Original Article

Plaque Removal Efficiency of Chewable Toothbrushes among 10–12-year-old Children: A Randomized Control Trial

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ABSTRACT

Aim and Objectives: Toothbrushing is one of the most important factors in controlling plaque accumulation and dental caries. There are vast varieties of toothbrushes available in the market. This study was designed to evaluate the effectiveness of novel chewable toothbrushes as compared to manual toothbrushes in plaque removal among 10–12-year-old children. **Materials and Methods:** This randomized controlled trial was conducted on 40 healthy children aged between 10 and 12 years of age who were randomly assigned to either of the groups: Group I—Chewable Toothbrushes and Group II—Manual Toothbrushes. Following oral prophylaxis, baseline records of oral hygiene indices (Simplified oral hygiene index (OHI-S) in indexed teeth and Turesky modification of Quigley Hein plaque index (TMQHI) were taken. Baseline Saliva samples were collected and sent for *Streptococcus mutans* counts. Children were then instructed to use their respective toothbrush twice daily for a week. Oral hygiene indices and *S. mutans* counts were repeated after 1 week. **Results:** Differences in pre-brushing and post-brushing plaque scores and salivary *S. mutans* counts were statistically significant when compared using paired-sample *t* test and independent-sample *t* test. There was a significant reduction in salivary *S. mutans* counts after using both chewable and manual toothbrushes. However, there was no statistically significant difference between the two groups ($P = 0.08$). **Conclusion:** Chewable toothbrushes are equally effective in plaque control when compared to manual toothbrushes. These can be a reliable alternative for children who lack manual dexterity.

Keywords: *Chewable toothbrush, children, manual toothbrush, plaque control, Streptococcus mutans counts*

Introduction

Dental caries remains to be a global issue when we consider overall dental health. Dental plaque plays a major role in initiation and progression of dental caries. Toothbrushing is invariably the easiest method to control plaque accumulation and thereby preventing dental caries as caries does not develop on constantly cleaned tooth surfaces.[1]

Maintaining good oral hygiene in children is challenging due to a variety of reasons: lack of motivation, relatively lesser manual dexterity, requisite parental involvement, and an overall reluctance to brush teeth.[2,3] Toothbrushing is especially problematic in special children who lack neuromuscular control and grip over a manual toothbrush. Parents and caregivers report that daily toothbrushing is difficult to achieve in

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typically growing children.[3] To overcome the manual dexterity dilemma, many modifications of manual as well as powered toothbrushes have been marketed to children. However, the impact that different designs have on the efficacy of a newer toothbrush (bristles, bristle angle, handle, user-friendliness) needs to be studied.[4]

Moreover, children have been described as brief, haphazard, and erratic toothbrushes which adds up to the lack of manual dexterity.[5] A handier and more convenient toothbrush design would theoretically overcome both, the lack of motivation and the lack of motor skills to effectively brush teeth. A new oral hygiene aid in the form of an all-in-one "Chewable Toothbrush" (Fuzzy Brush) was developed and is marketed in the United Kingdom as a convenient, travel, and child friendly alternative to the manual toothbrush [Figure 1].

It is made of an elastic component that gets compressed when squeezed by upper and lower jaws. It has a brush used for brushing the upper teeth in combination with upper surface of the elastic part and another brush that is used to brush the lower teeth in combination with the lower surface of the elastic part. As per the manufacturer's description, a disposable Fuzzy Brush contains poly-dextrose with 95% xylitol crystals and aqua for flavoring. The key ingredient in this chewable toothbrush is xylitol which has proven "caries preventive" effects.[6] The size of the brush is 2 cm × 3 cm and has medium-soft bristles arranged in a single tuft manner.

Myoken *et al.*[7] reported a significant amount of plaque removal with the use chewable toothbrushes in

Figure 1: Fuzzy Brush

a care-dependent elderly population. Bezgin *et al.*[8] and Rasa *et al.*[9] documented comparable plaque removal efficiency in chewable and manual toothbrushes in their pilot study on 10–12-year-oldchildren. On the contrary, Kayalvizhi *et al.*[10] found chewable toothbrushes to be more efficient than manual toothbrushes in their clinical trial conducted on 8–10-year-old children. Govidaraju and Gurunathan[11] reported a statistically significant reduction in *S. mutans* counts after. using chewable toothbrushes.

