BMC Research Notes

RESEARCH NOTE

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Single versus two dental implants retained mandibular over dentures: comparison of function, patient satisfaction, oral health–related quality of life and success of treatment

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Abstract

Objective To compare the effectiveness of prosthetic rehabilitation of edentulous patients using conventional complete dentures (CD), single median dental implant retained over dentures (SIMOD) with over dentures retained by two dental implants (TIMOD).

Methods Thirty completely edentulous patients (fifteen each arm) presented to the Faculty of Dental Sciences, University of Peradeniya were randomly selected for the SIMOD or TIMOD groups. Patients were initially provided with CD. Surgical implant placement and prosthetic procedures were conducted at the Faculty of Dental Sciences. Osseointergration was confirmed, healing caps and then ball attachments were fixed on the implants. Clinical outcome was assessed by clinician, patient, and oral health related quality of life (OHRQOL) using OHIP-14 scale. Data were analyzed using Minitab $P < 0.05$ was considered as statistically significant level.

Results Patient comfort, esthetics, chewing, speech, general satisfaction, denture retention, stability, and support with TIMOD & SIMOD had been significantly increased than CD ($p < 0.05$) at 3, 6 months, and 1 year review. OHIP-14 scale showed statistically significant improved oral health related quality of life with SIMOD and TIMOD compared to CD.

Conclusion SIMOD & TIMOD have improved outcome assessed by the patient and clinician and OHRQOL of the individual than CD. SIMOD can also be considered for successful management of completely edentulous patients.

Keywords Single implant, Two-implant, Overdentures, Implant retained over dentures, OHIP-14, Patient outcomes

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Introduction

Edentulism constitutes significant challenges in prosthodontic management and can have an intense impact on an individual's quality of life. Traditional complete dentures have long been used to treat completely edentulous patients. However, they frequently present challenges such as instability and poor retention, causing discomfort and anxiety, especially with mandibular dentures [1]. Some find it dificult to adapt due to various reasons such as compromised denture bearing area mainly in the mandibular arch which led to seek other opportunities of prosthetic management for such patients [2]. Emergence of dental implants as an option for providing support for removble prostheses could be consiered as a giant step towards managing such patients. This transformation enabled the clinicians to explore the therapeutic possibilities such as single or two implant retained complete dentures and even the use of tilted implants such as "all on 4 " techniques which were inroduced quite lately [3]. Implant-supported complete dentures improve the quality of life of edentulous patients compared to conventional complete dentures (CD) [4]. Many have recommended using two-implant retained mandibular over dentures (TIMOD) as the first choice in standards of care for an edentulous mandible [5, 6]. However, it may become unrealistic for the edentulous patients especially elderly from developing countries such as Sri Lanka considering the higher cost involved. In the light of this challenge, the concept of single implant retained mandibular over denture (SIMOD) was introduced by Cordioli in 1993. Good surgical as well as prosthetic success rates and better patient satisfaction than conventional dentures have been reported with SIMOD. [7, 8] According to a systematic review and a meta-analysis, a cumulative survival rate of 96.6% over a mean follow-up period of 37.3 months is evident with implant retained overdentures. The procedure used (SIMOD vs. TIMOD) did not affect dental implant failure (P = 0.45) or prosthetic failure [9]. According to another study, implant survival rate has also been calculated as high with the SIMOD compared to TIMOD [8]. Therefore, it is considered as a suitable and cost-effective treatment option over a conventional denture [10]. Further, a total of 19 studies on SIMOD, with a mean follow-up period between 6 months and 9 years reporting on 547 patients were considered by Passia and Carn in 2023 and the authors concluded a survial rate ranging from 82.4% to 100%. They concluded that the main indication for this therapy option is when the use of multiple implants is not possible for financial or other reasons [11]. Compared to conventional dentures, ovedentures have proven records with enhanced masticatory forces, chewing efficinecy, aethetics, patient comfort and preservation of residual alveolar ridge enabling improved denture retention and stbility [12]. Considering the economic deprivation and substandard living conditions of the elderly population in Sri Lanka, it is prudent to assess the effectiveness of SIMOD and incorporating the implant supported overdenture options available to the society aiming at improving the quality of life of people in the country (Fig. 1).

