Session D
Home Oral Hygiene Revisited. Options and evidence

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Key words: oral hygiene, manual toothbrushes, powered toothbrushes, orthodontic patients, interproximal plaque control, dental floss, interproximal brushes

Oral Health Prev Dent 2003; 1: Supplement 1: 407-422.

All methods aimed at achieving ideal plaque control should include two aspects: toothbrushing and interdental tooth cleaning.

No scientific evidence has been found to support the consistent superiority of a particular manual toothbrush. However the results observed with the newly designed models should be carefully studied in the future. Long-term studies are needed. Nevertheless, there appears to be evidence that supports the use of powered toothbrushes in the general population, especially those of the oscillating-rotating and counter-rotational type, as they have shown their ability to reduce gingival bleeding or inflammation, and dental plaque with greater efficacy than manual brushes.

There is a need for long-term trials on the efficacy of powered brushes in orthodontic patients. We can conclude from existing studies that there is limited evidence that orthodontic patients using a powered toothbrush show a slight, but significant, reduction of bleeding, compared with users of manual brushes. No conclusion can be made concerning the type of brush to be used.

The techniques of interproximal oral hygiene, fundamentally the use of dental floss and interproximal brushes, when they are associated with conventional manual brushes, appear to add additional benefits in terms of plaque reduction. Further long-term studies are necessary to confirm their efficacy in the reduction of gingival bleeding or inflammation. The choice of the type of technique must be made in relation to the characteristics of the patient: dental floss could be indicated in individuals with closed interdental spaces, and interproximal brushes in periodontal patients or in those with open embrasures.

INTRODUCTION

From 1965 experimental studies demonstrated conclusively that the accumulation of plaque in healthy gums produced gingivitis and that, after the restitution of oral hygiene measures the inflamed gums reverted to normality (Löe, et al, 1965). We can say that the scientific evidence on the effect of the control of plaque in gingival health began at this time. However, Albucasis, one of the most important historical figures in dental medicine (Hoffmann-Axthelm, 1981), and possibly the first 'European periodontist' (born in Cordoba, Spain in 936) already acted mechanically on the plaque and dental calculus in the 10th century. The questions that arise from this revelation are: "Was Albucasis mistaken? Were the thousands of professionals who applied these techniques before 1965 also wrong?" Certainly not. In these times the 'winds of evidence' blow on occasions in directions that do not complement, but rather appear to replace the clinical experience. In perspective these historical observations can help us understand that the evidence is limited; and, although their principles should be fundamental pillars of our professional and scientific development, they do not provide an answer for all the daily problems faced by clinicians. The clinical experience should also have its complementary field.

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We currently know that both caries and periodontal disease are the consequences of the interaction of dental plaque bacteria with the host. Scientific evidence exists showing that the presence of bacteria plays a decisive role in the development of both pathologies. For this reason a treatment-oriented regimen directed at inhibiting the accumulation of plaque, and its mechanical removal, by means of oral hygiene techniques, is an aspect of maximum importance in the prevention of both entities (Lang et al, 1998; Löe, 2002). All methods oriented toward achieving ideal plaque control should include two fundamental aspects: toothbrushing and interdental tooth cleaning (Kinane, 1998), which is the reason why both aspects should be revised as suggested in the following pages.

EFFICACY OF ORAL HYGIENE PROCEDURES AND TECHNIQUES

In order to evaluate the efficacy of oral hygiene procedures we have separately analyzed the long-term randomized studies made on the use of manual toothbrushes, interdental toothbrushes and powered toothbrushes. In the section on the efficacy of the use of powered toothbrushes we have considered those with six months or more of follow-up as 'long-term' studies (Sicilia et al, 2002). However, in the remaining sections, given the reduced number of studies with follow-ups around six months (and following the criteria of previous reviews) we have considered as 'long-term' those with two or more months of follow-up (Jepsen, 1998).

1. EFFICACY OF THE USE OF MANUAL DENTAL TOOTHBRUSHES

Manual dental toothbrushing is the oral hygiene procedure most commonly used in the world (Löe, 2002), and sufficient evidence exists that it is efficient in the removal of plaque and the treatment and prevention of gingivitis (Hancock, 1996; Rebelo and Romao, 2003). In recent decades the industry has produced a considerable variety of designs of brushes oriented toward improving the efficacy of manual toothbrushes. The majority of these designs have been oriented toward modifying general ergonomic factors of the brush, in order to improve the efficacy of the oral hygiene technique in the general population, or to develop specific factors indicated in particular cases, such as individuals with physical and mental handicaps. The factors on which manufacturers have worked most are the filaments, bristles and tufts (form, disposition and orientation), the brush-head (number, form and dimensions) and the handle (Rebelo and Romao, 2003).

Traditionally the reviews and workshops which have compared the efficacy of different types of manual toothbrushes have not found evidence of significant differences, or, where differences exist, these have been minimal and without clinical repercussions (Egelberg, 1999; Frandsen, 1986; Jepsen, 1998). In his classical review in 1986, Frandsen concluded that no scientific evidence existed which indicates that one type of brush was superior in relation to the removal of plaque, and that these were always useful tools of oral hygiene, if the persons who used them were adequately instructed and motivated. In this way he concluded: "if performance fails, it is more likely that improvements will occur by altering the conditions which determine the use of the toothbrush rather than by changing the toothbrush itself" (Frandsen, 1986).

Currently, the appearance of new brushes on the market is preceded by in vitro studies, and also 'rapid design' studies, which allow results to be obtained that are targeted at facilitating or providing support for their distribution, thus demonstrating evidence of 'clinical superiority'. In this way 'industry-oriented-research' has developed some particular designs, such as 'single-use tests', or 'short-term' studies which limit the follow-up of the patients to a few days or weeks (Rebelo and Romao, 2003). However, although these types of investigations can be useful, they have limitations, which indicate a clear necessity for long-term studies (Egelberg, 1999).

Thus, the literature is full of articles on the use of a particular type of manual toothbrush which claim superiority in the removal of plaque supported by only one 'rapid design' study, although in many cases some other studies found contradictory results (Jepsen, 1998). In fact, when we evaluate the problem through the analysis of the long-term studies (2 or more months), we find that the type of brush has a limited impact on the reduction of plaque or gingivitis (Table 1). Four long-term studies have evaluated the comparative efficacy of new designs of manual toothbrushes with a single head. In two of these (Grossman et al, 1994; Reardon et al, 1993) no significant, or very slight, differences in gingivitis reduction were found. On the other hand, in the third (Sharma et al, 1994), significant differences, clearly marked in favor of the 'Colgate Total®' brush were detected, which reduced the plaque and gingivitis by 50% at three months, while their competitors (the 'New Improved Crest Complete®', the 'Reach Advanced Design®' and the 'Oral-B Advantage®') achieved reductions of only 13 to 26%. These results are contradictory (Egelberg, 1999; Jepsen, 1998) to those of the study by Grossman et al (1994), in which significantly slight differences were found in favor of the 'Oral-B Advantage®'.

