A clinical trial comparing the effectiveness of a three-headed versus a conventional toothbrush for oral hygiene in children

M.S. KICHE, S.A. FAYLE, M.E.J. CURZON

**Abstract**

**Aim** The study was designed to compare the efficacy of the Superbrush three-headed with a conventional brush for oral hygiene in children. **Materials and methods** The study population was 78 children attending three primary schools in Leeds (UK). The clinical trial consisted of a single blind, randomized, four visits, crossover and single use toothbrush design. Subjects were randomized to one of two test groups (A and B). The 16-week trial consisted of four visits with a washout period of four weeks between the second and third visits. Both brushes were used with a horizontal mini-scrubbing strokes technique. Plaque scores were recorded at each visit using the Quigley and Hein Plaque Index as modified by Turesky et al. [1970]. **Results** Using a paired t-test the results from the outcome measures of the four visits indicated that buccally the conventional brush was superior in plaque removal to the three-headed brush, lingually there was no difference between brushes. Although over-all plaque removal was similar for both brushes, 85% of the children preferred the Superbrush. **Conclusion** Significant improvements in plaque removal in children can be achieved following good tooth brushing instructions regardless of the design of toothbrush used.

**Key Words:** Children, Toothbrushes, Oral health

**Introduction**

It is generally accepted that dental plaque is an important aetiologic factor in the development of periodontal disease and dental caries. Tooth brushing is one of the most efficient measures for the prevention of both oral diseases, and considerable emphasis has been placed over the past two hundred years on the design of toothbrushes to maximize effective removal of dental plaque.

A correlation between good oral hygiene and gingival health has been demonstrated in adults [Ash et al., 1964; Loe et al., 1965] and also in children [Bastiaan, 1986]. However, the relationship between oral hygiene and dental caries remains controversial, so that no correlation has been found [Ainamo and Parvianen, 1979], while some authors have found the opposite [Tucker et al., 1976].

Although about 75% of children in the UK claim to brush their teeth at least once a day, the majority still have plaque on their teeth [O’Brien, 1974]. Naturally the quality of cleaning is thought to be more important than the frequency of performance [Bellini, 1981]. Various methods of tooth brushing have been advocated over the years. Greene [1966] grouped the methods as: vertical, horizontal, roll, vibrating, circular and physiological. Comparative studies of these different techniques have yielded conflicting results and each has its protagonists. The more predominant technique is the roll followed by the vibrating. Ainse [1975], in a study of four techniques in children aged 11 to 14 years, concluded that the horizontal scrubbing method was better than others. Other workers have supported this finding. The most frequently used worldwide appears to be the horizontal mini-scrubbing method [Rugg-Gunn and MacGregor, 1978].

Toothbrush designs have changed many times in the years to include variations in head size, length, diameter, elasticity and number of fibres, distribution and angulations. All these variables confound comparison of the many investigations. Thus variation in head angulation has been advocated [Shick and Ash, 1961] or bristle design [Scopp et al., 1976]. Updyke [1979] concluded it was best to use a smaller head and thicker handle.
for children. Kanchanakamol et al. [1992], in a crossover trial in children, found that a 45° angled brush was superior to a straight one. In a later study by the same authors the angled brush removed significantly more plaque than a conventional [Kanchanakamol et al., 1992]. Filament stiffness and density may also have an effect [Scully and Wade, 1970; Berdon et al., 1974; Saxer and Yankell, 1997].

Multi-headed brushes have also been studied. Bay et al. [1967] compared seven different designs and found that a two-headed nylon brush had superior cleaning effectiveness. However, Suomi et al. [1972] and Horowitz and Suomi [1974] found a standard brush did a better job than a two-headed brush in children. On the other hand Bastiaan [1984] found that a double-headed brush removed significantly more plaque on lingual surfaces than a conventional brush. The same author [Bastiaan, 1986] found the same result in 34 boys aged 11-13 years. More recently a three-headed toothbrush design has been introduced. It has a short, firm, rounded headed bristle in the center of the brush to clean occlusal surfaces and longer, softer outer bristles, at 45°, to gently clean the smooth surfaces and gingival margins. A study was published using this new Superbrush on a population of mentally retarded patients [Sauvetre et al., 1995]. While there appeared to be no significant difference in controlling plaque between the test and control brushes, the authors observed a greater facility to be able to use the new brush. These authors recommended that this brush had advantages for patients where the manipulation of normal methods of oral hygiene were lacking, such as those with physical, mental handicaps or young children. Accordingly a study was designed to test the efficacy of this Superbrush in children compared with a conventional children’s brush.