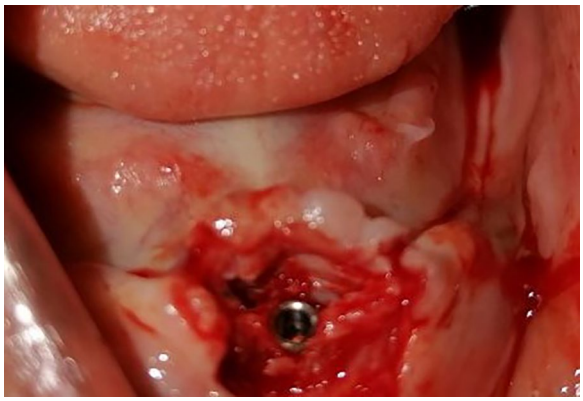

Fig. 1 .

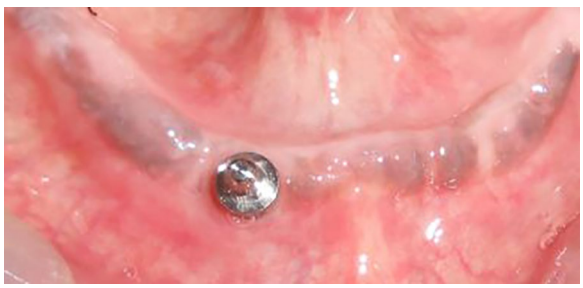

Fig. 2 .

In this milieu, the general objective of the study was to assess the effectiveness of prosthetic rehabilitation of edentulous mandible with SIMOD with TIMOD compared to CD. Specific objectives were to assess differences in SIMOD, TIMOD and CD in relation to patient assessment, clinician assessment and oral health related quality of life (OHRQOL). Research null hypothesis was defined as there is no difference between SIMOD and TIMOD considering patient function, satisfaction and oral health related quality of life (Fig. 2).

Main text

Materials and methods

Thirty-five completely edentulous patients who had been placed on a waiting list to consider implant supported over dentures in the Department of Prosthetic Dentistry, Faculty of Dental Sciences, University of Peradeniya were initially selected for the study. These

patients had already been screened to ensure that they are medically fit to undergo implant therapy. CBCT assessment of edentulous mandible was conducted by a single specialist in the field of maxillofacial radiology to explore their suitability to receive either treatment option. Thirty patients selected following the CBCT assessment were divided randomly into two groups using a computer-generated list. Patients in group A were to be provided with SIMOD while the patients in Group B were to be provided with TIMOD. Ethical clearance was obtained from the Ethics Review Committee, Faculty of Dental Sciences, University of Peradeniya, Sri Lanka. (ERC/FDS/UOP/I/2019/18) Written informed consent was obtained from all the participants prior to the study. All patients were provided with conventional complete dentures (CD) following routine fabrication procedures. They were allowed to wear the conventional dentures for minimum 3 months and the self-administered questionnaires about self-assessment of outcome in denture usage were distributed for data collection (Questionnaire reveals this in more details [Additional file 1]). Conventional dentures for the maxillary arch were kept without any change. The study was funded by the Peradeniya University research grant. As per the university procurement procedures the implant system with the lowest price quotation had to be selected. Hence Nucleoss T6 Dental Implantswere used for all the patients. Specific diameter and length for the implants were selected as per the findings of CBCT reports. Mucoperiosteal flaps were raised for implant placement under local anaesthesia in the canine or first premolar region for the TIMOD group whereas in the midline of the mandible for the SIMOD group and the implants were placed. Care was taken not to damage any vital structure in the vicinity. Immediate IOPA radiographs of the site were taken. Patients were reviewed over the phone in one day and physically in one week. They were reviewed again in 3 months, and radiographs were taken. Once successful osseointergration was confirmed following standard guidelines, healing caps were placed. Ball abutments were selected considering the collar height and the prosthetic platform. Two weeks later, ball abutments were fixed onto the implant fixtures and mandibular dentures were modified with cold cure acrylic to accommodate metal housings on the fitting surfaces. Patients were reviewed at 3 months, 6 months and 1 year with the implant supported dentures for clinical outcome assessed by the clinician (retention, stability, support of the overdenture and success of the treatment), by the patient (self-administered questionnaires), oral health related quality of life using OHIP-14 scale [13] (Additional file shows more details [Additional file 2]), and patient satisfaction with the prosthesis using a questionnaire. Data were analyzed using Minitab. $P < 0.05$ was considered as statistically significant level (Fig. 3).

