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Plaque-removing efficacy of new and used manual toothbrushes – a professional brushing study

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Rosema NAM, Hennequin-Hoenderdos NL, Versteeg PA, van Palenstein Helderman WH, van der Velden U, van der Weijden GA. Plaque-removing efficacy of new and used manual toothbrushes – a professional brushing study.

Abstract: *Objectives:* The present study assessed whether 3-month-old used manual toothbrushes are less effective in reducing plaque scores compared with new toothbrushes with or without the use of dentifrice. *Material and methods:* The present study was performed employing a single-use, examiner-blinded, professional brushing model. Four brushing modalities were randomly allocated to one of four quadrants, that is, 3-month-old used toothbrushes and new toothbrushes both with and without the use of dentifrice. Prebrushing and post-brushing plaque scores (Quigley Hein plaque index) and gingival abrasion (GA) scores were obtained. A dental hygienist performed the professional brushing procedure. The 3-month-old used toothbrushes were assessed for wear. *Results:* No significant differences were observed among the treatments with regard to the prebrushing scores. The post-brushing plaque scores ranged from 1.59 for the new brush with dentifrice to 1.76 for the old brush with dentifrice. There was a significant difference ($P = 0.036$) among the four treatments regarding the old brush with dentifrice, which removed less plaque than the other treatment modalities. Regarding GA scores, no significant differences were observed. With regard to toothbrush wear after 3 months of use, the scores varied widely among the individually evaluated brushes. *Conclusion:* The present study did not show a clinically relevant difference in plaque score reductions following a 2-minute brushing exercise among 3-month-old used and new manual toothbrushes. However, the wear rate of the brushes seemed to be the determining factor in loss of efficacy, rather than the age of the toothbrush. Furthermore, dentifrice did not show an additional effect on instant plaque removal.

Key words: dental plaque; dentifrice; gingival abrasion; manual toothbrush; toothbrush wear

Introduction

Daily toothbrushing with fluoride toothpaste is probably the most important and cost-effective method for maintaining or improving oral health. Manual toothbrushes have been used for almost 1000 years, although the forerunners of today's brushes were developed in the 1930s. Brush heads have been subject to changes to improve their efficacy and the patients' comfort, as well as to increase their safety to soft oral tissues. The handles used to be straight and flat; however, ergonomically shaped and curved handles are becoming more common (1, 2). The brush head shape, filament shape and filament insertion method into the handle have also been subject to changes (3–6). Consequently, there have been

numerous investigations of the efficacy of new features of manual toothbrushes.

Irrespective of specific characteristics, an attribute that all toothbrushes have in common is that they do not last forever. Few studies have investigated the aspect of the wear of a toothbrush, as it affects the efficacy of plaque removal (7–10). It is generally accepted that toothbrushes should be replaced after 3 months of use; however, this time period is not evidence based. The American Dental Association advocates toothbrush replacement every 3 to 4 months or sooner if the bristles become frayed (11). Surveys among dentists in Australia and the United States have shown that the majority of dentists advise their patients to replace their toothbrushes every 2 to 3 months (12, 13). The effective life of a toothbrush can vary because wear is dependent on user habits, such as frequency and duration of use, brushing force and brushing technique (14). Therefore, in the present study, a professional brushing model was employed to ensure that brushing technique was not an interfering factor.

It is generally accepted that one should use dentifrice when toothbrushing. There are many reasons for the use of dentifrice; however, the function of dentifrice in the 'instant' removal of plaque is questionable (15). Paraskevas *et al.* concluded that dentifrice does not contribute to plaque removal using new toothbrushes (16, 17). However, this result may have been partly due to their use of new toothbrushes. Therefore, the question arises of whether dentifrice might have an additional effect on instant plaque removal when a toothbrush is utilized that has been used for some time.

The primary objective of the present study was to test whether 3-month-old manual toothbrushes are less effective compared with new toothbrushes, with regard to plaque reduction following professional brushing. Furthermore, the use of dentifrice as a contributing factor with regard to instant plaque removal was evaluated in relation to brushing with 'new' or 'used' toothbrushes. As secondary objective gingival abrasion scores (GA) were assessed, as a safety measure to investigate possible differences between the different treatment modalities.

