Assessment of Various Technologies of Toothbrushes in Plaque Removal and Gingival Enhancement

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ABSTRACT

Effective control of dental plaque is critical for the prevention of dental caries, gingivitis and periodontal diseases. The protocol of this study was firstly submitted to ethical committee of the National Research Centre, Cairo, Egypt. Twenty Egyptian girls were selected from Bent Misr Orphanage, Cairo, Egypt, aged 11-13 years to compare the efficacy of manual, electric and ionic toothbrushes on plaque removal and gingival health. Plaque and gingival indices were recorded for each girl before and after using each type of brush using rolling technique twice daily for three weeks followed by one week wash out period. Statistical analysis was performed with SPSS 16® for Windows. Electric toothbrush showed a greater reduction of plaque (Mean % 33.84, 21.05, 19.00) and gingival indices (Mean % 26.19, 11.36, 10.83) than the manual and ionic toothbrushes. Ionic toothbrush showed a greater reduction of plaque than manual without any superiority regarding the gingival index. The three brushes showed a cumulative effect regarding plaque and gingival indices reduction (p<0.001).

In conclusion the electric toothbrush was the most efficient in plaque reduction and gingival health improvement.

Key words: Toothbrushes; Plaque removal; Gingival enhancement.

Introduction

Research over the last decade has established that the etiology of most of the periodontal diseases is of a bacterial infection mediated by the host inflammatory response. While effective daily removal or disruption of dental plaque is essential, it may not be enough to completely prevent the disease (Page et al., 1997). Improvement in a child’s oral hygiene is often accomplished through the cooperative interaction between the patient and the dental professional (Ohrn and Sanz, 2009). Hence regular removal of dentogingival plaque is crucial for maintenance of periodontal health. Since the earliest recorded evidence of the natural toothbrush as a plaque fighter, the evolution of toothbrushes has lead to the development of three distinct technologies; manual, electromechanical and ultrasonic brushes (Whitmyer et al., 1998). Oral hygiene prevention is based on compliance with self performed plaque control, mainly through the use of either a manual or a powered toothbrush together with effective interdental cleaning (Nicholas, 2008). Toothbrushing is a principle contributor to oral hygiene, and mechanical tooth cleaning remains the most reliable method of controlling supra and subgingival bacterial plaque (Haffajee et al., 2001). Non contact removal was originally described solely to sonic brushes, but other powered toothbrushes, such as oscillating-rotating brushes, were subsequently demonstrated to be able to remove initially adhering and co-adhering bacterial pairs from salivary conditioning films in a non-contact mode. But to what extent acoustic pressure waves generated by powered brushes are able to transfer energy has never been measured until now (Busscher et al., 2010). The Cochrane systematic report found that only the rotating-oscillating powered brush is superior to the manual toothbrush and stated that the available data for other powered toothbrushes are inconsistent (Heanue et al., 2003, Forrest et al., 2004). The efficacy of powered toothbrushes as compared to manual toothbrushes is still cause for discussion. But some studies ensure that the powered toothbrush significantly reduces mean gingival index and probing attachment level (Haffajee et al., 2001, Moritis et al., 2002, Penick, 2004 and Sharma et al., 2006). In searching to improve the efficacy of tooth brushing, the ionic toothbrush was developed to change the polarity of the tooth surface thus facilitates plaque removal. Some studies have been performed with ionic toothbrushes; however the results were controversial (Van Swol et al., 1996; Deshmukh et al., 2006 and Moreira et al., 2008). Although the availability of several models of toothbrushes, still there is contradictory about which of them is the most effective in plaque disruption and gingival enhancement?
Aim of the study:

Compare the efficacy of manual, electric and ionic toothbrushes on plaque removal and gingival health.