In recent years the appearance of 'Oral-B Cross-Action®', a new brush with a system of inter-crossed tufts (criss-crossed bristles) designed in order to improve the control of plaque, has been comparatively evaluated in a long-term study (Sharma, et al, 2000). A clear clinical superiority was found in comparison to the 'Dr. Best Interdent®' and the 'Crest Deep Sweep®' (Table 1). Even

Table 1 Long-term randomized studies comparing the efficacy of the use of different manual toothbrushes in the reduction of gingival bleeding or inflammation and plaque

Study	Duration/Patients	Indices	Groups	Plaque Baseline	Plaque Final	% Plaque Reduction	GI Baseline	GI Final	% GI Reduction
Reardon et al, 1993	3 months/2 studies (140 & 66 patients). Adults with plaque and gingivitis. Matched for GI and PL	MGI PI	1.- Oral-B P-35®	2.59	2.64	– 2%	2.32	2.46	– 6%
			Crest Complete®	2.56	2.49	3%	2.28	2.43	– 7%
			2.- Oral-B P-35®	2.78	2.37	15%	2.20	1.79	19%
			Crest Complete®	2.88	2.39	17%	2.22	1.85	17%
Grossman et al, 1994	2 months/2 studies (109 & 121 patients). Adults with plaque and gingivitis	MGI PI	1.- Oral-B Advantage®	2.28	1.26	45%	1.25	1.08	14%
			Crest Complete®	2.36	1.58	33%	1.30	1.30	0%
			Colgate Precision®	2.13	1.48	31% ♦	1.29	1.29	0% ♦
			2.- Oral-B Advantage®	2.29	1.25	45%	1.69	1.58	7%
			Colgate Plus®	2.41	1.61	33%	1.73	1.68	3%
			Reach Adv. Design®	2.38	1.42	40%	1.67	1.64	2%
			Jordan Exact®	2.30	1.56	32% ♦	1.68	1.68	0% ♦
Sharma et al, 1994	3 months/ (193 patients). Adults with plaque and gingivitis	MGI RPI	Colgate Total®	0.63	0.29	54%	2.11	1.08	49%
			N.I. Crest Complete®	0.63	0.47	25%	2.13	1.82	15%
			Oral-B Advantage®	0.62	0.46	26%	2.15	1.83	15%
			Reach Adv. Design®	0.63	0.48	24% ♦	2.07	1.81	13% ♦
Yankell et al, 1996	6 months/ (93 patients). Adults with plaque and gingivitis	MGI PI	Dentrust® (buccal)	2.66	2.73	– 3%	2.38	1.52	36%
			Dentrust® (lingual)	2.80	2.64	6%	2.39	1.52	♦ 36%
			Oral-B P-35® (buccal)	2.71	2.57	5%	2.41	1.69	30%
			Oral-B P-35® (lingual)	2.81	2.73	3%	2.40	1.73	♦ 28%
Sharma et al 2000	3 months/2 studies (99 & 87 patients). Adults (18 to 65 years)	MGI RPI	1.- Oral-B Cross Action®	0.68	0.38	44.8%	2.12	1.63	23.1%
			Dr. Best Interdent®	0.67	0.50	25.4% ♦	2.13	1.76	17.4% ♦
			2.- Oral-B Cross Action®	0.65	0.35	46.2%	1.99	1.63	18.1%
			Crest Deep Sweep®	0.64	0.51	20.3% ♦	1.93	1.87	5.1% ♦

Abbreviations:
PI: Turesky plaque index. MGI: Lobene modified gingival index. RPI: Rustogi/Navy index.
♦: Statistically significant difference between test and control (numbers in bold indicate the most favorable result).

though it has not been included in the table, due to the fact that it is not a 'long-term' study (follow-up of 6 weeks), the paradoxical study of Singh et al (2001) deserves special mention. In this case the 'Colgate Total®' (CT) brush appears to be superior to the 'Oral-B Cross-Action®' (OB) brush, as it achieved greater values, around 30%, in the reduction of plaque and gingivitis (Singh et al, 2001). However, a meticulous review of the manuscript found that at three weeks no clinically important differences existed between the groups (reduction of plaque by 33% for the CT compared to 31% for the OB; and reduction of gingivitis by 34% compared to 26%). 'Surprisingly' a discrete improvement was produced in the CT group between the third and sixth weeks (as is to be expected in these types of studies), while an unexplained worsening was observed in the OB group, which led to the appearance of significant differences. This aspect was not analyzed or explained by the authors.

In regard to the limited literature on the subject, and the contradictions observed, we can not conclude that the types of brushes produce clinically important effects on the patients' gingival health, or that these effects can be detected consistently. However, the best results have been obtained with 'Colgate Total®' and the 'Oral-B Cross-Action®', and future studies are necessary to clarify the existing contradictions.

There is even less documentation on double and triple-headed toothbrushes, capable of simultaneously cleaning the buccal, lingual and occlusal faces. There is one long-term study (Yankell, et al, 1996), where minimal differences are found in favor of the triple-headed brush, which reach statistical significance only on the lingual face (Table 1). This is in accordance with what the non-reviewed 'single-use' and 'short-term' studies found, which analyze the effect of this type of brushes (Egelberg, 1999; Jepsen, 1998). Manual brushes which employ mechanisms based on 'light energy conversion' (Hoover et al, 1992) or ionic filaments (Van Swol et al, 1996) are not included in this table.

The classical studies of the different toothbrushing methods (Stillman, Bass, Charters...) do not permit us to demonstrate the superiority of any of these (Egelberg, 1999; Jepsen, 1998), nor their efficacy for eliminating the interproximal plaque (Egelberg, 1999). A considerable lack of long-term studies, and investigations on the tendency of the patient to continue using the technique demonstrated by the professional, or to return to using their usual methods exist in this field (Egelberg, 1999). A new technique has been proposed by Watanabe which appears to be promising, as has been shown in two 'single-brush' experiments (with the teeth brushed by the professional and by the patient) (Morita et al, 1998).

Finally, little scientific documentation exists on the frequency of brushing. Classic studies support the fact that the minimum should be twice a day (Kelner et al, 1974; Lang et al, 1973).

2. EFFICACY OF THE USE OF POWERED TOOTHBRUSHES

The first generations of powered toothbrushes had a head very similar to manual ones and a basic vertical and horizontal movement that reminded one a lot of what patients did with the manual toothbrushes. The use of these designs did not offer a clear advantage over the conventional brushing and the products disappeared from the market (Löe, 2002).

