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A systematic review of professional mechanical plaque removal for prevention of periodontal diseases

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Abstract

Aim: To investigate the effect of professional mechanical plaque removal (PMPR) on the prevention of periodontal diseases.

Methods: We searched for randomized controlled trials, controlled clinical trials and cohort studies from 1950 to October 2004. Screening and data abstraction were conducted independently and in duplicate. Critical appraisal of studies was based on objective criteria and evidence tables were constructed.

Results: From 2179 titles and abstracts, 132 full-text articles were screened and 32 studies were relevant. Evidence exists that PMPR in adults, particularly in combination with oral hygiene instruction (OHI), may be more effective than no treatment judged by surrogate measures. The evidence for a benefit of PMPR+OHI over OHI alone is less clear. The optimum frequency of PMPR has not been investigated although more frequent PMPR is associated with improved markers of health. The strength of evidence for these results ranges from weak to moderate due to risk of bias, inconsistent results, lack of appropriate statistics and small sample size.

Conclusions: There appears to be little value in providing PMPR without OHI. In fact, repeated OHI might have a similar effect as PMPR. Some forms of PMPR might achieve greater patient satisfaction. There is little difference in beneficial or adverse effects of different methods of PMPR.

Key words: dental prophylaxis; dental scaling; periodontal diseases; primary prevention; systematic review

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The prevalence of periodontal diseases remains high despite reductions in other oral diseases in many countries and in particular dental caries (U.S. Department of Health and Human Services (HHS) 2000). The World Health Organization Global Data Bank indicates that the prevalence of moderate severity periodontal disease ranges from 2% to 67% of individuals and for advanced disease to range from 1% to 79% of the population (WHO 2004). Within the overall population of the USA, 50% of individuals present with gingival bleeding and 35% with periodontitis, and there are considerable differences according to racial groups (Albandar et al. 1999, Albandar 2002). Similar findings in the UK have suggested a need for improvement in the management of the periodontal diseases (Morris et al. 2001).

Periodontal diseases are important health issues and may lead to increasing impairment with eating, pain, changes in facial appearance and finally tooth loss. Oral health can have a significant effect on overall general health and well-being. Furthermore, disturbances of well-being will also impact on social functionality and quality of life (Locker 1988, Needleman et al. 2004). Thus, the impact of periodontal diseases on an individual may be broader than that measured by dental signs and symptoms alone.

The bulk of periodontal services provided to patients are preventive in nature (Brown et al. 2002); however, the prevalence of periodontal diseases remains high (Albandar et al. 1999, WHO 2004). As an illustration, for patients aged 35–64 the number of periodontal services received per patient per annum in the USA is between 0.19 and 0.42. When preventive and periodontal procedures are considered together these figures rise to 1.49 to 1.99 for the same age range. In total, nearly 28.5 million periodontal procedures were undertaken in the USA in 1999 alone,

and periodontal and preventive care accounted for an expenditure of over $14 billion (Brown et al. 2002) indicating the considerable burden to society of attempts to manage these diseases. This figure represents only the direct cost of providing care and not the total burden (both financial and otherwise) to society. The proportional financial burden in other countries is likely to be higher given the relatively effective care provided in the USA and other comparable countries.

Much of the cost of current periodontal preventive interventions is accounted for by professional mechanical plaque removal (PMPR). PMPR is not a defined intervention. It may include scaling or polishing teeth (or both) at supragingival locations, subgingival sites or a combination of each. Oral hygiene instructions (OHIs) for personally performed plaque control may be an integral aspect of this intervention. Thus the term PMPR covers a heterogeneous group of procedures.

The effect of PMPR is unclear. This is highlighted epidemiologically by the lack of convincing data on periodontal disease prevalence reduction even in populations exposed to such therapy as described above. Similarly, individual studies on PMPR show marked differences in their effect on periodontal health (Axelsson & Lindhe 1978, Gaare et al. 1990). The reasons for these differences are unclear. Heterogeneity might result from the effect of differences between studies in such characteristics as study populations, methodological quality and types of interventions. However, this has not been studied systematically. Since periodontal diseases are prevalent, may have a large impact on an individual and population and consume significant health service resources, determination of the effect of a widely used preventive intervention is important.

The aim of this investigation was therefore to evaluate the effect of PMPR on primary and secondary prevention of periodontal diseases in adults. The focused research question for the systematic review was: ''What is the effect of PMPR on clinical and patient-centred outcomes related to the prevention of periodontal diseases in adults?''

Materials and Methods

For this systematic review, a detailed protocol was developed and agreed upon by all authors prior to commencement of the study.

The objectives and null hypotheses to be investigated are as follows:

Primary

- To test the null hypothesis of no difference between PMPR and no mechanical professional plaque removal.
- To test the null hypothesis of no difference between different types of mechanical professional plaque removal.

Secondary

- To report on post-procedure adverse events.
- To report on quality of life changes.
- To report on aesthetics.
- To report on patient experience of the interventions.

Types of studies

The types of studies considered relevant to this investigation were randomized controlled trials (RCTs), controlled clinical trials (CCTs) and cohort studies with comparison groups. However, the data were stratified according to study type. Both parallel arm and split mouth treatment studies were eligible for inclusion. All durations of follow-up were included, thus not limiting study inclusion by trial duration. This was to be as inclusive as possible and to allow for different duration for follow-up appropriate to different types of outcomes.

Study populations

Studies which included men or women of a minimum age of 18 years presenting with or without gingivitis and/or periodontitis were included. All studies including children 17 years or under were excluded as the review question was focused on periodontal diseases in adults.