Subjects and methods:

The protocol was submitted to the ethical committee of the National Research Centre. Twenty girls were selected from Bent Misk Orphanage, Cairo, Egypt within the age range 11 to 13 year provided that they were healthy with the presence of more than twenty natural teeth with absence of major hard and soft tissue oral lesions. Plaque and gingival indices were assessed for all subjects (according to Turesky modification of Quigley Hein plaque index and Löe and Silness gingival index subsequently) at the beginning of examination (Base line 1, Fig.5). Subjects were taught to brush their teeth thoroughly by using roll brushing technique. The study consists of three stages with two wash out periods separating between them. Stage I: each subject was provided with a manual toothbrush (orai B) and Signal 2 toothpaste. Subjects were instructed to brush their teeth twice daily (soon after breakfast and dinner). Subjects were re-examined to assess plaque and gingival indices on a weekly basis for three successive weeks. At the end of the Stage I, (Fig.6), subjects were instructed to return back to their previous oral hygiene regimen according to their old way that was carried out before the beginning of the study in order to counteract any carry over effects until the start of the stage II (wash out period 1). At day 28th, plaque and gingival indices were assessed as a new base line for stage II (Base line 2). Stage II: each of the subjects was provided by Oral-B Cross-Action Power electric toothbrush and Signal 2 toothpaste with explanation and demonstration of the method of its use. Subjects were instructed to brush their teeth twice daily and were re-examined to assess plaque and gingival indices on a weekly basis for three successive weeks. At the end of stage II,(Fig.7), subjects were instructed to return back to their previous oral hygiene regimen according to their old way that was followed before the beginning of the study until the start of the stage III (wash out period 2). At day 56th, plaque and gingival indices were again assessed as a new base line for stage III. Stage III: each subject was provided by dr Tung’s HyG active ionic toothbrush and Signal 2 toothpaste with explanation and demonstration of the method of its use by holding the metal band on the toothbrush handle with moistened thumb continuously during brushing and was instructed to brush their teeth as taught before. Subjects were re-examined to assess plaque and gingival indices on a weekly basis for three weeks (the end of Stage III, Fig.8). Friedman’s test was used to compare between the percentage of reduction in plaque and gingival indices of the three stages and Wilcoxon-signed rank test was used in the procedure of pair-wise comparisons. The significance level was set at $P \leq 0.05$.

Results:

As regards the efficacy of plaque removal, after one week, a statistically significant difference was found between manual and each of electric and ionic toothbrushes and no statistically significant difference between electric and ionic ones (Tab. 1). While after two and three weeks, there was a difference between the three toothbrush types (Fig. 1). The electric toothbrush showed the statistically significant highest mean percentage of reduction in plaque index followed by ionic and manual toothbrushes (Tab. 1). All the three types of brushes showed a cumulative effect regarding plaque reduction (Fig. 2).

<table>
<thead>
<tr>
<th>Toothbrush Period</th>
<th>Manual Mean % ±SD</th>
<th>Electric Mean % ±SD</th>
<th>Ionic Mean % ±SD</th>
<th>P_value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base line - 1 week</td>
<td>3.78 ±0.48</td>
<td>8.43 ±7.21</td>
<td>10.16 ±6.96</td>
<td>0.004*</td>
</tr>
<tr>
<td>Base line - 2 weeks</td>
<td>10.51 ±7.18</td>
<td>21.30 ±5.64</td>
<td>15.09 ±6.14</td>
<td>0.001*</td>
</tr>
<tr>
<td>Base line - 3 weeks</td>
<td>19.00 ±8.03</td>
<td>33.84 ±6.32</td>
<td>21.05 ±6.14</td>
<td>0.001*</td>
</tr>
</tbody>
</table>

* Significant at $P \leq 0.05$.

Means with different letters are statistically significantly different according to Wilcoxon signed-rank test.
Fig. 1: Mean percentage of reduction in plaque index of the three toothbrush types

Fig. 2: Cumulative changes of plaque index of the three toothbrush types

The effect on the gingiva after one week showed a difference between the manual and each of electric and ionic toothbrushes (Fig. 3). There was a statistically significant difference between the electric and each of manual and ionic toothbrushes after two and three weeks, while there was no statistically significant difference between the last two types, Tab. 2). All the three brush types showed a cumulative effect regarding gingival health improvement (Fig. 4). Figure5 to 8 shows the dental plaque stain at base line and at the end of stages I, II, and III consequently.

Table 2: Mean and standard deviation (SD) values for the percentage of change in gingival index in the three toothbrush types.

