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Comparison of manual versus sonic and ultrasonic toothbrushes: a review

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Abstract: *Purpose:* This review of the literature intends to evaluate the effect of brushes with high frequency motion when compared with manual toothbrushes regarding the indices of plaque and gingival bleeding. *Methods:* Patients presenting gingivitis and/or chronic periodontitis were evaluated in addition to patients having osseointegrated implants and fixed orthodontic appliances. Pertinent literature was reviewed to select articles according to previously defined inclusion criteria. *Results:* In the assessed studies results showed significant decreases in plaque and gingival indices by utilization of both types of brushes. However, in the selected studies where sonic brushes were tested in orthodontic and dental implant patients there was a more significant decrease in the indices. Furthermore, there was no indication of gingival recession attributed to product use. *Conclusion:* Future studies with a more homogeneous methodology and better experiment designs will be needed.

Key words: electric toothbrushes; oral hygiene; plaque

Introduction

Caries and periodontal disease are the outcome of an imbalance between bacteria of the dental biofilm and the host. Inhibition of biofilm formation and its mechanical removal continue to be the leading procedures for prevention and treatment of these two pathologies (1, 2). As such, personal daily oral hygiene by brushing and using other hygiene aids is crucial for oral health and is a more accessible, effective and economical method (3).

Patients undergoing orthodontic therapy face more difficulties in trying to practise adequate methods of oral hygiene than

regular patients. Orthodontic appliances with bands, brackets and arches act as barriers for brush bristles and dental floss, therefore leading to greater accumulation of plaque and impairment of gingival health. Changes most often found in the gingival tissue of patients undergoing orthodontic therapy with fixed appliances usually include inflammation, bleeding, swelling and an increased probing depth (4, 5).

In the long term, successful treatment of osseointegrated implants rests upon a support therapy including prevention and control of the microbiological and occlusal factors (6, 7). Significant correlations between bacterial plaque and mucositis have been reported. Also reported were correlations between increased probing depth and inflammation of the periimplant mucosa (7, 8), justifying a strict regiment of plaque control with those patients.

Oral hygiene has been a source of concern since ancient times. Many historians attribute the development of brushes to the Chinese in the year 1498, although there is evidence that in the year 1000 this civilization used artefacts made of ivory sticks and horse bristles. New models of brushes were only reinvented in the 18th century; however, only at the end of the 19th century did their use become more widespread. More recently natural bristles were replaced by nylon and plastic substituted the wooden handles, therefore with these changes toothbrushes became less expensive. As a result this encouraged a more widespread use of brushing (9).

Although oral hygiene is efficient when carried out correctly, for some it is tedious and rather difficult (10). In this context, in the early 1960s, aiming to increase motivation and facilitate the brushing techniques, electric brushes emerged as an alternative to conventional ones (11). Since then, these brushes progressed undergoing a series of modifications such as inclusion of oscillatory movements and the development of brushes with high frequency movements known as sonic and ultrasonic.

Despite much research into the efficiency of the diverse types of brushes, results are still contradictory. Thus, the purpose of this review was to assess the effect of brushes with high frequency movements when compared with manual ones regarding the indices of plaque and gingival bleeding in patients with chronic gingivitis or periodontitis, including patients having osseointegrated implants and fixed orthodontic appliances.

Materials and methods

Selection of studies

Randomized studies were selected for this review, which compared the efficiency of a sonic/ultrasonic brush and a conventional brush, in patients with chronic gingivitis or periodontitis (group 1). Patients should have gingivitis or periodontitis and have no dental implants, extensive prosthetic restorations or be under orthodontic treatment. Studies including use of such brushes in patients under orthodontic treatment with fixed appliances and in patients with osseointegrated implants were analysed separately (group 2).

In both groups, the treatment of interest (test) was the use of sonic and ultrasonic brushes and the standard treatment (control) was the utilization of conventional manual brushes. There were two objectives to this review. The first was the reduction in gingivitis/mucositis. The second was to evaluate the decrease in the plaque index and presence of abrasions and or trauma on the soft tissues.