Types of interventions

Mechanical professional plaque removal/removal is not a specific intervention but can include various modes of professional plaque removal. For the purpose of this review, we initially designed the protocol to include only interventions aimed at supragingival plaque removal by a healthcare professional. Healthcare professional was intended to include dental hygienists, dental therapists, dentists and dental specialists. However, following screening of full-text articles we changed the protocol to include subgingival instrumentation that was not clearly intended to comprise scaling and root planing (SRP). PMPR used as a supplement to SRP was included, as were studies using SRP as a comparison to PMPR. In addition, PMPR was included, with and without OHI. Therefore, interventions included:

- supragingival plaque removal using hand instruments (scalers, curettes), or powered instruments (sonic, ultrasonic, rotating devices, air polishing)
- subgingival plaque removal using hand or powered instruments, if the intention was to debride minimally into the gingival sulcus

Studies employing the adjunctive use of antiseptics or other antiplaque chemical agents, and studies where the only professional intervention was deliberate subgingival debridement were excluded. Comparison interventions included no treatment, different modes of supragingival plaque removal, or patient performed oral hygiene alone.

Outcome measures

The outcomes measures to be included were as follows:

Primary

- Tooth loss.
- Changes in clinical attachment level (CAL).
- Changes in gingival inflammation assessed by gingival indices or bleeding on probing.

Secondary

- Change in plaque level.
- Changes in probing depths (PDs).
- Changes in gingival recession.

Patient-centred outcomes
These included:

- Quality of life.
- Effects on wellness and function
- Effects on aesthetics.
- Patient experience of the treatment.

- Pain.
- Discomfort (e.g. taste alteration, sensation, function disruption).
- Preferences.

Post-operative adverse events

- Root sensitivity
- Tooth surface damage
- Tissue trauma

Search strategy

The search strategy incorporated searching of electronic databases, supplemented by checking bibliographies of review articles

Electronic databases

Databases searched were:

- Cochrane Central Register of Controlled Trials (CENTRAL) – whole database at third week October 2004.
- Ovid MEDLINE – 1966 to third week October 2004.
- Ovid OLD MEDLINE – 1950–1965.
- EMBASE – 1981 to third week October 2004.

A comprehensive search strategy was based on a combination of controlled vocabulary (MeSH) and free text terms. This was modified from a comprehensive Cochrane protocol designed to search for studies on dental recalls and scaling (Beirne et al. 2005). The modifications included deletion of terms relating to the dental recalls and addition of terms specific to identifying cohort studies. The initial electronic search strategy was formulated for MEDLINE and later revised as appropriate for each individual database to which it was applied. Complete details of the electronic search strategy are outlined in Appendix A. A combination of terms describing the intervention and types of study design were used. Searching was limited to English language only due to limitations of resources. The bibliographies of previously published review articles were checked for studies not retrieved through electronic searches.

Study eligibility assessment

Titles and abstracts (when available) of all reports identified through the searches were scanned by one of the reviewers. Broad inclusion criteria were implemented. These were study design, mechanical professional plaque removal, prospective design and an adult population. Full reports were obtained for trials appearing to meet the inclusion criteria or for which there was insufficient information in the title and abstract to make a clear decision. The full reports were assessed, independently and in duplicate, by two reviewers to establish whether the trials met the inclusion criteria. Disagreements were resolved by discussion. The agreement between the reviewers for study inclusion in the review was assessed using the kappa statistic.

Inclusion/exclusion criteria were as follows:

Inclusion criteria

- Randomized controlled trial, CCT, cohort studies with a control group.
- Human studies.
- Professional plaque removal with a comparison group of no intervention, oral hygiene instruction only or different modes of mechanical professional plaque removal.
- Patient-based analysis.

Exclusion criteria

- Studies including individuals with <18 years.
- Studies including use of chemical agents to control plaque.

Bias protection assessment

Bias protection assessment of included trials was undertaken independently and in duplicate by two reviewers as part of the data abstraction process.

Randomized controlled trials (RCTs)

Included RCTs were assessed on four criteria shown to affect the size of treatment effect: method of randomization, allocation concealment, blinding of examiners and information on reasons for withdrawal by trial group (Schulz 1995, Jadad 1996, Moher 1998, Juni 2001, Touloumi 2002). Any disagreements between reviewers were resolved by discussion. Definition of the bias protection components were based on those derived from two guidelines for systematic reviews (Cochrane Collaboration Cochrane Reviewers' Handbook 2004, Centre for Reviews and Dissemination 2001) as defined below (Montenegro et al. 2002):

- Randomization: adequate if generated by random number table (computer-generated or not), tossed coin and shuffled cards. Unclear if the study referred to randomization but either does not adequately explain the method or no method was reported. Inadequate randomization methods included alternate assignment, hospital number and odd/even birth date.
- Adequate allocation concealment methods included central randomization (e.g. by telephone to pharmacy or trial office), pharmacy sequentially numbered/coded containers and sequentially numbered, opaque envelopes. Concealment was unclear if the study referred to allocation concealment but either did not adequately explain the method or no method was reported. Inadequate concealment involved methods where randomization could not be concealed, such as alternate assignment, hospital number and odd/even birth date.
- Blinding of examiner was recorded as adequate, inadequate, unclear, or not applicable if the study design precluded the possibility of blinding.
- Handling of withdrawals and drop-outs was assessed by analysis of whether all patients who entered the trial were properly accounted for at the end. Where drop-outs occurred, the use of analyses to allow for losses (such as intention to treat) was noted.
- Assessment of the appropriateness of the statistical analysis was recorded

CCTs

Included controlled trials were assessed for the following:

- Blinding of examiner was recorded as adequate, inadequate, unclear, or not applicable if the study design precluded the possibility of blinding.
- Handling of withdrawals and drop-outs were assessed by analysis of whether all patients who entered the trial were properly accounted for at the end. Where drop-outs occurred, the use of analyses to allow for losses (such as intention to treat) was noted.
- Assessment of the appropriateness of the statistical analysis was recorded.

