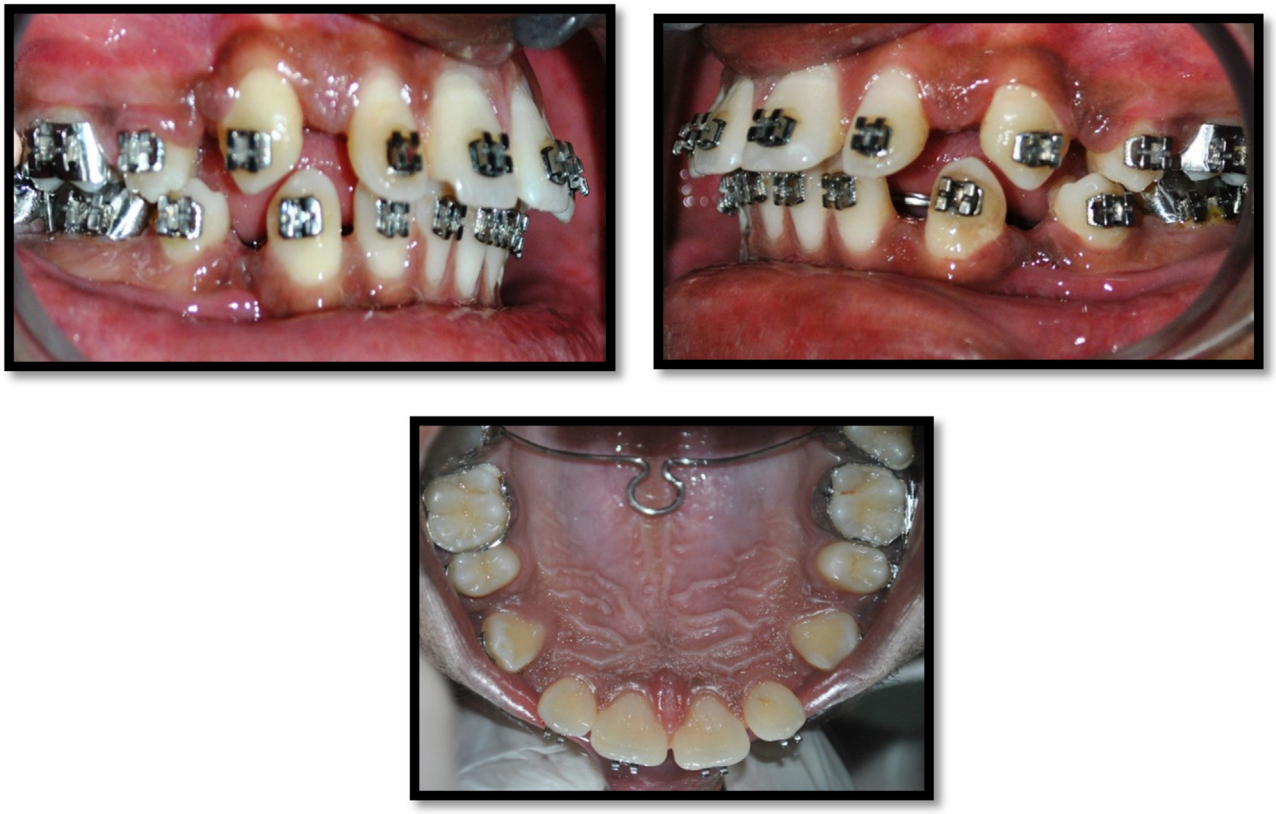

**Fig. 4 – After 2 months of start of treatment 3 mm of retraction achieved.**

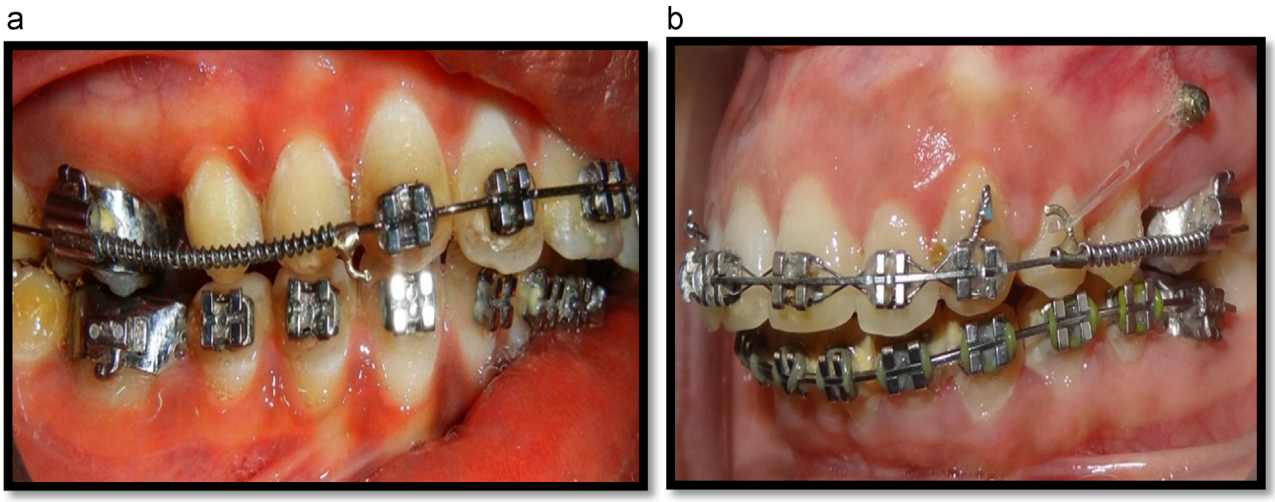


**Fig. 5 – Distalization achieved with the use of Smart Sliding Hook and coil spring. (a) Class II elastic from hook on 0.019" × 0.025" TMA wire before shifting to stainless steel wire. (b) Miniscrew anchorage used with elastomeric chain to deliver the force on 0.019" × 0.025" Steel wire.**