Survey and quantitative analysis

An extensive survey was carried out in the electronic database MEDLINE (http://www.pubmed.com) using July 1994 as baseline and December 2005 as the end date. This survey was restricted to articles written in English while classical articles, literature reviews and reports of clinical cases were excluded. The strategy used in selecting the articles of group 1 consisted of searching for the following words: 'ultrasonic toothbrush', OR 'sonic toothbrush' AND 'gingivitis' OR 'plaque'. Forty articles were found. For group 2, the words 'implant' and 'orthodontic treatment' were added to the group of words aforementioned and seven articles were found.

Studies excluded

In the first group, of the 40 articles, eight were considered valid (Tables 1 and 2) and 32 were excluded because of one of the following reasons:

- Use of integrated systems electric brushes and toothpaste dispenser (12–15).
- *In vitro* studies (16–22).
- Patients undergoing orthodontic therapy. These studies were included in the second group (4, 5, 23).
- Absence of manual brushes in the methodology (24–35).
- Studies with special populations. Day *et al.* (36) utilized destitute populations. Whitmyer *et al.* (37) assessed the use of ultrasonic brushes in aged patients.
- Lack of analysis of the indices of plaque and gingival (38–40) or only interproximal plaque analysis (41).

In the second group, seven articles were found relating high frequency brushes to orthodontic patients and bearers of implants. Three of these studies were considered valid

Table 1. **Studies that evaluated different toothbrushes for periodontal patients (group 1)**

Study	Methodology	Final participants	Intervention	Index	Other hygiene aids
Terezhalmy *et al.* (52)	Two treatment groups Parallel groups Examinations on days 0, 15 and 30	44 adult patients (22 test, 22 control) (Gingivitis, WIP)	Oral-B 40 (Redwood City, USA) (without instruction) Ultrasonex (Brewster, USA)	PI – Turesky Teeth Ramfjord GI – Löe & Silness Teeth Ramfjord	Yes
Johnson and McInnes (47)	Two treatment groups Parallel groups Examinations 0, 1, 2 and 4 weeks	43 patients (24 test, 19 control) (Gingivitis, WIP)	Oral-B 30 (Redwood City, USA) (Bass modified) Sonicare (Bellevue, USA)	PI – Turesky GI – Ainamo & Bay Teeth Ramfjord	No
Terezhalmy *et al.* (48)	Two treatment groups Parallel groups Examinations 0, 15, 30 days and 6 months	46 patients (23 test, 23 control) (Gingivitis, WIP)	Oral-B (Redwood City, USA) (without instruction) Ultrasonex (Brewster, USA)	PI – Turesky Teeth Ramfjord GI – Löe & Silness Teeth Ramfjord	Yes
Tritten and Armitage (46)	Two treatment groups Parallel groups Examinations 0, 1, 2, 4 and 12 weeks	56 patients (29 test, 27 control) Gingivitis or periodontitis	Butler No. 311 (Chicago, USA) (without instruction) Sonicare (Bellevue, USA)	PI – Turesky GI – Löe & Silness Teeth Ramfjord	No (1st month)
O'Beirne *et al.* (45)	Two treatment groups Parallel groups Examinations 0, 2, 4 and 8 weeks	40 patients (20 test, 20 control) Gingivitis or periodontitis	Oral-B (Redwood City, USA) (Bass modified) Sonicare (Bellevue, USA)	Three sites with OS from 5 to 7 mm/patient GI – Löe & Silness 3 Teeth PI – no report	Yes
Forgas-Brockmann *et al.* (49)	Two treatment groups Parallel groups Examinations 0, 15 and 30 days	56 patients (30 test, 26 control) (Gingivitis, WIP)	Oral-B (Redwood City, USA) (Bass modified) Ultrasonex (Brewster, USA)	PI – Turesky Teeth Ramfjord GI – Löe & Silness Teeth Ramfjord	Yes
Zimmer *et al.* (50)	Two treatment groups Parallel groups Examinations 0, 4 and 8 weeks	63 patients (31 test, 32 control) (Gingivitis, WIP)	Aronal kompakt (Lörrach, Germany) (Bass) Ultrasonex (Brewster, USA)	PI – Turesky GI –Rate of Papillary bleeding	No
Moritis *et al.* (51)	Two treatment groups (cross-over) Examinations after 10 days of use	25 patients (absence of severe gingivitis) (or periodontitis)	Oral-B 35 (Boston, USA) (Bass) Sonicare Elite (Snoqualmie, USA)	PI – Turesky	No report

WIP, without information on periodontitis.

