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EFFECTIVENESS OF SMARTPHONE APPLICATION BASED BRUSHING REMINDER THERAPY FOR PLAQUE CONTROL IN ORTHODONTIC PATIENTS: A RANDOMIZED CONTROLLED TRIAL

Salman Khan[1], Sohrab Shaheed[2], Aneela Nausheen[3]

Abstract:

Objective: *The aim of this randomized controlled trial was to assess the effect of the smartphone application-based reminders on plaque scores in orthodontic patients.* ***Methods:*** *60 patients aged 12-30 years undergoing orthodontic treatment were randomly allocated to two groups (30 each). Control group which received standard oral hygiene instructions and experimental groups which received standard oral hygiene instructions along with smart phone application-based reminders twice a day. Plaque scores were assessed by using Turesky modified Quigley-Hein plaque index (TMQHPI) at three time points, baseline (T0), after 2 weeks (T1) and after 6 weeks (T2) of screening.* ***Results:*** *Both experimental and control group exhibited comparable plaque scores and baseline statistics. No significant difference was found at T1 (control: 16.2±4.3, experimental: 14.9±4.9, p-value: 0.29). Significant reduction in plaque scores was found at T2 (control: 16.3±5.2, experimental: 12.2±6.1, p-value: 00007).* ***Conclusions:*** *Smartphone application-based reminder therapy for oral hygiene maintenance during fixed appliance orthodontic treatment decreases the plaque scores at 6 weeks.*

Keywords: *oral hygiene, appliances, reminder therapy, smart phone*

Introduction:

Orthodontic therapy with fixed orthodontic appliances is a well-known risk factor for plaque growth.[1] It causes a rise in number of microbes both in saliva and dental plaque, owing to quantitative modifications in oral microorganisms.[2] The role of dental plaque is well known in the production of dental caries and periodontal diseases; hence, its elimination is critical for the long-term preservation of oral health.[3] Oral hygiene maintenance is one of the most vital variables that can be regulated by the patient during orthodontic therapy.[4] Prevalence of plaque in orthodontic patients range from 5.1% to 85.3%, about 37%of the patients have plaque levels over 50%of the dentition. Different interventions have been recommended in order to minimize the occurrence of bacterial plaque such as reminder therapy.[5]

Active reminders have been suggested in medical care and dentistry to increase appointment presence, adherence to medication schedule, and constructive behavioral change.[6] Systematic reviews have shown a positive influence of text messages on behavioral modifications, and a significant relationship

[1] Final year resident, department of orthodontics, Rehman college of dentistry, Peshawar
[2] Professor and head of department of orthodontics, Rehman College of dentistry, Peshawar.
[3] Assistant professor, department of orthodontics Rehman College of dentistry, Peshawar.

between the use of mobile technologies and the enhancement in dental

plaque control and gingival bleeding.[7,8] Several studies have also concluded that reminder therapy and use of smart phone applications are effective in improving oral hygiene in patients.[4,6–12] Frequently used social media applications among young subjects, such as Instagram, or other digital platforms, such as YouTube, have shown to improve oral health awareness among orthodontic patients.[13,14] Active reminders induce both motivational effect and a 'Hawthorne effect'.[15] The latter refers to a type of reactivity in which individuals modify an aspect of their behavior in response to the knowledge of being observed.[16] Compliance is especially important for adolescents, who are the patients frequently treated with orthodontics.[5]

Periodic phone calls and post-mails have been used in the past as reminder processes for medical appointments. In recent times, advanced communication methodologies such as Short Message Service (SMS), Multimedia Message Service (MMS), and e-mails are being used as approaches to inform people and facilitate adherence to medical activities.[10] Many orthodontic patients are adolescents and young adults, and this age group uses smart phones on a regular basis to perform several tasks and important activities. The use of smartphone-based applications in health care and public health, otherwise known as mHealth is getting popular recently. Considering the wide spread popularity of smart phones and applications (apps) available for general utilities, some apps expressively intended for medical and dental reminders are now available.[11,17]

Previous studies have explored the effect of reminder therapy on plaque control, and they mostly used SMSs and e-mails which depend on an active mobile network and internet availability. In this study, we used smartphone application-based reminders which neither require an active mobile network or internet nor need the extra effort of sending SMSs and e-mails to the patients daily. The purpose of present study was to assess the plaque control in orthodontic patients undergoing fixed appliance therapy with or without smartphone application-based reminders for tooth brushing.