Materials and methods

Study population

Volunteers (non-dental students) from different universities and colleges in and around Amsterdam were recruited by an e-mail advertisement. They were informed about the study, first in the recruitment letter and then at a screening appointment. They were also asked to bring their own manual toothbrushes that they had been using for the current period of time. At this first visit, the subjects received a written explanation of the background of the study, its objectives, and their involvement. Before screening for their eligibility, the subjects were all requested to give their written informed consent. They were required to fulfil the following criteria: being $\geq$18 years of age; having a minimum of five evaluable teeth in each quadrant (with no partial dentures, orthodontic banding or wires); having an absence of oral lesions; having no periodontal pockets >5 mm; having an absence of generalized recession; not being pregnant; and not having any systemic diseases, such as AIDS or diabetes, or any adverse medical history or being on long-term medication. Subjects using powered toothbrushes were not allowed to take part in this study. Of 60 subjects who were screened, 50 subjects met the inclusion criteria and were enrolled in the study. The study was conducted in accordance with the ethical principles that have their origin in the Declaration of Helsinki, and it approximated Good Clinical Practice guidelines. Medical Ethics approval was obtained prior to the start of the study (MEC 07/117 # 07.17.0782).

Study design

The efficacy of new manual brushes in comparison with 3-month-old used toothbrushes, with regard to plaque-removing efficacy, was evaluated using an examiner-blinded, professional brushing model. The toothbrushes were used by an experienced dental hygienist, who was the professional brusher. In addition, the effect of dentifrice use on plaque removal when brushing was evaluated. In all of the subjects, four treatment modalities were performed, each in one of four quadrants. The treatment modalities were as follows: new brush with dentifrice (new brush^{+D}), new brush without dentifrice (new brush^{-D}), old brush with dentifrice (old brush^{+D}) and old brush without dentifrice (old brush^{-D}).

Pretrial

The brush age and frequency of use of the submitted manual toothbrushes of the panellists were recorded. After screening, all of the eligible subjects were provided with a new ADA (47) flat, trimmed reference toothbrush (Fig. 1) and were instructed to use it at home, twice daily for two minutes on each occasion, for the duration of the pretrial phase (3 months). A brushing calendar was provided to optimize compliance. All of the subjects received a written instruction leaflet about the Bass brushing technique (18), and a timer was provided to enhance compliance with the instructed brushing duration.

Two days prior to the end of the pretrial phase, all of the subjects received SMS text messages as reminders for their second appointments, to reduce the number of dropouts. They were reminded to bring the provided ADA brush that they had used during the 3-month pretrial phase. Furthermore, they were instructed to abstain from all oral hygiene procedures for 48 h prior to the assessment to assure plaque build-up when they reported to the clinic. After evaluation of the amount of plaque and the presence of gingival abrasion, all of the subjects were professionally brushed by a dental hygienist (NLHH).

Brushing procedure

The brushes were moistened with cold, running tap water prior to use. A timer was used to ensure that the brushing time per quadrant was 30 s, 15 for the buccal side and 15 for the lingual side. Thus, the brushing time for the whole mouth was

Fig. 1. ADA (47) reference toothbrush.

2 min. An acoustic sign was given to the dental hygienist to change quadrants. To retain the blindness of the treatment regimens, all toothbrushing was performed in a different location than the site of the clinical examination.

The 3-month-old ADA toothbrush or new ADA toothbrush was used in two randomly chosen contra-lateral quadrants, being either the first and third quadrants or the second and fourth quadrants. The alternate brush was used in the opposing two quadrants. In addition, the use of dentifrice [Zendium classic (RDA76), Sara Lee, Amersfoort, the Netherlands] was randomly allocated to one of the two contra-lateral quadrants. To avoid contamination of the non-dentifrice quadrants with dentifrice slurry, the first brushing procedure was always performed without dentifrice. Brushing always began in the upper jaw. Next, the opposing contra-lateral quadrant was brushed with the alternate brush without dentifrice. Subsequently, the other upper jaw quadrant was brushed with the use of dentifrice, using either the new or the old brush. Finally, the lower jaw quadrant was brushed with the use of dentifrice with the alternate brush. A fixed amount of dentifrice (0.5 ml) was used and was applied on the brush head using a syringe.

After the brushing procedure was completed, the subjects were asked to rinse thoroughly to ensure the removal of all dentifrice remnants. Fifty millilitres of tap water was obligatory to be used for rinsing.