In the past the general opinion was that powered toothbrushes were only indicated in special patients: the elderly, the physically and mentally handicapped and orthodontic patients (Löe, 2002). However, at the present time these indications have been increased by technological development, which has brought new designs, and by experimental studies, which, in certain conditions, tend to support their efficacy in the general population.

A. EFFICACY OF THE USE OF POWERED TOOTHBRUSHES IN THE GENERAL POPULATION

A recent systematic review of the literature (Sicilia et al, 2002, 2003), groups the clinical trials that have attempted to evaluate the efficacy of the use of powered toothbrushes compared to manual ones in the reduction of bleeding or gingival inflammation in four different models:

1. The patient who acquires a brush in retail outlet and uses it without previous professional education. The 'Over The Counter' model (OTC)
2. The patient who receives previous professional education. The Oral Hygiene Education model (OHE)
3. The patient who receives previous professional education and Professional Mechanical Tooth Cleaning (PMTC). The PMTC and Oral Hygiene Education model (POHE)
4. The patient who receives Supportive Periodontal Treatment (SPT model).

1. The Patient who Aquires a Brush in Retail Outlet and who Uses it without any Previous Professional Education. The 'Over The Counter' Model (OTC)

Within this model we have included those studies in patients who have acquired as their only treatment a powered or manual brush, with general instructions, and without professional education in oral hygiene (Chilton et al, 1962; Dentino et al, 2002; Forgas-Brockmann et al, 1998; Lobene 1964; McKendrick et al, 1968; Stoltze and Bay, 1994) (Table 2).

Three of the six studies reviewed were from the 60 s, and tested brushes which are no longer available on the market (Chilton et al, 1962; Lobene, 1964; McKendrick

Table 2 Studies which compare the efficacy of the use of manual versus powered toothbrushes made with the Over The Counter model (OTC: absence of professional education or modification of the oral hygiene habits of the patient)

Study	Duration/ (Patients)	B-G/Plaque Indexes	Groups	B-G Baseline	B-G End of study	B-G Baseline-end of study reduction	% B-G Reduction	% Plaque Reduction
Chilton et al, 1962	2 months/ (30 dental students)	PMA/CI	Test: Broxodent® Control: Manual brush ' 'standard brush'	5.9 6.4	7.2 7.7	– 1.3 – 1.3	– 22.0% – 20.3%	5.9% 6.3%
Forgas-Brockmann et al, 1998	1 month/ (56 adults)	EBI/PI	Test: Ultra-sonex® Control: Manual brush Oral-B®	0.76 0.9	0.56 0.69	0.2 0.19	26.3% 24.1%	0.09% 0.06%
Lobene, 1964	3 months/ (185 women students)	PMA	Test: General Electric® Control: Manual brush Oral-B 40 advantage ®	69.11 69.3	39.84 67.23	29.27 2.07	42.3% 3.0% ♦	– –
Stoltze and Bay, 1994	1.5 months/ (38 medical students)	BSI/VPLI	Test: Braun D5 PC® Control: Manual brush Tandex®	12.4 12.7	3.2 11	9.2 1.7	74.2% 13.4% ♦	79.8% 24.2% ♦
Dentino et al, 2002*	6 months/ (157 adults with gingivitis)	BOP PI	Test: Braun Oral-B D9 UPR® Control: ADA reference manual brush	24.2% 25.1%	13.4% 15.5%	10.8 9.6	44.6% 38.2%	15.6%** 6.7% ♦
McKendrick et al, 1968 (Only the oral hygiene uninstructed patients)	24 months/ (44 students)	RPI ODI	Test: Ronson® Control: Manual brush Gibb's Short-head Med. ®	0.80 0.71	0.50 0.40	0.30 0.31	37.5% 43.7%	23.9% 20.7%

Abbreviations:
B-G: Bleeding or gingivitis. -: No data. *: Absence of professional education in mechanical plaque control, but baseline prophylaxis. **: Three month results, at six month only immediate post-brushing plaque index was recorded.
PMA: PMA index of gingivitis. CI: Chilton cleanliness index. EBI: Eastman bleeding index. PI: Turesky plaque index. BSI: % of sites with bleeding to stroking or showing 'spontaneous' bleeding, codes 2 or 3 of the Löe and Silness gingival index (GI). VPLI: % of sites with 'visible plaque', codes 2 or 3 of the Silness and Löe plaque index (PII). BOP: % of sites with bleeding on probing.
♦: Statistically significant difference between test and control (numbers in bold indicate the most favorable result).
Broxodent®: Electric brush (Broxodent®). Ultra-sonex®: Ultrasonic electric brush (Ultra-sonex®). General Electric®: General Electric reciprocating electric brush. Braun D5 PC®: Oscillating-rotating electric brush (Braun D5 Plak Control®).

et al, 1968). A significant reduction of gingivitis was found in only one study, which was made from a sample of 185 female college students (Lobene, 1964). In this paper no information on plaque control was published. In two of the remaining studies, dating from the 90 s, one evaluated an ultrasonic type of brush (Forgas-Brockmann et al, 1998), and the other an oscillating-rotating one (Stoltze and Bay, 1994). Only in the second of the cases was a significantly superior reduction of the gingival bleeding detected in the test group (74 vs 13%), which was accompanied by a concomitant reduction of dental plaque (80 vs 24%). Finally, in the most recent study, a long-term one (Dentino et al, 2002), reductions of bleeding and gingival inflammation were observed to be discretely superior, but not significant, in the test group. It is difficult to evaluate the evolution of the plaque index in this study (Blanco-Carrión et al, 2003), as at baseline and at three months it measures 'overnight' plaque accumulation, while at six months it registers the plaque 'after' dental brushing.

2. The Patient who Receives Previous Professional Education. The Oral Hygiene Education Model (OHE)

In this model professional intervention is introduced by means of meticulous instruction in oral hygiene instruction associated with motivation and modification of the patients oral hygiene habits (Baab and Johnson, 1989; Cronin et al, 1998; Johnson and McInnes, 1994; Khocht et al, 1992; Killoy et al, 1989; McKendrick et al, 1968; O'Beirne et al, 1996; Terezhalmy et al, 1995; Tritten and Armitage, 1996; van der Weijden et al, 1998; Warren et al, 2001) (Table 3). Some studies also include systems of control of compliance with the hygiene protocol (Baab and Johnson, 1989; Cronin et al, 1998; Johnson and McInnes, 1994; Khocht et al, 1992; Killoy et al, 1989; Warren et al, 2001).