<table>
<thead>
<tr>
<th>Toothbrush Period</th>
<th>Manual</th>
<th>Electric</th>
<th>Ionic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base line - 1 week</td>
<td>3.42 b</td>
<td>3.57 a</td>
<td>7.57 a</td>
<td>0.020*</td>
</tr>
<tr>
<td>Base line - 2 weeks</td>
<td>8.21 b</td>
<td>3.62 a</td>
<td>16.74 a</td>
<td>0.001*</td>
</tr>
<tr>
<td>Base line - 3 weeks</td>
<td>10.83 b</td>
<td>5.11 a</td>
<td>26.19 a</td>
<td>0.001*</td>
</tr>
</tbody>
</table>

* Significant at $P \leq 0.05$.
Means with different letters are statistically significantly different according to Wilcoxon signed-rank test.

Fig. 3: Mean percentage of reduction in gingival index of the three toothbrush types
Discussion:

Personal oral hygiene performed with a toothbrush is currently the most widespread method for controlling plaque, cleaning the teeth and maintaining gingival health. This is greatly affected by technique and brushing time, both factors that are difficult to influence. Optimization of the technology and the design of brush have focused on improving elimination of plaque from inaccessible areas. The manufacturer design incorporated significant advances based on extensive scientific and ergonomic research. However, effectiveness depends not only on toothbrush design but also on brushing technique and the frequency and time spent during brushing (Mary el al, 2006). Powered toothbrushes have overcome the limitation of manual dexterity with the added advantage that they have a tendency to help the patient to use a better brushing technique and increase the motivation to brush regularly (Johnstone et al., 2010). The study design and frequency of scoring in the present study agreed with a work carried out by Deshmukh et al., 2006 but was different from another work carried out by Pizzo et al., 2009 in which they follow a single-use assessment model as a different type of assessment. The significantly higher mean plaque index of manual above electric toothbrush means that the oscillating-rotating electric toothbrush is more effective in plaque reduction, this agreed with Robinson et al., 2005 who stated that powered toothbrushes with a rotation-oscillation action are shown to be superior and demonstrating greater plaque removal efficiency and as a consequence, greater improvement in periodontal condition compared with that achieved by a manual toothbrush. Despite such evidence of efficacy another study made by Versteeg et al.,
2006 found that there is no difference between the manual and the cross action electric toothbrush but this may be because the examiner had performed a professional cleaning for all the subjects using both brushes, so he eliminated the lack of manual dexterity and skill of brushing factors of the children while in present study the subjects cleaned their teeth by themselves under just a supervision of their caregivers. The use of ionic toothbrush showed a lower mean plaque index than that of manual toothbrush which denotes that the active ionic toothbrush is more effective in plaque reduction than the manual one, this agreed with Deshmukh et al., 2006 who compared between ionic and manual toothbrushes and found that ionic toothbrush is more effective in plaque reduction than manual one and attribute this to its ionic action mechanism, while this disagreed with the results of another work carried out by Van der Weijden et al., 2002 who found that there is no difference between ionic and manual toothbrushes regarding to plaque index but the difference present in this study may be attributed to the long time separating the examination and follow up visits. The results revealed that electric toothbrush showed a reduction in gingival index more than the manual toothbrush and this is in agreement with the studies of Ruhlman et al., 2001 and Heins et al., 2002 which observed that manual toothbrush can only remove about 50% of the plaque on the smooth surfaces of teeth, and even less interproximally, while a definite reduction were found with powered toothbrushes which in turn results in a greater reduction in gingivitis. No significant difference in percentage of reduction of gingival index between ionic and manual toothbrush, this agreed with a study carried out by Moreira et al., 2008 which concluded that the performance of an ionic toothbrush does not differ from that of a conventional brush when comparing their efficacy in reducing gingival inflammation measured by gingival crevicular fluid volume, on the other side the results disagreed with Deshmukh et al., 2006 who found that ionic toothbrush is more effective in gingival health improvement than the manual one, this controversy may be due to difference in the gingival index that was used to evaluate the gingival health which assesses only the presence or absence of bleeding, so it is not accurate in cases with mild to moderate inflammation which is different from the index used in the present study.

**Conclusion:**

A greatest action in supragingival plaque removal and gingival enhancement was noted with electric followed by ionic and manual toothbrushes without superiority between ionic and manual toothbrushes in enhancing gingival health.

**Recommendations:**

Further studies should be done to assess the effect on electric, ionic and manual toothbrushes on enamel surface topography and structural properties when used for a long time period.

**References**