Materials and Methods

A study population of school children aged 7-10 years of age living in Leeds (UK) was selected. Three primary schools, located in moderate to lower socioeconomic areas, were selected and approval of the educational authorities gained. Ethical approval was obtained from the Leeds General Infirmary Research Committee. Children were only included if their parents consented to the study and fulfilled the following inclusion criteria:
- No history of cardiac defects;
- No history of bleeding disorders;
- No history of any medical problems requiring hospital care.

Each participating child received a baseline dental examination in school using portable dental equipment. Illumination was by a portable Daray Light. The examination recorded plaque scores from six sites in the mouth (teeth 16, 21, 24, 36, 41, 44), as described by Ramfjord [1967]. Where primary teeth were present, the teeth used were 55, 61, 64, 75, 81 and 84. If no suitable tooth was present, then the directly adjacent tooth or the tooth of the same type in the opposite quadrant of the same arch was used.

Plaque scoring was by the method of Quigley and Hein [1962], as modified by Turesky et al. [1970]. The plaque index was used by applying 4% erythrosine disclosing solution with a cotton bud. A score of 0 to 5 was assigned to each facial and lingual non-restored surface of the selected teeth. Each tooth surface was considered as divided vertically into three divisions in order to record the variation of plaque accumulation. Each tooth selected was given a score according to the following criteria:
- No plaque;
- Separate flecks of plaque at the cervical margin of the tooth;
- A thin continuous band of plaque (up to 1 mm) from the cervical margin;
- A band of plaque wider than 1 mm, but covering less than 1/3 of the tooth crown;
- Plaque covering at least 1/3 but less than 2/3 of the tooth crown;
- Plaque covering 2/3 or more of the tooth crown.

Before commencing the main study, a pilot study for calibration was carried out on 12 children attending the Department of Paediatric Dentistry (Leeds Dental Institute), where the examiner (M SK) was trained and calibrated by a member of staff with many years of experience in using the indices. A power calculation based on the results of the pilot study showed that the minimum number of children that were required to record a difference between the two brushes was 60. In all 108 children were recruited to the study but, because of missed dental examinations, complete data was available for 78. There were 38 boys and 40 girls with a mean age of 9.3 years.

The study was carried out blind from the examiner’s point of view but could not be double blind as the difference in toothbrushes was obvious. The children were assigned initially to test (Superbrush-A, Fig. 1a) or control (a conventional
children’s Brush-B, Fig. 1b) by another member of staff on a random basis, Visit 1. Each child used exactly the same toothpaste throughout the trial. The brushes, either A or B, were used for four weeks after which their plaque scores were repeated, Visit 2. The children attended for examination in a random fashion without their toothbrush so that the examiner was unaware as to which brush had been used. All brushes were collected and each child issued with another commonly available child’s brush to use over the next four weeks (washout period). On returning, Visit 3, another plaque score was recorded and each child issued with the opposite toothbrush to that had been used in the first test period. After the second test period a final plaque score was taken, Visit 4, and each child asked as to which brush it had preferred. The study design was therefore a single blind, randomized, four visits, crossover and single use toothbrush design with subjects randomized to one of two test groups (A and B); the sequence of events is shown in Table 1.

As there is little difference in effectiveness of the various toothbrushing methods [McClure, 1966], the horizontal mini-scrubbing technique was used. Every child watched a video showing the mini-scrubbing technique and was able to discuss the brushing technique. This video film was shown to every child at the beginning of each test period. The manufacturers of the Superbrush state that the horizontal mini-scrub technique while tilting the brush head outwards and inwards is best. This was the method taught to the children in this study. The parents of the children were not involved in the study and so no instructions were given to parents. The brushing methods used by the children at home were those demonstrated to the children without any parental assistance.

TABLE 1 - Design of the clinical trial to compare use of the Superbrush a conventional toothbrush.

