

Powered versus manual toothbrushing for oral health (Review)

Yaacob M, Worthington HV, Deacon SA, Deery C, Walmsley AD, Robinson PG, Glenny AM



**THE COCHRANE
COLLABORATION®**

This is a reprint of a Cochrane review, prepared and maintained by The Cochrane Collaboration and published in *The Cochrane Library* 2014, Issue 6

<http://www.thecochranelibrary.com>

WILEY

TABLE OF CONTENTS

HEADER	1
ABSTRACT	1
PLAIN LANGUAGE SUMMARY	2
SUMMARY OF FINDINGS FOR THE MAIN COMPARISON	4
BACKGROUND	6
OBJECTIVES	7
METHODS	7
RESULTS	11
Figure 1.	12
Figure 2.	15
Figure 3.	16
Figure 4.	21
Figure 5.	22
DISCUSSION	23
AUTHORS' CONCLUSIONS	24
ACKNOWLEDGEMENTS	25
REFERENCES	25
CHARACTERISTICS OF STUDIES	36
DATA AND ANALYSES	93
Analysis 1.1. Comparison 1 All powered toothbrushes versus manual toothbrushes, Outcome 1 Plaque scores at 1 to 3 month at all sites.	97
Analysis 1.2. Comparison 1 All powered toothbrushes versus manual toothbrushes, Outcome 2 Gingival scores at 1 to 3 months at all sites.	100
Analysis 1.3. Comparison 1 All powered toothbrushes versus manual toothbrushes, Outcome 3 Plaque scores at >3 months.	103
Analysis 1.4. Comparison 1 All powered toothbrushes versus manual toothbrushes, Outcome 4 Gingival scores at >3 months.	104
Analysis 2.1. Comparison 2 Side to side powered toothbrushes versus manual toothbrushes, Outcome 1 Plaque scores at 1 to 3 month at all sites.	106
Analysis 2.2. Comparison 2 Side to side powered toothbrushes versus manual toothbrushes, Outcome 2 Gingival scores at 1 to 3 months at all sites.	107
Analysis 2.3. Comparison 2 Side to side powered toothbrushes versus manual toothbrushes, Outcome 3 Plaque scores at >3 months.	108
Analysis 2.4. Comparison 2 Side to side powered toothbrushes versus manual toothbrushes, Outcome 4 Gingival scores at >3 months.	109
Analysis 3.1. Comparison 3 Counter oscillation powered toothbrushes versus manual toothbrushes, Outcome 1 Plaque scores at 1 to 3 month at all sites.	110
Analysis 3.2. Comparison 3 Counter oscillation powered toothbrushes versus manual toothbrushes, Outcome 2 Gingivitis scores at 1 to 3 months at all sites.	111
Analysis 3.3. Comparison 3 Counter oscillation powered toothbrushes versus manual toothbrushes, Outcome 3 Plaque scores at >3 months.	112
Analysis 3.4. Comparison 3 Counter oscillation powered toothbrushes versus manual toothbrushes, Outcome 4 Gingival scores at >3 months.	113
Analysis 4.1. Comparison 4 Rotation oscillation powered toothbrushes versus manual toothbrushes, Outcome 1 Plaque scores at 1 to 3 month at all sites.	114
Analysis 4.2. Comparison 4 Rotation oscillation powered toothbrushes versus manual toothbrushes, Outcome 2 Gingival scores at 1 to 3 months at all sites.	116
Analysis 4.3. Comparison 4 Rotation oscillation powered toothbrushes versus manual toothbrushes, Outcome 3 Plaque scores at >3 months.	118
Analysis 4.4. Comparison 4 Rotation oscillation powered toothbrushes versus manual toothbrushes, Outcome 4 Gingival scores at >3 months.	119

Analysis 5.1. Comparison 5 Circular powered toothbrushes versus manual toothbrushes, Outcome 1 Plaque scores at 1 to 3 month at all sites.	121
Analysis 5.2. Comparison 5 Circular powered toothbrushes versus manual toothbrushes, Outcome 2 Gingival scores at 1 to 3 months at all sites.	122
Analysis 6.1. Comparison 6 Ionic toothbrushes versus manual toothbrushes, Outcome 1 Plaque scores at 1 to 3 months.	123
Analysis 6.2. Comparison 6 Ionic toothbrushes versus manual toothbrushes, Outcome 2 Plaque scores at >3 months at all sites.	124
Analysis 6.3. Comparison 6 Ionic toothbrushes versus manual toothbrushes, Outcome 3 Gingivitis at 1 to 3 months.	124
Analysis 6.4. Comparison 6 Ionic toothbrushes versus manual toothbrushes, Outcome 4 Gingival scores at >3 months at all sites.	125
Analysis 7.1. Comparison 7 Ultrasonic powered toothbrushes versus manual toothbrushes, Outcome 1 Plaque scores at 1 to 3 month at all sites.	126
Analysis 7.2. Comparison 7 Ultrasonic powered toothbrushes versus manual toothbrushes, Outcome 2 Gingival scores at 1 to 3 months at all sites.	127
Analysis 7.3. Comparison 7 Ultrasonic powered toothbrushes versus manual toothbrushes, Outcome 3 Plaque scores at >3 months at all sites.	128
Analysis 7.4. Comparison 7 Ultrasonic powered toothbrushes versus manual toothbrushes, Outcome 4 Gingival scores at >3 months.	128
Analysis 8.1. Comparison 8 Unknown or other action versus manual toothbrushes, Outcome 1 Plaque scores at 1 to 3 months at all sites.	129
Analysis 8.2. Comparison 8 Unknown or other action versus manual toothbrushes, Outcome 2 Gingival scores at 1 to 3 months at all sites.	130
Analysis 8.3. Comparison 8 Unknown or other action versus manual toothbrushes, Outcome 3 Gingival scores >3 months at all sites.	130
ADDITIONAL TABLES	130
APPENDICES	134
WHAT'S NEW	138
HISTORY	138
CONTRIBUTIONS OF AUTHORS	139
DECLARATIONS OF INTEREST	139
SOURCES OF SUPPORT	139
INDEX TERMS	140

[Intervention Review]

Powered versus manual toothbrushing for oral health

Munirah Yaacob¹, Helen V Worthington², Scott A Deacon³, Chris Deery⁴, A Damien Walmsley⁵, Peter G Robinson⁶, Anne-Marie Glenn²

¹Department of Periodontics, Kulliyah of Dentistry, International Islamic University Malaysia (IIUM), Kuantan, Malaysia. ²Cochrane Oral Health Group, School of Dentistry, The University of Manchester, Manchester, UK. ³South West Cleft Unit, Frenchay Hospital, Bristol, UK. ⁴Department of Oral Health and Development, University of Sheffield, Sheffield, UK. ⁵Department of Prosthetic Dentistry, School of Dentistry, Birmingham, UK. ⁶School of Clinical Dentistry, University of Sheffield, Sheffield, UK

Contact address: Helen V Worthington, Cochrane Oral Health Group, School of Dentistry, The University of Manchester, Coupland III Building, Oxford Road, Manchester, M13 9PL, UK. helen.worthington@manchester.ac.uk.

Editorial group: Cochrane Oral Health Group.

Publication status and date: New search for studies and content updated (no change to conclusions), published in Issue 6, 2014.

Review content assessed as up-to-date: 23 January 2014.

Citation: Yaacob M, Worthington HV, Deacon SA, Deery C, Walmsley AD, Robinson PG, Glenn AM. Powered versus manual toothbrushing for oral health. *Cochrane Database of Systematic Reviews* 2014, Issue 6. Art. No.: CD002281. DOI: 10.1002/14651858.CD002281.pub3.

Copyright © 2014 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.

ABSTRACT

Background

Removing dental plaque may play a key role maintaining oral health. There is conflicting evidence for the relative merits of manual and powered toothbrushing in achieving this. This is an update of a Cochrane review first published in 2003, and previously updated in 2005.

Objectives

To compare manual and powered toothbrushes in everyday use, by people of any age, in relation to the removal of plaque, the health of the gingivae, staining and calculus, dependability, adverse effects and cost.

Search methods

We searched the following electronic databases: the Cochrane Oral Health Group's Trials Register (to 23 January 2014), the Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2014, Issue 1), MEDLINE via OVID (1946 to 23 January 2014), EMBASE via OVID (1980 to 23 January 2014) and CINAHL via EBSCO (1980 to 23 January 2014). We searched the US National Institutes of Health Trials Register and the WHO Clinical Trials Registry Platform for ongoing trials. No restrictions were placed on the language or date of publication when searching the electronic databases.

Selection criteria

Randomised controlled trials of at least four weeks of unsupervised powered toothbrushing versus manual toothbrushing for oral health in children and adults.

Data collection and analysis

We used standard methodological procedures expected by The Cochrane Collaboration. Random-effects models were used provided there were four or more studies included in the meta-analysis, otherwise fixed-effect models were used. Data were classed as short term (one to three months) and long term (greater than three months).

Powered versus manual toothbrushing for oral health (Review)

Copyright © 2014 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.

1

Main results

Fifty-six trials met the inclusion criteria; 51 trials involving 4624 participants provided data for meta-analysis. Five trials were at low risk of bias, five at high and 46 at unclear risk of bias.

There is moderate quality evidence that powered toothbrushes provide a statistically significant benefit compared with manual toothbrushes with regard to the reduction of plaque in both the short term (standardised mean difference (SMD) -0.50 (95% confidence interval (CI) -0.70 to -0.31); 40 trials, n = 2871) and long term (SMD -0.47 (95% CI -0.82 to -0.11; 14 trials, n = 978). These results correspond to an 11% reduction in plaque for the Quigley Hein index (Turesky) in the short term and 21% reduction long term. Both meta-analyses showed high levels of heterogeneity ($I^2 = 83%$ and $86%$ respectively) that was not explained by the different powered toothbrush type subgroups.

With regard to gingivitis, there is moderate quality evidence that powered toothbrushes again provide a statistically significant benefit when compared with manual toothbrushes both in the short term (SMD -0.43 (95% CI -0.60 to -0.25); 44 trials, n = 3345) and long term (SMD -0.21 (95% CI -0.31 to -0.12); 16 trials, n = 1645). This corresponds to a 6% and 11% reduction in gingivitis for the Löe and Silness index respectively. Both meta-analyses showed high levels of heterogeneity ($I^2 = 82%$ and $51%$ respectively) that was not explained by the different powered toothbrush type subgroups.

The number of trials for each type of powered toothbrush varied: side to side (10 trials), counter oscillation (five trials), rotation oscillation (27 trials), circular (two trials), ultrasonic (seven trials), ionic (four trials) and unknown (five trials). The greatest body of evidence was for rotation oscillation brushes which demonstrated a statistically significant reduction in plaque and gingivitis at both time points.

Authors' conclusions

Powered toothbrushes reduce plaque and gingivitis more than manual toothbrushing in the short and long term. The clinical importance of these findings remains unclear. Observation of methodological guidelines and greater standardisation of design would benefit both future trials and meta-analyses.

Cost, reliability and side effects were inconsistently reported. Any reported side effects were localised and only temporary.

PLAIN LANGUAGE SUMMARY

Powered/electric toothbrushes compared to manual toothbrushes for maintaining oral health

Review question

This review has been conducted to assess the effects of using a powered (or 'electric') toothbrush compared with using a manual toothbrush for maintaining oral health.

Background

Good oral hygiene, through the removal of plaque (a sticky film containing bacteria) by effective toothbrushing has an important role in the prevention of gum disease and tooth decay. Dental plaque is the primary cause of gingivitis (gum inflammation) and is implicated in the progression to periodontitis, a more serious form of gum disease that affects the tissues that support the teeth. The build up of plaque can also lead to tooth decay. Both gum disease and tooth decay are the primary reasons for tooth loss.

There are numerous different types of powered toothbrushes available to the public, ranging in price and mode of action. Different powered toothbrushes work in different ways (such as moving from side to side or in a circular motion). Powered toothbrushes also vary drastically in price. It is important to know whether powered toothbrushes are more effective at removing plaque than manual toothbrushes, and whether their use reduces the inflammation of the gums (gingivitis) and prevents or slows the progression of periodontitis.

Study characteristics

Authors from the Cochrane Oral Health Group carried out this review of existing studies and the evidence is current up to 23 January 2014. It includes 56 studies published from 1964 to 2011 in which 5068 participants were randomised to receive either a powered toothbrush or a manual toothbrush. Majority of the studies included adults, and over 50% of the studies used a type of powered toothbrush that had a rotation oscillation mode of action (where the brush head rotates in one direction and then the other).

Key results

The evidence produced shows benefits in using a powered toothbrush when compared with a manual toothbrush. There was an 11% reduction in plaque at one to three months of use, and a 21% reduction in plaque when assessed after three months of use. For gingivitis, there was a 6% reduction at one to three months of use and an 11% reduction when assessed after three months of use. The benefits of this for long-term dental health are unclear.

Few studies reported on side effects; any reported side effects were localised and only temporary.

Quality of the evidence

The evidence relating to plaque and gingivitis was considered to be of moderate quality.

SUMMARY OF FINDINGS FOR THE MAIN COMPARISON *[Explanation]*

Powered toothbrushes compared with manual toothbrushes for oral health						
Patient or population: Individuals of any age with no reported disability that might affect toothbrushing Intervention: Powered toothbrushes with any mode of action Comparison: Manual toothbrushes						
Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Manual toothbrush	Powered toothbrush				
Plaque scores at 1 to 3 months Scale from: 0 to 5	The mean plaque score in the control group was 2.16 points ¹	The mean plaque score in the intervention groups was 0.23 lower (0.32 lower to 0.14 lower)		2871 (40 studies)	⊕⊕⊕○ moderate ^{3,4}	This effect represents an 11% reduction in plaque at 1 to 3 months Long-term data (>3 months) also showed a statistically significant reduction in plaque for powered toothbrushes compared to manual toothbrushes
Gingival scores at 1 to 3 months Scale from: 0 to 3	The mean gingivitis score in the control group was 1.1 points ²	The mean gingivitis score in the intervention groups was 0.07 lower (0.10 lower to 0.04 lower)		3345 (44 studies)	⊕⊕⊕○ moderate ^{3,4}	This effect represents a 6% reduction in gingivitis at 1 to 3 months Long-term data (>3 months) also showed a statistically significant reduction in gingivitis for powered toothbrushes compared to manual toothbrushes

Adverse events

There was no apparent relationship between the use of powered toothbrushes and soft tissue trauma. In part this finding was due to the very small number of adverse events reported in the trials

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI)

CI: confidence interval

GRADE Working Group grades of evidence

High quality: Further research is very unlikely to change our confidence in the estimate of effect

Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate

Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate

Very low quality: We are very uncertain about the estimate

1. Based on median of control means for all trials presenting data using Quigley Hein index at 1 to 3 months
2. Based on median of control means for all trials presenting data using Löe and Silness index at 1 to 3 months
3. Downgraded due to statistically significant heterogeneity ($I^2 = 83\%$ for plaque; $I^2 = 82\%$ for gingivitis)
4. No downgrading was undertaken for risk of bias although 46/56 included trials were assessed as being at unclear risk of bias. Given that many of the studies were conducted over 10 years ago, it was felt much of the uncertainty may be due to poor reporting

BACKGROUND

Description of the condition

Periodontal diseases

Periodontal diseases are a diverse family of oral health conditions affecting the periodontium. As the most prevalent periodontal diseases, gingivitis and periodontitis are of major public health importance. Dental plaque is the primary cause of gingivitis (gum inflammation), which is recognised by redness of the gums at the junction with the teeth, together with slight swelling and bleeding from the gingival margin (Farina 2013). Globally, 80% to 90% of adolescents between 15 and 19 years of age have mild to moderate gingivitis, rising to 92% to 97% in adults between 35 and 44 (Petersen 2012).

Gingivitis can progress to involve the periodontal membrane (periodontitis). A pocket between the gingiva and the tooth forms, and with further destruction bone supporting the tooth is eroded. Eventually the tooth becomes mobile and can be lost. This is a slow process and is related to the amount of plaque and calculus present on the tooth surface, mediated by genetic factors, age, and lifestyle choices such as smoking (British Society of Periodontology 2012). Severe periodontitis is the sixth most prevalent condition, affecting 11% of the global population (Marcenes 2013) and tooth loss as a result is found in 5% to 20% of most adult populations worldwide (Petersen 2005).

Dental caries

Caries (decay) in permanent teeth is the most prevalent disease worldwide, with a global prevalence of 35% for all ages combined (Marcenes 2013). Whilst in high-income countries the prevalence of caries has decreased over the past decade, in lower- and middle-income countries (LMICs) the incidence is increasing due to population growth, an aging population, changing diets and inadequate exposure to fluorides (Marcenes 2013). In the United Kingdom (UK), 85% of adults have at least one filling (Steele 2011) and 31% have obvious untreated caries (White 2011).

The presence of plaque (biofilm) on the tooth is necessary for the development of caries. Like periodontal disease, caries has a complex aetiology, being an interaction between lifestyle, particularly diet and fluoride use, together with host factors. Although the relationship between the presence of plaque and caries is not as clear as with gingivitis, there is clear evidence that the presence of plaque makes teeth more at risk of caries. Zenkner 2013 demonstrated that on erupting teeth with visible plaque accumulation were 14.5 times more likely to have caries than teeth without the presence of visible plaque.

Over twice as many adults who reported not brushing their teeth have caries compared to those who report brushing their teeth

twice a day (White 2011). Almost all people in industrialised countries use fluoride toothpaste. When teeth are brushed with a fluoride toothpaste there is clear evidence that this is effective at preventing caries (White 2011) and that this is overall more important than brushing per se (Chesters 1992).

Description of the intervention

Powered versus manual toothbrushing for oral health

Good oral hygiene (the removal of plaque or biofilm from the tooth and gums) by effective toothbrushing has a key role in oral health. In general, populations of high-income countries have adopted regular toothbrushing (Albertsson 2010). There is, however, substantial within-country variation correlating strongly with educational level (Chen 1997). Toothbrushing is much less frequent in LMICs but is again associated with social status indicators (McKittrick 2014).

Effective toothbrushing depends on a number of factors including motivation, knowledge and manual dexterity. Powered brushes simulate the manual motion of toothbrushes with lateral and rotary movements of the brush head. Brushes which operate at a higher frequency of vibration have also been introduced (Johnson 1994; Terezhalmay 1995b). Powered toothbrushes were first introduced commercially in the early 1960s (Chilton 1962a; Cross 1962; Elliot 1963; Hoover 1962) and have become established as an alternative to manual methods of toothbrushing. In the UK a quarter of adults report using a powered toothbrush (Chadwick 2011) and use by children may be even higher (White 2004).

How the intervention might work

Dental plaque is the primary cause of gingivitis and is implicated in the progression of periodontitis. Therefore more effective removal of plaque by a powered toothbrush compared to a manual brush will reduce the inflammation of the gums (gingivitis), a benefit in itself, and in the long term may prevent or slow the progression of periodontitis and therefore maintain a functioning dentition for longer (Aspiras 2013).

There is a potential to reduce caries incidence by the effective removal of plaque (Zenkner 2013) but previous reviews on the effectiveness of powered toothbrushes have not identified any studies reporting this outcome (Deacon 2010; Robinson 2005).

Why it is important to do this review

Powered toothbrushes are popular and expensive compared to manual toothbrushes. However, the question remains, which is better, powered or manual? This is an update of the Cochrane review first published in 2003 and previously updated in 2005

comparing powered and manual toothbrushes (Heanue 2003; Robinson 2005). There is also a related review comparing the effectiveness of different designs of powered toothbrushes (Deacon 2010). However, the previous review comparing powered and manual toothbrushes was published in 2005, and there is a requirement to update that review to identify new evidence, and to include any evaluations of new designs of powered toothbrush introduced to the market.

OBJECTIVES

To compare manual and powered toothbrushes in everyday use, by people of any age, in relation to the removal of plaque, the health of the gingivae, staining and calculus, dependability, adverse effects and cost.

METHODS

Criteria for considering studies for this review

Types of studies

The review is confined to randomised controlled trials comparing manual and powered toothbrushes. It excludes trials only comparing different kinds of powered brushes or those comparing different kinds of manual brushes.

In the current update an agreement was made that cross-over trials were eligible for inclusion if the wash-out period length was more than two weeks. This was particularly important to diminish any carry-over effects of the different toothbrushes on clinical gingivitis. Split-mouth trials were excluded, as these were not considered representative of 'everyday use'.

Studies were included irrespective of publication status or language.

Types of participants

We included individuals of any age with no reported disability that might affect toothbrushing. We also included individuals wearing orthodontic appliances.

Types of interventions

The toothbrushes included in the review were all forms of manual brushes and all forms of powered brushes. Trials instituting combined interventions, e.g. brushing combined with the use of mouthrinse or irrigation, were excluded. However, trials where participants were permitted to continue with their usual adjuncts to oral hygiene, such as flossing, were included.

Trials were excluded where the brushing intervention was carried out or was supervised by a professional less than 28 days before a follow-up assessment.

Trials of 28 days and over were eligible and a subgroup analysis was carried out on the duration of trials for the different outcome measures.

Powered toothbrushes were divided into seven groups according to their mode of action.

1. Side to side action, indicates a brush head action that moves laterally from side to side.

2. Counter oscillation, indicates a brush action in which adjacent tufts of bristles (usually six to 10 in number) rotate in one direction and then the other, independently. Each tuft rotating in the opposite direction to that adjacent to it.

3. Rotation oscillation, indicates a brush action in which the brush head rotates in one direction and then the other.

4. Circular, indicates a brush action in which the brush head rotates in one direction.

5. Ultrasonic, indicates a brush action where the bristles vibrate at ultrasonic frequencies (> 20 kHz).

6. Ionic, indicates a brush that aims to impart an electrical charge to the tooth surface with the intent of disrupting the attachment of dental plaque.

7. Unknown, indicates a brush action that the review authors have been unable to establish based on the trial report or confirm with the manufacturers.

An additional group was added in a parallel review of the effectiveness of different powered brushes (Deacon 2010). This 'multi-dimensional group' included brushes with two of the above action types. Due to the limited number of trials conducted using this brush type, they were considered as part of the rotation oscillation group in this update.

It was agreed from the earlier reviews that analysis of filament arrangement, orientation, size, shape and flexibility, brush head size and shape along with presence or absence and characteristics of a timer would prove difficult to define across time and brush types.

Types of outcome measures

Primary outcomes

The primary outcome measures employed were quantified levels of plaque or gingivitis or both. Where possible, values recorded on arrival at the assessment were used. If necessary, measures of gingivitis taken after participants had been instructed or permitted to brush their teeth at the assessment visit were used as it was assumed that toothbrushing would not affect gingivitis within such a short period. However, measures of plaque taken after participants had been instructed or permitted to brush their teeth at the assessment visit were not used. It was assumed that plaque scores

achieved during toothbrushing under these circumstances would not reflect scores achieved in normal home use.

Secondary outcomes

Secondary outcome measures sought were levels of calculus and staining; dependability and cost of the brush used, including mechanical deterioration; and adverse effects such as hard or soft tissue injury and damage to orthodontic appliances and prostheses. Future updates of this review will include caries as an outcome.

Search methods for identification of studies

For the identification of studies included or considered for this review, we developed a detailed search strategy for each database, based on the strategy developed for MEDLINE (OVID) but revised accordingly. The search strategy used a combination of controlled vocabulary and free text terms and was linked with the Cochrane Highly Sensitive Search Strategy (CHSSS) for identifying randomised trials (RCTs) in MEDLINE: sensitivity maximising version (2008 revision) as referenced in Chapter 6.4.11.1 and detailed in box 6.4.c of the *Cochrane Handbook for Systematic Reviews of Interventions*, Version 5.1.0 (updated March 2011) (Higgins 2011). Details of the MEDLINE search are provided in Appendix 3. The searches of EMBASE and CINAHL were linked to the Cochrane Oral Health Group filters for identifying RCTs.

Electronic searches

We searched the following electronic databases:

- the Cochrane Oral Health Group's Trials Register (to 23 January 2014) (Appendix 1);
- the Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2014, Issue 1) (Appendix 2);
- MEDLINE via OVID (1946 to 23 January 2014) (Appendix 3);
- EMBASE via OVID (1980 to 23 January 2014) (Appendix 4);
- CINAHL via EBSCO (1980 to 23 January 2014) (Appendix 5).

No restrictions were placed on the language or date of publication when searching the electronic databases.

Searching other resources

We searched the following databases for ongoing trials, see Appendix 6 for details of the search strategy:

- US National Institutes of Health Trials Register (<http://clinicaltrials.gov>) (to 23 January 2014);
- the WHO Clinical Trials Registry Platform (<http://apps.who.int/trialsearch/default.aspx>) (to 23 January 2014).

Only handsearching done as part of the Cochrane Worldwide Handsearching Programme and uploaded to CENTRAL was included (see the [Cochrane Masterlist](#) for details of journal issues searched to date).

All references cited in the included trials were checked for additional studies. Identified manufacturers were contacted and additional published or unpublished trial reports requested.

Data collection and analysis

Selection of studies

Two review authors independently reviewed the titles and abstracts identified in the search. If in the opinion of both authors an article clearly did not fulfil the defined inclusion criteria it was considered ineligible. We obtained full reports of all trials of possible relevance for assessment. On receipt of the full article, two review authors assessed each study independently using specifically designed data extraction forms. Disagreements were resolved by discussion with the review team.

Data extraction and management

For this update, piloting of data extraction was performed independently by two authors on eight pilot articles. However, all authors reported back on the design of the data extraction forms and their interpretation of the inclusion and exclusion criteria along with their understanding of the outcome measures and new risk of bias (ROB) assessment. On the basis of this feedback the data extraction forms were altered and the inclusion, exclusion, outcome measures and ROB assessment were redefined to avoid misinterpretation. All data extraction for the included studies was then undertaken independently and in duplicate.

The final data extraction protocol considered the following information.

1. Bibliographic details of the study.
2. Funding source for the trial. A trial was considered to have been funded by a brush manufacturer if it was reported that any material sponsorship from the manufacturer occurred, including the donation of brushes. It was considered unclear, if there was no statement on funding. A trial was only considered to be unsponsored by a manufacturer if it clearly stated so.
3. Inclusion eligibility.
4. Baseline characteristics of the participants in the study, including age, number of participants in the study and gender. Also, specific groups, such as dental students or orthodontic patients were noted, where mentioned.
5. Intervention characteristics including type of brush and its mode of action, duration of use and delivery of instructions.
6. Outcomes including plaque and gingivitis indices.

7. Additional information on a priori calculation of sample size, duration of study, reliability and validity of outcomes measures and monitoring of compliance.

Trials were considered as 'short term' or 'long term'. 'Short-term' data included follow-up between 28 days and three months. 'Long-term' data included follow-up beyond three months. Within each category of long term and short term, where a trial reported multiple end points, only the latest data were extracted.

Data from trials that reported follow-up before and after three months were included in the short- and long-term meta-analyses. Likewise, data from trials that reported both plaque and gingivitis would be included in meta-analyses for both outcomes. These were the only circumstances when data from the same trial were considered more than once.

Many different indices of plaque and gingivitis were used across trials and some trials reported multiple indices. A frequencies table was prepared of the indices used and they were ranked based on common usage and simplicity. For plaque we extracted, where possible, data reported as the Turesky modification of the Quigley-Hein plaque index (Quigley 1962; Turesky 1970). For gingival inflammation we extracted where possible data reported as the gingival index of Löe and Silness (Löe 1963) or, if unavailable, bleeding on probing (Ainamo 1975). Data for Russell's periodontal index were excluded because this index fails to distinguish between gingivitis and periodontitis (Russell 1967).

Where available, data were extracted for whole as opposed to part-mouth scores. Where only part-mouth scores were reported in a study, they were extracted and a sensitivity analysis carried out to consider their impact on the results of the review. Part-mouth scoring was said to have occurred if plaque or gingivitis or both were not recorded around all erupted teeth, except third molars. Completed data extraction forms were compared. Where there was disagreement between review authors with regard to any part of the extraction details it was resolved by discussion between the authors and a note made on the data collection forms. Any disagreement, unresolved between the two authors, was settled by majority vote of the entire panel of review authors. Authors were contacted for clarification where necessary.

Assessment of risk of bias in included studies

We conducted this assessment using the recommended approach for assessing risk of bias in included studies for Cochrane reviews (Higgins 2011). All included studies were assessed independently and in duplicate by two review authors as part of the data extraction process. The risk of bias tool evaluates six specific domains.

- Sequence generation (selection bias).
- Allocation concealment (selection bias).
- Blinding of outcome assessment (detection bias).
- Incomplete outcome data (attrition bias).
- Selective outcome reporting (reporting bias).
- Other sources of bias; comparability of groups at baseline.

Risk of bias assessment.

- A trial was considered to have adequately generated a random sequence of allocation, if it fully reported the type of allocation generation and it satisfied the CONSORT guidelines as true randomisation (<http://www.consort-statement.org/>).

- A trial was considered to have adequate blinding, if the report indicated that the method of outcome assessment did not allow the recording clinician to know to which group the participants had been allocated, with no other contradicting statement.

- Attrition was considered to have been adequately reported if there was a clear indication of how many withdrawals occurred in each group during the trial and an attempt made to give reasons why the withdrawals occurred.

The first part of the entry involved authors' describing what was reported in the study. The second part involved the authors' judgements of the adequacy of the study, that is, whether they are at low, high or unclear risk of bias. Numerical data extracted from the included trials were checked by a third author for accuracy and entered into Review Manager (RevMan) software (RevMan 2012).

Two risk of bias figures were generated to illustrate the findings of the assessment. A 'Risk of bias graph' illustrated the proportion of studies across the domain with each of the judgements ('low risk', 'high risk', 'unclear risk'). A 'Risk of bias summary' summarised all of the judgements for a study entry. We assumed that the risk of bias of outcomes was equally important both within and across studies. They were assessed as follows.

Low risk of bias	Interpretation	Within a study	Across studies
Low risk of bias	Plausible bias unlikely to seriously alter the results	Low risk of bias for all key domains	Most information is from studies at low risk of bias
Unclear risk of bias	Plausible bias that raises some doubt about the results	Unclear risk of bias for one or more key domains	Most information is from studies at low or unclear risk of bias

(Continued)

High risk of bias	Plausible bias that seriously weakens confidence in the results	High risk of bias for one or more key domains	The proportion of information from studies at high risk of bias is sufficient to affect the interpretation of results
-------------------	---	---	---

Measures of treatment effect

The estimate of effect used was the mean difference (MD) and corresponding 95% confidence intervals (CI). However, different indices for plaque measure the same concept on different scales, with high correlation between the different indices. The same is true for gingivitis. As it is not possible to combine the results from different indices, the effects were expressed as standardised values, which have no units, before combining. The standardised mean difference (SMD) was therefore calculated along with the appropriate 95% CI and was used as the effect measure for each meta-analysis where results were available for more than one index (Deeks 2001). Where only one index was presented in a comparison, the treatment effect was measured as the MD with 95% CI.

Unit of analysis issues

No units of analysis issues were anticipated other than cross-over studies which were included using the generic inverse variance (GIV) approach (Elbourne 2002; Higgins 2011).

Dealing with missing data

Trial authors were contacted to retrieve missing data where necessary. Data remain excluded until further clarification becomes available. Standard deviations were imputed as in section 7.7.3 of the *Cochrane Handbook for Systematic Reviews of interventions* (Higgins 2011).

Assessment of heterogeneity

We assessed heterogeneity by inspection of a graphical display of the estimated treatment effects from the trials along with their 95% CI and by Cochran's test for heterogeneity undertaken before each meta-analysis as described in the *Cochrane Handbook for Systematic Reviews of interventions* (Higgins 2011). The heterogeneity was quantified using the I^2 statistic, where a guide for interpretation in the *Cochrane Handbook for Systematic Reviews of interventions* is (Higgins 2011):

- 0% to 40%: might not be important;
- 30% to 60%: may represent moderate heterogeneity;
- 50% to 90%: may represent substantial heterogeneity;

- 75% to 100%: considerable heterogeneity.

Assessment of reporting biases

A funnel plot (plots of effect estimates versus the inverse of their standard errors) was drawn. Asymmetry of the funnel plot may indicate publication bias and other biases related to sample size, though it may also represent a true relationship between trial size and effect size. A formal investigation of the degree of asymmetry was performed using the method proposed by Egger et al (Egger 1997). This was carried out using Stata version 12.0 (Stata Corporation, USA) using the program Metabias.

Data synthesis

Statistical values such as SMD have no inherent clinical meaning. Therefore we back-translated key effect scores using the clinical indices from a study where the difference was similar to the SMD. Such examples are given in the Discussion. Random-effects models were performed where four or more studies were to be combined, otherwise fixed-effect models were used.

Data from cross-over trials were included with that of similar parallel group trials, using the techniques described by Elbourne and colleagues (Elbourne 2002). This was done using the generic inverse variance method within RevMan (Higgins 2011).

Subgroup analysis and investigation of heterogeneity

Subgroup analyses were undertaken for assessments based on full mouth recording versus those based on a partial recording and to examine the effects of concealed allocation, randomisation generation and blinded outcome assessment on the overall estimates of effect for important outcomes.

Additional subgroup analyses were undertaken to explore heterogeneity. Evidence of variability in any subgroup was further explored by examining funnel plots.

Sensitivity analysis

Sensitivity analyses were conducted to test whether the assumptions involved in the design of this review affected the findings. These analyses were undertaken by repeating the meta-analyses

in the following cases: where a full mouth index had been used, where adequate concealment of randomisation occurred, where there was adequate generation of randomisation sequence, where there was blinding of the outcome assessor, if the trial was funded by a manufacturer, with adequate information about attrition and for trials that were not restricted to participants only wearing fixed orthodontic appliances.

Presentation of main results

A GRADE approach was used to interpret findings. A 'Summary of findings' table was developed for the primary outcomes of this review using GRADE Profiler software (version 3.6). These tables provide information concerning the overall quality of the evidence

from the trials, the magnitude of effect of the interventions examined, and the sum of available data on the primary outcomes and secondary outcomes. The outcomes selected for inclusion in these tables were plaque and gingivitis at two time points.

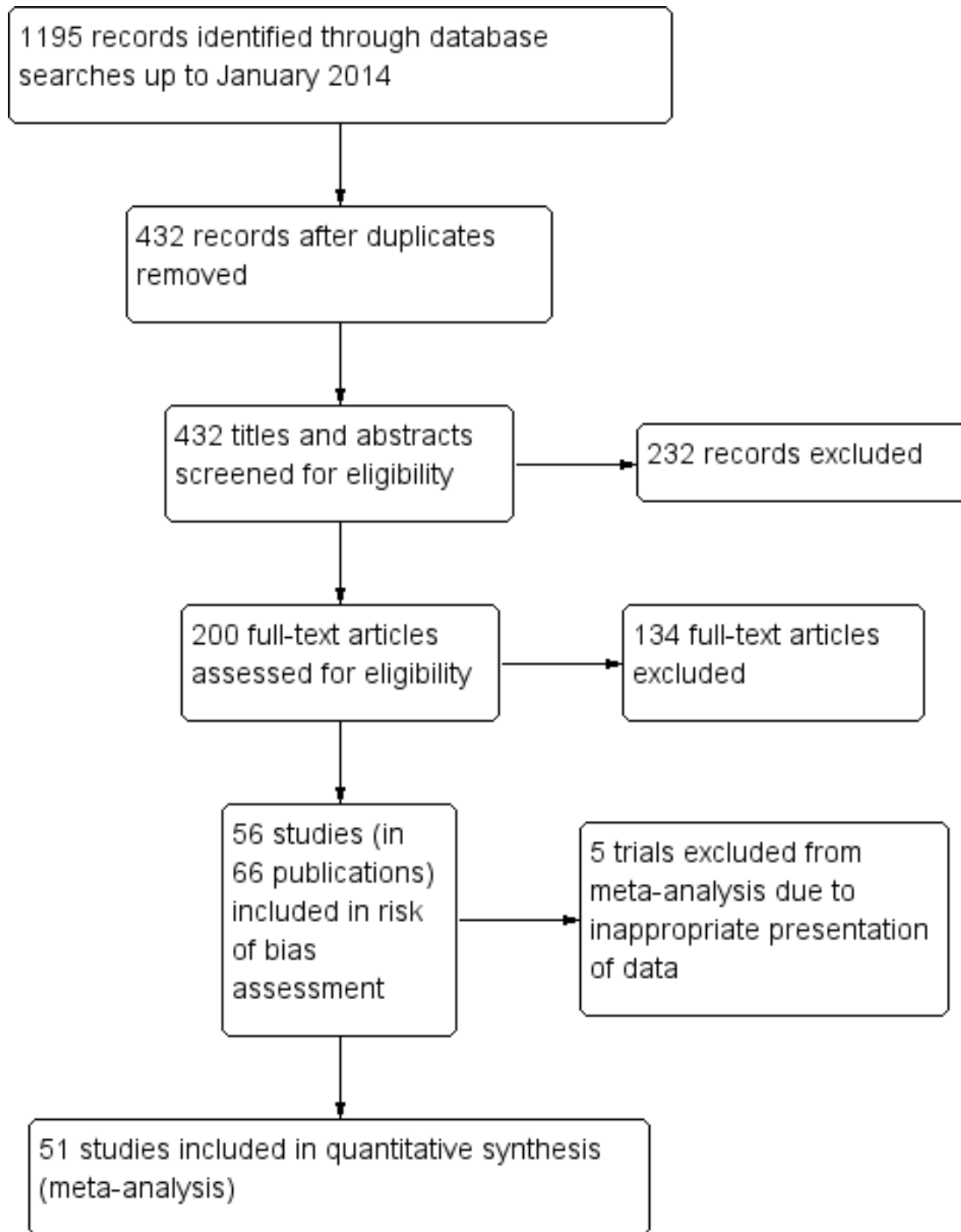
RESULTS

Description of studies

Results of the search

See [Figure 1](#).

Figure 1. Flow chart of study selection in this update.



This review was originally published in 2003, updated in 2005 and again for this version. Since its first publication to January 2014 a total of 1195 articles have been identified through the search strategy. After removing duplicates, this number falls to 432; titles and abstracts of these 432 articles were screened for eligibility. A total of 200 full-text articles were retrieved as potentially relevant trials. Of these, 134 were excluded ([Characteristics of excluded studies](#) table) leaving 56 trials, in 66 publications.

In the original review 29 trials, all providing data for meta-analysis, were included. In the 2005 update, an additional 10 trials were identified as meeting the inclusion criteria ([Galgut 1996](#); [Garcia-Godoy 2001](#); [Hickman 2002](#); [Pucher 1999](#); [Sharma 2000](#); [Soparkar 2000](#); [Sowinski 2000](#); [Toto 1966](#); [Van Swol 1996](#); [Zimmer 2002](#)). Data for three trials identified in the original search was received from the authors allowing their inclusion ([Haffajee 2001a](#); [Lapiere unpublished](#); [Singh unpublished](#)). Thus 42 trials were included in the 2005 publication.

In the current update, an additional 15 trials were identified as being eligible ([Biavati Silvestrini 2010](#); [Biesbrock 2007](#); [Costa 2007](#); [Dorfer 2009](#); [Goyal 2007](#); [Gugerli 2007](#); [Kallar 2011](#); [McCracken 2004](#); [McCracken 2009](#); [Moreira 2007](#); [Moritis 2008](#); [Rosema 2008](#); [Sharma 2010](#); [Silverman 2004](#); [Zimmer 2005](#)). Fourteen were parallel group designs and there was one cross-over trial ([Moreira 2007](#)). One trial included in the original review was excluded as it was not truly a randomised controlled trial ([McAllan 1976](#)), leaving a total of 56 trials included in this 2014 update. Of these 56 trials, five did not present data in a way that allowed for meta-analysis ([Costa 2007](#); [Galgut 1996](#); [Gugerli 2007](#); [Moreira 2007](#); [Zimmer 2005](#)). The meta-analyses are based on 51 trials with a parallel group design.

Included studies

Of the 56 included trials, 36 were conducted in North America ([Baab 1989](#); [Barnes 1993](#); [Biesbrock 2007](#); [Costa 2007](#); [Cronin 1998](#); [Dentino 2002](#); [Emling 1991](#); [Forgas-B 1998](#); [Garcia-Godoy 2001](#); [Glass 1965](#); [Goyal 2007](#); [Haffajee 2001a](#); [Ho 1997](#); [Johnson 1994](#); [Khocht 1992](#); [Lobene 1964a](#); [Moreira 2007](#); [O'Beirne 1996](#); [Pucher 1999](#); [Sharma 2000](#); [Sharma 2010](#); [Silverman 2004](#); [Singh unpublished](#); [Soparkar 1964](#); [Soparkar 2000](#); [Sowinski 2000](#); [Terezhalmly 1995a](#); [Toto 1966](#); [Tritten 1996](#); [Van Swol 1996](#); [Walsh 1989](#); [Warren 2001](#); [Wilson 1993](#); [Yankell 1996](#); [Yankell 1997](#); [Yukna 1993b](#)); 18 in Europe ([Ainamo 1997](#); [Biavati Silvestrini 2010](#); [Clerehugh 1998](#); [Dorfer 2009](#); [Galgut 1996](#); [Gugerli 2007](#); [Heasman 1999](#); [Hickman 2002](#); [Lapiere unpublished](#); [Lazarescu 2003](#); [McCracken 2004](#); [McCracken 2009](#); [Moritis 2008](#); [Rosema 2008](#); [Stoltze 1994](#); [van der Weijden 1994](#); [Zimmer 2002](#); [Zimmer 2005](#)), one each in Israel ([Stabholz 1996](#)) and in India ([Kallar 2011](#)).

Three trials remain unpublished ([Lapiere unpublished](#); [Lazarescu](#)

[2003](#); [Singh unpublished](#)). The remainder were published between 1964 and October 2011; four in the 1960s; one in the 1970s; two in the 1980s; 23 in the 1990s and 19 in the 20th century. At least 37 were funded in some part by the manufacturer of one of the powered toothbrushes, one was funded by government scholarship and the remainder were unclear about sponsorship.

The combined total number of participants included in the trials was 5068. The number of patients reported lost to follow-up was 334 (6.6%).

Characteristics of participants

The characteristics of participants in each study are noted in the [Characteristics of included studies](#) table and in Additional [Table 1](#). Out of the 56 included trials the four most frequently stated inclusion criteria were adults (77% of trials), no relevant medical history (55%), a stated minimum number of teeth (55%) and a criterion related to gingival or periodontal health or plaque at baseline (50%). Exclusion criteria used in the included trials were noted and are summarised in Additional [Table 2](#). Only seven trials included orthodontic patients ([Biavati Silvestrini 2010](#); [Clerehugh 1998](#); [Costa 2007](#); [Hickman 2002](#); [Ho 1997](#); [Pucher 1999](#); [Singh unpublished](#)).

Characteristics of interventions

The powered toothbrushes, included:

Braun, Interplak, Braun Plaque Remover with OD5 head, Braun Oral B Pro Care series, Oral B CrossAction, Braun Oral B Pro Care 8500, Braun Oral B D25, Braun Oral B 3D, Braun Oral B D9, PlaK Trac, Ultrasonex, GEC, Braun Oral B D7, Philips Jordan HP 735, Philips HP 550, Sonicare Ultrasonic, Philips Sonicare, Philips Sensiflex 2000, Philips Sonicare Elite, Epident, Braun Oral B D5, Philips 550, Touchtronic Teledyne Aqua Tec, Ronson, Dominion, Pulse Plaque Remover, Broxodent, Plaq and White, LPA/Broxox, Braun D17, Rowenta Dentiphant, Rowenta, Plaque Dentaccontrol Plus, Sangi Co Electronic, Braun Oral B D10, Braun Oral B D15 Plaque Remover, Braun Plaque Remover 3D with orthodontic head, Oral B Mickey Mouse, Hukuba Ionic, Colgate Actibrush, HyG Ionic, unspecified ionic, Ultra Sonex Ultima, Ultréo, Sunbeam cordless. These are summarised in Additional [Table 3](#).

Powered toothbrush, mode of action

The powered toothbrushes were subdivided into the seven groups according to their mode of action.