In this study, a complete enumeration sampling method is used due to the limited availability of data at the hospital. Each group, namely, patients with two implants and one implant, consist of 15 individuals. Inclusion of all the available data points provided comprehensive information to assess the objectives of the study. This method eliminates sampling bias and ensures that the results are fully representative of the collected data. Alongside graphical representations, the Wilcoxon Signed-Rank test was used to compare paired samples and assess the differences among the quality-of-life factors before and after the implants. A non-parametric test was chosen due to the smaller sample sizes while relaxing the normality assumption of data. Additionally, the Mann–Whitney test was applied to compare differences between two independent groups, patients with two-implants and one-implant. The respective test is the non-parametric alternative to the two-sample t-test and compares whether the medians of two independent groups are statistically significant or not.

Results

Comparison between outcome of TIMOD and CD

Patient comfort, aesthetics, chewing ability, speech, general satisfaction, denture retention, stability, and support were assessed with TIMOD at 3 months, 6 months, and 1 year after denture delivery. Wilcoxon signed-rank test indicated that the aesthetic and functional outcomes of TIMOD were superior compared to conventional dentures (CD). Both patient and clinician evaluations showed improvements in all outcomes with TIMOD. (Table 1, Additional file 3).

Fig. 3 .

Table 1 Outcome of TIMOD and SIMOD when compared with outcome of CD at 3 months, 6 months and 1 year review considering patients' and clinicians' evaluation

	TIMOD				SIMOD		
	Variable	**p-value (3 months review)**	**p-value (6 months review)**	**p-value (1 year review**	**p-value (3 months review)**	**p-value (6 months review)**	**p-value (1 year review**
Patient evaluation	Comfort	0.001	0.001	0.004	0.003	0.006	Did not have sufficient number of patients at follow up of one year
	Aesthetics	0.006	0.011	0.09	0.006	0.135	
	Chewing	0.002	0.002	0.004	0.007	0.007	
	Speech	0.006	0.007	0.028	0.016	0.018	
	General satisfaction	0.002	0.001	0.004	0.004	0.002	
Clinician evaluation	Retention	0.002	0.002	0.003	0.003	0.003	
	Stability	< 0.001	< 0.001	0.003	0.002	0.002	
	Support	0.001	0.001	0.004	0.004	0.006	

Comparison between outcome of SIMOD and CD

The outcome in patient (patient comfort, aesthetics, chewing, speech, and general satisfaction) and clinician evaluation (mandibular SIMOD retention, stability, and support) had been significantly improved in all parameters with SIMOD than conventional dentures ($p < 0.05$) at 3 and 6 months review. Wilcoxon-signed rank test was used to check whether the assessment score with single implant retained mandibular overdentures (SIMOD) is higher than assessment score with conventional dentures (CD). (Table 1, Additional file 4). We were unable to complete adequate number of reviews for 1 year duration after the treatment with SIMOD.

Table 1 represents the p value of outcome of TIMOD and SIMOD when both were compared with CD in relation to patient evaluation (patient comfort, aesthetics, chewing, speech and general satisfaction) and clinician evaluation (outcome in relation to retention, stability and support in mandibular complete dentures).

Comparison between outcome of TIMOD and SIMOD

Patient assessment and clinician evaluation of outcome of TIMOD group was compared with SIMOD group. Although 1 year review had been planned, we were unable to carry out 1 year review for SIMO group due to unavailability of sufficient number of cases with SIMOD. Nonparametric two sample test (Mann–Whitney U test) was performed. There was a statistically significant difference between the outcome of TIMOD and SIMOD groups making better outcome for TIMOD group in relation to patient comfort. However, when patients' evaluated aesthetics, chewing, speech, and general satisfaction and clinician evaluated denture retention, stability and support were considered, there was no statistically significant difference between the two groups. (Table 2) Moreover, denture assessment was carried out for both TIMOD and SIMOD groups and statistical significance could not be assessed as all the observations were zeros.

Table 2 represents the p value of outcome with TIMOD when compared with outcome of SIMOD in relation to patients' evaluation of comfort, aesthetics, chewing, speech and general satisfaction and clinicians' evaluation in relation to retention, stability and support in mandibular complete dentures.