Cohort trials

Since no cohort studies were found, this section is not included.

Data extraction methods

Independent duplicate data extraction was always performed by two reviewers (J S, J P, I N and D M) using specially designed data extraction forms. As a quality assurance measure, forms were piloted on five papers and amended as required before use for assessing selected review papers.

Data recorded from included studies were based directly on the focus of the research question including details of the population, interventions/comparisons, outcomes and study characteristics. The four categories of data were extracted as: study characteristics, population characteristics intervention characteristics and outcome and/or confounders data

Data Summary and Synthesis

Data were collated into evidence tables and grouped according to study design (RCT, CCT) and intervention. Descriptive analysis (summary) was first performed to determine the quantity of data, checking further for study variations in terms of study characteristics (populations, interventions, outcomes, design, quality and results). In addition, this step was used to determine the similarity of studies in order to plan for possible meta-analysis.

Since marked heterogeneity was evident in many aspects of study characteristics, meta-analysis was not employed and synthesis of data was determined from the evidence tables alone. Studies which were judged similar in the interventions investigated were compared for their effects on primary and secondary outcomes.

We have also attempted to rate the possible strength of the evidence for each comparison. This was a subjective and post-hoc grading based on the characteristics of these studies that we felt were most likely to affect the validity of their findings.

The grading was:

- Strong evidence: minimal risk of bias (e.g. from inadequate/unclear randomization, concealment, examiner blinding, losses to follow-up) and consistent results between outcomes within and between studies.
- Moderate evidence: risk of bias, consistent results between outcomes within and between studies.
- Weak evidence: risk of bias, conflicting/inconsistent results between outcomes either within or between studies.

Modifying factors included; non-randomized study (CCT or cohort), lack of appropriate (or any) analytical statistics, short study follow-up, small sample size, etc. Since this was a subjective (though transparent) assessment, the grading was separated from the evidence found so that evidence and strength rating could be evaluated separately.

Table 1. Reasons for exclusion of full-text articles

Author	Reason for exclusion
Al Yahfoufi et al. (1995)	Study design (no control group)
Axelsson et al. (1991)	Duplicate report
Baab & Weinstein (1986)	Interventions of interest not reported
Badersten et al. (1981)	Interventions of interest not reported
Badersten et al. (1984)	Interventions of interest not reported
Beltrami et al. (1987)	Site-based analysis
Bergendal et al. (1982)	Interventions and outcomes of interest not reported
Bijella et al. (1985)	Outcomes of interest not reported
Boehmer et al. (1999)	Interventions and outcomes of interest not reported
Bollmer et al. (1986)	Study design (no control group)
Budtz-Jorgensen et al. (2000)	Duplicate report
Cercek et al. (1983)	Interventions of interest not reported
Claffey et al. (1996)	Interventions of interest not reported, site based analysis
Claydon et al. (2000)	Study design (no relevant control group)
Cons et al. (1970)	population and outcomes of interest not reported
Cutress et al. (1991)	Interventions and outcomes of interest not reported
Dahlen et al. (1992)	Study design (no control group)
DePaola (1967)	Population and outcomes of interest not reported
Donnan & Ball (1989)	Letter/commentary of existing research
Donnan & Ball (1988)	Population, intervention and outcomes of interest not reported
Doungudomdacha et al. (2001)	Interventions of interest not reported
Drisko et al. (2002)	Interventions of interest not reported
El-Ashiry et al. (1964)	Site-based analysis
Fleming et al. (1991)	Outcomes of interest not reported
Furuichi et al. (1992)	Interventions of interest not reported
Gillette (1986)	Letter/commentary of existing research
Gjermo & Flotra (1970)	Interventions of interest not reported
Greenstein et al. (1997)	Narrative review
Greenwell et al. (1983)	Interventions of interest not reported
Haffajee et al. (1995)	Population and interventions of interest not included
Hamp et al. (1982)	Interventions of interest not reported
Hamp & Johansson (1982)	Population of interest not included
Hazen et al. (1965)	Intervention and outcomes of interest not reported
Horowitz & Lucye (1967)	Population and outcomes of interest not reported
Hugoson et al. (2003)	Interventions of interest not reported
Hujoel et al. (2000)	Interventions of interest not reported
Ireland (1998)	Outcomes of interest not reported
Johnston & De Marco (1974)	Interventions of interest not reported
Joss et al. (1994)	Interventions of interest not reported
Kaldahl et al. (1996a, b)	Outcomes of interest not reported
Kaldahl et al. (1990a, b)	Interventions of interest not reported
Kontturi-Närhi et al. (1990)	Study design (no control group)
Kristoffersson et al. (1984)	Population and outcomes of interest not reported
Laurell & Pettersson (1988)	Interventions of interest not reported
Levinkind & Auger (1988)	Letter/commentary of existing research
Lewis et al. (1996)	Intervention and outcomes of interest not reported
Lewis & Thompson (1996)	Intervention and outcomes of interest not reported
Lindhe & Axelsson (1973)	Population of interest not included
Listgarten & Schifter (1982)	Duplicate report
Listgarten et al. (1986)	Duplicate report
Loesche (1984)	Narrative review
Lovdal et al. (1961)	Population and outcomes of interest not reported
Magnusson et al. (1996)	Interventions and outcomes of interest not reported
Nyman & Lindhe (1979)	Interventions of interest not reported
Page & Sturdivant (2002)	Narrative review
Papantonopoulos (2004)	Interventions of interest not reported

Table 1. (Contd.)

