Effectiveness of a Three-headed Toothbrush in Pre-school Children

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Purpose: The aim of the study was to compare the effectiveness in plaque removal of a three-headed toothbrush with a conventional toothbrush in pre-school children.

Materials and Methods: Twenty-nine children (aged 4–5 years) participated in this study. Fourteen children (group A) used a three-headed toothbrush, and 15 children (group B) used a conventional toothbrush for 3 months. At the initial visit, the children brushed their teeth with their regular toothbrush, and at the final visit with the type of toothbrush they had used for the past 3 months. Plaque was recorded at 48 surfaces (molars: vestibular, oral, occlusal; front teeth: vestibular, oral). Plaque reduction was assessed on anterior and posterior areas of the dentition, and on the different tooth surfaces in sextants (I = 55/54; II = 53/63; III = 64/65; IV = 74/75; V = 73/83; VI = 84/85). Statistical evaluation was performed using Wilcoxon signed rank and Mann-Whitney tests.

Results: In group A, the median number of surfaces with plaque was reduced significantly after 3 months ($p < 0.05$). At final examination the number of surfaces with plaque in both groups differed significantly ($p < 0.05$). Significant decreases in plaque scores were recorded at maxillary and mandibular posterior and mandibular anterior teeth in group A ($p < 0.05$). The comparison of changes in plaque scores of both groups showed significant differences ($p < 0.05$) on the occlusal surfaces of molars, except in sextant IV. Significant differences between the groups were also noted on all surfaces of the left side and on the occlusal surfaces of the right side of the mouth ($p < 0.05$).

Conclusions: This study indicates that the three-headed toothbrush could be an alternative to the conventional toothbrush.

Key words: pre-school children, oral hygiene, toothbrush

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In small children an increasing number of erupted teeth, a diet rich in sugar and also poor oral hygiene promote the growth of a number of cariogenic bacteria, particularly mutans streptococci, and thus support the plaque development that subsequently increases the severity of caries, and can also lead to gingivitis (Etty et al, 1994; Ramberg et al, 1994; Mohan et al, 1998; Wan et al, 2003). The early onset of good oral hygiene measures can help maintain the healthy conditions of teeth and gingiva, and it can also favor the early establishment of toothbrushing habits (Wendt et al, 1996).

Parents are mainly responsible for the oral care of their children during the first years of life as toddlers (aged 1–3 years) and older pre-school children. In accordance with their degree of development, pre-school children attempt to become more independent. However, toothbrushing is a fine motor activity, which the pre-school children cannot completely perform without assistance, especially on the buccal surfaces of the maxillary teeth and the lingual surfaces of the mandibular teeth

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(Tsamtsouris et al, 1979; Kleber et al, 1982; Koroluk et al, 1994).

The duration of toothbrushing is an important factor for effective plaque removal (Nyyssönen and Honkala, 1984; Honkala et al, 1986). However, Mentes and Atukeren (2002) found a mean toothbrushing duration of only 28 seconds in young children between 3–5 years of age. Even adults spend just 68.8 – 83.5 seconds on toothbrushing (Saxer et al, 1998). Over the last decades various manual and electric toothbrushes were developed to simplify oral hygiene and to shorten the duration of plaque removal. The benefits of powered toothbrushes for the removal of plaque have been shown in many studies (Yankell and Emling, 1996; Walmsley, 1997; Jongenelis and Wiedemann, 1997; McCracken et al, 2001; Dentino et al, 2002). The studies with younger children, however, reported only limited improvements when using powered toothbrushes (García-Godoy et al, 2001; Borutta, 1997; Willershausen and Watermann, 2001). Therefore, novel manual toothbrushes were designed with different tuft forms and lengths for enhanced plaque removal (Singh et al, 1992; Sharma et al, 1994; Yankell and Emling, 1995; Singh et al, 2001). Another variety from Scandinavia was the double-headed toothbrush that was constructed for improved plaque removal at difficult areas, e.g. oral surfaces of teeth, using the modified Bass technique by adults and children (Horowitz and Suomi, 1974; Bastiaan, 1984, 1986; Gibson et al, 1988; Agerholm, 1991; Almajed, 1994). Although the clinical evaluations of the two-headed toothbrushes were promising, there was limited acceptance by patients who found the two-headed toothbrushes with flexible arms uncomfortable to hold. Another brush was found to be too large for the children to shift within the mouth (Gibson et al, 1988; Bastiaan, 1986). Only a later form was well accepted by patients (Almajed, 1994).