Material and methods:

The study was a single-centre parallel arm, randomized, controlled clinical trial undertaken from August 2020 to January 2021. Ethical approval for the trial was obtained from the research cell of XX college with EC Ref No: 2020-09-055. This study was registered with clinicaltrials.gov, identifier number: NCT05001490. Written informed consent was taken from the trial participants.

Sample size was calculated using OpenEpi software. Farhadifard et al[12] reported a mean cumulative plaque index of 69.18±11.84 in reminder group and 78.9±8.89 in the control group at 4-8 weeks. With a significance level of 5% and power of 90%, 25 participants were required in each group. A total of Sixty (60) patients between 12-30 years of age undergoing fixed appliance therapy were included in the study. All the participants had to be in at least 4 weeks of active orthodontic therapy with fixed appliances in all the

quadrants of the oral cavity. Further inclusion criteria were familiarity with smartphone (should be using smartphone for at least 4 months) and a personal smartphone with Android version ≥ 6.0 or iOS version ≥ 10 operating system, good general and dental health (no active caries, no advanced gingivitis, or periodontitis needing periodontal therapy), with no history of smoking or any other form of tobacco use, no antibiotic or chlorhexidine containing mouth rinses used within two weeks of screening. Patients with prosthesis in the mouth and those taking antibiotics, anti-epileptics, anti-hypertensives, antidiabetics and immunosuppressive medications were excluded from the study.

The patients were randomized into control and experimental groups by using computer generated tables in Microsoft Excel Software. This study was single blinded, with data analyst blinded to the intervention.

In the control group, patients received the conventional instructions for maintaining their oral hygiene comprising of instructions from the dentist and videos on oral hygiene maintenance, while patients in experimental group in addition to the conventional instructions also received reminders, twice a day to brush their teeth, by an application on their smart phones (Quick brush version1.0 by Samy Nakayoma Driss, for android users and Reminder version 2.5 by Sergio Licea, for iOS users). Reminder consisted of an alarm and vibration of phone along with notification on notification bar, patient had to stop the reminder once it sets off. Reminders were allotted according to each patient's routine. Most of the patients followed a routine of waking up early in the morning for the educational institutes and sleeping early so, the mean time for reminders was between 7-8 am and 10-11pm daily.

Plaque control was assessed using Turesky modified Quigley-Hein plaque index (TMQHPI) (Table 1) for the buccal surfaces of teeth with fixed appliances at the screening (T0) and 2 weeks after the screening (T1) and then 6 weeks after screening (T2). Plaque scoring was done on the following six teeth: maxillary right second premolar(15), maxillary right lateral incisor(12), maxillary left first premolar(24), mandibular left second premolar(35), mandibular left lateral incisor(32), mandibular right first premolar(44). In the premolar extraction cases, adjacent available premolar was scored. This index was used widely in literature for assessing oral hygiene and plaque accumulation assessment in orthodontic patients.[6,18,19]

All the measurements were taken by two examiners. Interobserver reliability was calculated by Pearson correlation test and was found to be in excellent correlation with each other (0.98 and 0.95). Intraobserver reliability could not be assessed because the scoring was done clinically by a single observer at a single time point.

Score	Presentation
0	No plaque
1	Discontinuous band of plaque at gingival margin
2	Up to 1mm continuous band of plaque at gingival margin
3	Band of plaque wider than 1mm but less than 1/3 of surface
4	Plaque covering between 1/3 and 2/3 of the surface
5	Plaque covering more than 2/3 of surface

Table 1. Turesky modified Quigley-Hein Plaque Index

Statistical analysis:

Statistical package for Social Sciences Software IBM version 22.0 for windows (SPSS Inc, IBM Corporation, Armonk, NY) was used for data analysis. Mann-Whitney U analysis and Wilcoxon signed rank test was used for comparing the scores of plaque index between the two groups and in the same group respectively, at different intervals of time (T0, T1, T2). P value of < 0.05 was considered significant.

Results:

Sixty participants were randomly allocated to the experimental and control groups equally. All the patients completed the trial and there were no drop-outs or drop-ins. (Figure 1)

The study included 39 female and 21 male participants with mean age of 19.5±4 years, ranging from 12 to 30 years. Gender distribution was 21 (70%) females and 09 (30%) males in experimental group, whereas in the control group 18 (60%) were females and 12 (40%) were males.