<table>
<thead>
<tr>
<th>Study Visit</th>
<th>Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>Plaque disclosing and scoring; a toothbrush (either Superbrush or conventional brush) and toothpaste given; toothbrushing instruction specific to the brush issued was given to each child; viewing of demonstration video; instructions on home brushing schedules.</td>
</tr>
<tr>
<td>Two</td>
<td>Plaque disclosing and scoring; collect used toothbrushes; each child asked to use usual brush for the next month (wash-out period).</td>
</tr>
<tr>
<td>Three</td>
<td>Plaque disclosing and scoring; each child given Superbrush if she/he had used the conventional brush and vice versa; fresh toothpaste given; tooth brushing instructions specific to the brush issued given to each child; viewing of demonstration video; instructions on home brushing schedules.</td>
</tr>
<tr>
<td>Four</td>
<td>Plaque disclosing and scoring; each child was asked 10 as to which type of brush they had preferred and why? What were the problems with the other brush?</td>
</tr>
</tbody>
</table>

FIG. 1 - a) End view of the three-headed Superbrush. b) Side view of a conventional children’s brush.
Results

The calibration-pilot study recorded a Kappa statistical test [Cohen, 1960] for the examiner of 0.82 between first and second plaque scores. This showed a high degree of consistency. A power calculation based on the results of the pilot study showed that the minimum number of children required to record a difference between the two brushes was 60.

In all, 108 children started the study but, because of missed dental examinations, complete data was available for 78. The mean age of the children was 9.3 years and there were 20 boys and 21 girls. The Superbrush was used first by 37 children, while 41 used the conventional brush first. The mean plaque scores are shown in Table 2, which records an improved plaque score for both groups between visits one and two, but only a marginal reduction between visits three and four.

The paired t-test was carried out on plaque data for the first and third visits showed scores of +2.69 and +2.34 respectively, which was a significant difference (t = 5.09, p < 0.001). A comparison between the two toothbrushes according to any improvement in overall buccal plus lingual or buccal and lingual scored separately, mean plaque scores showed no statistically significant difference between them for combined or lingual scores (Table 3), but there was a modest difference for buccal scores (p < 0.05). The later however showed that the figure for the Superbrush was -0.02, indicating the amount of plaque increased when the Superbrush was used. Finally a comparison of the effectiveness of the two brushes in different areas of the mouth, such as incisors, molars etc, showed no significant differences (Table 4).

When asked for a preference for one brush or the other, 65 of the 78 children preferred the Superbrush to the conventional brush. The reasons given were that 33% felt that the three-headed brush made their mouth feel cleaner, 20% felt that it cleaned faster. It was also felt to be easier to use (10%), more comfortable to use (11%) and that it cleaned back teeth better (9%).

### Table 2 - Mean plaque scores for toothbrush groups and the difference in scores between visits for clinical trial of use of the Superbrush versus a conventional toothbrush.

<table>
<thead>
<tr>
<th>Visit</th>
<th>Mean Plaque score ± SE</th>
<th>Group A</th>
<th>Group B</th>
<th>Difference ± SE</th>
<th>t test</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visit 1</td>
<td>2.60 ± 0.08</td>
<td>2.76 ± 0.05</td>
<td></td>
<td>+0.16 ± 0.08</td>
<td>0.73</td>
<td>0.46 NS</td>
</tr>
<tr>
<td>Visit 2</td>
<td>2.21 ± 0.11</td>
<td>2.43 ± 0.09</td>
<td></td>
<td>+0.22 ± 0.12</td>
<td>2.23</td>
<td>0.03*</td>
</tr>
<tr>
<td>Difference</td>
<td>+0.39</td>
<td>+0.33</td>
<td></td>
<td></td>
<td>1.05</td>
<td>0.30 NS</td>
</tr>
<tr>
<td>Visit 3</td>
<td>2.41 ± 0.10</td>
<td>2.26 ± 0.07</td>
<td></td>
<td>+0.15 ± 0.03</td>
<td>0.73</td>
<td>0.46 NS</td>
</tr>
<tr>
<td>Visit 4</td>
<td>2.28 ± 0.12</td>
<td>2.15 ± 0.04</td>
<td></td>
<td>+0.13 ± 0.08</td>
<td>0.73</td>
<td>0.46 NS</td>
</tr>
</tbody>
</table>

Group A = Superbrush at first visit, conventional brush at third visit
Group B = Conventional brush at first visit, Superbrush at third visit

### Table 3 - Comparison of mean plaque scores of buccal plus lingual and buccal and lingual surfaces separately for the Superbrush compared with the conventional brush.

