Efficacy of different designs of tooth brushes in plaque removal

Neeraj kant Panwar,* Aprajita Mohan,† Ruchi Arora‡

*Senior lecturer, Department of Pedodontics & Preventive Dentistry, IDST Dental College & Hospital, Ghaziabad, U.P., India. †Postgraduate student, Department of Physiology, GMC, Amritsar, India. ‡Prof&Head, Dept. of Pedodontics & Preventive Dentistry, Darshan Dental College and Hospital, Udaipur, Rajasthan, India.

Abstract

Aims: To compare the efficacy of commonly used designs of manual tooth brushes and powered tooth brush in plaque removal. Material and methods: The study was randomized single examiner cross sectional in design performed on 20 subjects within the age of 10-12 years. The subjects were made plaque free by oral prophylaxis four days prior to the commencement of the study and were told to abstain from brushing for 24 hours before the study. On the day of the examination, all the subjects were scored for plaque using Quigley- Hein plaque index. Four subjects were randomly allocated to any of the five experimental tooth brushes. The subjects brushed with the allocated tooth brushes for two minutes and post brushing plaque scores were assessed. Results: It was observed that powered toothbrush exhibited significantly greater efficacy in removing plaque than the manual toothbrushes while no significant differences were observed between the manual toothbrushes. Residual plaque score on lingual surfaces of manual toothbrush group (1.11±0.09) was significantly greater than in powered tooth brush users (0.43±0.09). Manual tooth brushes were significantly more effective in removing plaque on buccal than lingual surfaces and left than right quadrants. Conclusions: It is evident from the present study that no manual toothbrush design is better than the other. However, powered tooth brush efficacy in plaque removal was superior over manual tooth brushes.

Key words: Manual toothbrush; Powered toothbrush; Plaque; Effectiveness

*Author for correspondence: Dr Neeraj kant Panwar, Senior Lecturer, Department of Pedodontics & Preventive Dentistry, IDST dental College & hospital, Ghaziabad, Uttar Pradesh, India.
Tel: +91-9634388807
E-mail: dr.neerajkantpanwar@gmail.com
Introduction

Dental caries and periodontal disease are the most commonly occurring diseases affecting mankind. Dental plaque is a very important factor in the causation of both these diseases (1-3). Realistically, these diseases are kept at bay through personal and professional oral hygiene measures.

Toothbrush is one of the most commonly used adjuncts for maintaining oral hygiene. The bristles are perhaps the most important consideration in selecting a good toothbrush. The different bristle designs include flat, multilevel, curved, zigzag and many more but no evidence of the superiority of one design over the other has been documented (4-6).

Because of the varieties of brushes currently available and the constant development of new brushes, the dental professional must maintain a high level of knowledge of these products and advice the patients appropriately. There are very few studies conducted in India on the efficacy of manual toothbrushes in plaque removal and their results have been contradictory. Hence this study has been undertaken with the aim to compare the plaque-removing efficacy of commonly used designs of manual toothbrushes and powered toothbrush.

Material and methods

The target population for the present study comprised of 10 – 12 year old children reporting for regular check-up to the department of pedodontics and preventive dentistry of Darshan Dental College and Hospital. Ethical clearance was obtained from the Institutional ethical committee before the initiation of the study. Moreover, each participant was informed regarding the study and proxy written informed consent was obtained from their parents.

All the children coming to the department during the period of October to December 2009 were invited to participate in the study and no incentives were promised. Subsequently, 43 children agreed to participate and two children who agreed to participate were excluded as they were systemically ill. However, only 20 children met the selection criteria which constituted healthy dentition, healthy gingiva and no orthodontic appliances.

This was double blind, randomized five group cross-sectional study with random allocation of the subjects into any one of the five experimental tooth brush groups. The design of the five experimental tooth brushes were namely: Group I (Zigzag), Group 2 (Flat), Group III (Curved), Group IV (Multilevel), Group V (Powered). Manual brushes were used in groups I to IV while group V constituted powered tooth brush. The subjects were given oral prophylaxis to make them plaque free four days prior to the commencement of the study and were told to abstain from brushing for 24 hours before the study.

On the day of the examination, the subjects were assessed for plaque prior to brushing according to the criteria of Turesky and Gilmore modification of Quigley-Hein plaque index (7) followed by which the subjects brushed with the allocated tooth brushes and tooth paste provided for two minutes. After the tooth brushing session, post brushing plaque scores were assessed.