Due to the limited availability of the product, the literature on the effectiveness of chewable toothbrushes is scarce and hence more clinical trials are needed before chewable toothbrushes can be recommended for use in children. Moreover, to the best of our knowledge, only one study[11] has compared manual and chewable toothbrushes for *S. mutans* counts so far. Therefore, this study was designed to evaluate the effectiveness of commercially available chewable toothbrushes in plaque removal and to check the effect of this all-in-one toothbrush on salivary *S. mutans* counts.

Aims and objectives

The aim of this study was to compare the efficacy of chewable toothbrushes against manual toothbrushes.

Objectives

1. To evaluate the reduction in plaque score with the use of chewable toothbrushes and compare it with manual toothbrushes.
2. To evaluate salivary *S. mutans* counts before and after using manual and chewable toothbrushes.

Materials and Methods

This study was designed as a single-blinded randomized controlled trial in accordance with Consolidated Standards of Reporting Trials (CONSORT) and the Helsinki Declaration of Human Rights [Figure 2]. This study was approved by the Institutional Ethics Committee, Kasturba Hospital (ECR/146/INST/KA/2013/RR-16) and registered with Clinical Trial Registry, Government of India (CTRI/2018/09/015655).

Sample size and randomization

A total of 200, 10–12-year-old children who visited the Department of Pedodontics and Preventive Dentistry, Manipal as a part of the department's school health program were screened. Sample size was calculated to detect a statistically significant difference between manual and chewable toothbrushes. Based on previous studies, a total sample size of n = 40 was determined and sample size of 20 per group was calculated with the power of study being 80% at a confidence level of 5%.