<table>
<thead>
<tr>
<th>Surfaces</th>
<th>Conventional Brush</th>
<th>Superbrush</th>
<th>Difference ± SE</th>
<th>t test</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buccal + lingual</td>
<td>+0.24</td>
<td>+0.18</td>
<td>+0.06 ± 0.88</td>
<td>0.73</td>
<td>0.46 NS</td>
</tr>
<tr>
<td>Buccal</td>
<td>+0.21</td>
<td>-0.02</td>
<td>+0.23 ± 0.10</td>
<td>2.23</td>
<td>0.03*</td>
</tr>
<tr>
<td>Lingual</td>
<td>-0.22</td>
<td>+0.33</td>
<td>-0.11 ± 0.11</td>
<td>1.05</td>
<td>0.30 NS</td>
</tr>
</tbody>
</table>

+ = improvement in mean plaque score
- = deterioration in mean plaque score
* = significant at p<0.05; NS = not significantly different
Discussion

The aim of the study was to compare the effectiveness of the Superbrush with a conventional children’s brush. The results have shown that there was no statistically significant difference between plaque scores. These results support the findings of Suomi et al. [1972] and Horowitz and Suomi [1974]. Possible explanations for our findings are several. Firstly, the toothbrushing instructions might have been insufficient. However, each child watched the video and was able to discuss the brushing technique. Secondly, there could be variation in individual skills, compliance and motivation. But these comments could be made equally to all previous toothbrush studies. Thirdly, theoretically, because of the 45° angle of the side bristles there might be a tendency for them to enter the sulcal area automatically including the interproximal area. Finally, it was noticed during this study, when watching the children practice brushing, that when the Superbrush was applied to the tooth surfaces, the bristles did not adhere to the cervical region of a tooth. This was due to the inadequate length of the bristles and the limited vertical movement of the head.

The duration of the study can be considered a factor especially when applied to children, as it has been shown that plaque control improves when periods of brushing increase [Bastiaan, 1984]. This was apparent in the present study, with plaque scores improving over the total period of the study. Thus, by just being in the study, all children improved their plaque control and this may have masked any inherent advantage of one brush design over another.

Our results were also different to others studies [Bay et al., 1967; Bastiaan, 1984; Bastiaan, 1986] where a two-headed brush cleaned the lingual surfaces better than a conventional one. This was so in the present study but the improvement did not reach significance. In our study the Superbrush did not clean the buccal surfaces as well as the conventional brush, and this difference was significant (p=<0.05). It has also been suggested that any increase in effectiveness of a two-headed brush may be due to the brushing time being effectively double that of a single headed brush [Bastiaan, 1986]. Our results do not show any such effect because the mean plaque score improvement of the Superbrush was inferior to that of the conventional brush on the buccal surfaces. The children in our study were instructed to spend the same amount of time on brushing, one minute, whichever brush they were using. The actual time taken was not recorded as the children used the brushes at home. Whether there was any difference in usage is not known.

It was interesting that a substantial majority of children preferred using the Superbrush. This may be because of a novelty effect. Many of the children felt they liked the Superbrush because they felt it did a better job. Therefore, if there is a novelty effect this may well be to the good if it encourages children to brush their teeth.

Conclusion

There was no statistically difference in the cleaning ability of tooth surfaces between a Superbrush three-headed toothbrush compared with a conventional single-headed brush when used by children. However, the children preferred the use of the Superbrush by a substantial majority.

<table>
<thead>
<tr>
<th>Surfaces</th>
<th>Conventional Brush</th>
<th>Superbrush</th>
<th>Difference ± SE</th>
<th>t test</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incisors</td>
<td>+0.25</td>
<td>+0.08</td>
<td>+0.18 ± 0.15</td>
<td>1.19</td>
<td>0.24 NS</td>
</tr>
<tr>
<td>Premolars</td>
<td>+0.20</td>
<td>+0.13</td>
<td>+0.07 ± 0.11</td>
<td>0.59</td>
<td>0.56 NS</td>
</tr>
<tr>
<td>Molars</td>
<td>+0.26</td>
<td>+0.24</td>
<td>-0.02 ± 0.10</td>
<td>-0.18</td>
<td>0.86 NS</td>
</tr>
</tbody>
</table>

+ = improvement in mean plaque score
- = deterioration in mean plaque score

Table 4 - Comparison of mean plaque scores of buccal plus lingual for incisor, premolar and molar surfaces comparing the Superbrush with the conventional brush.
Acknowledgements

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