Author	Reason for exclusion
Persson et al. (1998)	Interventions of interest not reported
Poulsen & Horowitz (1974)	Population, intervention and outcomes of interest not reported
Ramaglia et al. (1999)	Population of interest not included
Ramfjord et al. (1973)	Population and interventions of interest not included
Reynolds et al. (1981)	Interventions of interest not reported
Ripa et al. (1976)	Population of interest not included
Ripa et al. (1984)	Population and outcomes of interest not reported
Rosen et al. (1999)	Interventions of interest not reported
Rosling et al. (2001)	Interventions of interest not reported
Scola & Ostrom (1966)	Outcomes of interest not reported
Sculean et al. (2004)	Interventions of interest not reported
Shelton et al. (2003)	Interventions and outcomes of interest not reported
Simaan & Skach (1966)	Interventions and outcomes of interest not reported
Slots et al. (1985)	Outcomes of interest not reported
Somacarrera et al. (1994)	Interventions of interest not reported
Stiefel et al. (1995)	Interventions of interest not reported
Suomi et al. (1969)	Duplicate report
Tan (1979)	Outcomes of interest not reported
Tenenbaum et al. (1957)	Interventions and outcomes of interest not reported
Walsh et al. (1984)	Duplicate report
Wierzbicka et al. (1989)	Interventions of interest not reported
Winslow & Millstone (1965)	Population and outcomes of interest not reported
Wolff et al. (2001)	Population of interest not included

Key to tables

Indices

BI	Bleeding index	Ainamo & Bay (1975)
BOP*	Bleeding on probing	Sidi & Ashley (1984)
BS	Bleeding score	Cowell et al. (1975)
BT	Bleeding tendency	Armitage et al. (1982)
CI	Calculus index	Greene & Vermillion (1964)
DI	Debris index	Greene & Vermillion (1964)
GI	Gingival Index	Löe & Silness (1963)
GI	Gingival index	Löe & Silness (1963)
GI#	Gingival (bleeding) index	Cheraskin et al. (1968)
GI*	Gingival index (bleeding)	Lenox & Kopczyak (1978)
GI^{+}	Gingival index	Keller et al. 1963
GI¥	Gingival index	O'Leary et al. (1963)
GI¶	Modified gingival index	Löe (1967)
GIØ	Gingival index (colour change)	Suomi et al. (1969)
OHI	Simplified oral hygiene index	Greene & Vermillion (1970)
OHI:S	Oral hygiene index	O'Leary et al. (1972)
PDI	Periodontal disease index	Ramfjord et al. (1967)
PeI	Periodontal index	O'Leary et al. (1963)
PI	Plaque index	Silness & Loe (1964)
PI#	Modified plaque index	Löe (1967)
PI*	Plaque index	O'Leary et al. (1972)
PI¶	Plaque index	O'Leary et al. (1963)
PMGI	Papillary marginal gingivitis index	de la Rousa & Sturzenberger (1976)
PS	Plaque score	Cowell et al. (1975)
SI	Stain index	Lobene (1968)
TI	Trauma index	Weaks et al. (1984)

Abbreviations

N/A	Not applicable
N/R	Not reported
NS	Not statistically significant (original author's conclusions)
OH	Oral hygiene
OHI	Oral hygiene instruction
PMPR	Mechanical professional plaque removal
Prophy	Prophylaxis
Repeat	Indicates whether or not a course of treatment is repeated not the individual items
Sc	Scaling
SPT	Supportive periodontal therapy (maintenance)
SRP	Scaling and root planning

Results

Search and screening results

Combined total of references resulting from the electronic search strategy modified for each database resulted in 2164 citations after removal of duplicates. In addition, total non-database search results were 15 citations. This resulted in a total number of titles and abstracts to be screened of 2179. 132 full-text articles were identified and all obtained for full-text screening. Figure 1 summarizes the screening process showing the number of citations at each step.

Ninety-three articles were excluded during full-text screening, resulting in the 39 included articles of this review (representing 32 trials). The majority of the irrelevant articles contained information pertaining to non-surgical periodontal therapy, some were narrative reviews, were cohort studies without control group, or included only outcomes or populations outside the inclusion criteria of this review (Table 1).

The κ score for agreement on inclusion of full-text studies was $K = 0.939$ (95% CI 0.871 to 1.000), indicating a very good level of agreement.

Descriptive results

Study characteristics

Major characteristics of each study are listed in Table 2. This is followed by tables summarizing the aspects referred to in the following paragraphs.

Duration of follow-up (Table 3). The range of follow-up was very heterogeneous from immediate post-treatment (Hunter et al 1989, Miller & Hodges 1991, Checchi et al. 1997) to as much as 6 years or more (Suomi et al. 1971 a, b, 1973a, Axelsson & Lindhe 1978, 1981a, b). Although a full range of follow-ups were represented, the majority dichotomized into either less than 1 month duration (10 reports) or over one year (19 reports), with relatively few studies reporting intermediate intervals.

Setting/target group (Table 4). The vast majority of trials recruited patients from a hospital/university setting (23 reports). Large commercial organizations and public sector/government organizations such as the military were the source of patients in 10 reports; with one study

