Clinical Effectiveness of Toothbrushes and Toothbrushing Methods of Plaque Removal on Partially Erupted Occlusal Surfaces

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Purpose: The aim of this crossover study was to compare the efficacy of conventional and end-tufted toothbrushes and two methods of plaque removal on partially erupted occlusal surfaces in schoolchildren.

Materials and Methods: Thirty-seven subjects, aged 5–7 years, with at least one partially erupted lower permanent first molar, were randomly divided into three groups. Occlusal plaque (baseline) was scored using a disclosing solution applied to the occlusal surface of an erupting molar. Subjects were instructed to use a conventional toothbrush with horizontal scrubbing (conventional group); a conventional toothbrush with transverse technique (modified group); or an end-tufted toothbrush (end-tufted group). Subjects returned after a one-week washout period and brushed with the alternate toothbrush or technique. Final plaque condition was evaluated again using the same scoring as at baseline. Occlusal plaque reduction (baseline to final) percentiles were compared using paired t-test.

Results: No statistically significant difference was found among transverse and end-tufted techniques (modified and end-tufted groups respectively) ($p > 0.05$). The conventional group was less effective on occlusal plaque removal in erupting first molars than the other groups ($p < 0.05$).

Conclusion: The conventional toothbrushing technique was not satisfactory compared with other tested techniques on occlusal plaque removal. Moreover, the use of a conventional toothbrush with a modified technique was very effective on erupting first permanent molars without any additional costly device.

Key words: dental plaque, effectiveness, tooth eruption, toothbrushing

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Decay on occlusal surfaces is the most common type of caries in permanent dentition and first permanent molars are frequently affected by caries due to several factors (Carvalho et al, 1989), including the complex macromorphology of occlusal surfaces with pits and fissures which are favourable sites for plaque accumulation (Carvalho et al, 1989, 1991, 1992).

Erupting teeth are more likely to develop caries than fully erupted teeth (Carvalho et al, 1989) and the period before full occlusion may last 6 to 12 months. In this period, first permanent molars can be covered with gingival tissue and have no direct contact with antagonist teeth (i.e. not in full occlusion). These conditions make tooth cleaning by toothbrushing difficult, and consequently there is plaque accumulation (Helm and Seidler, 1974; Carvalho et al, 1989, 1991, 1992, 1998; Arrow, 1998; Azrak et al, 2004). The functional usage of teeth is improved by cleaning with a toothbrush (Carvalho et al, 1989).

An SEM study (Thylstrup, 1990) has demonstrated that permanent teeth, with different degrees of eruption, and which also had superficial signs of enamel

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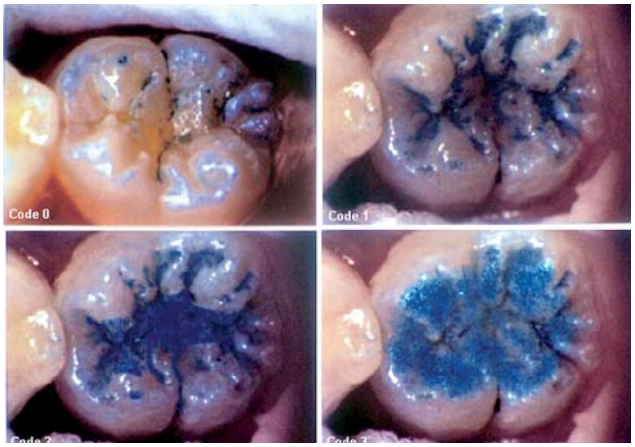

Fig 1 Plaque accumulation scores.

dissolution, returned to normality with only plaque removal.

Many preventive programmes based on intensive education and tooth-cleaning have already reported positive results, concerning not only plaque removal, but also the arrest of occlusal caries (Noronha et al, 1999; Kiche et al, 2002; Maltz et al, 2003). Consequently, clinical time and cost are reduced (Addy et al, 1986; Carvalho et al, 1992, 1998).

