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RESEARCH ARTICLE

EVALUATION OF THE PLAQUE REMOVING EFFICACY OF DIFFERENT TYPES OF TOOTHBRUSH GRIPS AMONG CHILDREN OF AGE GROUP 6-10 YEARS

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ABSTRACT

Background: Among different plaque controlling methods tooth brushing is the primary and most important measure to remove dental plaque and to maintain good oral hygiene. Effective tooth brushing is dependent on multiple factors. Toothbrush grip among different factors affecting tooth brushing is less well studied and documented.

Aim and Objective: The aim of the present study is to evaluate the effectiveness of plaque removing ability with tooth brush grip in children aged 6-10 year. The objectives are to investigate effectiveness of tooth brush grip and to assess plaque reduction after standardizing brushing time and standardized brushing motion at different interval.

Materials and Methods: Participants were selected on the basis of inclusion and exclusion criteria. Pre brushing plaque index were calculated for different tooth brush grip. Participants were given tooth brush and tooth paste and asked to brush as they do at home for standardized time. Immediate post brushing plaque index was calculated. Participants and their parents were taught a standard tooth brushing motion (modified stillman) and asked to brush at home twice daily for 7 days under strict parental guidance. After 7 days plaque index were calculated. Difference in plaque index for each grip were calculated and statistical analysis was done.

Result and conclusion: Plaque reduction has a direct correlation with tooth brush grip. Distal oblique type of tooth brush grip is most prevalent and most effective type.

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INTRODUCTION

Of all the diseases by which mankind is afflicted, one of the most prevalent diseases are diseases of oral cavity. Dental caries and periodontal disease are the two most common oral diseases in man. Dental plaque is the most important risk factor for the development of dental caries and periodontal disease and daily removal of plaque is very important for the maintenance of gingival, periodontal and dental health (Kumar *et al*., 2012). Among different plaque controlling methods tooth brushing is the primary and most important measure to remove dental plaque and to maintain good oral hygiene. Effective tooth brushing is dependent on tooth brush design, tooth brushing motion, co-ordinated muscular movements, psychomotor skills, hand function ability, innate skill, motivation and good manual dexterity. (Ogasawara *et al*., 1992; Unkel *et al*., 1995) For tooth brushing to be effective a certain degree of manual dexterity is required. This is especially important in children since the dexterity of the child varies and increases according to his/her age. Beals *et al*. documented the interaction between the human hand and toothbrush during a tooth brushing session. They observed five grips, namely, the distal oblique and power grips, which use the palm of the hand, and the oblique, precision, and spoon grips, which rely on the fingers. (Beals *et al*., 1999) There are a very few studies which determines the relationship between grip of tooth brushing and effectiveness of plaque removal. The aim of the present study is to evaluate the effectiveness of plaque removal ability with tooth brush grip in children aged 6-10 year. The objectives are to investigate effectiveness of tooth brush grip and to assess plaque reduction after standardizing brushing time and standardized brushing motion keeping the tooth brush grip constant at different interval.

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MATERIALS AND METHODS

The study was conducted in Department of Pedodontics and Preventive Dentistry of Guru Nanak Institute of Dental Science

and Research. 102 children (56 male and 46 female) aged between 6 to 10 years were selected for the study from the Out Patient Department of Pedodontics and Preventive Dentistry of Guru Nanak Institute of Dental Science and Research. The native language of all these children were Bengali. All these participants were right handed and children having dmf score 0 were included in the study. Only those who brush two times per day were taken. Children having history of neuromuscular disorder, hearing impairment, sight impairment, mental impairment, those with orthodontic appliances and those who don't use toothbrush to clean their teeth were excluded. The parents of the participating children were informed about the procedure. The children were asked to avoid tooth brushing in the evening and morning before clinical examination. During clinical examination plaque score was recorded according to Sillness and Loe in 1964 (Silness and Loe, 1964). Each child were given same toothbrush (Colgate Kids Toothbrush, Colgate India) which satisfied the British Standard specifications for toothbrushes (BS 5757–1979) and toothpaste (Kidodent toothpaste, Indoco Remedies Limited, India) and asked to brush their teeth as they do at home for a fixed duration (3 minutes). During brushing the type of grip and the motion of toothbrush are recorded. Tooth brush grip of the children is evaluated according to Beals *et al*. (1999) (Distal oblique, Oblique, Precision, Power, Spoon). After completion of brushing plaque score (according to Sillness and Loe in 1964) were recorded. On the same day a standardized method of brushing (Nassar *et al*., 2013) (the modified Stillman technique) was taught to the children as well as their parents and instructed to brush their teeth with this method for next 7 days with same toothbrush and toothpaste without changing the tooth brush grip. Tooth brushing duration was fixed for all children (3 minutes). After 7 days children were asked to brush their teeth with the new technique for the same duration. During brushing again the type of grip and the motion of toothbrush are recorded. Plaque score was calculated using the same procedure. Parents of the subjects were instructed to keep a strict guidance during brushing of the participants and report whether the subjects followed the instructions properly or not.