Clinical assessment

Prebrushing and post-brushing plaque was assessed using the Turesky *et al.* (19) modification of the Quigley & Hein (20) (1962) plaque index, scored at six sites per tooth, as described by Paraskevas *et al.* (17) and evaluating the amount of plaque on a 6-point scale (0 = no plaque to 5 = plaque covering more than two-thirds of the tooth surface). A new cotton swab with fresh disclosing solution was used for each quadrant to disclose the plaque (Mira-2-Ton® Hager & Werken GmbH & Co. KG, Duisburg, Germany).

Subsequently as secondary response variable, the epithelium of the gingivae was examined for abrasions (GA) according to Versteeg *et al.* (21). The gingival tissues were divided into three areas: cervical, interdental and mid-gingival. The sizes of the abrasions were assessed on the basis of the largest diameter of the lesion, and the abrasions measured by means of a PQ-William's periodontal probe (Hu-Friedy Mfg. Co., Inc., Chicago, IL, USA). The lesions were assessed as small ($\leq$2 mm), medium (>2 but $\leq$5 mm) and large (>5 mm).

All clinical examinations were performed by one examiner (NAMR) under the same conditions. The examiner was masked to treatment allocation and was experienced in using both indices (6, 22, 23). Third molars, as well as central incisors, were excluded from the examinations. Incisors were excluded because of possible overlapping during brushing.

Wear assessment

The submitted brushes, collected from the subjects at their first visit, as well as the 3-month-old ADA toothbrushes used during the pretrial phase, were assessed for wear using a 5-point scale, from 0 (no wear) to 4 (extreme wear), according to the method described by Conforti *et al.* (8). The wear ratings were independently judged by three examiners (NAMR, SS, GVA), who were calibrated (Cronbach's alpha: 0.95) regarding this wear index. In the event that an individual toothbrush was not unanimously rated, the three examiners discussed the rating until a consensus was reached.

Data analysis

The unit of analysis was the subject, and the collected data were analysed according to 'intention to treat'. The plaque scores were used as the main response variable and the gingival abrasion scores and wear scores as secondary response variables.

A priori calculations, with an alpha of 0.05, a difference of 0.085 in the plaque indices among the groups, and 80% power, based on a pooled SD of 0.20 as derived from previous studies, supported a sample size of 45 subjects. Taking possible drop-outs into account because of the duration of the 3-month pretrial phase, it was decided to enrol 50 subjects in the study. Both for plaque and gingival abrasions, means were calculated and compared using non-parametric tests (Friedman's test and Wilcoxon's test). Correlations (Spearman) were calculated for

wear related to the clinical parameters, as well as for 3-month-old brushes regarding the subjects' brushes that were submitted at the start of this trial.

Results

In total, 45 subjects participated in the brushing experiment. The five dropouts included two subjects who disliked the ADA reference toothbrush and three subjects who could not attend their second appointment due to scheduling conflicts.

With regard to the prebrushing plaque scores, no significant differences were observed. The mean values varied between 2.55 for the new brush^{+D} quadrants and 2.60 for the new brush^{-D} quadrants. All of the brushing procedures resulted in significant plaque reductions, and post-brushing plaque scores differed significantly among the groups ($P = 0.036$) (Table 1). There was, however, a significant difference between treatments ($P = 0.013$) with the old brush^{+D} showing the least (0.81), and the new brush^{-D} showing the largest (1.00) plaque score reduction. Table 2 shows further explorative analyses in plaque reduction scores of the four brushing modalities. The old brush^{+D} appeared to remove significantly less plaque as compared with the new brush with or without the use of dentifrice. The percentage plaque score reductions also differed significantly ($P < 0.001$) and amounted 31% for the old brush^{+D}, 34% for the old brush^{-D}, 37% for the new brush^{+D} and 38% for the new brush^{-D}.

In the comparison of 'old versus new' toothbrushes, the data from two quadrants were pooled irrespective of the use of dentifrice, resulting in old brush^{+D} + old brush^{-D} versus new brush^{+D} + new brush^{-D}. This comparison revealed a statistically significant difference ($P < 0.001$) in favour of the new toothbrushes removing more plaque (i.e. a 5.1% absolute difference; Table 3a). In the case of a 'with versus without' dentifrice comparison using the pooled data from the new and old brushes, no significant differences were observed (Table 3b).

The mean prebrushing GA scores varied from 1.60 sites per quadrant for the new brush^{-D} quadrants to 2.10 for the old brush^{+D} quadrants, and all of the brushing procedures resulted in increases in GA scores. The increments varied from 1.13 for the old brush^{+D} quadrants to 1.94 for the new brush^{+D} quadrants, but no significant differences could be assessed between them. However, there seemed to be a numerical trend ($P = 0.083$) towards higher GA scores for the new brush^{+D} quadrants (Table 4).