Table 2. **Means of initial and final plaque (PI) and gingival (GI) indices in the studies that evaluated toothbrushes in periodontal patients (group 1)**

Study	Mean baseline PI	Mean final PI	Mean baseline GI	Mean final GI	Results
Terezhalmy *et al.* (52)					
Control	2.05	3.15	0.89	0.89	Ultrasonic more effective to reduce GI
Test	2.18	3.07	0.99	0.71	
Johnson and McInnes (47)					
Control	1.71	4 weeks: 1.56	1.58	4 weeks: 1.28	Decrease of PI and GI with the two brushes
Test	1.86	4 weeks:1.38	1.47	4 weeks: 1.26	
Terezhalmy *et al.* (48)					
Control	2.05	6 months: 0.76	0.89	6 months: 0.33	Although manual was more effective, US was more efficient for plaque and gingivitis reduction
Test	2.18	6 months: 0.82	0.99	6 months: 0.33	
Tritten and Armitage (46)					
Control	2.26	12 weeks: 1.95	1.14	12 weeks: 1.19	Sonic better for removal of upper plaque. Both were effective for reduction of GI
Test	1.96	12 weeks: 1.79	1.4	12 weeks: 1.12	
O'Beirne *et al.* (45)					
Control			1.75	8 weeks: 0.53	Difference, baseline to 8 weeks in two groups, no difference between groups
Test			1.8	8 weeks: 0.43	
Forgas-Brockmann *et al.* (49)					
Control	1.53	30 days: 1.66	1.71	30 days: 1.55	No difference between groups for PI and GI
Test	1.33	30 days: 1.32	1.68	30 days: 1.47	
Zimmer *et al.* (50)					
Control	2.36	8 weeks: 1.96	0.84	8 weeks: 0.63	Both were effective for reduction of PI and GI, but US had a higher reduction
Test	2.33	8 weeks: 0.92	0.75	8 weeks: 0.29	
Moritis *et al.* (51)					
Control	2.55	1.89			Both significantly reduced PI, but the Sonicare was more effective
Test	2.7	1.73			

(Tables 3 and 4) with only one in the area of implantodontics. Four studies were excluded for one of the following reasons:

- Absence of comparison between toothbrushes (42).
- *In vitro* studies (43, 44).
- Studies assessing usage of brushes associated with auxiliary methods of hygiene (23).

Discussion

All the included studies were defined by the authors as randomized, although description of the randomizing process was found only in the studies by O'Beirne *et al.* (45) and Tritten and Armitage (46).

Table 3. **Studies that evaluated different toothbrushes for orthodontic and implant patients (group 2)**

Study	Methodology	Final participants	Intervention	Index	Other hygiene aids
White (4)	Two treatment groups	40 adolescent patients	Sonicare (Bellevue, USA)	PI – Hygiene Analysis Index	No
	Parallel groups	(20 test, 20 control)	(Bass modified)	GI – Papillary Bleeding Index	
	Examinations on 0, 1, 2, 3 and 4 weeks		Manual (no report)		
Ho and Niederman (5)	Two treatment groups Parallel groups	24 adolescent patients (12 test, 12 control)	Sonicare (Bellevue, USA) (brush as indicated in the manual)	PI – Silness & Löe GI – Löe & Silness	No report
	Examinations on 0,and 4 weeks		Manual (Oral B, USA)		
Wolf *et al.* (6)	Two treatment groups Parallel groups	31 patients (16 test, 15 control)	Sonicare (Bellevue, USA) Manual (Crest, Cincinnati, USA)	PI – Silness & Löe GI – Löe & Silness	No report
	Examinations 0, 4, 8, 12 and 24 months				

WIP, Without Information on Periodontitis.

Table 4. **Means of initial and final plaque (PI) and gingival (GI) indices in the studies that evaluated toothbrushes in orthodontic and implant patients (group 2)**

Study	Mean baseline PI	Mean final PI	Mean baseline GI	Mean final GI	Results
White (4)					
Control	0.99	0.93	1.57	1.81	Sonicare superior in removing plaque and in improving gingival health
Test	0.98	0.80	1.74	1.34	
Ho and Niederman (5)					
Control	2.58	2.33	2.02	1.96	Sonicare was superior to a manual in improving periodontal health
Test	2.65	1.15	2.00	1.42	
Wolf *et al.* (6)					
Control	1.27	24 weeks: 0.60	1.58	6 months: 0.94	Sonicare subjects had significantly lower PI around dental implants when compared with manual subjects
Test	1.31	24 weeks: 0.46	1.46	6 months: 0.87	

In five studies of group 1, patients dropped out of the testing period (46–50). The dropout rate ranged from 1.58% (50) to 18.86% (57). In group 2, a dropout rate of 20% during the testing period was reported by White (4).