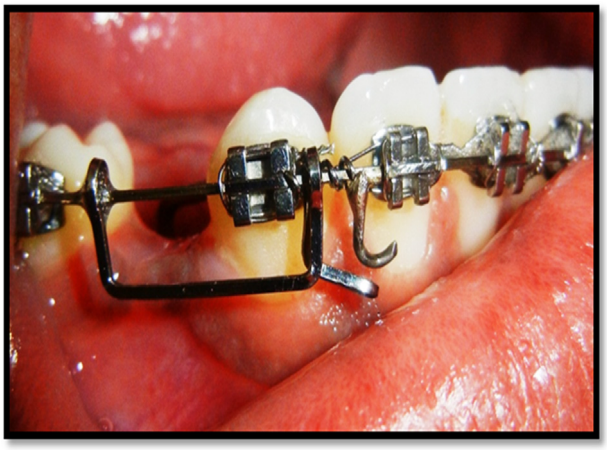

**Fig. 6 – Anterior eyelet entangled with coil spring.**

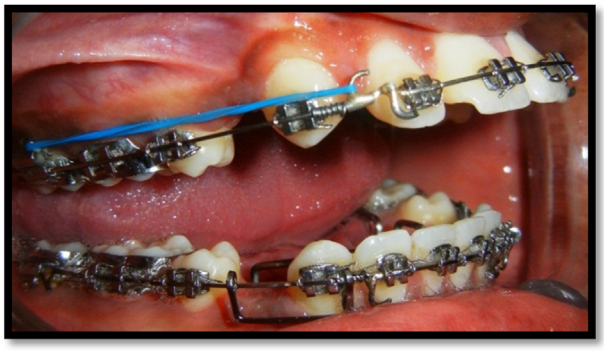

**Fig. 7 – Smart hook is used in upper arch whereas on contrary to this a conventional jig is used in lower arch. Canine retraction has started in the upper arch but in lower arch coil is entangled with the anterior eyelet so no retraction has been achieved.**

Intermaxillary elastics can also be applied to the hook as shown in Fig. 3. For this, light forces are to be used on a heavy rectangular stainless steel wire preferably 0.019" × 0.025" SS wire which would cause crown tipping and root uprighting thus preventing undue distal tipping of teeth. In cases with mini-implant anchorage, an elastomeric chain or closed coil spring can also be used to activate the hook. Canine was retracted with the help of Smart Sliding Hook as shown in Fig. 4.

In addition, after the partial retraction of canine, the hook can be crimped on to the archwire using hook crimping plier. Then the same hook can be used for anterior retraction. For this the hook should be cut with a longer segment of the needle, so that the solder free part of the needle segment can be crimped onto the archwire.

## Smart sliding hook for molar distalization

The sliding hook can also be used for molar distalization. In this case, the premolar bracket is bypassed and a coil spring is inserted into the main arch wire from mesial of molar to the distal of canine. The hook is inserted mesial to coil spring and activated either with the help of mini-implant or headgear or intermaxillary elastic. The main archwire to be used should be 0.019" × 0.025" and not less than because smaller dimension wire may not support itself in the long span between molar and canine as premolar is not there as shown in Fig. 5.

## Discussion

Sliding movement along the archwire implies friction between archwire, bracket and ligature surfaces. In sliding mechanics the force of friction is encountered which tends to reduce the force available for effective tooth movement [5–12]. It is estimated that 50% of the orthodontic force applied is used to overcome friction [13–14].

The use of the sliding hook attached to a mini-implant approximates the force vector to the center of resistance of the tooth, providing better mechanical control. greater force

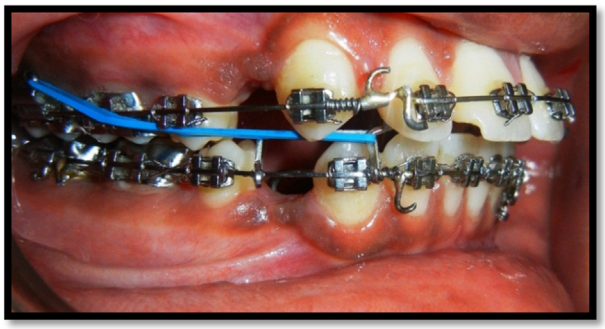

**Fig. 8 – Occlusal interference caused by the jig.**

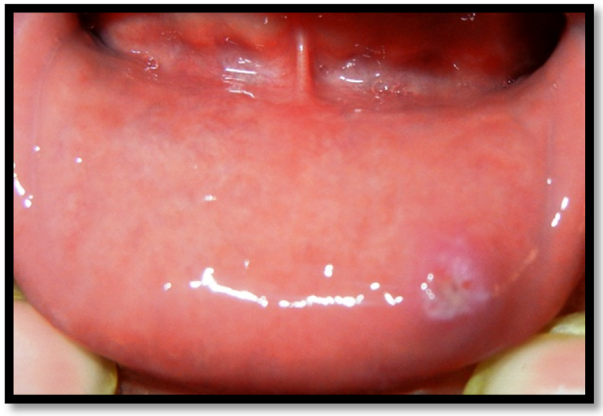

**Fig. 9 – Mucosal irritation and ulceration due to movement of jig.**

is required due to the fact that this system produces more bodily movement (translation) than distal tipping. The greatest difficulty for bodily movement is the great amount of force required [15–17]. The length of the hook can be altered so as to apply the force closer to the centre of resistance of the tooth for body movement.

When class II elastics are used, the hook rotates outward minimally which in practical use is similar to a crimped hook or a soldered post on wire. Though this seems to be a shortcoming, this with rotation there is minimal to no mucosal irritations and ulcerations as shown in Fig. 3. The operator can also reduce any irritations by smoothening and polishing the free end of the hook and rotating and tucking the end towards teeth. Because of this rotation, the point of application of class II and III force is away from the center of resistance which may increase the chances of tipping of the canine. This can simply be avoided by using a stiff wire such as 0.019" × 0.025" SS wire with light class II elastics (2.5–3 Oz) which will cause tipping and root uprighting.