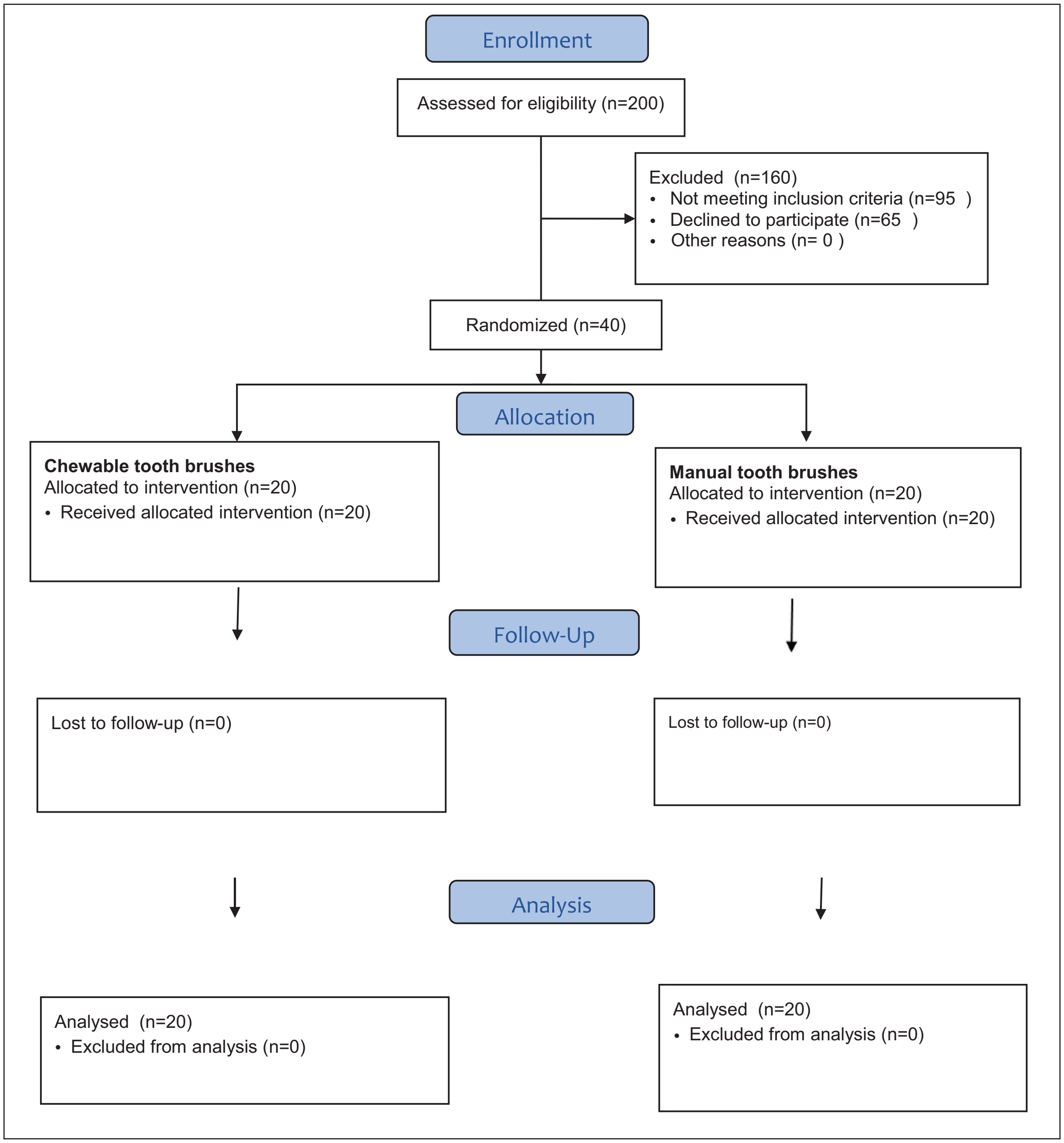

Figure 2: CONSORT 2010 flow diagram

The selected children (*n* = 40) were randomly assigned to the two groups using simple randomization.

Selection criteria

Cooperative children in the age group of 10–12 years, with good overall health, fair oral hygiene, and presence of all four fully erupted permanent first molar teeth were included in the study through random allocation. Informed consent from their parents was obtained before allocation. Uncooperative children, those suffering from known systemic diseases, those undergoing orthodontic treatment, having severe malocclusions or extensive carious lesions, and those who had consumed antibiotics in the past month were excluded from the study.

Null hypothesis

1. There is no statistically significant difference between chewable toothbrushes and manual toothbrushes in terms of plaque removal efficiency.
2. There is no statistically significant difference between chewable toothbrushes and manual toothbrushes in reducing salivary *S. mutans* counts.

Following a general oral examination, a professional oral prophylaxis was performed for all the participants prior to the commencement of the study to make sure that all the subjects had equally clean teeth for baseline standardization. Subjects were selected using simple random sampling and were divided into two groups by fishbowl method wherein the subjects picked lots and were grouped accordingly:

Group I: Chewable toothbrush

Group II: Manual toothbrushing

Participants were instructed to refrain from brushing their teeth for 24 h prior to the intervention. Disclosing agents were used to aid in identifying plaque.[12] This also helps in educating the children about the plaque on tooth surfaces. Simplified oral hygiene index (OHI-S) in indexed teeth[13] and Turesky modification of Quigley Hein plaque index[13] in all teeth were recorded on buccal/labial and lingual surfaces of the teeth. The indices were recorded by a postgraduate pediatric dental resident who was blinded to the allotment of groups. Followed by this, unstimulated saliva was collected and transferred to the laboratory for the estimation of *S. mutans* levels [Figure 3].

Mitis Salivarius Agar Base media from Hi-Media was modified by the addition of 20% sucrose and 0.2 units/ml of bacitracin for the requisite *S. mutans* growth. For quantitative culture, the samples were diluted in ten (10) 0–10 –2 dilutions using standard loop. Plates were incubated at 37°C for 48 h in CO_2 incubators. Microbiological assessment was done by a trained microbiologist who was also blinded to the group allotment. *Streptococcus mutans* was identified using its cultural characteristics. Doubtful isolates were identified using Vitak 2 identification system. The growth was quantified taking loop factor and dilution factor into account.

In Group I, the disposable chewable toothbrush (Fuzzy Brush) was introduced to the children and the participants were trained to roll the toothbrush inside their mouth according to the manufacturer's instructions. Due to the presence of xylitol, aroma mint, and an aquatic component; Fuzzy Brush does not require toothpaste or rinsing.

Children were given a demonstration on how to use this toothbrush they were asked to grip the brush between their teeth, to use their teeth to swivel it from left to right and then to use their tongue to move the brush around their mouth similar to the way one would use a chewing gum. They were asked to follow the regimen 3 min twice daily for a week [Figure 4].

In Group II, children were instructed to brush their teeth for 3 min using a manual toothbrush (Colgate Super Flexi toothbrush) and toothpaste (Colgate Total Advanced Health) as part of their normal routine twice daily for a week.

After 1 week of post-intervention, plaque scores (OHI-S and TMQHI) and *S. mutans* counts were repeated for both the groups using the same procedure and criteria. Children were called in the morning after they have taken breakfast. The indices were recorded by the same postgraduate student who was blinded for the group allotment.

Results

Statistical analysis

The data were tabulated using Microsoft Excel and subjected to statistical analysis with IBM SPSS Statistics version 20. Paired *t* test was used for intragroup comparison and an independent sample *t* test was used for intragroup comparison.