No significant differences were found in the mean, median, mode of plaque index between both the groups at the baseline, T0 (Table 2,3 Figure 2). Data analysis showed that there was no significant difference in plaque scores of the experimental and control group at T0 to T1 while a significant difference was found at T0 to T2 (Table 4). Significant difference in plaque scores was found in all the teeth except at maxillary left first premolar (Figure 3). Mode of the plaque scores decreased significantly in experimental group, whereas it remained the same in the control group (Figure 3,4).

There were differences associated with gender in both the groups at T2 in combined cumulative scores, plaque scores reduced more in females than males at T2 (Table 5, Figure 5). Plaque scores increased in male participants of control group at T2 (Table 6, Figure 2). These gender-based differences were, however, not statistically significant.

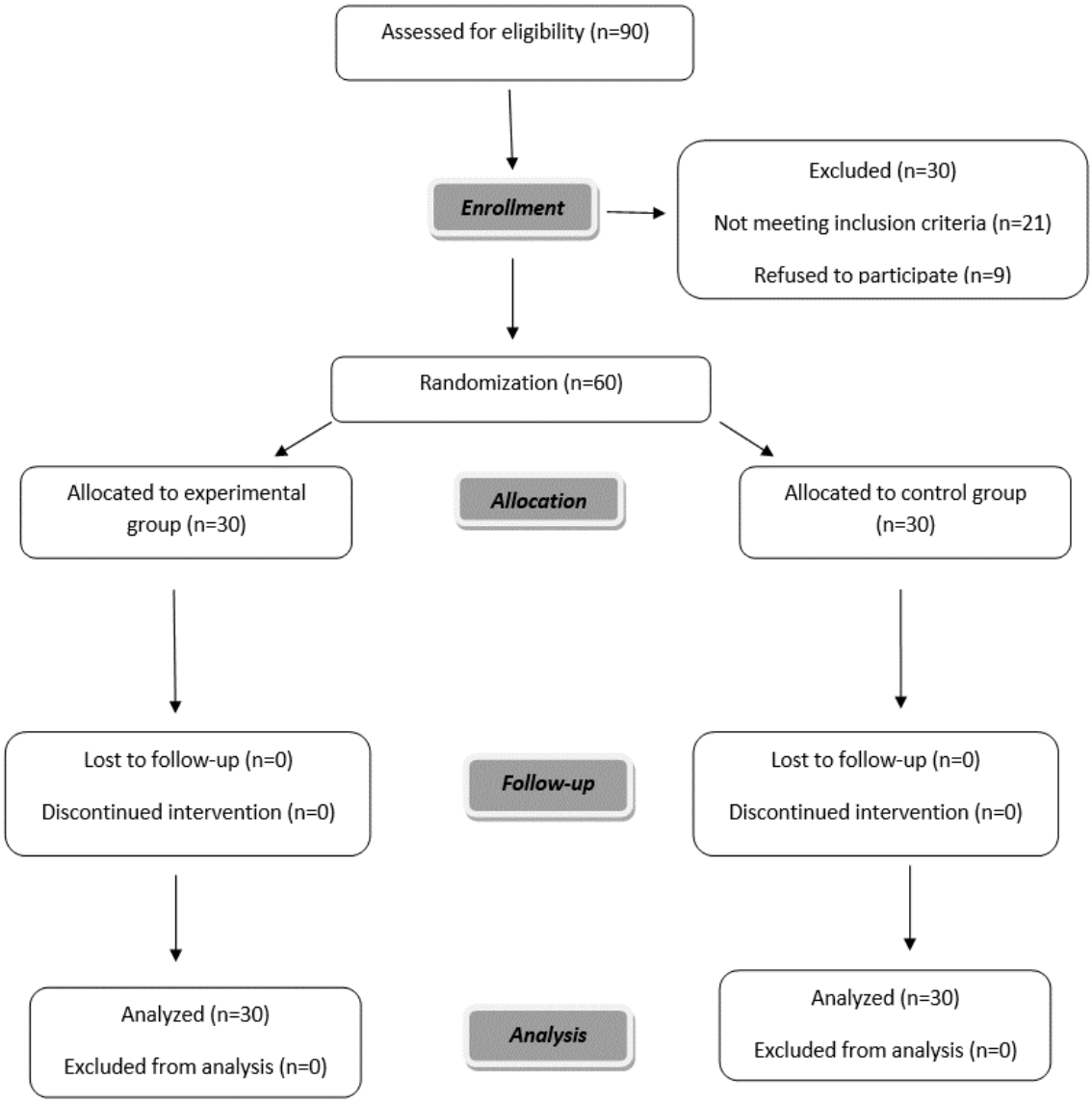

Figure 1: The CONSORT flow diagram for the study

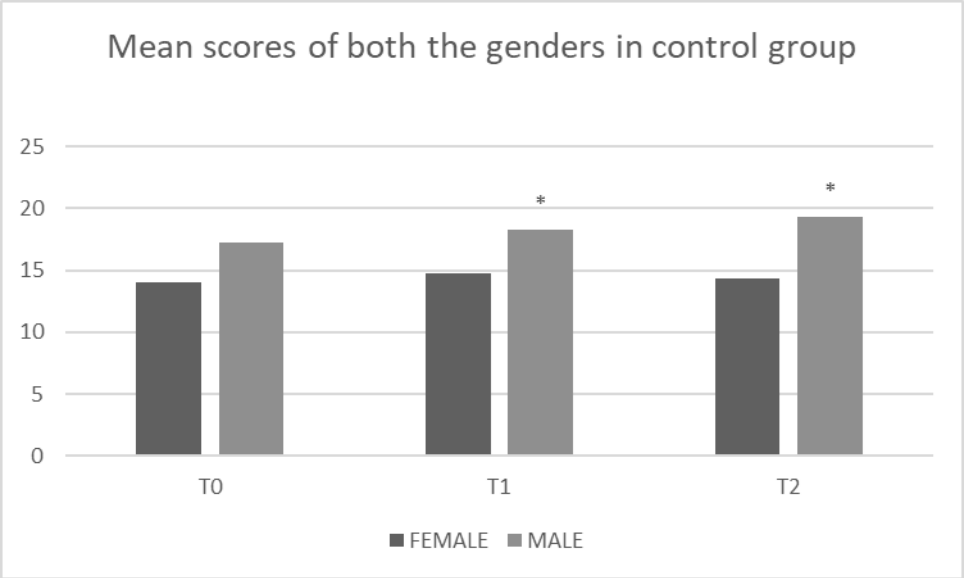

Figure 2. Increase in plaque score

	T015		T012		T024		T035		T032		T044	
	Median	Mode	Median	Mode	Median	Mode	Median	Mode	Median	Mode	Median	mode
Experimental	3	4	2	2	3	4	3	3	2	2	3	3
Control	3	3	2	2	3	3	2	2	2	2	2	3

Table 2. Scores at T0

Groups	T0	P value
Experminetal	16.1±5.6	0.6
Control	15.3±5.8	

Table 3. Mean at T0

Cumulative scores		Mean and SD	Mean difference	p value
T0	Control	15.3±5.8	-0.83	0.57
	Experimental	16.2±5.6		
T1	Control	16.2±4.3	1.26	0.29
	Experimental	14.9±4.9		
T2	Control	16.3±5.2	4.16	0.007
	Experimental	12.2±6.1		

Table 4. Cumulative scores

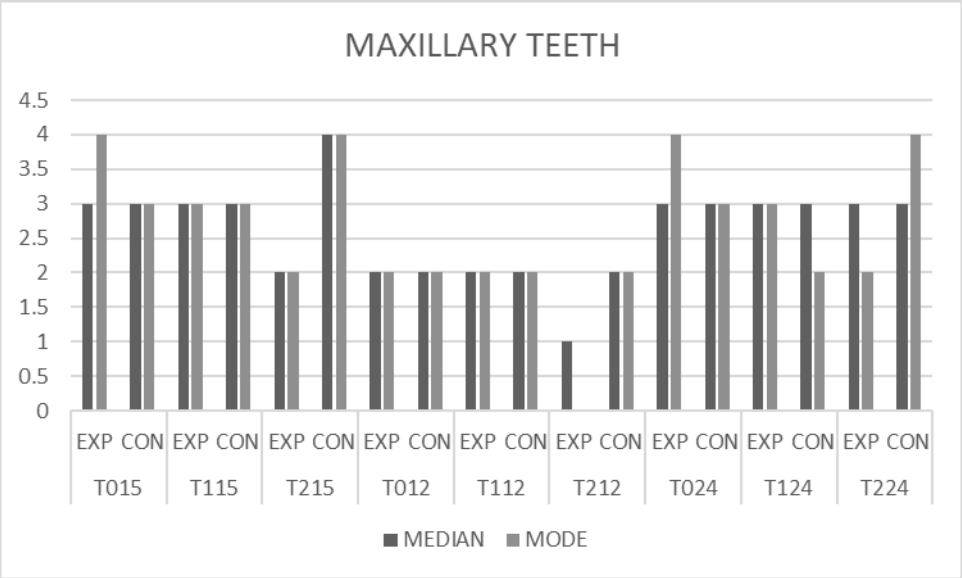

Figure 3.

