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Evaluation Of The Effectiveness Of Mobile Apps For Oral Hygiene Care In Dental Undergraduate Students.

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Abstract

Introduction: Plaque is the primary causative factor of oral diseases. Tooth brushing is the most widely accepted mechanical means of plaque control. By combining technology and effective tooth brushing techniques, it will be easier for people to maintain oral health. The mobile app 'EASY BRUSH' was created and used in this study to measure its effectiveness, along with its impact on plaque control, and maintaining oral hygiene.

Material and methods: 100 under-graduate BDS students from the 1st and 2nd year participated in the study, and were divided into control(50) and test groups(50). The control group was demonstrated the modified Bass technique and flossing at the start of the study, While the test group was requested to download the Easy Brush app, instruction were given how to use it while brushing their teeth and flossing. The plaque index(PI), gingival index(GI), and Sulcus Bleeding index(SBI) were recorded at baseline(D0), seventh day(D7), and thirtieth day(D30). In the end, participants were given a questionnaire (Google Form) to complete.

Results: Intragroup comparisons of the plaque index score, gingival index score and sulcus bleeding index score for the control and test groups showed significant reductions. In the intergroup comparison, significant reductions were observed in the PI, GI, and SBI for the test group compared to control group($p<0.05$).

Conclusion: The use of mobile brushing apps such as Easy brush has a significant effect on improving the oral health of users. It educated them about the importance of brushing and flossing and motivated them to practice it correctly.

Keywords: Easy brush app, mHealth, gingivitis, Teeth brushing, mouth wash, flossing

Introduction

In India, the prevalence of oral diseases is high with dental caries and periodontal diseases being the two most commonly reported oral entities[1]. Plaques are the primary causative factor of dental caries and periodontal diseases. It is a soft, tenacious material found on tooth surfaces that is not readily removed by rinsing with water[2]. Failure to practice good oral hygiene results in prolonged accumulation of dental plaque, which potentially increases levels of cariogenic bacteria such as Streptococcus mutans[3,4]. These produce acids that cause enamel demineralization[3,4]and affect periodontal tissues, leading to periodontal diseases. Thus, maintaining good oral hygiene that would aid in plaque control is of utmost importance. The effect of plaque control on gingivitis and periodontitis is well documented, and

tooth brushing twice daily along with the use of other oral hygiene aids prevents the initiation of gingivitis. Gingivitis can be noted within a few days of stopping oral hygiene practices[5]. Tooth brushing is the most widely accepted mechanical means of plaque control due to its effectiveness, convenience, and low cost[6]. Therefore, what if we modernize one step ahead and enhance oral health care by combining effective tooth brushing techniques and technology, thus making it easier for an individual to obtain access and practice it regularly!

Mobile devices are a useful means to deliver health interventions because of their widespread adoption, powerful technical capabilities, and portability. The usage of mobile phones to promote health care is 'mHealth' (mobile health). It is a new term that refers to the use of mobile phones and wireless communication technologies to promote healthcare. This enhances telemedicine, data collection, and decision making, provides simple and fast access to healthcare information, promotes a fast response system in emergencies, helps to control patient conditions, and improves patient compliance with treatment[9]. The increasing use of smartphones has led to explosive growth in the usage of smartphone applications (apps) aiming to promote health status and hygienic behavior.

The main aim of the study was to measure the extent to which mHealth was beneficial and effective and its impact on plaque control, thus maintaining overall oral hygiene. Additionally, it is effective in educating and motivating young adults in maintaining oral hygiene. The app named 'EASY BRUSH' was created and used in this study.

Materials And Methods:

This study was performed in Dept. of Periodontology MGV Dental College and Hospital, Nashik. Ethical committee approval was obtained from KBH Dental College- Institutional Ethics Committee.