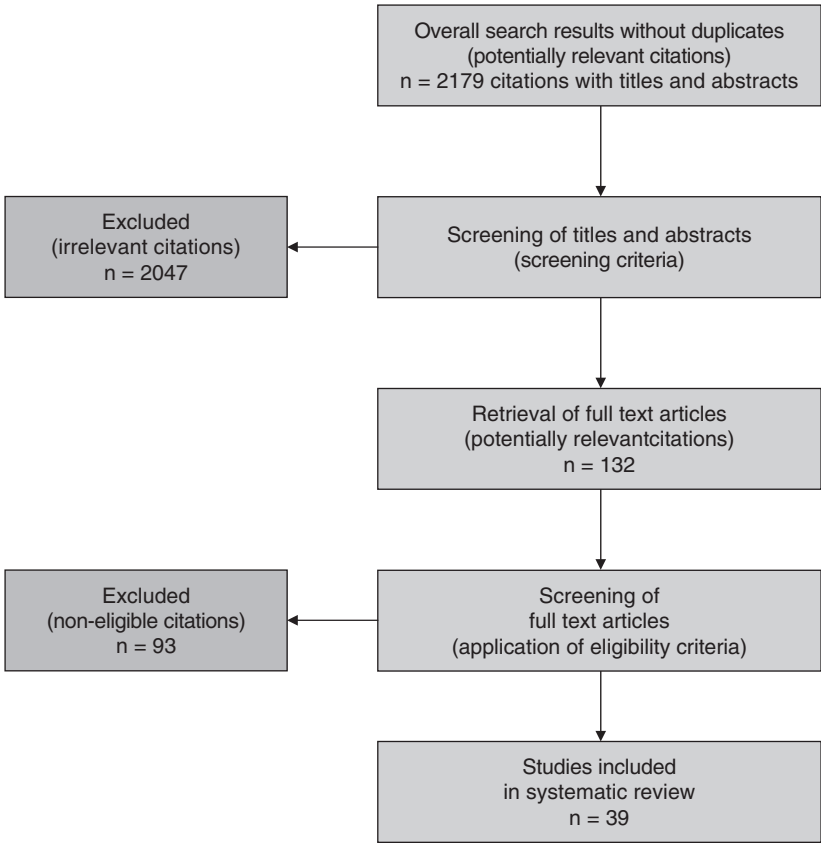

Fig. 1. Study identification flow chart.

recruiting participants from both an academic/hospital setting and from fire/police departments (Keller et al. 1963). Two studies recruited participants from nursing/care homes (Mojon et al. 1998, Adachi et al. 2002), while Axelsson & Lindhe (1978, 1981a) used public health clinics to recruit participants. None of the reviewed studies based recruitment in a general dental practice environment.

Disease characteristics (Table 5). PMPR was investigated in solely gingivitis patients in 5 reports; solely periodontitis patients in 12 and both/either in 6. One study stated that participants were recruited who did not exhibit either gingivitis or periodontitis (Checchi et al. 1997). There were 14 reports in which the authors did not make it clear which disease was being treated. Smoking status was not defined in any study.

Intervention characteristics (Table 6) The components of PMPR and the comparison groups selected in studies varied widely. Fundamental differences were whether PMPR was supragingival only or included subgingival instrumentation. Similarly, PMPR was compared with no treatment, oral hygiene instruction only, SRP and different types of PMPR. Some studies considered OHI an integral part of PMPR or investigated the effect of PMPR with and without oral hygiene instruction. Even these descriptions risk suggesting a degree of homogeneity of interventions in these studies, and such an interpretation would be misleading.

Protection from bias (Tables 7 and 8). Of the 32 studies, 24 were RCTs and eight were CCTs. Of the RCTs, only one (Keller et al. 1963) reported an adequate randomization method although no study reported on how the allocation code was concealed. Examiner blinding was reported in eight (33%) RCTs (Lightner et al. 1971, Weaks et al. 1984, Mishkin et al. 1986, Miller & Hodges 1991, Katsanoulas et al. 1992, Aldridge et al. 1995, Somacarrera et al. 1997, Mojon et al. 1998). Clear accounting for study participants was present in 16 (67%) RCTs. Other aspects relating to protection from bias are listed in Table 8. Of the CCTs, examiner blinding was reported in one (13%) study (Suomi et al. 1973b) and clear accounting of participants was found in four (50%) reports.

Outcomes

PMPR+OHI versus no treatment. RCTs (Table 9)

Plaque (four studies). PMPR+OHI produced generally greater changes in plaque than no treatment in three studies (Tan & Saxton 1978, Aldridge et al. 1995, Lim & Davies 1996). However, the differences between PMPR+OHI and no treatment were not always statistically significant and this might have been affected by insufficient study power. In the fourth study, both experimental groups showed little change in plaque (Mojon et al. 1998), although this was set in a long-term care facility.

Bleeding/inflammation (three studies). The results are similar to plaque, although with a smaller magnitude of change (Tan & Saxton 1978, Aldridge et al. 1995, Lim & Davies 1996).

PD (one study). No evidence of a difference in PD change was recorded in this study of a non-periodontitis population (Aldridge et al. 1995)

Other outcomes (two studies). One study, conducted in a long-term care facility (Adachi et al. 2002), suggested that PMPR+OHI produced a reduction in adverse systemic health outcomes, including percentage of subjects with fever, death or aspiration pneumonia. However, follow-up was complete on only 40% of PMPR+OHI subjects and 52% of no treatment subjects, and the results may have been confounded by differences in general health status. One study examined the effect of PMPR+OHI on diabetes metabolic control (Aldridge et al. 1995). No differences were found for metabolic markers, although the small sample size and short duration of follow-up might have rendered the study underpowered.

Protection from bias. Only two studies were clearly examiner blind (Aldridge et al. 1995, Mojon et al. 1998). No study detailed randomization/concealment methods, and two studies lost more