Further, oral health related quality of life (OHRQOL) was assessed in all groups using OHIP-14 scale (Version with Sri Lankan language as it was clearly accepted by all the patients). Wilcoxon signed rank test was used to evaluate whether the median quality of life had been increased after provision of implant retained overdentures (SIMOD and TIMOD) compared to CD. The results revealed that OHRQOL had been improved with TIMOD and SIMOD when compared with conventional dentures (CD) and the difference was statistically significant ($p < 0.05$). However, no statistically significant difference was observed between the outcome of TIMOD and SIMOD groups except the finding of higher patient comfort at 3 months review in the TIMOD group. (Table 3).

Table 3 represents the p values when all fourteen items of OHIP-14 scale of TIMOD and SIMOD groups were compared with CD.

Discussion

Replacing missing teeth aims to restore function, aesthetics, and quality of life. Although the removable and fixed options are available to replace missing teeth, a variety of factors such as patient preference, economical constraints and available resources determine the options considered by the individual. According to the results of 2015–16 National Oral Health Survey, Sri Lanka, there were 11.3% completely edentulous people in the age group of 65–74 years. However, only 3.1% wore

Table 2 Comparison between outcome of TIMOD with outcome of SIMOD at 3 months, 6 months review considering patients' and clinicians' evaluation

	Variable	p-value	Conclusion
TIMOD group			
Patient evaluation (3 months)	Comfort	0.043	There is a significant difference between the median assessment difference between two implants and one implant making better outcome for TIMOD group
	Aesthetics	0.831	No significant difference between the median assessment difference between two implants and one implant
	Chewing	0.212	Same as above
	Speech	0.756	Same as above
	General	0.976	Same as above
Clinician evaluation (3 months)	Retention	0.479	Same as above
	Stability	0.807	Same as above
	Support	0.269	Same as above
SIMOD group			
Patient evaluation (6 months)	Comfort	0.132	No significant difference between the median assessment difference between two implants and one implant
	Aesthetics	0.163	Same as above
	Chewing	0.374	Same as above
	Speech	0.716	Same as above
	General	0.775	Same as above
Clinician evaluation (6 months)	Retention	0.789	Same as above
	Stability	0.278	Same as above
	Support	0.534	Same as above

Table 3 Improvement of OHRQOL when patients were managed with TIMOD and SIMOD compared to CD in the study

OHIP14 scale	TIMOD P value	SIMOD	
1	0.0017	0.0026	Wilcoxon signed rank test was used to evaluate whether the median quality of life has been increased after the provision of implant retained prostheses (SIMOD and TIMOD). All the p-values were less than 0.05 indicates that the improvement of OHRQOL was statistically significant in both SIMOD and TIMOD groups compared to CD
2	0.0096	0.0058	
3	0.0007	0.0017	
4	0.0006	0.0027	
5	0.0011	0.0026	
6	0.0007	0.0017	
7	0.0007	0.0017	
8	0.0007	0.0018	
9	0.0006	0.0016	
10	0.0017	0.0041	
11	0.0017	0.0069	
12	0.0011	0.0017	
13	0.0007	0.0016	
14	0.0011	0.0024	

complete dentures for both arches [14]. Further, use of implant retained overdentures is never assessed in the national survey as minimal number of patients select for the option due to the high cost involved. This highlights the economical constraints and non-availability of the treatment options for replacing missing teeth for elderly patients in the socio-economically deprived countries like Sri Lanka. Although most edentulous patients seem to benefit from conventional complete dentures and they report satisfactory oral and masticatory functions with their use, it is common to find patients who become devastated due to poorly adapted to their dentures. The challenges are overwhelming in the edentulous mandible compared to edentulous maxilla.

Rehabilitation of the edentulous mandible by implant supported prosthesis is a successful and satisfying treatment as suggested by many clinical trials. [2] However, the minimum number of implants required for this rehabilitation seems to be controversial.

However, economic constraints make this treatment option financially challenging, especially for the rising elderly population in many countries. [14–16] In order to reduce the cost and time of treatment, the concept of single implant-retained overdenture has been recommended by many clinicians. A cost comparison study between an unsplinted two implant retained mandibular overdenture and a conventional complete mandibular denture showed the direct cost of the overdenture to be 2.4 times the cost of the conventional complete denture. [17] A study by Walton et al. compared the treatment costs of overdentures supported by one or two implants. It further estimated the chair side time involved in the fabrication of each. The two-implant overdenture cost 1.75 times more than Single implant retained overdenture (SIMOD). SIMOD has gained popularity as a simple cost cost-effective protocol that is very suitable, especially for financially challenged elderly edentulous patients. [7] Therefore, it is prudent to study the possibility of using SIMOD for edentulous patients in Sri Lanka.

