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Evaluation of tablet PC as a tool for teaching tooth brushing to children

ABSTRACT

Aim This study evaluated the effect of a single time tooth brushing instruction using video on a tablet PC (Apple iPad) compared to operator presentation using jaw model for plaque removal.

Methods This cross-sectional study included a convenience sample of 100 children divided into two groups. For Group 1 brushing was demonstrated to the child by the operator with the use of a jaw model. This demonstration was videotaped for subsequent use in Group 2 using a tablet PC (Apple iPad). Plaque index was recorded before and after demonstration of the assigned method of teaching tooth brushing.

Results The results showed a significant difference using the two methods. The difference between the mean plaque index values with the jaw model and tablet PC at baseline and after tooth brushing represented 17.27% (50% improvement) and 11.56% (34% improvement) respectively. Boys showed a 18.3% higher improvement in tooth brushing compared to girls. Seventy-five percent of the children reported using tablet computers in their daily life.

Conclusions Teaching children by using a jaw model was more effective in improving plaque index score than using video on tablet PC by 16%. Both methods of tooth brushing teaching were fully accepted by all children.

Keywords Dental plaque; Oral health education; Oral hygiene; Patient education; Tablet computers; Tooth brushing.

Introduction

Published research demonstrate that daily plaque removal is important to prevent gingival and periodontal diseases as well as caries [Taschner et al., 2012; van Palenstein Helderma et al., 2006]. Increased accumulation of dental plaque in the oral cavity directly reflects the lack of effectiveness of tooth brushing [Anggraeni, 2009]. Proper tooth brushing should be established early in life because, once learned, it is likely that this pattern will continue throughout life [Nowak et al., 2002]. Studies on tooth brushing education reported that correct tooth brushing technique is correlated with the attractiveness of the model used to demonstrate, and the human models achieved greatest learning success [Makuch et al., 2011], and that the individual instruction method was superior compared to audiovisual and child as a model [Leal et al., 2002]. A recent study showed the positive effect of teaching autistic children by using educational pictures [Pilebro and Bäckman, 2005]. It was reported that the effectiveness of tooth brushing is largely dependent on brushing frequency, length of time, toothbrush design and brushing technique [Beals et al., 2000]. Brushing twice daily for 2 minutes each with a good technique assists in plaque removal and reduces the risk of onset of periodontal diseases and caries [Jepsen, 1998]. However although tooth brushing is an easy and efficient way of plaque removal, studies have shown that brushing time and performance of children are insufficient and change as they grow [Santos et al., 2007; Sayegh et al., 2005]. The majority of children brush their teeth regularly, but for only 30 to 45 seconds [Santos et al., 2007; Sayegh et al., 2005]. Depending on their manual skills and age, teeth may be inadequately cleaned [Santos et al., 2007; Sayegh et al., 2005].

It has been shown that single use of video instruction considerably improves tooth cleaning with electric toothbrushes [Renton-Harper et al., 2001; Renton-Harper et al., 1999]. A study evaluated the tooth brushing behaviour in children aged 6–12 years concluded that plaque removal from buccal surfaces averaged 19% for 6-year olds and 30% for older children [Sandström et al., 2011]. Tooth brushing should consider the age of the child and inspire the child by using colour and additional motivational stimulus [Makuch, 2000].

Currently, children are attracted to new technologies such as tablet PC and smart phones, and their use as teaching tools is increasing. Some studies showed the positive effect of using such new technologies as teaching tools [Hampton, 2012; McQueen et al., 2012; Tanaka et al., 2012; Wang et al., 2012]. There is scarcity of published data on the usefulness of different new technologies for patient education and as tools for teaching tooth brushing to children in the clinical setting and at home. Therefore, there is a need for studies to evaluate the outcome and associated parameters of the new technology as tools for teaching tooth brushing to children in relation to plaque

removal. Consequently, a research question arises as follows: is watching tooth brushing videos on a tablet PC a useful tool for teaching children? Therefore, the purpose of this study was to evaluate the effect of a single time tooth brushing instruction using a video on a tablet PC (Apple iPad) compared to a traditional operator presentation using a jaw model on plaque removal by testing the null hypothesis that there is no difference between the two methods.