Side to side action

Philips Sonicare, Philips Sonicare Elite and Sonicare brushes (Sonicare c/o Philips Oral Healthcare, 35301 SE Center Street, Snoqualmie, WA 98065; <http://www.sonicare.com/>); Philips 550 (Philips Jordan, PO Box 324, 5500 AH Veldhoven, The Netherlands; <http://www.philips-jordan.com/>) and Philips Sensiflex 2000 (<http://www.philips.co.uk/c/electric-toothbrushes/sensiflex-hx1610-05/prd/>).

Counter oscillation

Interplak brush (Interplak Conair Corporation, 1 Cummings Point Road, Stamford, CT 06904; <http://www.conair.com/products/>).

Rotation oscillation

Oral B CrossAction, Braun Oral B 3D, D17, Plaque Remover with OD5 head, Oral B D9, Oral B D7, Oral B D5, Oral B D10, Oral B D25, Oral B Pro Care 8500, Oral B Mickey Mouse, Braun Plaque Remover 3D with orthodontic head, Braun Oral B D15 Plaque Remover (Braun Oral B Consumer Services, 1 Gillette Park, South Boston, MA; <http://www.oralb.com/>); Philips Jordan HP 735, Philips HP 550 (Philips Jordan PO Box 324, 5500 AH Veldhoven, The Netherlands; <http://www.philips-jordan.com/>); Colgate Actibrush (Consumer Affairs, Colgate-Palmolive (UK) Limited, Guildford Business Park, Middleton Road, Guildford, Surrey GU2 8JZ UK; <http://www.colgate.co.uk/contact/index.shtml>).

Circular

Rowenta Dentiphant, Rowenta, Plaque Dentacontrol Plus (Rowenta Werke GmbH, Franz Alban, Stützer, Germany; <http://www.products.rowenta.de/row/index.html>); Epident (EPI Products, Santa Monica, CA).

Ultrasonic

Ultrasonex brush, Ultra Sonex Ultima (Salton-Maxim 1801 N Stadium Boulevard, Columbia, MO 65202; <http://www.salton-maxim.com/salton/ultrasonex/ultrasonex.asp>) and Ultreo (<http://www.ultreo.com/meet-ultreo>), Oral B Pulsonic.

Ionic

Sangi Co Electronic (Tokyo), Hukuba Ionic and the HyG Ionic (Hukuba Dental Corporation, 914-1 Nazukari, Nagareyama, Chiba, 270-01 Japan).

Unknown

Some companies are no longer trading or complete details of the relevant toothbrushes are not easily found. The following toothbrushes fall into this latter category: PlaK Trac, GEC, Epident, Touchtronic, Ronson, Dominion, Broxodent, Plaq and White, LPA/Broxox, Sunbeam cordless.

The names and addresses of the manufacturers have changed over the years and those quoted above are correct at the time of the present review. Some of the trials were conducted when another company made the powered toothbrush.

Ten trials recruiting 988 participants compared manual brushing versus side to side powered toothbrushing. Five trials recruited 267 participants and compared manual brushing versus counter oscillating toothbrushing. Twenty-seven trials recruiting 2159 participants compared manual brushing versus rotation oscillation powered brushing. Two trials recruiting 162 participants compared manual brushing versus circular powered brushing and seven trials recruiting 506 participants compared manual brushing versus ultrasonic powered brushing. Four trials recruiting 221 participants compared manual brushing versus ionic brushing. Five trials recruiting 1130 participants compared manual brushing and a powered toothbrush with an unknown action. It should be noted that four trials evaluated two powered brushes (Costa 2007; Khocht 1992; Yankell 1997; Zimmer 2005).

Summary of trials by toothbrush action

See Additional Table 3 for list of trials by mode of action.

Characteristics of outcome measures

Forty trials (2871 participants at the end of the trials) provided data for analysis on plaque at one to three months and 14 trials (978 participants at the end of the trials) provided data at longer than three months. Forty-four trials (3345 participants at the end of the trials) provided data for analysis on gingivitis at one to three months and 16 trials (1645 participants at the end of the trials) provided data at longer than three months.

If it was not stated that a full or partial mouth index was used, we assumed it was full mouth. Fifty-four trials reported plaque data, and of these eight trials reported that a partial mouth assessment was used. Fifty-two trials reported gingivitis data and 10 of these reported using a partial mouth index.

The following plaque indices were reported.

- Quigley Hein (Turesky) (Barnes 1993; Cronin 1998; Dentino 2002; Dorfer 2009; Emling 1991; Forgas-B 1998; Garcia-Godoy 2001; Glass 1965; Haffajee 2001a; Heasman 1999; Johnson 1994; Kallar 2011; Khocht 1992; Lapiere unpublished; Lazarescu 2003; McCracken 2004; McCracken 2009; Pucher 1999; Rosema 2008; Silverman 2004; Sowinski 2000; Terezhalmay 1995a; Tritten 1996; Van Swol 1996; Warren 2001; Wilson 1993; Yankell 1996; Yankell 1997; Yukna 1993b; Zimmer 2002).

- Silness and Loe (Galgut 1996; Ho 1997; Moritis 2008; Stoltze 1994; van der Weijden 1994; Walsh 1989).
- Visible plaque index Ainamo Bay (Ainamo 1997).
- Ortho modification of Silness and Loe (Hickman 2002).
- Navy plaque index mod Rustogi (Biesbrock 2007; Sharma 2000; Sharma 2010).
- O'Leary index (Biavati Silvestrini 2010).

The following gingivitis indices were reported.

- Loe Silness (Baab 1989; Barnes 1993; Biesbrock 2007; Clerehugh 1998; Cronin 1998; Dorfer 2009; Emling 1991; Forgas-B 1998; Goyal 2007; Haffajee 2001a; Heasman 1999; Hickman 2002; Ho 1997; Johnson 1994; Khocht 1992; Lapiere unpublished; Moritis 2008; O'Beirne 1996; Pucher 1999; Sharma 2000; Silverman 2004; Singh unpublished; Soparkar 1964; Soparkar 2000; Stoltze 1994; Terezhalmly 1995a; Tritten 1996; Van Swol 1996; Walsh 1989; Warren 2001).
- Lobene gingival index (Dentino 2002; Glass 1965; Lobene 1964a; Sharma 2010; van der Weijden 1994; Yankell 1996; Yankell 1997; Yukna 1993b).
- Bleeding on probing (BOP) (0 to 1 scale) (Ainamo 1997; Biavati Silvestrini 2010; Lazarescu 2003; McCracken 2009; Wilson 1993).
- Papillary bleeding index (0 to 4 scale) (McCracken 2004; Zimmer 2002).
- Bleeding on marginal probing (BOMP) (0 to 2 scale)

(Rosema 2008).

- Papillary marginal attachment (PMA) (Toto 1966).

Excluded studies

The primary reason for the exclusion of each study is given in the [Characteristics of excluded studies](#) table. Many trials were ineligible for more than one reason, however the primary reason for exclusion was study duration of less than 28 days. Other reasons included a high potential for compromised self toothbrushing efficacy; combined interventions that did not allow for assessment of the effect of powered toothbrushing; split-mouth design; or insufficient information to determine whether inclusion criteria were met (in these situations authors have been contacted and if further information is supplied to confirm criteria for inclusion are met, the studies will be included in subsequent updates).

Risk of bias in included studies

See [Figure 2](#); [Figure 3](#). Fifty-six studies were assessed for risk of bias, including five that were not meta-analysed (Costa 2007; Galgut 1996; Gugerli 2007; Moreira 2007; Zimmer 2005). Overall, only five were assessed as being at low risk of bias (Clerehugh 1998; Haffajee 2001a; McCracken 2009; Sharma 2010; Silverman 2004). Five trials were assessed as being at high risk of bias (Glass 1965; Kallar 2011; Lazarescu 2003; Walsh 1989; Wilson 1993).

Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

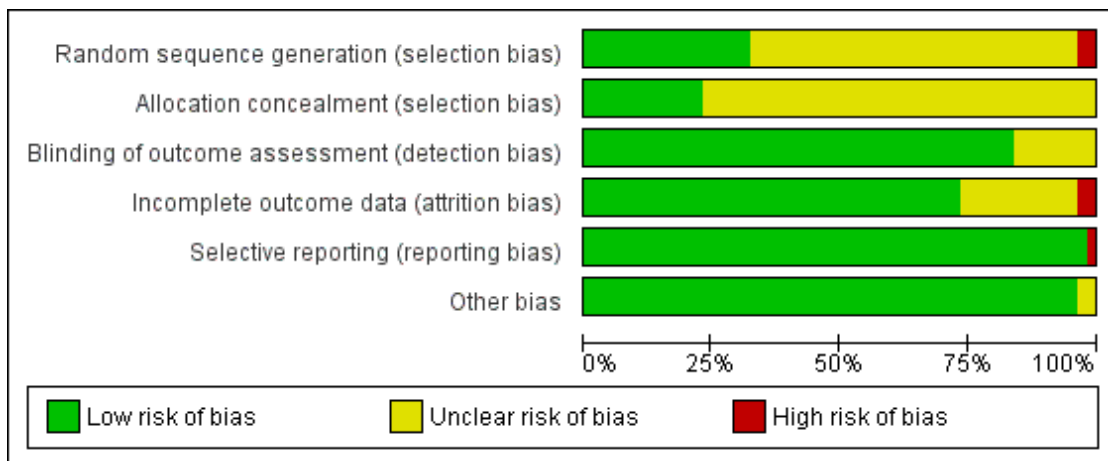


Figure 3. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Ainamo 1997	?	?	?	?	?	?
Baah 1989	?	?	?	?	?	?
Barnes 1993	?	?	?	?	?	?
Blavati Silvestrini 2010	?	?	?	?	?	?
Blesbrock 2007	?	?	?	?	?	?
Clerihugh 1998	?	?	?	?	?	?
Costa 2007	?	?	?	?	?	?
Cronin 1998	?	?	?	?	?	?
Dentino 2002	?	?	?	?	?	?
Dorfer 2009	?	?	?	?	?	?
Emling 1991	?	?	?	?	?	?
Forgas-B 1998	?	?	?	?	?	?
Galgud 1996	?	?	?	?	?	?
Garcia-Godoy 2001	?	?	?	?	?	?
Glass 1965	?	?	?	?	?	?
Goyal 2007	?	?	?	?	?	?
Gugeri 2007	?	?	?	?	?	?
Haffajee 2001a	?	?	?	?	?	?
Hearnman 1999	?	?	?	?	?	?
Hickman 2002	?	?	?	?	?	?
Ho 1997	?	?	?	?	?	?
Johnson 1994	?	?	?	?	?	?
Kallar 2011	?	?	?	?	?	?
Khocho 1992	?	?	?	?	?	?
Lapiere unpublished	?	?	?	?	?	?
Lazarescu 2003	?	?	?	?	?	?
Lobene 1964a	?	?	?	?	?	?
McCracken 2004	?	?	?	?	?	?
McCracken 2009	?	?	?	?	?	?
Moreira 2007	?	?	?	?	?	?
Moritis 2008	?	?	?	?	?	?
O'Beime 1996	?	?	?	?	?	?
Pucher 1999	?	?	?	?	?	?
Rosema 2008	?	?	?	?	?	?
Sharma 2000	?	?	?	?	?	?
Sharma 2010	?	?	?	?	?	?
Silverman 2004	?	?	?	?	?	?
Singh unpublished	?	?	?	?	?	?
Soparkar 1964	?	?	?	?	?	?
Soparkar 2000	?	?	?	?	?	?
Sowinski 2000	?	?	?	?	?	?
Stabholz 1996	?	?	?	?	?	?
Stoltze 1994	?	?	?	?	?	?
Terezhalmay 1995a	?	?	?	?	?	?
Toto 1966	?	?	?	?	?	?
Tritten 1998	?	?	?	?	?	?
van der Weijden 1994	?	?	?	?	?	?
Van Swol 1996	?	?	?	?	?	?
Walsh 1989	?	?	?	?	?	?
Warren 2001	?	?	?	?	?	?
Wilson 1993	?	?	?	?	?	?
Yankell 1996	?	?	?	?	?	?
Yankell 1997	?	?	?	?	?	?
Yukna 1993b	?	?	?	?	?	?
Zimmer 2002	?	?	?	?	?	?
Zimmer 2005	?	?	?	?	?	?

Allocation

The generation of randomisation sequence was at low risk of bias for 18 trials (32.1%), unclear risk for 36 (64.3%) and at high risk of bias for two trials (3.6%) (Lazarescu 2003; Walsh 1989). The concealment of allocation was at low risk of bias in 13 trials (23.2%) and unclear risk of bias in all other trials.

Blinding

The outcome assessment was at low risk of bias in 47 trials (83.9%). The adequacy of blinding was unclear in nine trials (16.1%).

Incomplete outcome data

The reported drop-out rate ranged from 1% to 34%. Forty-one trials were at low risk of bias with regard to attrition bias, either due to no drop-outs, or drop-outs unlikely to influence findings. Thirteen trials were at unclear risk of bias due to insufficient data for assessment; two studies with high drop-out rates that did not present reasons for the losses were assessed as at high risk of bias (Glass 1965; Wilson 1993).

Selective reporting

All of the trials apart from one reported important outcomes and were assessed as at low risk of bias. Kallar 2011 failed to report gingivitis and was assessed as at high risk of bias for this domain.

Other potential sources of bias

Two trials were at unclear risk of bias due to other potential sources (Kallar 2011; Yukna 1993b) due to lack of information on the methods or insufficient detail regarding baseline comparison. All other trials were assessed as at low risk of bias for this domain.

Effects of interventions

See: [Summary of findings for the main comparison](#)

As mentioned in the methods section, the differences in plaque and gingivitis reduction between the powered and manual brushes were expressed as standardised mean differences (SMDs) unless all the studies used the same index in which case mean difference (MD) was used. The results are presented for both short-term and long-term studies.

All powered toothbrushes versus manual toothbrushes (Comparison 1)

[Analysis 1.1](#); [Analysis 1.2](#); [Analysis 1.3](#); [Analysis 1.4](#).

This primary analysis compared all powered brush types with manual.

Plaque

The meta-analyses for both short-term (40 trials $n = 2871$) and long-term (14 trials $n = 978$) plaque indices indicated that there was a reduction in plaque when the powered toothbrushes were used, short term (one to three months) SMD -0.50 (95% confidence interval (CI) -0.70 to -0.31) and long term (>3 months) SMD -0.47 (95% CI -0.82 to -0.11). Both meta-analyses showed high levels of heterogeneity ($I^2 = 83%$ and $86%$ respectively). These were not explained by the different powered toothbrush type subgroups, and there was considerable heterogeneity within these.

Gingivitis

The meta-analyses for both short-term (44 trials $n = 3345$) and long-term (16 trials $n = 1645$) gingival indices indicated that there was a reduction in gingivitis when the powered toothbrushes were used, short term (1-3 months) SMD -0.43 (95% CI -0.60 to -0.25) and long term (>3 months) SMD -0.21 (95% CI -0.31 to -0.12). Both meta-analyses showed high levels of heterogeneity ($I^2 = 82%$ and $51%$ respectively). These were not explained by the different powered toothbrush type subgroups, and there was considerable heterogeneity within these.

Side to side powered toothbrushes versus manual toothbrushes (Comparison 2)

[Analysis 2.1](#); [Analysis 2.2](#); [Analysis 2.3](#); [Analysis 2.4](#).

Ten studies ($n = 988$) compared side to side toothbrushes with manual, one of which was at low risk (McCracken 2009) and two at high risk of bias (Glass 1965; Walsh 1989), the remainder being unclear.

No significant differences were found between side to side action and manual brushes in the reduction of plaque or gingivitis in the long or short term.

Counter oscillation powered toothbrushes versus manual (Comparison 3)

[Analysis 3.1](#); [Analysis 3.2](#); [Analysis 3.3](#); [Analysis 3.4](#).

All five studies ($n = 267$) that compared counter oscillation powered toothbrushes with manual toothbrushes were at unclear (Baab

1989; Khocht 1992; Stabholz 1996; Yukna 1993b) or high risk of bias (Wilson 1993). There was no evidence that counter oscillation powered toothbrushes were more effective than manual brushes for the removal of plaque or reduction of gingivitis with the exception of being associated with less plaque in the long term, where the MD was -0.27 (95% CI -0.48 to -0.07; two trials, n = 69; I²=0) (Analysis 3.3).

Rotation oscillation powered toothbrushes versus manual (Comparison 4)

Analysis 4.1; Analysis 4.2; Analysis 4.3; Analysis 4.4.

Twenty-seven trials (n = 2159) compared rotation oscillation powered with manual toothbrushes. Only three of these were at low risk of bias (Clerehugh 1998; Haffajee 2001a; Silverman 2004) and one at high risk of bias (Lazarescu 2003), the remainder being unclear. This comparison contained the greatest number of trials, with 20 (n = 1404) and 21 (n = 1479) trials included in the meta-analyses for plaque and gingivitis respectively in the short term, and seven (n = 527) and eight (n = 684) trials included in the meta-analyses for plaque and gingivitis in the long term. Brushes with a rotation oscillation action removed more plaque and reduced gingivitis more effectively than manual brushes in the short term. For plaque at one to three months the SMD was -0.53 (95% CI -0.74 to -0.31; I² = 72%) (Analysis 4.1) and for gingivitis the SMD was -0.49 (95% CI -0.73 to -0.26; I² = 78%) (Analysis 4.2). Rotation oscillation brushes also reduced plaque and gingivitis in the long term. The SMD for plaque over 3 months was -0.66 (95% CI -1.28 to -0.03; I² = 91%) (Analysis 4.3) and for gingivitis was -0.35 (95% CI -0.50 to -0.20; I² = 53%) (Analysis 4.4). There was heterogeneity between the trials in the meta-analyses for both short-term and long-term follow-up, which is reported later in this section.

Three studies examined both outcomes but did not include sufficient information for meta-analysis (Costa 2007; Gugerli 2007; Zimmer 2005). Two suggested treatment benefits from using rotation oscillation toothbrushes (Analysis 4.5). All three were at unclear risk of bias.

Circular powered toothbrushes versus manual (Comparison 5)

Analysis 5.1; Analysis 5.2.

Two trials (n = 162) were included in this comparison, both were at unclear risk (Khocht 1992; Yankell 1996). Both trials were included in the analyses for plaque and gingivitis in the short term; there were no long-term data. There was no evidence that brushes with a circular action removed plaque or reduced gingivitis more effectively than manual brushes in either time period.

Ionic toothbrushes versus manual (Comparison 6)

Analysis 6.1; Analysis 6.2; Analysis 6.3; Analysis 6.4.

Four trials (n = 221) compared an ionic toothbrush with a manual brush. All four trials were at unclear risk of bias (Galgut 1996; Moreira 2007; Pucher 1999; Van Swol 1996). One trial (Moreira 2007) did not present data in a form suitable for meta-analysis (Analysis 6.5).

Three trials provided data for meta-analysis (Galgut 1996; Pucher 1999; Van Swol 1996). The short-term analyses (one to three months) indicated an effect on plaque in favour of the ionic brush (SMD -0.57 (95% CI -0.87 to -0.27)) but not gingivitis (MD -0.01 (95% CI -0.04 to 0.02)).

The single long-term trial showed a difference in favour of the ionic toothbrush on both plaque (MD -0.50 (95% CI -0.74 to -0.26)) and gingivitis (MD -0.36 (95% CI -0.59 to -0.13)).

Ultrasonic toothbrushes versus manual (Comparison 7)

Analysis 7.1; Analysis 7.2; Analysis 7.3; Analysis 7.4.

Seven trials (n = 506) compared ultrasonic toothbrushes with manual. One of the seven trials in this comparison was at low risk of bias (Sharma 2010) and all others were at unclear risk of bias. There were four trials for the meta-analysis for the short-term assessment of plaque and five for gingivitis; two trials did not provide data for meta-analysis (Analysis 7.5). Ultrasonic powered toothbrushes reduced plaque and gingivitis in the short term, with SMDs of -1.33 (95% CI -1.59 to -1.07; I² = 93%) (Analysis 7.1) and -0.99 (95% CI -1.21 to -0.76; I² = 84%) (Analysis 7.2) respectively. Only one trial presented long-term data and showed no statistically significant difference between brushes for either plaque or gingivitis (Terezhalmay 1995a) (Analysis 7.3; Analysis 7.4).

Unknown versus manual (Comparison 8)

Analysis 8.1; Analysis 8.2; Analysis 8.3.

Five studies (n = 1130) compared powered brushes of unknown action against manual brushes. One was assessed as being at high risk of bias (Kallar 2011) and four were at unclear risk. The data are presented in forest plots however, due to the lack of clarity about the toothbrushes being compared it is difficult to draw any conclusions.

Investigation of heterogeneity

Heterogeneity was present for both plaque at one to three months and plaque at >3 months and gingivitis at >3 months for the rotation oscillation brushes compared with manual. We were unable to put forward covariates other than those considered in the sensitivity analyses below to explain this.

Sensitivity analyses

Sensitivity analyses were limited to the data on all types of powered toothbrushes (Comparison 1: [Analysis 1.1](#); [Analysis 1.2](#); [Analysis 1.3](#); [Analysis 1.4](#)) as this was the primary analysis for this review. These were conducted for trials with (1) full mouth indices only, (2) low risk of bias trials, (3) manufacturer funded (reported) and (4) excluding orthodontic patients (Additional [Table 4](#)). The effect estimates were similar to those for all trials apart from those for the low risk of bias studies. There are only five low risk of bias trials in total and two to three included in the sensitivity analyses. Due to the lack of evidence none of these were statistically significant although the effect estimates for plaque and gingivitis at one to three months were higher than those for all trials.

Converting SMDs back to original indices

As the results of both gingivitis and plaque meta-analyses were calculated as SMDs, which are unit-less and difficult to interpret, we re-expressed them in [Summary of findings table 1](#) by calculating SMDs back into the most commonly reported indices (Quigley Hein for plaque and Löe Silness for gingivitis). In order to back translate we calculated the mean difference by multiplying the median standard deviation of the control group (end of study mean) by the pooled SMD. The table below shows this for plaque and gingivitis in both the short and long term. The differences are also expressed as percentage reductions of the median control group mean.

Plaque index	Time	Pooled SMD	Control mean*	Control standard deviation*	Difference in mean scores (95% CI)	Difference as % of control mean
Quigley Hein	1-3 months	-0.50 (-0.70 to -0.31)	2.16	0.46	-0.23 (-0.32 to -0.14)	11%
Quigley Hein	>3 months	-0.47 (-0.82 to -0.11)	1.05	0.46	-0.22 (-0.38 to -0.05)	21%

Gingivitis index	Time	Pooled SMD	Control mean*	Control standard deviation*	Difference in mean scores (95% CI)	Difference as % of control mean
Löe Silness	1-3 months	-0.43 (-0.60 to -0.25)	1.1	0.16	-0.07 (-0.10 to -0.04)	6%
Löe Silness	>3 months	-0.21 (-0.31 to -0.12)	0.74	0.4	-0.08 (-0.12 to -0.05)	11%

*median values for all trials presenting data using chosen indices (i.e. Quigley Hein for plaque; Löe Silness for gingivitis).

Publication bias

Publication bias was assessed for the studies included in the meta-analysis for all powered toothbrushes versus manual for the one to three month assessments. Both funnel plots appear asymmetrical in visual interpretation (Figure 4; Figure 5) with some evidence of publication bias. A formal test of small study effects (Egger test) was undertaken for the Quigley Hein (Turesky) index for plaque and the Löe Silness index for gingivitis. The slope was not significant for either index (P value = 0.203; 0.56) and the hypothesis of no small study effects was also not significant (P value = 0.748; 0.15). From the statistical tests there was no evidence of any publication bias.

Figure 4. Funnel plot of Comparison 1: All powered toothbrushes versus manual toothbrushes, Outcome 1.1: Plaque scores at 1 to 3 months at all sites.

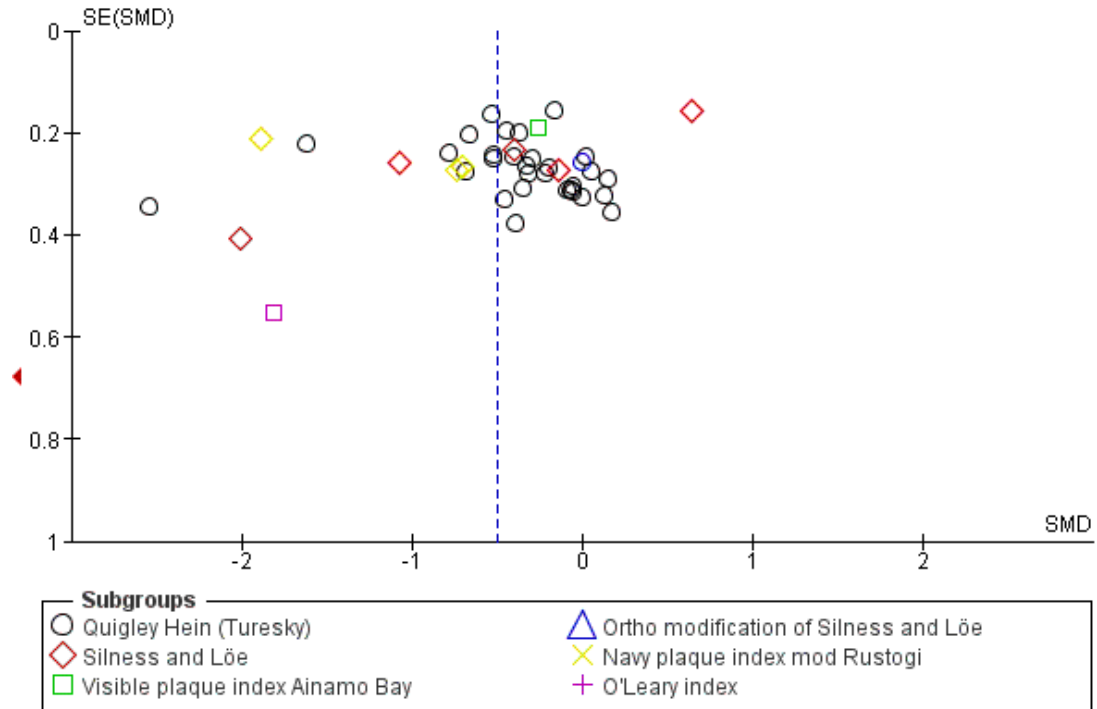
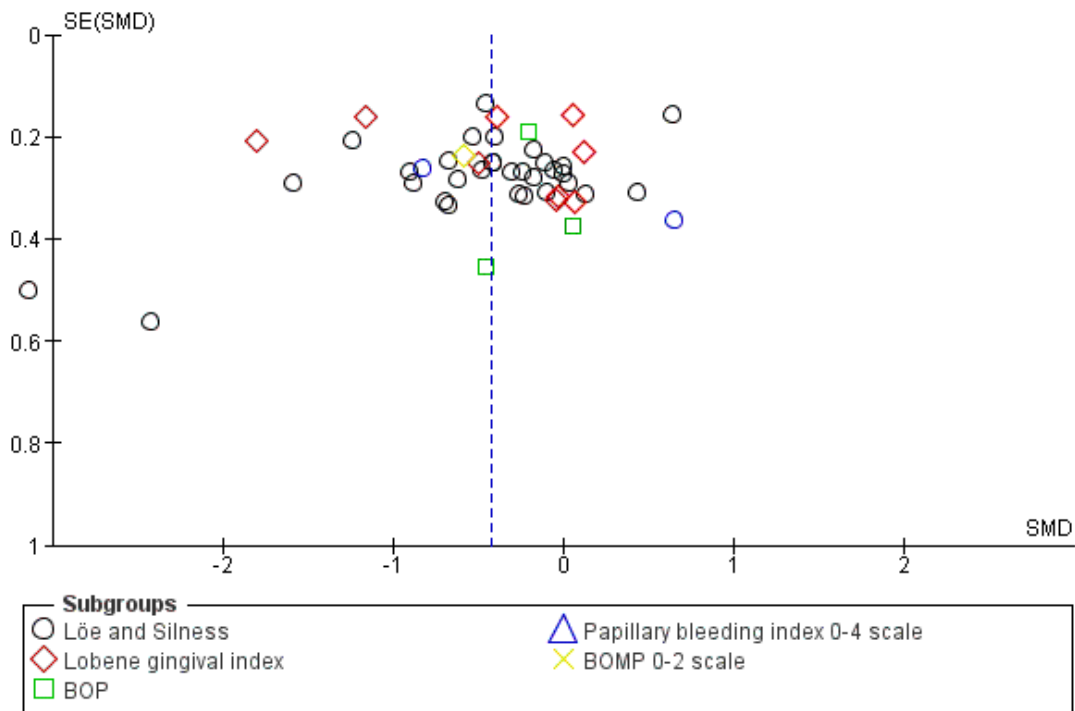


Figure 5. Funnel plot of Comparison 1: All powered toothbrushes versus manual toothbrushes, Outcome 1.2: Gingival scores at 1 to 3 months at all sites.



Secondary outcomes

in the accumulation of calculus at six months (P value < 0.01) ([Dentino 2002](#)).

Cost

None of the included trials reported on the relative costs of manual compared with powered toothbrushes.

Stain

Three trials reported that there was no difference in the degree of staining on the teeth between the brush types ([Dentino 2002](#); [Glass 1965](#); [Walsh 1989](#)).

Reliability

One trial reported a mechanical failure of one of the 48 powered toothbrushes used ([Clerehugh 1998](#)) and one trial reported mechanical failure in four of 20 powered brushes ([Yukna 1993b](#)). No other mechanical failures were reported.

Adverse events - Tissue trauma

There was no apparent relationship between the use of powered toothbrushes and soft tissue trauma. In part this finding was due to the very small number of adverse events reported in the trials. Sixteen trials did not report on adverse events ([Biavati Silvestrini 2010](#); [Costa 2007](#); [Galgut 1996](#); [Goyal 2007](#); [Haffajee 2001a](#); [Ho 1997](#); [Lazarescu 2003](#); [Lobene 1964a](#); [Moritis 2008](#); [Rosema 2008](#); [Sharma 2010](#); [Silverman 2004](#); [Soparkar 1964](#); [Van Swol 1996](#); [Zimmer 2002](#); [Zimmer 2005](#)). Of the 40 trials that did report on adverse events, 27 reported no trauma to soft or hard tissues or both ([Ainamo 1997](#); [Biesbrock 2007](#); [Clerehugh 1998](#); [Dentino 2002](#); [Dorfer 2009](#); [Emling 1991](#); [Forgas-B 1998](#);

Calculus

Three trials ([Dentino 2002](#); [Glass 1965](#); [van der Weijden 1994](#)) reported on calculus, two reporting that there was no significant difference between the brush types ([Glass 1965](#); [van der Weijden 1994](#)) and one reporting that, compared to the manual brush, the powered brush group showed a significant favourable difference

Galgut 1996; Garcia-Godoy 2001; Glass 1965; Heasman 1999; Hickman 2002; McCracken 2009; Moreira 2007; Pucher 1999; Sharma 2000; Singh unpublished; Soparkar 2000; Sowinski 2000; Stabholz 1996; Stoltze 1994; Toto 1966; Walsh 1989; Warren 2001; Wilson 1993; Yankell 1996; Yankell 1997) and six reported no significant differences between powered and manual toothbrushes, or that tissue trauma was negligible (Baab 1989; Barnes 1993; Cronin 1998; Lapiere unpublished; O'Beirne 1996; Terezhalmay 1995a).

Therefore, of the 56 studies, there were seven trials that described differences in tissue trauma between participants using manual and powered toothbrushes. One trial reported five cases of gingival abrasion in the manual and one case of abrasion in the powered group (Tritten 1996), another reported 12 cases of gingival abrasion in the manual and five cases of gingival abrasion in the powered group (van der Weijden 1994). One trial reported seven soft tissue abnormalities in six participants in the manual group and 10 abnormalities in seven participants in the powered group (Johnson 1994). In the trial by Yukna et al (Yukna 1993b) four cases of abrasion were reported in the powered toothbrush group and one in the manual group. Khocht 1992 reported soft tissue changes in four participants using the manual toothbrush, six using the experimental powered toothbrush and one participant using a control powered toothbrush. In the trial by McCracken 2004, soft tissue lesion which included abrasion and ulcer were reported in eight of manual toothbrushes group and five in powered toothbrushes group. Gugerli 2007 reported three cases of abrasion in both manual and powered toothbrushes. These soft tissue changes were seen as transient irritations that were possibly/probably due to the product.

DISCUSSION

We brush our teeth for many reasons: to feel fresh and confident; to have a nice smile; to avoid bad breath and to avoid disease. The selection of one's toothbrush is largely a matter of personal preference, affordability, availability and professional recommendation. Powered toothbrushes may have a particular appeal to some because they represent a 'high tech' solution to an everyday task. There is overwhelming evidence that toothbrushing reduces gingivitis (Lang 1973). It may prevent periodontitis and certainly prevents tooth decay if carried out in conjunction with fluoride toothpaste. These benefits occur whether the brush is manual or powered and the results of this review do not indicate that toothbrushing is only worthwhile with a powered toothbrush.

Summary of main results

The results of this review demonstrate that powered toothbrushes remove statistically significantly more plaque and gingivitis than manual brushes in both the short and long term. The results of

the meta-analyses are presented as standardised mean differences (SMD), which do not relate to tangible differences in clinical indices. To help interpret the magnitude of the effect, the results of the 'all powered toothbrushes' meta-analysis have been back-translated to the most commonly reported plaque and gingivitis indices. An 11% reduction in plaque was shown at one to three months for the Quigley Hein (Turesky) index and a 21% reduction in plaque at longer than three months. The longer term result was based only on 14 trials, compared to 40 trials for the short-term analysis. With regard to gingivitis a 6% reduction was seen at one to three months for the Löe Silness index, based on 44 trials, and a greater reduction of 11% in the long term (16 trials). When looking at individual modes of action of powered brushes there are inconsistencies with regard to reductions of plaque and gingivitis. Rotation oscillation brushes showed statistically significant reductions in both plaque and gingivitis at both time points. All other brushes, apart from side to side, showed some statistically significant findings but not consistently across both outcomes and time points. It is difficult to explain this inconsistency that a particular toothbrush design could affect plaque or gingivitis at one time but not at another and so the findings of these analyses may warrant further research, particularly given the small number of trials for some modes of action.

Overall completeness and applicability of evidence

The effectiveness of powered toothbrushes in removing plaque and reducing gingivitis can be related to destructive periodontal disease (periodontitis) only with some difficulty. Many factors are associated with the occurrence of periodontitis including plaque, tobacco use and individual medical factors. Periodontitis takes many years to develop whereas the trials have much shorter follow-up. There is little compelling evidence that plaque and gingivitis are reliable proxies for long-term destructive disease and it is difficult to estimate a threshold for clinically important reductions in either. We conclude that powered brushes reduce plaque accumulation and gingivitis but the clinical importance of these reductions cannot be assessed. More high quality long-term studies are required to investigate the effectiveness of rotation oscillation brushes in the treatment and prevention of periodontitis.

Some authorities have advocated the use of arbitrary thresholds to make superiority claims for a specific product. For example, Imrey has proposed that a product cannot be claimed to be superior unless it provides a 20% improvement in performance (which was not the case for any types of brush in this review, in terms of long-term plaque removal) (Imrey 1992; Imrey 1994). However, other authors have criticised the use of arbitrary thresholds and prefer a threshold for clinical significance to be decided in advance and selected on clinical grounds (D'Agostino 1992).

Few data were reported on the costs or reliability of the brushes or the side effects of their use. When reported, injuries to the gums

were minor and transient.

Many factors may influence the effectiveness of toothbrushes including filament arrangement, orientation, size, shape and flexibility, brush head size and shape along with presence or absence and characteristics of a timer, that not all of them could be isolated and analysed. Whether the brush has a battery or rechargeable power source may also be important. These factors could be considered in subgroup analyses in the parallel review of different powered toothbrushes by Deacon and colleagues (Deacon 2010). More recently powered toothbrushes have been introduced with multidimensional actions (for example the filaments on some rotation oscillation brushes now also move in and out towards the tooth). Trials of such designs are yet to be identified.

The funnel plots for the trials of all powered toothbrushes were skewed for both plaque and gingivitis. This observation suggests but does not conclusively demonstrate publication bias. In the review intervention effects were measured by SMDs, which are naturally correlated with their standard error, which can produce spurious asymmetry in funnel plots. Other potential factors that may contribute to asymmetry include poor methodological quality of studies, true heterogeneity and the play of chance.

Publication bias might be expected in the reporting of toothbrush trials as manufacturers would like to have scientific support for the effectiveness of their products. Studies sponsored by pharmaceutical companies are more likely to favour the sponsor (Lexchin 2003). There was no evidence of this when publication bias was examined statistically, and no evidence of a difference in effect estimates when a sensitivity analysis was conducted for trials which did not mention commercial funding. It should be noted that the methods for detecting publication bias relate effect size to sample size, and in this review the trials tend to be of similar size. Therefore other methods may be required to examine publication bias in short-term, low cost studies.

Quality of the evidence

The current review focused purely on truly randomised trials. Five trials were assessed as at low risk of bias (8.9%), five at high risk of bias (8.9%) and the remaining 46 trials (82%) at unclear risk of bias. Only three trials were able to be used in the sensitivity analysis for trials at low risk of bias. These trials were unable to demonstrate statistically significant differences between powered and manual toothbrushes, although the effect estimates for plaque and gingivitis at one to three months were higher than those for all trials.

There was considerable unexplained heterogeneity in the meta-analyses for plaque and gingivitis for the primary analysis of powered toothbrushes versus manual brushes, and for the meta-analyses of individual modes of action. This heterogeneity could not be explained.

AUTHORS' CONCLUSIONS

Implications for practice

This review has found that compared with manual toothbrushes, powered toothbrushes are more effective than manual brushes in reducing plaque and gingivitis in the long and short term. An 11% reduction in plaque (Quigley Hein (Turesky) index) was shown at one to three months and a 21% reduction in plaque at longer than three months. With regard to gingivitis a 6% reduction (Löe Silness index) was seen at one to three months and a greater reduction of 11% in the long term. The clinical importance of these findings remains unclear.

Cost, reliability and side effects were inconsistently reported. Any reported side effects were localised and only temporary.

Implications for research

Trials of longer duration are required to fully evaluate the effects of powered toothbrushes. There are few trials reporting data over more than three months. Data on the long-term benefits of powered toothbrushes would be valuable in their own right and could be used to trial other outcomes such as the adverse effects and benefits in the prevention of periodontitis and dental caries.

This review continued to identify idiosyncrasies in the design of the trials and in some cases data could not be included for this reason. Whilst many of the trials were conducted before the current emphasis on experimental design, even recent trials lacked power calculations and had not been analysed on an intention-to-treat basis. Researchers in this field would be advised to study guidance on the design and reporting of clinical trials such as that provided in the CONSORT statement (<http://www.consort-statement.org/>) and Robinson and colleagues (Robinson 2006). Specific guidance exists for trials in the treatment or prevention of periodontal diseases (Imrey 1994) but greater standardisation of both the follow-up intervals and the indices used would benefit both trials and future meta-analyses. Thought should also be given to when the mouth should be examined in relation to when the teeth were last cleaned. Authors might also seek guidance on the analysis and presentation of cross-over trials.

Some research designs created an artificial research environment that may have undermined the generalisability of the findings. In particular the external validity was questionable in trials with split-mouth designs where participants were asked to clean each side of their mouth with a different brush, in trials where interventions were used in combination and those where toothbrushing was supervised. Hence their exclusion from this meta-analysis.

More research with improved rigour is also needed on the relative benefits of powered and manual toothbrushes to prevent or remove extrinsic staining of the teeth and calculus.

Finally, empirical data on thresholds for clinically important differences in plaque and gingivitis levels would help to determine whether oral hygiene aids provide important health benefits.

ACKNOWLEDGEMENTS

Thanks are due to Anne Littlewood and Sylvia Bickley, Trials Search Co-ordinator for the Cochrane Oral Health Group for carrying out the searches for the review; Philip Riley and Liz Asbridge for administration of the review, co-ordination of databases and location of articles for the review; Luisa Fernandez Mauleffinch, Managing Editor for the Cochrane Oral Health Group for copy editing the review; and Bill Shaw and Mike Heanue for their contribution to previous versions of this review. For help with the translations of foreign papers our thanks go to Selva Can (German), Dr Mona Nasser (German), Dr Patrick Sequeira-Byron

(German), Regina Mitezki (German), Paul Tramini (French), Professor Stéphanie Tubert-Jeannin (French) and Giovanni Lodi (Italian).

We would also like to thank the following investigators who replied to our requests for additional information about their trials: J de Boever (Universitair Ziekenhuis, Gent), C Burge (University of Colorado), M Darby (Old Dominion University), A Dentino (Marquette University), W Killoy (University of Missouri), A Korerber (University of Illinois), I Moschén (Leopold-Franzens-Universität), R Nolden (Rheinische Friedrich-Wilhelms Universität), T Palmer (Clinical Research Associates), M Thompson (Gillette Company), P Warren (Gillette Company), AK Pelka (University Hospital of Munich), C Kossack (University of Berlin) and G.I MacCracken (Newcastle University). For their help as referees, we express our thanks to Martin Addy, Nik Barstow, Robin Davies, Marco Esposito, Eleanor Grey, Jayne Harrison, Lee Hooper, Ian Needleman, Richard Niederman, Derek Richards and Philip Riley.

REFERENCES

References to studies included in this review

Ainamo 1997 *{published data only}*

Ainamo J, Xie Q, Ainamo A, Kallio P. Assessment of the effect of an oscillating/rotating electric toothbrush on oral health. A 12-month longitudinal study. *Journal of Clinical Periodontology* 1997;**24**(1):28–33.

Baab 1989 *{published data only}*

Baab DA, Johnson RH. The effect of a new electric toothbrush on supragingival plaque and gingivitis. *Journal of Periodontology* 1989;**60**(6):336–41.

Barnes 1993 *{published data only}*

Barnes CM, Weatherford TW 3rd, Menaker L. A comparison of the Braun Oral-B Plaque Remover (D5) electric and a manual toothbrush in affecting gingivitis. *Journal of Clinical Dentistry* 1993;**4**(2):48–51.

Biavati Silvestrini 2010 *{published data only}*

Silvestrini Biavati A, Gastaldo L, Dessi M, Biavati Silvestrini F, Migliorati M. Manual Orthodontic versus oscillating-rotating electric toothbrush in orthodontic patients: a randomised clinical trial. *European Journal of Pediatric Dentistry* 2010;**11**:200–2.

Biesbrock 2007 *{published data only}*

Biesbrock AR, Bartizek RD, Gerlach RW, Terezhalmay GT. Oral hygiene regimens, plaque control, and gingival health: a two-month clinical trial with antimicrobial agents. *Journal of Clinical Dentistry* 2007;**18**(4):101–5.

Clerehugh 1998 *{published data only}*

Clerehugh V, Williams P, Shaw WC, Worthington HV, Warren P. A practice-based randomised controlled trial of the efficacy of an electric and a manual toothbrush on

gingival health in patients with fixed orthodontic appliances. *Journal of Dentistry* 1998;**26**(8):633–9.

Costa 2007 *{published data only}*

* Costa MR, Silva VC, Miqui MN, Sakima T, Spolidorio DM, Cirelli JA. Efficacy of ultrasonic, electric and manual toothbrushes in patients with fixed orthodontic appliances. *Angle Orthodontist* 2007;**77**(22):361–6.
Costa MR, da Silva VC, Miqui MN, Colombo AP, Cirelli JA. Effects of ultrasonic, electric, and manual toothbrushes on subgingival plaque composition in orthodontically banded molars. *American Journal of Orthodontics & Dentofacial Orthopedics* 2010;**137**(2):229–35.

Cronin 1998 *{published data only}*

Cronin M, Dembling W, Warren PR, King DW. A 3-month clinical investigation comparing the safety and efficacy of a novel electric toothbrush (Braun Oral-B 3D Plaque Remover) with a manual toothbrush. *American Journal of Dentistry* 1998;**11**(Spec No):S17–21.

Dentino 2002 *{published and unpublished data}*

Dentino A, Derderian G, Wolf M, Johnson R, Warren P. Evaluation of powered vs manual toothbrushing on plaque, calculus and stain. *Journal of Dental Research* 1999;**78** (IADR Abstracts):413 (Abstract No 2463).
Dentino A, Wirth C, Williams C, Wolf M, Shaw T, Warren P. Comparison of powered vs manual toothbrushing on gingivitis reduction. *Journal of Dental Research* 1999;**78** (IADR Abstracts):413 (Abstract No 2462).
* Dentino AR, Derderian G, Wolf M, Cugini M, Johnson R, Van Swol RL, et al. Six-month comparison of powered versus manual toothbrushing for safety and efficacy in the absence of professional instruction in mechanical plaque control. *Journal of Periodontology* 2002;**73**(7):770–8.