Our study has assessed the patients' perception regarding comfort, esthetics, chewing, speech, and general satisfaction; clinician's evaluation of denture retention, stability, and support of conventional dentures, with TIMOD and SIMOD at reviews. All variables in both TIMOD and SIMOD were shown to be significantly higher compared to CD at similar reviews. (These observations are comparable with the previous reports which concluded the same. [18] Further, this difference in outcome could be explained with literature findings that overdentures have shown improved chewing efficiency, aesthetics, comfort and superior retention and stability of prostheses compared to conventional dentures [12]. Moreover, implant retained overdentures have proven to be more cost efficient and prudent than tooth retained complete dentures. [19]

In this study, when TIMOD and SIMOD were compared for the same parameters, it has been shown that there is a statistically significant difference only about the patient perceived comfort at 3 months review. There was no statistically significant difference with any other parameter either at the 3 months or 6 months review. It is possible that the patients' perceived comfort to be greater with TIMOD during the initial learning period as opposed to SIMOD. This is discussed in a Malaysian study as it is reported that all the subscales indicated a similar trend except the "psychological discomfort" which had shown a greater reduction in the scores with the SIMOD compared with the TIMOD. This could not be explained as why only "psychological discomfort" was improved to a greater extent with the TIMOD. [20] A systematic review and a metal analysis concluded that the implant survival of SIMOD is not significantly different from TIMOD. As described in the literature, single implant-retained overdentures have become popular recently due to their lower costs, less tissue stress, minimized surgical procedures, reduced associated morbidity, and less post-surgical maintenance [11]. However, as the existing scientific evidence in the literature in prospective comparative studies is less, clinicians have recommended long-term observations with a larger range of functional, prosthodontic, and patient-described outcome measures before recommending SIMOD as a treatment modality [21].

This study also assessed the OHRQL with CD, TIMOD and SIMOD during reviews. OHIP-14 scale showed statistically significant improved OHRQoL with TIMOD and SIMOD when compared with CD. This fact is well described in a systematic review as retention, stability, comfort, speech and chewing efficiency being improved drastically with implant retained mandibular complete dentures, with enhanced patient's satisfaction and a better OHRQoL than conventional ones [22]. Further, our finding is comparable with a randomized controlled study done in Malaysia, where it has been shown that compared to baseline OHIP-14 scores, participants had a statistically significant decrease in total OHIP-14 at 1 month and 1 year review in SIMOD and TIMOD groups ($P < 0.05$) [18]. Other studies also have identified comparable results in improvement of OHRQoL with SIMOD and TIMOD groups [23]. A systematic review and a meta-analysis of randomized controlled studies had described that all implant supported overdentures improve various aspects of QOL of edentulous patients than conventional dentures [24]. A systematic review in 2021 had reported that the edentulous patients restored with SIMOD had improved OHRQoL and general satisfaction compared to those with conventional complete dentures (CD) [25]. However, contrary to our findings, the improvement of masticatory efficiency was controversial in this study. Like our findings, TIMOD and SIMOD showed no significant differences regarding general satisfaction and satisfaction with speech, comfort, chewing ability, aesthetics, and social life [25]. Another systematic review with meta-analyses highlighted the fact that the mandibular implant-retained overdentures showing statistically significant improvements in the patients' general satisfaction, OHRQoL, and chewing ability, over the patients with complete dentures [26]. A recent study found that patients experienced significant improvements in all

assessed areas following rehabilitation. The study highlighted that converting a removable prosthesis into an implant-supported one can enhance patients' quality of life, with notable benefits in chewing ability, aesthetics, and self-satisfaction [27]. However, in the present study, a significant difference was observed with more patient comfort with TIMOD than SIMOD at 3 months review. It could be due to the improved stability of the mandibular denture with support from two implants at the initial time of denture wear before development of neuromuscular control for the improved outcome in mandibular complete dentures.

Use of ball attachments as the retention components in SIMOD and TIMOD have been well described in the literature with advantages of ease of maintenance of hygiene around the site, low cost, minimum chair-side time for fitting and modifications and ease of replacement of components if required [28]. Therefore, it was justified to use ball attachments in the present group of patients.