Materials and methods

This cross-sectional study was approved by the Ethical Committee of Human Studies of the King Saud University, College of Dentistry Research Center, Riyadh, and informed consent was obtained from the parents or legal guardians. A pilot study was carried out before the start of the main study to familiarise with all procedures and to complete training and calibration exercises for inter- and intra-examiner reproducibility. The plaque scoring system was explained by the senior investigator with the use of clinical, coloured photographic images showing the different locations of plaque and the concomitant score. This visual training session was followed by calibration of plaque scoring on children and using representative photographs.

Participants of this study were a convenience sample of 100 children, divided randomly into two groups of 50 each. The sample power for this study was 0.90 with sample size in each group 50 subjects. Demographic data of all children were collected and parents or guardians were asked if their children were previously instructed on tooth brushing and for how many minutes the children brush their teeth. Inclusion criteria included children of both genders aged 8–12 years, no medical condition that causes impaired motor function (i.e., psychomotor disorders, etc.), no active periodontal disease, cooperative children, right-handed children and signed consent form by parent or guardian. Exclusion criteria included subjects under orthodontic treatment, children unable to cooperate, children with active periodontal disease, being left-handed, impaired mobility of the arm or hand and parent or guardian not signed the consent form.

In Group 1, brushing was demonstrated to the child by the operator with the use of a jaw model (Typodont; Nissin Dental Products Inc.; Kyoto, Japan). This demonstration was videotaped for subsequent use in Group 2 using a tablet PC (Apple iPad). The demonstration used a standard reference toothbrush approved by the American Dental Association [2012] and standard tooth brushing method using Bass technique [Ganss et al., 2009]. Each child used a standardised amount of a disclosing solution (Reveal, Henry Schein; Melville, NY) to all tooth surfaces according to the instructions of the manufacturer. The children were examined using a standardised method. Plaque index was recorded using a modified plaque record method developed by O'Leary and coworkers [O'Leary et al.,

1972), by recording the presence of plaque on individual tooth surfaces (buccal and lingual). The operator used the tip of an explorer (size 23) (Hu-Friedy Co., Chicago, IL, USA) and mouth mirror (Hu-Friedy Co., Chicago, IL, USA) to examine each surface for soft plaque accumulation at the dentogingival junction. Demonstration of the assigned method of teaching tooth brushing was shown to each child. Children in Group 1 were demonstrated tooth brushing with the use of a jaw model by the same operator who appeared in the video. Then a toothbrush (Oral B pro expert; stages +8 "soft") with a standardised amount of toothpaste (Signal; Bizngar Unilever Ltd.; Kingdom of Saudi Arabia) was given to each child. The children were instructed to brush their teeth to the best of their ability with the help of a mirror for 2 minutes, following the same tooth brushing instructions given to them. Tooth brushing was observed by the dentist without interference and brush time was recorded using a stopwatch. At completion of brushing, the children rinsed with a fixed amount (30 mL) of water. Subsequently, the remaining plaque was recorded by each examiner under the same conditions using the plaque index. Opinion of the child about the instruction method used was rated using a Likert-type scale. Also, children were asked if they used tablet computers and smartphones in their daily life.

The statistical analysis of the data was performed using SPSS 16.0 (SPSS, Inc., Chicago, USA). Student's t-test and Tukey HSD post-hoc test were used to compare the difference between the two groups as related to plaque score reduction from baseline. Comparisons were considered significant at $P < 0.05$.