There are various shortcomings of the conventional jigs that are used in standard edgewise technique for canine retraction:

1. An open coil spring is used between the mesial of canine bracket and anterior eyelet of the sliding jig. When force is applied to the hook of the jig, it should compress the open coil spring and a distal force will act on the canine. Generally, the spring is entangled with the eyelet and passes through it there by hindering tooth movement as shown in the Figs. 6 and 7. This also hinders reactivation of the jig on subsequent visits which would require removal of wire and refabricating the jig.

2. Another problem is the slipping of the jig which causes occlusal interferences. Since the eyelets do not closely adapt to the archwire, it rotates while applying force as shown in Fig. 8. Due to this problem the hook of the jig may cause mucosal irritation and ulceration as shown in Fig. 9.

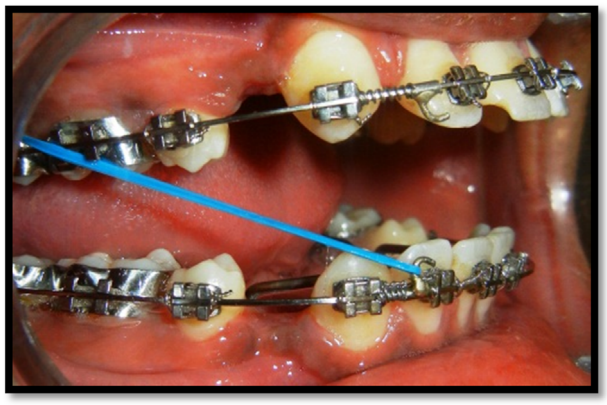

**Fig. 10 – Even if the hook rotates, there will not be any occlusal interference.**

There are various advantages of the Smart hook described above:

1. The foremost advantage to an orthodontist is easy fabrication of these hooks which can be a ready to use auxiliary thus saving from fabrication of jig for individual patients.
2. The open coil spring placed mesial to the canine is effectively compressed by the Smart Hook and does not allow coil spring to pass through it. This also eases the reactivation of hook on subsequent visits as compared to conventional jigs.
3. It reduces food and plaque accumulation compared to the conventional jig hence promoting better oral hygiene maintenance and patient acceptance.
4. It is economical.
5. These hooks can be reused after sterilization.
6. The size of the hooks can be changed as per the need hence can be made closer to center of resistance of the tooth to have more bodily movement.
7. Due to appropriate size of the lumen of the hook, coil spring is nicely compressed and there is no binding with the archwire.
8. In case the hook rotates, it will not cause any occlusal interference & mucosal irritation as shown in Fig. 10.
9. Canine is ligated with steel ligature during retraction, reduces friction during sliding and rotation which is encountered if e-chain is placed directly over the canine.
10. Same hook can be crimped and used for anterior retraction thus saving time in final removal of wire, soldering a post and religating it.

11. When used for molar distalization, the same arch wire, hook and spring can be moved mesially for the retraction of rest of the teeth. So it is time saving and easy for the orthodontist.

## Conclusion

The Smart Sliding Hook has proven to be a ready to use, versatile, simple, cost effective and time saving method for individual tooth retraction and molar distalization. These hooks can be an important and integral part of an orthodontist's inventory.

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## REFERENCES

[1] K. Hayashi, J. Uechi, M. Marata, I. Mizoguchi, Comparison of maxillary canine retraction with sliding mechanics and a retraction spring: a three dimensional analysis based on a midpalatal orthodontic implant, Eur. J. Orthod. 26 (2004) 585–589.
[2] Charles H. Tweed, Clinical Orthodontics, vol. 2, The C.V. Mosby Company 433–434.
[3] E. Mizrahi, Orthodontic Auxiliaries, in Orthodontic Pearls: A Selection of Practical Tips and Clinical Expertise, Taylor & Francis Books, London 100.
[4] Deocleciano da Silva Carvalho, An interview with Ademir Roberto Brunetto, Dental Press J. Orthod. 15 (2010) 31–45.
[5] D.H. Huffman, D.C. Way, A clinical evaluation of tooth movement along archwires of two different sizes, Am. J. Orthod. 83 (1986) 453–459.
[6] V. Cacciafesta, M.F. Sfondrini, A. Ricciardi, A. Scribante, C. Klersy, F. Auricchio, Evaluation of friction of stainless steel and esthetic self-ligating brackets in various bracket-archwire combination, Am. J. Orthod. Dentofacial Orthop. 124 (2003) 395–402.
[7] P. Zielger, B. Ingervall, Maxillary canine retraction with a retraction spring and with sliding mechanics, Am. J. Orthod. Dentofacial Orthop. 95 (1989) 99–106.
[8] R.H.A. Samuels, S.J. Rodge, L.H. Mair, A comparison of the rate of space closure using a nickel-titanium spring and an elastic module: a clinical study, Am. J. Orthod. Dentofacial Orthop. 103 (1993) 464–467.
[9] H. Tripolt, C.J. Burstone, P. Bantleon, W. Manschiebel, Force characteristics of nickel-titanium tension coil springs, Am. J. Orthod. Dentofacial Orthop. 15 (1999) 498–507.
[10] C. Nishio, A.F.J. Da Motta, C.N. Elias, N. Mucha, In vitro evaluation of frictional forces between archwires and ceramic brackets, Am. J. Orthod. Dentofacial Orthop. 125 (2004) 56–64.
[11] M. Redlich, Y. Mayer, D. Harari, I. Lewinstein, In vitro study of frictional forces during sliding mechanics of "reduced-friction" brackets, Am. J. Orthod. Dentofacial Orthop. 124 (2003) 69–73.
[12] P. Gjessing, Biomechanical design and clinical evaluation of a new canine-retraction spring, Am. J. Orthod. 87 (1985) 353–362.
[13] W.R. Profit, H.W. Fields Jr, D.M. Sarver, Contemporary Orthodontics, 4th ed., Mosby, St Louis, 2007.
[14] L.P. Lotzof, H.A. Fine, G.J. Cisneros, A comparison of two preadjusted bracket systems, Am. J. Orthod. Dentofacial Orthop 110 (1996) 191–196.
[15] A.C.O. Ruellas, M.M. Pithon, R.L. Santos, Evaluation of the mechanical behaviour of different devices for canine retraction, Dental Press J. Orthod. 17 (3) (2012) 83–87.
[16] Kevin A. Young, Colin A. Melrose, Jayne, E. Harrison, Skeletal anchorage systems in orthodontics: absolute anchorage. A dream or reality?, J. Orthod. 34 (2007) 101–110.
[17] Paik Cheol-Ho, Orthodontic miniscrew implant: clinical applications, Elsevier Health Sciences (2009) 112.