Table 2. Study characteristics

Authors	Sample characteristics	Disease	Study design	Interventions
Adachi et al. (2002)	**Country:** Japan **Age:** mean: 84 years **Setting:** nursing home **Control group (*n*):** *Baseline:* 64 *Finish*: 33* **Test group (*n*):** *Baseline*: 77 *Finish*: 30* *Randomised patients developing dementia excluded **Smoking status:** unclear	**Type:** Unclear **Inclusion/exclusion criteria:** resident in nursing home and consent obtained	**RCT** **Parallel group** **Length of follow-up:** 24 months	**Control** *Description*: no treatment *OH*: basic oral hygiene, swabbing with sponge brush and denture cleaning *No. sessions*: N/R *No. minutes*: N/R *Interval*: N/R *Performed by*: patient or staff member *Repeat* : no **Test** *Description*: mechanical cleaning with hand scalers, electric rotating brush *OH*: toothbrush, interdental brush and sponge brush *No. sessions*: 1 *No. minutes:* N/R *Interval*: weekly *Performed by*: dental hygienists *Repeat*: weekly
Aldridge et al. (1995)	**Country:** UK **Age:** unclear **Setting:** university/hospital **Control group (*n*):** *Baseline*: Unclear *Finish*: 15 **Test group (*n*):** *Baseline*: unclear *Finish:* 16 (total starting study = 41) **Smoking status:** unclear	**Type:** gingivitis and periodontitis (all patients with diabetes) **Inclusion/exclusion criteria:** age 16–40, no pd >5 mm, receiving diabetic treatment for >1 year (inclusion)	**RCT** **Parallel** **Length of follow-up:** 2 months	**Control** *Description*: no treatment *OHI*: none *No. sessions*: N/A *No. minutes*: N/A *Interval*: N/A *Performed by*: N/A *Repeat* : N/A **Test** *Description*: scaling and adjustment of restorative margins *OHI*: bass technique, flossing *No. sessions*: 1 *no. minutes*: N/R *Interval*: N/A *Performed by*: N/R *Repeat* : OHI at 1 month
Axelsson & Lindhe (1978, 1981a)	**Country:** Sweden **Age:** unclear **Setting:** public health clinics. NB only volunteers who had sought/ received treatment annually in the last 5 years were selected. **Control group (*n*):** *Baseline:* 180 *3 years:* 156 *6 years:* 146 **Test group (*n*):** *Baseline:* 375 *3 years:* 324	**Type:** unclear **Inclusion/exclusion criteria:** N/R	**CCT** **Parallel group** **Length of follow-up:** up to 6 years. NB data also published for 15-year follow-up. These data are not included in the review as the control group was discontinued.	**Control** *Description*: case presentation. At 12 and 24 month recalls individuals received ''whatever dental treatment the examining dentist found indicated''. *OH*: at baseline, toothbrushing (Bass method). Told to use floss and toothpicks. *No. sessions*: 1 *No. minutes*: N/R *Interval*: N/A *Performed by*: hygienist *Repeat* : no, but see above **Test** *Description*: case presentation. Prophylaxis including scaling,

Table 2. (Contd.)

Authors	Sample characteristics	Disease	Study design	Interventions
	6 years: 310 **Smoking status:** Unclear			root planing, rubber cup polishing (vestibular/lingual surfaces), rotating pointed brush (occlusal surfaces), floss and interproximal (EVA) tips for interdental surfaces and sodium MFP paste. *OH*: At baseline, toothbrushing (Bass method). Told to use floss and toothpicks. *No. sessions*: 3–4 *No. minutes*: 30 *Interval*: N/R *Performed by*: hygienist *Repeat*: years 1 and 2 – every 2 months. Years 3 to 6 – every 3 months.
Axelsson & Lindhe (1981b)	**Country:** Sweden **Age:** mean 52.0 years **Setting**: university hospital **Control group (*n*):** *Baseline:* 30 *6 years:* 25 **Test group (n):** *Baseline:* 60 *6 years:*52 **Smoking status:** unclear	**Type:** Periodontitis (treated) **Inclusion/exclusion criteria:** treated for advanced disease	**CCT** **Parallel group** **Length of follow-up:** 6 years	**Control** *Description*: previously thoroughly treated including non-surgical and surgical treatment with extraction of hopeless teeth. During experimental period maintenance with referring dentist (written instructions sent). *OH*: as initial therapy. *No. sessions*: N/A *No. minutes*: N/R *Interval*: N/A *Performed by*: N/A *Repeat* : N/A **Test** *Description*: previously thoroughly treated including non-surgical and surgical treatment with extraction of hopeless teeth. At recalls, disclosed, removal of all supra- and subgingival deposits and root surfaces planed ''if needed''. *OH*: at baseline, toothbrushing (Bass method). Instructed to use floss and toothpicks. *No. sessions*: 1 *No. minutes*: 30 *Interval*: N/A *Performed by*: hygienist *Repeat*: every 2 months for 2 years, followed by every 3 months for 4 years.
Chawla et al. (1975)	**Country:** India **Age:** 26±2 years **Setting:** factory workers **Control group (*n*):** *Baseline:* 150 *Finish*: 90 **Test group (*n*):** *Baseline:* 200 *Finish*: 99 *Smoking status:* unclear	**Type:** Gingivitis and periodontitis **Inclusion/exclusion criteria:** N/R	**CCT** **Parallel group** **Length of follow-up:** 2 years	**Control** *Description*: no treatment *OH*: none *No. sessions*: N/A *No. minutes*: N/A *Interval*: N/A *Performed by*: N/A *Repeat* : N/A **Test** *Description*: ''standard oral prophylaxis''