RESULTS

Statistical Analysis was performed with help of Epi Info (TM) 3.5.3. EPI INFO is a trademark of the Centers for Disease Control and Prevention (CDC). $p \leq 0.05$ was taken to be statistically significant. Among 102 subjects four subjects did not return in the last visit and five subjects did not brush according to instructions given. So they were excluded from the study. This resulted in effective study population of 93 children. Age and gender distribution of these 93 children are shown in table no 1 and table no 2. 1st plaque index that is pre brushing plaque index (P.I-1) before intervention was 1.44±0.22 (Mean ± S.d). After 1st brushing type of grips were noted (Table 3), motion of brushing (Table 4) and plaque index (P.I-2) was measured. Maximum children showed distal oblique grip (64.5%). Among 93 participants 90 showed horizontal scrubbing motion while only 3 showed varied type of motion (vertical + horizontal + rolling). The mean plaque index immediately after brushing (P.I-2) is 0.62±0.25. (Mean ± S.d). After one week (07 days) of intervention plaque index (P.I-3) was 0.48±0.18 (Mean ± S.d). ANOVA showed that there was significant difference in P.I-1, P.I-2 and P.I-3 (Table 5) at different time interval ($F_{2,20} = 158.86; p<0.01$). Mean plaque index was also calculated according to each grip of brushing 1st day just after brushing and 7 days after brushing with a fixed new motion without changing the grip (Table 6). It was noted that for both cases minimum plaque index was found for precision grip followed by distal oblique grip. The reduction of plaque score between 1st day just after brushing and 7 days after brushing with a fixed motion without changing the grip was also recorded for individual grip (Table 7). Decrease in plaque score for distal-oblique grip was significantly highest of all ($p<0.01$) i.e. it showed it showed best performance.

Table 1. Age distribution

Age Group(in years)	Number	%
6	21	22.6%
7	21	22.6%
8	27	29.0%
9	15	16.1%
10	9	9.7%

Table 2. Gender distribution

Gender	Number	%
Male	51	54.8%
Female	42	45.2%

Table 3. Type of grip

Type of grip	Number	%
Distal- oblique grip	60	64.5%
Oblique grip	18	19.4%
Power grip	6	6.5%
Precision grip	3	3.2%
Other grip	6	6.5%

Test of proportion showed that proportion of subject with first kind of type of grip (64.5%) was significantly higher ($p<0.01$)

Table 4. Type of motion

Type of motion	Number	%
Horizantal scrubbing	90	96.8%
Other motion	3	3.2%

Test of proportion showed that proportion of subject with first kind of type of motion (96.8%) was significantly higher ($p<0.01$)

Table 5. Comparison of mean Plaque Index

Descriptive statistics	Plaque Index		
	Before Intervention	After Intervention	After 01 week of Intervention
Mean ± s.d	1.44±0.22	0.62±0.25	0.48±0.18
Median	1.46	0.58	0.46
Range (Maximum-Minimum)	0.92 – 1.96	0.21 – 1.42	0.17 – 0.95

D.F. – Degrees of Freedom
F – F-Statistic
* - Statistically Significant
ANOVA showed that there was significant difference in plaque index at different time interval ($F_{2,20} = 158.86; p<0.01$).