We noted significant reductions of bleeding or gingivitis in six short-term studies (6 out of 10), two with a contra-rotational brush (Baab and Johnson, 1989; Killoy et al, 1989), three with an oscillating-rotating one (Cronin et al, 1998; van der Weijden et al, 1998; Warren et al, 2001), and one with an ultrasonic brush (Terezhalmy et al, 1995). In the first five studies the reduction of the gingival parameters is accompanied by a significant similar behavior in the plaque indexes, achieving in some cases a baseline-end of study plaque index reduction between 60 to 80%. The average plaque index reduction was 52% in these cases (Table 3).

On the other hand, in four of the five remaining studies (including the patients with oral hygiene education of the McKendrick study) major reductions of gingival bleeding and or gingival inflammation were found in the control group (Johnson and McInnes, 1994; Khocht et al, 1992; McKendrick et al, 1968; Tritten and Armitage, 1996), although only in one of these was this reduction significant (Tritten and Armitage, 1996). No differences were found in the reduction of plaque between the groups with powered and manual brushes, this reduction ranging between 9 and 26%. The average plaque index reduction was 17.3% in these cases (Table 3).

3. The Patient who Receives Previous Professional Education and Professional Mechanical Tooth Cleaning (PMTC). The PMTC and Oral Hygiene Education Model (POHE)

In the POHE model the patients are instructed in oral hygiene by a professional and receive at least a prophylaxis after the initial examination (Ainamo et al, 1997; Heasman et al, 1999; Killoy et al, 1993; Love et al, 1993; Quirynen et al, 1994; van der Weijden et al, 1994; Walsh et al, 1989; Yukna and Shaklee, 1993) (Table 4). Given the characteristics of these studies we have grouped them into short and medium term, which include those with a follow-up of less than six months (normally 4 to 6 weeks), and those of long term, which include those of six months or more.

In the three short-term studies no marked differences were seen among the groups (Heasman et al, 1999; Love et al, 1993; Quirynen et al, 1994), while in the long-term ones significant reductions were seen in gingival bleeding in the two articles selected (Ainamo et al, 1997; van der Weijden et al, 1994), both with oscillating-rotating type brushes, although only in the second of these was a concomitant significant reduction of the dental plaque observed (Table 4).

4. The Patient who Receives Supportive Periodontal Treatment (SPT model)

Included in this model are long-term studies in patients who have suffered moderate periodontal disease that have required treatment and received professional mechanical tooth cleaning, and/or subgingival scaling, every three months (Killoy et al, 1993; Walsh et al, 1989; Yukna and Shaklee, 1993) (Table 5). It is noteworthy that in this model a specific long-term article in patients undergoing supportive periodontal treatment has been removed (Haffajee et al, 2001), due to the absence of numerical data which could be employed in our review. Short-term studies (2 months) in patients following supportive periodontal treatment (Love et al, 1993; O'Beirne et al, 1996), that could have been considered in this section (Sicilia et al, 2003), have been previously analyzed in the POHE model.

In all those finally included in this model a significantly greater reduction is observed in gingival bleeding and dental plaque in the test group. Two of the studies (2 out of 3) employ a counter-rotational brush (Killoy et al, 1993; Yukna and Shaklee, 1993).

Table 3 Studies which compare the efficacy of the use of manual versus powered toothbrushes made with the Oral Hygiene Education model (OHE: professional education or modification of the oral hygiene habits of the patient)

Study	Duration/ (Patients)	B-G/Plaque indexes	Groups	B-G Baseline	B-G End of study	B-G Baseline-end of study reduction	% B-G reduction	% Plaque reduction
Baab and Johnson, 1989	1 month/ (40 adults)	GBI OPCR	Test: Interplak® Control: Manual brush Butler 411®	69.9 72.8	46.5 56.2	23.4 16.6	33.5% 22.8% ♦	63.6% 33.3% ♦
Cronin et al, 1998	3 months/ (105 healthy volunteers)	BSI (GI) PI	Test: Braum Oral-B 3D PR® Control: ADA manual reference toothbrush	0.17 0.18	0.06 0.08	0.11 0.10	64.7% 55.5% ♦ ?	14.9% 8.0% ♦
Johnson and McInnes, 1994	1 month/ (43 adults)	GBI PI	Test: Sonicare® Control: Manual brush Oral-B 30®	57.5 71.6	40.7 45.9	16.8 25.7	29.2% 35.9%	25.8% 8.8% ♦
Khocht et al, 1992	1 month/ (95 adults)	GI PI	Test I: Epident® Test II: Interplak® Control: Manual brush Oral-B 40 advantage®	1.25 1.21 1.26	1.01 1.06 0.99	0.24 0.15 0.27	19.2% 12.4% 21.4%	21.5% 18.9% 15.5%
Killoy et al, 1989	1 month/ (24 adults)	BMBI PI	Test: Interplak® Control: Manual brush 'conventional brush'	1.01 1.07	0.23 0.6	0.78 0.47	77.2% 43.9% ♦	82.0% 59.9% ♦
O'Beirne et al, 1996	2 months/(40 SPT patients)	MPBI	Test: Sonicare® Control: Manual brush Oral-B 30®	1.85 1.87	0.43 0.53	1.42 1.34	76.8 71.7	* *
Terezhalmy et al, 1995	1 month/ (46 adults)	EBI PI	Test: Ultra-sonex® Control: Manual brush Oral-B®	0.45 0.40	0.18 0.44	0.27 – 0.04	60% – 10% ♦	– 40.8% – 53.7%
Tritten and Armitage, 1996	1 month/ (56 adults)	BOP PI	Test: Sonicare® Control: Manual brush Butler 331®	41.2 42.0	29.9 24.3	11.3 17.7	27.4% 42.1% ♦	20.7% 19.1%
Van der Weijden et al, 1998	1 month/ (35 Univ. students)	BMPI PI	Test: Braum Oral-B 3D® Control: Manual brush Butler GUM 311®	1.32 1.28	0.33 0.55	0.99 0.73	75% 57% ♦	79.5% 64.8% ♦
Warren et al, 2001	3 months/ (110 healthy volunteers)	BSI PI	Test: Braum Oral-B D17® Control: ADA manual reference toothbrush	* *	* *	0.09 0.06	68.0% 49.0% ♦	20.0% 12.7% ♦
McKendrick et al, 1968 (Only the oral hygiene instructed patients)	24 months/ (40 Univ. students)	RPI ODI	Test: Ronson® Control: Manual brush Gibb's Short-head Med.®	0.77 0.80	0.52 0.32	0.25 0.48	32.5% 60.0%	16.2% 25.8%