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This was a randomized control trial; which was carried out in 100 participants who were 1st- and 2nd-year dental undergraduate students from dental college. Voluntary participants were included and informed verbal and written consent was obtained from each participant. The study subjects were selected according to the following inclusion and exclusion criteria:

Inclusion Criteria:

Each participant must have at least 20 teeth present. Participant must have a mobile phone, tablet, or any other smart device. Individuals suffering from gingivitis following routine oral hygiene.

Exclusion Criteria:

Participants undergoing any kind of dental treatment that would hamper tooth brushing on a regular basis and not willing to participate in the study.

After the selection of the participants, simple random sampling was performed, and participants were divided into two groups, i.e., the control and test groups**.** The plaque index (Silness and Loe 1964), gingival index (Loe and Silness 1963), and gingival sulcus bleeding index(Muhelmann and H R Sons) of each participant were recorded at baseline.

1. Control group**:** (50 participants) In this group, participants were explained the modified Bass technique for tooth brushing and the flossing technique by demonstrating on the jaw-set at the onset of the study and were asked to practice routine tooth brushing and flossing twice daily.
2. Test group: (50 participants) In this group, participants were asked to install the EASY BRUSH mobile application on their respective smartphones and were explained the usage of the application. They were asked to use this app twice daily while brushing their teeth and flossing.

The indices were recorded at baseline (D0), on the 7th day (D7), and 30th day (D30). A questionnaire was shared in Google form format with each participant of both groups that recorded their experience, knowledge, education, and motivation throughout the study. The collected sample data were then recorded in MS-excel data sheets and analyzed statistically.

Easy brush mobile application:

"EASY BRUSH" is an application that is available on Google Play-store (*figure 1*) which assists the user in Brushing, Flossing, and using Mouthwash. The app has a specific timer for brushing (3 min), flossing (2 min), and mouthwash (1 min) that allows the user to develop a habit of performing the oral care routine

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for the average required time (*figure 2*). This app also has special icons on the screen, clicked on which leads the user to the YouTube video screen. There are demonstration videos available in Hindi and English languages for brushing, flossing, and using mouthwash. One of the most important features of the app is the FAQ section which contains a detailed explanation of most of the common queries a person may have regarding oral care. Certain questions help bust major myths; for instance, many people consider using mouthwash as an alternative to brushing. This misconception is very well cleared, and there are many more. There are questions regarding diet and its impact on oral health. Thus, the FAQ section makes this app unique in its way.