With regard to the influence of the degree of wear of the 3-month-old used ADA toothbrushes on GA and plaque removal, no significant correlations were found. A strongly significant ($P < 0.01$) correlation (Spearman's rho: 0.526) was found between the wear status of the two brushes belonging to the same subject, that is, the one that was used in the pretrial phase for 3 months and the one that was submitted at the screening appointment. One subject failed to turn in his brush; therefore, 44 collected brushes were analysed. The mean age of the brushes was 12 (SD = 7) weeks, and 84% of the subjects reported brushing twice daily. The wear scores varied from 0 to 4 for the brushes collected at the screening and from 1 to 4 for the 3-month-old used ADA brushes. Both the brushes collected at the screening and the 3-month-old used ADA brushes were categorized with per wear classifications. It appeared that in 11 cases, the old brushes showed greater plaque score reductions compared with the new brushes, whereas in 34 cases, the reverse was true (Table 5). Old brushes with a wear score of 1 showed similar plaque score reductions compared with the new brushes. In contrast, old toothbrushes with a score >1 removed less plaque than the new brushes, with reductions of 0.81 and 0.98, respectively ($P = 0.03$).

Table 1. **Mean plaque score‡ per brushing modality**

n = 45	Baseline	End	Reduction
Old Brush^{+D}	2.57 (0.48)	1.76 (0.39)	0.81 (0.40)†
Old Brush^{-D}	2.59 (0.45)	1.71 (0.41)	0.88 (0.37)†
New Brush^{+D}	2.55 (0.45)	1.59 (0.38)	0.96 (0.37)†
New Brush^{-D}	2.60 (0.41)	1.60 (0.34)	1.00 (0.40)†
*P-value**	0.815	0.036	0.013

**P*-value from Friedman test.
†Statistically significant ($P < 0.05$) reduction from baseline to end (Wilcoxon test).
‡Modified Quigley and Hein (20) plaque index according to Paraskevas *et al.* (17).

Table 2. **Plaque score† comparisons for all brushing modalities**

n = 45	Difference in reduction	95% CI Lower	95% CI Upper	*P*-value*
Old Brush^{+D} versus Old Brush^{-D}	0.07	−0.21	0.07	0.354
Old Brush^{+D} versus New Brush^{+D}	0.15	−0.25	−0.05	0.007
Old Brush^{+D} versus New Brush^{-D}	0.19	−0.30	−0.09	0.001
Old Brush^{-D} versus New Brush^{+D}	0.08	−0.18	0.03	0.111
Old Brush^{-D} versus New Brush^{-D}	0.12	−0.24	0.003	0.068
New Brush^{+D} versus New Brush^{-D}	0.04	−0.15	0.07	0.352

**P*-value from Wilcoxon test.
†Modified Quigley and Hein (20) plaque index according to Paraskevas *et al.* (17).

Discussion

Common sense dictates that toothbrushes should be replaced because the filaments and tufts do not retain their shape forever. Completely worn brushes lose the capacity to remove plaque effectively. This result most likely occurs because of a loss of shear force because the tips of the filaments cannot adequately disrupt the plaque. The exact moment at which a toothbrush should be replaced is difficult to determine.

Focusing on toothbrush wear, a crossover study by Tan *et al.* (7) showed that subjects reduced their plaque scores with approximately the same magnitude of 34% after 1 min of

Table 3. **(a) Plaque scores† for old and new brushes irrespective of the use of dentifrice. (b) Plaque scores† for brushing with and without dentifrice irrespective of the type of brush used**

				95% CI		
n = 45	Baseline (PI)	End (PI)	Reduction (PI)	Lower	Upper	Mean reduction
a						
Old	2.58 (0.40)	1.73 (0.32)	0.85 (0.31)	−0.20	−0.07	−0.13 (0.21)
New	2.58 (0.39)	1.60 (0.31)	0.98 (0.35)			
*P-value**	0.977	<0.001	<0.001			
b						
With	2.56 (0.42)	1.68 (0.33)	0.89 (0.35)	−0.14	0.04	−0.06 (0.27)
Without	2.60 (0.39)	1.65 (0.31)	0.94 (0.33)			
*P-value**	0.353	0.388	0.257			