Dorfer 2009 {published data only}

Dorfer CE, Joerss D, Wolff D. A prospective clinical study to evaluate the effect of manual and power toothbrushes on pre-existing gingival recessions. *Journal of Contemporary Dental Practice* 2009;**10**(4):1–8.

Emling 1991 {published data only}

Emling RC, Raidl A, Greco MR, Shi X, Yankell SL. Clinical evaluation of the Plak Trac toothbrush. *Journal of Clinical Dentistry* 1991;**2**(3):57–62.

Forgas-B 1998 {published data only}

Forgas-Brockmann LB, Carter-Hanson C, Killoy WJ. The effects of an ultrasonic toothbrush on plaque accumulation and gingival inflammation. *Journal of Clinical Periodontology* 1998;**25**(5):375–9.

Galgut 1996 {published data only}

Galgut PN. Efficacy of a new electronic toothbrush in removing bacterial dental plaque in young adults. *General Dentistry* 1996;**44**(5):441–5.

Garcia-Godoy 2001 {published data only}

Garcia-Godoy F, Marcushamer M, Cugini M, Warren PR. The safety and efficacy of a children's power toothbrush and a manual toothbrush in 6–11 year-olds. *American Journal of Dentistry* 2001;**14**(4):195–9.

Glass 1965 {published data only}

Glass RL. A clinical study of hand and electric toothbrushing. *Journal of Periodontology* 1965;**36**:322–7.

Goyal 2007 {published data only}

Goyal CR, Qaqish JG, Galustians J, Ortbal K. Efficacy and safety of a new power toothbrush in a population with mild to moderate gingivitis. *Journal of Clinical Dentistry* 2007;**18**(3):65–9.

Gugerli 2007 {published data only}

Gugerli P, Secci G, Mombelli A. Evaluation of the benefits of using a power toothbrush during the initial phase of periodontal therapy. *Journal of Periodontology* 2007; Vol. 78, issue 4:654–60.

Haffajee 2001a {published and unpublished data}

Haffajee AD, Thompson M, Torresyap G, Guerrero D, Socransky SS. Efficacy of manual and powered toothbrushes (I). Effect on clinical parameters. *Journal of Clinical Periodontology* 2001;**28**(10):937–46.

Heasman 1999 {published data only}

* Heasman PA, Stacey F, Heasman L, Sellers P, Macgregor ID, Kelly PJ. A comparative study of the Philips HP 735, Braun/Oral B D7 and the Oral B 35 Advantage toothbrushes. *Journal of Clinical Periodontology* 1999;**26**(2): 85–90.

Heasman PA, Stacey F, Heasman L, Swan N, Steen N, De Jager M, et al. Comparative study of powered and manual toothbrushes in patients with periodontal disease. *Journal of Dental Research* 2002;**81**(Spec Iss 1):A374 (Abstract No 3003).

McCracken GI, Stacy F, Heasman L, Sellers P, Macgregor ID, Kelly PJ, et al. A comparative study of two powered toothbrushes and one manual toothbrush in young adults. *Journal of Clinical Dentistry* 2001;**12**(1):7–10.

Hickman 2002 {published data only}

Hickman J, Millett DT, Sander L, Brown E, Love J. Powered vs manual tooth brushing in fixed appliance patients: a short term randomized clinical trial. *The Angle Orthodontist* 2002;**72**(2):135–40.

Ho 1997 {published data only}

Ho HP, Niederman R. Effectiveness of the Sonicare sonic toothbrush on reduction of plaque, gingivitis, probing pocket depth and subgingival bacteria in adolescent orthodontic patients. *Journal of Clinical Dentistry* 1997;**8**(1 Spec No):15–9.

Johnson 1994 {published data only}

Johnson BD, McInnes C. Clinical evaluation of the efficacy and safety of a new sonic toothbrush. *Journal of Periodontology* 1994;**65**(7):692–7.

Kallar 2011 {published data only}

Kallar S, Pandit IK, Srivastava N, Gugnani N. Plaque removal efficacy of powered and manual toothbrushes under supervised and unsupervised conditions: A retrospective clinical study. *Journal of Indian Society of Pedodontics and Preventive Dentistry* 2011;**29**(3):235–8.

Khocht 1992 {published data only}

Khocht A, Spindel L, Person P. A comparative clinical study of the safety and efficacy of three toothbrushes. *Journal of Periodontology* 1992;**63**(7):603–10.

Lapiere unpublished {unpublished data only}

Lapiere A, Donck L, De Vree H, De Boever JA. Effectiveness of three toothbrushes for plaque removal in patients with low compliance. (Europerio 2). *Journal of Clinical Periodontology* 1997;**24**:863.

* Lapiere A, Donck L, De Vree H, De Boever JA. Effectiveness of two electric toothbrushes as compared to a manual for plaque control in periodontitis patients with low compliance. Unpublished 2002.

Lazarescu 2003 {published data only}

Lazarescu D, Boccaneala S, Illiescu A, De Boever JA. Comparative study of an electric and manual toothbrush in patients unfamiliar with electric brushes. *Journal of Dental Research* 2000;**79**(IADR Abstracts):298 (Abstract No 1234).

* Lazarescu D, Boccaneala S, Illiescu A, De Boever JA. Efficacy of plaque removal and learning effect of a powered and a manual toothbrush. *Journal of Clinical Periodontology* 2003;**30**(8):726–31.

Lobene 1964a {published data only}

Lobene RR. Evaluation of altered gingival health from permissive powered toothbrushing. *Journal of the American Dental Association* 1964;**69**:585–8.

* Lobene RR. The effect of an automatic toothbrush on gingival health. *Journal of Periodontology* 1964;**35**:137–9.

McCracken 2004 {published data only}

McCracken GI, Heasman L, Stacey F, Steen N, DeJager M, Heasman PA. A clinical comparison of an oscillating/rotating powered toothbrush and a manual toothbrush in patients with chronic periodontitis. *Journal of Clinical Periodontology* 2004;**31**(9):805–12.

McCracken 2009 {published data only}

McCracken GI, Heasman L, Stacey F, Swan M, Steen N, de Jager M, et al. The impact of powered and manual toothbrushing on incipient gingival recession. *Journal of Clinical Periodontology* 2009;**36**(11):950–7.

Moreira 2007 {published data only}

Moreira CH, Luz PB, Villarinho EA, Petri LC, Rosing CK. Efficacy of an ionic toothbrush on gingival crevicular fluid—a pilot study. *Acta Odontologica Latinoamericana* 2008;**21**(1):17–20.

* Moreira CH, Luz PB, Villarinho EA, Petri LC, Weidlich P, Rosing CK. A clinical trial testing the efficacy of an ionic toothbrush for reducing plaque and gingivitis. *The Journal of Clinical Dentistry* 2007;**18**(4):123–5.

Moritis 2008 {published data only}

Moritis K, Jenkins W, Hefti A, Schmitt P, McGrady M. A randomized, parallel design study to evaluate the effects of a Sonicare and a manual toothbrush on plaque and gingivitis. *Journal of Clinical Dentistry* 2008;**19**(2):64–8.

O’Beirne 1996 {published data only}

O’Beirne G, Johnson RH, Persson GR, Spektor MD. Efficacy of a sonic toothbrush on inflammation and probing depth in adult periodontitis. *Journal of Periodontology* 1996;**67**(9):900–8.

Pucher 1999 {published data only}

Pucher JJ, Lamendola-Sitenga K, Ferguson D, Van Swoll R. The effectiveness of an ionic toothbrush in the removal of dental plaque and reduction on gingivitis in orthodontic patients. *Journal of the Western Society of Periodontology/Periodontal Abstracts* 1999;**47**(4):101–7.

Rosema 2008 {published data only}

Rosema NA, Timmerman MF, Versteeg PA, van Palenstein Helderma WH, Van der Velden U, Van der Weijden GA. Comparison of the use of different modes of mechanical oral hygiene in prevention of plaque and gingivitis. *Journal of Periodontology* 2008;**79**:1368–94.

Sharma 2000 {published data only}

Sharma N, Galustians HJ, Qaqish JG, Rustogi KN, Petrone ME, Volpe AR. Comparative efficacy on supragingival plaque and gingivitis of a manual toothbrush (Colgate Plus) and a battery-powered toothbrush (Colgate Actibrush) over a 30-day period. *Compendium of Continuing Education Dental Supplement* 2000;**21**(31):S9–13.

Sharma 2010 {published data only}

Sharma NC, Qaqish JG, He T, Walters PA, Grender JM, Biesbrock AR. Plaque and gingivitis reduction efficacy of an advanced pulsonic toothbrush: a 4-week randomized and controlled clinical trial. *American Journal of Dentistry* 2010;**23**(6):305–10.

Silverman 2004 {published data only}

Silverman J, Rosivack RG, Matheson PB, Houpt MI. Comparison of powered and manual toothbrushes for plaque removal by 4- to 5-year-old children. *Pediatric Dentistry* 2004;**26**ID-110:225–30.

Singh unpublished {unpublished data only}

* Singh A, Maddalozzo D, Geivelis M, Koerber A, Cornell W. A clinical comparison of the Butler GUM Pulse plaque remover and manual toothbrushing in adolescent orthodontic patients. Unpublished.

Singh A, Maddalozzo D, Geivelis M, Koerber A, Cornell W, Grys E. Efficacy of the Butler Pulse (TM) plaque remover in orthodontic patients. *Journal of Dental Research* 2000;**79** (IADR Abstracts):298 (Abstract No 1237).

Soparkar 1964 {published data only}

Soparkar PM, Quigley GA. Power versus hand brushing: effect on gingivitis. *Journal of the American Dental Association* 1964;**68**:182–7.

Soparkar 2000 {published data only}

Soparkar PM, Rustogi KN, Petrone ME, Volpe AR. Comparison of gingivitis and plaque efficacy of a battery-powered toothbrush and an ADA-provided manual toothbrush. *Compendium of Continuing Education in Dentistry Supplement* 2000;**(31)**:S14–8.

Sowinski 2000 {published data only}

Sowinski JA, Battista GW, Petrone DM, Petrone ME, Rustogi KN, Chaknis P, et al. Comparative efficacy of Colgate Actibrush battery-powered toothbrush and Colgate Plus (manual) toothbrush on established plaque and gingivitis: a 30-day clinical study in New Jersey. *Compendium of Continuing Education in Dentistry Supplement* 2000;**(31)**:S4–8.

Stabholz 1996 {published data only}

Stabholz A, Babayof I, Mann J. The clinical effect of a newly designed electric toothbrush on supragingival plaque, gingivitis and gingival bleeding. *Journal of Clinical Dentistry* 1996;**7**(1):17–20.

Stoltze 1994 {published data only}

Stoltze K, Bay L. Comparison of a manual and a new electric toothbrush for controlling plaque and gingivitis. *Journal of Clinical Periodontology* 1994;**21**(2):86–90.

Terezhalmay 1995a {published data only}

Terezhalmay GT, Iffland H, Jelepik C, Waskowski J. Clinical evaluation of the effect of an ultrasonic toothbrush on plaque, gingivitis, and gingival bleeding: a six-month study. *Journal of Prosthetic Dentistry* 1995;**73**(1):97–103.

Toto 1966 {published data only}

Toto PD, Goljan KR, Evans JA, Sawinski VJ. A study on the uninstructed use of an electric toothbrush. *Journal of the American Dental Association* 1966;**72**(4):904–5.

Tritten 1996 {published data only}

Tritten CB, Armitage GC. Comparison of a sonic and a manual toothbrush for efficacy in supragingival plaque removal and reduction of gingivitis. *Journal of Clinical Periodontology* 1996;**23**(7):641–8.

van der Weijden 1994 {published data only}

van der Weijden GA, Timmerman MF, Reijerse E, Danser MM, Mantel MS, Nijboer A, et al. The long-term effect of an oscillating/rotating electric toothbrush on gingivitis. An 8-month clinical study. *Journal of Clinical Periodontology* 1994;**21**(2):139–45.

Van Swol 1996 {published data only}

Van Swol RL, Van Scotter DE, Pucher JJ, Dentino AR. Clinical evaluation of an ionic toothbrush in the removal of established plaque and reduction of gingivitis. *Quintessence International* 1996;**27**(6):389–94.

Walsh 1989 {published data only}

Walsh M, Heckman B, Leggott P, Armitage G, Robertson PB. Comparison of manual and power toothbrushing, with and without adjunctive oral irrigation, for controlling plaque and gingivitis. *Journal of Clinical Periodontology* 1989;**16**(7):419–27.

Warren 2001 {published data only}

Warren PR, Cugini M, Marks P, King DW. Safety, efficacy and acceptability of a new power toothbrush: a 3-month comparative clinical investigation. *American Journal of Dentistry* 2001;**14**(1):3–7.

Wilson 1993 {published data only}

Wilson S, Levine D, Dequincey G, Killoy WJ. Effects of two toothbrushes on plaque, gingivitis, gingival abrasion, and recession: a 1-year longitudinal study. *Compendium Supplement* 1993;**(16)**:S569–79.

Yankell 1996 {published data only}

Yankell SL, Emling RC. A thirty-day evaluation of the Rowenta Dentiphant powered toothbrush in children for safety and efficacy. *Journal of Clinical Dentistry* 1996;**7**(4): 96–100.

Yankell 1997 {published data only}

Yankell SL, Emling RC. A thirty-day safety and efficacy evaluation of the Rowenta, Braun and Sonicare powered toothbrushes and a manual toothbrush. *Journal of Clinical Dentistry* 1997;**8**:120–7.

Yukna 1993b {published data only}

Yukna RA, Shaklee RL. Evaluation of a counter-rotational powered brush in patients in supportive periodontal therapy. *Journal of Periodontology* 1993;**64**(9):859–64.

Zimmer 2002 {published and unpublished data}

Zimmer S, Nezhat V, Bizhang M, Seemann R, Barthel CR. Clinical efficacy of a new sonic/ultrasonic toothbrush. *Journal of Clinical Periodontology* 2002;**29**(6):496–500.

Zimmer 2005 {published data only}

Zimmer S, Strauss J, Bizhang M, Krage T, Raab W H, Barthel C. Efficacy of the Cybersonic in comparison with the Braun 3D Excel and a manual toothbrush. *Journal of Clinical Periodontology* 2005; Vol. 32, issue 4:360–3.

References to studies excluded from this review

Aass 2000 {published data only}

Aass AM, Gjermo P. Comparison of oral hygiene efficacy of one manual and two electric toothbrushes. *Acta Odontologica Scandinavica* 2000;**58**(4):166–70.

Ainamo 1991 {published data only}

Ainamo J, Hormia M, Kaunisaho K, Sorsa T, Suomalainen K. Effect of manual versus powered toothbrushes. *Journal of Dental Research* 1991;**70**:557 (Abstract No 2329).

Albers 1988 {published data only}

Albers HK, Schusseler BG, Bossmann K. Acceptance and effectivity of electric and hand toothbrushes [Die Akzeptanz und Effektivität von elektrischen und von Handzahnbürsten]. *Zahnärztliche Mitteilungen* 1988;**78** (16):1777–80.

Anaise 1976 {published data only}

Anaise JZ. Plaque removal by different types of toothbrush. *Israel Journal of Dental Medicine* 1976;**25**(3):19–22.

Andreana 1998 {published data only}

Andreana S, Cataldo J, Mather ML. Clinical evaluation of the Ionoral toothbrush. *Journal of Dental Research* 1998;**77**: 211 (Abstract No 847).

Arceneaux 1996 {published data only}

Arceneaux A, Panacek J, Tellis L, Kiger R, Stephens J, Kettering J. Efficacy of sonic Vs manual toothbrushes in maintaining oral health. *Journal of Dental Research* 1996; **75**:86 (Abstract No 551).

Ash 1967 {published data only}

Ash M Jr. An examination of the problems and results in the use of manual and electric toothbrushes. *Revista Española de Periodoncia* 1967;**5**(5):269–94.

Barnes 2003 {published data only}

Barnes CM, Russell CM, Hlava GL, Utecht B, Reinhardt RA. A comparison of a waterpik dual-motor powered toothbrush and a manual toothbrush in affecting interproximal bleeding reduction and dental biofilm accumulation. *Journal of Clinical Dentistry* 2003;**14**(3): 49–52.

Bartizek 2002 {published data only}

Bartizek RD, Biesbrock AR. Dental plaque removal efficacy of a battery-powered toothbrush vs. a control Japanese manual toothbrush. *American Journal of Dentistry* 2002;**15** Spec No:33A–36A.

Bhanji 2002 {published data only}

Bhanji S, Williams B, Sheller B, Elwood T, Mancl L. Transient bacteremia induced by toothbrushing: a comparison of the Sonicare toothbrush with a conventional toothbrush. *Pediatric Dentistry* 2002;**24**(4):295–9.

Biesbrock 2005 {published data only}

Biesbrock AR, Bartizek RD. Plaque removal efficacy of a prototype power toothbrush compared to a control manual toothbrush. *American Journal of Dentistry* 2005;**18**(2): 116–20.

Blahut 1993 {published data only}

Blahut P. A clinical trial of the INTERPLAK powered toothbrush in a geriatric population. *Compendium Supplement* 1993;**(16)**:S606–10.

Buchmann 1987 {published data only}

Buchmann R. Indications and use of electric toothbrushes in individual oral hygiene - a comparison [Indikation und Einsatz von elektrischen Zahnbürsten in der individuellen Mundhygiene – Ein Vergleich]. *Die Quintessenz* 1987;**38** (3):531–5.

- Chaikin 1965** {published data only}
Chaikin BS, Goldman HM, Schulman SM, Ruben MP. Comparative cleansing efficiency of power-driven and conventional toothbrushes: I. Effect in uninstructed patients. *Periodontics* 1965;**149**:200–2.
- Chilton 1962** {published data only}
Chilton NW, Didio A, Rothner JT. Comparison of the clinical effectiveness of an electric and a standard toothbrush in normal individuals. *Journal of the American Dental Association* 1962;**64**:777–82.
- Ciancio 1990** {published data only}
Ciancio SG, Mather ML. A clinical comparison of two electric toothbrushes with different mechanical actions. *Clinical Preventive Dentistry* 1990;**12**(3):5–7.
- Ciancio 1998** {published data only}
Ciancio S, Shibly O, Mather ML, Al-Mubarak S, Ho A. Clinical comparison of the butler G-U-M(r) Pulse(tm) plaque remover to a manual and electric toothbrush. *Journal of Dental Research* 1998;**77**(IADR Abstracts):211 (Abstract No 845).
- Cohen 1964** {published data only}
Cohen MM, Winer RA. Comparative effectiveness of manually and power operated toothbrushing on tooth deposits. *Periodontics* 1964;**2**:122–4.
- Conforti 2003** {published data only}
Conforti NJ, Cordero RE, Liebman J, Bowman JP, Putt MS, Kuebler DS, et al. An investigation into the effect of three months' clinical wear on toothbrush efficacy: results from two independent studies. *Journal of Clinical Dentistry* 2003;**14**(2):29–33.
- Conroy 1965** {published data only}
Conroy CW. Comparison of automatic and hand toothbrushes: cleaning effectiveness. *Journal of the American Dental Association* 1965;**70**:921–9.
- Conroy 1966** {published data only}
Conroy CW. Comparison of automatic and hand toothbrushes: cleaning effectiveness for children. *ASDC Journal of Dentistry for Children* 1966;**33**:219.
- Coontz 1983** {published data only}
Coontz EJ. The effectiveness of a new oral hygiene device on plaque removal. *Quintessence International* 1983;**14**(7):739–42.
- Coontz 1985** {published data only}
Coontz EJ. The effectiveness of a new home plaque-removal instrument on plaque removal. *Compendium of Continuing Education in Dentistry* 1985;**Suppl 6**:S117–22.
- Cronin 1996a** {published data only}
Cronin M, Dembling W. An investigation of the efficacy and safety of a new electric interdental plaque remover for the reduction of interproximal plaque and gingivitis. *Journal of Clinical Dentistry* 1996;**7**(3 Spec No):74–7.
- Cronin 2000** {published data only}
Cronin MJ, Dembling WZ, Low MA, Jacobs DM, Weber DA. A comparative clinical investigation of a novel toothbrush designed to enhance plaque removal efficacy. *American Journal of Dentistry* 2000;**13**(Spec No):21A–26A.
- Cronin 2001** {published data only}
Cronin MJ, Dembling W, Conforti NJ, Liebman J, Cugini M, Warren PR. A single-use and 3-month clinical investigation of the comparative efficacy of a battery-operated power toothbrush and a manual toothbrush. *American Journal of Dentistry* 2001;**14** Spec No:19B–24B.
- Cross 1962b** {published data only}
Cross WG. A comparative study of tooth cleansing using conventional and electrically operated toothbrushes. *British Dental Journal* 1962;**113**:19–22.
- Danser 2000** {published data only}
Danser MM, Timmerman MF, Ijzerman Y, Piscoer M. Efficacy of novel manual toothbrush compared to electric toothbrush. *Journal of Dental Research* 2000;**79**(IADR Abstracts):298 (Abstract No 1236).
- Danser 2003** {published data only}
Danser MM, Timmerman MF, Ijzerman Y, Piscoer MI, van der Velden U, van der Weijden G. Plaque removal with a novel manual toothbrush (X-Active) and the Braun Oral-B 3D Plaque Remover. *Journal of Clinical Periodontology* 2003;**30**(2):138–44.
- de Leeuw 1977** {published data only}
de Leeuw J. Comparison between hand and electric toothbrushing. *Journal of Dental Research* 1977; **56** (Spec Iss D).
- Dentino 1999** {published data only}
Dentino AR, Van Swol RL, Derderian GM, Wolf MAR, Warren PR, Braun AG. Comparative evaluation of the safety of a powered versus a manual toothbrush over one year. *Journal of Periodontology* 1999;**70**(2):230.
- Derbyshire 1964** {published data only}
Derbyshire JC, Mankodi SM. Cleansing effectiveness of conventional and electric toothbrushes: a clinical comparison. *Journal of the American Dental Association* 1964;**69**:317–20.
- Dogan 2004** {published data only}
Dogan M C, Alacam A, Asici N, Odabas M, Seydaoglu G. Clinical evaluation of the plaque-removing ability of three different toothbrushes in a mentally disabled group. *Acta Odontologica Scandinavica* 2004;**62**(6):350–4.
- Doherty 1999** {published data only}
Doherty F. Plaque removal efficacy of a Novel, advanced toothbrush. *Journal of Dental Research* 1999;**78**:216 (Abstract No 885).
- Doll 1999** {published data only}
Doll GM, Typolt A, Sergl HG. The efficiency of different toothbrushes in patients with fixed orthodontic appliances. *European Journal of Orthodontics* 1999;**21**:581.
- Dorfer 2001** {published data only}
Dorfer CE, von Bethlenfalvy ER, Pioch T, Galustians HJ, Qaqish J, Sharma NC. Clinical evaluation of the efficacy of a battery-powered toothbrush. Results from two independent studies. *American Journal of Dentistry* 2001;**14**(5):273–7.

- Dorfer 2001a** *{published data only}*
Dorfer CE, Berbig B, von Bethlenfalvy ER, Staehle HJ, Pioch T. A clinical study to compare the efficacy of 2 electric toothbrushes in plaque removal. *Journal of Clinical Periodontology* 2001;**28**(11):987–94.
- Dunkin 1975** *{published data only}*
Dunkin RT. Abrasiveness of automatic vs. manual toothbrushes. *Dental Survey* 1975;**51**(5):36, 39-40, 44.
- Elliott 1963** *{published data only}*
Elliott JR. A comparison of the effectiveness of a standard and electric toothbrush. *Journal of Clinical Periodontology* 1963;**34**:375–9.
- Farrell 2006** *{published data only}*
Farrell S, Terezhalmay GT, Bartizek RD, Biesbrock AR. Comparative plaque removal efficacy of a dual-action power toothbrush and a manual tooth: effects by tooth type. *American Journal of Dentistry* 2006;**19**(4):195–200.
- Fourle 1974** *{published data only}*
Fourle J, Falabregues R, Hitzig C. Comparative evaluation of manual and electric brushing. *Actualites Odonto-Stomatologiques* 1974;**(108)**:619–46.
- Fraleigh 1965** *{published data only}*
Fraleigh CM. Tissue changes with manual and electric brushes. *Journal of the American Dental Association* 1965;**70**:380–7.
- Galustian 2002** *{published data only}*
Galustian HJ, Qaqish JG, Sharma NC, Lemli B. Plaque removal efficacy of a battery-powered toothbrush versus a manual toothbrush. *Journal of Dental Research* 2002;**81** (Spec Iss):A30–A507.
- Goldman 1975** *{published data only}*
Goldman HM. Effectiveness of an ultrasonic toothbrush in a group of uninstructed subjects. *Journal of Periodontology* 1975;**45**:84–7.
- Grossman 1994** *{published data only}*
Grossman E, Dembling W, Walley DR. Two long-term clinical studies comparing the plaque removal and gingivitis reduction efficacy of the Oral-B Advantage Plaque Remover to five manual toothbrushes. *Journal of Clinical Dentistry* 1994;**5**(2):46–53.
- Hall 1971** *{published data only}*
Hall AW, Conroy CW. Comparison of automatic and hand toothbrushes: toothbrushing effectiveness for preschool children. *Journal of Dentistry for Children* 1971;**38**:309–13.
- Heasman 2001** *{published data only}*
Heasman P, De Jager M, Stacey F, Heasman L. Testing prototype brush heads for powered toothbrushes - refining the model. *Journal of Dental Research* 2001;**80**:548 (Abstract No 0172).
- Heins 2002** *{published data only}*
Heins P, Bartizek RD, Walters PA, Biesbrock AR. Plaque removal efficacy of a battery-operated power toothbrush compared to two control manual toothbrushes in single use studies. *American Journal of Dentistry* 2002;**15** Spec No: 28A–32A.
- Heintze 1996** *{published data only}*
Heintze SD, Jost-Brinkmann PG, Loundos J. Effectiveness of three different types of electric toothbrushes compared with a manual technique in orthodontic patients. *American Journal of Orthodontics & Dentofacial Orthopedics* 1996;**110** (6):630–8.
- Hoover 1962** *{published data only}*
Hoover DR, Robinson HB. Effect of automatic and hand toothbrushing on gingivitis. *Journal of the American Dental Association* 1962;**65**:361–7.
- Hotta 1992** *{published data only}*
Hotta M, Aono M. A clinical study on the control of dental plaque using an electronic toothbrush with piezo-electric element. *Clinical Preventive Dentistry* 1992;**14**(4):16–8.
- Hou 2002** *{published data only}*
Hou L, Walters P, Bartizek RD, Biesbrock AR. Plaque removal by a battery-powered toothbrush relative to a manual toothbrush. *Journal of Dental Research* 2002;**81** (Spec Iss A):A–398.
- Howorko 1993** *{published data only}*
Howorko N, Gutek M, Naidoo S, Hoover JN. Effectiveness of an electric toothbrush on plaque removal in periodontal patients. *American Journal of Dentistry* 1993;**6**(1):49–51.
- Johnson 1994a** *{published data only}*
Johnson B, McInnes C. Efficacy and safety of the Sonicare™: a clinical evaluation. *Journal of Dental Research* 1994;**73**:434 (Abstract No 2655).
- Jongenelis 1997** *{published data only}*
Jongenelis AP, Wiedemann W. A comparison of plaque removal effectiveness of an electric versus a manual toothbrush in children. *ASDC Journal of Dentistry for Children* 1997;**64**(3):176-82, 165.
- Killoy 1988** *{published data only}*
Killoy WJ, Love JW, Love J, Fedi PF. Comparative plaque removal with power contra-rotary and conventional toothbrushes. *Journal of Dental Research* 1988;**67**(Spec Iss): 95–408.
- Killoy 1989** *{published data only}*
Killoy WJ, Love JW, Love J, Fedi PF Jr, Tira DE. The effectiveness of a counter-rotary action powered toothbrush and conventional toothbrush on plaque removal and gingival bleeding. A short term study. *Journal of Periodontology* 1989;**60**(8):473–7.
- Killoy 1993** *{published data only}*
Killoy WJ, Love JW, Love JD, Tira DE. Clinical and cost effectiveness of the counter-rotational brush in private practice. *Compendium Supplement* 1993;**(16)**:S599-605, quiz S612-4.
- Lamendola-Sitenga 1998** *{published data only}*
Lamendola-Sitenga K. Effectiveness of an ionic toothbrush on the removal of plaque in orthodontic patients: A clinical study. *Journal of Dental Research* 1998;**77**(IADR Abstracts): 123 (Abstract No 140).

- Lange 1978** *{published data only}*
Lange VDE, Munster RF. [Über die Plaquereduktion durch multi-Bursten in Verbindung mit elektrischen Zahnbursten]. *Deutsche Zahnärztliche Zeitschrift* 1978;**33**: 84–7.
- Leftkowitz 1962** *{published data only}*
Leftkowitz W, Robinson HBG. Effectiveness of automatic and hand brushes in removing dental plaque and debris. *Journal of the American Dental Association* 1962;**65**:351–61.
- Lim 1995** *{published data only}*
Lim LP, Chiu GKC, Davies WIR. Evaluation of a mechanical toothbrush for oral hygiene. *Journal of Dental Research* 1995;**74**(IADR Abstracts):589 (Abstract No 1510).
- Long 1985** *{published data only}*
Long D, Killoy WJ. Evaluation of the effectiveness of the INTERPLAK home plaque removal instrument on plaque removal and orthodontic patients. *Compendium of Continuing Education in Dentistry* 1985;**Suppl 6**:S156–60.
- Love 1988** *{published data only}*
Love JW, Drisko CL, Killoy WJ, Tira DE, Sackuvich DA. Effectiveness of a rotary action versus a manual toothbrush. *Journal of Dental Research* 1988;**67**:125.
- Lundergan 1988** *{published data only}*
Lundergan WP, Hughes WR, Hall WB. The effectiveness of a powered toothbrush on plaque removal in periodontal patients. *Compendium* 1988;**9**(8):658, 660, 662.
- Mantokoudis 2001** *{published data only}*
Mantokoudis D, Joss A, Christensen MM, Meng HX, Suvan JE, Lang NP. Comparison of the clinical effects and gingival abrasion aspects of manual and electric toothbrushes. *Journal of Clinical Periodontology* 2001;**28**(1): 65–72.
- Mascarenhas 2005** *{published data only}*
Mascarenhas AK, Soparkar P, Al-Mutawaa S, Udani TM. Plaque removal using a battery-powered toothbrush compared to a manual toothbrush. *Journal of Clinical Dentistry* 2005;**16**(1):23–5.
- Mayer 1978** *{published data only}*
Mayer R, Wieland D, Hemleben C. [Rasterelektronenmikroskopische Untersuchungen der Zahnoberfläche]. *Deutsche Zahnärztliche Zeitschrift* 1978;**33** (9):599–607.
- Mayer 1988** *{published data only}*
Mayer R, Zalitis-Cezis IE. Toothbrushing - manual or electromechanical? [Zahneputzen – manuell oder elektrisch–mechanisch?]. *ZWR* 1988;**97**(1):50–2, 54.
- McAllan 1976** *{published data only}*
* McAllan LH, Murray JJ, Brook AH, Crawford AN. Oral hygiene instruction in children using manual and electric toothbrushes. Benefits after six months. *British Dental Journal* 1976;**140**(2):51–6.
McAllan LH, Murray JJ, Brook AH, Crawford AN. Oral hygiene instruction in children using manual and electric toothbrushes. Benefits after six months. *Journal of Periodontology* 1977;**48**:409.
- Moritis 2002** *{published data only}*
Moritis K, Delaurenti M, Johnson MR, Berg J, Boghosian AA. Comparison of the Sonicare Elite and a manual toothbrush in the evaluation of plaque reduction. *American Journal of Dentistry* 2002;**15 Spec No**:23B–25B.
- Morris 1997** *{published data only}*
Morris HF, Ochi S, Truhlar R, Olson J. DICRG report: Differences in attachment levels; INTERPLAK (r) vs. manual toothbrushes: 24 month comparison. *Journal of Dental Research* 1997;**76**(IADR Abstracts):204 (Abstract No 1527).
- Moschen 1999** *{published data only}*
Moschen J, Furtlehner H, Kulmer S, Hoerl R, Falk M, Kemmler G. Clinical comparative study of one manual and three electric toothbrushes with different mechanical movement patterns. *Deutsche Zahnärztliche Zeitschrift* 1999;**54**:372–9.
- Mueller 1987** *{published data only}*
Mueller LJ, Darby ML, Allen DS, Tolle SL. Rotary electric toothbrushing. Clinical effects on the presence of gingivitis and supragingival dental plaque. *Dental Hygiene* 1987;**61** (12):546–50.
- Murray 1989** *{published data only}*
Murray PA, Boyd RL, Robertson PB. Effect of periodontal status of rotary electric toothbrushes vs. manual toothbrushes during periodontal maintenance. II. Microbiological results. *Journal of Periodontology* 1989;**60** (7):396–401.
- Niemi 1986** *{published data only}*
Niemi ML, Ainamo J, Etemadzadeh H. Gingival abrasion and plaque removal with manual versus electric toothbrushing. *Journal of Clinical Periodontology* 1986;**13** (7):709–13.
- Niemi 1987** *{published data only}*
Niemi ML. Gingival abrasion and plaque removal after toothbrushing with an electric and a manual toothbrush. *Acta Odontologica Scandinavica* 1987;**45**(5):367–70.
- Niemi 1988** *{published data only}*
Niemi ML, Ainamo J, Etemadzadeh H. Gingival abrasion and plaque removal with manual vs. electric toothbrushes. *Oral-Prophylaxe* 1988;**10**(1):11–7.
- Ojima 2003** *{published data only}*
Ojima M, Shizukuishi S, Matsuo T, Kanesaki N, Hanioka T. Comparative clinical study in plaque removal efficacy of a new sonic toothbrush (Float-Brush) with floating bristle action. *Journal of Clinical Dentistry* 2003;**14**(2):42–4.
- Ousehal 2011** *{published data only}*
Ousehal L, Lazrak L, Es-Said R, Hamdoune H, Elquars F, Khadija A. Evaluation of dental plaque control in patients wearing fixed orthodontic appliances: a clinical study. *International Orthodontics* 2011;**9**(1):140–55.
- Owen 1972** *{published data only}*
Owen TL. A clinical evaluation of electric and manual toothbrushing by children with primary dentitions. *ASDC Journal of Dentistry for Children* 1972;**39**(1):15–21.

- Palmer 1999** *{published data only}*
Palmer TM, Hall MW, Smith SL, Woolf SH, Ploeger BJ, Christensen RP. Plaque removal capabilities of one manual and five automated toothbrushes. *Journal of Dental Research* 1999;**78**(IADR Abstracts):216 (Abstract No 882).
- Parizi 2011** *{published data only}*
Parizi MT, Mohammadi TM, Afshar SK, Hajizamani A, Tayebi M. Efficacy of an electric toothbrush on plaque control compared to two manual toothbrushes. *International Dental Journal* 2011;**61**(3):131–5.
- Pelka 2008** *{published data only}*
* Pelka A, Hopp I, Nagler T, Petschelt A, Pelka M. Time-dependent cleaning effectivity of the Sonicare in comparison with the ADA manual tooth brush. *Parodontologie* 2008;**19**(3):344–5.
Pelka AK, Nagler T, Hoop I, Petschelt A, Pelka MA. Professional brushing study comparing the effectiveness of sonic brush heads with manual toothbrushes: a single blinded, randomized clinical trial. *Clinical Oral Investigations* 2011;**15**(4):451–60.
- Pizzo 2010** *{published data only}*
Izzo G, Licata ME, Pizzo I. Plaque removal efficacy of power and manual toothbrushes: a comparative study. *Clinical Oral Investigation* 2010;**14**:375–81.
- Platt 2002** *{published data only}*
Platt K, Moritis K, Johnson MR, Berg J, Dunn JR. Clinical evaluation of plaque removal efficacy and safety of the Sonicare Elite toothbrush. *American Journal of Dentistry* 2002;**15** Spec No:18B–22B.
- Powers 1967** *{published data only}*
Powers GK, Tussing GJ, Bradley RE. A comparison of effectiveness in interproximal plaque removal of an electric toothbrush and a conventional hand toothbrush. *Periodontics* 1967;**5**(1):37–41.
- Preber 1991** *{published data only}*
Preber H, Ylipaa V, Bergstrom J, Ryden H. A comparative study of plaque removing efficiency using rotary electric and manual toothbrushes. *Swedish Dental Journal* 1991;**15**(5):229–34.
- Quigley 1962** *{published data only}*
Quigley GA, Hein JW. Comparative cleansing efficiency of manual and power brushing. *Journal of the American Dental Association* 1962;**65**:26–9.
- Quirynen 1994** *{published data only}*
Quirynen M, Vervliet E, Teerlinck J, Darius P, van Steenberghe D. Medium- and long-term effectiveness of a counterrotational electric toothbrush on plaque removal, gingival bleeding, and probing pocket depth. *International Journal of Periodontics & Restorative Dentistry* 1994;**14**(4):364–77.
- Rashid 1998** *{published data only}*
Rashid Z, Kleivmyr M, Aass AM, Gjerme P. The effect upon plaque and gingivitis of two electrical and one manual toothbrush. *Journal Dental Research* 1998;**77**(IADR Abstracts):845 (Abstract No 1706).
- Renton-Harper 2001** *{published data only}*
Renton-Harper P, Addy M, Newcombe RG. Plaque removal with the uninstructed use of electric toothbrushes: comparison with a manual brush and toothpaste slurry. *Journal of Clinical Periodontology* 2001;**28**(4):325–30.
- Roscher 2004** *{published data only}*
Roscher T, Rosing CK, Gjerme P, Aass AM. Effect of instruction and motivation in the use of electric and manual toothbrushes in periodontal patients. A comparative study. *Pesquisa Odontologica Brasileira* 2004;**18**(4):296–300.
- Ruhlman 2001** *{published data only}*
Ruhlman CD, Bartizek RD, Biesbrock AR. Plaque removal efficacy of a battery-operated toothbrush compared to a manual toothbrush. *American Journal of Dentistry* 2001;**14**(4):191–4.
- Ruhlman 2002** *{published data only}*
Ruhlman CD, Bartizek RD, Biesbrock AR. Comparative efficacy of two battery-powered toothbrushes on dental plaque removal. *Journal of Clinical Dentistry* 2002;**13**(3):95–9.
- Sato 1995** *{published data only}*
Sato S, Nakagawa T, Kamoi H, Agatsuma H, Yamada S, Kamoi K. Effect of plaque removal by new electric toothbrush. *Journal of Dental Research* 1995;**74**:575 (Abstract No 1399).
- Schifter 1983** *{published data only}*
Schifter CC, Emling RC, Seibert JS, Yankell SL. A comparison of plaque removal effectiveness of an electric versus a manual toothbrush. *Clinical Preventive Dentistry* 1983;**5**(5):15–9.
- Schmage 1999** *{published data only}*
Schmage P, Platzer U, Nergiz I. Comparison between manual and mechanical methods of interproximal hygiene. *Quintessence International* 1999;**30**(8):535–9.
- Schuler 1996** *{published data only}*
Schuler N, Lang H, Nolden R. Plaque and gingivitis control in children and adults - a comparative study. *Journal of Dental Research* 1996;**75**:86 (Abstract No 548).
- Sharma 2001a** *{published data only}*
Sharma NC, Galustians HJ, Qaqish J, Cugini M. Safety and plaque removal efficacy of a battery-operated power toothbrush. *American Journal of Dentistry* 2001;**14** Spec No:9B–12B.
- Sharma 2005** *{published data only}*
Sharma NC, Qaqish JG, Galustians HJ, Cugini M, Thompson MC, Warren PR. Plaque removal efficacy and safety of the next generation of manual toothbrush with angled bristle technology: results from three comparative clinical studies. *American Journal of Dentistry* 2005;**18**(1):3–7.
- Sharma 2006** *{published data only}*
Sharma NC, Lyle DM, Qaqish JG, Galustians J. Evaluation of the plaque removal efficacy of three power toothbrushes. *Journal of the International Academy of Periodontology* 2006;**8**(3):83–8.