A three-headed toothbrush, which was constructed to clean all the tooth surfaces together, was also developed in Scandinavia (Dentaco AS, Bergen, Norway). The two heads for oral and vestibular tooth surfaces were shaped with an angle of 45 degrees, so that plaque on gingival and proximal areas could also be removed with a simple movement. The third head was planned for cleaning of the occlusal surfaces. The three-headed toothbrush was well accepted by parents of 970 pre-school children (Van Steenkiste, 2001). The studies comparing the effectiveness of the three-headed toothbrush compared with manual and powered toothbrushes in different age groups demonstrated improved plaque removal with this novel toothbrush (Zimmer et al, 1999; Bloch-Zupan and Maniere, 1996).

The aim of the present study was to compare the effectiveness of a three-headed toothbrush with a conventional toothbrush in pre-school children.

MATERIAL AND METHODS

Twenty-nine healthy kindergarten-attending children (aged 4–5 years; all 20 deciduous teeth present) participated in this study. None of the participants had unrestored cavities or other hard tissue disorders in any of their teeth. Written consent was obtained from the parents of the children.

The children were randomly assigned to two groups (A, B): 15 children in group A (7 girls and 8 boys; mean age 4.5 ± 0.5 years) used the three-headed toothbrush (Superbrush® , small, Dentaco AS; Figs 1a and 1b), and 14 children in group B (8 girls and 6 boys; mean age: 4.4 ± 0.5 years) used a conventional toothbrush (Elmex® 29). All children were right-handed. The parents of the children from both groups received separate instructions about the relevant oral hygiene techniques. They were also informed about the necessity of their assistance for plaque removal. Also the tutors in kindergarten were informed about the different toothbrushing practices.

At baseline, the children brushed their teeth as usual. Following toothbrushing, the presence or absence of plaque was recorded on 48 surfaces of primary teeth (molars: vestibular, oral, occlusal; front teeth: vestibular, oral), using a disclosing solution (Plaviso® , Voco, Germany) (Figs 2a and 2b). Instructions on how to use a three-headed and conventional toothbrush were given separately. After demonstrating the relevant oral hygiene techniques on a model, each child was also trained individually.

The children used the toothbrushes for three months in kindergarten and at home. Two toothbrushes and toothpaste (Elmex® toothpaste for children) were distributed at the initial visit, and every 4 weeks following the first visit. The demonstration of the oral hygiene techniques was repeated at each visit. At the final examination the children brushed their teeth with the type of toothbrush they had used for the past 3 months. Following toothbrushing, the presence of plaque was record-

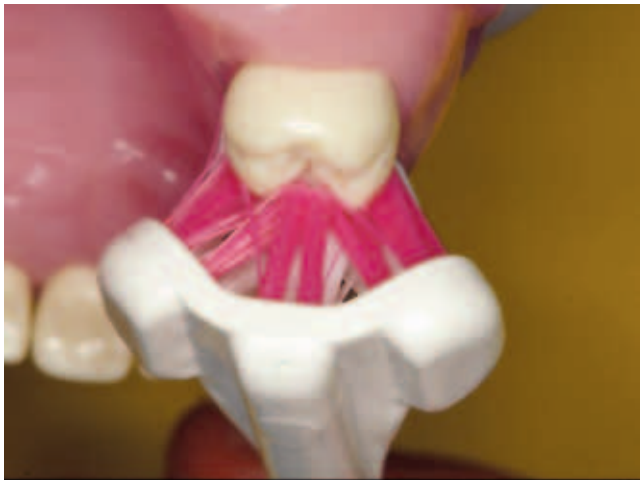

Fig 1a

Fig 1b

Figs 1a and 1b The three-headed toothbrush from Scandinavia (Superbrush, Dentaco AS); the two heads for oral and buccal tooth surfaces shaped with an angle of 45 degrees and the third head for the occlusal surfaces.