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Case Report

# Pigmented oral compound nevus of retromolar area – A rare case report

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ABSTRACT

Solitary pigmented melanocytic intraoral lesions of the oral cavity are rare. Oral nevus is a congenital or acquired benign neoplasm. Oral compound nevus constitutes 5.9%–16.5% of all oral melanocytic nevi. The oral compound nevus is commonly seen on hard palate and buccal mucosa and rarely on other intraoral sites. The objective of this article is to present a rare case report of oral compound nevus in the retromolar pad region along with a review of literature. A 22 year old female reported with a solitary black pigmented papule at retromolar pad region which was surgically removed and microscopic investigation confirmed the diagnosis of oral compound nevus.

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## Introduction

A nevus is a congenital or acquired benign neoplasm of the skin or mucous membrane [1]. Melanocytic nevi are pigmented benign tumors that occur as a sequel of melanocytic growth and proliferation [2]. The oral nevus was first documented in 1943 by Ackermann and Field [3]. Solitary pigmented intraoral lesions of melanocytic origin are uncommon. These intraoral lesions include melanotic macule, melanocytic nevus, melanoacanthoma, melanoma and atypical melanocytic hyperplasia/proliferation, and melanoma [4,5].

Oral melanocytic nevi are benign proliferations of nevus cells in the epithelial layer, the submucosal layer, or both. They are histopathologically classified into three phases: proliferation of nevus melanocytes along the submucosal–mucosal junction (junctional nevus); migration of nevus cells to the underlying mesenchymal tissue (compound nevus); and loss of the junctional component of the nevi, so that all remaining nevus cells are located within the subepithelial connective tissue stroma (subepithelial or intramucosal nevus) [5,6]. The nevus cells in compound nevus shows variation in melanin production capacity, with pigmentation being greater near the surface [7].

It is theorized that over a period of time, the junctional nevus develop gradually into a compound nevus and further into an intramucosal nevus. The neural crest is the suggested site of origin for the nevus cells. It is not clear whether the neural cells are true melanocytes or are closely related. Melanocytes are dendritic cells, located suprabasally in the epithelium, that can transfer melanin to the adjacent keratinocytes. On the contrary, nevus cell are round cells that do not transfer melanin to adjacent keratinocytes [3].

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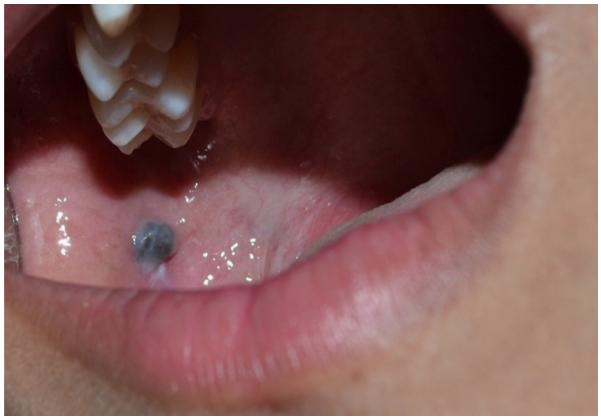

**Fig. 1 – Showing solitary black pigmented papule at retromolar mucosa.**

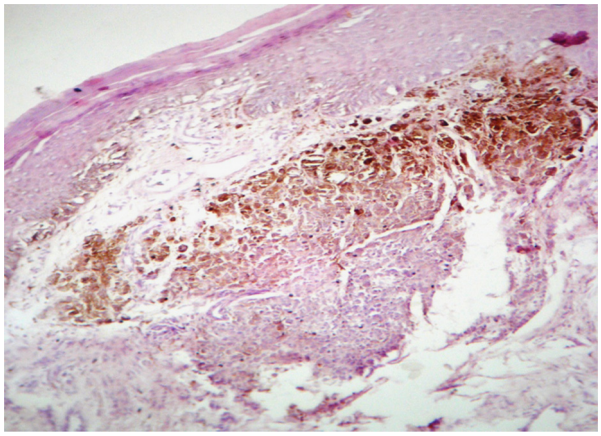

**Fig. 2 – Histopathological view of hematoxylin and eosin stained slide at low power showing pigmented ovoid shaped nevus cells with melanin granules in the superficial connective tissue and overlying epithelium.**

Irrespective of the nevus histological subtype, they present with similar clinical appearance [2].

In the oral cavity the most commonly found nevus is the intramucosal nevus (63%–80.6%) followed by blue nevus (8.3–32%). Oral compound nevus is one of the rarest forms of oral mucosal nevi accounting for only 5.9%–16.5% [8]. This case report highlights this rare subtype of oral nevus at an unusual site, the retromolar pad region.

## Case report

A 22 year old female patient reported with complaint of discomfort in the oral cavity adjacent to right posterior teeth since 1 year. On examination a solitary black papule approximately of size $3 \times 4$ mm was seen on right retromolar pad region (Fig. 1). Lesion was slightly tender. Medical and surgical history of the patient was non contributory. Provisional diagnosis of melanocytic nevus was given and differential diagnosis of melanocytic macule, oral melanoacanthoma, varix and oral melanoma was considered.