The technique of tooth brushing was demonstrated prior to the initiation of the study by one of the investigator so that uniform brushing pattern is followed by each subject.

The assessment of plaque scores was made by a single calibrated and experienced examiner (NP). In order to investigate examiner repeatability with respect to plaque scoring, 10 subjects were selected and reevaluated before and after the tooth brushing session. Reliability was assessed by means of the intraclass correlation coefficient which was 0.88.

The data collected was subjected to statistical analysis using Statistical Package for Social Sciences (SPSS), 17.0. Paired ‘t’ was
executed to assess the significant differences between the paired set of data. Post hoc Dunnett’s C test was used to make multiple comparisons between the groups.

**Results**

Table 1 depicts that the levels of pre brushing plaque scores among all the five tooth brush groups during test periods were to a similar degree. There was a significant difference between the pre and post brushing plaque scores in all the experimental groups. Though insignificant, it was observed that the zigzag toothbrush (Group I) was slightly more effective in removing plaque than the flat, curved and multi level toothbrushes. While the powered toothbrush exhibited significantly greater efficacy in removing plaque than the manual toothbrushes. Although multilevel toothbrush showed greater post brushing residual plaque when compared to the other three manual toothbrush groups, it was not statistically significant.

<table>
<thead>
<tr>
<th>Tooth Brush Group</th>
<th>Pre-brushing plaque score</th>
<th>Post-brushing plaque score</th>
<th>% reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (Zigzag)</td>
<td>3.25±1.23§</td>
<td>0.80±0.08§</td>
<td>72.75</td>
</tr>
<tr>
<td>II (flat)</td>
<td>3.30±1.12§</td>
<td>0.75±0.24§</td>
<td>70.89</td>
</tr>
<tr>
<td>III (curved)</td>
<td>3.33±0.86§</td>
<td>0.70±0.35§</td>
<td>71.65</td>
</tr>
<tr>
<td>IV (multi level)</td>
<td>3.35±0.74§</td>
<td>0.73±0.14§</td>
<td>69.12</td>
</tr>
<tr>
<td>Manual</td>
<td>3.30±0.92§</td>
<td>0.74±0.20§</td>
<td>71.10</td>
</tr>
<tr>
<td>V (powered)</td>
<td>3.28±0.64§</td>
<td>0.25±0.13§</td>
<td>83.34</td>
</tr>
</tbody>
</table>

‡Post hoc Dunnett’s C test, P<0.05, §Paired t test, p<0.05

It is evident from table 2 that the residual plaque scores were almost similar in the upper arch for all the groups while in the lower arch powered tooth brush was significantly effective in removing the plaque than manual toothbrushes. When paired comparisons were made between the residual plaque score of upper and lower arch for each tooth brush group, it was observed that powered toothbrush was significantly effective in reducing plaque in lower arch than the upper arch.

It has been observed that the residual plaque accumulation on buccal surfaces was 0.40±0.10 in manual brush group and 0.37 ± 0.13 for powered tooth brushes which was insignificant. The post brushing plaque scores on the lingual surfaces were almost similar (1.11 ± 0.08,1.15 ± 0.16, 0.95 ± 0.1, 1.25 ± 0.05 for brushes I, II, III and IV respectively) in all the toothbrush groups which was significantly greater than the residual plaque score in powered tooth brushes (0.43 ± 0.09). Manual tooth brushes were significantly more effective in removing plaque on buccal than lingual surfaces and left than right quadrants.

Powered brushes were significantly more effective in removing plaque in both right and left quadrants than the manual tooth brushes. Moreover, powered toothbrushes were significantly more effective in removing plaque in the left quadrant than the right one.

**Discussion**

There is a general agreement that a positive correlation exists between bacterial plaque on the tooth surfaces and gingival inflammation. Mechanical plaque control is the most important strategy to prevent periodontal disease and manual toothbrushes are the most frequently used devices. The clinical evaluation of toothbrushing efficiency is constrained by a number of factors such as time devoted to brushing, hand pressure, manual dexterity, patient motivation, brushing technique and also by the criteria used to measure plaque (8). However these constraints were managed in the present study as the brushing procedure was demonstrated to all the participants.
Although several workshops and reviews have consistently concluded that there is no superior design of manual toothbrush (4, 5, 8) yet different companies are coming out with different designs, each claiming superiority, backed by the results of their own clinical research teams. Therefore, the present clinical study was undertaken to find out if any significant differences exist in plaque removal efficacy between different bristle designs of toothbrushes.