				OH: modified Stillman's toothbrushing technique with hard toothbrush. Had to demonstrate brushing to demonstrate effectiveness. *No. sessions*: 1 *No. minutes*: N/R *Interval*: N/A *Performed by*: dentists *Repeat* : unclear
Checchi et al. (1997)	**Country:** Italy **Age:** unclear **Setting:** university/hospital **Control group (*n*):** *Baseline*: 4 *Finish*: 4 **Test group 1 (*n*):** *Baseline*: 4 *Finish:* 4 **Test group 2 (*n*):** *Baseline*: 4 *Finish:* 4 **Smoking status:** unclear	**Type:** no gingivitis or periodontal disease **Inclusion/exclusion criteria:** no pd >3 mm	**RCT** **Parallel** **Length of follow-up:** immediate post-treatment	**Note: one patient treated by all 12 (4 $\times$ 3) dental hygienists** **Control** *Description*: ultrasonic scaler and prophylaxis cup. *OHI*: none *No. sessions*: 1 *No. minutes*: no limit on time *Interval*: N/A *Performed by*: hygienist *Repeat* : N/A **Test 1** *Description*: ultrasonic scaler, prophylaxis cup and dental floss *OHI*: none *No. sessions*: 1 *No. minutes*: no limit on time *Interval*: N/A *Performed by*: hygienist *Repeat* : N/A **Test 2** *Description*: Gracey curettes and prophylaxis cup *OHI*: none *No. sessions*: 1 *No. minutes*: no limit on time *Interval*: N/A *Performed by*: hygienist *Repeat* : N/A
Cheraskin et al. (1968)	**Country:** USA **Age:** unclear **Setting:** unclear **Control group (*n*):** *Baseline*: 16 *Finish*: 16 **Test group (*n*):** *Baseline*: 16 *Finish:* 16 **Smoking status:** unclear **Note:** only placebo-treated groups reported	**Type:** Unclear **Inclusion/exclusion criteria:** N/R	**RCT** **Split-mouth** **Length of follow-up:** 2 weeks	**Control** *Description*: no treatment *OHI*: unclear *No. sessions*: N/A *No. minutes*: N/R *Interval*: N/A *Performed by*: N/R *Repeat* : no **Test** *Description*: thorough scaling with hand scalers and polishing with rubber cup and pumice *OHI*: N/R *No. sessions*: 1 *No. minutes*: N/R *Interval*: N/A

Table 2. (Contd.)

Authors	Sample characteristics	Disease	Study design	Interventions
				Performed By: N/R *Repeat* : no
Gaare et al. (1990)	**Country:** Indonesia **Age:** 20–25 years **Setting:** soldiers **Control group (*n*):** *Baseline*: 41 *Finish*: 41 *Test group (n):* *Baseline*: 95 *Finish:* 92 **Smoking status:** unclear **Note:** Subjects had ''no experience of modern oral hygiene practice''. Target group was chosen as having ''large amounts of calculus''.	**Type:** Gingivitis **Inclusion/exclusion criteria:** CPITN $\leqslant 2$ in all segments	**CCT** **Parallel** **Length of follow-up:** 2 months	**Control** *Description*: no treatment *OHI*: 5 min. motivational video and distribution of toothbrush and toothpaste *No. sessions*: 1 *No. minutes*: N/R *Interval*: N/A *Performed by*: N/R *Repeat* : 1 month reinforce individual motivation **Test** *Description:* dental prophylaxis including ultrasonic and hand scaling *OHI*: 5 min. motivational video and demonstration of toothbrush and toothpaste *No. sessions*: 1 *No. minutes*: 1 h *Interval*: N/A *Performed by*: N/R *Repeat*: 1 month reinforce individual motivation
Glavind (1977)	**Country:** Denmark **Age:** 25–64 years **Setting:** university/hospital **Control group (*n*):** *Baseline*: 28 *Finish*: 28 *Test group (n):* *Baseline*: 28 *Finish:* 28 **Smoking status:** unclear	**Type:** Periodontitis **Inclusion/exclusion criteria:** completed periodontal treatment. No pockets >3 mm	**RCT** **Split-mouth** **Length of follow-up:** 11 months	**Control** *Description*: initial removal of all plaque and calculus, then no treatment *OHI*: no further OH other than that received during periodontal therapy *No. sessions*: unclear *No. minutes*: N/R *Interval*: N/R *Performed by*: hygienist *Repeat* : N/A **Test** *Description*: initial removal of all plaque and calculus, then monthly prophylaxis with floss and rubber cup and interproximal tip (EVA) disclosed to ensure plaque removal *OHI*: no further OH other than that received during periodontal therapy *No. sessions*: unclear *No. minutes:* N/R *Interval*: monthly *Performed by*: hygienist *Repeat:* monthly
Hunter et al. (1989)	**Country:** New Zealand **Age:** Unclear **Setting:** university/hospital **Control group (*n*):** *Baseline*: 20	**Type:** Unclear **Inclusion/exclusion criteria:** At least 10 natural teeth on each side of mouth.	**RCT** **Parallel** **length of follow-up:** 5 min	**Control** *Description*: polishing with rotating rubber cup and pumice, 1 mm into crevice. *OHI*: no *No. sessions*: 1

	Finish: 20 **Test group (*n*):** *Baseline*: 20 *Finish:* 20 *Smoking status:* unclear			*No. mins*: N/R *Interval*: N/A *Performed by*: N/R *Repeat*: N/A **Test** *Description*: air polishing device held 45° to gingival margin and 5 mm away *OHI*: no *No. sessions*: 1 *No. minutes:* N/R *Interval*: N/A *Performed by*: N/R *Repeat:* N/A
Kaldahl et al. (1988) (also Kalkwarf et al. 1989, 1992, Kaldahl et al. 1996a, b)	**Country:** USA **Age:** Mean: 43.5 years **Setting:** university/hospital **Control group (*n*):** *Baseline*: 82 *Finish*: 75 **Test group (*n*):** *Baseline*: 82 *Finish:* 75 **Smoking status:** unclear	**Type:periodontitis** **Inclusion/exclusion criteria:** Moderate-advanced periodontal destruction.	**RCT** **Split-mouth** **Length of follow-up**: 2 years	**NOTE: All patients received occlusal adjustment/splinting if needed.** **Control** *Description*: scaling and root planing *OHI*: brushing and interdental techniques to achieve PI* < 30%. *No. sessions*: N/R *No. minutes*: time for three quadrants: 4.2 h hygienist plus 0.3 h periodontist *Interval*: N/R *Performed by*: dental hygienists and periodontist *Repeat*: at 4 weeks if needed. Subgingival instrumentation every 3 months. **NOTE:** Sites losing > 2 mm attachment were exited and root planed. Data up to this point maintained then changed to another group. Eighty-three teeth exited (number of patients unclear) **Test** *Description*: coronal scaling with hand and ultrasonic instruments. *OHI*: brushing and interdental techniques to achieve PI* < 30%. *No. sessions*: 1 *No. minutes*: N/R *Interval*: N/A *Performed by*: hygienist *Repeat* : 1 month then every 3 months **NOTE:** At 7 months, sites losing > 2 mm attachment were re-root planed. If further loss of ⩾1 mm attachment occurred, sites were retreated and exited. Three teeth were exited (number of patients unclear).
Katsanoulas et al. (1992)	**Country:** Sweden **Age:** 27–77 years **Setting:** university/hospital **Control group (*n*):** *Baseline*: 13 *Finish*: 13 **Test group (*n*):**	**Type:** periodontitis **Inclusion/exclusion criteria:** untreated disease, pockets 4–6 mm with BOP, proportion of spirochetes and motile rods ⩾15%	**RCT** **Split-mouth** **Length of follow-up:** 3 weeks	**Control** *Description*: no treatment. *OHI*: none *No. sessions*: N/A *No. minutes*: N/A *Interval*: N/A *Performed by*: NA

