Dental Plaque Removal Efficacy of Three Toothbrushes with Different Designs: A Comparative Analysis

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Purpose: This study aimed to compare dental plaque removal efficacy of three manual toothbrushes.

Materials and Methods: Three toothbrushes (Colgate Flexível[®] - Colgate (T1), Oral B Advantage[®] Control Grip[®] - Oral B[®] (T2), Comfort Clean[®] - Johnson & Johnson - Reach[®] (T3) were evaluated for dental plaque removal in 17 subjects. Dental plaque was scored before and after seven days' use of each toothbrush, employing an adaptation of Quigley-Hein Index modified by Turesky (Plaque Index). Assessments were performed at days 0, 7, 14, 21, 28, and 35. At the end of the trial each subject was asked which toothbrush was preferred.

Results: Final dental plaque scores for toothbrush T3 were statistically different from toothbrushes T1 and T2, which in turn did not differ from each other. Subjects showed preference towards toothbrush T3.

Conclusion: Toothbrush T3 was more efficient in terms of dental plaque removal when compared with toothbrushes T2 and T1.

Key words: toothbrushes, dental plaque, mechanical control

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ORIGINAL ARTICLE

Periodontal disease and dental caries are the most prevalent oral diseases. Presence of dental plaque is positively correlated with these conditions. Mechanical procedures of dental hygiene are the main and most common means of controlling dental plaque (Axelsson and Lindhe, 1981).

Toothbrushes are the most employed and safest instruments to remove dental plaque. Due to its effectiveness and convenience, the toothbrush is regarded as a therapeutic device (Pader, 1993). However, improper use of this device by subjects lacking adequate instructions or manual dexterity, can lead to injuries to

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the oral tissues, varying from reversible gingival laceration to gingival recession with exposure of the root surface, deep abrasions in cementum and dentin; these deleterious effects can also be caused by poorly designed and constructed toothbrushes (Niemi et al. 1984). Due to the acknowledgement of the toothbrush as the most used device in oral hygiene, and also due to the great variety of toothbrushes released into the market, numerous clinical trials have been developed to evaluate and improve the effectiveness of toothbrushes.

Knowledge of the characteristics of a toothbrush is fundamental for the safe achievement of efficient oral hygiene by dental patients. The desirable features of a toothbrush include a relatively small head for easy access, a wide and long handle in order to ensure firm grasp, soft nylon bristle tips to minimize gingival damage, and a multi-tufted head, trimmed flat for optimal cleansing effect (Park et al, 1985). Although toothbrushes may all look essentially the same, specific details, such as the specific bristle material, length, diameter and total number of fibers, length and design of the brush head, number and arrangement of bristle

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Fig 1 Lateral view of the three toothbrushes. Oral B Advantage Control Grip (bottom), Colgate Flexível (middle), Comfort Clean-Reach (top).



Fig 2 Frontal view of the three toothbrushes tested. Oral B Advantage Control Grip (midle), Colgate Flexível (top), Comfort Clean-Reach (bottom).



Fig 3 Closer view of the toothbrushes head. Oral B Advantage Control Grip (midle), Colgate Flexível (left), Comfort Clean-Reach (right).

Table 1 Toothbrushes evaluated					
Toothbrushes	Model	Manufacturer			
T1	Colgate Flexível®	Colgate			
T2	Oral B Advantage®				
	Control Grip®	Oral B			
ТЗ	Comfort				
	$Clean^{\mathbb{R}}$ – Reach $^{\mathbb{R}}$	Johnson & Johnson			

tufts, handle-head angle and handle design can affect the quality of oral hygiene. Thus, investigations on the peculiarities of each toothbrush component are necessary, as well as clinical trials to evaluate the effect of different toothbrush designs upon the overall oral health (Beaty et al, 1990).

Many types of toothbrushes have been developed worldwide. Nowadays, electric or manual toothbrushes, with a variety of design combinations of design and features are available. The aim of these variations is, invariably, to achieve a design able to safely remove a greater quantity of plaque. Within this context, over the years toothbrush manufacturers have developed modifications to improve cleaning efficacy, continuously launching toothbrushes with new designs.

Taking into account that the motor skills and motivation of users are also very important factors in the maintenance of oral health (Claydon et al, 2002), the hypothesis of this study was based on the fact that toothbrushes with different designs could offer different degrees of cleanliness (Laher et al, 2003). Within a wide range of similarly priced toothbrushes developed by well-known manufacturers, which one is the most capable of safely removing plaque?

This clinical study was carried out to establish the relationship between design and effectiveness of three different toothbrushes available in the market.