**P*-value from Wilcoxon test.
†Modified Quigley and Hein (20) plaque index according to Paraskevas *et al.* (17).

Table 4. **Mean scores for gingival abrasion‡ per regimen**

n = 45	Baseline	End	Increment
Old Brush^{+D}	2.09 (3.20)	3.22 (3.33)	1.13 (1.20)†
Old Brush^{-D}	1.93 (2.24)	3.38 (3.10)	1.44 (1.29)†
New Brush^{+D}	1.93 (2.94)	3.84 (3.34)	1.91 (1.94)†
New Brush^{-D}	1.60 (1.98)	2.91(2.80)	1.31 (1.66)†
*P-value**	0.803	0.261	0.083

**P*-value from Friedman test.
†Statistically significant ($P < 0.001$) increment from baseline to end (Wilcoxon test).
‡According to Versteeg *et al.* (21).

Table 5. **Frequencies for wear scores* for both turned in brushes and 3-month-old used ADA brushes and performance in plaque† reduction for old versus new brushes**

Wear score	Turned in brushes (*n*)	ADA brushes (*n*)	Plaque reduction ADA old < ADA new	Plaque reduction ADA old > ADA new
0	2	–	–	–
1	16	19	14	5
2	18	15	9	6
3	4	7	7	0
4	4	4	4	0
Total	44	45	34	11

*According to Conforti *et al.* (8).
†Modified Quigley and Hein (20) plaque index according to Paraskevas *et al.* (17).

brushing time. However, in contrast to this study, they did not find a significant difference between 3-month-old and new toothbrushes. Conforti *et al.* (8) also did not report a significant difference between 3-month-old and new brushes. There have been other studies using parallel study designs that reached the same conclusion: no significant differences between used and new brushes with regard to the reduction of plaque scores (24–27). In contrast, other studies such as the present one have indeed found significant differences with regard to plaque score reduction. A parallel clinical study by Glaze and Wade (28) compared the plaque scores of twice-weekly replaced brushes with non-replaced brushes over a 10-week period and favourably reported on the unworn brushes. The non-replaced toothbrushes showed higher plaque scores over time. Other studies investigating plaque score reductions using crossover designs (9, 10) have also shown results favouring new brushes over worn toothbrushes, advocating for periodic replacement. The variability in conclusions reported in the above-mentioned studies might be the result of the use of different plaque indices. Additionally, differences in the numbers of examined teeth and the numbers of sites per tooth could have played a part in these outcomes. The majority of the studies mentioned did not perform full-mouth plaque scoring (7, 9, 12, 24, 28). When significant differences between old and new brushes have been reported, they have mainly been observed at proximal sites or at other 'hard-to-reach areas'. Therefore, it is of great importance to use full-mouth scores, and an index that is able to distinguish various areas of interest when conclusions are to be drawn regarding the efficacy of toothbrushes. Another explanation for the variability in the results of the above-mentioned studies could be the study designs. As those studies were panellist-brushing studies, variation in the brushing skills of the subjects could have had an effect on the study outcomes. In contrast to the above-mentioned panellist-brushing studies, the present study used the approach of professional brushing. This design has been used previously by other investigators in the evaluation of different brushing techniques (29). The variability of the brushing skill of the panellist was thus avoided in this type of study design. Therefore, the potential ability of the toothbrush to reduce the plaque score could be studied without being biased or influenced, for example, by manual dexterity and/or the brushing experience of the subject. Furthermore, using a different treatment in each quadrant allowed the evaluation of four treatments over a short period of time and reduced the number of subjects needed for the study to have adequate power (30).

The magnitude of the differences in plaque removal efficacy might be important to determine whether new brushes have clinically relevant merit over worn brushes. The ADA

guidelines on toothbrushes suggest a minimum absolute difference of 15% between brushes and permit the claim that one brush is better than the other (31). In this study, the observed 5% absolute difference between old and new brushes did not exceed this limit. Therefore, based on the differences in percentage plaque score reductions, one cannot say that the new brushes had clinically relevant merit over the 3-month-old used brushes. Another approach in interpreting the present data was to divide the 3-month-old used brushes according to wear category and to count the number of old brushes that removed less plaque than the new brushes. Toothbrushes with wear scores of 3 and 4 were always outperformed by the new brushes with regard to plaque score reduction. In contrast, in 11 cases of 34 brushes given scores of 1 and 2, the old brushes performed better than the new brushes. In other words, the new brushes had greater benefits over old brushes when the old brushes showed more wear. Therefore, it seems appropriate to replace a brush when it shows a wear score ≥ 3, which means 'outer tufts are splayed and have lost tuft definition', 'inner tufts are splayed and becoming less distinct' and 'definition between inner and outer tufts is lost'. In contrast, when the plaque score reduction data of new brushes were compared with data from old brushes with wear scores of 2, 3 and 4, a significant difference was also observed. Based on this argument, one could opt for a replacement when a brush shows a wear score ≥ 2, which means 'outer tufts are splayed and have lost tuft definition', 'inner tufts are splaying but still distinct', and 'definition between inner and outer tufts is losing distinction'.