Abbreviations:
B-G: Bleeding or gingivitis. *: No data.
GBI: Ainamo and Bay modified gingival bleeding index. OPCR: O'Leary plaque control record. PI: Turesky plaque index. GI: Löe and Silness gingival index. BSI: % of sites bleeding to stroking or showing 'spontaneous' bleeding, codes 2 or 3 of the Löe and Silness gingival index (GI). BMBI: Barnett-Mühlemann bleeding index. EBI: Eastman bleeding index. BOP: Bleeding on probing. . BMPI: Bleeding on marginal probing index. MPBI: modified papillary bleeding index. RPI: Rusell Periodontal Index. ODI: Greene and Bermillion oral debris index.
Interplak®: Counter-rotational electric brush (Interplak®). Sonicare®: Sonic electric brush (Sonicare®). Epident®: Oscillating-rotating,-three heads electric brush (Epident®). Ultra-sonex®: Ultrasonic electric brush (Ultra-sonex®). Braum Oral-B 3D®: Oscillating-rotating electric brush (Braum Oral-B 3D®). Ronson®: Arcuate movement electric brush (Ronson®).
♦: Statistically significant difference between test and control (numbers in bold indicate the most favorable result). ♦ ?: Statistically significant differences in gingivitis (GI) and not in bleeding (BSI).

Table 4 Studies which compare the efficacy of the use of manual versus powered toothbrushes made with the Professional mechanical tooth cleaning and Oral Hygiene Education model (POHE)

Study	Duration	B-G/Plaque indexes	Groups	B-G Baseline	B-G End of study	B-G Baseline-end of study reduction	% B-G reduction	% Plaque reduction
Heasman et al, 1999	1.5 months	GI PI	Test I: Phillips J 2-A® Test II: Braun O. B D7® Control: Manual brush Oral-B 35 advantage®	1.44 1.44 1.47	1.49 1.61 1.64	– 0.05 – 0.17 – 0.17	– 3.5% – 11.8% – 11.6%	16.1% 17.7% 5.6%
Love et al, 1993	2 months	BMBI OPCR	Test: Interplak® Control: Manual brush Butler 311 GUM®	0.245 0.245	0.125 0.120	0.115 0.120	49.0% 49.0%	18.2% 23.8%
Quirynen et al, 1994	3 months	SBI Q-HPI	Test: Interplak® Control: Manual brush Oral-B 30®	* *	* *	* *	77.6% 63.8%	3.5% – 33.1%
Ainamo et al, 1997	12 months	GBI VPI	Test: Braun Oral B PC® Control: Manual brush Jordan soft®	40.9 39.1	19.8 24.4	21.1 14.7	51.6% 37.6% ♦	34.5% 30.5%
Van der Weijden et al, 1994	8 months	BA PI	Test: Braun PC® Control: Manual brush Butler GUM 311®	1.63 1.56	0.69 0.89	0.94 0.67	57.7% 42.9% ♦	41.9% 25.2% ♦

Abbreviations:
B-G: Bleeding or gingivitis. *: No data.
GI: Löe and Silness gingival index. PI: Turesky plaque index. BMBI: Barnett-Mühlemann bleeding index. OPCR: O'Leary plaque control record. SBI: Mühlemann and Son sulcus bleeding index. Q-HPI: Quigley and Hein plaque index. GBI: Ainamo & Bay modified gingival bleeding index. VPI: Ainamo & Bay visible plaque index. BA: Bleeding assessment.
Phillips J 2-A®: Oscillating-rotating electric brush (Phillips Jordan 2-Action®). Braun O. B D7®: Oscillating-rotating electric brush (Braun Oral B D7®). Interplak®: Counter-rotational electric brush (Interplak®). Braun Oral B PC®: Oscillating-rotating electric brush (Braun Oral B Plak Control®). Braun PC®: Oscillating-rotating electric brush (Braun Plak Control®).
♦: Statistically significant difference between test and control (numbers in bold indicate the most favorable result).

Table 5 Studies which compare the efficacy of the use of manual versus powered toothbrushes made with the Periodontal Supportive Treatment model (PST)

Study	Duration	B-G/Plaque indexes	Groups	B-G Baseline	B-G End of study	B-G Baseline-end of study reduction	% B-G reduction	% Plaque reduction
Killoy et al, 1993	18 months	BMBI PI	Test: Interplak® Control: Manual brush	0.45 0.23	0.06 0.17	0.39 0.06	86.7% 26.1% ♦	72.7% 46.9% ♦
Walsh et al, 1989	6 months	BOP VPLI	Test: Broxo® Control: Manual brush Oral-B 40®	49.0 38.0	31.0 28.0	18.0 10.0	36.7% 26.3% ♦	61.0% 59.2% ♦
Yukna et al, 1993	6 months	BOP PI	Test: Interplak® Control: Manual brush	15.3 13.2	8.5 11.0	6.8 2.2	44.4% 16.7% ♦	63.0% 38.0% ♦

Abbreviations:
B-G: Bleeding or gingivitis.
BMBI: Barnett-Mühlemann bleeding index. PI: Turesky plaque index.
BOP: Bleeding on probing. VPLI: % of sites with 'visible plaque' (codes 2 or 3 of the Silness and Löe plaque index).
SPT patients: Supportive periodontal therapy patients. Interplak®: Counter-rotational electric brush (Interplak®). Broxo®: Oscillating electric brush (Broxo®).
♦: Statistically significant difference between test and control (numbers in bold indicate the most favorable result).

IMPORTANCE OF ORAL HYGIENE EDUCATION FOR THE EFFICACY OF A POWERED TOOTHBRUSH

In the two-year follow-up study by McKendrick et al (1968), using four treatment groups, two with oral hygiene instructions and two without, which in both cases compared a powered toothbrush and a manual one, no significant differences were found between the groups with or without oral hygiene education. This could indicate that oral hygiene education is not so important for the achievement of clinical efficacy when using a powered toothbrush. However, on comparing the OTC and OHE models we found that, in the former only one study achieved an important reduction of plaque in the test group (79.8%), the others having values less than 16% (Table 2). On the other hand, in the OHE model three studies found values of a considerable reduction of plaque (64 to 82% in the test group) and the rest (with the exception of Terezhalmy et al, 1995) ranged in values around 20% (Table 3). Perhaps due to the fact that many of the studies in this last group are short term, one month (Table 3), these differences in plaque reduction are not associated with significant differences in the reduction of gingival bleeding or inflammation. However, in the OTC group only two studies found significant reductions of this parameter (2 out of 6), while this was achieved in 6 out of 11 studies in the OHE model.

EFFICACY OF THE USE OF A POWERED TOOTHBRUSH

In relation to the efficacy of the use of a powered toothbrush, 8 studies that support a greater efficacy of the use of a powered toothbrush in the reduction of the gingival bleeding or inflammation were found in the OTC and OHE models, the majority having in common a concomitant reduction of the dental plaque. Of these studies, 6 had been made with oscillating rotating (O-R) and counter-rotational (CR) brushes.