In this study, a parallel design assessing the efficacy of five different bristle designs of manual toothbrushes and power toothbrush in single-use plaque removal was employed. Single-use plaque removal studies are considered to be as accurate as conventional plaque removal studies in assessing the efficacy of brushes (7).

The choice of the index in the present study was based on the fact that with this index all natural teeth (except third molars) can be assessed for plaque and it provides more sensitive and accurate evaluation of brushing effectiveness compared to other indices used in other studies (7) where only certain designated teeth are assessed. Moreover, the index is simple, reliable and reproducible and facilitates comparison with other studies.

The results of the study showed that left quadrant and lingual surface showed greater accumulation when compared to their counterparts. This is in agreement with most of the previous studies (9). The results of the study also showed no statistically significant differences in the plaque removal efficacy between the four manual brushes. This is in line with the previous studies (10, 11).

In the present study, the reduction of the mean plaque scores reached approximately 71.50% compared to the baseline plaque scores. This is in line with the study by Claydon and Addy (12) who conducted a single-use plaque removal study to compare the efficacy of four different bristle designs of toothbrushes and concluded that all the subjects removed approximately 60% of the accumulated plaque with different designs of brushes and whatever minute differences were observed were of little clinical significance.

Zigzag (group I) toothbrush was slightly more effective than the other types of toothbrushes and which is in accordance with the previous studies by Turner et al., (13) and Kakar et al., (14). Moreover, powered toothbrush definitely showed greater plaque removal efficiency over the manual toothbrush which is similar to study by Andrew et al (15) that showed similar results by comparing them over a period of six months.

**Conclusions**

Marked changes in the design of toothbrushes have occurred in the last decade but still no data demonstrates unequivocally that one manual toothbrush design is better than the other as evident in

---

**Table 2: Post brushing plaque scores in relation to arch, surface and quadrant**

<table>
<thead>
<tr>
<th>Group</th>
<th>Upper arch</th>
<th>Lower arch</th>
<th>Buccal surface</th>
<th>Lingual surface</th>
<th>Left quadrant</th>
<th>Right quadrant</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (Zigzag)</td>
<td>1.66 ± 0.12</td>
<td>1.11 ± 0.19</td>
<td>0.45 ± 0.08</td>
<td>1.11 ± 0.08</td>
<td>0.85 ± 0.08</td>
<td>1.35 ± 0.08</td>
</tr>
<tr>
<td>II (flat)</td>
<td>1.54 ± 0.16</td>
<td>1.15 ± 0.17</td>
<td>0.35 ± 0.18</td>
<td>1.12 ± 0.16</td>
<td>0.90 ± 0.16</td>
<td>1.35 ± 0.16</td>
</tr>
<tr>
<td>III (curved)</td>
<td>1.36 ± 0.22</td>
<td>0.95 ± 0.1</td>
<td>0.38 ± 0.09</td>
<td>0.95 ± 0.1</td>
<td>0.80 ± 0.1</td>
<td>1.20 ± 0.1</td>
</tr>
<tr>
<td>IV (multi level)</td>
<td>1.54 ± 0.12</td>
<td>1.25 ± 0.06</td>
<td>0.42 ± 0.04</td>
<td>1.25 ± 0.05</td>
<td>0.90 ± 0.05</td>
<td>1.23 ± 0.05</td>
</tr>
<tr>
<td>Manual</td>
<td>1.52 ± 0.15</td>
<td>1.11 ± 0.13</td>
<td>0.40 ± 0.10</td>
<td>1.11 ± 0.09</td>
<td>0.81 ± 0.09</td>
<td>1.28 ± 0.1</td>
</tr>
<tr>
<td>V (powered)</td>
<td>1.48 ± 0.08</td>
<td>0.64 ± 0.13</td>
<td>0.37 ± 0.13</td>
<td>0.43 ± 0.09</td>
<td>0.33 ± 0.11</td>
<td>0.60 ± 0.03</td>
</tr>
</tbody>
</table>

*Post hoc Dunnett’s C test, p<0.05; † Paired t test, p<0.05
the present study. Powered tooth brush efficacy in plaque removal was superior over manual tooth brushes. Finally, it is apparent that single-use brushing studies are merely screening experiments and should not be considered definitive. Thus, longitudinal studies on large samples would provide authoritative results.

References