MATERIALS AND METHODS

This study was approved by the Ethics Committee on Research, FORP-USP (University of São Paulo, School of Dentistry of Ribeirão Preto, Brazil) prior to initiation. Twenty-one subjects ranging from 18 to 60 years of age were randomly selected at the School of Dentistry of Ribeirão Preto to evaluate three different toothbrushes. Patients were in good general health and had at least, 24 natural teeth (not including teeth with bridges, crowns or implants). Also, patients were in good general oral health, not presenting gingivitis, periodontitis, caries or other oral diseases.

Table 2 Baseline values of dental plaque for each toothbrush evaluated				
	Level 0	Level 1	Level 2	Level 3
Toothbrush 1	0.14706	0.19608	0.08824	0.56863
Toothbrush 2	0.23529	0.16667	0.19608	0.40196
Toothbrush 3	0.22549	0.11765	0.16667	0.49020

Table 3	Comparison between the plaque index before and after using
each of	the three toothbrushes

Toothbrushes	Ho significant level	
	Lingual	Buccal
T1	0.4751	0.2533
T2	0.1600	0.9414
ТЗ	0.0089	<0.0001

At the first visit, all selected subjects read and signed an informed consent prior to having their plaque index (PI) assessed based on the Turesky et al (1970) modification of the Quigley and Hine (1962) procedure (0= no plaque; 1=plaque at 1/3 of the dental surface; 2= plaque at 2/3 of the dental surface; 3= plaque at more of 2/3 of dental surface) baseline clinical examinations (CE) in accordance to the ADA (American Dental Association) were conducted to observe eventual side effects of the toothbrushes, as reported by Aass and Germo (2000). All clinical measurements were carried out by a previously calibrated examiner.

The subjects were allocated in three subgroups and 1/3 of the subjects started with T1, another 1/3 started with T2, and the last 1/3 started with T3. The order in which the subjects used the toothbrushes was not the same for all subjects, and each volunteer used all three toothbrushes evaluated (Table 1; Figs 1-3). A one-week interval was established between the use of each toothbrush, expecting that the return to the habitual toothbrush would bring dental plaque values back to the initial scores. In order to prevent changes in the pattern of brushing employed by the subjects prior to this study, the participants did not receive oral hygiene instructions.

During the period of the study, PI and CE were assessed weekly; the same toothpaste (Sorriso Dentes Brancos - Kolynos, Brazil) was used with the three evaluated toothbrushes. At the end of each week, the lastused toothbrush was retained by the examiner to ensure that the subject would use the toothbrush established for the following period. At the end of the trial period, volunteers were surveyed for their preferences among the three toothbrushes used.

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The plaque index scores result in an ordinal scale. This type of data requires specific models for analysis. Thus, the values obtained in this study were handled with statistical techniques for categorical data, specific for ordinal responses using a general linear model including multinomial responses and repeated measurements, and employing generalized estimation equations, GEE (Liang and Zeger, 1986). Data were analysed using the SAS System, version 8.2 (SAS Institute, Cary, NC), under Mandrake Linux 10.1 operating system.

RESULTS

Of the 21 subjects enrolled, 17 satisfactorily concluded this clinical trial. A test was initially applied to verify whether the plaque index distributions evaluated prior to the testing period of each toothbrush could be compared. Table 2 shows the plaque index at the baseline. The initial distribution (baseline) for the Tureskey index was statically similar for the three toothbrushes. Also, at the baseline we can notice a higher amount of 'level 3' of plaque (50%). This means that the volunteers had the same pattern of dental plaque at the beginning of the evaluation for each toothbrush.

The basic analysis consisted of comparison of the plaque index distribution values at the beginning and end of the testing period for each toothbrush. As the measurement was ordinal, the proportions in each rank were compared, analyzed separately by surface





Fig 4 Pattern of the plaque index distribution before and after the use of the toothbrush T1 (lingual surfaces).

Fig 5 Pattern of the plaque index distribution before and after the use of the toothbrush T1 (buccal surfaces).



Fig 6 Pattern of the plaque index distribution before and after the use of the toothbrush T2 (lingual surfaces).

(buccal and lingual). Table 3 shows the comparison between the plaque index before and after using each of the three toothbrushes.

There were no significant differences between the plaque index at the initial and final brushing periods for T1 and T2. However, the resulting data for T3 was highly significant (p= 0.0089 for the lingual surface and p<0.0001 for the buccal surface). Figs 4-9 depict the changes induced by the different toothbrushes. Alterations in the pattern of the plaque index distribution are clearly noticed in Fig 9. In this case, the amount of plague observed was lower after the use of the toothbrush T3. The pattern of plaque distribution at the beginning of the investigation for toothbrush T3 was similar to the other two toothbrushes: a triangle-shaped distribution with score 3 prevailing. After the use of T3, there was an inversion in distribution; the use of toothbrush T3 led to the prevalence of score 0. Accordingly, there is strong evidence that toothbrush T3 reduced the amount of plaque when used for seven days.