Fig 2a

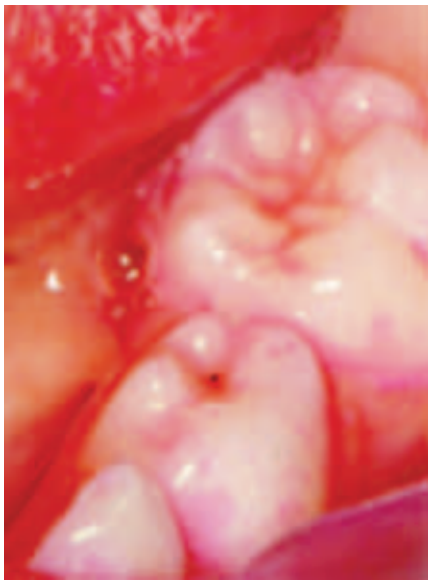

Fig 2b

Figs 2a and 2b Plaque assessment at tooth surfaces of primary teeth (molars: vestibular, oral, occlusal; front teeth: vestibular, oral) using a disclosing solution.

ed with the same method as at baseline. The reduction of plaque was assessed separately on anterior and posterior areas of the dentition, upper and lower jaws and on the different tooth surfaces in sextants (I = 55/54; II = 53/63; III = 64/65; IV = 74/75; V = 73/83; VI = 84/85).

The statistical evaluation of the data was performed using the SPSS program at the Institute for Medical Biometrics, Epidemiology and Computer Sciences, Johannes Gutenberg University, Mainz. The changes in plaque scores within each group were evaluated with the Wilcoxon signed rank test. The differences between the two groups were determined with the Mann-Whitney test.

RESULTS

At the initial examination, plaque was recorded in group A on 52% (median value) of the surfaces, and this percentage decreased significantly to 25% after 3 months of using the three-headed toothbrush ($p < 0.05$). In group B plaque was noted on 47% of the surfaces at the first visit and this changed to

Table 1 The median values of plaque scores at baseline and at the final examination for group A (three-headed toothbrush) and group B (conventional toothbrush) in the whole mouth and in different segments

	Whole mouth		Maxillary anterior		Mandibular anterior		Maxillary posterior		Mandibular posterior	
	(n = 48)	p-value	(n = 12)	p-value	(n = 12)	p-value	(n = 12)	p-value	(n = 12)	p-value
Group A (baseline)	25.0		6.0		7.0		6.0		4.0	
		0.0001		0.0574		0.0018		0.0018		0.0010
Group A (final)	12.0		4.0		4.0		3.0		2.0	
Group B (baseline)	22.5		7.0		5.0		5.0		4.0	
		0.7905		0.3877		0.2668		0.0923		0.5078
Group B (final)	21.5		6.0		5.0		6.0		5.0	

45% at the final examination ($p > 0.05$). At the final examination the Mann-Whitney test showed significant differences between the plaque scores of both groups ($p < 0.05$).

A significant decrease in the number of surfaces with plaque (median values) on maxillary and mandibular posterior teeth and also on the mandibular anterior areas was recorded in group A ($p < 0.05$) (Table 1). The median number of surfaces with plaque also decreased on maxillary anterior areas when using the three-headed toothbrush, but this reduction was not statistically significant ($p = 0.0574$). In group B, the number of surfaces with plaque did not change significantly after three months using the conventional toothbrush (Table 1).

In group A, the separate evaluations of the surfaces in the different sextants showed significant reductions ($p < 0.05$) in plaque scores after three months, except on the oral surfaces of sextant I and II, on the occlusal surface of sextant IV, and on the buccal and occlusal surfaces in sextant VI (Table 2). The plaque score changes in group B were not significant at the final examination.

The comparison of the changes in plaque values of both groups showed significant differences ($p < 0.05$) on the occlusal surfaces of primary molars, except in sextant IV (Table 2). When comparing the groups A and B, the evaluation of primary molars of the right (sextants I/VI) and left (sextants III/IV) sides of the mouth showed significant differences on all surfaces of the left side and on the occlusal surfaces of the right side ($p < 0.05$) (Table 3).