Conclusions

Single and two implant retained mandibular overdentures improve outcome assessed by the patient and clinician and oral health related quality of life of the individual than conventional mandibular complete dentures. Single implant retained mandibular overdentures can also be considered for improved outcomes in the management of completely edentulous patients.

Limitations

This study involved a small group of patients, so the findings may not be generalizable to a larger population. Additionally, the participants were selected from the hospital's waiting list register, which may not equally represent individuals from all regions of the country. Variations in lifestyle and undiagnosed medical conditions among participants could also influence the results. Moreover, not everyone in the country undergoes regular health check-ups, and some may ignore or conceal medical conditions, even at dental clinics. Only one brand of dental implants was used throughout the study, so the outcomes may differ with other available brands. Therefore, a large-scale population study is recommended to gain a more comprehensive understanding of how the number of implants affects patient outcomes in managing mandibular implant-supported complete overdentures.

Abbreviations

SIMOD Single implant retained mandibular over dentures.
TIMOD Two implants retained mandibular over dentures.
CD Conventional mandibular complete dentures

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13104-024-07040-y.

Additional file 1: The sheet contains details related to patient self evaluation of prosthetic outcome with 1 implant/ 2 implants retained mandibular ovr denture and conventional mandibular over denture. Clinican evaluation data sheet includes prosthetic outcome assessed by the clinician.

Additional file 2: The questionnaire outlines the assessment of OHRQOL using OHIP-14 scale

Additional file 3: Graph 1: Comparison between outcome before TIMOD and after TIMOD at 3months, 6 months and 1year review according to patient and clinician evaluation. Graph 1 depicts the improvement of patient evaluated comfort, aesthetics, chewing and general satisfaction and clinician evaluated denture retention, stability and support at 3months and 6 months with provision of TIMOD for the mandibular complete dentures.

Additional file 4: Graph 2: Comparison between outcome before SIMOD and after SIMOD at 3months, 6 months and 1year review according to patient and clinician evaluation. Graph 2 depicts the improvement of patient evaluated comfort, aesthetics, chewing and general satisfaction and clinician evaluated denture retention, stability and support at 3months and 6 months with provision of SIMOD for the mandibular complete dentures.

Acknowledgements

Ms. G.R.S. Subhashini, Ms. S.K.Rajapaksha, Ms. K.Vijayakumari, Ms. M.G.R.P. Mahawatta, Ms. W.M.R.C Walisundara, Mr. A. Galpotthegedara, Mr. K.A.N.S.. Perera, Mr. J.G.D.G. Edirisinghe, Mr...B.G.J.C. Gunathilake, Ms. B.H.M.Gunathilake, Ms. P.M.K.Sunethra, Mr. P.W.M.B Uduwawala, Ms. R.M.L.M.B Abeykoon, Ms. S.Bandara ,Ms. B.K.L.Perera , Mr. W.M.P.A Walgampaya, Mr. W.M.P.B. Weerasooriya, Mr. J.D.N.Jayarathne, Ms. A.C.K. Abeykoon, Mr. A.M.N.K. Adikaram, Ms. M.I.K.Kulasooriya, Ms. S.H.A. Padmini are acknowledged for the kind assistance with clinical and laboratory procedures.

Author contributions

RMJ: Conceptualization, Methodology, Investigation, Writing—original draft, Writing—review & editing, Project administration. MA: Methodology, Supervision, Writing—review & editing, Funding acquisition MCNF: Methodology, Investigation, Writing—review & editing, Data curation SPA: Data curation, Formal analysis, Software, Writing—review & editing, Validation IPT: Writing—review & editing, Visualization, Investigation, Methodology RDJ: Conceptualization, Methodology, Investigation, Resources, Writing—review & editing, Writing—original draft, Supervision, Project administration. All authors read and approved the final manuscript before the submission.

Funding

Peradeniya University research grant 'URG/2019/08/D' is acknowledged for funding for the study.

Availability of data and materials

https://doi.org/10.6084/m9.figshare.24916338.

Declarations

Ethics approval and consent to participate

Ethical clearance was obtained from the Ethics Review Committee, Faculty of Dental Sciences, University of Peradeniya, Sri Lanka. (ERC/FDS/UOP/I/2019/18) Written informed consent was obtained from the all the participants prior to inclusion in the study.

Consent for publication

Not applicable.

Competing interests
The authors declare no competing interests.

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Received: 15 April 2024 Accepted: 13 December 2024
Published online: 20 December 2024

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