Results

The inter-examiner reliability of Kappa was 0.99, which indicates almost perfect agreement between the two examiners. The intra-examiner reliability of Kappa was 1 for each examiner which indicates perfect agreement. The treatment sequence for both groups was well balanced and each group has the same sequence of examination and number of children. One hundred children (57 boys, 43 girls) enrolled in the study and none withdrew prematurely. Group 1 consists of 30 (60%) boys and 20 (40%) girls while Group 2 consists of 27 (54%) boys and 23 (46%) girls. The mean age was 10.5 (+ 1.38 SD) years and range was 8–12 years. Table 1 shows the distribution of participants by age.

Table 2 shows the mean plaque index values at baseline and after tooth brushing as well as the percentage of score change in both groups. The differences between the mean plaque index values with the jaw model and tablet PC at baseline and after tooth brushing were 17.27% (50% improvement) and 11.56% (34% improvement) respectively. The average improvement in plaque scores for both groups was 42%. Figures 1 and 2 show the mean plaque index values at baseline and after tooth brushing

Age	Frequency	Percent
8	11	11
9	17	17
10	15	15
11	25	25
12	32	32
Total	100	100

TABLE 1
Distribution of participants by age.

for different ages in Groups 1 and 2 respectively. Teaching children by using a jaw model was more effective than using video on tablet PC by 16%.

There were significant differences between gender and age for the combined plaque scores of both groups. The differences in the combined plaque scores could be detected between boys and girls after brushing in all age groups ($P < 0.05$). Boys showed improvement in tooth brushing more than girls by 18.3%. The combined plaque scores of both groups at baseline at different ages was statistically significantly higher in 8-year old children compared with 10-year olds ($P < 0.05$) (Fig. 3). Similarly, combined plaque scores of both groups after brushing at different age range was statistically significantly higher in 8-year old children compared with 10-year olds ($P < 0.05$) (Fig. 4).

Parents or guardians reported that 48 children (48%) brushed their teeth for only one minute and 92 children (92%) had previously been instructed on tooth brushing. Children who had been previously instructed on tooth brushing showed better plaque score after brushing ($P < 0.05$). Fifty seven percent and 41% of the children reported using tablet computers and smartphones in their

daily life, respectively. Children rated the acceptability of both methods of tooth brushing instruction using a Likert-type scale and marked 10 out of 10, which indicates that children were happy with the teaching method used for tooth brushing.

Discussion

The results of this study showed that teaching children by using a jaw model was more effective in improving plaque index score than using video on iPad by 16%. The American Dental Association [2012] in its Acceptance Program Guidelines - Toothbrushes states that "under unsupervised conditions, a 15% statistically significant reduction in plaque is needed to provide evidence of greater effectiveness in the cleaning of teeth." In this study with unsupervised tooth brushing and after a single tooth brushing instruction, the difference between the mean plaque index values using a jaw model and a tablet PC at baseline and after tooth brushing was 17.27% (50% improvement) and 11.56% (34% improvement) respectively. A study aimed to evaluate the plaque removal ability of toothbrushes without a standardised brushing time reported that the reductions in plaque score were 24% for new tooth brushes and 16% for old tooth brushes and the average time needed by children for tooth brushing was about 2 minutes at the first visit and about 15 seconds less at the second visit [van Palenstein Helderma et al., 2006]. Another study compared the use of new brushes and 3-month-old toothbrushes showing various degrees of wear for plaque score reductions

Group	Plaque Index Score			
	Mean (SD) baseline brushing	Mean (SD) after brushing	Percentage of change	P-value
Group 1 Jaw model	33.98 + 15.60	16.71 + 9.10	17.27	$P < .001$
Group 2 Tablet PC	33.38 + 16.78	21.82 + 16.78	11.56	$P < .001$

TABLE 2 Mean plaque index values at baseline and after tooth brushing in Group 1 (jaw model) and in Group 2 (Tablet PC) ($n = 50$).