Ten studies utilized a model of two parallel groups with independent patients, one group used a sonic or ultrasonic brush (test) and the other used a manual brush. Only one study (51) used a cross-over experimental design in which all patients used both types of brush with only a change in the utilization sequence.

Precise information on the severity of the periodontal disease at the beginning of the study was not available. In five studies of group 1 and three of group 2, patients seemed to have gingivitis, but the information was not reported (4–6, 47–50, 52). In two other studies patients had gingivitis or moderate periodontitis (45, 46). The study by Moritis *et al.* (51) reported only that patients did not have severe gingivitis or periodontitis.

The influence of the initial periodontal condition of the patient and the populations' characteristics must also be discussed. The effective measurement of oral hygiene is related to the motivational level of the sample or the willingness to learn a correct brushing technique. That is why many authors avoid studies with undergraduate students as the sample in each assessed study is composed of patients enrolled in university programmes on periodontal maintenance (53). Regarding the severity of periodontal disease at baseline, negligible improvements in hygiene are perceived in individuals who presented lower indices of gingival inflammation (54). In the current review, no article was found in which the authors classify disease severity in a specific manner. Thus there is a need for greater standardization of patients or for uniformity of the sample's initial framework.

Use of other oral hygiene aids such as dental floss or mouthrinses must be taken into account. In only two studies of group 1 (47, 50) and in two studies of group 2 (4, 6) usage of dental floss and mouthwashes was clearly forbidden during the test period. It is important to standardize the absence of auxiliary means because they may interfere with the results, as they reduce formation of the interproximal plaque and of gingival inflammation.

The duration of the studies must also be questioned. Research lasting for up to 30 days is considered 'short' and may have biased results, for instance, the Hawthorne effect existing in clinical studies with dental brushes. In this kind of studies generally we have a patient's positive contribution, in other words, patients pay more attention to their oral hygiene when they know that this will be evaluated (55). Likewise, the Novelty effect hinders the effectiveness of mechanical devices for plaque control (56). This effect relates to the fact that a new brush attracts more attention while it is a novelty, thereby resulting in more collaboration from the patient in controlling plaque.

The mean plaque scores and gingival indexes at baseline and post-brush evaluation are shown in Table 2 for the first group and in Table 4 for the second. The numbers indicate that for all surfaces combined, the two devices had the same pattern over time. The use of both devices decreased the gingival inflammation and plaque accumulation in control and test groups. However, the brushes used in these studies had very different designs and modes of operation.

Use of different indices, lack of standardization of the number of analysed teeth/implants, in addition to variations in the initial condition of patients and of methodology do not permit statistical combination of these studies' results. Nevertheless, significant reductions were detected in the plaque and gingival indices in the studies assessed with the utilization of two types of brushes. The sonic brushes were more effective in five articles (4, 5, 48, 50, 52) regarding the GI and in four studies regarding the PI (4–6, 51).

One of the secondary objectives of this review was to evaluate the emergence of complications after the use of the brushes, mainly as gingival recessions or abrasions. Among the selected studies, only Johnson and McInnes (47) specifically assessed the gingival recessions after use of the brushes. There was no indication of gingival recession after 6 months attributed to product use. Other articles evaluated the appearance of gingival abrasions (46–48, 51, 52) and of these studies only Tritten and Armitage (46) reported a smaller abrasive effect with use of sonic brushes.

Conclusion

It can be surmised that although the use of high frequency brushes has been considered safe and has produced satisfactory results, the surveyed studies did not show conclusive results regarding the superiority of these products in reducing gingival and plaque indices when compared with conventional brushes used by patients with chronic gingivitis and periodontitis. On the other hand, in the selected studies where these brushes were tested in orthodontic and dental implant patients, there was a more significant decrease in the indices. However, it became evident that there is a need for future studies with homogeneous methodologies and better experiment designs.

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