Intragroup comparison [Table 1]

Group I

Paired-sample *t* test was used to compare the plaque scores and *S. mutans* counts at baseline and post-intervention. Post-intervention TMQHI mean score in children of group I were significantly lower when compared to that of at baseline ($P < 0.001$). Similarly, OHI-S scores at baseline and post-intervention also

Figure 3: Collection of salivary samples

Figure 4: Fuzzy brush instructions

showed significant difference ($P < 0.001$). The mean log CFU counts at baseline post-intervention period were 5.08 ± 0.60 and 3.95 ± 2.05 ($P = 0.025$). The difference in the plaque scores between baseline and post-intervention showed a significant difference ($P < 0.001$). The debris and calculus scores (OHI-S) also showed a significant difference. There is a statistically significant difference in *S. mutans* counts also between baseline and post-intervention.

Group II

The mean TMQHI score at baseline and post-intervention have shown statistically significant difference ($P < 0.001$). The OHI-S mean scores at post-intervention were significantly lower compared to that of baseline ($P < 0.001$). The mean log CFU counts at baseline and post-intervention period were 5.20 ± 0.39 and 2.75 ± 2.55 ($P = 0.025$). The difference in OHI-S and plaque scores between baseline and post-intervention showed a significant difference ($P < 0.001$). There was also a statistically significant difference between *S. mutans* counts at baseline and post-intervention ($P < 0.001$).

Intergroup comparison [Table 2]

Independent sample *t* test was used to compare the mean differences of plaque scores and *S. mutans* counts pre- and post-intervention between both the groups. The TMQHI mean difference for group I and group II were 0.63 ± 0.41, 0.80 ± 0.42 ($P = 0.183$). The difference in TMQHI scores at baseline and post-intervention between group I and group II did not show any statistically significant difference. The OHI-S mean difference for group I and II were 0.90 ± 0.78 and 0.98 ± 0.54 ($P = 0.707$). The log *S. mutans* counts were 1.13 ± 2.07 and 2.46 ± 2.57 ($P = 0.08$). Both OHIS scores and log *S. mutans* counts did not show statistically significant differences.

Discussion

This study was a single-blinded randomized controlled trial to compare the efficacy of a new disposable chewable toothbrush against a manual toothbrush. This study included 40 children who were divided into two groups of 20 children each. In both groups, children were asked to brush their teeth for 1 week. When plaque scores were analyzed for chewable and manual toothbrush groups across all the subjects, they showed statistically significant reduction in the plaque scores from baseline to post-intervention period. In this study, the oral hygiene status of children aged 10–12 years was assessed using OHI-S index and TMQHI index. Children in the mixed dentition stage are more prone to plaque accumulation both due to disuse of some teeth as well as due to lack of motivation.10

To date, many studies have reported about various dental hygiene product other than manual toothbrushes, such as high-pressure oral spray devices,[1] sonic electric toothbrushes,[14] and essential oil mouth rinses.[15] However, very few studies have been conducted on

Table 1: Intragroup comparison (paired sample *t* test)

		Baseline		Post-intervention		*P* Value
		Mean	SD	Mean	SD	
Group I	TMQHI	1.53	0.40	0.90	0.40	<0.001
	DIS	1.44	0.40	0.69	0.26	<0.001
	CIS	0.23	0.41	0.04	0.15	0.071
	OHIS	1.64	0.73	0.73	0.30	<0.001
	Log mutans	5.08	0.60	3.95	2.05	0.025
Group II	TMQHI	1.34	0.35	0.54	0.43	<0.001
	DIS	1.33	0.43	0.52	0.49	<0.001
	CIS	0.16	0.22	0.02	0.07	0.006
	OHIS	1.50	0.53	0.52	0.52	<0.001
	log mutans	5.20	0.39	2.75	2.55	<0.001

Table 2: Intergroup comparison (independent sample *t* test)

Mean difference	Group				*P* Value
	1		2		
	Mean	SD	Mean	SD	
TMQHI	0.63	0.41	0.80	0.42	0.183
DIS	0.75	0.47	0.82	0.48	0.637
CIS	0.19	0.44	0.15	0.21	0.713
OHIS	0.90	0.78	0.98	0.54	0.707
log_mutans	1.13	2.07	2.46	2.57	0.08

the use of chewable toothbrushes in children.[7-10] The chewable toothbrush used in this present study was a modified version of a toothbrush that effectively reduces dental plaque using a masticatory motion, without the use of hands, unlike manual toothbrushes. Myoken *et al.*[7] and Bezgin *et al.*[8] compared chewable and manual toothbrushes and reported dental plaque reduction. These finding are in accordance with our study. In both studies, they have reported that with manual toothbrushes there was a greater reduction of plaque on the buccal surface. Whereas in chewable toothbrush group, it was lesser plaque accumulation on lingual surface. It was concluded that this finding was due to the fact that the user of a chewable toothbrush subconsciously places it on the lingual rather than buccal surface. In this study, assessments were not made separately for each tooth surface; therefore, direct comparisons could not be made.