- Sharma 2011** *{published data only}*
Sharma NC, Qaqish J, Klukowaska M, Grender J. The plaque removal efficacy of a novel power brush head. *Journal of Clinical Dentistry* 2011;**22**:19–22.
- Silverstone 1992** *{published data only}*
Silverstone LM, Tilliss TS, Cross-Poline GN, Van der Linden E, Stach DJ, Featherstone MJ. A six-week study comparing the efficacy of a rotary electric toothbrush with a conventional toothbrush. *Clinical Preventive Dentistry* 1992;**14**(2):29–34.
- Singh 2005** *{published data only}*
Singh S, Rustogi KN, Chaknis P, Petrone ME, DeVizio W, Proskin HM. Comparative efficacy of a new battery-powered toothbrush and a commercially available manual toothbrush on the removal of established supragingival plaque: a single-use crossover study in adults. *Journal of Clinical Dentistry* 2005;**16**(2):57–61.
- Smith 1964** *{published data only}*
Smith WA, Ash MM Jr. A clinical evaluation of an electric toothbrush. *Journal of Periodontology* 1964;**35**:127–36.
- Stadtler 1984** *{published data only}*
Stadtler P. Effect of electrical toothbrushes and manual toothbrushes on oral hygiene in children. *Zeitschrift für Stomatologie* 1984;**81**(1):21–4.
- Swenson 1967** *{published data only}*
Swenson HM, Bixler D. Effectiveness of Iontophoresis in the control of plaque and calculus formation in adults. *Journal of Periodontology* 1967;**38**:481–3.
- Taylor 1995** *{published data only}*
Taylor JY, Wood CL, Garnick JJ, Thompson WO. Removal of interproximal subgingival plaque by hand and automatic toothbrushes. *Journal of Periodontology* 1995;**66**(3):191–6.
- Tenenbaum 1984** *{published data only}*
Tenenbaum H, Kayserlian D. Comparative evaluation of manual and electric toothbrushes in the elimination of bacterial plaque in a population of dental students. *Journal de Parodontologie* 1984;**3**(3):295–302.
- Terezhalmay 2005** *{published data only}*
Terezhalmay GT, Bartizek RD, Biesbrock AR. Relative plaque removal of three toothbrushes in a nine-period crossover study. *Journal of Periodontology* 2005;**76**(12):2230–5.
- Thienpont 2001** *{published data only}*
Thienpont V, Dermaut LR, Van Maele G. Comparative study of 2 electric and 2 manual toothbrushes in patients with fixed orthodontic appliances. *American Journal of Orthodontics & Dentofacial Orthopedics* 2001;**120**(4):353–60.
- Trimpeners 1997** *{published data only}*
Trimpeners LM, Wijgaerts IA, Grogard NA, Dermaut LR, Adriaens PA. Effect of electric toothbrushes versus manual toothbrushes on removal of plaque and periodontal status during orthodontic treatment. *American Journal of Orthodontics & Dentofacial Orthopedics* 1997;**111**(5):492–7.
- Trombello 1995** *{published data only}*
Trombello L, Scabbia A, Griselli A, Zangari F, Calura G. Clinical evaluation of plaque removal by counterrotational electric toothbrush in orthodontic patients. *Quintessence International* 1995;**26**(3):199–202.
- Tscharre-Z 1989** *{published data only}*
Tscharre-Zachhuber C, Riedl MA, Kulmer S, Kemmler G. Effectiveness of power toothbrushes. *Zeitschrift für Stomatologie* 1989;**86**(6):369–75.
- Vandana 2004** *{published data only}*
Vandana KL, Penumatsa GS. A comparative evaluation of an ultrasonic and a manual toothbrush on the oral hygiene status and stain removing efficacy. *Journal of the Indian Society of Pedodontics & Preventive Dentistry* 2004;**22**(1):33–5.
- van der Weijden 1993** *{published data only}*
van der Weijden GA, Danser MM, Nijboer A, Timmerman MF, van der Velden U. The plaque-removing efficacy of an oscillating/rotating toothbrush. A short-term study. *Journal of Clinical Periodontology* 1993;**20**(4):273–8.
- van der Weijden 1998** *{published data only}*
van der Weijden GA, Timmerman MF, Piscoer M, IJzerman Y, Warren PR, van der Velden U. A comparison of the efficacy of a novel electric toothbrush and a manual toothbrush in the treatment of gingivitis. *American Journal of Dentistry* 1998;**11**(Spec No):S23–8.
- van der Weijden 2002a** *{published data only}*
van der Weijden GA, Timmerman MF, Piscoer M, IJzerman Y, van der Velden U. A clinical comparison of three powered toothbrushes. *Journal of Clinical Periodontology* 2002;**29**(11):1042–7.
- van Venrooy 1985** *{published data only}*
van Venrooy JR, Phillips C, Christensen J, Mayhew MJ. Plaque removal with a new powered instrument for orthodontic patients in fixed appliances. *Compendium of Continuing Education in Dentistry* 1985;**Suppl 6**:S142–6.
- Versteeg 2006** *{published data only}*
Versteeg PA, Timmerman MF, Paraskevas S, van der Weijden GA. Evaluation of several brushing motion combinations in relation to plaque-removing efficacy with Oral-B CrossAction Power: a professional brushing study. *International Journal of Dental Hygiene* 2006;**4**(4):204–8.
- Vervliet 1989** *{published data only}*
Vervliet E, Teerlinck J, Quirynen M, van Steenberghe D. The effectiveness of a powered toothbrush (interplak) on plaque removal: a pilot study. *Journal of Dental Research* 1989;**68**:614.
- Walsh 1984** *{published data only}*
Walsh TF, Glenwright HD. Relative effectiveness of a rotary and conventional toothbrush in plaque removal. *Community Dentistry and Oral Epidemiology* 1984;**12**(3):160–4.
- Warren 2007** *{published data only}*
Warren P, Thompson M, Cugini M. Plaque removal efficacy of a novel manual toothbrush with MicroPulse bristles and

- an advanced split-head design. *Journal of Clinical Dentistry* 2007;**18**(2):49–54.
- Whitmyer 1998** *{published data only}*
Whitmyer CC, Terezhalmay GT, Miller DL, Hujer ME. Clinical evaluation of the efficacy and safety of an ultrasonic toothbrush system in an elderly patient population. *Geriatric Nursing* 1998;**19**(1):29–33.
- Wiedemann 2001** *{published data only}*
Wiedemann W, Sturm D, de Jager M. Plaque removal efficacy of an electric and a manual toothbrush with additional interdental tufts. *Journal of Clinical Dentistry* 2001;**12**(1):21–3.
- Wilcoxon 1991** *{published data only}*
Wilcoxon DB, Ackerman RJ Jr, Killoy WJ, Love JW, Sakumura JS, Tira DE. The effectiveness of a counterrotational-action power toothbrush on plaque control in orthodontic patients. *American Journal of Orthodontics & Dentofacial Orthopedics* 1991;**99**(1):7–14.
- Williams 2003a** *{published data only}*
Williams K, Haun J, Dockter K, Ferrante A, Bartizek RD, Biesbrock AR. Plaque removal efficacy of a prototype power toothbrush compared to a positive control manual toothbrush. *American Journal of Dentistry* 2003;**16**(4): 223–7.
- Williams 2004** *{published data only}*
Williams K, Ferrante A, Dockter K, Haun J, Biesbrock AR, Bartizek RD. One- and 3-minute plaque removal by a battery-powered versus a manual toothbrush. *Journal of Periodontology* 2004;**75**(8):1107–13.
- Williams 2010** *{published data only}*
Williams K, Rapley K, Haun J, Walters P, Grender J, He T, et al. Benefit of the power component of sonic and rotation-oscillation modes of action for plaque removal using power toothbrushes. *American Journal of Dentistry* 2010;**23**(2): 60–4.
- Wilson 1991** *{published data only}*
Wilson S, Levine D, Porush J. A clinical study to compare the antiplaque and antigingivitis effectiveness of 2 electric toothbrushes and a manual toothbrush after 3 months of normal usage. *Journal of Periodontology* 1991;**62**:808.
- Yankell 1994** *{published data only}*
Yankell SL, Emling RC. A study of gingival irritation and plaque removal following a three-minute toothbrushing. *Journal of Clinical Dentistry* 1994;**5**(1):1–4.
- Yukna 1993a** *{published data only}*
Yukna RA, Shaklee RL. Interproximal vs midradicular effects of a counter-rotational powered brush during supportive periodontal therapy. *Compendium of Continuing Education in Dentistry* 1993;**(16)**:S580–6, quiz S612–4.
- Zimmer 1999** *{published data only}*
Zimmer S, Didner B, Roulet JF. Clinical study on the plaque-removing ability of a new triple-headed toothbrush. *Journal of Clinical Periodontology* 1999;**26**(5):281–5.
- Borutta 2002** *{published data only}*
Borutta A, Pala E, Fischer T. Effectiveness of a powered toothbrush compared with a manual toothbrush for orthodontic patients with fixed appliances. *Journal of Clinical Dentistry* 2002;**13**(4):131–7.
- De Beule 1990** *{published data only}*
De Beule F, Bercy P. Comparative effectiveness of the Interplak electric rotary toothbrush. *Journal de Parodontologie* 1990;**9**(1):45–8.
- Horton 1989** *{published data only}*
Horton J. A study to evaluate a new commercially available rotary type electric toothbrush. Unpublished report Ohio State University.
- Jain 2013** *{published data only}*
Jain Y. A comparison of the efficacy of powered and manual toothbrushes in controlling plaque and gingivitis: a clinical study. *Clinical, Cosmetic and Investigational Dentistry* 2013; **5**:3–9.
- Marini 2014** *{published data only}*
Marini I, Bortolotti F, Parenti SI, Gatto MR, Bonetti GA. Combined effects of repeated oral hygiene motivation and type of toothbrush on orthodontic patients: A blind randomized clinical trial. *The Angle Orthodontist* 2014 [Epub ahead of print].
- Mayer 1990** *{published data only}*
Mayer R. Electric toothbrushes—manual toothbrushes, a comparison. *ZWR* 1990;**99**(3):188–92.
- Nathoo 2012** *{published data only}*
Nathoo S, Mankodi S, Mateo LR, Chaknis P, Panagakos F. A clinical study comparing the supragingival plaque and gingivitis efficacy of a specially engineered sonic powered toothbrush with unique sensing and control technologies to a commercially available manual flat-trim toothbrush. *Journal of Clinical Dentistry* 2012;**23** Spec No A:A11–6.
- Sharma 2001** *{published data only}*
Sharma N, Rustogi K, Petrone M, Volpe AR, Sintes J. Comparative efficacy on supragingival plaque and gingivitis of a manual and battery powered toothbrush (Abstract FDI World Dental Congress). *International Dental Journal* 2001;**51**(5):374.
- Sharma 2012** *{published data only}*
Sharma NC, Klukowska M, Mielczarek A, Grender JM, Qaqish J. A 4-week clinical comparison of a novel multi-directional power brush to a manual toothbrush in the reduction of gingivitis and plaque. *American Journal of Dentistry* 2012;**25**(Spec No A):14A–20A. [PUBMED: 23248894]
- Swierkot 2013** *{published data only}*
Swierkot K, Brusius M, Leismann D, Nonnenmacher C, Nüsing R, Lubbe D, et al. Manual versus sonic-powered toothbrushing for plaque reduction in patients with dental implants: an explanatory randomised controlled trial. *European Journal of Oral Implantology* 2013;**6**(2):133–44. [PMID:23926585.]

References to studies awaiting assessment

Additional references

Ainamo 1975

Ainamo J, Bay I. Problems and proposals for recording gingivitis and plaque. *International Dental Journal* 1975;**25**(4):229–35.

Albertsson 2010

Albertsson KW, van Dijken JW. Awareness of toothbrushing and dentifrice habits in regularly dental care receiving adults. *Swedish Dental Journal* 2010;**34**:71–8.

Aspiras 2013

Aspiras MBL, Barros SP, Moss KL, Barrow DA, Phillips ST, Mendoza L, et al. Clinical and subclinical effects of power brushing following experimental induction of biofilm overgrowth in subjects representing a spectrum of periodontal disease. *Journal of Clinical Periodontology* 2013;**40**(12):1118–25.

British Society of Periodontology 2012

British Society of Periodontology. *The Young Practitioners Guide to Periodontology*. London, UK: British Society of Periodontology, 2012.

Chadwick 2011

Chadwick B, White D, Lader D, Pitts N. *5: Preventive Behaviour and Risks to Oral Health - a Report from the Adult Dental Health Survey 2009*. UK: The Health and Social Care Information Centre, 2011.

Chen 1997

Chen M, Anderson RM, Barmes DE, Leclercq M-H, Lyttle CS. Comparing oral health care systems a second international collaborative study. Geneva: World Health Organization. *Comparing oral health care systems a second international collaborative study*. Geneva: World Health Organization, 1997.

Chesters 1992

Chesters RK, Huntington E, Burchell CK, Stephen KW. Effect of oral care habits on caries in adolescents. *Caries Research* 1992;**26**(4):299–304.

Chilton 1962a

Chilton NW, Didio A, Rothner JT. Comparison of the clinical effectiveness of an electric and a standard toothbrush in normal individuals. *Journal of the American Dental Association* 1962;**64**:777–82.

Cross 1962

Cross WG, Forrest JO, Wade AB. A comparative study of tooth cleansing using conventional and electrically operated toothbrushes. *British Dental Journal* 1962;**113**:19–22.

D'Agostino 1992

D'Agostino RB. Discussion: Logical and analytic issues in dental/oral product comparison research. *Journal of Periodontal Research* 1992;**27**(4 Pt 2):349–51.

Deacon 2010

Deacon SA, Glennly A-M, Deery C, Robinson PG, Heanue M, Walmsley AD, et al. Different powered toothbrushes for plaque control and gingival health. *Cochrane Database of Systematic Reviews* 2010, Issue 12. [DOI: 10.1002/14651858.CD004971.pub2]

Deeks 2001

Deeks JJ, Altman DG, Bradburn MJ. Statistical methods for examining heterogeneity and combining results from several studies in meta-analysis. In: Egger M, Davey Smith G, Altman DG editor(s). *Systematic Reviews in Health Care*. 2nd Edition. London: BMJ Books, 2001:285–312.

Egger 1997

Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ* 1997;**315**(7109):629–34.

Elbourne 2002

Elbourne DR, Altman DG, Higgins JP, Curtin F, Worthington HV, Vail A. Meta-analyses involving cross-over trials: methodological issues. *International Journal of Epidemiology* 2002;**31**(1):140–9.

Elliot 1963

Elliot JR. A comparison of the effectiveness of a standard and electric toothbrush. *Journal of Periodontology* 1963;**34**:375–9.

Farina 2013

Farina R, Tomasi C, Trombelli L. The bleeding site: a multi-level analysis of associated factors. *Journal of Clinical Periodontology* 2013;**40**(8):735–42. [DOI: 10.1111/jcpe.12118.]

Higgins 2011

Higgins JPT, Green S (editors). *Cochrane Handbook for Systematic Reviews of Interventions* version 5.1 (updated March 2011). The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

Hoover 1962

Hoover DR, Robinson HB. Effect of automatic and hand toothbrushing on gingivitis. *Journal of the American Dental Association* 1962;**65**:361–7.

Imrey 1992

Imrey PB. Logical and analytic issues in dental/oral product comparison research. *Journal of Periodontal Research* 1992;**27**(4 Pt 2):328–41.

Imrey 1994

Imrey PB, Chilton NW, Pihlstrom BL, Proskin HM, Kingman A, Listgarten MA, et al. Recommended revisions to American Dental Association guidelines for acceptance of chemotherapeutic products for gingivitis control. *Journal of Periodontal Research* 1994;**29**(4):299–304.

Lang 1973

Lang NP, Cumming BR, Loe H. Toothbrushing frequency as it relates to plaque development and gingival health. *Journal of Periodontology* 1973;**44**(7):396–405.

Lexchin 2003

Lexchin J, Bero LA, Djulbegovic B, Clark O. Pharmaceutical industry sponsorship and research outcome and quality: systematic review. *BMJ* 2003;**326**(7400):1167–70.

Löe 1963

Löe H, Silness J. Periodontal disease in pregnancy. I. Prevalence and severity. *Acta Odontologica Scandinavica* 1963;**21**:533–51.

Marcenes 2013

Marcenes W, Kassebaum NJ, Bernabé E, Flaxman A, Naghavi M, Lopez A, et al. Global burden of oral conditions in 1990-2010: a systematic analysis. *Journal of Dental Research* 2013;**92**:592.

McKittrick 2014

McKittrick TR1, Jacobsen KH. Oral hygiene practices among middle-school students in 44 low- and middle-income countries. *International Dental Journal* 2014 [Epub ahead of print].

Petersen 2005

Petersen PE, Bourgeois D, Ogawa H, Estupinan-Day S, Ndiaye C. The global burden of oral diseases and risks to oral health. *Bulletin of the World Health Organization* 2005; **83**:9.

Petersen 2012

Petersen PE, Ogawa H. The global burden of periodontal disease: towards integration with chronic disease prevention and control. *Periodontology 2000* 2012;**60**(1):15–39.

RevMan 2012

The Nordic Cochrane Centre, The Cochrane Collaboration. Review Manager (RevMan). Version 5.2. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2012.

Robinson 2006

Robinson PG, Walmsley DA, Heanue M, Deacon S, Deery C, Glenny AM, et al. Quality of trials in a systematic review of powered toothbrushes: suggestions for future clinical trials. *Journal of Periodontology* 2006;**77**(12):1944–53.

Russell 1967

Russell AL. The Periodontal Index. *Journal of Periodontology* 1967;**38**(6):585–91.

Steele 2011

Steele J, Treasure E, Fuller L, Morgan M. *4: Complexity and Maintenance - a Report from the Adult Dental Health Survey 2009*. UK: The Health and Social Care Information Centre, 2011.

Terezhalmay 1995b

Terezhalmay GT, Gagliardi VB, Rybicki LA, Kauffman MJ. Clinical evaluation of the efficacy and safety of the

Ultrasonex toothbrush: a 30-day study. *Compendium* 1995; **15**(7):866, 868, 870-2.

Turesky 1970

Turesky S, Gilmore ND, Glickman I. Reduced plaque formation by the chloromethyl analogue of vitamin C. *Journal of Periodontology* 1970;**41**(1):41–3.

White 2004

White D, Lader D. Children's Dental Health in the United Kingdom, 2003. *Children's Dental Health in the United Kingdom, 2003*. London, UK: Office for National Statistics, 2004.

White 2011

White D, Pitts N, Steele J, Sadler K, Chadwick B. *2: Disease and Related Disorders - a Report from the Adult Dental Health Survey 2009*. UK: The Health and Social Care Information Centre, 2011.

Zenkner 2013

Zenkner JE, Alves LS, de Oliveira RS, Bica RH, Wagner MB, Maltz M. Influence of eruption stage and biofilm accumulation on occlusal caries in permanent molars: a generalized estimating equations logistic approach. *Caries Research* 2013;**47**(3):177–82.

References to other published versions of this review**Heanue 2003**

Heanue M, Deacon SA, Deery C, Robinson PG, Walmsley AD, Worthington HV, et al. Manual versus powered toothbrushing for oral health. *Cochrane Database of Systematic Reviews* 2003, Issue 1. [DOI: 10.1002/14651858.CD002281]

Robinson 2005

Robinson P, Deacon SA, Deery C, Heanue M, Walmsley AD, Worthington HV, et al. Manual versus powered toothbrushing for oral health. *Cochrane Database of Systematic Reviews* 2005, Issue 2. [DOI: 10.1002/14651858.CD002281.pub2]

* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Ainamo 1997

Methods	RCT, parallel, single blind, 12 months, n = 112 with 1 drop-out
Participants	Finland, adults, 20 to 63 years, 64 M 47 F, bleeding on probing >30% sites, no medical problems
Interventions	Braun Oral B Plak Control versus Jordan soft, 2 min twice daily. Use of timer not stated
Outcomes	Ainamo and Bay Visible plaque index and modified gingival bleeding index. 3, 6 and 12 months. Whole mouth recording PI and GI
Notes	No pre-examination instructions reported.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "The study was randomised..." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "... parallel group, single blind (to examiner), with a duration of 12 months."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 1/112. 1 withdrew from the electric toothbrush group for personal (non-clinical) reasons before the 3-month assessment. Unlikely to influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Baab 1989

Methods	RCT, parallel, single blind, 1 month, n = 41, with 2 drop-outs
Participants	USA, adults, 18 to 59 years, 24 M:16 F, >20 teeth with moderate gingivitis, no medical problems
Interventions	Interplak versus Butler 411, 3 min twice daily. Use of timer not stated

Baab 1989 (Continued)

Outcomes	O'Leary plaque index, Löe and Silness gingival index, Ainamo and Bay gingival bleeding index. Ramfjord teeth for GI, whole mouth for PI. Gingival abrasion reported to be not significant. Plaque scores awaiting assessment
Notes	Manufacturer funded. No pre-examination instructions reported.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned.." Insufficient information.
Allocation concealment (selection bias)	Low risk	Quote: "...The manufacturer provided 20 Interplak electric toothbrushes and 20 Butler 411 toothbrushes... arranged randomly in consecutively-numbered boxes."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "...One investigator (DAB) served as the blind examiner and made all clinical.."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 2/41. 1 participant did not comply (manual) and 1 other withdrew from study (electric). Unlikely to influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Barnes 1993

Methods	RCT, parallel, single blind, 3 months, n = 70 with 1 drop-out
Participants	USA, adults, 18 to 65 years, >20 teeth, gingival index >1.5, plaque index >2
Interventions	Braun Oral B Plaque Remover versus Johnson & Johnson Reach, as per normal use
Outcomes	Quigley Hein (Turesky) plaque index, Löe and Silness (Lobene) gingival index at full mouth sites. Soft tissue trauma, no difference between brushes. Whole mouth recording PI and GI
Notes	Manufacturer funded. No pre-examination instructions reported.

Barnes 1993 (Continued)

<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned.." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "All clinical examinations were performed by the same evaluator. This study was conducted in a single-blind manner."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 1/70. Unlikely to influence results.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Biavati Silvestrini 2010

Methods	RCT, parallel, 8 weeks, n = 20, no drop-outs, F 12:M 8.
Participants	Italy, orthodontic patients, 10 to 14 years with permanent dentition, scheduled to receive multibracket
Interventions	Oral B 35 versus Oral B Pro Care 8500, 2 min twice daily.
Outcomes	O'Leary plaque index, Ainamo and Bay index, unsure full mouth sites or partial mouth score, not monitored compliance and adverse event
Notes	Source of funding unclear, no pre-examination instruction reported, low number of subjects

<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly divided..." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information.

Biavati Silvestrini 2010 (Continued)

Incomplete outcome data (attrition bias) All outcomes	Low risk	No drop-outs.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Biesbrock 2007

Methods	RCT, parallel, single blind, 8 weeks, n = 179 with 5 drop-outs in full trial (n = 59 for powered versus manual comparison)
Participants	United States, adults, 18 to 69 years, ≥15 sites with bleeding on probing
Interventions	Oral B Pro Care series versus Oral B Cross Action, 2 min twice daily, use of timer not stated
Outcomes	Rustogi Mod of the Navy plaque index, Löe & Sillness gingival index at 0 and 8 weeks. Whole mouth recording of plaque and gingivitis. Adverse event reported; no difference between groups
Notes	Manufacturer funded. This is a trial of 2 manual groups with different toothpaste. 3 other groups with numerous combinations - 2 powered toothbrushes and mouthwash were also assessed. We used the comparison of manual and powered using the same toothpaste. Pre-intervention prophylaxis done. Pre-examination instruction given; no brushing for 12 hours and no drinking, no eating or tobacco for 4 hours

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "Eligible subjects were stratified based on gender and the number of baseline sites (≤40 or ≥41), and randomly assigned to" Insufficient information.
Allocation concealment (selection bias)	Low risk	Quote: "... all test products were distributed in blinded kit boxes...."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "... all clinical assessment (efficacy and safety) were conducted by examiners who were blinded as to treatment assignment."

Biesbrock 2007 (Continued)

Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 1/59. None due to product-related adverse events. Unlikely influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Clerehugh 1998

Methods	RCT, parallel, single blind, 8 weeks, n = 84 with 5 drop-outs
Participants	UK, children and adolescents, 10 to 20 years, orthodontic patients in practice, fixed appliances, gingival bleeding at 30% sites, no medical conditions
Interventions	Braun Plaque Remover with OD 5 head versus Reach medium compact head, 2 min twice daily. Timer used
Outcomes	Orthodontic modification of Silness and Løe plaque index, Eastman bleeding index at all buccal sites at 4, 8 weeks. No evidence of trauma. 1 mechanical brush failed
Notes	Manufacturer funded. Participants asked to brush in the morning and under supervision prior to assessment

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...subjects were randomly allocated to groups using the minimisation methods..."
Allocation concealment (selection bias)	Low risk	Quote: "...and the clinical trial investigator remained blind to the toothbrush group allocation."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "...and the clinical trial investigator remained blind to the toothbrush group allocation."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 5/84 completed. Reason for drop-outs: electric toothbrush group (37/41) - 1 failed to attend final examination, 1 failed to follow brushing instruction, 1 failed to use the product for 7 days prior to the week 4 examination, 1 was put on tetracycline; manual group (42/43) - 1 de-

Clerhugh 1998 (Continued)

		veloped chicken pox and could not attend for examination. Unlikely to influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Costa 2007

Methods	RCT, single blind, cross-over, n = 21 with no drop-outs, 30 days (15 days wash-out period)
Participants	Brazil, orthodontics patients, aged 12 to 18 years, at least 20 teeth assessable, orthodontic treatment a minimum of 1 year, non-smokers with no history of periodontal disease
Interventions	Ultrasonex Ultima versus Oral B 3D versus Oral B Model 30, 2 min 3 times daily, use of timer not stated
Outcomes	Sillness and Løe plaque indices, Løe and sillness gingival indices, microbiological parameters assessed, no difference in clinical and microbiological parameters. No adverse effect reported
Notes	Funding unclear, pre-intervention prophylaxis done.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly divided into three groups ..." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No drop-outs.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Cronin 1998

Methods	RCT, parallel, single blind, 3 months, n = 114, 9 drop-outs.
Participants	USA, adults, >18 teeth, no medical problems, 18 to 65 years.
Interventions	Braun Oral B 3D Plaque Remover versus standard ADA reference manual, 2 min twice daily. Timer used
Outcomes	Quigley Hein (Turesky) plaque index, Löe and Silness gingivitis and bleeding index, at 14, 35 and 90 days, at all sites. Gingival recession recorded, no change seen. No other adverse effects. Whole mouth recording PI and GI
Notes	Manufacturer funded. Participants asked to refrain from brushing 12 to 14 hours prior to assessment

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomly assigned to 2 groups by Zelen's method of permuted blocks of size 4
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "...all subject were evaluated by the same examiner who was unaware of the type of toothbrush used by the subject."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 9/114 completed. Reasons for drop-outs: powered group - 8 with reasons unrelated to treatment; manual group - 1 failed to return for final examination. Unlikely to influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Dentino 2002

Methods	RCT, parallel, single blind, 6 months, n = 172 with 15 drop-outs
Participants	USA, adults, mild to moderate gingivitis with >20 teeth, no previous powered brush experience. Excluded if pregnant/lactating
Interventions	Braun Oral B D9 versus ADA accepted standard soft bristle manual, 2 min twice daily. Use of timer not stated

Dentino 2002 (Continued)

Outcomes	Quigley Hein (Turesky) plaque index and Lobene gingival index at 3 and 6 months. Powered brush removed more calculus. No difference in stain removal reported. PI and GI whole mouth
Notes	Manufacturer funded. Participants asked to brush teeth (non-supervised) immediately prior to 6-month plaque assessment

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Based on the screening visits, patients were stratified by gender, MGI, plaque index (PI), and smoking using a computer program, and were randomly assigned..."
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "This 6-month, single-masked, parallel design..."
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Drop-outs: 15/172 but unclear as to which group these were from
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Dorfer 2009

Methods	RCT, parallel, single blind, 6 months, n = 109 with 3 drop-outs
Participants	Germany, adult with recession, 18 to 70 years, ≥18 teeth present, ≥2 sites with at least 2 mm recession
Interventions	Oral B 7000 (D17) versus ADA toothbrush, 2 min twice daily, use of timer not stated
Outcomes	Turesky modified Quigley Hein plaque indices and gingivitis indices at 0, 6 months. Whole mouth recording of plaque and gingivitis. Main outcome measured was gingival recession; reduced pre-existing gingival recession in both groups. Other outcomes: PPD, PAL. Adverse event reported; no different between both groups. All patients reported to be compliant

Dorfer 2009 (Continued)

Notes	Manufacturer funded. Pre-intervention instruction on use of each toothbrushes done. Matched or stratified groups	
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "prospective randomized, controlled ..." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "...examiner blind.."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 3/109. Unlikely to influence results.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Emling 1991

Methods	RCT, parallel, single blind, 30 days, n = 60 with 3 drop-outs	
Participants	USA, adults, no medical problems, no current ortho, not pregnant, >17 teeth, 18 to 60 years	
Interventions	Plak Trac versus Colgate ADA approved, twice daily. Use of timer not stated	
Outcomes	Quigley and Hein (Turesky) plaque index. Yankell, interproximal plaque index, Löe and Sillness gingival index. Ramfjord teeth for both PI and GI	
Notes	Pre-brushing measurements used.	
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned ..." Insufficient information.

Emling 1991 (Continued)

Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "The study was thus conducted in a single-blind manner."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 3/60.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Forgas-B 1998

Methods	RCT, parallel, single blind, 30 days, n = 62 with 6 drop-outs
Participants	USA, adults, mean age 37 years +/- 10 years, >16 teeth, plaque index >2, no medical problems, 21 M:35 F
Interventions	Ultrasonex versus manual Oral B, twice daily. Use of timer not stated
Outcomes	Quigley and Hein (Turesky) plaque index, Eastman gingival bleeding index at 30 days. Ramfjord teeth for PI and GI. Soft tissue trauma reported, no difference between groups
Notes	Manufacturer funded. Participants asked to refrain from brushing for 12 to 14 hours before assessment

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned ..." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "Examiners were blind to group assignment."
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Drop-outs: 6/62 (5 from manual group; 1 from powered group). Uneven drop-outs across groups; reasons not stated
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.

Forgas-B 1998 (Continued)

Other bias	Low risk	No other apparent biases.
------------	----------	---------------------------

Galgut 1996

Methods	RCT, parallel, single blind, 28 days, n = 70 with 7 drop-outs
Participants	UK, Caucasians, male, 19 to 36 years.
Interventions	Sangi Co Electronic (Active) versus Sangi Co Electronic (non-active), 3 minutes when brushing. No frequency stated. Use of timer not stated
Outcomes	Quigley and Hein (Turesky) plaque index, Löe and Silness gingival index at 2, 4 weeks. Whole mouth recording for indices. No adverse events recorded
Notes	Manufacturer funded. Assessment after 24 hours of no brushing

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "The company supplied 75 toothbrushes, numbered 1 to 75. Some ... were electrically active, and others...inactive" "Subjects received a trial toothbrush in numerical order.." Not explicit but probably appropriate method.
Allocation concealment (selection bias)	Low risk	Quote: "Subjects received a trial toothbrush in numerical order..." "After completion of the clinical trial, coding ...was revealed to the primary investigator."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "...toothbrushes were indistinguishable by anyone concerned with the clinical trial...."
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Drop-outs: 7/70. Unclear as to drop-outs by group.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Garcia-Godoy 2001

Methods	RCT, parallel, single blind, 30 days, n = 70 with 4 drop-outs
Participants	USA, children, 6 to 11 years, able to understand procedure.
Interventions	Braun Oral B D10 per manufacturers instructions versus ADA approved manual brush as normal
Outcomes	Quigley Hein (Turesky) plaque index. Whole mouth. No adverse events recorded
Notes	Manufacturer funded. Assessment after 12 to 18 hours from last brushing

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomized to..." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "...conducted by the same examiner who was blinded to the treatment group."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 4/70. Unlikely to influence results.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Glass 1965

Methods	RCT, parallel, single blind, 11 months, n = 250 with 84 drop-outs
Participants	USA, dental students, male, 20 to 29 years.
Interventions	GEC powered versus Pycopay brand manual twice daily. Use of timer not stated
Outcomes	Glass debris and gingival indices at 6 weeks, 7 and 11 months at all sites. Stain and calculus reported to be no different between brush types. Whole mouth recording PI and GI. No soft tissue trauma reported
Notes	Manufacturer funded. No pre-examination instructions reported.

Risk of bias

Glass 1965 (Continued)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "A random, binary digit was punched by a computer into each name card to provide identification of two groups" "A coin was tossed to determine the assignment of brushes."
Allocation concealment (selection bias)	Low risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "...the examiner was unaware of the brush type used by the subject."
Incomplete outcome data (attrition bias) All outcomes	High risk	Drop-outs: 84/250 drop-outs. Unclear of drop-outs by group; could influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Goyal 2007

Methods	RCT, parallel, single blind, 30 days, n = 53 with no drop-outs
Participants	Canada, adults, 18 to 65 years, Löe and Sillness gingival index ≥ 1.5
Interventions	Ultreo Versus Oral B 35, twice daily, period of brushing not stated, use of timer not stated
Outcomes	Löe and Silness gingival indices at 0, 30 days at all sites. Whole mouth. Adverse event reported; no different between groups. Subjective experience of cleanliness assessed revealed higher score in Ultreo group. No adverse event reported
Notes	Manufacturer funded. No pre-intervention treatment and pre-examination instruction given

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned ..." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.

Goyal 2007 (Continued)

Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: “ ..was a randomised, examiner blind, parallel...”
Incomplete outcome data (attrition bias) All outcomes	Low risk	No drop-outs.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Gugerli 2007

Methods	RCT, parallel, single blind, 28 days, n = 70 with no drop-outs
Participants	Switzerland, adults, 18 to 70 years, M 46 F 46, minimum of 12 score able teeth, chronic periodontitis, Class II, good general health
Interventions	Oral B Pro Care 8000 versus ADA, twice daily, period of brushing not stated, use of timer not stated
Outcomes	Sillness and Löe plaque indices and Löe and Sillness gingival indices at 0, 28 days at all sites. Whole mouth recording of plaque and gingival indices. Compliance recorded in diaries. Abrasion reported in 3 patients of each groups
Notes	Manufacturer funded. Pre-intervention prophylaxis done, pre-intervention instructions on oral hygiene given for 15 min

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: “Subjects were assigned randomly by a computer-generated table...”
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: “This was an examiner-masked...”
Incomplete outcome data (attrition bias) All outcomes	Low risk	No drop-outs.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.

Gugerli 2007 (Continued)

Other bias	Low risk	No other apparent biases.
------------	----------	---------------------------

Haffajee 2001a

Methods	RCT, parallel, single blind, 6 months, n = 52 with 4 drop-outs
Participants	USA, systemically healthy participants with adult periodontitis, 20 to 64 years, minimum of 20 teeth
Interventions	Crest Complete versus Braun Oral B D15 Plaque Remover. Frequency unclear. Use of timer not stated
Outcomes	Turesky plaque index , L�oe and Silness gingival index, bleeding on probing and probing attachment level at baseline, 3 and 6 months. Measurements taken for 6 sites per tooth for up to 28 teeth
Notes	Manufacturer funded. No pre-examination instructions reported.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: " ..toothbrushing group using a pre-determined randomisation schedule."
Allocation concealment (selection bias)	Low risk	Quote: " A copy of randomization schedule and study codes were kept by the principal investigator."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "In this 6 months, single-blind study,..."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 4/52. Reasons for drop-outs: moving away from the area, did not want to use toothpaste provided and reasons unrelated to study. Unlikely to influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Heasman 1999

Methods	RCT, parallel, single blind, 6 weeks, n = 75 with 1 drop-out
Participants	UK, adults, >permanent 20 teeth, 18 to 25 years, no medical problems
Interventions	Braun Oral B D7 versus Philips Jordan HP 735 versus Oral B Advantage B35, >90 seconds twice daily. Use of timer not stated
Outcomes	Quigley Hein (Turesky) plaque index at 24 hours and 6 weeks, Löe and Silness gingival index at 6 weeks, all sites. Whole mouth recording PI and GI.
Notes	Assessment done within 3 to 4 hours of last brushing. 2 powered groups combined for meta-analysis.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...allocated ranomly..."
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "...single-blind clinical trial was undertaken..."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 1/75. Unlikely to influence results.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Hickman 2002

Methods	RCT, parallel, blinding unclear, 8 weeks, n = 63 with 3 drop-outs
Participants	UK, orthodontic patients, 10 to 20 years, medically fit.
Interventions	Braun Plaque Remover 3D with orthodontic head versus Reach compact head manual, 2 min twice daily. Timer supplied
Outcomes	Silness and Löe plaque index (orthodontic modification) and Löe and Silness gingival index, full mouth at 4 and 8 weeks
Notes	Manufacturer funded. Brush as normal post-breakfast.

Hickman 2002 (Continued)

<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...randomly assigned...", "...prepared by the trial statistician..." Sequence generation not explicit, but assumed low risk of bias
Allocation concealment (selection bias)	Unclear risk	Quote: "The trial coordinator who opened a sealed envelopes, prepared by the trial statistician, containing the group allocation, undertook randomization." Unclear if sealed envelopes were sequentially numbered.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "The trial researcher was blinded to the group allocation.."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 3/63. Unlikely to influence results.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Ho 1997

Methods	RCT, parallel, single blind, 4 weeks, n = 24, drop-outs unclear
Participants	USA, orthodontic patients, with fixed appliances, 11 to 18 years, gingival index >2, no medical conditions
Interventions	Sonicare Ultrasonic versus Oral B P35, 2 min twice daily. Timer supplied
Outcomes	Silness and Löe gingival and plaque indices on 6 sites per bonded tooth and bleeding on probing all at 4 weeks. Whole mouth recording PI and GI
Notes	Manufacturer funded. No pre-examination instructions reported.

<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement

Ho 1997 (Continued)

Random sequence generation (selection bias)	Low risk	Quote: “..subjects to the two groups was done through use of two tables of random numbers.”
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: “A single investigator (HH), who was blinded as to which toothbrush was being used..”
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Drop-outs unclear.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Johnson 1994

Methods	RCT, parallel, single blind, 4 weeks, n = 53 with 10 drop-outs
Participants	USA, adults, >20 teeth, gingival index >1.5 on Ramfjord teeth, no medical conditions, 20 to 54 years
Interventions	Philips Sonicare versus Oral B 30, 2 min twice daily. Timer supplied
Outcomes	Quigley Hein (Turesky) on all sites, Ainamo and Bay gingival index and sulcular bleeding indices on Ramfjord at 1, 2, 4 weeks. Soft tissue trauma “abnormalities” 7 sites in 6 subjects for manual and 10 sites in 7 subjects for powered
Notes	Manufacturer funded. Post-brushing evaluation.

Risk of bias

Bias	Authors’ judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: “...randomly assigned....” Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: “..randomised, single-blind, controlled clinical study.”

Johnson 1994 (Continued)

Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 10/53. Even drop-outs, due to missed visits. Unlikely to influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Kallar 2011

Methods	RCT, parallel, 12 weeks, n = 200 and unsure of drop-outs (assume no drop-outs)
Participants	India, school children aged 6 to 13 years.
Interventions	Unknown powered versus unknown manual toothbrush, no information on methods, time and duration of brushing
Outcomes	Turesky Quigley Hein plaque index on all sites, full mouth at 3, 6, 9 and 12 weeks
Notes	Funding source not stated. Mix of supervised and unsupervised brushing.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "Children were randomly divided into two groups." Insufficient information
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear but assumed no drop-outs.
Selective reporting (reporting bias)	High risk	Gingivitis not reported.
Other bias	Unclear risk	Unclear as little text in the report.

Khocht 1992

Methods	RCT, parallel, single blind, 4 weeks, n = 96 with 1 drop-out
Participants	USA, adults, >15 teeth with no restorations affecting cervical region plaque score >1.8 and gingival score >0.9, no medical conditions
Interventions	Epident and Interplak versus Oral B 40, twice daily. Use of timer not stated
Outcomes	Quigley Hein (Turesky) plaque index and Löe and Silness gingivitis index at all sites at 28 days. Whole mouth recording for PI and GI. No reported soft tissue abrasion
Notes	Manufacturer funded. Pre-brushing evaluation.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned...." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "This single (examiner) blind.."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 1/96. Unlikely to influence results.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Lapiere unpublished

Methods	RCT, parallel, single blind, 12 weeks, n = 48 with no drop-outs stated
Participants	Belgium, periodontal patients, 18 to 65 years, 20 natural teeth, no removable dentures, probing pocket depth >2 mm but <5 mm, free from subgingival calculus
Interventions	Philips HP 550 versus P Oral B 35 versus Braun Oral B D5, 2 min 3 times a day. Use of timer not stated
Outcomes	Quigley Hein (Turesky) plaque index and Löe and Silness gingivitis index, whole mouth at 12 weeks

Lapiere unpublished (Continued)

Notes	Funding unclear. No pre-examination instructions reported. Data for 2 powered brushes combined as same mode of action.	
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Only mentions randomised. Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "Everything was done to keep the whole procedure as blinded as possible."
Incomplete outcome data (attrition bias) All outcomes	Low risk	No drop-outs.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Lazarescu 2003

Methods	RCT, parallel, single blind, 18 weeks, n = 80 with 2 drop-outs	
Participants	Romania, adults, >20 teeth, medically fit and no previous powered brush experience	
Interventions	Philips/Jordan HP 735 versus Oral B 40 manual with normal brushing pattern. Use of timer not stated	
Outcomes	Quigley Hein (Turesky) plaque index at 6 sites per tooth and gingival bleeding index at proximal smooth surfaces at 18 weeks. Whole mouth recording PI and GI	
Notes	Manufacturer funded. Assumed pre-brushing evaluation.	
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quote: "...subjects were divided into two groups by an independent examiner not taking part in the further clinical assessment."

Lazarescu 2003 (Continued)

Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: “The investigator were blinded to the toothbrush used by the subjects.”
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 2/80. Unlikely to influence results.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Lobene 1964a

Methods	RCT, parallel, single blind, n = 185, 3 months, drop-outs unclear
Participants	USA, female college students, aged 17 to 21 years.
Interventions	General electric reciprocating action versus Oral B 40 manual with no instruction. Use of timer not stated
Outcomes	Lobene gingivitis index at 3 months. Whole mouth recording PI and GI
Notes	Manufacturer funded. No pre-examination instructions reported.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Only mentions randomised. Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: “..the examiner was unaware of the group to which any subject was assigned.”
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Drop-outs unclear.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.

Lobene 1964a (Continued)

Other bias	Low risk	No other apparent biases.
------------	----------	---------------------------

McCracken 2004

Methods	RCT, parallel, single blind, 16 months, n = 40 with 8 drop-outs
Participants	UK, patients who attended periodontal clinic, 25 to 70 years, periodontal disease identified clinically by minimum of 10 sites with PPD \geq 5 mm confirmed by radiograph, full mouth plaque score at least 2.0, minimum of 20 permanent teeth. Excluded: previous use of powered toothbrush
Interventions	Philip Sensiflex 2000 brand versus Oral B Advantage. 2 min twice daily, use of timer not stated
Outcomes	Turesky modified Quigley Hein plaque indices and Papilla bleeding indices at 0, 3, 10, 16 months, whole mouth recordings. Other outcomes: pocket depth reported: no different between both groups. Soft tissue lesion (abrasion and ulcer) reported; 8 in manual and 5 in powered
Notes	Manufacturer funded. Pre-intervention prophylaxis at baseline. No prophylaxis done at different visit. Use of interdental cleaning was recommended for at least once a day

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "A numerically balanced, stratified (for gender,age,smoking status) and randomised allocation of patients produced two groups..", "A 75% weighted randomisation was used to balance the distribution of the stratification characteristics between the groups."
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "A two group, parallel, single blind. ..."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 8/40. Even distribution of drop-outs and reasons not linked to interventions. Unlikely to influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.

McCracken 2004 (Continued)

Other bias	Low risk	No other apparent biases.
------------	----------	---------------------------

McCracken 2009

Methods	RCT, parallel, single blind, 12 months, n = 60 with 8 drop-outs
Participants	UK, periodontal patients from dental hospital, 18 to 45 years, localised areas of buccal/labial gingival recession with at least 1 mm attachment loss with Miller classification I and II recession defects. Excluded: moderate to severe chronic and aggressive periodontitis and routinely using powered toothbrushes
Interventions	Philips Sonicare Elite versus Oral B 35. 2 min twice daily, use of timer not stated
Outcomes	Turesky modified Quigley Hein plaque indices and bleeding on probing (dichotomous) at 0, 3, 6, 9 and 12 months. Whole mouth. Other outcomes on CAL, PD, recession, wear of the brushes reported; no differences between both groups. Adverse events reported not related to studies; 18 in manual and 16 in powered groups
Notes	Manufacturer funded. Pre-intervention prophylaxis and instruction done. Reinforced oral hygiene at each visits

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "The randomization sequence was generated using SPSS (version 14) using a block methodology..."
Allocation concealment (selection bias)	Low risk	Quote: "This remained concealed until the time of brush allocation..."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "two clinical examiners remained blinded to group allocation..."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 8/60. Even distribution of drop-outs and reasons not linked to interventions. Unlikely to influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Moreira 2007

Methods	RCT, cross-over, single blind, 28 days, n = 20 with no drop-outs, 14 days wash-out period
Participants	Brazil, first year dental students, 18-29 years old, 15 F 5 M, at least 20 teeth present, right handed subjects, 15% plaque visible at buccal and lingual surfaces. Excluded: subjects with orthodontics appliances, taking any medication would interfere plaque formation and antibiotics treatment during the 3/12 prior to study
Interventions	HyG ionic versus Close-up Essential, 2 min twice daily. Use of timer not stated
Outcomes	Turesky modified Quigley Hein plaque indices and gingival bleeding indices (Ainamo and Bay dichotomization of the Löe gingival index) at 0 and 28 days. Full mouth score. No difference between groups. Adverse event reported in later study (Moreira 2008); no differences between groups
Notes	No external funding for initial study. Scholarship by CAPES acknowledged in Moreira 2008 Pre-intervention prophylaxis at baseline and between wash-out period. Refrained oral hygiene 10-12 hours prior to examination

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...after the examination and by means of the flip of a coin, individuals were assigned to either one of the two tooth-brushes..."
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "...blinded calibrated examiner..."
Incomplete outcome data (attrition bias) All outcomes	Low risk	No drop-outs.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Moritis 2008

Methods	RCT, parallel, single blind, 4 weeks, n = 180 with 12 drop-outs
Participants	UK, adults, 18 to 65 years, 142 F 27 M, non-smokers with at least 20 natural teeth, gingival index of ≥ 2.0 on at least 20 sites and plaque index of ≥ 0.8 , excluded: severe gingivitis and periodontitis
Interventions	Sonicare Elite versus manual. 2 min twice daily. Use of timer not stated
Outcomes	Sillness and L�e plaque indices and L�e and Sillness gingival indices at 0, 2, 4 weeks. Whole mouth. Abrasion reported: 1 in manual and 1 in powered. Compliance monitored at average subjects brushed 2 min twice daily. Adversed events not reported
Notes	Manufacturer funded. No pre-intervention treatment. Refrained from oral hygiene for 2 to 6 hours before baseline examination

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned...." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "...examiner calibrated and blinded to product assignment."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 12/180. 4 lost to follow-up, 5 drop-outs due to adverse event not related to study, 3 scheduling conflicts
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

O'Beirne 1996

Methods	RCT, parallel, single blind, 8 weeks, n = 40, drop-outs unclear
Participants	USA, adults with inflammatory periodontal disease, >20 teeth and received periodontal treatment, 22 M: 18 F, 18 to 65 years
Interventions	Sonicare Ultrasonex versus Oral B manual 2 min twice daily. Timer supplied

O’Beirne 1996 (Continued)

Outcomes	Löe and Silness gingival index, Barnett papillary bleeding index at 2, 4 and 8 weeks, at all sites. Whole mouth recording PI and GI. Minor gingival trauma seen in 1 participant in each group
Notes	Part funded by manufacturer.