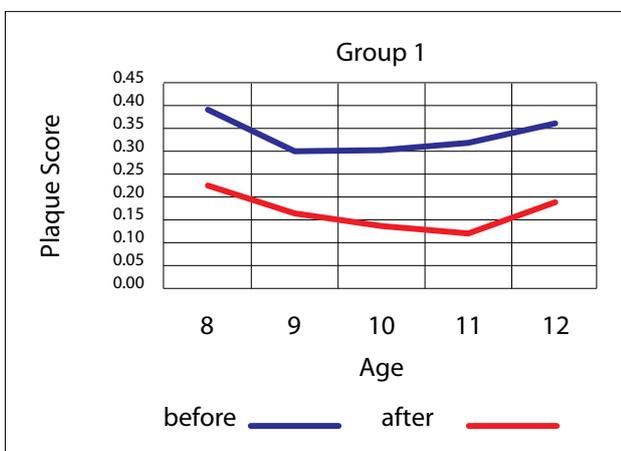


FIG. 1 Mean plaque index values for different ages at baseline and after tooth brushing in Group 1 - Jaw model.

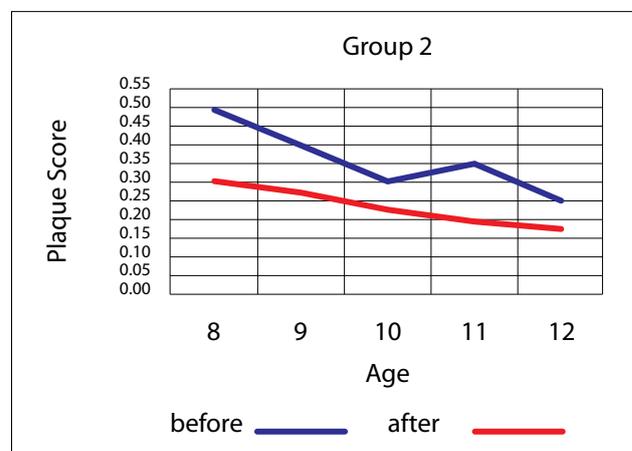


FIG. 2 Mean plaque index values for different ages at baseline and after tooth brushing in Group 2 - Tablet PC.

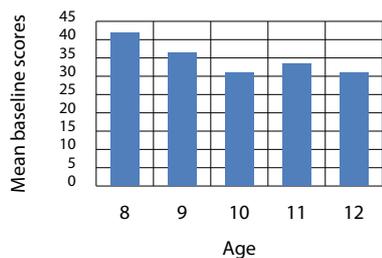


FIG. 3 The combined plaque scores of both groups at baseline for different ages.

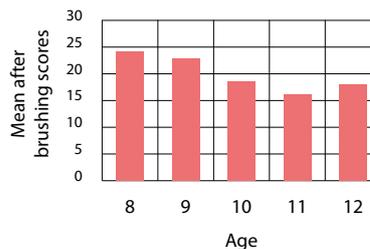


FIG. 4 The combined plaque scores of both groups after brushing for different ages.

reported that new toothbrushes are equally effective as worn ones [Malekafzali et al., 2011]. In this study, each child used a new toothbrush which may be more effective in plaque removal than old toothbrush and also the brush time was set at two minutes. Habitual brushing times of participating children are probably shorter at home as parent or guardians reported that 48 children (48%) brushed their teeth for only one minute. A study reported that the mean duration of brushing was of 60.3 seconds in 85 un instructed schoolchildren [Macgregor and Rugg-Gunn, 1979]. A recent study reported that the mean duration of tooth brushing in children aged 6-12 years was 1.71 min (Pujar and Subbareddy, 2013). Another study reported that the results of brushing for children aged 8-12 years could benefit from increasing tooth brushing time [Sandström et al., 2011]. The recommended tooth brushing time is two minutes (Guideline on Infant Oral Health Care, 2012). In the present study children were brushing for two minutes and plaque scores were statistically significantly higher in the 8-year old children compared with the 10-year olds. Also in this study, there were significant differences between gender and age for the combined plaque scores of both groups. Therefore, it is important that dentist observe such variation in tooth brushing for age and gender.