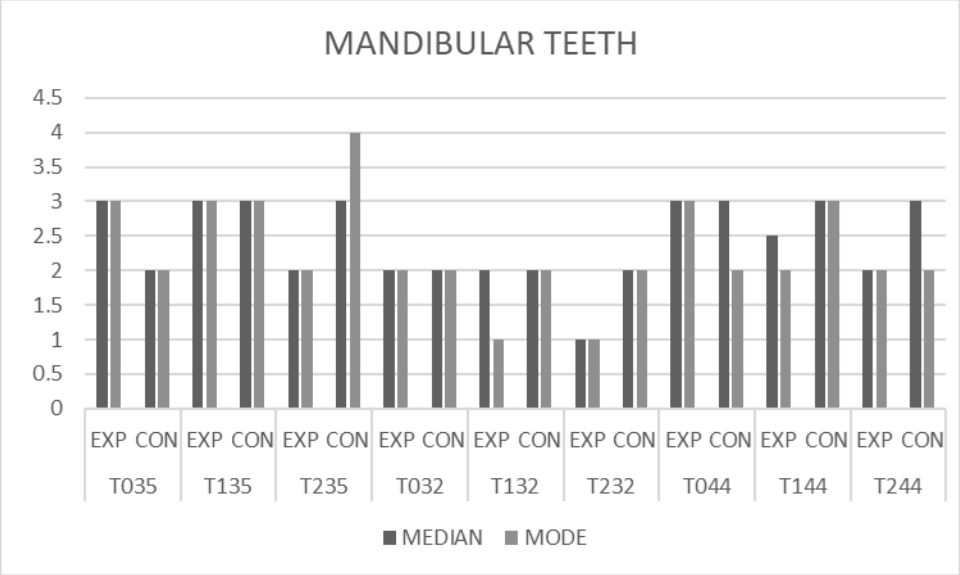

Figure 4

Cumulative scores		Mean and SD	p value
T0	Female	15.9±6.1	0.71
	Male	16.7±4.6	
T2	Female	11.04±5.9	0.12
	male	14.8±6.2	

Table 5. Cumulative scores for both genders in experimental the groups at TO and T2

Cumulative scores		Mean and SD	p value
T0	Female	14.0±5.6	0.86
	Male	17.3±5.7	
T2	Female	14.8±4.9	0.46
	Male	19.3±4.4	

Table 6. Cumulative scores for both genders in control group at TO and T2

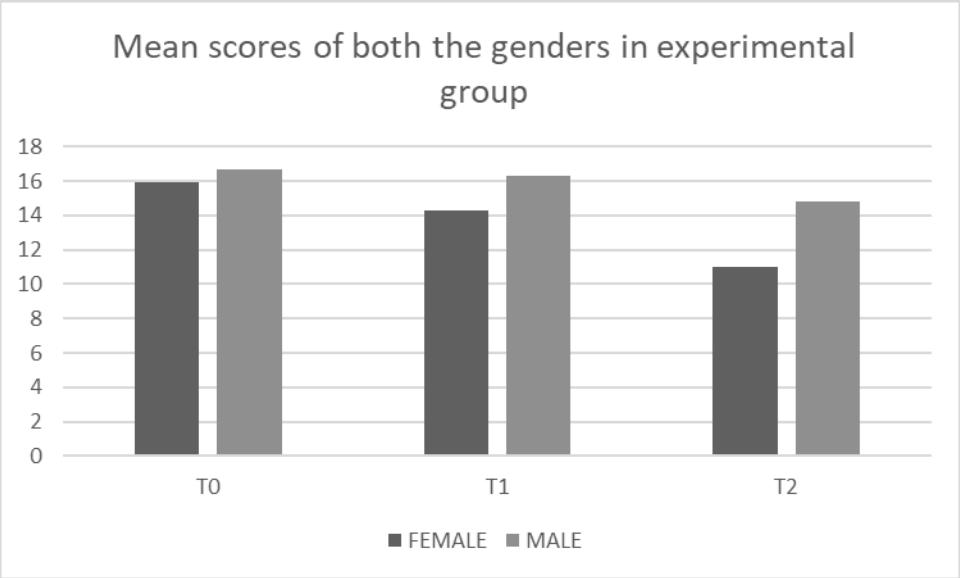

Figure 5.