Risk of bias

Bias	Authors’ judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: “ devices were packaged in kits, arranged in random order and numbered in sequence by the sponsoring company, independent of the investigators.”
Allocation concealment (selection bias)	Low risk	Quote: “ devices were packaged in kits, arranged in random order and numbered in sequence by the sponsoring company, independent of the investigators.”
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: “ ..single-blinded, randomised clinical investigation..”
Incomplete outcome data (attrition bias) All outcomes	Low risk	No drop-outs.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Pucher 1999

Methods	RCT, parallel, double blind, 6 weeks, n = 60 with 8 drop-outs
Participants	USA, orthodontic patients, >20 teeth, >12 years, 23 M: 29 F after drop-outs
Interventions	Hukuba ionic (active) versus Hukuba ionic (non-active) with usual technique twice daily. Use of timer not stated
Outcomes	Quigley and Hein (Turesky) plaque index, Löe and Silness gingival index, whole mouth at 6 weeks. No adverse events/effects recorded
Notes	Funding not stated. No brushing for 12 hours and pre-brushing data used

Risk of bias

Pucher 1999 (Continued)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned.." Insufficient information.
Allocation concealment (selection bias)	Low risk	Quote: "The patients were given a prepackaged, coded toothbrush."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "...both participants and the examiner were unaware of which toothbrush the participants were using during..."
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Drop-outs: 8/60. Unclear as to which group drop-outs came from
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Rosema 2008

Methods	RCT, parallel, single blind, 9 months, n = 118 with 4 drop-outs
Participants	Netherlands, general population (with intensive pre-intervention oral hygiene care), aged ≥ 18 years, minimum of 5 evaluable teeth per quadrant, gingival bleeding $\geq 40\%$, absence of oral lesion. No pocket depth >5 mm, no wearing partial denture, orthodontic wires
Interventions	Oral B D25 Pro Care 9000 versus ADA toothbrush, 2 min twice daily. Use of timer
Outcomes	Modified Quigley and Hein plaque indices, partial mouth score, bleeding on marginal probing index (BOMP 0-2 scale) at 0, 10 weeks, 6 and 9 months. Powered toothbrush maintained lower plaque levels for 9 months better than manual toothbrush. No adverse events reported
Notes	Manufacturer funded. Pre-intervention: very intensive oral home care for 3 weeks. Pre-intervention prophylaxis at baseline, reinforced oral hygiene intervention at 6 and 10 months

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Randomization was performed using true random numbers generated by ..."

Rosema 2008 (Continued)

Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "... examiner masked..."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 4/118. Even distribution of drop-outs and reasons not linked to interventions. Unlikely to influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	The subjects who smoked were not balanced between the groups; 5 for manual group and 2 only for powered group but unlikely to influence results

Sharma 2000

Methods	RCT, parallel, single blind, 30 days, n = 62 with 1 drop-out
Participants	Canada, adults, 18 to 62 years, good general and oral health, 26 M: 36 F
Interventions	Colgate Actibrush versus Colgate diamond headed manual for 1 min twice daily. Use of timer not stated
Outcomes	Navy (Rustogi) plaque index, Löe and Silness (Chilton) gingival index, full mouth at 30 days, no adverse effects
Notes	Manufacturer funded. No pre-examination brushing for 8 hours

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "randomly assigned..." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 1/62. Unlikely to influence results.

Sharma 2000 (Continued)

Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Sharma 2010

Methods	RCT, parallel, single blind, 4 weeks, n = 132 with 3 drop-outs
Participants	USA, adults, aged 18 to 56 years, ≥18 years old, good general health. Gingivitis 1.75-2.3
Interventions	Oral B Pulsonic versus ADA manual toothbrush, 2 min and twice daily
Outcomes	Rustogi modified Navy plaque index, modified gingival index, full mouth at 0, 4 weeks. No reported adverse events from both groups
Notes	Manufacturer funded. Pre-examination instruction: abstain from oral hygiene procedure 12 hours prior to investigation

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...randomly allocated via a computer-generated balance and assignment program to one of the two toothbrush test groups...."
Allocation concealment (selection bias)	Low risk	Quote: "... test product distribution processes were conducted in a separate area not accessible to the clinical examiner and data recorders."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "examiner blind, parallel group design."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 3/132. Unlikely to influence results.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Silverman 2004

Methods	RCT, parallel, single blind, 6 weeks, n = 59 with 2 drop-outs
Participants	USA, children, 4 to 5 years, excluded: history of periodontal disease
Interventions	Oralgene 60 second time machine versus Oral B Mickey Mouse versus Oral B Rugrats 20; (2 powered and 1 manual), 60 seconds twice daily for Oralgene, others 2 min twice daily. Own toothpaste used. Timer used
Outcomes	Turesky modified Quigley and Hein plaque indices and Löe and Sillness gingival indices at 0, 6 weeks. Whole mouth. No adverse effects reported. Mechanical reliability checked on compressive load needed to activate the powered toothbrush, revealed higher compressive load needed for Oralgene 60 seconds
Notes	Manufacturer funded. Use own toothpaste. Less parents involvement. All examination done at school Baseline, pre-brushing and post-brushing data available but decided to use the baseline data. The Oral B Rugrats 20 (manual) and Oral B Mickey mouse (powered) are considered for analysis

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Using random numbers table..."
Allocation concealment (selection bias)	Low risk	Quote: "...the assignment of toothbrushes and brushing were performed without the presence of examining investigator.."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Reported as blind.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 2/59. Reasons unclear, but unlikely to influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases. Age of children?

Singh unpublished

Methods	RCT, parallel, single blind, 60 days, n = 73 with 8 drop-outs
Participants	USA, orthodontic patients, 11 to 19 years, >19 teeth, good health, no prophylaxis within last month
Interventions	Pulse Plaque Remover versus Oral B 35, 2 min. Frequency not stated. Use of timer not stated
Outcomes	Quigley and Hein (Turesky) plaque index, papillary bleeding score (Loesche) for gingivitis
Notes	Manufacturer funded. No pre-examination brushing for 12 to 24 hours

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned..." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Quote: "The examiner were blinded with respects to the methods used for brushing." .
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Drop-outs: 8/73. Unclear as to which group drop-outs came from
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Soparkar 1964

Methods	RCT, parallel, single blind, 11 weeks, n = 270 with 32 drop-outs
Participants	USA, college students non-dental.
Interventions	Unknown action powered versus old manual with normal regimen. Use of timer not stated
Outcomes	Gingival index (assumed Löe and Silness) on 0-3 scale at 11 weeks. Anterior teeth only
Notes	No pre-examination instructions reported.

Risk of bias

Soparkar 1964 (Continued)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...divided at random..." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Quote: "...the examiner was not aware of either the previous gingival score of the subject being examined or the type of toothbrush...."
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Drop-outs: 32/270. Reasons for drop-outs not discussed; unclear as to which group drop-outs came from
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Soparkar 2000

Methods	RCT, parallel, single blind, 30 days, n = 66 with 3 drop-outs
Participants	USA, healthy adults, 18 to 70 years, 25 M: 38 F (data on drop-outs not presented)
Interventions	Colgate Actibrush versus ADA approved manual brush, 1 min twice daily. Use of timer not stated
Outcomes	Rustogi modification of Navy plaque index and Mandel-Chilton modification of Löe Silness gingival index, all surfaces
Notes	Manufacturer funded. No pre-examination brushing for 8 hours

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "It was a parallel, examiner-blind, randomised, balanced, two-group design.." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.

Soparkar 2000 (Continued)

Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: “It was a parallel, examiner-blind, randomised, balanced, two-group design..”
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 3/66 completed. 3 from ADA group failed to complete. Unlikely to influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Sowinski 2000

Methods	RCT, parallel, single blind, 30 days, n = 110 with no drop-outs
Participants	USA, adults, 18 to 70 years, >15 teeth, no orthodontic appliances, no oral disease, 22 M: 88 F
Interventions	Colgate Actibrush versus Colgate diamond head manual, 1 min twice daily. Use of timer not stated
Outcomes	Quigley and Hein (Turesky) and Löe and Silness gingival index, full mouth at 30 days. No adverse events
Notes	Manufacturer funded. No pre-examination brushing for 24 hours

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	ADA guidelines followed but no word random. Only mentions that “Qualifying participants were stratified into two balanced treatment groups according to their baseline plaque index and gingivitis index scores.” Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: “This independent clinical study, employed an examiner-blind, two-treatment...”
Incomplete outcome data (attrition bias) All outcomes	Low risk	No drop-outs.

Sowinski 2000 (Continued)

Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Stabholz 1996

Methods	RCT, parallel, single blinded, n = 56 with 4 drop-outs, 60 days
Participants	Israel, general population, no medical conditions.
Interventions	Plaq and White A to Z technology versus Oral B 35 as per normal regimen. Use of timer not stated
Outcomes	Quigley and Hein (Turesky) and Löe and Silness gingival and Eastman bleeding on probing indices on Ramfjord teeth at 15 and 30 days. No difference in soft tissue trauma between brush types
Notes	Participants asked to refrain from brushing for 12 hours prior to each assessment

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned..." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Quote: "An independent person was responsible for distributing the different toothbrushing and was the only..." Insufficient information given lack of detail regarding randomisation
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "Each examiner recorded 28 participants of both groups without knowing their brush assignment..."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 4/56. 2 participants from each group did not complete for reasons not related to the protocol
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Stoltze 1994

Methods	RCT, parallel, unclear blinding method used, n = 40 with 2 drop-outs, 6 weeks
Participants	Denmark, young adults 18 to 30 years, with plaque and gingival scores >1, >20 teeth, no medical problems
Interventions	Braun Oral B Plak Control D5 versus Tandex 40 manual, 2 min twice daily. Use of timer not stated
Outcomes	Silness and Löe plaque index, Löe and Silness gingival index at all sites, 1, 2 and 6 weeks. Whole mouth recording PI and GI. No gingival abrasion reported
Notes	No pre-examination instructions reported.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...participants were at random allocated to a group..." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 2/40. Reasons not stated. Unlikely to influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Terezhalmay 1995a

Methods	RCT, parallel, single blind, 6 months, n = 54 with 4 drop-outs
Participants	USA, adults, good health and free of oral pathology.
Interventions	Ultra-sonex ultrasonic versus Oral B manual 3 min twice daily. Use of timer not stated
Outcomes	Quigley and Hein (Turesky) plaque index and Löe and Silness gingival index at all sites and Eastman bleeding on probing index on contralateral Ramjford teeth. Assessed at 15 and 30 days and 6 months. No soft tissue trauma
Notes	Participants asked to refrain from brushing 12 to 14 hours prior to assessment

Terezhalmly 1995a (Continued)

<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned..." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 4/54. Reasons for drop-outs was breach of compliance. Unlikely to influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Toto 1966

Methods	RCT, parallel, blinding unclear, 120 days, n = 527 with 17 drop-outs
Participants	USA, boarding school children, 6 to 18 years.
Interventions	Sunbeam cordless versus unspecified manual. Frequency not stated. Use of timer not stated
Outcomes	PMA index, whole mouth.
Notes	Funding not clear. No pre-examination instructions.

<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...distributed at random..." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information.

Toto 1966 (Continued)

Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 17/527. Reasons not discussed but unlikely to influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Tritten 1996

Methods	RCT, parallel, single blind, 12 weeks, n = 60 with 4 drop-outs
Participants	USA, adults 18 to 65 years, dental hospital patients, no professional cleaning previous 3 months, minimum 20 teeth, no previous periodontal treatment and unaware of active pregnancy
Interventions	Sonicare versus Butler 311, 2 min twice daily. Timer supplied
Outcomes	Quigley and Hein (Turesky) plaque index all teeth, Löe and Silness gingival index Ramfjord teeth. Gingival abrasion seen in 5 manual and 1 powered brush subjects
Notes	Manufacturer funded. Pre-brushing evaluation.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...patients were randomised by having them draw their group assignment from a box containing a mixture of 30 labels marked 'manual group' and 30 labels marked ..."
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "One investigator (CT), who was blinded to the brush assignments of each group.."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 4/60. Excluded from analysis; either received antibiotics therapy (2) or failed to appear for 1 of the scheduled study visit (2). Drop-outs unlikely to influence results

Tritten 1996 (Continued)

Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

van der Weijden 1994

Methods	RCT, parallel, single blind, 8 months, n = 87 with 10 drop-outs
Participants	Netherlands, non-dental students, bleeding on probing at least 35% of sites and modified gingival index of at least 1, no previous experience of electric toothbrush. Healthy. No ortho. No pockets >5 mm
Interventions	Braun Plak control versus Butler Gum 311 for 2 min. Timer supplied
Outcomes	Silness and Löe plaque index, Lobene gingival index at all sites at 1, 2, 5, 8 months. Whole mouth recording PI and GI. 12 manual brush subjects and 5 powered brush subjects with gingival abrasion. Calculus scored no difference in change between groups
Notes	Participants asked to brush thoroughly, but not within 1 hour of assessment

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly divided..." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "Therefore in the course of the experiment, the examiner was unaware of the brush types used by the subject.."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 10/87. 8 participants (control group) and 2 participants (powered brush) left the study because of scheduling conflicts with clinical examination
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Van Swol 1996

Methods	RCT, parallel, double blind, 6 months, n = 71 with 7 drop-outs
Participants	USA, adults, >20 teeth, not using mouthrinse, 9 M: 55 F.
Interventions	HyG ionic brush (active) versus HyG ionic brush (non-active), usual time twice daily. Use of timer not stated
Outcomes	Quigley and Hein plaque index and Löe and Silness gingival index, whole mouth at 3 and 6 months. Adverse events not reported despite being collected
Notes	Manufacturer funded. No pre-examination instructions.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "The subject were given prepackaged and coded hyG ionic action toothbrush. The toothbrushes were received evenly divided (36 of each) between those that had active batteries .."
Allocation concealment (selection bias)	Low risk	Quote: "Each packet had a code number that was recorded for the subject at the time of delivery neither the researchers nor the subjects knew whether their toothbrush contained an active or inactive battery."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "Neither the researcher nor the subject knew whether their toothbrush contained an active or inactive battery."
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Drop-outs: 7/71. Reasons were "four did not use their assigned toothbrush exclusively during the test period, and three took physician prescribed antibiotics." Number of drop-outs by group unclear but unlikely to influence results
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Walsh 1989

Methods	RCT, parallel, single blind, n = 108, 6 months, drop-outs unclear
Participants	USA, adults from university and dental clinics, 18 to 65 years, >20 teeth, no dental/medical problems, gingival index >1 on 6+ sites of 18 sites probed on Ramfjord teeth
Interventions	LPA/Broxo powered versus Oral B 40 manual, twice daily. Use of timer not stated
Outcomes	Silness and Löe plaque index on Ramfjord teeth, bleeding on probing on Ramfjord teeth at 3, 6 months. No soft tissue changes reported. Stain reported as no difference between brush types
Notes	No pre-examination instructions reported.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quote: "...subjects were randomly allocated to groups in consecutive order by time and date of entry into study."
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "examiners did not know to which groups the patients belonged....."
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to determine drop-outs.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Warren 2001

Methods	RCT, parallel, single blind, 12 weeks, n = 110 with 9 drop-outs
Participants	USA, adult volunteers, 18 to 65 years, >18 teeth, plaque index >1.8, non-smokers, with no medical problems
Interventions	Braun Oral B D 17 versus ADA standard manual, 2 min twice daily. Timer supplied
Outcomes	Quigley and Hein (Turesky) plaque index, Löe and Silness gingival index and modified Löe and Silness bleeding index, on all sites at 1, 3 months. Whole mouth recording PI and GI. No soft tissue changes reported

Warren 2001 (Continued)

Notes	Manufacturer funded. Participants asked to refrain from brushing 12 to 18 hours prior to assessment	
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...were randomly assigned to one of two treatment groups, according to the method of Zelen."
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "...all subjects were evaluated by the same examiner who was unaware of the types of toothbrush..."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 9/110. Reasons unrelated to intervention and drop-outs evenly balanced
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Wilson 1993

Methods	RCT, parallel, single blind, 12 months, n = 32 with 3 drop-outs	
Participants	USA, adults, 18+ years, minimum 20 teeth, at least 50% tooth surface plaque coverage (O'Leary), bleeding score >0.75. Barnett-Muhleman bleeding index, no medical problems, no orthodontics, no untreated perio or pockets >6 mm	
Interventions	Interplak, Bausch and Lomb versus Butler 311, 3 min. Use of timer not stated	
Outcomes	Quigley and Hein (Turesky) plaque index, Barnett Muhleman gingival index on all sites at 1, 2, 6, 9 and 12 months. Whole mouth recording PI and GI. No difference in gingival abrasion found between brush types	
Notes	Participants asked to brush 1 hour prior to assessment.	
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned..." Insufficient information.

Wilson 1993 (Continued)

Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "...a single-blind,"
Incomplete outcome data (attrition bias) All outcomes	High risk	Drop-outs: 3/32. All drop-outs from control group. Reasons were: 1 generalised periodontal diseases progression; 2 non-compliance/withdrawn from study
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Yankell 1996

Methods	RCT, parallel, single blind, 4 weeks, n = 66 with 1 drop-out
Participants	USA, children with 4 of 6 Ramfjord teeth present, no medical problems
Interventions	Rowenta Dentiphant versus Oral B 20, 1 min twice daily. Use of timer not stated
Outcomes	Quigley and Hein (Turesky) plaque and Löe and Silness (Lobene) gingival indices on Ramfjord teeth at 2 and 4 weeks. No soft tissue changes reported
Notes	Manufacturer funded. Pre-brushing evaluation.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned.." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "The same clinical investigators saw and assessed the same subjects at each examination period and were unaware of the toothbrush product being used by the subjects."
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Quote: "...attrition not related to product use.."

Yankell 1996 (Continued)

		Insufficient information.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Yankell 1997

Methods	RCT, parallel, single blind, 30 days, n = 128 with 13 drop-outs
Participants	USA, adults, 18 to 50 years, >18 teeth, no current orthodontic bands, no medical problems
Interventions	Rowenta Plaque Dentacontrol Plus versus Sonicare versus Braun Oral B Ultra versus Oral B P35, 2 min twice daily. Timer specified for powered. Excluded Rowenta data which were 5 min twice daily.
Outcomes	Quigley and Hein (Turesky) plaque and Eastman bleeding indices on Ramfjord teeth and also Löe and Silness (Lobene) gingival index on whole mouth at 4 weeks. No soft tissue changes reported
Notes	Rowenta data excluded due to extended brushing period. Participants asked to refrain from brushing 10 to 16 hours before evaluation

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned..." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "...single-blind.."
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Drop-outs: 13/128. Quote: "...attrition not related to product use.."
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Yukna 1993b

Methods	RCT, parallel, single blind, 6 months, n = 42 with 2 drop-outs
Participants	USA, adults with past periodontal surgical treatment. Excluded if on antibiotics/NSAIDS or orthodontic appliances
Interventions	Interplak, Bausch and Lomb versus unspecified manual brush. Use of timer not stated
Outcomes	Quigley and Hein and O'Leary plaque indices, Lobene gingival index and bleeding on probing. Whole mouth recording PI and GI. 4 of 20 powered brushes had mechanical failure
Notes	Manufacturer funded.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned.." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Quote: "All the instruction and device distribution were performed by auxiliary personal without examiner being present."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "All intraoral examinations for a given patient were performed by one of the two examiners, who were blinded to the grouping of the subjects."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 2/42. Reasons for drop-outs were non-compliance with appointments (manual brush) and restorative dentistry resulted in too few scorable teeth (powered brush)
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Unclear risk	Comparability of groups at baseline unclear.

Zimmer 2002

Methods	RCT, parallel, single blind, 8 weeks, n = 64 with 1 drop-out
Participants	Germany, adults, 18 to 56 years good general health, no periodontal disease, 32 M: 32 F
Interventions	Ultra Sonex Ultima versus Aronal compact manual, 3 min twice daily. Timer supplied

Zimmer 2002 (Continued)

Outcomes	Quigley and Hein (Turesky) and papillary bleeding index, full mouth at 4 and 8 weeks	
Notes	Manufacturer funded.	
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned.." Insufficient information.
Allocation concealment (selection bias)	Low risk	Quote: "...each participant received the assigned toothbrush and instructions for use by a person not involved in the study."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "All examinations were treatment blind and performed by one examiner."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Drop-outs: 1/64.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

Zimmer 2005

Methods	RCT, parallel, single blind, 8 weeks, n = 120, no drop-outs.	
Participants	Germany, adults, 18 to 65 years, exclusion: orthodontic fixed appliance patient, severe periodontal disease, long-term use of NSAIDs, wear removable partial denture, less than 20 teeth, regular use of electric toothbrush, dental professionals	
Interventions	2 electric toothbrushes: Cybersonic and Oral B 3D excel versus Elmex Super 29 manual, 2 min twice daily. Digital timer supplied	
Outcomes	Quigley and Hein (Turesky) and papillary bleeding index, full mouth at 4 and 8 weeks. Nor report on adverse events	
Notes	Peer review grant and other source of funding. Pre-intervention scaling ad prophylaxis	
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement

Zimmer 2005 (Continued)

Random sequence generation (selection bias)	Unclear risk	Quote: "...randomly assigned.." Insufficient information.
Allocation concealment (selection bias)	Unclear risk	Insufficient information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote "All examination were treatment blind.."
Incomplete outcome data (attrition bias) All outcomes	Low risk	No drop-outs.
Selective reporting (reporting bias)	Low risk	Adequate reporting of important outcomes.
Other bias	Low risk	No other apparent biases.

ADA = American Dental Association; BOMP = bleeding on marginal probing; CAL= clinical attachment level; F = female; GI = gingival index; M = male; PAL = probing attachment level; PD = pocket depth; PI = plaque index; PMA = papillary marginal attachment; PPD = periodontal pocket depth; RCT = randomised controlled trial.

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Aass 2000	Less than 28 days.
Ainamo 1991	Contacted authors for more information, no reply after 3 months
Albers 1988	Less than 28 days.
Anaise 1976	Less than 28 days.
Andreana 1998	No movement of powered head.
Arceneaux 1996	Less than 28 days.
Ash 1967	Contacted authors for more information, no reply after 3 months
Barnes 2003	Less than 28 days.
Bartizek 2002	Less than 28 days.
Bhanji 2002	Outcome not under consideration.

(Continued)

Biesbrock 2005	Potential high for compromised self toothbrushing efficacy.
Blahut 1993	Brush used by another person.
Buchmann 1987	Less than 28 days.
Chaikin 1965	Less than 28 days.
Chilton 1962	Split-mouth study.
Ciancio 1990	Less than 28 days.
Ciancio 1998	Contacted authors for more information, no reply after 3 months
Cohen 1964	Potential high for compromised self toothbrushing efficacy.
Conforti 2003	Less than 28 days.
Conroy 1965	Less than 28 days.
Conroy 1966	Less than 28 days.
Coontz 1983	Less than 28 days.
Coontz 1985	Less than 28 days.
Cronin 1996a	Combined intervention.
Cronin 2000	Less than 28 days.
Cronin 2001	Data on number of participants in each group not presented. The study will be included once these data are determined
Cross 1962b	Less than 28 days.
Danser 2000	Less than 28 days.
Danser 2003	Split-mouth design.
de Leeuw 1977	Abstract only.
Dentino 1999	Outcomes not under consideration.
Derbyshire 1964	Less than 28 days.
Dogan 2004	Less than 28 days.

(Continued)

Doherty 1999	Less than 28 days.
Doll 1999	Less than 28 days.
Dorfer 2001	Less than 28 days.
Dorfer 2001a	Split-mouth design.
Dunkin 1975	Less than 28 days.
Elliott 1963	Less than 28 days.
Farrell 2006	Potential high for compromised self toothbrushing efficacy.
Fourel 1974	Split-mouth design.
Fraleigh 1965	Split-mouth design.
Galustian 2002	Less than 28 days.
Goldman 1975	Less than 28 days.
Grossman 1994	Less than 28 days.
Hall 1971	Potential high for compromised self toothbrushing efficacy.
Heasman 2001	Less than 28 days.
Heins 2002	Less than 28 days.
Heintze 1996	Combined intervention.
Hoover 1962	Less than 28 days.
Hotta 1992	Less than 28 days.
Hou 2002	Single used study design.
Howorko 1993	Less than 28 days.
Johnson 1994a	Abstract with insufficient information.
Jongenelis 1997	Less than 28 days.
Killoy 1988	Previously author was contacted for information but no reply after 3 months
Killoy 1989	Contacted authors for more information, no reply after 3 months

(Continued)

Killooy 1993	Contacted authors for more information, no reply after 3 months
Lamendola-Sitenga 1998	No mechanical action of brush head.
Lange 1978	Less than 28 days.
Leftkowitz 1962	Less than 28 days.
Lim 1995	Contacted authors for more information, no reply after 3 months
Long 1985	Split-mouth design.
Love 1988	Contacted authors for more information, no reply after 3 months
Lundergan 1988	Less than 28 days.
Mantokoudis 2001	Less than 28 days.
Mascarenhas 2005	Less than 28 days.
Mayer 1978	Less than 28 days.
Mayer 1988	Split-mouth design.
McAllan 1976	Not true randomisation; alternate allocation.
Moritis 2002	Less than 28 days.
Morris 1997	Contacted authors for more information, no reply after 3 months
Moschen 1999	Less than 28 days.
Mueller 1987	Contacted authors for more information, after reply still not adequate to be included
Murray 1989	Outcomes not under consideration.
Niemi 1986	Less than 28 days.
Niemi 1987	Less than 28 days.
Niemi 1988	Split-mouth design.
Ojima 2003	Less than 28 days.
Ousehal 2011	Participants selected from population at random, but not allocated to groups at random

(Continued)

Owen 1972	Cross-over study, contacted authors for more information, no reply after 3 months
Palmer 1999	Contacted authors for more information, no reply after 3 months
Parizi 2011	Less than 28 days.
Pelka 2008	Split-mouth design.
Pizzo 2010	Single used study design.
Platt 2002	Less than 28 days.
Powers 1967	Less than 28 days.
Preber 1991	Less than 28 days.
Quigley 1962	Less than 28 days.
Quirynen 1994	Split-mouth design.
Rashid 1998	Less than 28 days.
Renton-Harper 2001	Less than 28 days.
Roscher 2004	Less than 28 days.
Ruhlman 2001	Less than 28 days.
Ruhlman 2002	Less than 28 days.
Sato 1995	Less than 28 days.
Schifter 1983	Less than 28 days.
Schmage 1999	Split-mouth design.
Schuler 1996	Abstract only.
Sharma 2001a	Split-mouth design.
Sharma 2005	Potential high for compromised self toothbrushing efficacy.
Sharma 2006	Potential high for compromised self toothbrushing efficacy.
Sharma 2011	Potential high for compromised self toothbrushing efficacy.

(Continued)

Silverstone 1992	Contacted authors for more information, no reply after 3 months
Singh 2005	Potential high for compromised self toothbrushing efficacy.
Smith 1964	Cross-over study, contacted authors for more information, no reply after 3 months
Stadtler 1984	Less than 28 days.
Swenson 1967	Contacted authors for more information, no reply after 3 months
Taylor 1995	Less than 28 days.
Tenenbaum 1984	Less than 28 days.
Terezhalmay 2005	Less than 28 days.
Thienpont 2001	Cross-over study, contacted authors for more information, no reply after 3 months
Trimpeeneers 1997	Cross-over study, contacted authors for more information, no reply after 3 months
Trombali 1995	Less than 28 days.
Tscharre-Z 1989	Combined interventions.
van der Weijden 1993	Less than 28 days.
van der Weijden 1998	Split-mouth study.
van der Weijden 2002a	Split-mouth study.
van Venrooy 1985	Less than 28 days.
Vandana 2004	Potential for compromised self toothbrushing efficacy.
Versteeg 2006	Teeth brushed by other person.
Vervliet 1989	Split-mouth design.
Walsh 1984	Less than 28 days.
Warren 2007	Less than 28 days.
Whitmyer 1998	Potential high for compromised self toothbrushing efficacy.
Wiedemann 2001	Split-mouth design.
Wilcoxon 1991	Cross-over study, contacted authors for more information, no reply after 3 months

(Continued)

Williams 2003a	Less than 28 days.
Williams 2004	Less than 28 days.
Williams 2010	No movement of brush head.
Wilson 1991	Contacted authors for more information, no reply after 3 months
Yankell 1994	Less than 28 days.
Yukna 1993a	Combined intervention.
Zimmer 1999	Less than 28 days.

Characteristics of studies awaiting assessment [ordered by study ID]

Borutta 2002

Methods	
Participants	
Interventions	
Outcomes	
Notes	Unable to locate a copy to date.

De Beule 1990

Methods	
Participants	
Interventions	
Outcomes	
Notes	Unable to locate a copy to date.

Horton 1989

Methods	
Participants	
Interventions	
Outcomes	
Notes	Unable to locate a copy to date.

Jain 2013

Methods	6-week, parallel arm RCT.
Participants	Adults (aged 18-28) with moderate gingivitis (at least 25% of test sites showing bleeding on probing) Excludes orthodontic patients.
Interventions	Group 1 - Oral B Classic Ultraclean medium manual toothbrush Group 2 - Oral B Vitality Dual Clean powered toothbrush (rotation oscillation) Both groups' intervention was combined with commercially available fluoridated toothpaste (Pepsodent Regular)
Outcomes	Gingivitis (Löe and Silness gingival index, 1963) recorded at 1, 2, and 6 weeks. Plaque (O'Leary plaque index, 1972) recorded at 1, 2, and 6 weeks Oral hygiene (Green and Vemillion Oral Hygiene Index Simplified (OHI-S), 1964) recorded at 1, 2, and 6 weeks
Notes	

Marini 2014

Methods	20-week, 4-parallel arm RCT.
Participants	Adolescent fixed-orthodontic treatment patients.
Interventions	Group 1 - Oral B Triumph 5000 powered toothbrush (rotation oscillation), combined with oral hygiene instruction and motivation at baseline and at 4, 8, 12, 16, and 20 weeks Group 2 - Oral B Triumph 5000 powered toothbrush (rotation oscillation), combined with oral hygiene instruction and motivation at baseline Group 3 - Oral B Ortho P35, combined with oral hygiene instruction and motivation at baseline and at 4, 8, 12, 16, and 20 weeks Group 4 - Oral B Ortho P35, combined with oral hygiene instruction and motivation at baseline All groups' intervention was combined with commercially available fluoridated toothpaste (Colgate Total, 1450 ppm fluoride) All groups also received an interdental brush (Plakkontrol, 7 mm) at baseline and at 8 and 16 weeks Replacement brushes (both manual and powered groups) were also issued at 8 and 16 weeks
Outcomes	Plaque index (Quigley Hein plaque index, 1962) recorded at baseline and at 4, 8, 12, 16, and 20 weeks

Marini 2014 (Continued)

Notes	
-------	--

Mayer 1990

Methods	16-week, parallel arm RCT.
Participants	Adults (aged 20-30) with poor oral hygiene (scoring between 76-90 on approximal area plaque index)
Interventions	Group 1 - Oral B Plus 30 manual toothbrush. Group 2 - Braun dental timer D31 electric toothbrush. Both groups' intervention was combined with commercially available toothpaste (Oral-B Zendium)
Outcomes	Plaque (Lange approximal area plaque index, 1987), recorded at 1, 2, 3, 4, 9, 10, and 11 weeks
Notes	

Nathoo 2012

Methods	12-week, parallel arm RCT.
Participants	Adults (aged 18-70) with mild gingivitis (at least scoring 1 on Löe and Silness gingival index) and mild plaque (at least scoring 0.6 on Rustogi modification of the modified Navy plaque index) Excludes orthodontic patients.
Interventions	Group 1 - Colgate ProClinical A1500 powered toothbrush with Triple Clean Brush Head (auto mode) Group 2 - Oral B Indicator manual flat-trim toothbrush. Both groups' intervention was combined with commercially available fluoridated toothpaste (Colgate Cavity Protection)
Outcomes	Gingivitis (Löe and Silness gingival index, 1963), recorded at baseline and at 4 and 12 weeks Gingival bleeding (gingivitis severity index, 1990), recorded at baseline and at 4 and 12 weeks Plaque (Rustogi modification of the modified Navy plaque index, 1992), recorded at baseline and at 4 and 12 weeks
Notes	Study supported by Colgate-Palmolive.

Sharma 2001

Methods	30-day, parallel arm RCT.
Participants	Healthy adults.
Interventions	Group 1 - Colgate Actibrush battery-powered toothbrush. Group 2 - Colgate Plus Diamond Head, full-head soft-bristled manual toothbrush Both groups' intervention was combined with commercially available toothpaste (type not mentioned)

Sharma 2001 (Continued)

Outcomes	Plaque (index not mentioned), reported at baseline and 30 days Gingivitis (index not mentioned), reported at baseline and 30 days
Notes	Abstract only.

Sharma 2012

Methods	4-week, parallel arm RCT.
Participants	Adults with mild-moderate gingivitis. Excludes orthodontic patients.
Interventions	Group 1 - Oral B Professional Deep Clean TRICLEAN 1000 multi-directional power toothbrush (D16u/EB30) (AKA Oral-B TriZone) Group 2 - ADA reference standard soft manual control toothbrush Both groups' intervention was combined with commercially available fluoridated toothpaste (Crest Cavity Protection, 0.243% sodium fluoride)
Outcomes	Gingivitis (Lobene modified gingival index), reported at baseline and 4 weeks Gingival bleeding (gingival bleeding index), reported at baseline and 4 weeks Plaque (Rustogi modified Navy plaque index), reported at baseline, and 1 and 4 weeks
Notes	

Swierkot 2013

Methods	52-week, parallel arm RCT.
Participants	Partially edentulous adults (aged 45-78), with at least 1 posterior implant
Interventions	Group 1 - Philips Sonicare FlexCare sonic toothbrush. Group 2 - Oral B P40 manual toothbrush. Both groups' intervention was combined with commercially available fluoridated toothpaste (Colgate Total)
Outcomes	Gingivitis (Löe and Silness gingival index, 1963; bleeding on probing scale), recorded at baseline and at 3, 6, 9 and 12 months (for both tooth and implant) Plaque (Silness and Löe plaque index, 1964), recorded at baseline and at 3, 6, 9 and 12 months (for both tooth and implant)
Notes	Study supported by Philips Healthcare Systems.

ADA = American Dental Association; ppm = parts per million; RCT = randomised controlled trial.

DATA AND ANALYSES

Comparison 1. All powered toothbrushes versus manual toothbrushes

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Plaque scores at 1 to 3 month at all sites	40	2871	Std. Mean Difference (IV, Random, 95% CI)	-0.50 [-0.70, -0.31]
1.1 Quigley Hein (Turesky)	28	2000	Std. Mean Difference (IV, Random, 95% CI)	-0.39 [-0.56, -0.22]
1.2 Silness and Løe	6	431	Std. Mean Difference (IV, Random, 95% CI)	-0.94 [-1.83, -0.05]
1.3 Visible plaque index Ainamo Bay	1	111	Std. Mean Difference (IV, Random, 95% CI)	-0.26 [-0.63, 0.12]
1.4 Ortho modification of Silness and Løe	1	60	Std. Mean Difference (IV, Random, 95% CI)	0.0 [-0.51, 0.51]
1.5 Navy plaque index mod Rustogi	3	249	Std. Mean Difference (IV, Random, 95% CI)	-1.13 [-1.94, -0.31]
1.6 O'Leary index	1	20	Std. Mean Difference (IV, Random, 95% CI)	-1.81 [-2.88, -0.73]
2 Gingival scores at 1 to 3 months at all sites	44	3345	Std. Mean Difference (IV, Random, 95% CI)	-0.43 [-0.60, -0.25]
2.1 Løe and Silness	30	2109	Std. Mean Difference (IV, Random, 95% CI)	-0.46 [-0.66, -0.25]
2.2 Lobene gingival index	8	907	Std. Mean Difference (IV, Random, 95% CI)	-0.43 [-0.88, 0.03]
2.3 BOP	3	159	Std. Mean Difference (IV, Random, 95% CI)	-0.19 [-0.50, 0.12]
2.4 Papillary bleeding index 0-4 scale	2	95	Std. Mean Difference (IV, Random, 95% CI)	-0.11 [-1.55, 1.33]
2.5 BOMP 0-2 scale	1	75	Std. Mean Difference (IV, Random, 95% CI)	-0.58 [-1.04, -0.12]
3 Plaque scores at >3 months	14	978	Std. Mean Difference (IV, Random, 95% CI)	-0.47 [-0.82, -0.11]
3.1 Quigley Hein (Turesky)	11	736	Std. Mean Difference (IV, Random, 95% CI)	-0.51 [-0.97, -0.04]
3.2 Silness and Løe	2	131	Std. Mean Difference (IV, Random, 95% CI)	-0.38 [-1.09, 0.34]
3.3 Visible plaque index Ainamo Bay	1	111	Std. Mean Difference (IV, Random, 95% CI)	-0.28 [-0.66, 0.09]
4 Gingival scores at >3 months	16	1645	Std. Mean Difference (IV, Fixed, 95% CI)	-0.21 [-0.31, -0.12]
4.1 Løe and Silness	5	318	Std. Mean Difference (IV, Fixed, 95% CI)	-0.27 [-0.49, -0.05]
4.2 Lobene gingival index	4	440	Std. Mean Difference (IV, Fixed, 95% CI)	-0.14 [-0.33, 0.04]
4.3 BOP	4	270	Std. Mean Difference (IV, Fixed, 95% CI)	-0.46 [-0.70, -0.22]
4.4 Papillary bleeding index 0-4 scale	1	32	Std. Mean Difference (IV, Fixed, 95% CI)	0.65 [-0.07, 1.36]
4.5 BOMP 0-2 scale	1	75	Std. Mean Difference (IV, Fixed, 95% CI)	-0.24 [-0.69, 0.22]
4.6 PMA	1	510	Std. Mean Difference (IV, Fixed, 95% CI)	-0.16 [-0.34, 0.02]

Comparison 2. Side to side powered toothbrushes versus manual toothbrushes

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Plaque scores at 1 to 3 month at all sites	7	570	Std. Mean Difference (IV, Random, 95% CI)	-0.27 [-0.77, 0.23]
1.1 Quigley Hein (Turesky)	4	324	Std. Mean Difference (IV, Random, 95% CI)	-0.14 [-0.36, 0.08]
1.2 Silness and Loe	3	246	Std. Mean Difference (IV, Random, 95% CI)	-0.78 [-2.25, 0.68]
2 Gingival scores at 1 to 3 months at all sites	9	795	Std. Mean Difference (IV, Random, 95% CI)	-0.32 [-0.81, 0.17]
2.1 Loe and Silness	6	385	Std. Mean Difference (IV, Random, 95% CI)	-0.28 [-0.88, 0.32]
2.2 Lobene gingival index	3	410	Std. Mean Difference (IV, Random, 95% CI)	-0.39 [-1.24, 0.46]
3 Plaque scores at >3 months	3	272	Std. Mean Difference (IV, Fixed, 95% CI)	0.02 [-0.21, 0.26]
3.1 Quigley Hein (Turesky)	2	218	Std. Mean Difference (IV, Fixed, 95% CI)	0.03 [-0.24, 0.30]
3.2 Silness and Loe	1	54	Std. Mean Difference (IV, Fixed, 95% CI)	0.0 [-0.53, 0.53]
4 Gingival scores at >3 months	3	272	Std. Mean Difference (IV, Fixed, 95% CI)	0.10 [-0.14, 0.34]
4.1 Loe and Silness	1	54	Std. Mean Difference (IV, Fixed, 95% CI)	0.0 [-0.53, 0.53]
4.2 Lobene gingival index	1	166	Std. Mean Difference (IV, Fixed, 95% CI)	0.16 [-0.14, 0.47]
4.3 BOP	1	52	Std. Mean Difference (IV, Fixed, 95% CI)	0.0 [-0.54, 0.54]

Comparison 3. Counter oscillation powered toothbrushes versus manual toothbrushes

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Plaque scores at 1 to 3 month at all sites	4		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.1 Quigley Hein (Turesky)	4	184	Mean Difference (IV, Random, 95% CI)	-0.03 [-0.15, 0.10]
2 Gingivitis scores at 1 to 3 months at all sites	4	172	Std. Mean Difference (IV, Fixed, 95% CI)	0.01 [-0.30, 0.31]
2.1 Loe and Silness	2	103	Std. Mean Difference (IV, Fixed, 95% CI)	0.01 [-0.39, 0.40]
2.2 Lobene gingival index	1	40	Std. Mean Difference (IV, Fixed, 95% CI)	-0.03 [-0.65, 0.59]
2.3 BOP	1	29	Std. Mean Difference (IV, Fixed, 95% CI)	0.06 [-0.68, 0.79]
3 Plaque scores at >3 months	2		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
3.1 Quigley Hein (Turesky)	2	69	Mean Difference (IV, Fixed, 95% CI)	-0.27 [-0.48, -0.07]
4 Gingival scores at >3 months	2	69	Std. Mean Difference (IV, Fixed, 95% CI)	-0.19 [-0.66, 0.29]
4.1 Lobene gingival index	1	40	Std. Mean Difference (IV, Fixed, 95% CI)	-0.18 [-0.80, 0.44]
4.2 BOP	1	29	Std. Mean Difference (IV, Fixed, 95% CI)	-0.19 [-0.93, 0.54]

Comparison 4. Rotation oscillation powered toothbrushes versus manual toothbrushes

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Plaque scores at 1 to 3 month at all sites	20	1404	Std. Mean Difference (IV, Random, 95% CI)	-0.53 [-0.74, -0.31]
1.1 Quigley Hein (Turesky)	13	979	Std. Mean Difference (IV, Random, 95% CI)	-0.44 [-0.69, -0.20]
1.2 Silness and Løe	2	115	Std. Mean Difference (IV, Random, 95% CI)	-1.17 [-2.74, 0.40]
1.3 Visible plaque index Ainamo Bay	1	111	Std. Mean Difference (IV, Random, 95% CI)	-0.26 [-0.63, 0.12]
1.4 Ortho modification of Silness and Løe	1	60	Std. Mean Difference (IV, Random, 95% CI)	0.0 [-0.51, 0.51]
1.5 Navy plaque index mod Rustogi	2	119	Std. Mean Difference (IV, Random, 95% CI)	-0.72 [-1.09, -0.35]
1.6 O'Leary index	1	20	Std. Mean Difference (IV, Random, 95% CI)	-1.81 [-2.88, -0.73]
2 Gingival scores at 1 to 3 months at all sites	21	1479	Std. Mean Difference (IV, Random, 95% CI)	-0.49 [-0.73, -0.26]
2.1 Løe and Silness	14	952	Std. Mean Difference (IV, Random, 95% CI)	-0.68 [-0.99, -0.38]
2.2 Lobene gingival index	3	290	Std. Mean Difference (IV, Random, 95% CI)	-0.11 [-0.46, 0.24]
2.3 BOP	2	130	Std. Mean Difference (IV, Random, 95% CI)	-0.25 [-0.59, 0.10]
2.4 Papillary bleeding index	1	32	Std. Mean Difference (IV, Random, 95% CI)	0.65 [-0.07, 1.36]
2.5 BOMP 0-2 scale	1	75	Std. Mean Difference (IV, Random, 95% CI)	-0.58 [-1.04, -0.12]
3 Plaque scores at >3 months	7	527	Std. Mean Difference (IV, Random, 95% CI)	-0.66 [-1.28, -0.03]
3.1 Quigley Hein (Turesky)	5	339	Std. Mean Difference (IV, Random, 95% CI)	-0.73 [-1.69, 0.24]
3.2 Silness and Løe	1	77	Std. Mean Difference (IV, Random, 95% CI)	-0.73 [-1.19, -0.26]
3.3 Visible plaque index Ainamo Bay	1	111	Std. Mean Difference (IV, Random, 95% CI)	-0.28 [-0.66, 0.09]
4 Gingival scores at >3 months	8	684	Std. Mean Difference (IV, Fixed, 95% CI)	-0.35 [-0.50, -0.20]
4.1 Lobene gingival index	2	234	Std. Mean Difference (IV, Fixed, 95% CI)	-0.36 [-0.62, -0.10]
4.2 BOP	2	189	Std. Mean Difference (IV, Fixed, 95% CI)	-0.64 [-0.93, -0.34]
4.3 Løe and Silness	2	154	Std. Mean Difference (IV, Fixed, 95% CI)	-0.25 [-0.57, 0.07]
4.4 Papillary bleeding index 0-4 scale	1	32	Std. Mean Difference (IV, Fixed, 95% CI)	0.65 [-0.07, 1.36]
4.5 BOMP 0-2 scale	1	75	Std. Mean Difference (IV, Fixed, 95% CI)	-0.24 [-0.69, 0.22]
5 Rotation oscillation versus manual: data not suitable for meta-analysis			Other data	No numeric data