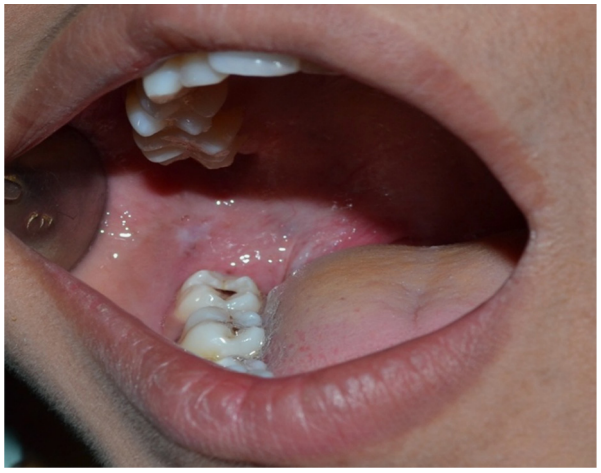

**Fig. 3 – Showing postoperative view of reromolar mucosa after 3 months.**

Excisional biopsy was performed followed by microscopic investigation which showed presence of pigmented ovoid shaped nevus cells with melanin granules in the superficial connective tissue and overlying epithelium (Fig. 2). The deeper connective tissue showed chronic inflammatory cell infiltrate and blood vessels. The clinical findings and histopathology was suggestive of compound nevus of retromolar pad. Follow up after 3 months revealed no recurrence of the lesion (Fig. 3).

## Discussion

Oral melanocytic nevi are usually asymptomatic lesions which are most commonly discovered co- incidentally with other chief complaint. Buchner et al. and Kaugars et al. reported a predilection for females [9]. The oral compound nevus, affects mainly the hard palate (33.3% to 57.1%), and rarely occurs in the retromolar pad area (8.3%) as seen in this case.

Ferreira et al. retrospectively studied 100 cases of intraoral nevus and reported intramucosal nevus as the most common type (61%), followed by common blue nevus (23%), compound nevus (7%), and junctional nevus (3%). Combined nevus, cellular blue nevus and dysplastic nevus are rare intraoral nevi. The hard palate was the most commonly affected site (33%), followed by the buccal mucosa (18%), vermilion border of the lip (18%), and gingiva (15%). Retromolar pad, soft palate and labial mucosa are an unusual site for oral nevi (5%) [7].

Melanocytic nevi frequently harbour oncogenic serine/threonine-protein kinase B-Raf (BRAF) or, less commonly, neuroblastoma ras viral oncogene homolog (NRAS) mutations. Initially oncogenic mutations might cause the hyperproliferation that, results in the formation of the nevi and a subsequent oncogenic-induced cellular senescence may account for the cessation of further growth [3].

Most compound oral nevi are elevated lesions. However, one-third appears as macules, which makes it difficult to differentiate from flat pigmented lesions, including melanoma in situ [8]. Clinically, oral nevi may appear as

asymptomatic, small, well circumscribed, brown, bluish-gray, or almost black and occasionally non-pigmented flat macules, as raised papules or nodules [2,5]. Cutaneous nevus is oval in shape with regular outlines and relatively sharp boundaries; have homogenous surface and colour. It may show pappilomatous, pedunculated, dome shaped or flat topped surface.The colour can vary from flesh colored, pink, brown, dark brown or black in colour. The oral nevus resembles extraoral dermal nevus in appearance. Although, in contrast to oral nevus; the cutaneous nevus may appear larger in size, can reveal coarse hair projections and papillomatous surface [9,10].

Diagnostic biopsy is required for oral melanocytic lesion to exclude melanoma. Excision facilitates histologic sampling to exclude melanoma, and presumably, may prevent malignant transformation [11], although dysplastic changes have been reported in oral nevi. According to National Institutes of Health Consensus Conference, dysplastic nevus (DN) appears clinically larger than a common mole with ill-defined borders and color variegation ranging from tan to dark brown. DN may occur anywhere on the body. DN microscopically shows architectural disorder, subepidermal fibroplasia, and lentiginous melanocytic hyperplasia with spindle or epithelioid melanocytes aggregating in variable sizes and fusing with adjacent rete ridges. A “shouldering” phenomenon may be seen in which the intraepidermal melanocytes extend individually or in nests beyond the main dermal component. DN is usually seen at puberty or adolescence, but true dysplastic nevi have been reported in prepubertal children [7]. The malignant transformation of intraoral nevi has not been reported in patients, even with mutiple nevi or congenital nevi [5]. Thus the question remains unanswered about their malignant transformation. Approximately one-third of oral melanomas are preceded by pigmented lesions, but the detailed microscopic types of these precursor lesions have not been reported [8].

## Conclusion

Solitary pigmented oral lesions should be clinically evaluated and the conservative surgical excision followed by histopathological confirmation of the lesion is strongly recommended for diagnosis and ruling out the dysplastic changes. The differential diagnosis for solitary melanocytic macules includes malignant melanoma, hence biopsy is strongly recommended for any oral pigmentation because an early melanoma may be mistaken as melanocytic nevi. Oral compound nevus is a rare pigmented nevus and its occurrence at rare site should be documented. Follow up is advised to rule out the recurrence of oral nevi.

## REFERENCES


[1] D.A. Freitas, P.R. Bonan, A.A. Sousa, M.M. Pereira, S.M. Oliveira, K.M. Jones, Intramucosal nevus in the oral cavity, J Contemp. Dent. Pract. 16 (1) (2015) 74–76.

[2] F. Alawi, Pigmented lesions of the oral cavity: an update, Dent. Clin. N Am. 57 (2013) 699–710.

[3] J. Agrawal, Intramucosal melanotic nevi - A case report of an unusual gingival enlargement (serial online)( 2013 [cited), J. Indian Soc. Periodontol. 17 (2015) 239–241.

[4] A. Buchner, P.W. Merrell, W.M. Carpenter, Relative frequency of solitary melanocytic lesions of the oral mucosa, J. Oral. Pathol. Med. 33 (9) (2004) 550–557.

[5] R.O. Gondak, R. da Silva-Jorge, J. Jorge, M.A. Lopes, P.A. Vargas, Oral pigmented lesions: clinicopathologic features and review of the literature, Med. Oral. Patol. Oral. Cir. Bucal 17 (6) (2012) e919–e924.

[6] R. Vinaya Kumar, et al., Pigmented intramucosal nevus of gingival – a case report.Int (September), J. Contemp. Dent. 1 (1) (2010).