Discussion:

This study aimed to assess the effect of smartphone application-based reminder on oral hygiene of the patients undergoing fixed orthodontic treatment. Oral hygiene was assessed using TMPHQI. This index is a reliable and frequently used source for the measurement of plaque. Intraclass reliability of TMPHQI was found to be high in a study.[20] In a systematic review this index was found to be more valid, reliable and easy to use than plaque index by Silness and Loe.[21]

Plaque was scored on the buccal surfaces of teeth which are more prone to plaque accumulation because orthodontic attachments are placed on them.[19]

Reminders induce a positive reinforcement. They encourage the behavior one likes to see. Many methods have been used for reminder therapy including e-mails, phone calls, SMSs and smartphone applications. Smartphone application based reminders were given in our study by using Quick brush version1.0 by Samy Nakayoma Driss, for android users and Reminder version 2.5 by Sergio Licea, for iOS users. These applications were used because they are easy to use and manipulate, only few simple steps are required to setup the reminders. Use of smartphone in adolescents and young adults has increased exponentially over the past few years, so does the popularity of smartphone health applications for life style modifications and medical monitoring.[6,11]

Many studies have analyzed the effects of periodic reminders on oral hygiene[4,6,10,16,18]. Results of our study are compliant with many of these studies monitoring the oral hygiene. Eppright et al[4] assessed the effect of text message reminders (SMS) on oral hygiene and concluded that reminder therapy improves oral hygiene. Similar to our study results, they also observed change at the T2 (after 4 appointments) and the values were not significant at T1 (after 2 appointments). Cozzani et al[6] also analyzed the effect of reminder therapy on oral hygiene using SMS services and compared the groups at 40 days

interval. In contrast to our study, they established that reminder therapy does influence the oral hygiene status of the patients. Abdul-jawad et al[5] studied the effect of SMS on the oral hygiene and their results were in agreement with those of our study. There was no difference between the groups at T1 (4 weeks) while a significant difference was seen at T2 (8 weeks). In our study there was no significant difference at T1 (2 weeks) but the scores were significant at T2 (6 weeks). Kumar et al[12] had the same conclusions after performing reminder therapy through SMS. Results of a study by Farhadifard et al[12] are in line with the results of our study and they reported a significant reduction in plaques scores at T2 (8 weeks). However, it is possible that a decrease in plaque scores and better oral hygiene could be the manifestation of Hawthorne effect.

Recent studies[4,6,10,12,18] revealed that there were no significant differences related to age and gender of orthodontic patients in improvement of oral hygiene. In our study, differences were observed between male and female participants in both the groups at T2 in combined cumulative scores. These differences were not statistically significant. Plaque scores reduced more in females than males at T2. Plaque scores increased in male participants of the control group at T1 and T2, but these differences were not statistically significant (Table 7). Clinical significance of the difference in plaque scores showed that male participants show comparably more decline in motivation towards maintaining their oral hygiene without active reminders. Determination of clinical significance may vary from observer to observer. We could not find comparable studies with gender differences in plaque scores.

Our study had several limitations. We used only TMQHPI for the assessment of oral hygiene and plaque control, while other indices indicating gingival health including modified gingival index (MGI), bleeding index (BI) could have reinforced the findings of our study. Another limitation was the limited time frame of recording the observations which was 6 weeks. Studies with longer duration of observations and larger sample size will further improve our knowledge of efficacy of the reminder therapy on oral hygiene. In our study another limitation was that the compliance of patients in following the reminder therapy was not assessed, whether patients actually did brush their teeth after reminder or not was assessed just by calculating TMQHPI score.

Conclusion:

Smartphone application-based reminder therapy for oral hygiene maintenance during the fixed orthodontic treatment decreases the plaque scores with oral hygiene improvement at 6 weeks. Orthodontists should therefore incorporate active reminder processes to their care regimen.

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