Figure 1

figure 2

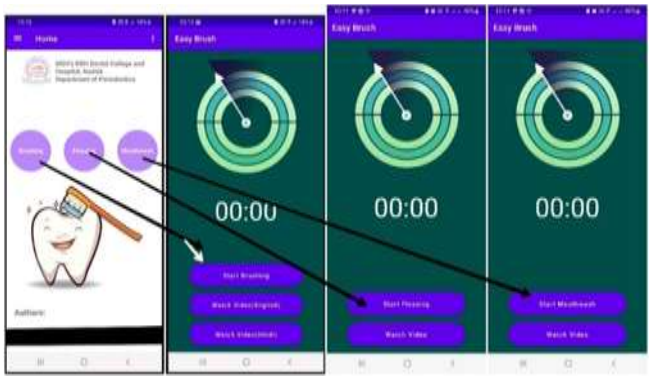

Fig: 3

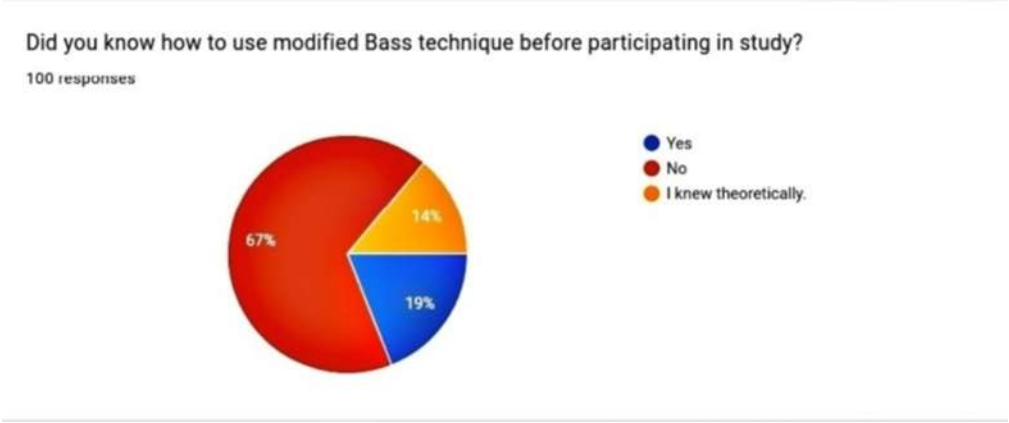

figure 4

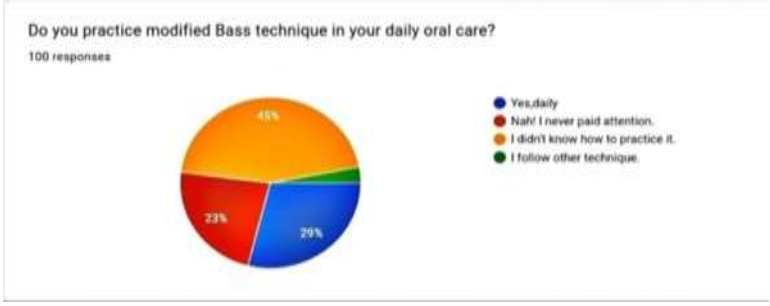

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Figure 5

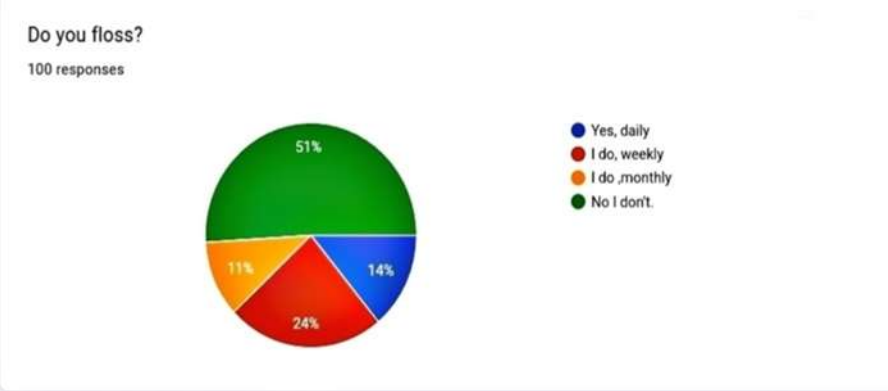