[7] L. Ferreira, B. Jham, R. Assi, A. Readinger, H.P. Kessler, Oral melanocytic nevi: a clinicopathologic study of 100 cases., Oral Surg. Oral Med. Oral Pathol. Oral. Radiol. 120 (2015) 358–367.

[8] Lyzete Berriel Cardoso, et al., Oral compound nevus, Dermatol. Online J. 20 (2) (2014) (doj_21542).

[9] K. Wolff, L. Goldsmith, S. Katz, B. Gilchrest, A. Paller, D. Leffell, Fitzpatrick’s Dermatology in General Medicine (Chapter-122), Seventh Edition, Publisher Mc Graw Hill, 2008.

[10] B.W. Neville, D. Damm, C. Allen, E.J. Bouquot, Textbook of Oral and Maxillofacial pathology (chapter-10, page no-383), Third edition, Elsevier, United states of America, 2009.

[11] Melanie, L. Gilbert, et al., Congenital melanocytic nevus of the oral mucosa: report of a rare pigmented lesion and review of the literature, Clin. Pract. volume 1 (2011) e17.

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Scientific article

# MCQ-construction improves Quality of Essay Assessment among undergraduate dental students

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ABSTRACT

A well-constructed essay is indicative of deep strategic understanding and is considered a valid assessment tool in many dental schools. It has been suggested that constructing MCQs could be an effective learning tool for students while at the same time contribute towards a pool of well-constructed MCQs that could stand up to scrutiny at high-stakes examinations. This study aimed to compare the quality of essays written by students trained and untrained in MCQ construction. The null hypothesis was that construction of MCQs did not result in higher grades achieved in "closed-book" time-limited assessment conditions. A Test cohort ($n=48$) of undergraduate dental students were taught and constructed MCQs during their preclinical prosthodontics course. The Control cohort ($n=48$) consisted of students who underwent the same course 1 year prior. The same question was administered to both cohorts without the students' knowledge. Answers were de-identified and randomized for grading by a blinded expert prosthodontic examiner not involved in the teaching of the students. Based on a passing grade of 50 and a maximum grade of 100, the Test cohort exhibited significantly improved essay quality, scoring a mean grade of $73.0 \pm 8.0$, compared to a mean grade of $63.6 \pm 11.8$ achieved by the control cohort ($p<0.001$). The null hypothesis was rejected. Under the conditions of this double-blind study, MCQ-construction resulted in better essays written by students under examination conditions.

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## Introduction

The dental school in Singapore traditionally assesses knowledge gained by a student by conducting summative essay assessment questions. While a well-constructed essay is indicative of deep strategic understanding [1,2], grading numerous essays within the short time usually allocated to dental examinations posed a challenge in objectivity and consistency. Alternatives to this mode of assessment such as Modified Essay Questions [3], Multiple Choice Question (MCQ) s [4], Reflective thinking [5], Feedback [6], multiple variety and combinations [1,7–12], have been advocated but their value in learning outcomes are not easily measured [1–3].

MCQs, as an assessment tool, have the advantage of consistency and objectivity. Constructing MCQs that can stand up to objective scrutiny and are capable of testing strategic understanding requires an in-depth knowledge of the subject matter [3,13]. While it has been proposed that constructing MCQs could be an effective learning tool for the student [13], there has been no objective testing of this hypothesis. This study aimed to compare the quality of essays written by students trained and untrained in MCQ construction. The null hypothesis was that construction of MCQs did not result in higher grades achieved in "closed-book" time-limited assessment conditions.

## Materials and methods

### (A) MCQ-construction trainers

Two Prosthodontists with over 15 years of clinical experience each (WW & PY) and were full-time teaching staff attended a MCQ-construction course conducted at the Centre for Development of Teaching and Learning (CDTL, National University of Singapore), under the Professional Development Programme – Teaching (PDP-T). The course was a single day (8 h) classroom-based workshop and comprised of lectures as well as practical exercises.

### (B) Pilot study

A pilot programme was conducted in a cohort of students (2011, Fig. 1) not involved in this study. The objectives were 2-fold: [1] To test the feasibility of training students in MCQ-construction by evaluating methodology as well as physical and time requirements; [2] To study the validity of the MCQs in terms of content knowledge and application in prosthodontic practice. The pilot program demonstrated feasibility and validity of the MCQs so that a double-blind study was implemented in the 2010 student cohort as Control, and the 2012 cohort as Test Group.

### (C) Study in MCQ-construction

Two student cohorts, an earlier (2010) Control Cohort ($n=48$ students) and a later (2012) Test Cohort ($n=48$ students) were examined (Fig. 1). Both cohorts had similar demographic and educational backgrounds (Table 1).

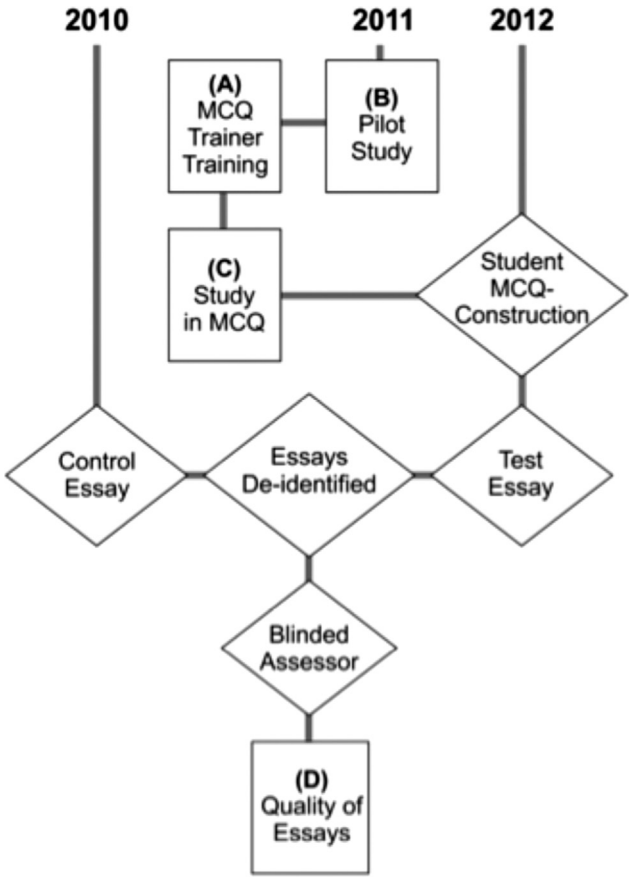


**Fig. 1 – Illustration of study flow.**

**Table 1 – Students at admission to dental course.**

| Cohort | Age at assessment (years) | Female | Male |
|---|---|---|---|
| Control (2010) | 20–22 | 29 | 19 |
| Test (2012) | 20–22 | 29 | 19 |