TMQHI measures labial, buccal, and lingual surfaces of all teeth in contrast to the OHI-S which is a simplified index used to measure only six representative teeth.[9] Both OHI-S index and Plaque Index (TMQHI) were used for a more reliable assessment and better accuracy.[10] It was found that there was a significant improvement in the oral hygiene of children after using chewable brushes. Although the reduction in the TMQHI scores was higher in group II than in group I, the difference was not significant. This means that chewable toothbrush was as effective as the manual toothbrush in removing plaque after 1 week of use. This finding is in agreement with the study done by Bezgin *et al.*,[8] which showed a significant reduction in the overall plaque scores, proposing a chewable brush can be an appropriate oral hygiene adjunct in children. Also, the results were found to be consistent with the study done by Myoken *et al.*[7] in the elderly population. These findings suggest that chewable brush can be used as an effective alternative to the manual brushing in all kinds of populations. When debris and calculus indices were evaluated separately, there was a significant difference in the debris index in both groups; however, no considerable change was seen in the calculus index. Jeong *et al.*[16] assessed dental plaque on proximal surfaces as well and claimed there was a reduction of plaque accumulation after using chewable toothbrushes. However, we did not measure the indices on proximal surfaces in our study.

Although the results of plaque indices were comparable, it may not be viable to completely replace manual toothbrushes with chewable toothbrushes. As it has been pointed out by Frandsen,[17] the method of brushing considerably influences plaque removal. Chewable toothbrushes might a viable alternative for elderly or physically disabled individuals who lack manual dexterity. These brushes can also be used in situations like traveling where a brush and a toothpaste might not be available.

In this study *S. mutans* counts reduced significantly in both the groups when compared to baseline. However, there was no statistically significant difference between manual and chewable toothbrushes. A study conducted by Govindaraju *et al.*[11] showed similar results where there was a marked reduction in *S. mutans* counts after using a chewable toothbrush (Rolly mini toothbrush, Rolly Brush, Italy). They attributed their results to the presence of fluoride and xylitol in the chewable brush.[6] Fuzzy brush mainly contains xylitol which is proven to inhibit the adherence of bacteria to the plaque and makes its removal easy.[18,19] Xylitol causes supersaturation of saliva and suppresses the formation of macromolecules like glucans, thereby interfering in acid production. It elevates salivary pH as well as aids in demineralization.[20] This could be the possible reason for the significant reduction of *S. mutans* counts in our study. In a recent study, Joshi and Dixit[21] reported that chewable and manual toothbrushes are equally efficacious in children. They concluded that chewable brush can be an appropriate oral hygiene adjunct for school children as they spend a considerable amount of time out of home. The findings in our study are consistent with their results.

Limitations

One of the plausible limitations is a smaller sample size of our study. The impact of the novelty effect cannot be underestimated because children who used chewable toothbrushes found the brushes to be more exciting and convenient, which could very well be a bias in the research.

Conclusion

Within the limits of the study, we concluded the following:

1. Chewable toothbrushes are equally efficacious in plaque and debris removal as manual toothbrushes.
2. Both manual and chewable toothbrushes showed a significant reduction of *S. mutans* counts.
3. Chewable toothbrushes can be used as an alternative to manual toothbrushes in those who lack manual dexterity in holding the brush although we have conducted this study in healthy children. However, more clinical studies are required to assess the efficacy of these novel toothbrushes.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Authors contributions

Sridhar Nekkanti: design of the study, execution, manuscript preparation, Kanwardeep Kaur: data interpretation, statistical analysis, manuscript preparation, Shwetha Balagopal: data acquisition, Priyanka Agarwal: data acquisition.

Ethical policy and institutional review board statement

This study was approved by the Institutional Ethics Committee, Kasturba Hospital (ECR/146/INST/KA/2013/RR-16).

Patient declaration of consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Data availability statement

The data set of the study is available on request from Sridhar Nekkanti (drsri.pedo@gmail.com).

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