Video and tablet technology have been promoted for use for health education purposes [Aronson et al., 2012; Brusco, 2011]. In this study tooth brushing demonstration was videotaped for subsequent use with a tablet PC. This type of video can be used not only to educate patients in the dental office but also at home and in large facilities such as schools, hospitals and dental clinics to deliver points of interaction to educated children and their parents or guardians. Future research in this area may develop an interactive media for tooth brushing for promotion of dental health as it was suggested that education of children needs to incorporate more interactive media [Baranowski and Frankel, 2012]. In this study 57% and 41% of the children reported using tablet computers and smartphones respectively in their daily life. The present study offered a video which could be viewed by children and parents or caregivers using smartphones, tablets and computers. It was reported that the majority of tablet users watch videos on their device and that tablet use among smartphone owners has more than doubled in the past year, rising from 9.7% to 23.6% in 2012 [Internet Technology Company, 2015]. The report also found that tablet users were nearly three times more likely to watch videos on their

device compared to smartphone users, with 1 in every 10 tablet users viewing video content almost on a daily basis on their device [Internet Technology Company, 2015]. Most children including those of lower socioeconomic status have cell phones, smartphones, tablets and play video games [Baranowski and Frankel, 2012]. The role of tablets as tools for patient education has been reported in different areas such as obesity prevention and weight loss maintenance, cosmetic consultations, and educational support [Wang et al., 2012; Baranowski and Frankel, 2012; King, 2012]. A study investigated the effectiveness of the Apple iPad as communication device with autistic subjects by comparing its use to a communication system using picture cards, and showed that communication improved when using the iPad [Flores, 2012].

The null hypothesis in the present study was rejected as there was a difference in plaque removal between tooth brushing instruction with an iPad-based video and operator presentation using a jaw model. The results showed that the Apple iPad as a communication device was less effective in plaque removal after single application and with unsupervised tooth brushing compared to operator presentation using the jaw model. A study recorded higher plaque scores at the second session compared with the first session, which was attributed to more critical assessment of the plaque at the second session [van Palenstein Helder et al., 2006]. It would be interesting for further research to evaluate the effectiveness of repeated watching of the video created in this study in plaque removal. It is interesting that a study reported that extended training using videos results in almost complete plaque removal even when pre-brushing plaque levels had been increased by 4 days of no oral hygiene [Renton-Harper et al., 2001]. Another study concluded that in the early period of learning to use an electric toothbrush, plaque removal can be greater by using an instructional video [Renton-Harper et al., 1999]. Even with the results of this study showing that teaching children by using a jaw model was more effective in improving plaque index score than using a video on an iPad, the latter iPad may be more practical and allow repeated watching of the video at any time and in different places. This is also inspired by the positive feedback from children in both tooth brushing groups, which indicated that children were happy using both methods. Other advantages of tablet PC are that they are smaller and lighter than notebook computers, the touchscreen feature makes it easy to scroll through while viewing, it is easy to handle and to hold with one hand, it can be used while

standing, sitting or lying down, and video watching is easy to pause and replay [Wang et al., 2012]. The present study has some limitations. The children who participated in the study were aware that their tooth brushing was observed and evaluated; so they might have tried to improve tooth brushing. Toothbrush strip type (e.g. distal, oblique, spoon grip) was not recorded or standardised and each child used a new toothbrush which may be more effective in plaque removal than an old toothbrush. Data collected in this study were self-reported and parent or guardians may or may not have answered questions about oral hygiene practice habits of their children fairly. Also, this study was completed in a single sitting and a long-term follow-up must be completed to determine permanent changes in oral hygiene practice habits.

Conclusions

Within the limitations of this study, it is concluded that a single time tooth brushing instruction for teaching children by using a jaw model was more effective in improving plaque index score than using video on a tablet. With unsupervised tooth brushing, the difference between the mean plaque index values with the jaw model and iPad tablet at baseline and after tooth brushing represented 50% and 34% improvement, respectively. The combined plaque scores were statistically significantly higher in 8-year old children compared with the 10-year olds. Both methods of tooth brushing were fully accepted by all children.

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