In many of the studies investigating toothbrush wear, it seems that the age itself of the toothbrush was not the critical parameter that was crucial to plaque removal efficacy (7, 12, 32). Wear rate seems to have been the determining factor with regard to loss of efficacy, and thus, the replacement advice is related more to wear than to the age of the toothbrush. It should be taken into account that in this respect, wear is considered to be bending, splaying or matting of the filaments, rather than the tapering effect of the filament ends, as suggested by Kreifeldt *et al.* (32).

With regard to dentifrice, there have been only a couple of studies that have assessed the instant additional effect on plaque removal. Originally, it was thought that abrasive additives in dentifrices would help to improve plaque removal during toothbrushing. Mankodi *et al.* (33) suggested that the type of abrasive agent might play a larger role than the RDA value itself. In a study by Creeth *et al.* (34), the use of 1.5 g of dentifrice showed no additional effect after 1 min of brushing, compared to brushing without dentifrice. Paraskevas *et al.* (17) also studied whether a dentifrice has a beneficial effect on plaque removal and whether the abrasive additive was a contributor. Their results showed that among 40 subjects using three different hydrated silica-based dentifrices in a crossover study, the difference in abrasiveness (RDA = 80 and RDA = 200) did not play a role in plaque removal. Moreover, significantly more plaque (3%) was removed when the brushing procedure was performed without dentifrice. In another study by Paraskevas *et al.* (17), a significant 6% difference was observed whereby the group that used dentifrice removed less plaque compared with the group that did not use dentifrice. Furthermore, in a study by Jayakumar *et al.* (35), a 9% difference in plaque removal in favour of the non-dentifrice group was observed. The results of the present study showed a difference in plaque removal of 2% in favour of the non-dentifrice group. Although this difference in plaque score reduction did not reach the level of significance, it is noteworthy that the use of dentifrice does not seem to increase the amount of plaque removal, similar to the conclusions of the above-mentioned studies. Dentifrice is, however, able to carry a multitude of different chemotherapeutic ingredients, such as fluoride, tartar controlling, desensitising or whitening agents, and flavours, which can have beneficial effects on the intra-oral environment and on patient compliance (36). With regard to gingival abrasion scores, the present study did not detect a significant difference between brushing with or without dentifrice. This finding is in agreement with the results from Versteeg *et al.* (21), who did not find a correlation between gingival abrasion scores and dentifrice use.

In general, dental professionals, as well as the oral care industry, advocate toothbrush replacement every 3 months (11–13). The question arises regarding whether this advice is based on clinical data or whether this message can be supported by an industry that benefits by selling more toothbrushes. On the basis of the present results, it can be concluded that a manual toothbrush should be discarded when it shows signs of matting, irrespective the age of the toothbrush. With respect to the use of dentifrice, one should realize that dentifrice provides no added beneficial effect on 'instant' plaque removal.

Clinical relevance

Patients are usually advised that toothbrushes should be replaced periodically. It is important to know when toothbrushes become less effective in removing plaque and what role dentifrice offers in daily oral hygiene.

This study provides the following information

The plaque removal efficacy and relative potential of causing gingival abrasions of new manual toothbrushes, compared with 3-month-old used toothbrushes, did not reveal striking, clinically relevant differences. Although the data revealed the statistically significantly greater efficacy of new brushes compared with 3-month-old brushes, it seems that because of great variation in toothbrush wear between individuals, a manual toothbrush should be discarded when it shows signs of matting, regardless of its age. Furthermore, the data showed that dentifrice does not contribute to plaque removal.

Practical implications

As individuals show great variation in the progression of toothbrush wear, the age of a toothbrush should not be the guiding factor for replacement. Instead, it seems appropriate to replace

a manual brush when it shows wear, which can be described as 'outer tufts are splayed and have lost tuft definition', 'inner tufts are becoming less distinct' and 'definition between inner and outer tufts is lost'.

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