Figure 6

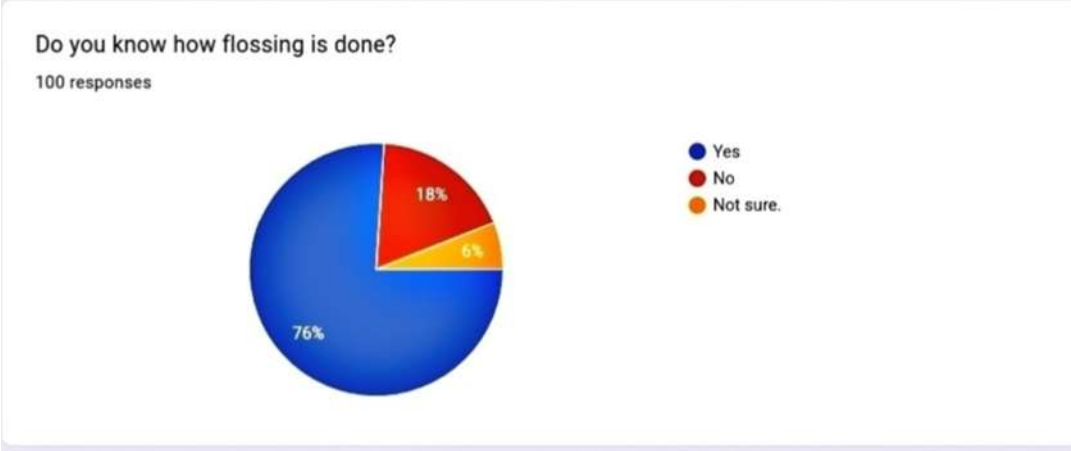

Figure 7

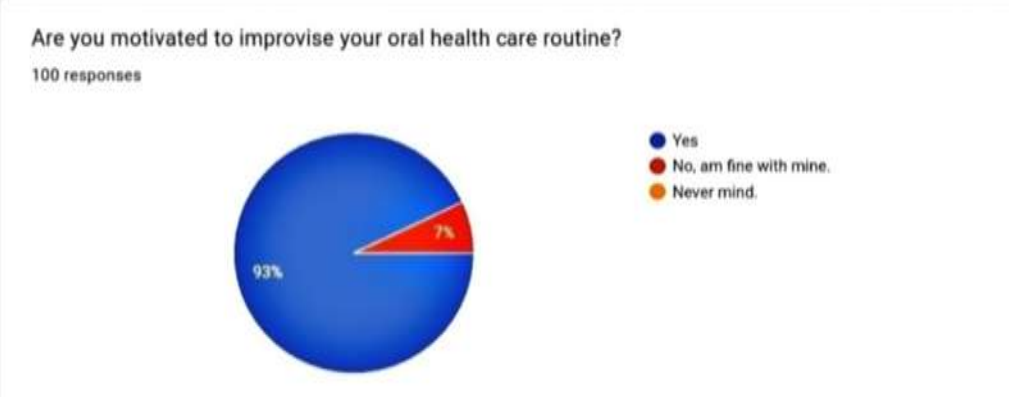

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Figure 8

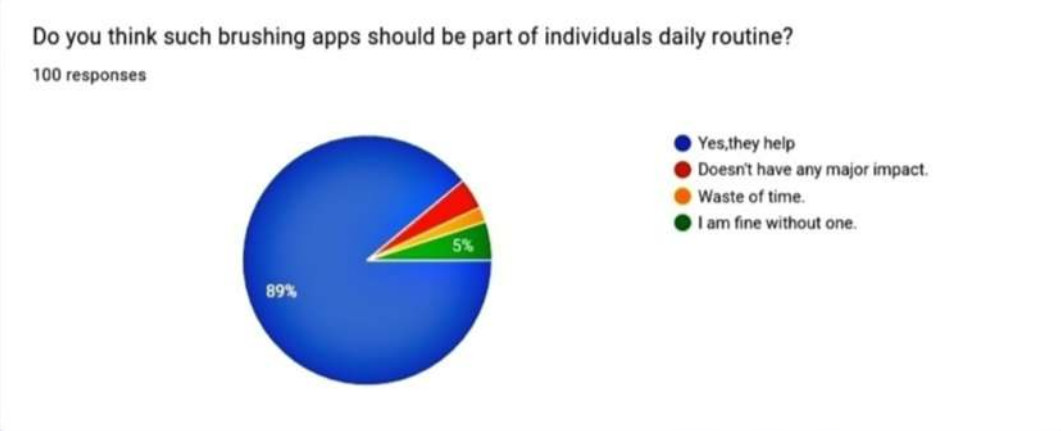
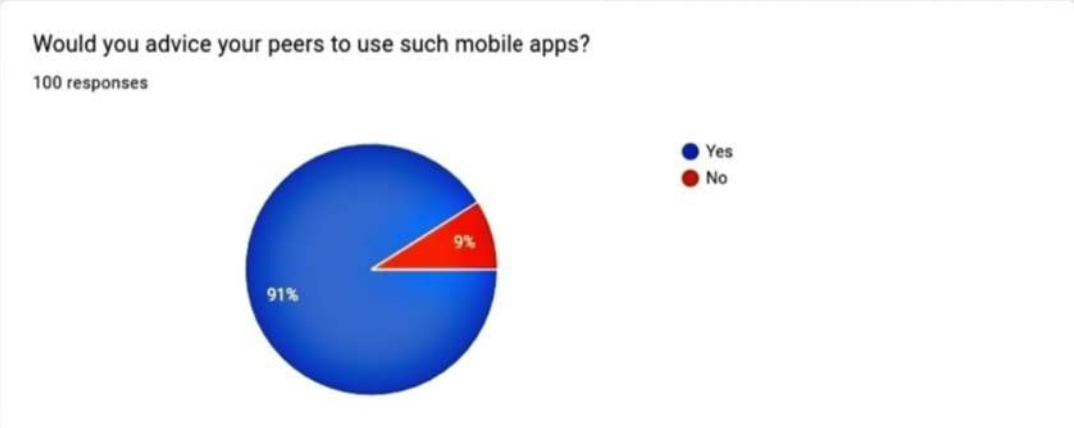