Comparison 5. Circular powered toothbrushes versus manual toothbrushes

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Plaque scores at 1 to 3 month at all sites	2	128	Std. Mean Difference (IV, Fixed, 95% CI)	-0.02 [-0.37, 0.33]
1.1 Quigley Hein (Turesky)	2	128	Std. Mean Difference (IV, Fixed, 95% CI)	-0.02 [-0.37, 0.33]
1.2 Silness and Løe	0	0	Std. Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]

2 Gingival scores at 1 to 3 months at all sites	2	128	Std. Mean Difference (IV, Fixed, 95% CI)	-0.18 [-0.53, 0.17]
2.1 Loe and Silness	1	63	Std. Mean Difference (IV, Fixed, 95% CI)	0.13 [-0.36, 0.63]
2.2 Lobene gingival index	1	65	Std. Mean Difference (IV, Fixed, 95% CI)	-0.50 [-0.99, -0.00]

Comparison 6. Ionic toothbrushes versus manual toothbrushes

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Plaque scores at 1 to 3 months	3	186	Std. Mean Difference (IV, Fixed, 95% CI)	-0.57 [-0.87, -0.27]
1.1 Quigley Hein (Turesky)	2	116	Std. Mean Difference (IV, Fixed, 95% CI)	-0.30 [-0.67, 0.06]
1.2 Silness and Loe	1	70	Std. Mean Difference (IV, Fixed, 95% CI)	-1.07 [-1.57, -0.57]
2 Plaque scores at >3 months at all sites	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
2.1 Quigley Hein (Turesky)	1		Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]
3 Gingivitis at 1 to 3 months	2	116	Mean Difference (IV, Fixed, 95% CI)	-0.01 [-0.04, 0.02]
3.1 Loe and Silness	2	116	Mean Difference (IV, Fixed, 95% CI)	-0.01 [-0.04, 0.02]
4 Gingival scores at >3 months at all sites	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
4.1 Loe and Silness	1		Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]
5 Ionic versus manual: data not suitable for meta-analysis			Other data	No numeric data

Comparison 7. Ultrasonic powered toothbrushes versus manual toothbrushes

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Plaque scores at 1 to 3 month at all sites	4	301	Std. Mean Difference (IV, Fixed, 95% CI)	-1.33 [-1.59, -1.07]
1.1 Quigley Hein (Turesky)	3	171	Std. Mean Difference (IV, Fixed, 95% CI)	-0.97 [-1.30, -0.63]
1.2 Navy plaque index mod Rustogi	1	130	Std. Mean Difference (IV, Fixed, 95% CI)	-1.89 [-2.30, -1.47]
2 Gingival scores at 1 to 3 months at all sites	5	354	Std. Mean Difference (IV, Fixed, 95% CI)	-0.99 [-1.21, -0.76]
2.1 Loe and Silness	3	161	Std. Mean Difference (IV, Fixed, 95% CI)	-0.56 [-0.88, -0.25]
2.2 Lobene gingival index	1	130	Std. Mean Difference (IV, Fixed, 95% CI)	-1.80 [-2.21, -1.39]
2.3 Papillary bleeding index 0-4 scale	1	63	Std. Mean Difference (IV, Fixed, 95% CI)	-0.82 [-1.34, -0.31]
3 Plaque scores at >3 months at all sites	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3.1 Quigley Hein	1		Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]
4 Gingival scores at >3 months	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
4.1 Loe and Silness	1		Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]

Comparison 8. Unknown or other action versus manual toothbrushes

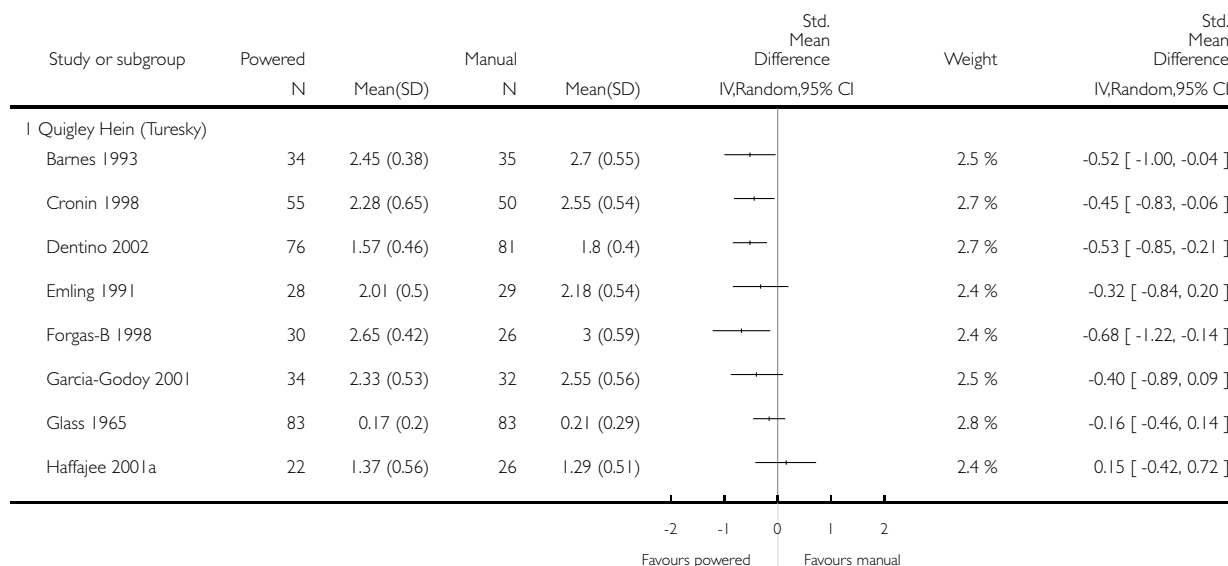
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Plaque scores at 1 to 3 months at all sites	2		Std. Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.1 Quigley Hein (Turesky)	2		Std. Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]
2 Gingival scores at 1 to 3 months at all sites	3		Std. Mean Difference (IV, Fixed, 95% CI)	Totals not selected
2.1 Loe and Sillness	3		Std. Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]
3 Gingival scores >3 months at all sites	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3.1 PMA	1		Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]

Analysis 1.1. Comparison 1 All powered toothbrushes versus manual toothbrushes, Outcome 1 Plaque scores at 1 to 3 month at all sites.

Review: Powered versus manual toothbrushing for oral health

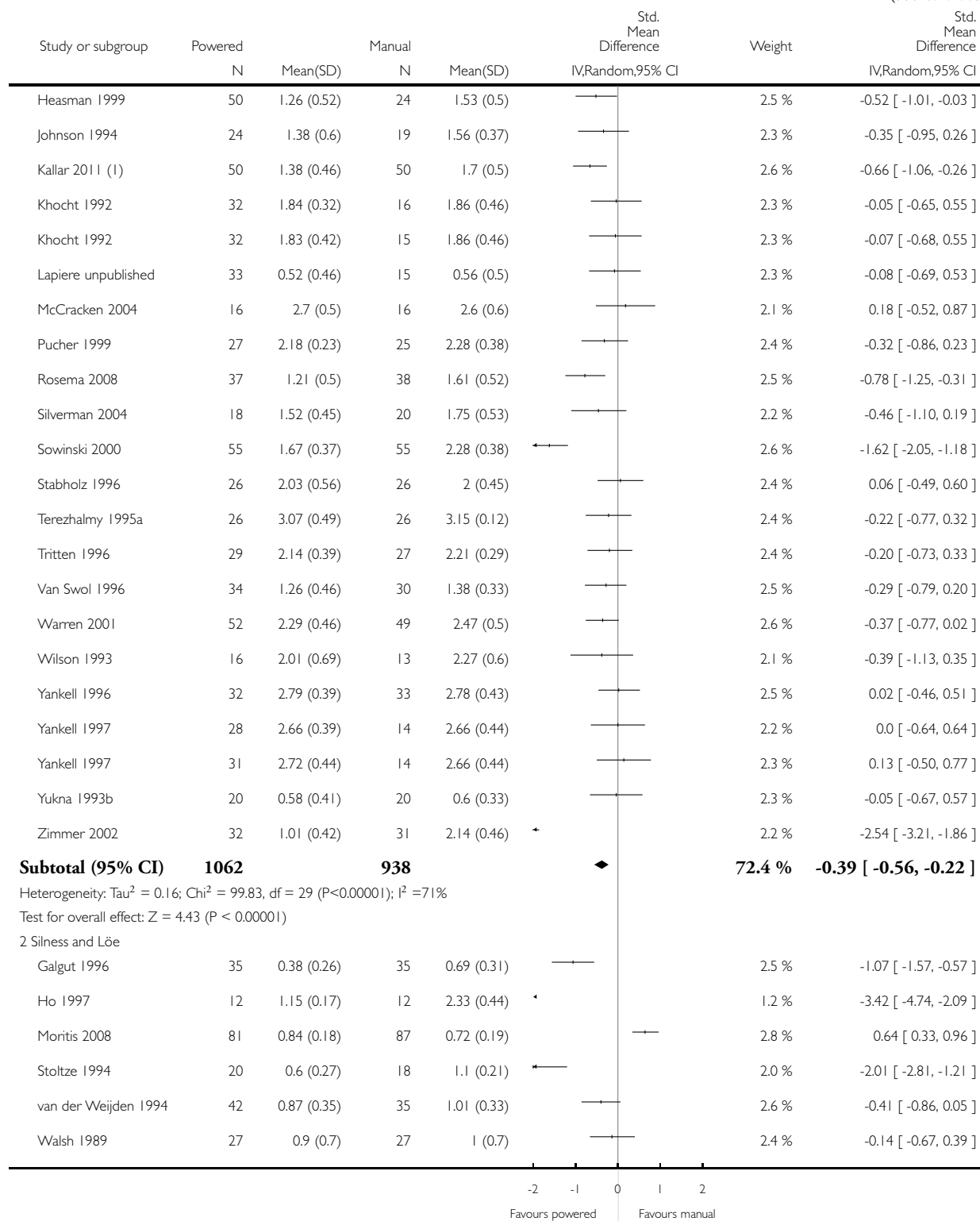
Comparison: 1 All powered toothbrushes versus manual toothbrushes

Outcome: 1 Plaque scores at 1 to 3 month at all sites



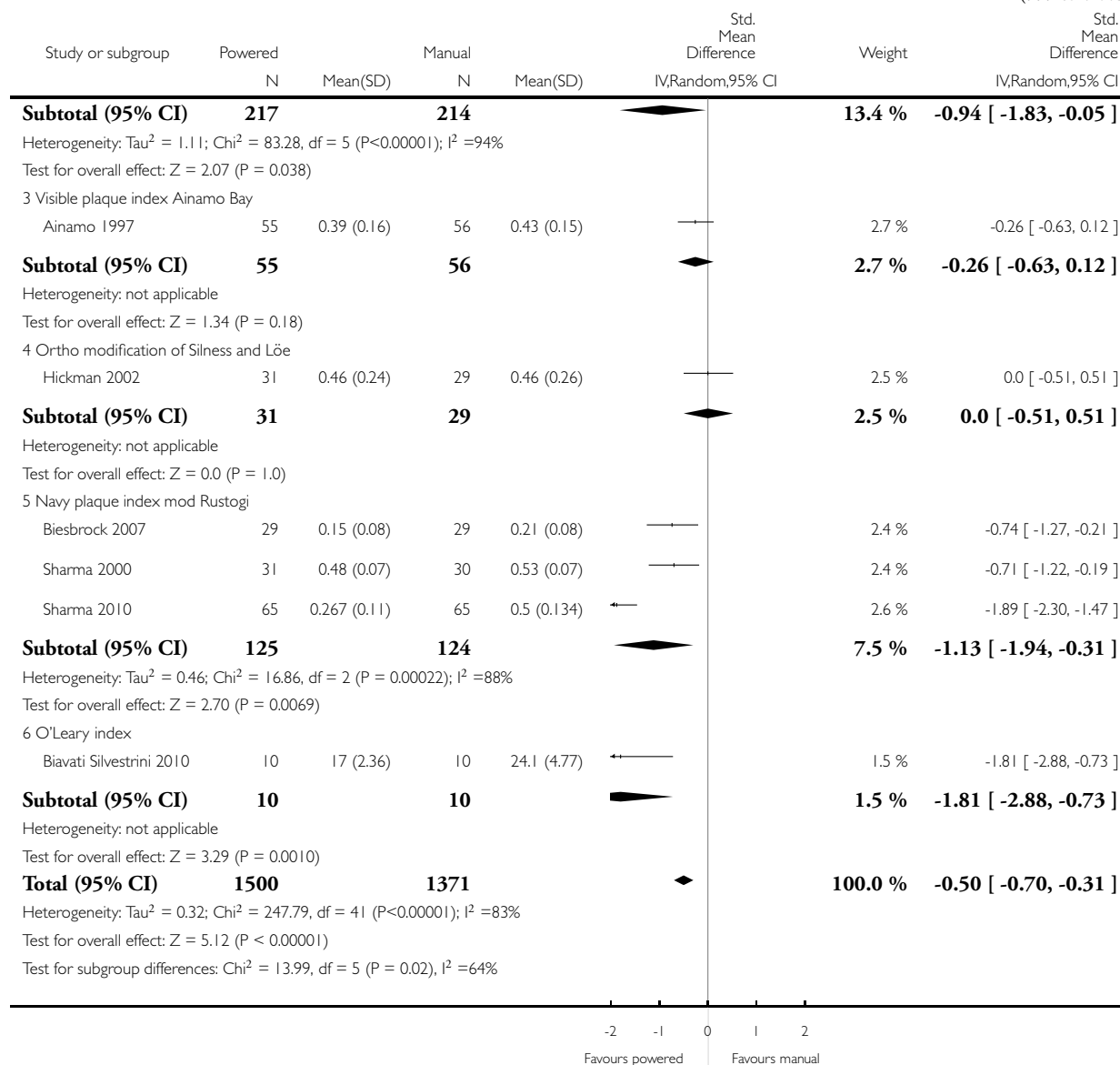
(Continued ...)

(... Continued)



(Continued ...)

(... Continued)



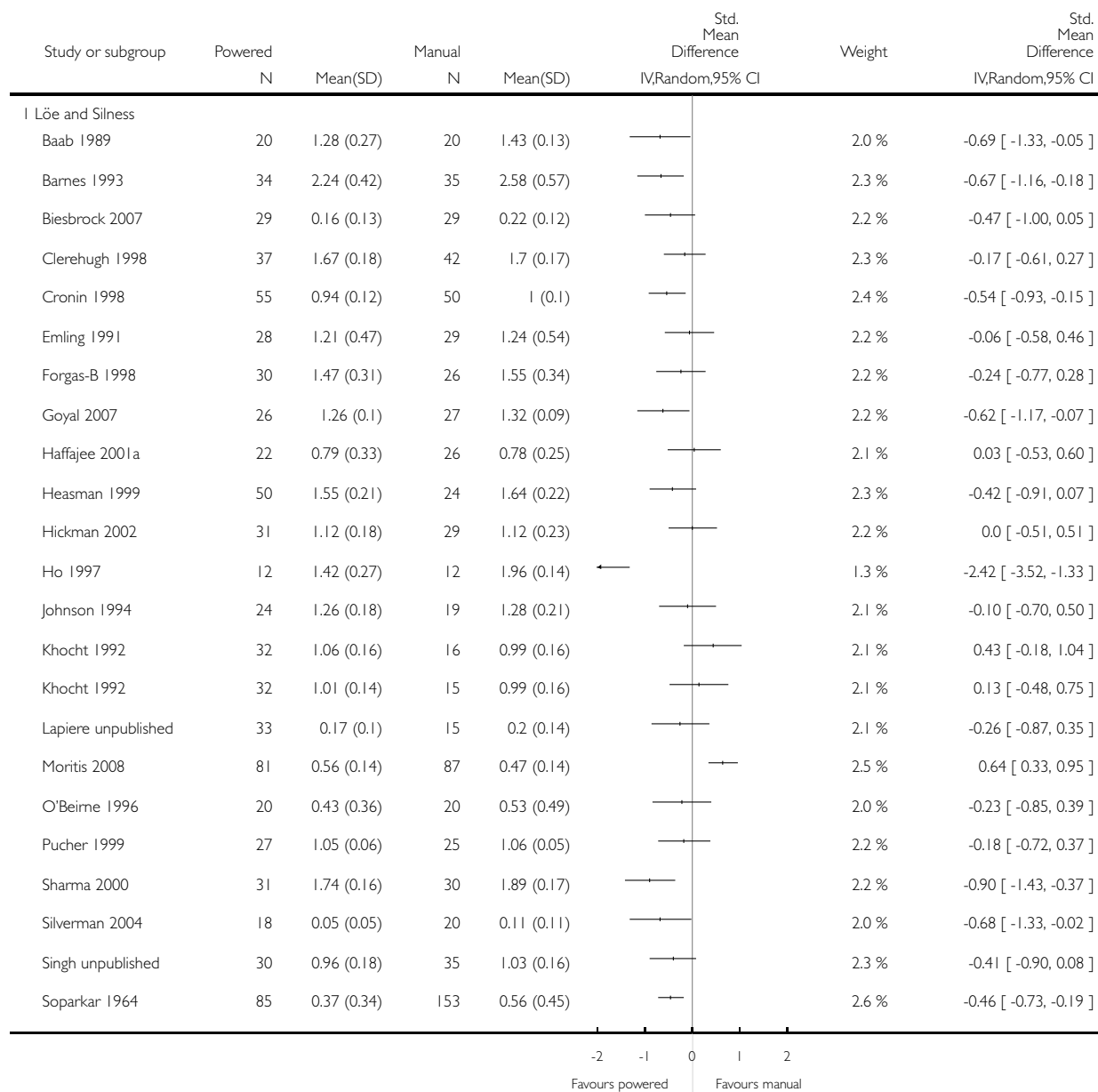
(1) median sd used as not reported

Analysis 1.2. Comparison 1 All powered toothbrushes versus manual toothbrushes, Outcome 2 Gingival scores at 1 to 3 months at all sites.

Review: Powered versus manual toothbrushing for oral health

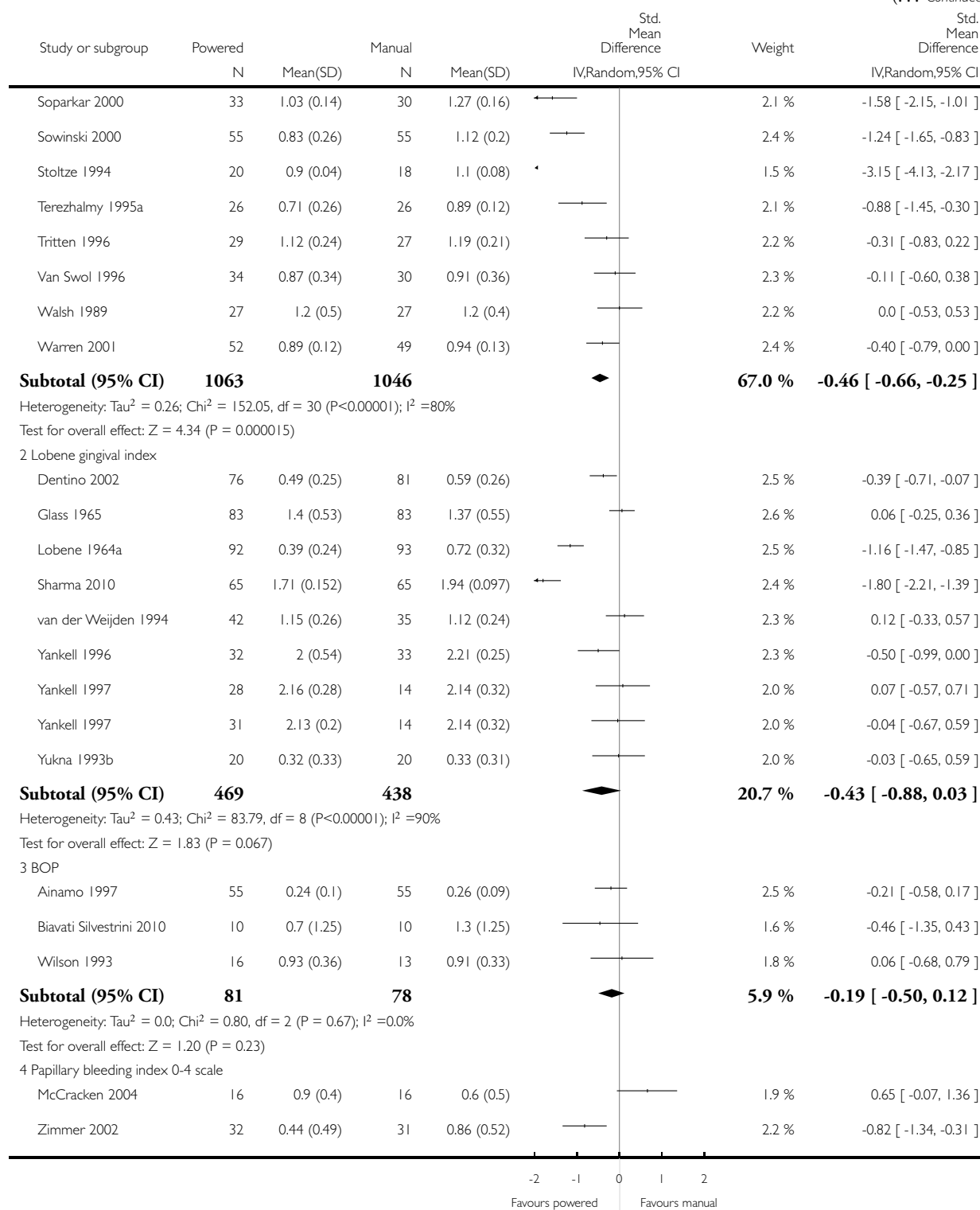
Comparison: 1 All powered toothbrushes versus manual toothbrushes

Outcome: 2 Gingival scores at 1 to 3 months at all sites



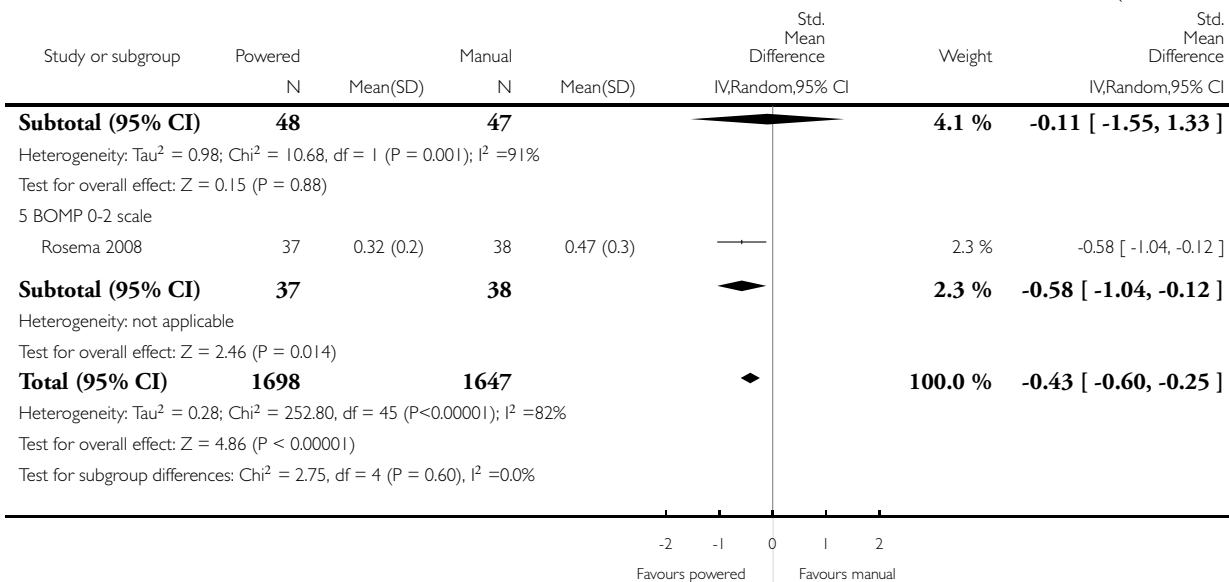
(Continued . . .)

(... Continued)



(Continued ...)

(... Continued)

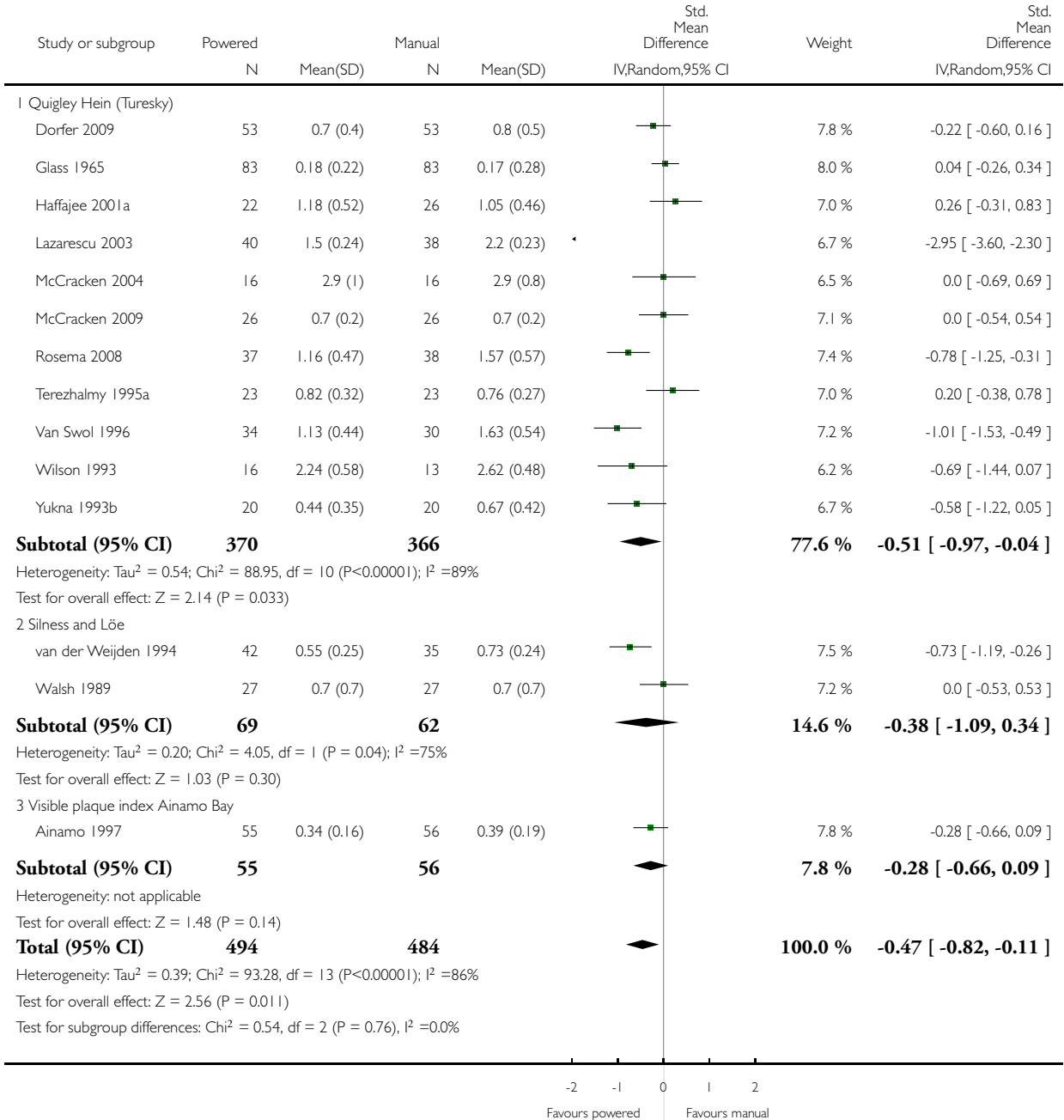


Analysis 1.3. Comparison 1 All powered toothbrushes versus manual toothbrushes, Outcome 3 Plaque scores at >3 months.

Review: Powered versus manual toothbrushing for oral health

Comparison: 1 All powered toothbrushes versus manual toothbrushes

Outcome: 3 Plaque scores at >3 months

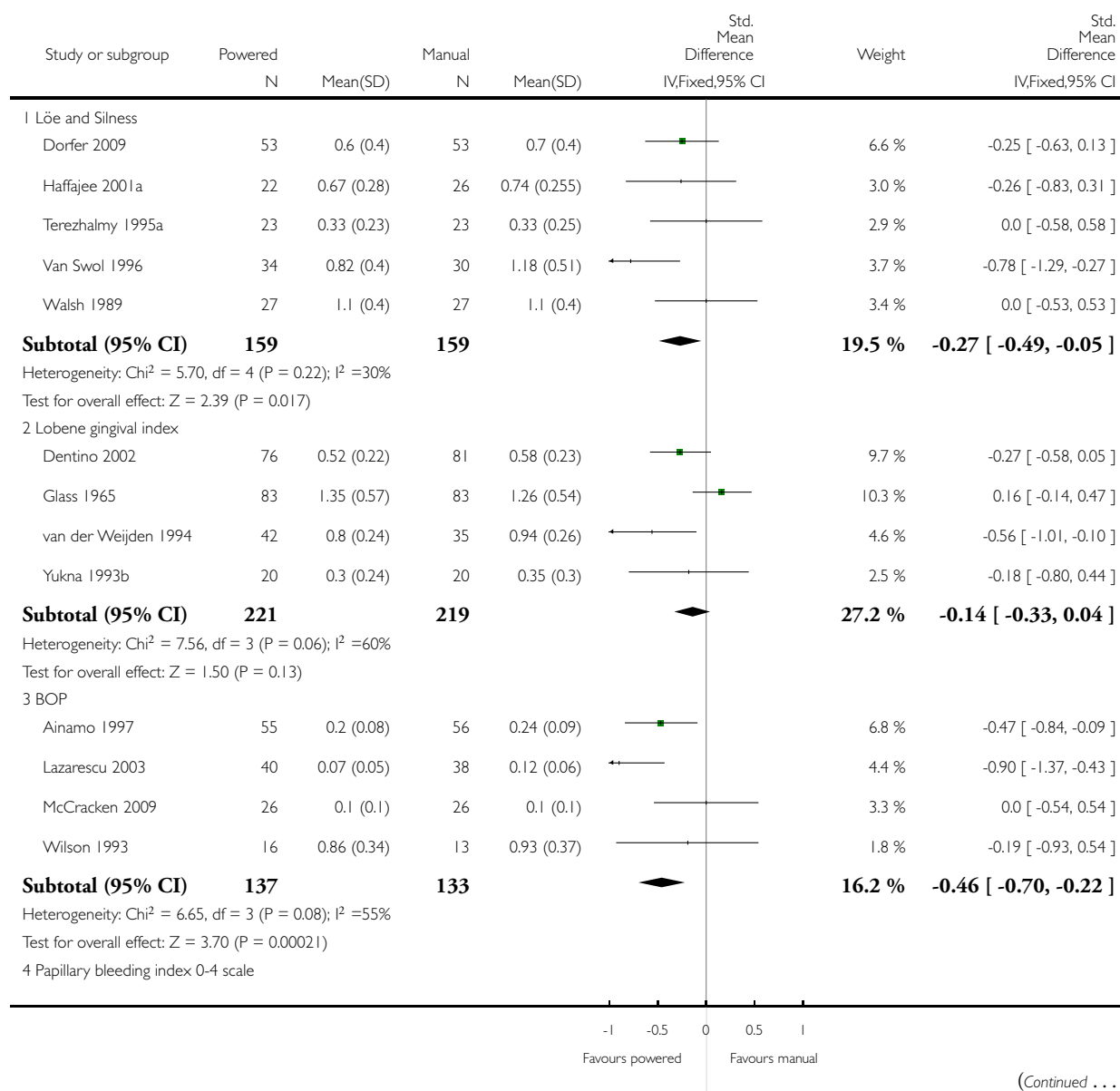


Analysis 1.4. Comparison 1 All powered toothbrushes versus manual toothbrushes, Outcome 4 Gingival scores at >3 months.

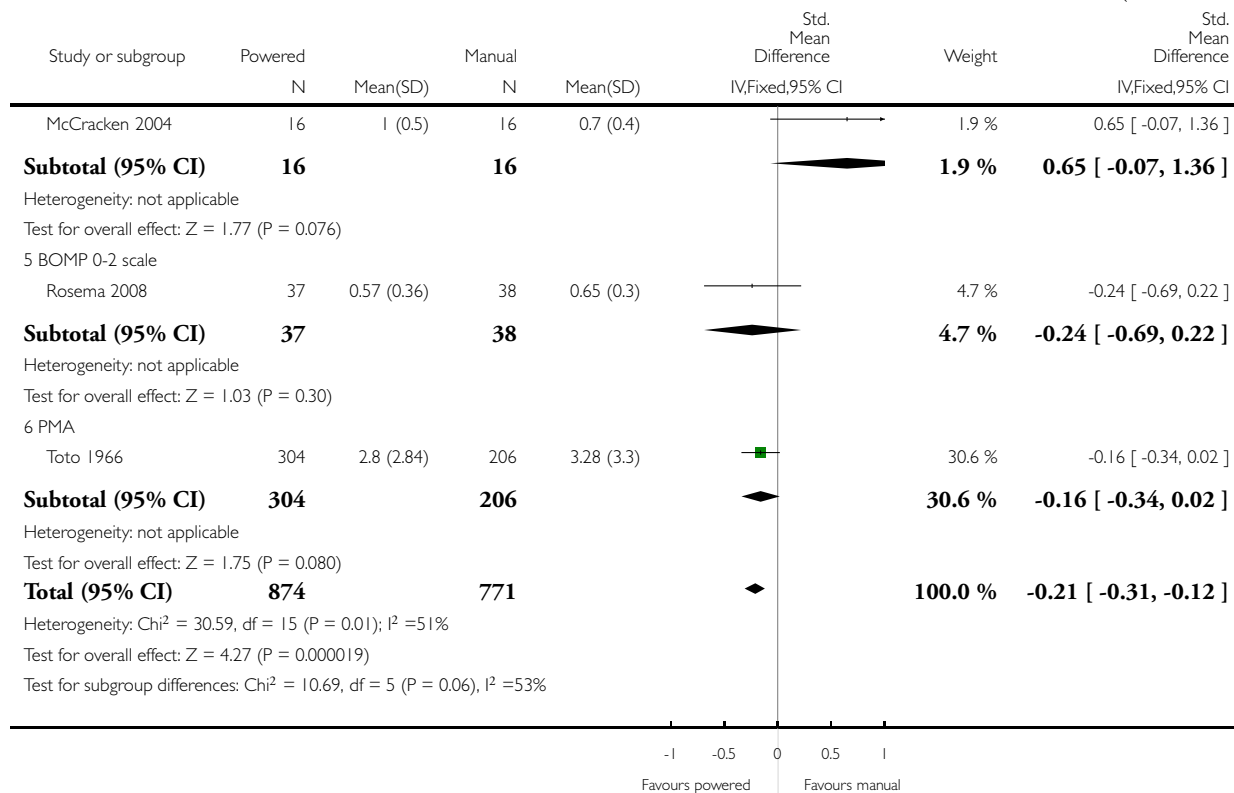
Review: Powered versus manual toothbrushing for oral health

Comparison: 1 All powered toothbrushes versus manual toothbrushes

Outcome: 4 Gingival scores at >3 months



(... Continued)

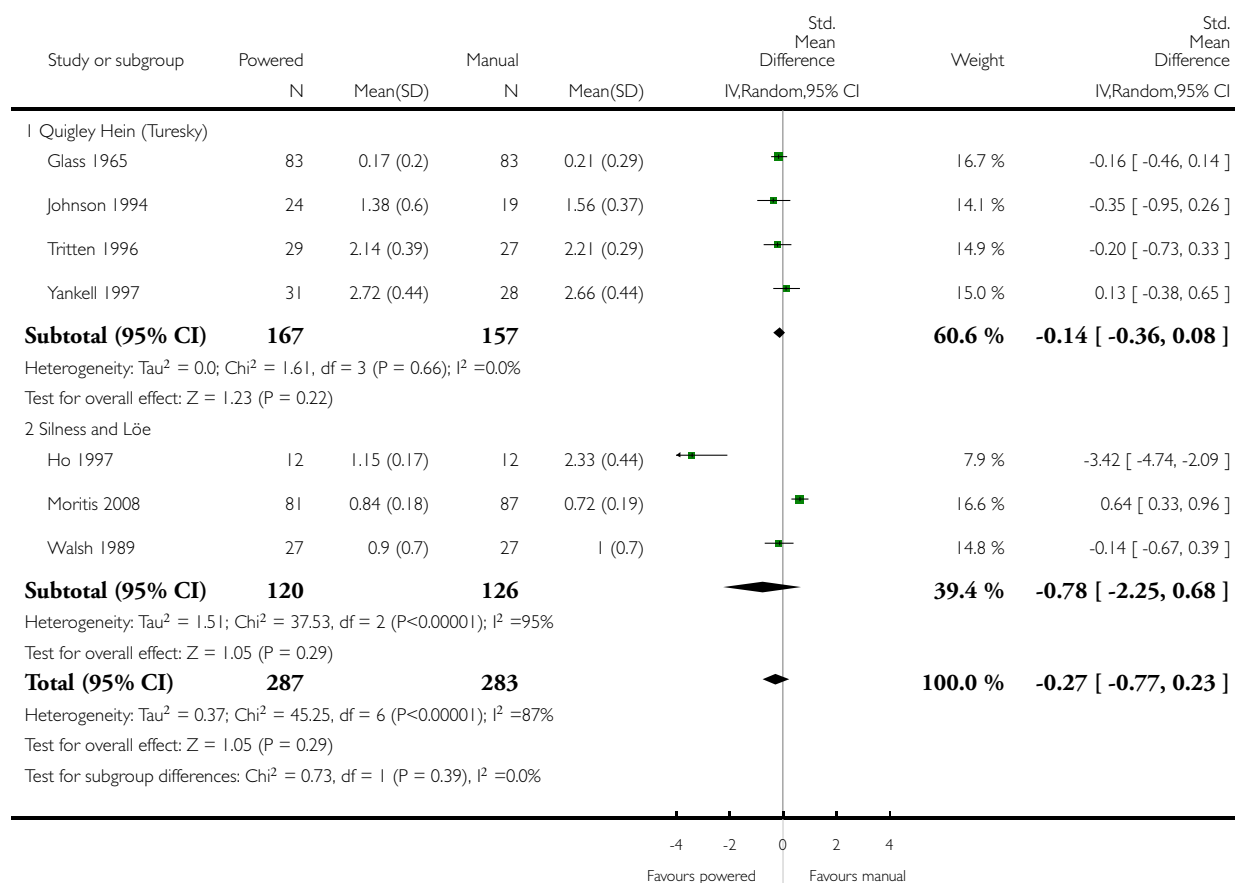


Analysis 2.1. Comparison 2 Side to side powered toothbrushes versus manual toothbrushes, Outcome 1 Plaque scores at 1 to 3 month at all sites.

Review: Powered versus manual toothbrushing for oral health

Comparison: 2 Side to side powered toothbrushes versus manual toothbrushes

Outcome: 1 Plaque scores at 1 to 3 month at all sites

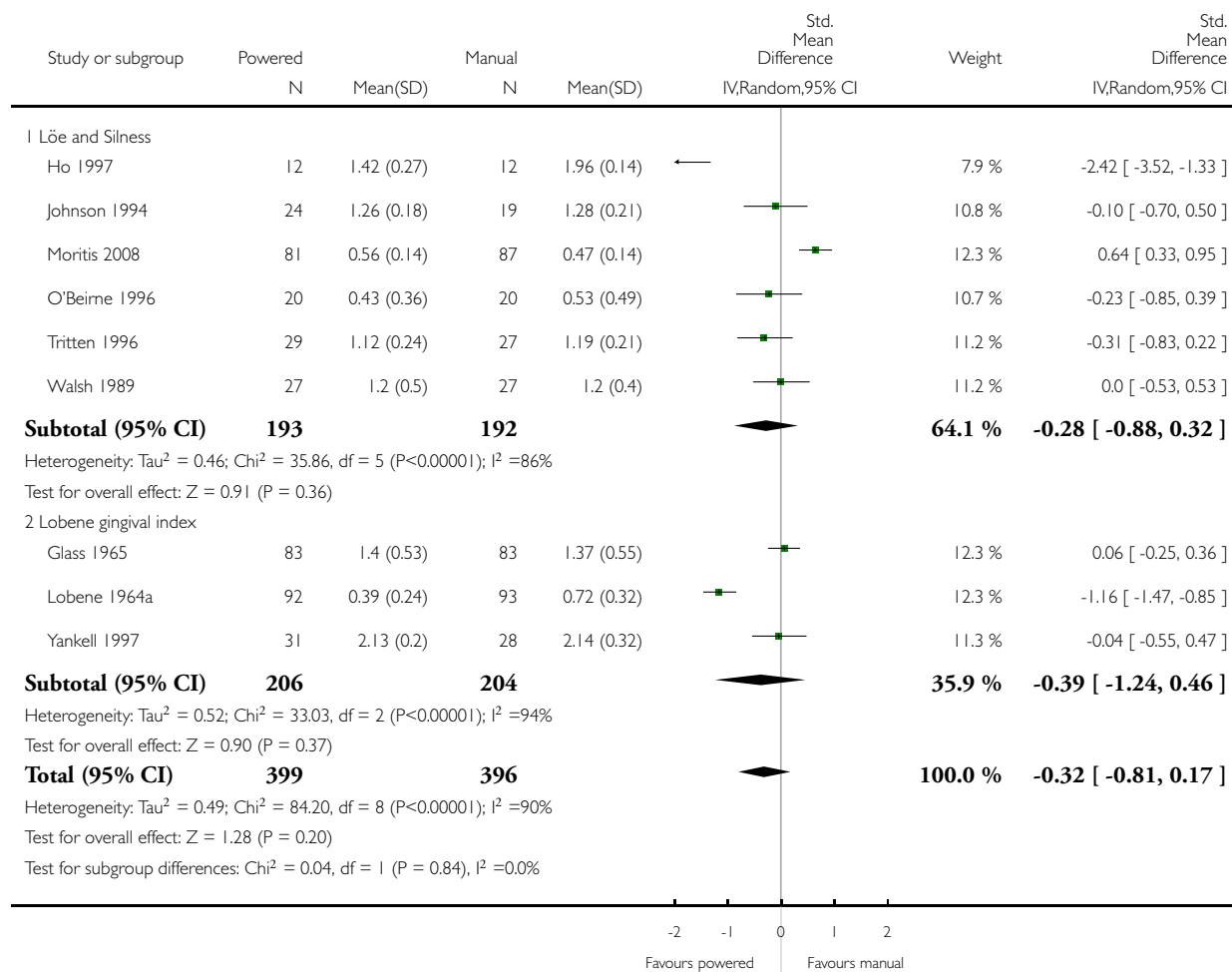


Analysis 2.2. Comparison 2 Side to side powered toothbrushes versus manual toothbrushes, Outcome 2 Gingival scores at 1 to 3 months at all sites.