DISCUSSION

Toothbrushing duration and technique, as well as toothbrush form and wear are factors influencing the efficacy of plaque removal, and preventive programs recommend an emphasis on the duration of toothbrushing (Nyyssönen and Honkala, 1984; Honkala et al, 1986; Singh et al, 1992; Sharma et al, 1994; Yankell and Emling, 1995; Singh et al, 2001). In the present study the children were not supervised during toothbrushing, and the duration time was not standardized, so that the effectiveness of both toothbrushes was compared according to the children's habitual duration time for the removal of plaque.

The effect of toothbrush wear on plaque control was investigated in a number of clinical trials (Warren et al, 2002; Sforza et al, 2000). Although some authors reported that plaque removal is not necessarily correlated with toothbrush wear (Sforza et al, 2000), the children in the current study received a new toothbrush every 4 weeks. The final examination of plaque removal was performed after usage of both types of toothbrushes for a period of 4 weeks, so that the wear effect of the tested toothbrushes was comparable with the toothbrushes used at baseline examination.

In previous studies the effectiveness of the three-headed toothbrush on plaque removal was investigated with crossover designs after a usage period of 8 days or 16 weeks (Bloch-Zupan and Maniere, 1996; Kiche et al, 2002). In both studies

the order in which the different toothbrushes were used did not influence the results. In this study, it was of interest to assess the long-term efficacy of the novel toothbrush in small children. Therefore an application time of three months was chosen, but without a crossover design.

After three months, the children using a conventional toothbrush showed a slightly better but not statistically significant plaque removal on the buccal and oral surfaces of the teeth, except at sextant I. This could be due to the regular instructions the children received about toothbrushing techniques every four weeks. The effectiveness of adequate oral hygiene instructions on the reduction of the plaque index of pre-school children has been demonstrated in previous studies (Sarvia et al, 1989; Leal et al, 2002). But in these studies this particular effect was evaluated after only 2–7 days, and thus they may not be adequate predictors for a long time effect.

The comparison of the changes between the groups brushing with a conventional or a three-headed toothbrush revealed statistically significant differences on the occlusal surfaces of the primary molars of sextants I, III and VI, and on the buccal surfaces of sextants IV and V. Contrary to these results, Zimmer et al (1999) found significant differences between the three-headed toothbrush and a manual as well as an electric toothbrush in plaque removal on all buccal and oral surfaces in 6–60-year-old volunteers. Bloch-Zupan and Maniere (1996) also observed better plaque index values on buccal and oral surfaces in 4–15-year-old children after 8 days of usage of a three-headed toothbrush in comparison to a conventional toothbrush. However, only two of the children were younger than 6 years.

The results of Almajed (1994) also confirmed the effectiveness of a two-headed toothbrush in comparison to a conventional toothbrush on all buccal and oral surfaces in 6.6–18-year-old participants after one week. Also further studies with patients older than 11 years of age using a double-headed toothbrush in comparison to a conventional toothbrush had shown a significant improvement in plaque scores on the oral surfaces of teeth after an application period of 1–3 weeks (Bastiaan, 1986; Gibson, 1988; Agerholm, 1991). The divergence of the results in this study compared to the previous findings could be explained by the differences in the age groups.

Sarvia et al (1989) demonstrated significant differences in the effectiveness of plaque removal in

Table 2 The mean values of the differences in plaque scores between baseline and final examination for group A (three-headed toothbrush) and group B (conventional toothbrush) in different sextants and the p-values for the comparison of the changes in both groups