It is difficult to evaluate the effect of sonic and ultrasonic brushes. In the first case no significant differences were found in the two studies evaluated (Johnson and McInnes, 1994; Tritten and Armitage, 1996), and in the second the significant reduction of gingival inflammation and/or bleeding in the test group was accompanied by a 'difficult to explain' increase in the plaque index of around 50% in both groups (Terezhalmy et al, 1995). In the other studies, classified into the POHE and SPT models (Tables 4 and 5) a professional intervention already existed, either in the form of a professional mechanical tooth cleaning after the initial exploration, or a programmed supportive periodontal treatment. Short-term studies of the POHE model have presented serious limitations in design in detecting significant differences (Sicilia et al, 2002). If we exclude these, when we analyze the five remaining long-term studies (two of the POHE model and three of the SPT model) we find that in all of these significant differences are produced in the reduction of gingival bleeding or inflammation in favor of the test group; and in five of the six, significant differences in the reduction of dental plaque were also seen (Tables 4 and 5). Of these 5 studies, 4 had been made with oscillating-rotating (O-R) and counter-rotational (CR) brushes.

It is not possible to establish definite conclusions in relation to the efficacy of a specific type of powered toothbrush. However, the global analysis of all the studies evaluated, considering a generic classification of the action mechanisms (counter-rotational, oscillating-rotating, sonic, ultrasonic and others) provides us with information of interest (Table 6).

The oscillating-rotating brushes demonstrated their efficacy in the reduction of gingival bleeding or inflammation in six studies: in the OTC model (Stoltze and Bay, 1994), in the OHI model (Cronin et al, 1998; van der Weijden et al, 1998; Warren et al, 2001), and in the long-term POHE model (Ainamo et al, 1997; van der Weijden et al, 1994). In these a reduction of gingival bleeding or inflammation between 0.35 and 4.5 greater was achieved in the test group. At the same time a reduction was observed in the plaque index (only non-significant in the study by Ainamo et al, 1997), which is between 0.13 y 2.3 times greater in the test group (Tables 2, 3 and 4). These findings confirm the results of a previous systematic review (Heanue et al, 2003).

In turn, the counter-rotational brushes have demonstrated their efficacy in four studies: two in the OHE model (Baab and Johnson, 1989; Killoy et al, 1989), and two in the SPT model (Killoy et al, 1993; Yukna and Shaklee, 1993). In this case the reduction of gingival bleeding observed is between 0.47 and 2.32 greater in the test group than in the control group, and the reduction in the plaque index is between 0.37 and 0.91 times greater (Tables 3 and 5).

No evidence was found in relation to the efficacy of the use of ultrasonic and sonic brushes in the review made. The ultrasonic brushes have been studied in two models, the OTC (Forgas-Brockmann et al, 1998) and the OHE (Terezhalmy et al, 1995). The first of these two studies did not find significant differences between the groups, and paradoxically, the second, which detected a significant reduction of gingival bleeding in the test group of 60%, simultaneously observed an unexplainable increase of gingival bleeding of 10% in the control group, and an increase of 40 to 54% of plaque in both groups (Tables 2 and 3). On the other hand, the sonic brushes have been evaluated in three studies, all within the OHE model (Johnson and McInnes, 1994; O'Beirne et al, 1996; Tritten and Armitage, 1996). In the first two, no significant differences were seen in gingival bleeding or inflammation between the two groups, while in the third these were in favor of the manual brush. This absence of efficacy to reduce the gingival bleeding or inflammation is associated with a slight reduction of the plaque index (Table 3).

Table 6 Summary of the comparisons between power-driven and manual toothbrushes in reduction of gingival bleeding or inflammation

Power-driven Toothbrushes	Better power-driven brush	No differences	Better manual brush	Difficult to interpret results
Oscillating/Rotating	6 Stoltze and Bay, 1994 Van der Weijden et al, 1994 Ainamo et al, 1997 Cronin et al, 1998 Van der Weijden et al, 1998 Warren et al, 2001	2* Heasman et al, 1999 Dentino et al, 2002	0	0
Counter-Rotational	4 Baab and Johnson, 1989 Killoy et al, 1989 Killoy et al, 1993 Yukna et al, 1993	1* Love et al, 1993	0	1* Quirynen et al, 1994
Sonic	0	2 Johnson and McInnes, 1994 O'Beirne et al, 1996	1 Tritten and Armitage, 1996	0
Ultrasonic	0	1 Forgas-Brockmann et al, 1998	0	1 Terezhalmy et al, 1995
Others	2 Lobene, 1964 Walsh et al, 1989	3 Chilton et al, 1962 McKendrick et al, 68 Kocht et al, 1992	0	0

* Studies made with the POHE model or OTC with baseline prophylaxis.

In summary there appears to be evidence that supports the use of powered toothbrushes in the general population, especially those of the oscillating-rotating and counter-rotational type, as they have demonstrated their ability to reduce gingival bleeding or inflammation, and dental plaque with greater efficacy than the manual brushes.

B. EFFICACY OF THE USE OF POWERED TOOTHBRUSHES IN ORTHODONTIC PATIENTS

A classical indication of powered toothbrushes has been the orthodontic patients with fixed appliances (Löe, 2002), since the presence of brackets, arch wires and bands enormously complicates any technique of oral hygiene, facilitating at the same time a greater tendency to accumulate plaque (Clerehugh et al, 1998; Trombelli et al, 1995). In the previously cited systematic review (Sicilia et al, 2002), the patients wearing orthodontic appliances were excluded. For this reason and with the same methodology, but selecting studies in patients under orthodontic treatment, a new systematic revision of the literature was made with June 2002 as the cut-off.

Out of a total of 357 articles initially found, 13 were selected for a detailed final reading. Of these, 9 were eliminated due to absence of evidence of randomization; for not presenting useful global patients data on the level of gingival bleeding and inflammation at the beginning and end of the study; or because they associate some other hygiene devices with the use of the powered toothbrush, thus making it difficult to isolate the effect of the use of the latter (Boyd and Rose, 1994; Boyd et al, 1989; Burch et al, 1994; Heintze et al, 1996; Jackson 1991; Thienpont et al, 2001; Trimpeneers et al, 1997; Trombelli et al, 1995; Womack and Guay, 1968).

The 4 articles finally accepted (Clerehugh et al, 1998; Heasman et al, 1998; White, 1996; Wilcoxon et al, 1991) are collected in Table 7.