The aim of this crossover clinical study was to compare the efficacy of conventional and end-tufted toothbrushes and two methods of plaque removal on partially erupted occlusal surfaces in 5-to-7-year-old schoolchildren.

MATERIALS AND METHODS

The protocol of this study was reviewed and approved by the local ethical committee (CEP/FOUSP 13/00).

Thirty-six 5-to-7-year-old children were selected at a public school. For all children an informed consent was obtained and information was previously provided to parents or legal guardians. Children were enrolled if they had at least one erupting mandibular first permanent molar. The inclusion criterion was: lower permanent first molars had their occlusal surface fully erupted but not in full functional occlusion. In order to ensure this condition, a 0.05 mm thick polyester strip was placed between the maxillary and mandibular first permanent molars in centric occlusion, and teeth were considered in infra-occlusion if the polyester strip was not held by the bite. Gingival operculum could be present or not. Thus 40 mandibular first permanent teeth, 20 with gingival operculum and 20 without, were selected from these 36 children.

Furthermore, these teeth needed to be clinically sound, without white spot lesions, cavities, fillings or dental sealants. A single trained examiner performed the visual inspection of cleaned and dried occlusal surfaces (Lussi, 1991).

The study included a plaque accumulation period of 24 hours, during which children in all experimental groups were asked to abstain from any kind of mechanical oral hygiene in order to obtain baseline plaque levels for all children. Four sessions were carried out for each child: an initial session and one evaluation session for each toothbrush or toothbrushing method. Each child was examined twice at each session to evaluate initial (baseline) and final plaque condition. Occlusal plaque was scored using a green disclosing solution, applied with a cotton swab to occlusal surfaces without previous cleaning procedures. After ten seconds of disclosing solution application, the tooth was rinsed and plaque accumulation on the occlusal surface of the first permanent molar was assessed according the criteria and classification described by Rodrigues et al (1999) (Fig 1) by a single trained examiner. Scores for plaque accumulation were:

- Code 0 - no plaque present on the occlusal surface (no evidence of disclosing solution);
- Code 1 - plaque only on pits and fissures;
- Code 2 - plaque on pits and fissures and on half of the occlusal surface;
- Code 3 - plaque on the entire occlusal surface.

After initial plaque evaluation, children were instructed about the importance of the first permanent molar and plaque control. All orientation was performed individually and using a mannequin. Children were trained individually by the same professional with only the toothbrushing method to be used on that day. Experimental toothbrushing methods were:

- Group I: conventional group – conventional toothbrush with nylon bristles (Tandy®, Kolynos) and horizontal scrubbing (anterior-posterior movements);
- Group II: modified group – conventional toothbrush with nylon bristles (Tandy®, Kolynos) and transverse technique: horizontal scrubbing was performed in the buccal-lingual direction (Fig 2);
- Group III: end-tufted group – end-tufted toothbrush (Kolynos end-tufted brush) (Fig 3) used as a 'broom that would sweep the occlusal surface from inside out', i.e. from the centre of tooth towards to buccal and lingual surfaces.

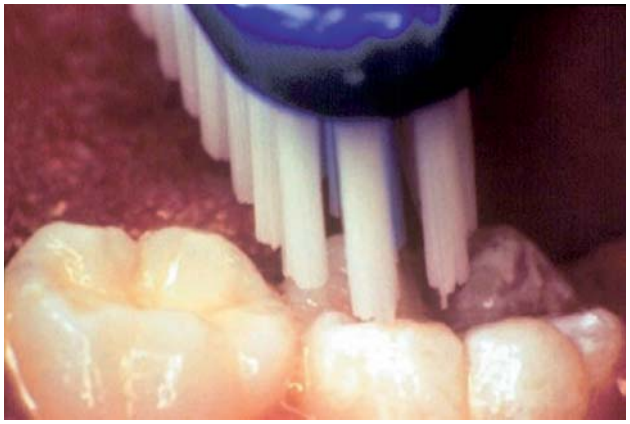

Fig 2 Buccal-lingual technique.