Review: Powered versus manual toothbrushing for oral health

Comparison: 2 Side to side powered toothbrushes versus manual toothbrushes

Outcome: 2 Gingival scores at 1 to 3 months at all sites

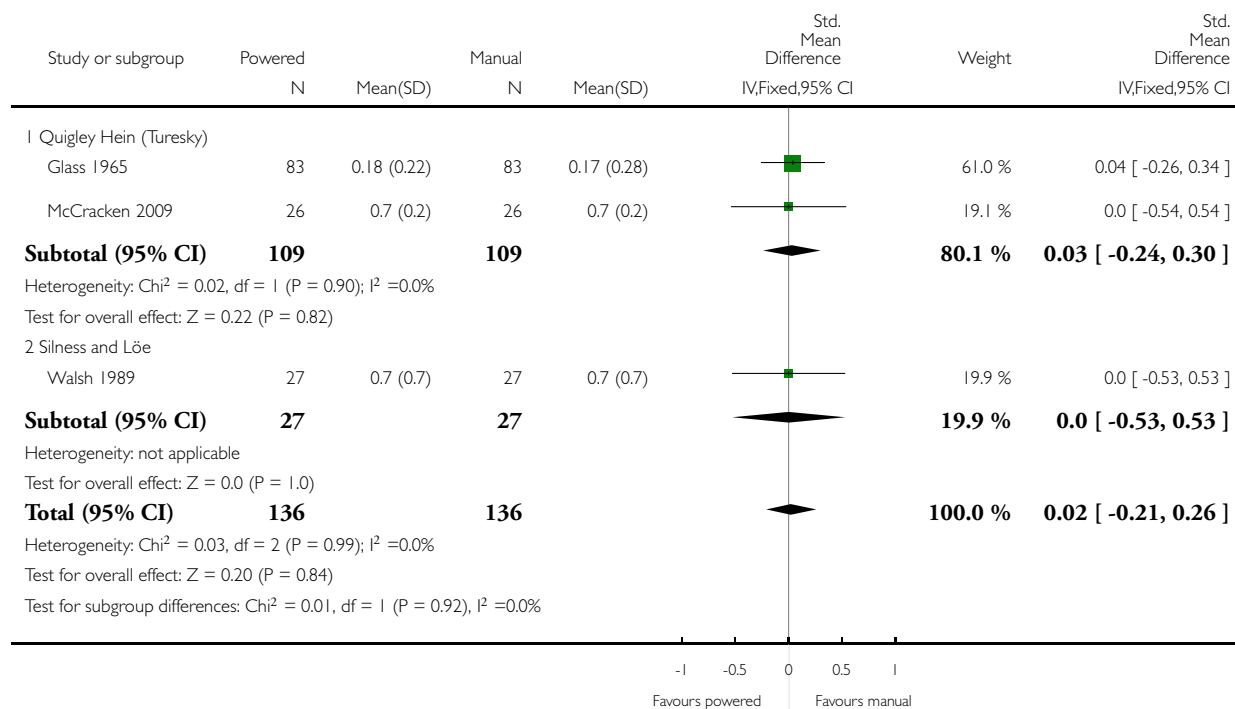


Analysis 2.3. Comparison 2 Side to side powered toothbrushes versus manual toothbrushes, Outcome 3 Plaque scores at >3 months.

Review: Powered versus manual toothbrushing for oral health

Comparison: 2 Side to side powered toothbrushes versus manual toothbrushes

Outcome: 3 Plaque scores at >3 months

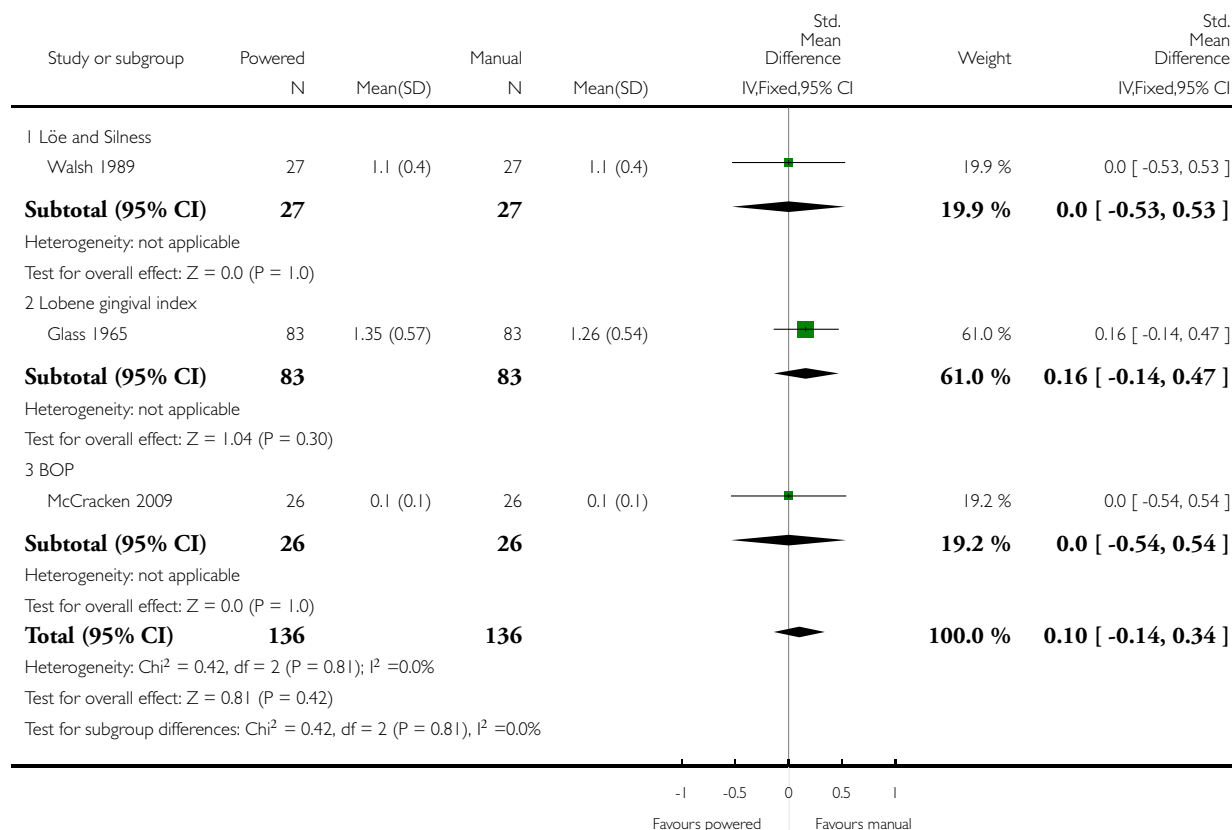


Analysis 2.4. Comparison 2 Side to side powered toothbrushes versus manual toothbrushes, Outcome 4 Gingival scores at >3 months.

Review: Powered versus manual toothbrushing for oral health

Comparison: 2 Side to side powered toothbrushes versus manual toothbrushes

Outcome: 4 Gingival scores at >3 months

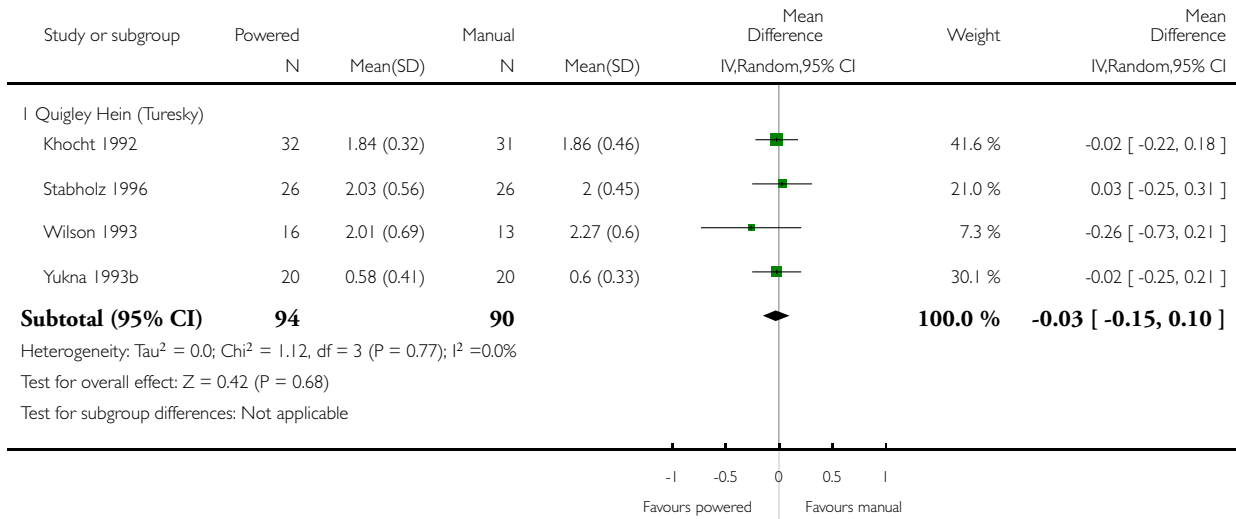


Analysis 3.1. Comparison 3 Counter oscillation powered toothbrushes versus manual toothbrushes, Outcome 1 Plaque scores at 1 to 3 month at all sites.

Review: Powered versus manual toothbrushing for oral health

Comparison: 3 Counter oscillation powered toothbrushes versus manual toothbrushes

Outcome: 1 Plaque scores at 1 to 3 month at all sites

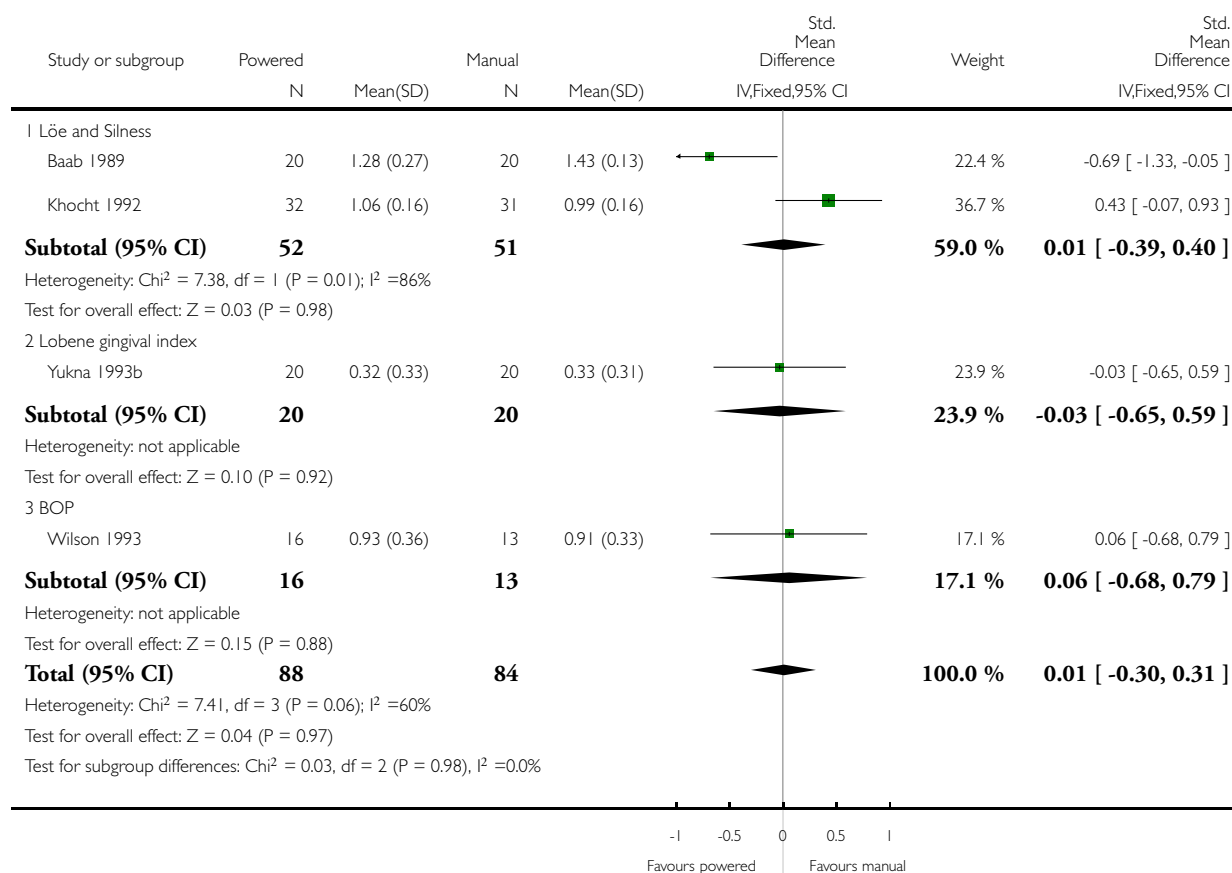


Analysis 3.2. Comparison 3 Counter oscillation powered toothbrushes versus manual toothbrushes, Outcome 2 Gingivitis scores at 1 to 3 months at all sites.

Review: Powered versus manual toothbrushing for oral health

Comparison: 3 Counter oscillation powered toothbrushes versus manual toothbrushes

Outcome: 2 Gingivitis scores at 1 to 3 months at all sites

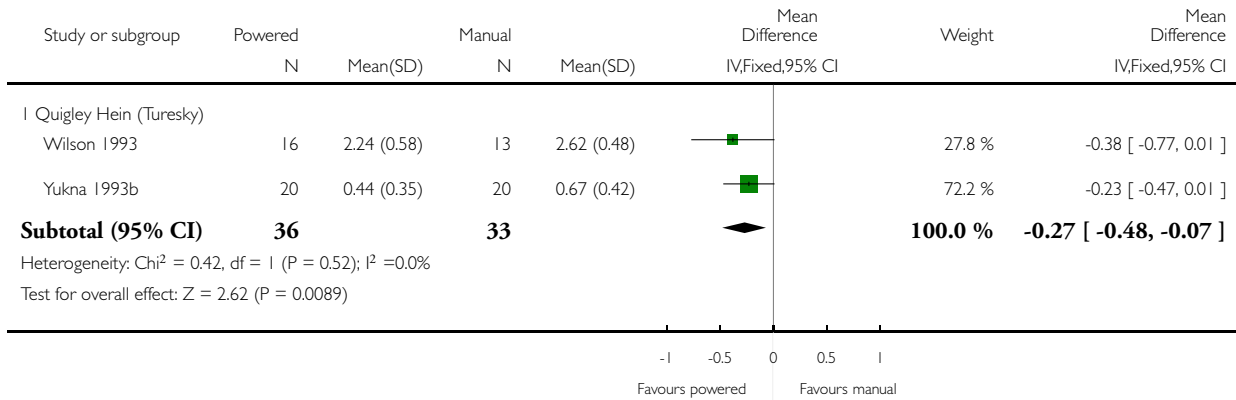


Analysis 3.3. Comparison 3 Counter oscillation powered toothbrushes versus manual toothbrushes, Outcome 3 Plaque scores at >3 months.

Review: Powered versus manual toothbrushing for oral health

Comparison: 3 Counter oscillation powered toothbrushes versus manual toothbrushes

Outcome: 3 Plaque scores at >3 months

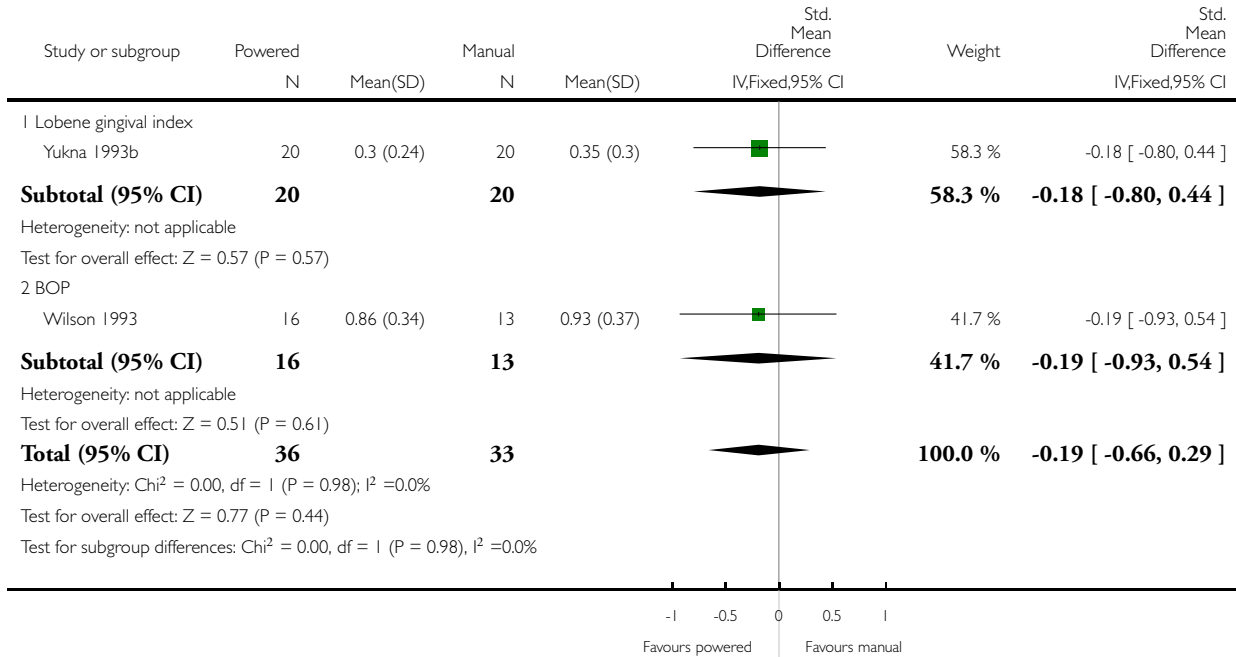


Analysis 3.4. Comparison 3 Counter oscillation powered toothbrushes versus manual toothbrushes, Outcome 4 Gingival scores at >3 months.

Review: Powered versus manual toothbrushing for oral health

Comparison: 3 Counter oscillation powered toothbrushes versus manual toothbrushes

Outcome: 4 Gingival scores at >3 months

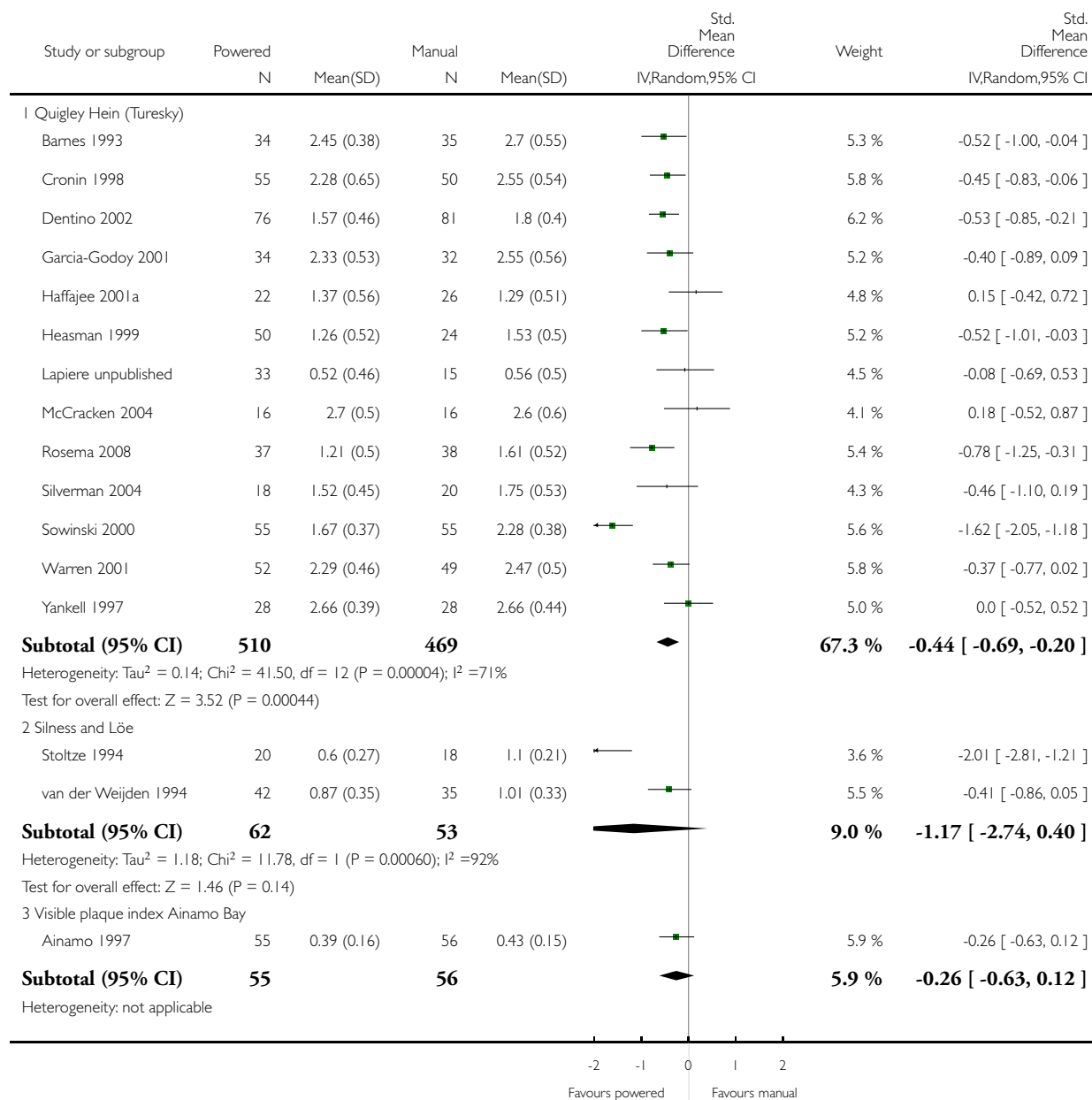


Analysis 4.1. Comparison 4 Rotation oscillation powered toothbrushes versus manual toothbrushes, Outcome 1 Plaque scores at 1 to 3 month at all sites.

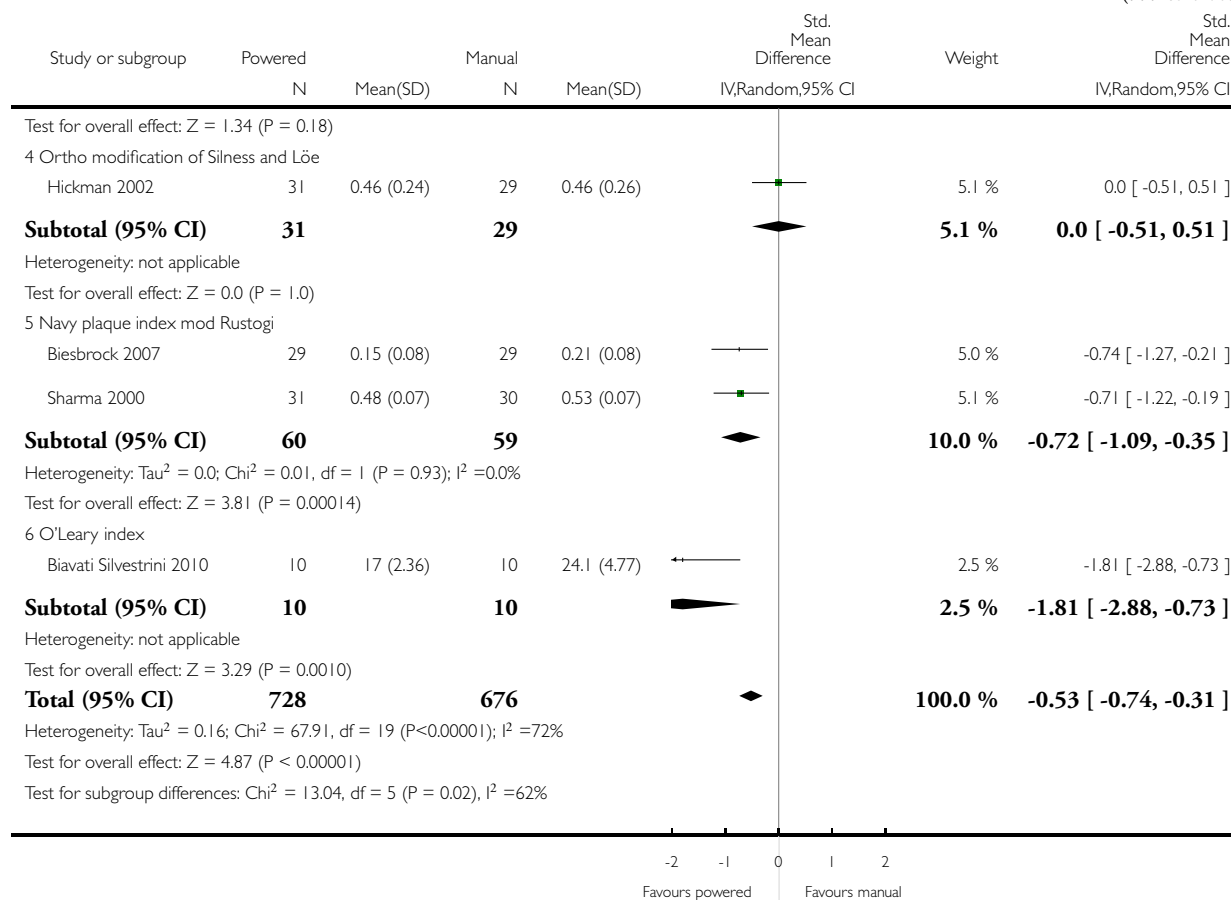
Review: Powered versus manual toothbrushing for oral health

Comparison: 4 Rotation oscillation powered toothbrushes versus manual toothbrushes

Outcome: 1 Plaque scores at 1 to 3 month at all sites



(... Continued)

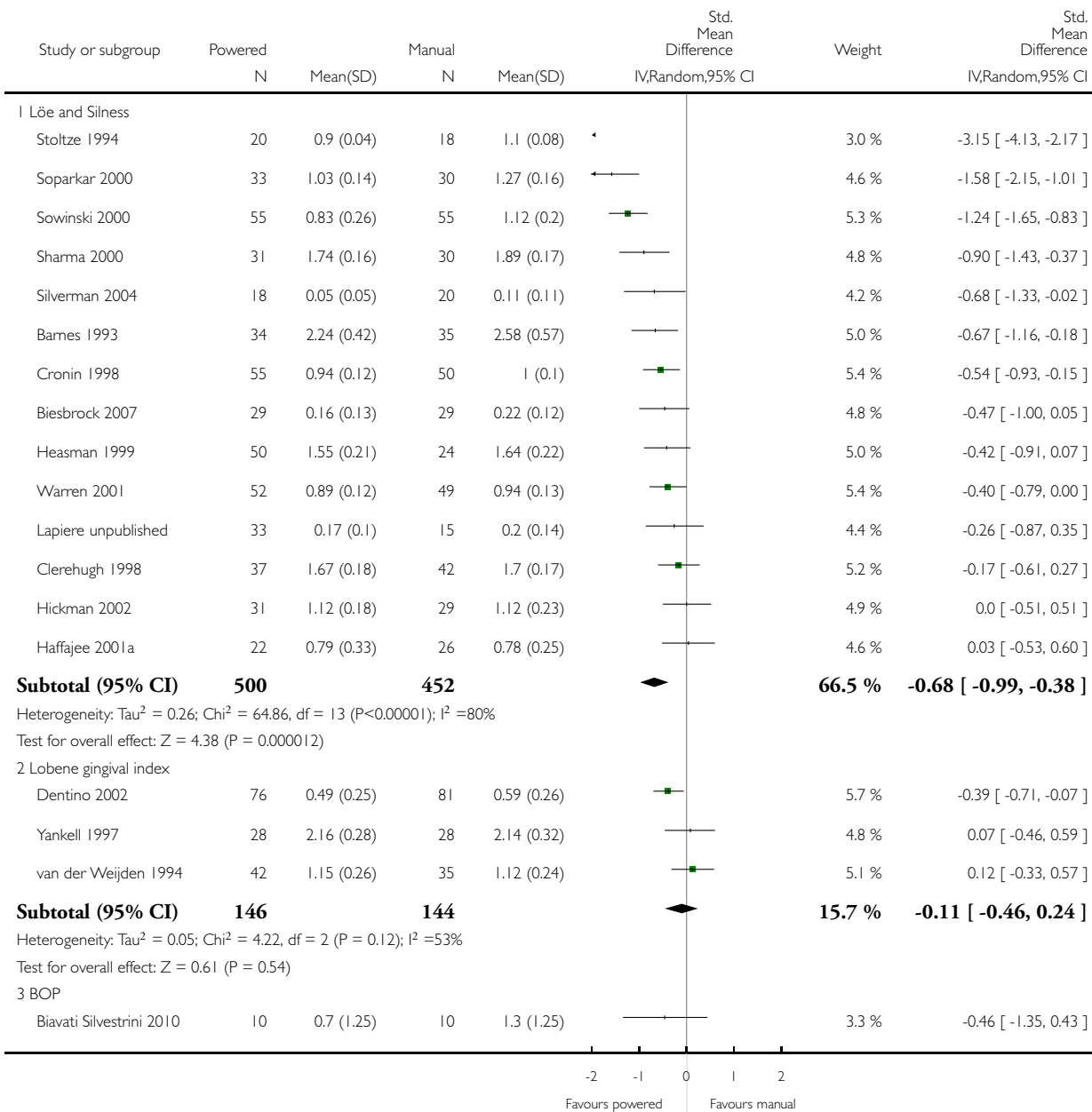


Analysis 4.2. Comparison 4 Rotation oscillation powered toothbrushes versus manual toothbrushes, Outcome 2 Gingival scores at 1 to 3 months at all sites.

Review: Powered versus manual toothbrushing for oral health

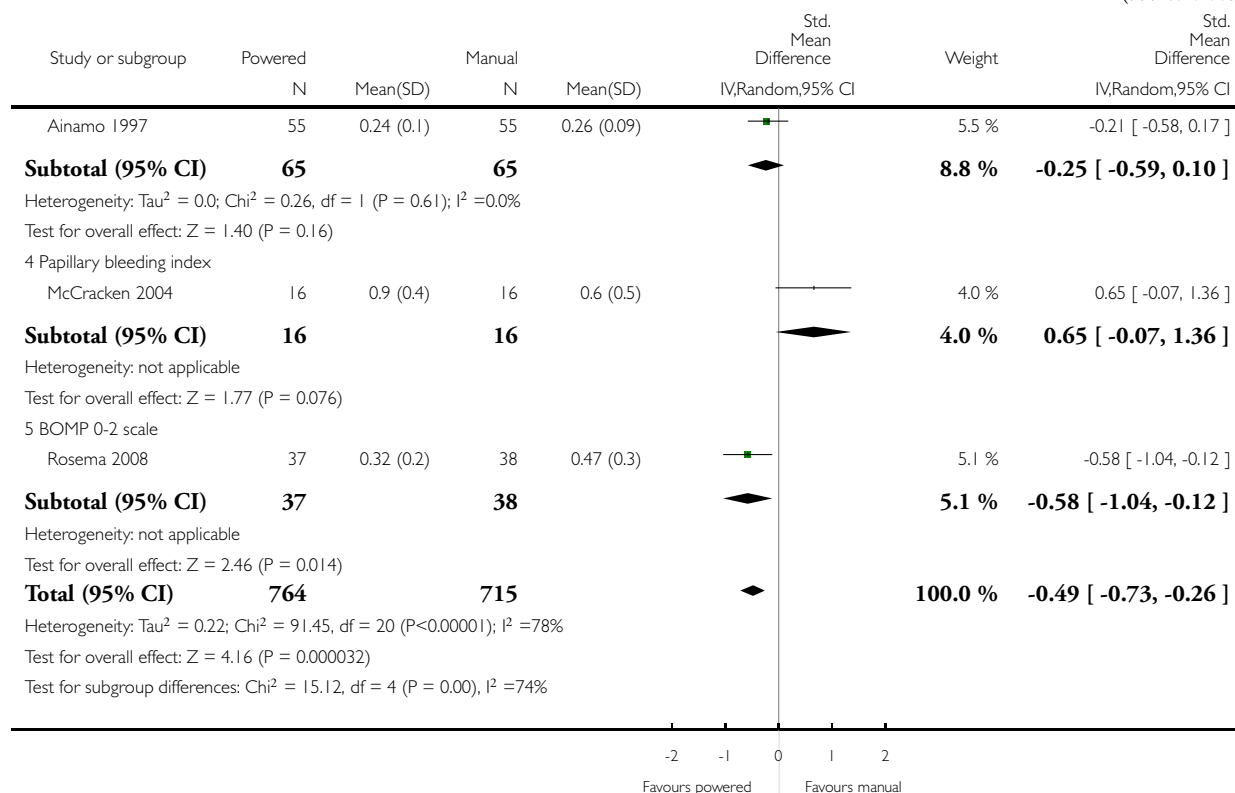
Comparison: 4 Rotation oscillation powered toothbrushes versus manual toothbrushes

Outcome: 2 Gingival scores at 1 to 3 months at all sites



(Continued ...)

(... Continued)

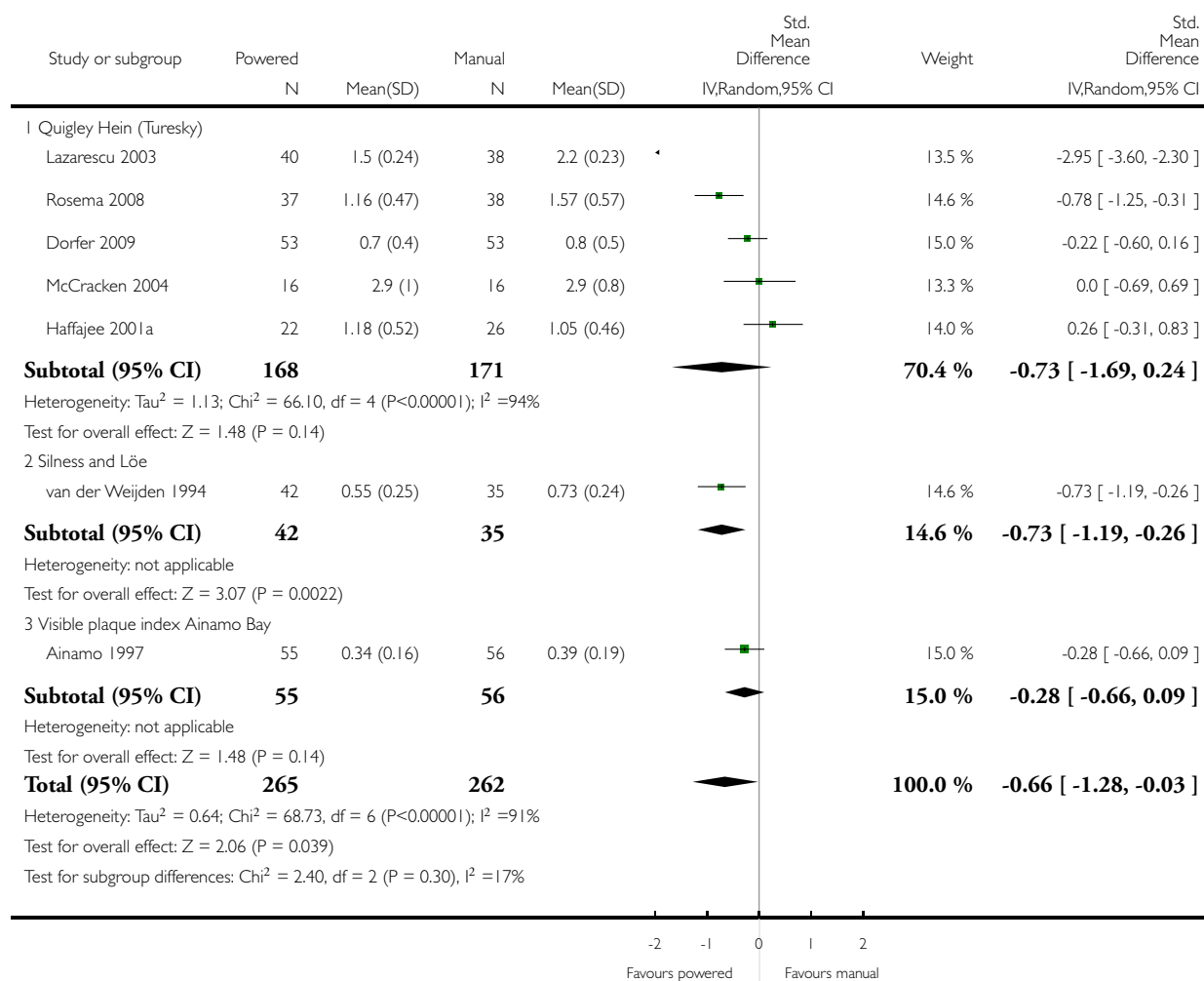


Analysis 4.3. Comparison 4 Rotation oscillation powered toothbrushes versus manual toothbrushes, Outcome 3 Plaque scores at >3 months.

Review: Powered versus manual toothbrushing for oral health

Comparison: 4 Rotation oscillation powered toothbrushes versus manual toothbrushes

Outcome: 3 Plaque scores at >3 months

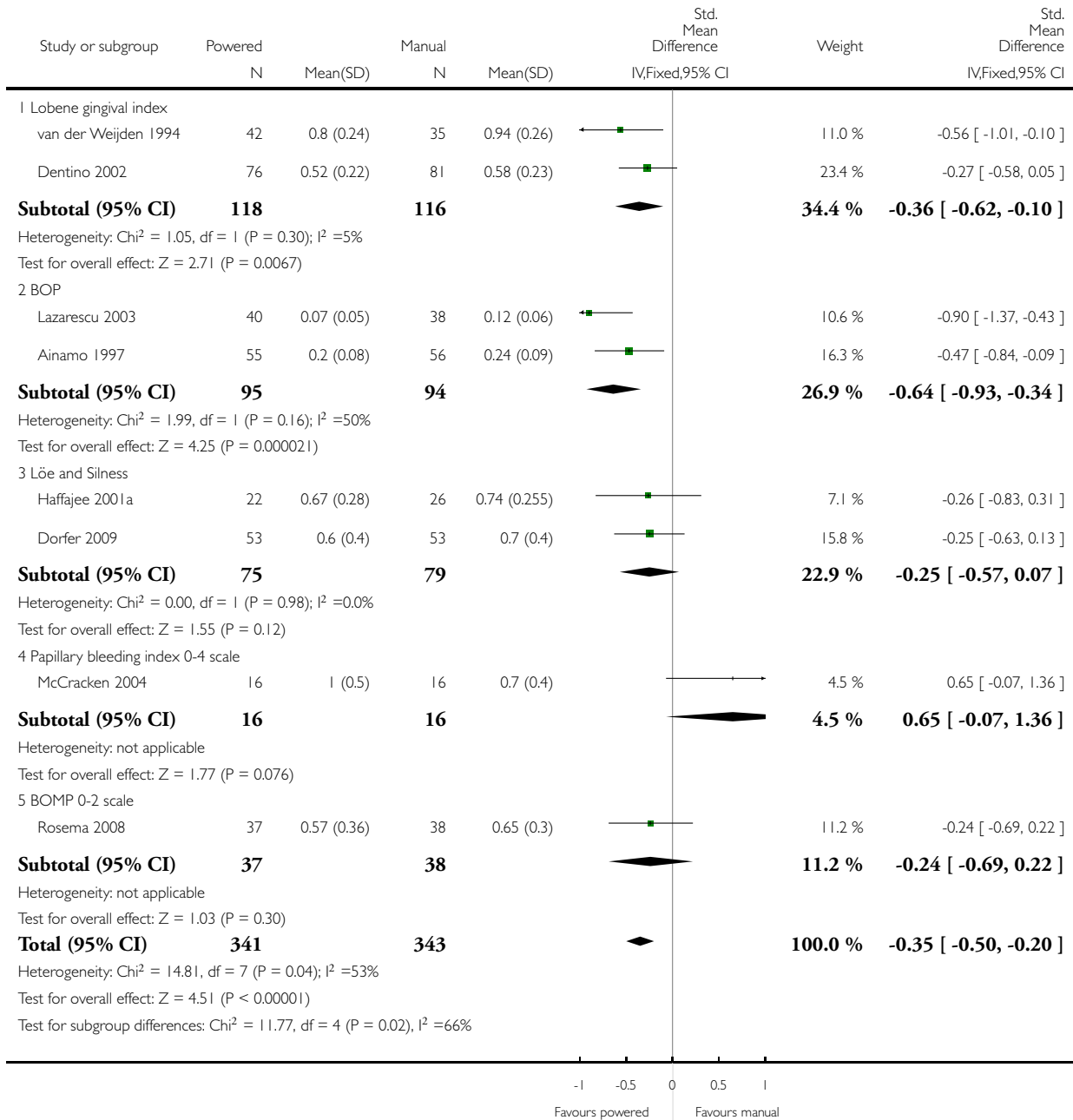


Analysis 4.4. Comparison 4 Rotation oscillation powered toothbrushes versus manual toothbrushes, Outcome 4 Gingival scores at >3 months.

Review: Powered versus manual toothbrushing for oral health

Comparison: 4 Rotation oscillation powered toothbrushes versus manual toothbrushes

Outcome: 4 Gingival scores at >3 months



**Analysis 4.5. Comparison 4 Rotation oscillation powered toothbrushes versus manual toothbrushes,
Outcome 5 Rotation oscillation versus manual: data not suitable for meta-analysis.**

Rotation oscillation versus manual: data not suitable for meta-analysis

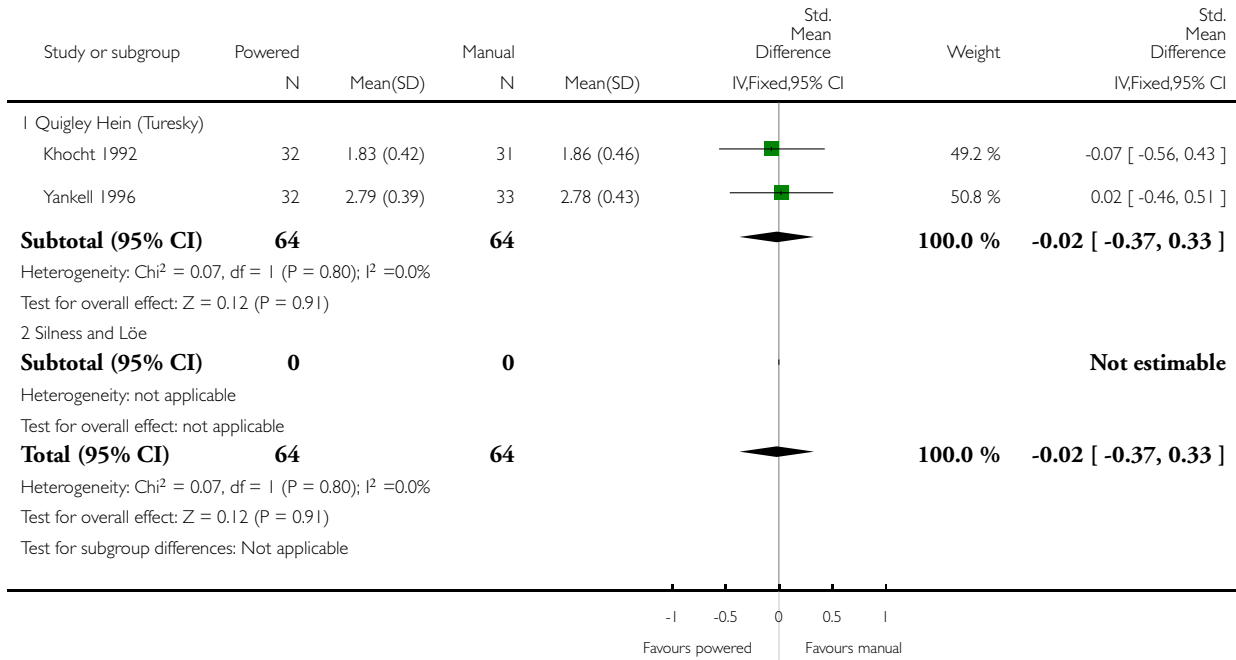
Study	Plaque	Gingivitis
Costa 2007	No statistically significant pre-post differences shown	No statistically significant pre-post differences shown
Gugerli 2007	“Subjects using a power toothbrush during initial treatment reduced supragingival plaque to lower levels...than subjects using a manual brush”	“Subjects using a power toothbrush ...showed significantly less bleeding on probing than subjects using a manual brush”
Zimmer 2005	Median change in Quigely-Hein at 4 weeks: Powered (Cybersonic): 0.23 Powered (Braun 3D Excel): 0.07 Manual: 0.22 Median change in Quigely-Hein at 8 weeks: Powered (Cybersonic): 0.41 Powered (Braun 3D Excel): 0.08 Manual: 0.35 All indices showed statistically significant reductions for both power toothbrushes which were superior to the manual brush	Median change in papillary bleeding index at 4 weeks: Powered (Cybersonic): 0.25 Powered (Braun 3D Excel): 0.02 Manual: 0.39 Median change in papillary bleeding index at 8 weeks: Powered (Cybersonic): 0.36 Powered (Braun 3D Excel): 0.10 Manual: 0.61

Analysis 5.1. Comparison 5 Circular powered toothbrushes versus manual toothbrushes, Outcome 1 Plaque scores at 1 to 3 month at all sites.