All the articles selected are short-term studies (1 to 3 months), and tested toothbrushes with the following mechanism of action: oscillating-rotating (Clerehugh et al, 1998); oscillating (Heasman et al, 1998); sonic (White, 1996); and counter-rotational (Wilcoxon et al, 1991). Significant reductions were obtained in the gingival bleeding and inflammation in 3 of the 4 studies, and it was very difficult to evaluate the data of the only one which did not follow this tendency (Heasman et al, 1998). In this study the patients were examined at the beginning of the investigation, and at 2 weeks, which was considered as baseline. In this period no type of intervention was performed in the patients and a spontaneous improvement (Hawthorne effect) of 16% in the gingival bleeding was observed. This method to reduce the possible Hawthorne effect, not applied in the other studies, makes the comparison difficult. This could help explain why an oscillating-rotating type of brush (very similar to the design which demonstrates its efficacy in the study by Clerehugh et al (1998) is not capable of significantly reduce gingival bleeding with respect to the manual brush in this study.

In general, in all the studies a slight reduction of gingivitis is observed (12 to 23% in the test group versus 15 to 2% in the control group), which can be related to the baseline gingival health of the individuals selected. In three of the studies healthy individuals were recruited, and only one included individuals with mild gingivitis (Table 7). This phenomenon is similarly observed in the plaque index, which showed slight reductions (1.8 – 32% test vs 5.1 – 28.5% control). It is difficult to explain the limited reduction of this parameter in the study by Wilcoxon et al (1991), in which after two months of treatment, with a monthly prophylaxis, a reduction of the pre-brushed plaque index of 1.8% was obtained in the group with a counter-rotational brush. Paradoxically in the same group the reduction of the post-brushed plaque index between the beginning of the study and the examination at 2 months was 56%.

There is a clear need for long-term trials in this field. We can conclude from the existing studies that there is limited evidence that orthodontic patients using a powered toothbrush show a slight, but significant, reduction of gingival bleeding or inflammation, compared with users of manual brushes. However, no conclusion can be made concerning the type of brush to be used.

C. EFFICACY OF THE TECHNIQUES AND PROCEDURES OF INTERPROXIMAL ORAL HYGIENE

The interdental area presents local conditions, which permit the establishment and maturity of bacterial plaque. This favors that both caries and periodontal disease are found predominantly in the interproximal spaces, for which reason an efficient interdental hygiene helps to reduce the extension and severity of both pathologies (Lang et al, 1998).

When we wish to evaluate the clinical efficacy of interproximal oral hygiene methods we have to do so bearing in mind that their use will be as a supplement to conventional brushing. In this sense, we have to analyze studies, which compare groups with identical techniques of manual tooth brushing, differing only in that the test group employs an additional technique of interdental hygiene.

On the other hand, if we wish to evaluate the repercussion on the patient in terms of measuring the gingival response, it is desirable that these results should be evaluated over the long term (Egelberg, 1999). This is the reason why, as we did previously with the use of the manual toothbrushes, we have selectively analyzed the results of studies lasting two months or longer (Jepsen, 1998).

Previous reviews suggest that according to short-term studies the majority of the methods of interproximal oral hygiene appeared to be effective (Egelberg, 1999; Kinane, 1998). In this way, various studies demonstrated the existence of a significant additional effect on the control of interdental plaque when using dental floss or interproximal brushes that could be estimated as a reduction from 3 to 32% for the former and from 2 to 57% for the latter. Yet the results of the index of gingival bleeding or inflammation, although following the same tendency (reduction from 3 to 34% for the dental floss, and 2.5 to 37% for the interdental brushes), are not as clear from the statistical point of view (Herrera and Roldán, 2003).

When we analyzed the long-term studies (only two in Table 8) we observed that although these tendencies appear to be confirmed, the little information that we have available makes it difficult to arrive at firm conclusions. Only in one of these was a significantly comparative reduction of the plaque observed in the group that used dental floss, which was accompanied by a non-significant reduction of the gingivitis (Lobene et al, 1982). This reduction in the plaque index is not detected in the study by Finkelstein et al (1990), probably due to the use of a global plaque index, and because the evaluations were made after twelve hours without brushing, and only a significant reduction of the gingivitis is observed in the group of patients who used interdental brushes, when the data are evaluated with specific interproximal gingival indexes (Finkelstein et al, 1990). This reduction, when the gingival response is evaluated with a general index such as the modified Löe and Silness index is not detected (Table 8).

Dental floss is the most commonly employed method, although a third of the population does not use this method according to the various epidemiological studies reviewed by Herrera and Roldán (Herrera and Roldán, 2003). A considerable diversity of types and forms of application exists, although significant differences have not been detected among the different variations of den-

Table 7 Studies which compare the efficacy of the use of manual versus powered toothbrushes made in patients with fixed orthodontic appliances

Study	Duration/Patients	Indices	Groups	B-G baseline	B-G end of study	B-G end of study Reduction	%B-G reduction	% PL Reduction
Clerehugh et al, 1998	2 months/(79 patients, 10 – 20 years). Mild gingivitis. Full mouth fixed orthodontics	EBI OPLI	Test: Braun-Oral – B D 5® (orthodontic head). Control: Reach Compact Medium® manual toothbrush	0.74 0.69	0.65 0.67	0.09 0.02	12.2% 2.9% ♦	32.0% 28.5%
Heasman et al, 1998	1 month**/(60 patients, 10 – 16 years). Healthy. Full mouth fixed orthodontics	GBI (%) VPI	Test 1: Phillips Hp 550®. Test 2: Braun-Oral – B D 7® (orthodontic head). Control: Oral-B P-35® manual toothbrush	26% 26% 26%	19% 20% 21%	7 6 5	27.0% 23.1% 19.2%	* * *
White 1996	3 months/(32 adolescent patients). Healthy. Full mouth fixed orthodontics	MPBI HAI	Test: Sonicare®. Control: Oral-B Advantage control grip® manual toothbrush	1.74 1.57	1.34 1.81	0.40 0.24	23.0% – 15.3% ♦	18.4% 6.1% ♦
Wilcoxon et al, 1991	2 months++/(20 patients, 12 – 53 years). Healthy. Full mouth fixed orthodontics. Baseline and monthly prophylaxis	RI mOPCR	Test: Interplak®. Control: Oral-B 15® manual toothbrush	55.7 60.8	49.0 62.0	6.7 1.2	12.0% 2.0% ♦	1.8% 5.1%

Abbreviations:
B-G: Bleeding or gingivitis. *: No full mouth data. ♦: Statistically significant difference between test and control (numbers in bold indicate the most favorable result).**: A 12-week crossover study with three parallel groups. Prophylaxis as wash-out period. Only information for the first month is included.
++: A 16-week crossover study with two parallel groups. Only information of the first 8 weeks is included.
EBI: Eastman interdental bleeding index. OPLI: Orthodontic modification of the Silness and Löe plaque index (PII). GBI: Ainamo and Bay modified gingival bleeding index. VPI: Ainamo and Bay visible plaque index. MPBI: modified papillary bleeding index. HAI: Hygiene analysis index. RI: Ramfjord gingival index. mOPCR: Modified O'Leary plaque control record.
Braun O. B D5®: Oscillating-rotating electric brush (Braun Oral B D5®). Braun O. B D7®: Oscillating-rotating electric brush (Braun Oral B D7®). Phillips Hp 550®: Oscillating electric brush, with brush head movements in two directions and at two speeds simultaneously. Sonicare®: Sonic electric brush (Sonicare®). Interplak®: Counter-rotational electric brush (Interplak®).

tal floss, a lesser efficacy has been seen with the Superfloss® in patients with closed spaces. Different additives (fluor, chlorhexidine, pyrophosphates) do not appear to provide greater efficacy (Egelberg, 1999; Herrera and Roldán, 2003).