Figure 9



Results:

All data were entered into a computer by a coding system and checked for entry errors.

Data obtained were compiled on an MS Office Excel Sheet (v 2019, Microsoft Redmond Campus, Washington, United States). Data were subjected to statistical analysis using the statistical package for social sciences (SPSS v 26.0, IBM). Descriptive statistics such as the mean and SD for numerical data have been depicted. The normality of numerical data was checked using the Shapiro–Wilk test, and it was found that the data did not follow a normal curve; hence**,** nonparametric tests were used for comparisons. Intergroup comparisons (2 groups) were performed using the Mann–Whitney U test. Intragroup comparisons were performed using Friedman's test (for >2 observations) followed by pairwise comparisons using the Wilcoxon signed rank test. For all the statistical tests, $p<0.05$ was considered to be statistically significant giving power to the study at 80%.

Intragroup comparison of the plaque index score, gingival index score and sulcus bleeding index score in the control group showed a significant reduction in the plaque score for the control group from D0 to D30 ($p<0.05$). No significant reduction was observed in the gingival index score and Sulcus Bleeding index score for the control group ($p>0.05$). Intragroup comparisons of the plaque index score, gingival index score, and Sulcus Bleeding index score in the test group showed statistically significant reductions from D0 to D30. (Table 1, Table 3, and Table 5)

Intergroup comparison of plaque index score, gingival index score, and sulcus bleeding index score. A statistically significant difference was observed in the intergroup comparison of the

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gingival index score and sulcus bleeding index score ($p<0.05$) from D0 to D30. Statistically, no significant differences were observed in the intergroup comparison of plaque index scores ($p>0.05$) from D0 to D30. (Table 2, Table 4, Table 6)

Discussion:

Plaque is a sticky film of bacteria that constantly forms on teeth. Bacteria in plaque produce acid after meals. Acid destroys tooth enamel, causes cavities, and affects gingiva, causing gingivitis (gum disease).Good oral hygiene, including regular brushing and flossing, removes plaque and prevents tartar buildup. In addition to the traditional methods of oral hygiene maintenance, the use of mobile applications may improve oral hygiene, as it notifies a person, provides audio-visual guidance for proper technique, and also allows a user with a fixed timer for brushing, flossing, and mouth rinsing. In this study, after the selection of the participants, simple random sampling was performed, and the participants were divided into two groups, i.e., control group A and test group B.

A significant reduction was seen in plaque score for the control group from baseline to D30 ($p<0.05$). This may be due to the live demo of the "modified Bass technique" on the jaw-set at baseline. Flossing was also demonstrated. This signifies the importance and benefits of the modified Bass technique. According to a study performed by **Ferrera M. P. et al. (2003)**[15], the modified Bass technique was useful for removing supragingival plaque, and it demonstrated that using a toothbrush and flossing thereafter can significantly improve oral cleanliness. A comparison study by **Torkzaban P et al. (2015)**[16] demonstrated how brushing and flossing together increase the likelihood of removing plaque. No significant reduction was observed in the gingival index score and sulcus bleeding index score for the control group ($p>0.05$). This may have occurred because the control group received the demo only once, as they were not able to perform the modified Bass technique effectively. Not only is the technique important but how long it is performed can have a significant impact. A study performed by Creeth J E et al. (2009) [17] explained how brushing for 2 minutes was more effective.