Review: Powered versus manual toothbrushing for oral health

Comparison: 5 Circular powered toothbrushes versus manual toothbrushes

Outcome: 1 Plaque scores at 1 to 3 month at all sites

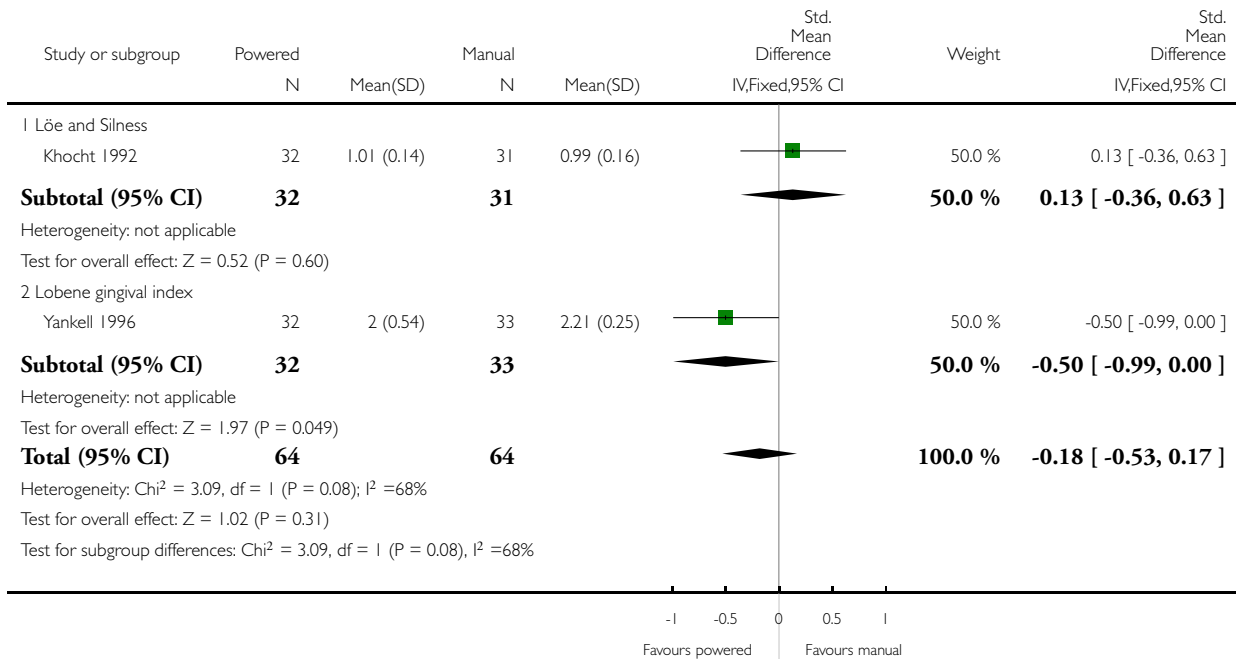


Analysis 5.2. Comparison 5 Circular powered toothbrushes versus manual toothbrushes, Outcome 2 Gingival scores at 1 to 3 months at all sites.

Review: Powered versus manual toothbrushing for oral health

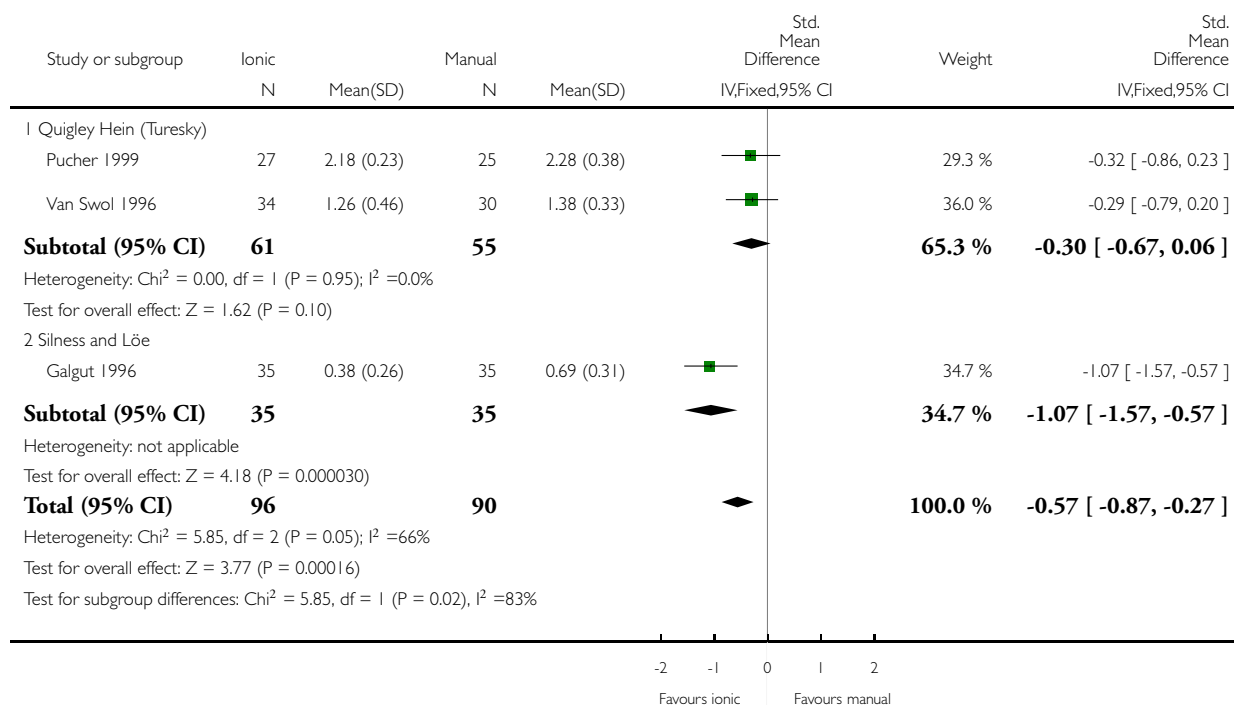
Comparison: 5 Circular powered toothbrushes versus manual toothbrushes

Outcome: 2 Gingival scores at 1 to 3 months at all sites



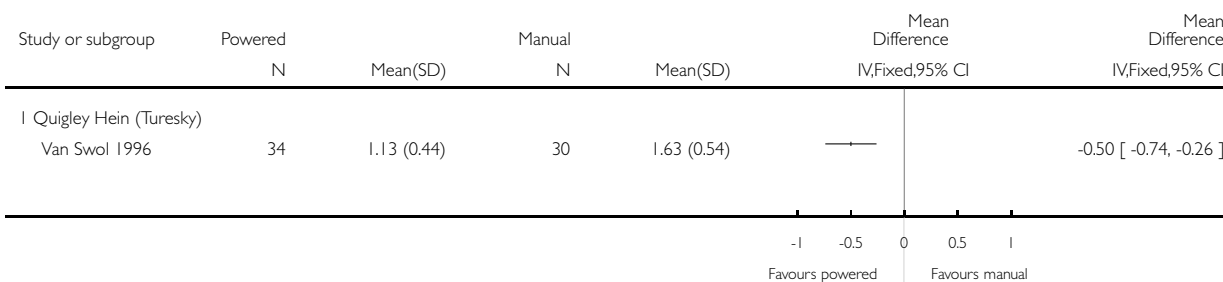
Analysis 6.1. Comparison 6 Ionic toothbrushes versus manual toothbrushes, Outcome 1 Plaque scores at 1 to 3 months.

Review: Powered versus manual toothbrushing for oral health
 Comparison: 6 Ionic toothbrushes versus manual toothbrushes
 Outcome: 1 Plaque scores at 1 to 3 months



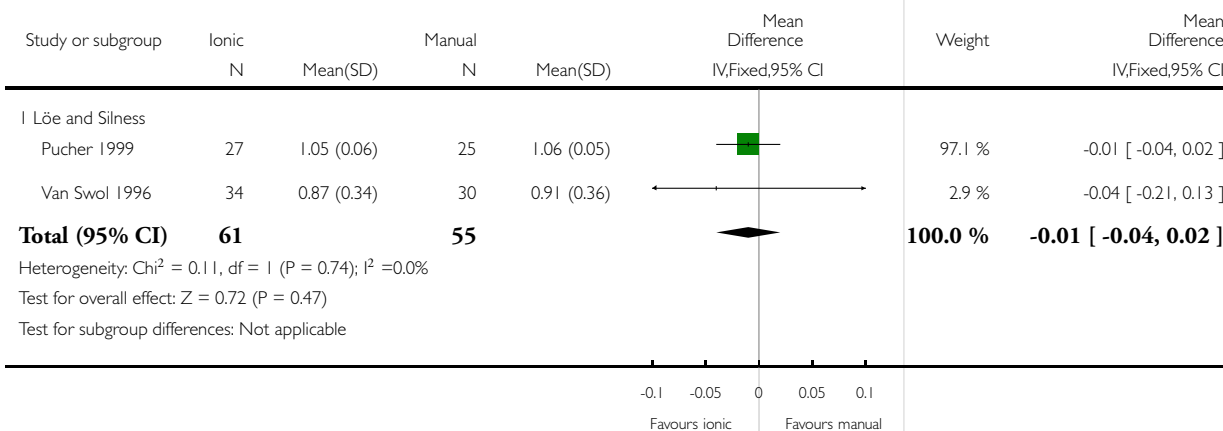
Analysis 6.2. Comparison 6 Ionic toothbrushes versus manual toothbrushes, Outcome 2 Plaque scores at >3 months at all sites.

Review: Powered versus manual toothbrushing for oral health
 Comparison: 6 Ionic toothbrushes versus manual toothbrushes
 Outcome: 2 Plaque scores at >3 months at all sites



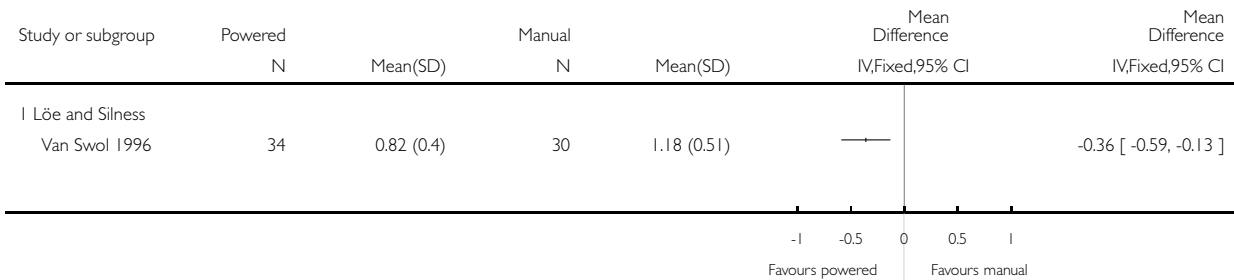
Analysis 6.3. Comparison 6 Ionic toothbrushes versus manual toothbrushes, Outcome 3 Gingivitis at 1 to 3 months.

Review: Powered versus manual toothbrushing for oral health
 Comparison: 6 Ionic toothbrushes versus manual toothbrushes
 Outcome: 3 Gingivitis at 1 to 3 months



Analysis 6.4. Comparison 6 Ionic toothbrushes versus manual toothbrushes, Outcome 4 Gingival scores at >3 months at all sites.

Review: Powered versus manual toothbrushing for oral health
 Comparison: 6 Ionic toothbrushes versus manual toothbrushes
 Outcome: 4 Gingival scores at >3 months at all sites



Analysis 6.5. Comparison 6 Ionic toothbrushes versus manual toothbrushes, Outcome 5 Ionic versus manual: data not suitable for meta-analysis.

Ionic versus manual: data not suitable for meta-analysis

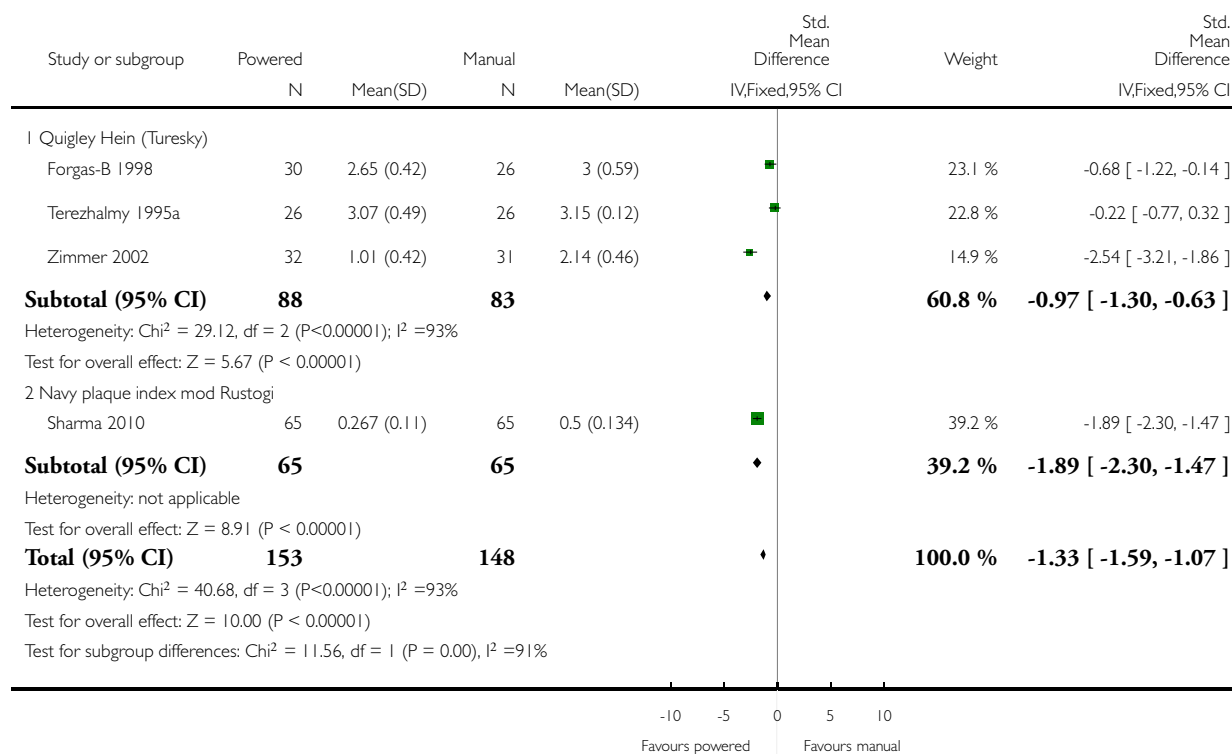
Study	Plaque	Gingivitis
Galgut 1996	The electrically active toothbrushes better plaque removal than the inactive toothbrushes (6.5% more plaque removal at final visit)	Not reported
Moreira 2007	Frequency distribution for plaque zero at baseline and 28 days was 9.27+/- 10.14/17.75+/-9.60 and 8.42+/-10.43/16.79+/-8.93 for ionic and conventional toothbrushes respectively	Not reported

Analysis 7.1. Comparison 7 Ultrasonic powered toothbrushes versus manual toothbrushes, Outcome 1 Plaque scores at 1 to 3 month at all sites.

Review: Powered versus manual toothbrushing for oral health

Comparison: 7 Ultrasonic powered toothbrushes versus manual toothbrushes

Outcome: 1 Plaque scores at 1 to 3 month at all sites

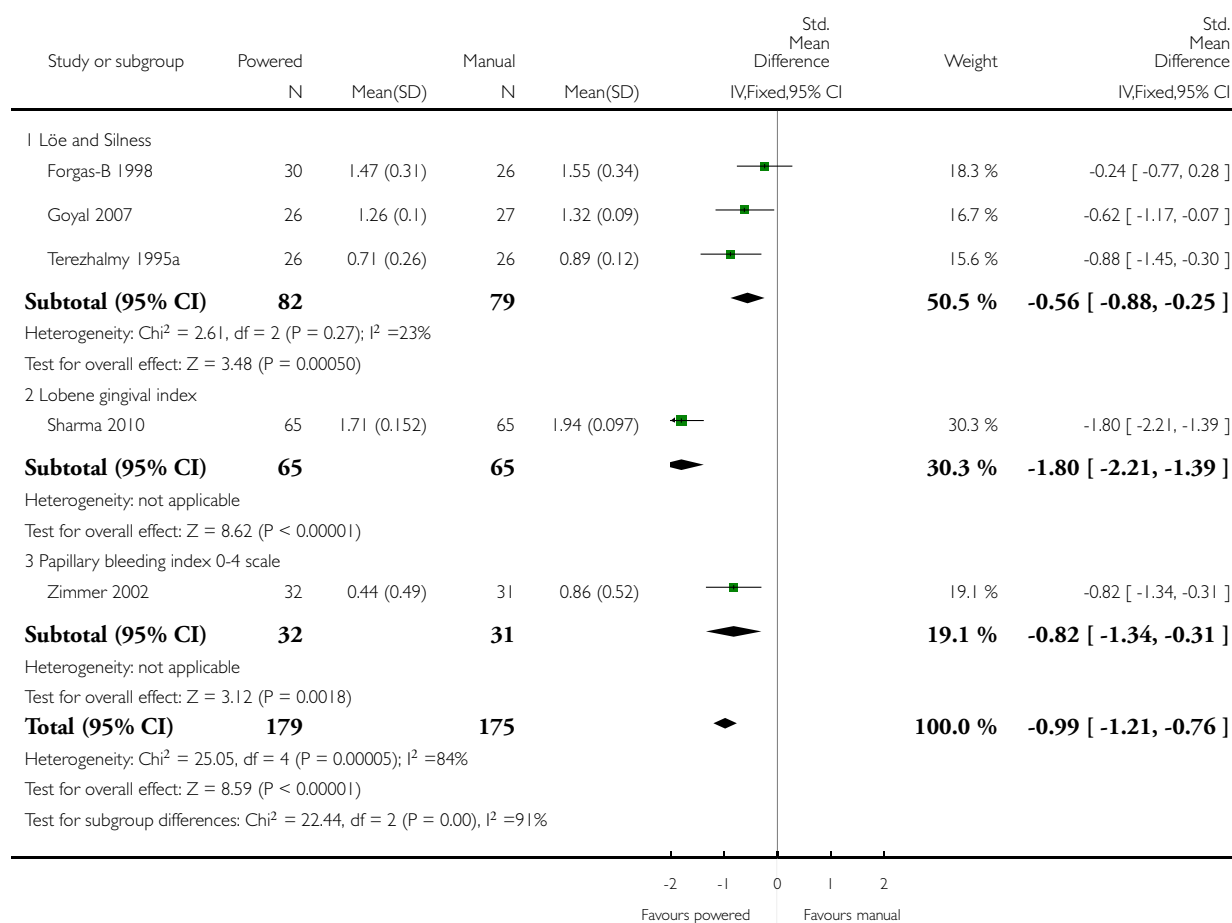


Analysis 7.2. Comparison 7 Ultrasonic powered toothbrushes versus manual toothbrushes, Outcome 2 Gingival scores at 1 to 3 months at all sites.

Review: Powered versus manual toothbrushing for oral health

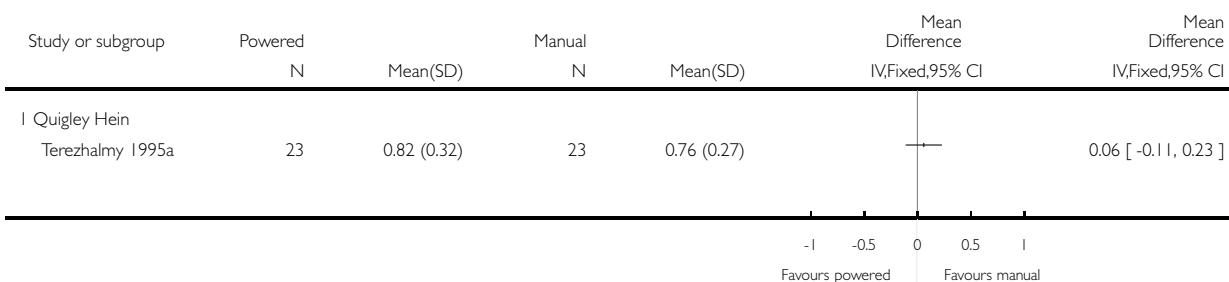
Comparison: 7 Ultrasonic powered toothbrushes versus manual toothbrushes

Outcome: 2 Gingival scores at 1 to 3 months at all sites



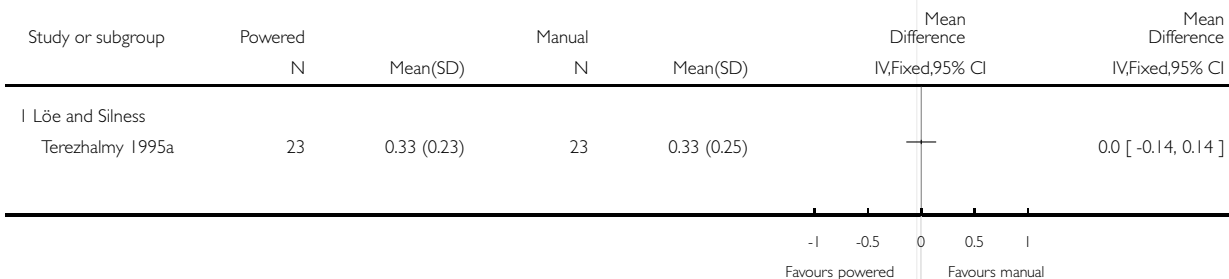
**Analysis 7.3. Comparison 7 Ultrasonic powered toothbrushes versus manual toothbrushes, Outcome 3
Plaque scores at >3 months at all sites.**

Review: Powered versus manual toothbrushing for oral health
 Comparison: 7 Ultrasonic powered toothbrushes versus manual toothbrushes
 Outcome: 3 Plaque scores at >3 months at all sites



**Analysis 7.4. Comparison 7 Ultrasonic powered toothbrushes versus manual toothbrushes, Outcome 4
Gingival scores at >3 months.**

Review: Powered versus manual toothbrushing for oral health
 Comparison: 7 Ultrasonic powered toothbrushes versus manual toothbrushes
 Outcome: 4 Gingival scores at >3 months



Analysis 7.5. Comparison 7 Ultrasonic powered toothbrushes versus manual toothbrushes, Outcome 5 Ultrasonic versus manual: data not suitable for meta-analysis.

Ultrasonic versus manual: data not suitable for meta-analysis

Study	Plaque	Gingivitis
Costa 2007	“There was a significant difference for the ultrasonic/ buccal group indicating that the ultrasonic brush improved plaque reduction on the buccal surfaces (p=0.007, Wilcoxon test)”	Marginal bleeding: “No significant differences were noted in the nine subgroups (p>0.05, Wilcoxon test)”
Zimmer 2005	“Improvements of the indices after 4 and 8 weeks were calculated for comparison between groups. After 4 and 8 weeks, with respect to all indices, the use of the power toothbrushes resulted in improvements which were statistically significant superior to what was found for the manual brush (p<0.001).” Results were presented as box-plots with medians and 25, 75 percentiles. Non-parametric tests have been used for the data analysis	“Improvements of the indices after 4 and 8 weeks were calculated for comparison between groups. After 4 and 8 weeks, with respect to all indices, the use of the power toothbrushes resulted in improvements which were statistically significant superior to what was found for the manual brush (p<0.001).” Results were presented as box-plots with medians and 25, 75 percentiles. Non-parametric tests have been used for the data analysis

Analysis 8.1. Comparison 8 Unknown or other action versus manual toothbrushes, Outcome 1 Plaque scores at 1 to 3 months at all sites.

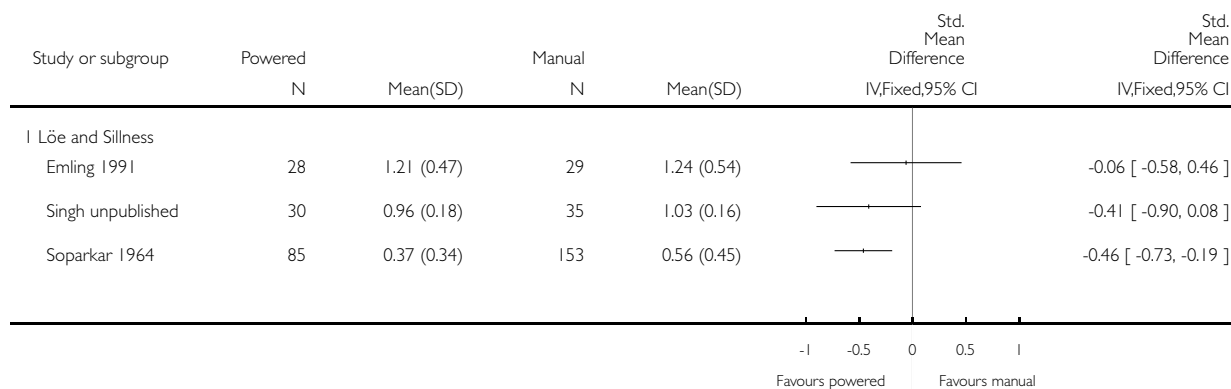
Review: Powered versus manual toothbrushing for oral health
 Comparison: 8 Unknown or other action versus manual toothbrushes
 Outcome: 1 Plaque scores at 1 to 3 months at all sites

Study or subgroup	Powered		Manual		Std. Mean Difference IV,Fixed,95% CI	Std. Mean Difference IV,Fixed,95% CI
	N	Mean(SD)	N	Mean(SD)		
I Quigley Hein (Turesky)						
Emling 1991	28	2.01 (0.5)	29	2.18 (0.54)		-0.32 [-0.84, 0.20]
Kallar 2011	100	0.6 (0.0677)	100	0.92 (0.0697)	+	-4.64 [-5.18, -4.10]

-10 -5 0 5 10
Favours powered Favours manual

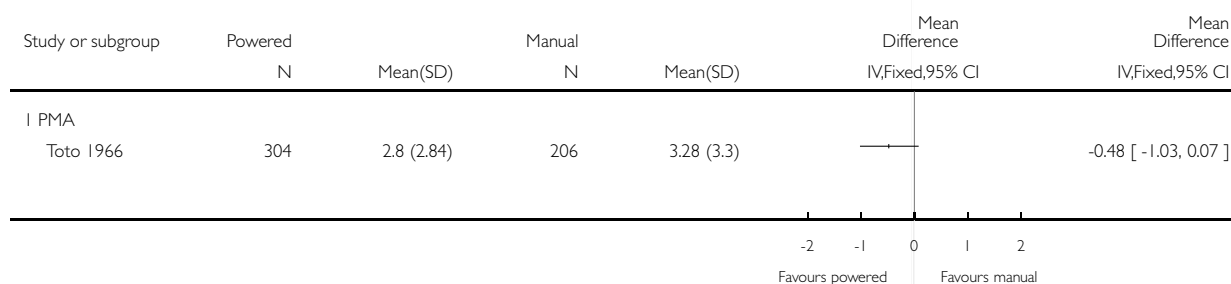
Analysis 8.2. Comparison 8 Unknown or other action versus manual toothbrushes, Outcome 2 Gingival scores at 1 to 3 months at all sites.

Review: Powered versus manual toothbrushing for oral health
 Comparison: 8 Unknown or other action versus manual toothbrushes
 Outcome: 2 Gingival scores at 1 to 3 months at all sites



Analysis 8.3. Comparison 8 Unknown or other action versus manual toothbrushes, Outcome 3 Gingival scores >3 months at all sites.

Review: Powered versus manual toothbrushing for oral health
 Comparison: 8 Unknown or other action versus manual toothbrushes
 Outcome: 3 Gingival scores >3 months at all sites



ADDITIONAL TABLES

Table 1. Summary of inclusion criteria categories within included studies

Inclusion criteria	Number (n = 56)
Adults	43
Minimum number of teeth	31
Minimum periodontal baseline measures	28
Participants recruited from dental clinics	9
Concurrent fixed orthodontic treatment	8
Some participants aged less than 16 years	11
Volunteer university students	3
Dental students	2
School children	3

Table 2. Summary of exclusion criteria categories within included studies

Exclusion criteria ¹	Number (n = 56)
Exclusion criteria related to medical history	31
Pregnancy or lactation	5
Previous use of powered toothbrushes	6
Patients undergoing orthodontic treatment	9
Previous periodontal treatment	3
Dental students	2
Cervical restorations	1
Smoking	3
Maximum periodontal measure	8
Wearing partial denture	2

¹ Not all trials explicitly stated exclusion criteria

Table 3. Summary of toothbrush modes of action, number of trials and participants

Mode of action	Trial ID	Number of trials	Number in trials
Side to side	Glass 1965, Ho 1997, Johnson 1994, Lobene 1964, McCracken 2009, Moritis 2008, O'Beirne 1996, Tritten 1996, Walsh 1989, Yankell 1997	10	988
Counter oscillation	Baab 1989, Khocht 1992, Stabholz 1996, Wilson 1993, Yukna 1993	5	267
Rotation oscillation	Ainamo 1997, Barnes 1993, Biavati Silvestrini 2010, Biesbrock 2007, Clerehugh 1998, Costa 2007, Cronin 1998, Dentino 2002, Dorfer 2009, Garcia-Godoy 2001, Gugerli 2007, Haffajee 2001a, Heasman 1999, Hickman 2002, Lapiere unpublished, Lazarescu unpublished, McCracken 2004, Rosema 2008, Sharma 2000, Silverman 2004, Soparkar 2000, Sowinski 2000, Stoltze 1994, van der Weijden 1994, Warren 2001, Yankell 1997, Zimmer 2005	27	2159
Circular	Khocht 1992, Yankell 1996	2	162
Ultrasonic	Costa 2007, Forgas-B 1998, Goyal 2007, Sharma 2010, Terezhalmay 1995, Zimmer 2002, Zimmer 2005	7	506
Unknown	Emling 1991, Kallar 2011, Singh unpublished, Soparkar 1964, Toto 1966	5	1130
Ionic	Galgut 1996, Moreira 2007, Pucher 1999, van Swol 1996	4	221

Four trials evaluated two powered toothbrushes

Table 4. Sensitivity analyses of all trials for all indices

Index	Group selected	Number of trials	SMD	Effect P value	Het. P value	I ²
Plaque 1-3 months	All trials	40	-0.50 (-0.70 to -0.31)	<0.0001	<0.0001	88
	Full mouth	34	-0.58 (-0.80 to -0.36)	<0.0001	<0.0001	85
	Low risk of bias	3	-0.83 (-2.02 to 0.36)	0.17	<0.0001	94
	Manufacturer funded	26	-0.56 (-0.82 to -0.29)	<0.0001	<0.0001	88
	Trials excluding ortho patients	36	-0.46 (-0.66 to -0.27)	<0.0001	<0.0001	83
Plaque >3 months	All trials	14	-0.37 (-0.50 to -0.24)	<0.0001	<0.0001	86
	Full mouth	13	-0.39 (-0.53 to -0.26)	<0.0001	<0.0001	87
	Low risk of bias	2	0.12 (-0.27 to 0.52)	0.53	0.51	0
	Manufacturer funded	9	-0.41 (-0.56 to -0.25)	<0.0001	<0.0001	91
	Trials excluding ortho patients	14 (all)	-0.37 (-0.50 to -0.24)	<0.0001	<0.0001	86
Gingivitis 1-3 months	All trials	44	-0.43 (-0.60 to -0.25)	<0.0001	<0.0001	82
	Full mouth	35	-0.47 (-0.68 to -0.25)	<0.0001	<0.0001	85
	Low risk of bias	3	-0.96 (-1.95 to 0.03)	0.06	<0.0001	93
	Manufacturer funded	32	-0.47 (-0.68 to -0.26)	<0.0001	<0.0001	84

Table 4. Sensitivity analyses of all trials for all indices (Continued)

		Trials excluding ortho patients	38	-0.42 (-0.61 to -0.23)	<0.0001	<0.0001	83
Gingivitis months	>3	All trials	16	-0.21 (-0.31 to -0.12)	<0.0001	<0.0001	51
		Full mouth	14	-0.25 (-0.37 to -0.13)	<0.0001	0.006	56
		Low risk of bias	2	-0.12 (-0.52 to 0.27)	0.54	0.52	0
		Manufacturer funded	10	-0.21 (-0.35 to -0.07)	0.003	0.003	68
		Trials excluding ortho patients	16 (all)	-0.21 (-0.31 to -0.12)	<0.0001	<0.0001	51

SMD = standardised mean difference

APPENDICES

Appendix I. Cochrane Oral Health Group's Trials Register search strategy

From January 2014, searches of the Cochrane Oral Health Group's Trials Register for this review were undertaken using the Cochrane Register of Studies and the search strategy below:

- 1 ((toothbrush* or tooth-brush* or "tooth brush*"):ti,ab) AND (INREGISTER)
- 2 ((manual or conventional or handbrush):ti,ab) AND (INREGISTER)
- 3 ((power* or mechanical* or electric* or electronic or ultrasonic* or sonic* or "motor driven" or "battery operated" or "battery power*" or automatic*):ti,ab) AND (INREGISTER)
- 4 (#1 and #2 and #3) AND (INREGISTER)

Previous searches of the Cochrane Oral Health Group's Trials Register were undertaken using the Procite software and the search strategy below:

(toothbrush* AND (manual or conventional or handbrush) AND (power* or mechanical* or electri* or electronic* or "motor driven" or ultrasonic* or automatic* or oscillat* or *sonic* or "counter rota*" or "battery operat" or battery-powered))

Appendix 2. Cochrane Central Register of Controlled Trials (CENTRAL) search strategy

#1 MeSH descriptor toothbrushing this term only

#2 toothbrush* in All Text

#3 ((tooth in All Text near/6 clean* in All Text) or (teeth in All Text near/6 clean* in All Text))

#4 (#1 or #2 or #3)

#5 (manual in All Text or conventional* in All Text or handbrush* in AllText)

#6 (power* in All Text or mechanical* in All Text or electric* in All Text or electronic in All Text or ultrasonic* in All Text or sonic* in All Text or “motor driven” in All Text or “battery operated” in All Text or “battery power*” in All Text or automatic* in All Text)

#7 (#4 and #5 and #6)

Appendix 3. MEDLINE (OVID) search strategy

1. exp Toothbrushing/

2. toothbrush\$.mp.

3. ((tooth or teeth) adj3 clean\$).mp.

4. or/1-3

5. manual\$.mp.

6. conventional\$.mp.

7. handbrush\$.mp.

8. 5 or 6 or 7

9. power\$.mp.

10. mechanical\$.mp.

11. electronic\$.mp.

12. electric\$.mp.

13. ultrasonic\$.mp.

14. sonic\$.mp.

15. “motor driven”.mp.

16. “battery operated”.mp.

17. automatic\$.mp.

18. or/9-17

19. 4 and 8 and 18

The above subject search was linked to the Cochrane Highly Sensitive Search Strategy (CHSSS) for identifying randomised trials in MEDLINE: sensitivity maximising version (2008 revision) as referenced in Chapter 6.4.11.1 and detailed in box 6.4.c of the *Cochrane Handbook for Systematic Reviews of Interventions*, Version 5.1.0 (updated March 2011) ([Higgins 2011](#)).

1. randomized controlled trial.pt.

2. controlled clinical trial.pt.

3. randomized.ab.

4. placebo.ab.

5. drug therapy.fs.

6. randomly.ab.

7. trial.ab.

8. groups.ab.

9. or/1-8

10. exp animals/ not humans.sh.

11. 9 not 10

Appendix 4. EMBASE (OVID) search strategy

1. Tooth brushing/
2. (toothbrush\$ or (tooth adj brush\$))
3. ((tooth or teeth) adj3 clean\$)
4. 1 or 2 or 3
5. manual\$
6. conventional\$
7. handbrush\$
8. 5 or 6 or 7
9. power\$
10. mechanical\$
11. electric\$
12. electronic\$
13. ultrasonic\$
14. sonic\$
15. "motor driven"
16. "battery operated"
17. automatic\$
18. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17
19. 4 and 8 and 18

The above subject search was linked to the Cochrane Oral Health Group filter for EMBASE via OVID:

1. random\$.ti,ab.
2. factorial\$.ti,ab.
3. (crossover\$ or cross over\$ or cross-over\$).ti,ab.
4. placebo\$.ti,ab.
5. (doubl\$ adj blind\$).ti,ab.
6. (singl\$ adj blind\$).ti,ab.
7. assign\$.ti,ab.
8. allocat\$.ti,ab.
9. volunteer\$.ti,ab.
10. CROSSOVER PROCEDURE.sh.
11. DOUBLE-BLIND PROCEDURE.sh.
12. RANDOMIZED CONTROLLED TRIAL.sh.
13. SINGLE BLIND PROCEDURE.sh.
14. or/1-13
15. ANIMAL/ or NONHUMAN/ or ANIMAL EXPERIMENT/
16. HUMAN/
17. 16 and 15
18. 15 not 17
19. 14 not 18

Appendix 5. CINAHL (EBSCO) search strategy

S1 MH “Toothbrushing+”
S2 toothbrush*
S3 (tooth N3 clean*) or (teeth N3 clean*)
S4 S1 or S2 or S3
S5 manual*
S6 conventional*
S7 handbrush*
S8 S5 or S6 or S7
S9 power*
S10 mechanical*
S11 electric*
S12 electronic*
S13 ultrasonic*
S14 sonic*
S15 “motor driven”
S16 “battery operated”
S17 automatic*
S18 S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16 or S17
S19 S4 and S8 and S18

The above subject search was linked to the Cochrane Oral Health Group filter for CINAHL via EBSCO

S1 MH Random Assignment or MH Single-blind Studies or MH Double-blind Studies or MH Triple-blind Studies or MH Crossover design or MH Factorial Design
S2 TI (“multicentre study” or “multicenter study” or “multi-centre study” or “multi-center study”) or AB (“multicentre study” or “multicenter study” or “multi-centre study” or “multi-center study”) or SU (“multicentre study” or “multicenter study” or “multi-centre study” or “multi-center study”)
S3 TI random* or AB random*
S4 AB “latin square” or TI “latin square”
S5 TI (crossover or cross-over) or AB (crossover or cross-over) or SU (crossover or cross-over)
S6 MH Placebos
S7 AB (singl* or doubl* or trebl* or tripl*) or TI (singl* or doubl* or trebl* or tripl*)
S8 TI blind* or AB mask* or AB blind* or TI mask*
S9 S7 and S8
S10 TI Placebo* or AB Placebo* or SU Placebo*
S11 MH Clinical Trials
S12 TI (Clinical AND Trial) or AB (Clinical AND Trial) or SU (Clinical AND Trial)
S13 S1 or S2 or S3 or S4 or S5 or S6 or S9 or S10 or S11 or S12

In a previous version of this review, the following search strategy was used for CINAHL via OVID:

1. exp toothbrushes/
2. toothbrush\$
3. ((tooth or teeth) adj3 clean\$)
4. 1 or 2 or 3
5. manual\$
6. conventional\$
7. handbrush\$
8. 5 or 6 or 7
9. power\$
10. mechanical\$
11. electric\$
12. electronic\$
13. ultrasonic\$
14. sonic\$

- 15. "motor driven"
- 16. "battery operated"
- 17. automatic\$
- 18. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17
- 19. 4 and 8 and 18

Appendix 6. US National Institutes of Health Trials Register (ClinicalTrials.gov) and WHO International Trials Register Platform search strategy

toothbrush* AND electric*
toothbrush* AND power*

WHAT'S NEW

Last assessed as up-to-date: 23 January 2014.

Date	Event	Description
2 June 2014	New search has been performed	Searches updated to January 2014.
2 June 2014	New citation required but conclusions have not changed	The review has been repeated 10 years after it was first completed. The update now includes 56 trials. 51 trials involving 4624 participants were available for meta-analysis. The update has findings consistent with the previous reviews that powered toothbrushes with a rotation oscillation action are more effective than manual brushes at removing plaque and reducing gingivitis

HISTORY

Protocol first published: Issue 2, 2000

Review first published: Issue 1, 2003

Date	Event	Description
20 August 2008	Amended	Converted to new review format.
17 February 2005	New search has been performed	This review has been repeated, 2 years after it was first completed. The original review included 29 trials involving 2547 subjects. 42 trials are now included, involving 3855 participants

(Continued)

17 February 2005	New citation required and conclusions have changed	<p>Substantive amendment.</p> <p>More studies have been included for brushes that work with a rotation oscillation action. The update confirms that these brushes removed more plaque and reduced gingivitis more effectively than manual brushes in the short term. Brushes of this design reduced gingivitis scores over 3 months.</p> <p>A refinement of the data analysis for brushes that work with a rotation oscillation action excluded 1 study from the current review for plaque over 3 months. Excluding this study does not substantially change our estimate of the treatment effect. However, because there are fewer studies in the analysis the 95% confidence intervals are wider and the findings are no longer statistically significant for this analysis.</p> <p>Trials of ionic brushes that impart a charge to the tooth surface have been included for the first time. The analyses show no benefit from these brushes on plaque or gingivitis in studies lasting 1 to 3 months but effects in studies over 3 months. This inconsistency cannot be explained but only 1 study was included in the long-term analyses</p>
------------------	--	--

CONTRIBUTIONS OF AUTHORS

Bill Shaw and Helen Worthington wrote the protocol. Anne-Marie Glenny, Bill Shaw, Mike Heanue, Peter Robinson, Damien Walmsley and Munirah Yaacob co-ordinated the review. Bill Shaw and Peter Robinson wrote the letters to the authors. Bill Shaw, Scott Deacon, Chris Deery, Mike Heanue, Peter Robinson, Damien Walmsley and Munirah Yaacob independently and in duplicate assessed the eligibility of trials, extracted data and assessed the quality of the trials. Damien Walmsley and Peter Robinson provided the background and sourced information on brush action and plaque and gingival indices. Helen Worthington conducted the statistical analysis. Scott Deacon, Anne-Marie Glenny, Munirah Yaacob and Mike Heanue checked and entered data. Anne-Mare Glenny, Helen Worthington and Munirah Yaacob wrote this version of the review, and checked for numerical consistency. Chris Deery updated the background.

DECLARATIONS OF INTEREST

Bill Shaw and Helen Worthington were co-researchers on a randomised controlled trial sponsored by Braun AG ([Clerehugh 1998](#)) through a grant to The University of Manchester. Damien Walmsley was a consultant and undertook laboratory trials of powered toothbrushes sponsored by Braun AG through a grant to the University of Birmingham.

SOURCES OF SUPPORT

Internal sources

- School of Dentistry, The University of Manchester, UK.
- School of Dentistry, The University of Birmingham, UK.
- Edinburgh Dental Institute, UK.
- University of Sheffield, School of Dentistry, UK.
- MAHSC, UK.

The Cochrane Oral Health Group is supported by the Manchester Academic Health Sciences Centre (MAHSC) and the NIHR Manchester Biomedical Research Centre.

External sources

- Cochrane Oral Health Group Global Alliance, UK.

All reviews in the Cochrane Oral Health Group are supported by Global Alliance member organisations (British Association of Oral Surgeons, UK; British Orthodontic Society, UK; British Society of Paediatric Dentistry, UK; British Society of Periodontology, UK; Canadian Dental Hygienists Association, Canada; Mayo Clinic, USA; National Center for Dental Hygiene Research & Practice, USA; New York University College of Dentistry, USA; and Royal College of Surgeons of Edinburgh, UK) providing funding for the editorial process (<http://ohg.cochrane.org/>).

- National Institute for Health Research (NIHR), UK.

CRG funding acknowledgement:

The NIHR is the largest single funder of the Cochrane Oral Health Group.

Disclaimer:

The views and opinions expressed therein are those of the authors and do not necessarily reflect those of the NIHR, NHS or the Department of Health.

INDEX TERMS

Medical Subject Headings (MeSH)

*Dental Devices, Home Care [adverse effects; economics]; Dental Plaque [complications; *prevention & control]; Gingival Diseases [prevention & control]; Gingivitis [*prevention & control]; Oral Health; Periodontal Diseases [prevention & control]; Randomized Controlled Trials as Topic; Toothbrushing [*instrumentation; methods]

MeSH check words

Humans