Both cohorts underwent a 6-month pre-clinical teaching module in fixed prosthodontics as part of their second year undergraduate dental training. The learning objectives of this module include: [1] understanding the biomechanical and aesthetic principles of the single crown preparation; [2] understanding the relationship of the single crown in the patient's occlusal scheme for functionality and health; and [3] application of knowledge in the technical requirements of cutting a crown preparation. Both cohorts were taught by the same instructors using the same curriculum material.

The Test cohort was divided into groups of 8 students and assigned portions of the recommended text from which to construct at least 10 MCQs during the 6 month module, according to the learning objectives. The quality and accuracy of the questions submitted were assessed and revised under the supervision of the two MCQ-construction trained staff members (WW & PY). These staff provided students regular

feedback on questions and concepts. The completed MCQs were made available to the entire cohort.

At the end of the module, both earlier and later cohorts undertook a "closed-book" time-limited (1.5 h) essay writing examination that was administered as part of the end-of-module assessment. This examination comprised of 2 essay questions selected from a Module Resource Bank. Students were blinded to the fact that one of the two essay questions (Question 1) was identical in both Test and Control cohorts.

### *(D) Assessment of the quality of essays*

A expert prosthodontic examiner with more than 20 years' experience, not involved in teaching these 2 cohorts and blinded to the students submitting the essays, was assigned the task of grading the de-identified and randomized essays. Grades were awarded for accuracy of content and application in prosthodontic practice, as well as fluency. The grades were analysed using 2-sample t-test in SPSS (Statistical Package for Social Science, v21, IBM, USA).

## Results

Mean grade (based on a passing grade of 50 and a maximum of 100) for the Test cohort was 73.0±8.0 and the mean grade for the Control cohort was 63.6±11.8. The difference was statistically significant ($p<0.001$).

In the Control cohort, the number of students scoring ≥75 (Grade A) was 10 (20.8%); between 65 and 74 (Grade B) was 13 (27.1%) and <65 (Grade C) was 25 (52.1%) which includes 5 (10.4%) students failing (≤49 marks). In the Test cohort, the number of students scoring A was 26 (54.2%), scoring B was 15 (31.3%) and scoring C was 7(14.6%) with no failures. These differences were also statistically significant ($p<0.0001$).

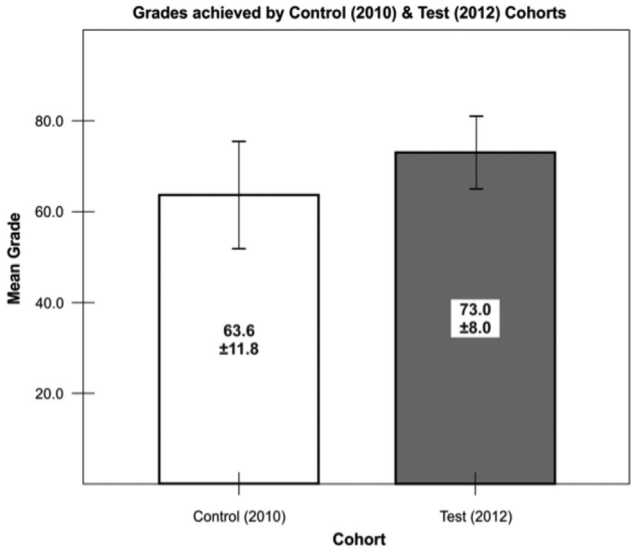


**Fig. 2 – Mean and standard deviation between control and test cohorts.**

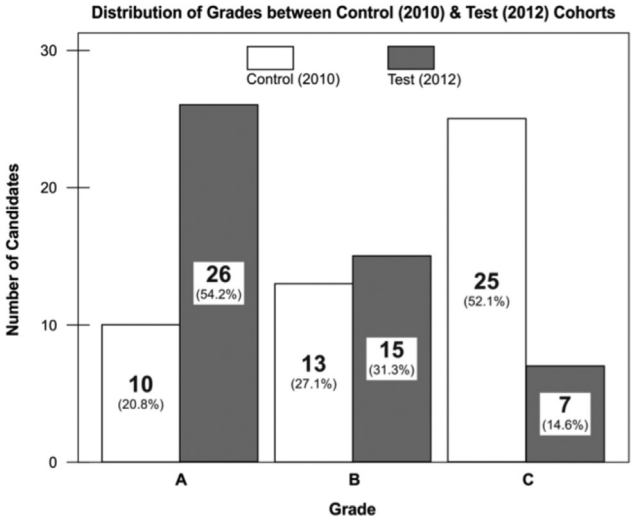


**Fig. 3 – Essay results by grade between 2 cohorts.**

## Discussion

This study set out to ask the question of whether students taught to construct MCQs to an acceptable standard for testing, would be better equipped to write essays in an examination. The results showed that the Test group wrote better examination essays compared to the Control group ( Figs. 2 and 3).