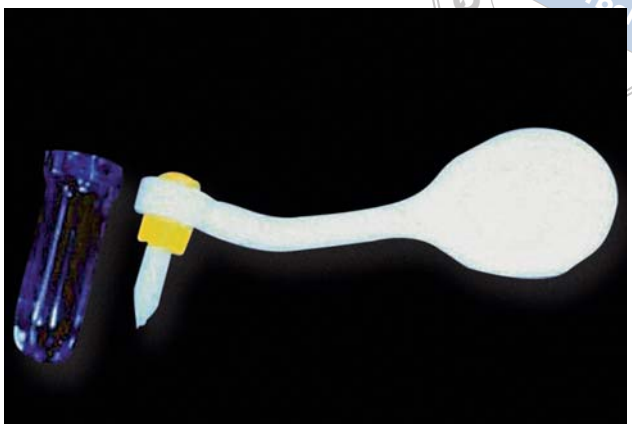

Fig 3 End-tufted toothbrush.

Table 1 Mean values ± standard deviations for initial and final plaque condition of erupting first permanent molars regarding toothbrushing method

Plaque condition	Group I	Group II	Group III
Initial (before toothbrushing)	2.20 ± 0.89	1.98 ± 0.89	1.80 ± 0.88
Final (after toothbrushing)	2.00 ± 0.88	1.48 ± 0.85	1.28 ± 0.82
Difference (final – initial)	0.23 ± 0.42[a]	0.50 ± 0.75[b]	0.53 ± 0.85[b]

[a] statistically significant ($p<0.05$) difference between Group I and Groups II and III
[b] no significant ($p<0.05$) difference between Group II and Group III

Toothbrushing was done with the addition of a small quantity (approx. 27g) of fluoridated dentifrice using the transverse technique of dentifrice application (Zaura et al, 2005). The same type of dentifrice was used in all groups. All children brushed their teeth in front of a mirror under professional supervision. No duration was set for toothbrushing.

Children were randomly assigned to all three toothbrushing groups with an interval of one week between each (washout period), in order to eliminate any possible residual effect. During this period children performed their oral hygiene as usual and with no special toothbrush or toothbrushing method and no special recommendations.

Subsequently final plaque condition was evaluated by the same means as at baseline. Initial and final plaque-scoring tables were recorded on separate sheets of paper for each subject, so that the examiner would not be influenced by any of the results.

Statistical analysis

The obtained data were subjected to paired t-test (level of significance of 5%) to compare plaque reduction between and within groups.

RESULTS

Averages and standard deviations for initial and final plaque condition scores are showed in Table 1. There was a highly significant difference when comparing initial and final plaque condition scores in all groups ($p = 0.0001$).

Plaque reduction comparisons showed that the conventional group had less of a reduction than the modified and end-tufted groups ($p = 0.043$ and $p = 0.049$ respectively) (Table 1).

The plaque-condition scores (means and standard deviations) for initial and final examinations according to the presence of gingival operculum are described in

Table 2 Mean values ± standard deviations for initial and final plaque condition of erupting first permanent molars regarding toothbrushing method and gingival operculum presence

	Presence of gingival operculum					
	Group I		Group II		Group III	
Plaque condition	absent	present	absent	present	absent	present
Initial	1.63 ± 0.77	2.70 ± 0.64	1.50 ± 0.76	2.45 ± 0.76	1.55 ± 0.76	2.05 ± 0.91
Final	1.42 ± 0.70	2.52 ± 0.68	1.20 ± 0.62	1.75 ± 0.97	1.10 ± 0.64	1.45 ± 0.94
Difference (final – initial)	0.21 ± 0.41[a]	0.24 ± 0.44[a]	0.30 ± 0.64[b]	0.70 ± 0.80[b]	0.45 ± 0.76[b]	0.60 ± 0.94[b]

[a] statistically significant ($p<0.05$) difference between Group I and Groups II and III
[b] no significant ($p<0.05$) difference between Group II and Group III

Table 2. Teeth with gingival operculum showed higher dental plaque scores than those without. However, no significant differences were observed in plaque reduction averages in any of the three groups in the presence of gingival operculum (Group I, $p = 0.840$; Group II, $p = 0.092$; and Group III, $p = 0.582$).