Intragroup comparisons of the Plaque index score, Gingival index score, and Sulcus Bleeding index score in the test group revealed statistically significant reductions in the Plaque index score, Gingival index score, and Sulcus Bleeding index score for the test group from baseline to D30. This signifies that the mobile app helped the user, as they had access to audio-visual aid for watching proper tooth brushing and flossing techniques. It also provided the user with a timer that helped them to perform the procedure for an adequate period.

A statistically significant difference was observed in the intergroup comparison of the gingival index score and sulcus bleeding index score ($p<0.05$) from baseline to D30. This showed that from the start of the study, the test group had no improvement until D7, but it continued to improve. This may have occurred because gingival health improved until D30; thus, it helped reduce sulcus bleeding as well. A longitudinal study by **Lang N P et al. (2009)** [19] showed that dental plaque initiates and promotes gingival inflammation, leading to gingivitis, sulcus bleeding, and periodontitis. Therefore, it infers that regular use of the EASY BRUSH application allows the patient for proper oral hygiene regularly, which helps in controlling dental plaque and can positively affect gingiva and periodontium. A statistically nonsignificant difference was observed in the intergroup comparison of plaque index score ($p>0.05$) from baseline to D30. This advocated that both the control and test groups showed improved plaque index scores.

The questionnaire was provided to all the participants and they were first asked to mention their email address.

The second question revealed that out of 100 students, 58 were 1st-year students and 42 were 2nd-year students. This question was included to ensure that only 1st- and 2nd-year students participated in the study.

In third question (*figure 3*), whether the participants were aware of the modified Bass technique was analyzed. It seems that 67% were unaware of it, whereas 14% were conceptually aware but lacked practical application; only 19% of the participants were proficient in the procedure. This verified that the majority of participants were ignorant of the appropriate brushing technique.

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The fourth question (*figure 4*) questioned whether they practiced the modified Bass technique daily, to which 45% answered that they did not know how to do it. Meanwhile, 23% never paid attention, which means they were not aware of it. However, approximately 29% stated that they practiced the technique daily. There was some minority saying that they practice some other technique.

The fifth question (*figure 5*) was asked about flossing, to which 51% revealed that they do not floss. This inferred why the gingival index showed fewer changes than the plaque index. Interdental plaque is the major cause of gingivitis, as suggested by the study performed by **Lang N P et al. (2009)** [19] and the cross-sectional study conducted by **Cepeda M S et al. (2017)**[20], which revealed that flossing can aid in reducing interdental plaque development.

In the sixth question (*figure 6*), participants were enquired if they knew how flossing is done. The results showed that 76% knew how flossing is done, as both groups were taught how flossing is done during this study, but 18% did not know how to do it. These might belong to the control group, as they were taught only once at the start of the study, while the participants of the experimental group had access to the demonstration video 24/7 through the app itself.

In the seventh question (*figure 7*), participants were questioned whether they were motivated to improvise their oral healthcare routine, to which 93% said yes. This showed their motivation and willingness to improve their oral care habits.

The eighth question (*figure 8*) asked was whether the EASY BRUSH brushing app will help them achieve good oral health. 89% said yes. This signified how the brushing app can help people be willing to improve their oral health care routine. Participants thought that the app will be helpful.

Ninety-one percent of people responded affirmatively when asked (*figure 9*) if they would recommend the Easy Brush app to their family and friends. This disclosed that participants understand the importance of oral health and how regular and proper brushing with flossing can help improve it. They also realized that brushing apps such as EASY BRUSH can assist them in doing so.