An evaluation of the efficacy of the use of dental floss or interdental brushes as a method of interproximal hygiene is of special interest in periodontics, and we only have long-term data in the study made by Finkelstein et al (1991) in non-periodontal patients, in which a significantly greater reduction of the interproximal bleeding is observed (Table 8). However, this aspect is evaluated in four short-term studies (Bergenholtz and Olsson, 1984; Christou et al, 1998; Kiger et al, 1991; Mauriello et al, 1987) reviewed by Herrera and Roldán (2003). Of these, the three studies made in periodontal patients (Bergenholtz and Olsson, 1984; Christou et al, 1998; Kiger et al, 1991), concluded that the use of interdental brushes is more efficient than the use of dental floss in the removal of interproximal plaque.

In relation to gingivitis, a clear tendency toward a greater response is observed in the gingival parameters of the patients who used interdental brushes, which were not statistically significant, possibly due to the short follow-up time. No adverse gingival effects were detected, and the preference of this type of patients for interdental brushes was observed. This appears to suggest a preference for interdental brushes in patients with wide interproximal spaces and in periodontal patients (Egelberg 1999; Herrera and Roldán, 2003). In the same way, when comparing Superfloss® with conventional dental floss in periodontal patients, or in patients with open embrasures, we found that, as opposed to persons with closed spaces, Superfloss® appeared to be more effective in removing interproximal plaque (Spindel and Person, 1987; Wong and Wade, 1985).

An alternative for improving the efficacy of interproximal dental hygiene has been the design of electrical interdental brushes (Cronin and Dembling, 1996; Cronin et al, 1997; Gordon et al, 1996; Isaacs et al, 1999; Schmage et al, 1999). However, up to the present, the studies conducted have not been able to demonstrate a greater efficacy than dental floss.

In conclusion and in accordance with previous reviews (Egelberg, 1999; Herrera and Roldán, 2003; Kinane, 1998), the techniques of interproximal hygiene (fundamentally the use of toothpick, dental floss and interproximal brushes) appear to add additional benefits, in terms of plaque reduction, when they are associated with conventional manual brushes. Further long-term studies are necessary to confirm their efficacy in the reduction of gingival bleeding or inflammation. The choice of the type of technique must be made in relation to the characteristics of the patient: dental floss could be indicated in individuals with closed interdental spaces, and interproximal brushes in periodontal patients, or in those with open embrasures.

Table 8 Long-term randomized studies comparing the efficacy of manual tooth brushing, with and without interproximal oral hygiene measures, in terms of the reduction of gingival bleeding or inflammation and dental plaque

Study	Duration/Patients	Indices	Groups	Plaque Baseline	Plaque Final	% Plaque Reduction	GI Baseline	GI Final	% GI Reduction
Finkelstein et al, 1990	3 months/5 groups* (158 patients). Healthy adults	Global PI ModGI(EBI)	1.- MTB	12.3%	5.9%	52.0%	0.19 (0.58)	0.15 (0.41)	21.1 (29.3)%
			2.- MTB + WDF	12.0%	5.5%	54.9%	0.18 (0.62)	0.13 (0.36)	27.8 (41.9)%
			3.- MTB + ITB	13.0%	5.9%	52.0%	0.17 (0.62)	0.13 (0.21)	23.5 (66.1◆)%
Lobene et al, 1982	2 months/4 groups (118 patients). Adults with gingivitis. Previous prophylaxis	Q-HPI GI	1.- MTB	0	1.0152	0%**	0.92	0.82	10.8%
			2.- MTB + WDF	0	0.9416	6.9%**◆	0.96	0.69	27.8%
			3.- MTB + UDF	0	0.8357	17.7%**◆	0.94	0.66	29.7%
			4.- MTB * MDF	0	0.9215	8.9%**◆	0.94	0.63	32.4%

Abbreviations:
Groups 4 (Listerine) and 5 (Cepacol), not included in this table.
** Reduction in plaque accumulation as compared with MTB alone. ◆: $P < 0.05$
MTB: Manual toothbrush. WDF: waxed dental floss. ITB: Interdental toothbrush. UDF: Unwaxed dental floss. MDF: Mint dental floss.
Global PI. ModGI: Modified Löe and Silness gingival index. EBI: Eastman interdental bleeding index. Q-HPI: Quigley and Hein plaque index. GI: Löe and Silness gingival index.

SUMMARY AND CONCLUSIONS

In regard to the limited literature on the subject, and the contradictions observed, we can not conclude that the types of manual brushes produce clinically important effects on the patients' gingival health, or that these effects can be detected consistently. However, the best results have been obtained with new brush designs, and future studies are necessary to clarify the existing contradictions. There is a clear need of long-term studies which comparatively evaluate the ability to reduce gingivitis and plaque with the newly designed brushes.

On the other hand, there is evidence that supports the use of powered toothbrushes in the general population, especially those of the oscillating-rotating and counter-rotational type, as they have shown their ability to reduce gingival bleeding or inflammation, and dental plaque with greater efficacy than manual brushes.

There is a clear need of long-term trials on the efficacy of powered brushes in orthodontic patients. With the existing studies we can conclude that there is limited evidence that orthodontic patients using a powered toothbrush show a slight, but significant, reduction of bleeding, compared with users of manual brushes. No conclusion can be made concerning the type of brush to be used.

The techniques of interproximal oral hygiene, fundamentally the use of dental floss and interproximal brushes, appear to add additional benefits, in terms of plaque reduction, when they are associated with conventional manual brushes. Further long-term studies are necessary to confirm their efficacy in the reduction of gingival bleeding or inflammation. The choice of the type of technique must be made in relation to the characteristics of the patient: dental floss could be indicated in individuals with closed interdental spaces, and interproximal brushes in periodontal patients, or in those with open embrasures.

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