Table 6. Mean Plaque Index at different intervals for each tooth brush grip

Grip system	Mean plaque Index before intervention	Mean plaque Index after intervention (1st day)	Mean plaque Index after intervention (1st week)
Distal Oblique	1.38±0.23	0.53±0.25	0.48±0.19
Oblique	1.53±0.16	0.77±0.09	0.42±0.15
Power	1.69±0.14	0.95±0.23	0.46±0.05
Precision	1.29±0.0	0.88±0.0	0.29±0.0
Other	1.52±0.08	0.66±0.28	0.79±0.05

Table 7. Comparison of decrease in Plaque Index

	Reduction After Ist day of brushing	Reduction After 1 week of brushing
Type of grip	Mean±s.d.	Mean±s.d.
Distal- oblique grip	0.87±0.34	1.04±0.27
Oblique grip	0.62±0.14	0.87±0.16
Power grip	0.58±0.22	0.84±0.28
Precision grip	0.43±0.02	0.46±0.04
Other grip	0.39±0.08	0.41±0.05
F-value	$F_{4,20} = 4.17; p<0.05$	$F_{4,20} = 6.24; p<0.01$

ANOVA showed that there was significant difference in plaque index due to different grip 1st day just after brushing ($F_{4,20} = 4.17; p<0.05$) and after one week ($F_{4,20} = 6.24; p<0.01$). As per the CD the decrease in PI for distal-oblique grip was significantly highest of all ($p<0.01$) i.e. it showed best performance.

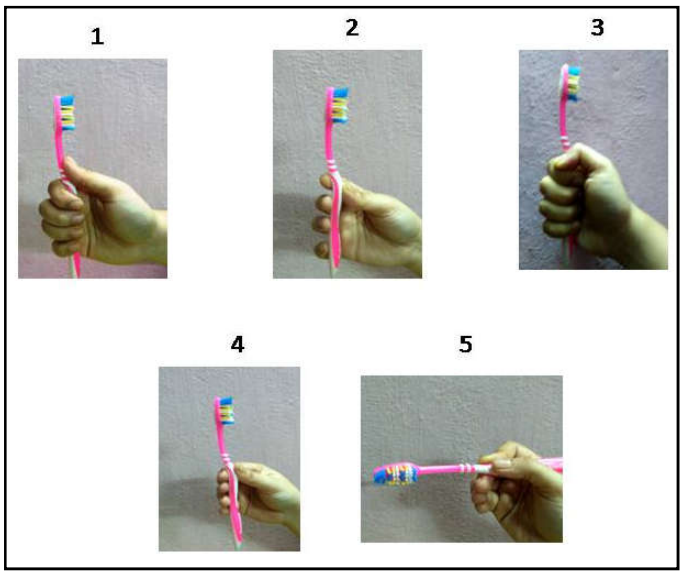

Figure 1. Different Tooth brush Grips

1: Distal Oblique 2: Oblique 3: Power 4: Precision 5: Spoon

DISCUSSION

Maintenance of ideal oral health depends on the efficacy of plaque removal. There are various methods of plaque removal among which tooth brushing is the most efficient and essential. Efficacy of tooth brushing depends upon various parameters like tooth brush design, tooth brushing motion, co-ordinated muscular movements, psychomotor skills, hand function ability, innate skill, motivation, tooth brush grip etc. There are many studies and research works regarding improvement of plaque removing efficiency of tooth brushing but relationship between tooth brush grip and tooth brushing efficacy is less well studied. (Sharma *et al*., 2012) Tooth brushing motion and brush grip depends directly on manual dexterity which is the ability to make coordinated hand and finger movements to grasp and manipulate objects. Children less than 6 years of age were not included in the study as Children <4 years did not comprehend the language necessary for effective tooth brushing and proper manual dexerity for effective brushing do not develop before 6 years. (Sharma *et al*., 2012; Mohebbi *et al*., 2008) Children with only dmf score 0 were included in the study as presence of caries or decay will affect plaque reduction. Children having history of neuromuscular disorder, hearing impairment, sight impairment, mental impairment were excluded as they lack the manual dexterity of proper brushing. Plaque Index (according to Sillness and Loe in 1964) were used to quantify dental plaque at various intervals because relative simplicity of this index to measure and calculate. The present study is divided into three visits. Plaque score (P.I-1) is calculated without any intervention first.