Significant difference in oral cleanliness was found only for T3, which showed ability to reduce the amount of dental plaque. For toothbrushes T2 and T1 the values observed were not significantly different. Table 4 summarises the findings from the preference survey applied at the end of the clinical trial. The responses show that the majority of the subjects chose toothbrush T3 as the most effective, comfortable and able to clean their posterior teeth. Three subjects reported that the toothbrushes had hurt their mouths, although no signs of soft tissue injury were observed in the CE.



Fig 7 Pattern of the plaque index distribution before and after the use of the toothbrush T2 (buccal surfaces).

Fig 9 Pattern of the plaque index distribution before and after the use of the toothbrush T3 (buccal sur-

DISCUSSION

faces).

faces).

Considering that motivation of the patient towards oral hygiene plays an important role on oral health, controversial factors, such as the ideal design of a toothbrush, must be investigated (Ostby et al, 1979). Thus, in the present study, toothbrushes recently launched into the market by three well-established manufacturers, with different designs and similar prices, were evaluated regarding their efficacy in dental plaque removal.

0

2

3

Each manufacturer claims the superiority of their particular toothbrush design. According to the manufacturers, 'the Oral B-Advantage Control Grip (T1) has an extra-long bristle at the tip to help clean hard-toreach areas'; 'Colgate Flexível (T2) has bristles arranged in a double-arch shape that follows the con-

an ergonomic rubber handle that offers better maneuverability during brushing, and a frontal bristle tuft to facilitate cleansing of the posterior teeth and lingual surfaces'. Statistical analysis of the results indicated that, regarding the initial and final plaque index score of each toothbrush, the use of T1 or T2 showed no evidence of

reduction on the amount of dental plague at the lingual and buccal surfaces. The use of toothbrush T3 resulted in lower levels of dental plague. The three toothbrushes tested were similarly priced, and all three products presented the desirable features of a safe and efficient toothbrush. Nevertheless, their handle

tours of the teeth, the handle design provides better brushing control and more comfort to the patient'; 'Comfort Clean®- Johnson & Johnson - Reach (T3) has

an exclusive rubber head that provides more softness,

0

1

2

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Table 4 Response of subjects to the preference questionnaire applied at the end of the clinical trial					
	T1	T2	ТЗ	All the toothbrushes	None of the toothbrushes
Which toothbrush did you					
feel as the most effective?	22.2%	5.55%	44.4%	16.6%	11.11%
Which had the most					
comfortable grip?	22.2%	5.55%	66.66%	0%	0%
Which toothbrush better					
cleaned your posterior teeth?	22.2%	5.55%	50%	0%	16.6%
Did any of the toothbrushes					
hurt your mouth?	5.55%	11.11%	0%	0%	77.77%

design, distribution of the bristles, and type of head were different. The specific peculiarities of the toothbrushes may explain the differences in the amount of dental plaque removed by each device. Although the design of the toothbrushes has to date been one of the least cited factors that may influence the ability of dental plaque removal (Claydon et al, 2002), several studies have shown significant differences on the levels of dental plaque when toothbrushes with different designs are used (Ostby, 1979; Niemi, et al, 1984, Beatty et al, 1990; Hanioka et al, 1999; Sasahara and Kamamura, 2000).

Analysis of the responses to the preference survey applied at the end of the study showed toothbrush T3 more frequently considered as the most efficient, comfortable, and the one that provided the best access to posterior teeth. The subjects' preference in a clinical trial is very important and has frequently been neglected. Patients' opinions, alone, about the products tested do not have the power to explain the results obtained. However, this kind of information represents the patients' point of view. With respect to this fact, the degree of approval of a toothbrush is not always linked with the best performance on plaque removal (Hanioka et al, 1999; Sharma et al, 1998; Aass and Gjermo, 2000; Laher et al, 2003. Consequently, the participation of the dentist in the process of choosing a good toothbrush is essential.

A great number of variables – brushing techniques, presence or absence of supervision, population differences, frequency and length of brushing time (Beatty et al, 1991) may influence the effectiveness of brushing. A properly designed experiment can shed light on the comparison of efficacy of clinical devices, notwithstanding other factors, not explicit in the comparison. This study, we think, bears clinical relevance, providing clinicians with proven information on specific toothbrushes. The plaque index values obtained before and after the use of each toothbrush in this investigation demonstrated a better performance of toothbrush T3.

CONCLUSION

- Toothbrush T3 has proven to be more effective than toothbrush T2 and T1 in terms of dental plaque removal.
- According to the preference survey, the majority of subjects chose toothbrush T3 as their favorite among the toothbrushes tested.

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