	Sextants																	
	I			II			III			IV			V			VI		
	buccal	oral	occlusal	buccal	oral		buccal	oral	occlusal	buccal	oral	occlusal	buccal	oral		buccal	oral	occlusal
Group A (n = 15)	– 0.80 (±1.08)*	0.27 (±1.03)	– 0.87 (±1.18)*	– 1.47 (±2.55)*	– 0.47 (±1.59)		– 0.67 (±0.81)*	– 0.80 (±0.67)*	– 0.67 (±1.17)*	– 0.67 (±0.81)*	– 0.53 (±0.91)*	– 0.33 (±1.29)	– 2.13 (±2.09)*	– 1.40 (±2.26)*		– 0.20 (±0.94)	– 0.47 (±0.63)*	– 0.40 (±0.82)
Group B (n = 14)	– 0.14 (±1.03)	0.29 (±0.61)	0.43 (±1.01)	– 0.14 (±1.95)	– 0.57 (±1.45)		– 0.14 (±1.16)	– 0.21 (±0.80)	0.43 (±1.08)	– 0.14 (±1.02)	– 0.14 (±0.94)	0.21 (±0.80)	– 0.29 (±1.38)	– 0.50 (±1.87)		– 0.14 (±0.77)	– 0.42 (±0.93)	0.36 (±0.84)
p-values (Group A/ Group B)	0.152	0.661	0.010	0.082	0.824		0.118	0.038	0.012	0.020	0.348	0.249	0.009	0.318		0.961	0.886	0.031

* $p < 0.05$ for the differences between baseline and final examination within each group.

Table 3 The p-values for the comparison of the differences in plaque scores of primary molars on the right and left sides between baseline and final examination in group A (three-headed toothbrush) and group B (conventional toothbrush)

	Sextants I/VI						Sextants III/IV					
	buccal	p-value	oral	p-value	occlusal	p-value	buccal	p-value	oral	p-value	occlusal	p-value
Group A	– 1.00 (±1.46)*	0.255	– 0.20 (±1.32)	0.907	– 1.27 (±1.53)	0.002	– 1.33 (±1.39)	0.006	– 1.33 (±1.29)	0.042	– 1.00 (±1.92)	0.016
Group B	– 0.28 (±1.48)		– 0.14 (±0.86)		0.78 (±1.31)		– 0.00 (±1.30)		– 0.36 (±1.27)		0.64 (±1.54)	

children under 7 compared with children over 7 years of age. Toothbrushing is a fine motor activity, and because of their limited manual dexterity pre-school children cannot adequately perform plaque removal without assistance (Tsamtsouris et al, 1979; Sarvia et al, 1989). Total removal of plaque cannot be achieved in this age group even under supervision; pre-school children find it harder to reach the posterior teeth than the anterior teeth, and they also have more difficulty brushing the mandibular teeth than the maxillary teeth (Tsamtsouris et al, 1979; Sarvia et al, 1989; Koroluk et al, 1994). Another reason for the differing results in the present study could be the longer application period of the toothbrushes. In the previous studies the toothbrushes were used for only 1–3 weeks before the final evaluation. Younger children are particularly curious when new objects are offered. However, interest in a new toothbrush might wear off during a three-month application period.

In the present study the decreases in the amounts of plaque on the primary molars on the left side of the mouth on all surfaces differed significantly for usage of the three-headed toothbrush compared with the conventional toothbrush, whereas on the right side only the occlusal surfaces showed significant differences. Bastiaan (1986) found no differences between the effectiveness of a two-headed and a conventional toothbrush on both sides of the mouth in children with a mean age of 12 years. However, Honkala et al (1986) found higher plaque values on the right side of the mouth in 13-year-old children when evaluating the effectiveness of habitual toothbrushing.

Some of the previous studies of younger children revealed greater amounts of plaque on the lingual than on the buccal surfaces of all teeth, and also on the occlusal surfaces of maxillary teeth (Kleber et al, 1981; Sarvia et al, 1989). On the contrary, Koroluk et al (1994) found significantly more plaque on the buccal surfaces in 3–5-year-old children than on the lingual surfaces of both arches. Further studies demonstrated differences between the jaws, and found more plaque on the buccal surfaces of the maxillary teeth and on the lingual surfaces of the mandibular teeth than on the opposite surfaces (Tsamtsouris et al, 1979; Sarvia et al, 1989). In the present study the three-headed toothbrush showed significant improvements in plaque removal on the buccal surfaces of all maxillary and on all oral surfaces of the mandibular teeth, and also on the occlusal surfaces of the maxillary teeth.

The present study showed that the three-headed toothbrush could be an alternative to the conventional toothbrush for cleaning the tooth surfaces that are difficult to reach for pre-school children, and that oral hygiene could be simplified for these children.

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