Advocates of blended learning in dentistry showed the merit of empowering students to navigate and integrate the vast amount of knowledge from multiple sources at a time and pace comfortable to students with different learning styles. Students learn more effectively when given the opportunity to gather information from sources in addition to the traditional classroom teaching [15,16]. However, students lack the experience to assess quality of the information and the judgment needed to apply relevant knowledge to provide consistent and predictable dental care to patients in a timely manner. Constructing MCQs requires a factual understanding of a subject matter, an ability to integrate information relevant to the subject, as well as the ability to identify contrasting ideas [3,13]; a burden often borne by teachers and examiners who assess students using MCQs. While studying for an MCQ examination could lead to fragmented learning of knowledge and recall of facts without higher cognitive integration of knowledge [2,3], constructing an MCQ with a single correct and 3 other plausible but unacceptable responses could deepen understanding and clarify misconceptions [13,14]. Based on the principles of flexibility and autonomy in blended learning, the strength of this study lies in giving students the opportunity to take on the role of an "examiner" while enjoying the guidance of expert clinicians as mentors in the safe environment of the classroom. Students also benefitted from working in groups, challenging one another with different viewpoints and insight. This empowerment could enhance intrinsic motivation, spurring students to integrate knowledge and hone higher cognitive abilities [17].

This work suggests that a foundational belief that a basic working knowledge of subject matter and topic-specific jargon is required before meaningful understanding can take place. Construction of MCQs is a possible way to achieve this

foundation and favourable essay outcomes an indicator of meaningful understanding.

A potential limitation of this study lies in the single examiner grading the essays. However, grading was conducted in a blinded and randomized manner; the essay question tested mainstream and foundational knowledge in the practice of prosthodontics; and the examiner is also an experienced teacher and clinician. While it could be argued that the expected standards of the written essays are high, the same standards are applied to both the Test and Control cohorts.

Another potential limitation could be the different cohorts of students assigned to the Test and Control groups. However, age and gender distributions, as well as university entrance grades were the same in both groups. The curriculum taught to both groups was also similar.

In conclusion, students with training and experience in construction of MCQs performed better at closed-book, time-limited written essay assessment under examination conditions, compared with students of similar educational ability and backgrounds, but without experience in MCQ construction.

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## REFERENCES

[1] S.L. Fowell, J.G. Bligh, Recent developments in assessing medical students, Postgrad. Med. J. 74 (1998) 18–24.
[2] S.W. Draper, Catalytic assessment: understanding how MCQs and EVS can foster deep learning, Br. J. Educ. Tech. 40 (2009) 285–293.
[3] E.J. Palmer, P.G. Devitt, Assessment of higher order cognitive skills in undergraduate education: modified essay or multiple choice questions? Research Paper, BMC Med. Educ. 7 (2007) 49.
[4] A.M. Brady, Assessment of learning with multiple-choice questions, Nurse Educ. Pract. 5 (2005) 238–242.
[5] K. Mann, J. Gordon, A. MacLeod, Reflection and reflective practice in health professions education: a systemic review, Adv. Health Sci. Educ. 14 (2009) 595–621.
[6] J. Hattie, H. Timperly, The power of feedback, Rev. Educ. Res. 77 (2007) 81–112.
[7] G.R. Norman, C.P.M. van der Vleuten, E.D. Graaff, Pitfalls in the pursuit of objectivity: issues of validity, efficiency and acceptability, Med. Educ. 25 (1991) 119–126.
[8] K. Scouller, The influence of assessment method on students' learning approaches: multiple choice question examination versus assignment essay, High. Educ. 35 (1998) 453–472.
[9] L.W.T. Schuwirth, C.P.M. van der Vleuten, Different written assessment methods: what can be said about their strengths and weaknesses?, Med. Educ. 38 (2004) 974–979.
[10] H.L. Roediger, J.D. Karpicke, Test-enhanced learning, Psychol. Sci. 17 (2006) 249–255.
[11] M.A. McDaniel, H.L. Roediger, K.B. McDerott, Generalizing test-enhanced learning from the laboratory to the classroom, Psychon. Bull. Rev. 14 (2007) 200–206.
[12] D.P. Larsen, A.C. Butler, H.L. Roediger, Test-enhanced learning in medical education, Med. Educ. 42 (2008) 959–966.
[13] E. Palmer, P. Devitt, Constructing multiple choice questions as a method for learning, Ann. Acad. Med. Singap. 35 (2006) 604–608.
[14] P. Denny, A. Luxton-Reilly, J. Hamer, The peerwise system of student contributed assessment questions, in: Proceedings of the Tenth Australasian Computing Education Conference (ACE2008), Wollongong, Australia.
[15] NUS Internal Blended Learning Online Course. ⟨http://community.nus.edu.sg/ibloc/iBLOC_FAQs_2016.html⟩. (accessed 26.01.2016).
[16] Christensen Institute for Disruptive Innovation: Blended. ⟨http://www.christenseninstitute.org/blended/⟩. (accessed 26.01.16).
[17] P. Anderson, J. Beeley, P. Manarte Monteiro, H. de Soet, S. Andrian, B. Amaechi, M.-C.D.N.J.M. Huysmans, A European core curriculum in cariology: the knowledge base, Eur. J. Dent. Educ. 15 (Suppl. 1) (2011) 18–22.

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1. Chew MT, Sandham A. An assessment of orthodontic treatment using occlusal indices. *Singapore Dent J* 2001;24: 9–16.
2. Smith RN, Rawlinson A, Lath D, Elcock C, Walsh TF, Brook AH. Quantification of dental plaque on lingual tooth surfaces using image analysis: reliability and validation. *J Clin Periodontol* 2004;31:569–73.
3. Olszewski R, Reychler H. Limitations of orthognathic models surgery: theoretical and practical implications. *Rev Stomatol Chir Maxillofac* 2004;105:165–9. [In French]

Books:

1. Stevens J. *Applied Multivariate Statistics for the Social Sciences*, 3rd edition. New Jersey: Lawrence Erlbaum Associates, 1996.
2. Sapp JP, Eversole LR, Wysocki GP. Infections of Teeth and Bone. In: Sapp JP, Eversole LR, Wysocki GP. *Contemporary Oral and Maxillofacial Pathology*, 2nd edition. St Louis: Mosby, 2004:70–93.

Report:

1. Committee on Mercury Hazards in Dentistry. *Code of Practice for Dental Mercury Hygiene*. London: Department of Health and Social Security, 1979, publication no. DHSS 79-F-372.

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