DISCUSSION

The aim of this study was to compare the efficacy of conventional and end-tufted toothbrush and two methods of plaque removal on partially erupted occlusal surfaces in schoolchildren. The erupting period is considered critical and takes from 6 to 12 months (Helm and Seidler, 1974; Carvalho et al, 1989, 1998; Arrow, 1998). Full functional occlusion makes plaque removal from occlusal surfaces easier since teeth are at the same occlusal level as the other teeth and due to chewing function. By that time, child psychological development and dexterity allow better oral hygiene performance.

Plaque control is essential for caries prevention. Cariogenic microorganisms do not then have a favourable environment for development on the deep and narrow occlusal fissures, as it is known that caries lesions on the occlusal surface begin at the entrance of the fissures and not in the depth of the fissures (Lussi, 1991). Although the relationship between toothbrushing and caries is not evident (Addy et al, 1986), the use of fluoride toothpaste as an adjunct to toothbrushing is effective for caries prevention. Fluoride toothpaste efficacy in fissure caries prevention has not been shown, unlike in smooth surfaces (Zaura et al, 2005).

Occlusal surface macromorphology increases plaque accumulation, and it is more important than pit and fissure areas for the beginning of carious lesions on this surface (Carvalho et al, 1991; Ekstrand et al, 1993; Ekstrand and Bjorndal, 1997; Addy et al, 1998). This is especially true at the early eruption period until full functional occlusion.

In Denmark, Carvalho et al (1991) performed a preventive three-year programme that maintained the first permanent molars, by frequent recalls throughout the year, and without using sealants. The investigators taught parents and children how to maintain these teeth. Individual strategies in oral health preventive programmes have better results than those designed for the community. In addition, these programmes have a lower cost and could be implemented with minimal effort (Maltz et al, 2003; Jackson et al, 2005).

In this study, the use of a conventional toothbrush with a different toothbrushing method (transverse brushing with the toothbrush placed in the buccal-lingual direction), showed statistically significant plaque reduction, when comparing the initial and final plaque scores of brushing with anterior-posterior movements. The same results were observed when children used the end-tufted toothbrush. On the other hand, statistical analyses showed no significant difference in plaque reduction when these two techniques were compared (modified and end-tufted groups).

The effectiveness of plaque removal by the three toothbrushing groups regarding the presence of gingival operculum showed no statistically significant differences (Table 2). Therefore, all toothbrushing techniques were efficient in plaque removal on first permanent molars with and without operculum. Therefore the presence or absence of gingival operculum did not

make the removal of plaque more difficult using these techniques. However, before toothbrushing, more plaque was present on occlusal surface of first permanent molars with gingival operculum than on those teeth without.

The results of this study indicated that the conventional group plaque removal was not satisfactory compared to other tested techniques. Azrak et al (2004) found that a conventional toothbrush was less effective than a specially designed toothbrush in pre-school children. However, in several studies it has been shown that a conventional toothbrush allows proper plaque removal from occlusal surfaces compared with specially designed toothbrushes (Kiche et al, 2002; Scheidegger and Lussi, 2005). Moreover, we found that the use of a conventional toothbrush with a modified technique or an end-tufted toothbrush was very effective in occlusal plaque removal in erupting mandibular first permanent molars.

All children easily assimilated the end-tufted toothbrushing technique, as well as the transverse method, and these two methods showed very similar plaque reduction on occlusal surfaces. Motivational status and training can influence positive results in plaque control by toothbrushing in spite of manual dexterity of children at ages 5 to 7. Therefore, these facts suggest that the conventional toothbrush could be used for plaque control on occlusal surfaces of erupting mandibular first permanent molars without any other device. This is extremely important, especially in countries such as Brazil, where a very large proportion of the population is not able to afford an end-tufted toothbrush.

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