Then the participants were asked to brush with a particular tooth brush and tooth paste for a specific time. The Tooth brush grips of all the child were noted. Most common grip was found to be distal oblique type (64.5%). Similar results were observed in previous studies by Beats *et al*. (1999), Das and Singhal (2009), Sharma *et al*. (2012), Pujar *et al*. (Slot *et al*., 2012). In the present study second most common grip was oblique followed by power group, and precision group. No participant was found to use spoon grip. Beals *et al*. (1999) also reported that spoon grip was relatively uncommon. In some previous articles another nonspecific grip type (others' grip) is mentioned. It is mentioned that 10-year-old and younger-aged children used many uncharacteristic grips during the entire brushing session which were categorized in the 'others' group. In a study by Pujar *et al*. (Slot *et al*., 2012) this other type of grip was found to be second most common type. In the present study only 6% participants used this other type of grip. The reason why children prefer a particular grip is not known and not discussed in the literature. However, it is necessary to know which grip a child prefers as this may help in designing tooth brush handles for children. Tooth brush motion of participants were also measured. Almost all the child (96.8%) used Horizontal Scrubbing technique. All participants were instructed to brush for a specific time (3 minutes) in whole of the mouth. Slot *et al*. (2012) demonstrated a significant correlation between the duration of brushing and the amount of plaque. In a study by Pujar *et al.* (2013) plaque reduction was also greater when the duration of tooth brushing increased. They also recommended a minimum duration of 3 min of tooth brushing time is in children to achieve 90 % plaque reduction. After brushing on the 1st day immediate plaque score (P.I-2) was measured. Individual plaque score and a mean plaque score were calculated. It was observed that mean plaque score (P.I-2) reduced to 0.62±0.25 from a mean pre brushing plaque score (P.I-1) of 1.44±0.22 9 (Table-5). Change in plaque score for individual grip type were also calculated. Plaque score (P.I-3) after 1 week (Table-5) was also calculated. All participants were asked to brush 2 times/day for 3 minutes at home under parental guidance. Grips of the participants were not altered as tooth brush is a inherent functioning of a child and difficult to modify and also why a particular child prefers a particular grip is not known and not discussed in literature. Moreover keeping the tooth brush grip constant at different interval will make comparison plaque removing capacity of different tooth brush grip at different interval easier.

Horizontal scrubbing is considered detrimental because vigorous scrubbing can encourage gingival recession may cause tooth abrasion eventually. (Piotrowski *et al*., 2001) Hence, in the present study children were taught the Modified Stillman technique (Nassar *et al*., 2013) of tooth brushing, which incorporates a rolling stroke after the vibratory phase. It minimizes gingival trauma and increases the efficiency of biofilm removal from tooth surfaces. Children and their parents were taught modified stillman method and asked to brush in this motion for 7 days in home under strict parental guidance. Mean Plaque score (P.I-3) and plaque score for (Table-6) different groups were measured. Mean plaque index reduced significantly from pre brushing plaque index to 1st day of brushing and 7 days after brushing (Table-6,7). Statistical

analysis was done and ANOVA showed that there was significant difference in plaque index due to different grip 1st day just after brushing ($F_{4,20} = 4.17; p<0.05$) and after one week ($F_{4,20} = 6.24; p<0.01$). As per the CD the decrease in PI for distal-oblique grip was significantly highest of all ($p<0.01$) i.e. it showed best performance. The result was in accordance with the results observed by Beals *et al*. (1999), Mentes and Atukeren (2002) and Sharma *et al*. (2012). Plaque reduction was found to be least with the other type of grip. It was also observed that there was marked reduction in plaque score in distal oblique, oblique and power group between immediate after brushing and 7 days after brushing. These findings show that the children did at least attempt to maintain their oral hygiene after the first visit, which is evident from the observable reduction in plaque scores for the second visit 7 days after brushing versus the first visit immediately after brushing. Thus, it is concluded that the oral hygiene of children can be improved by motivating them and instructing them a new brushing technique. Similar results were found in a study by Pujar *et al*. (2012).

In the present study during home brushing 5 children did not brush properly according to instructions. So they were excluded from the study. Video recording of brushing at home would have been a better option to check how much the participants were adapted to new brushing motion and whether their grip was constant or changing during brushing. But as most of the participants were from low and middle socioeconomic status it was not possible to perform video recording at home. Rather the results were dependent upon parental observation. So motivating parents along with the children was very important. Parents were repeatedly instructed to give proper guidance during brushing. Four children did not report in the second visit. Parental non motivation may be one of the reasons. To conclude it can be said that proper plaque reduction is achievable if proper brushing with adequate duration is done. Plaque reduction has a direct correlation with tooth brush grip. Distal oblique type of tooth brush grip is most prevalent and most effective type.

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