Conclusion:

From the results of the study, it can be concluded that the Modified Bass technique of brushing indeed helps to reduce plaque buildup when backed by interdental cleaning by flossing. Thus, brushing and flossing are both very important for oral hygiene. App such as EASY BRUSH makes it easy for the individual to practice these habits regularly and for a longer period. It also depends on one's willingness and motivation to improvise. However, when used in combination, the usage of brushing app willingly and consistently helps to improve one's oral health. This study was performed on BDS undergraduates, and further study can be done involving participants from different social and economic backgrounds, rural populations, the corporate sector, etc.

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Table 1: Intragroup comparison of plaque index for the control and test group

	N	Group	Mean	Std. Deviation	Chi-Square value	p value of Friedman Test

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PI D0	50	Control	1.44	.29		
	50	Test	1.48	.31		
PI D7	50	Control	1.44	.29	8.00	0.018*
	50	Test	1.47	.30	82.61	0.000**
PI D30	50	Control	1.43	.29		
	50	Test	1.44	.29		

Table 2: Intergroup comparison of plaque index for the control and test group

	Group	N	Mean	Std. Deviation	Std. Error Mean	Mann–Whitney U value	Z value	p value of Mann–Whitney U test
PI D0	1	50	1.44	.29	.04	1109.50	-0.96	0.33#
	2	50	1.48	.31	.04			
PI D7	1	50	1.44	.29	.04	1121.50	-0.88	0.37#
	2	50	1.47	.30	.04			
PI D30	1	50	1.43	.29	.04	1220.00	-0.20	0.83#
	2	50	1.44	.29	.04			

Table 3: Intragroup comparison of Gingival index for the control and test group

	N	Group	Mean	Std. Deviation	Chi-Square value	p value of Friedman Test
GI D0	50	Control	.43	.24		
	50	Test	.58	.23		
GI D7	50	Control	.43	.24	2.00	.36#
	50	Test	.58	.23	77.97	0.00*
GI D30	50	Control	.43	.24		

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	N	Group	Mean	Std. Deviation	Chi-Square value	p value of Friedman Test
GI D0	50	Control	.43	.24		
	50	Test	.58	.23		
GI D7	50	Control	.43	.24	2.00	.36#
	50	Test	.58	.23	77.97	0.00*
	50	Test	.23	.23		

Table 4: Intergroup comparison of Gingival index for the control and test group

	Group	N	Mean	Std. Deviation	Std. Error Mean	Mann–Whitney U value	Z value	p value of Mann–Whitney U test
GI D0	1	50	.43	.24	.03	857.50	-2.70	0.007**
	2	50	.58	.23	.03			
GI D7	1	50	.43	.24	.03	862.50	-2.67	0.008**
	2	50	.58	.23	.03			
GI D30	1	50	.43	.24	.03	912.50	-2.32	0.02*
	2	50	.56	.23	.03			

Table 5: Intragroup comparison of the Sulcular bleeding index for the control group

	N	Group	Mean	Std. Deviation	Chi-Square value	p value of Friedman Test
SBI D0	50	Control	.19	.18		
	50	Test	.27	.16		
SBI D7	50	Control	.19	.18	---	---
	50	Test	.27	.16	55.62	0.000**

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	N	Group	Mean	Std. Deviation	Chi-Square value	p value of Friedman Test
SBI D0	50	Control	.19	.18		
	50	Test	.27	.16		
SBI D7	50	Control	.19	.18	---	---
	50	Test	.27	.16	55.62	0.000**
SBI D30	50	Control	.19	.18		
	50	Test	.27	.16		

Table 6: Intergroup comparison of the Sulcular bleeding index for the control group

	Group	N	Mean	Std. Deviation	Std. Error Mean	Mann–Whitney U value	Z value	p value of Mann–Whitney U test
SBI D0	1	50	.19	.18	.02	779.00	-3.25	0.001**
	2	50	.27	.16	.02			
SBI D7	1	50	.19	.18	.02	785.00	-3.20	0.001**
	2	50	.27	.16	.02			
SBI D30	1	50	.19	.18	.02	800.50	-3.10	0.002**
	2	50	.26	.16	.02			

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