Table 2. (Contd.)

Authors	Sample characteristics	Disease	Study design	Interventions
	Baseline: 13 *Finish:* 13 **Smoking status:** unclear			*Repeat* : no **Test** *Description*: daily supragingival plaque removal by scaler *OHI*: none *No. sessions*: 1 *No. mins:* N/R *Interval:* three times per week for 3 weeks *Performed by*: N/R *Repeat*: no
Keller et al. (1963)	**Country:** USA **Age:** 25–55 years **Setting:** university/hospital and fire/police department **Control group (*n*):** *Baseline:* 50 *Finish*: 50 **Test group (*n*):** *Baseline:* 50 *Finish*: 50 **Smoking status:** unclear	**Type:** Gingivitis and periodontitis **Inclusion/exclusion criteria:** N/R	**RCT** **Split-mouth** **Length of follow-up:** 21 days	**Control** *Description*: no treatment *OH*: none *No. sessions*: N/A *No. minutes*: N/A *Interval*: N/A *Performed by*: N/A *Repeat* : N/A **Test** *Description*: ''Thorough scaling & prophylaxis on one side of mouth'' *OHI*: none *No. sessions*: 1 *No. minutes*: N/R *Interval*: N/A *Performed by*: N/R *Repeat* : no
Lavanchy et al. (1987)	**Country:** Switzerland **Age:** 41–60 years **Setting:** university/hospital **Control group (*n*):** *Baseline*: 7 *Finish*: 7 **Test group (*n*):** *Baseline*: 7 *Finish:* 7 **Smoking status:** unclear	**Type:** Periodontitis **Inclusion/exclusion criteria:** Advanced periodontitis	**CCT** **Split-mouth** **Length of follow-up***:* 10 weeks	**Control** *Description*: no treatment. *OHI*: none *No. sessions*: N/A *No. minutes*: N/A *Interval*: N/A *Performed by*: N/A *Repeat* : N/A **Test** *Description*: supragingival plaque removal with rubber cup and paste, floss and interdental brushes with avoidance of subgingival areas *OHI*: none *No. sessions*: 1 *No. minutes:* N/R *Interval:* as above *Performed by*: N/R *Repeat:* three times per week for 10 weeks
Lightner et al. (1971)	**Country:** USA **Age:** mean 22 years **Setting:** military academy	**Type:** Unclear **Inclusion/exclusion criteria:**N/R	**RCT** **Parallel**	**Control:** Description removal of calcified deposits and polishing *OH*: toothbrushing

	Control group (*n*): *Baseline:* unclear *Finish*: 108 **Test group 1 (*n*):** *Baseline:* unclear *Finish*: 121 **Test group 2 (*n*):** *Baseline:* unclear *Finish*: 110 **Test group 3a (*n*):** *Baseline:* Unclear *Finish*: 64 **Test group 3b (n):** *Baseline:* unclear *Finish*: 67 **Total at start:** 713 **Total at end:** 470 **Smoking status:** unclear		**Length of follow up:** 46 months	*No. sessions*: alternating every 6/12 *First treatment*: 2 × 30 min. plus 10 min. OH *Second treatment*: 1 × 30 min. plus 10 min. OH *Interval*: 6 months *Performed by*: Dental hygienist *Repeat* : 6 monthly **Test 3** *Description*: removal of calcified deposits and polishing *OH*: Toothbrushing *No. sessions*: 1 *No. minutes:* 30 *Group 3a*: 10 min. OH *Group 3b*: No OH *Interval*: 3 months *Performed by*: dental hygienist *Repeat* : 3 monthly
Lim & Davies (1996)	**Country:** Hong Kong **Age:** 25–44 years **Setting:** telephone company **Control group (*n*):** *Baseline*: 62 *Finish*: 60 **Test group-OH (*n*):** *Baseline*: 195 *Finish:* 164 **Test group-Sc (*n*):** *Baseline*: 148 *Finish:* 132 **Test group-Sc+OH (*n*):** *Baseline*: 145 *Finish:* 123 **Smoking status:** unclear	***Type:*** unclear **Inclusion/exclusion criteria:** N/R	RCT **Parallel** **Length of follow-up: Data used:** Control: 16 months Test: 10 months **Note: follow-up used for control group is different from the test groups since the test groups received additional treatment at 10 months:**	**Control** *Description*: no treatment *OHI*: none *No. sessions*: N/A *No. minutes*: N/A *Interval*: N/A *Performed by*: N/A *Repeat*: no **Test-OH** *Description*: no treatment *OHI*: mix of personal instruction, self-educational manual, and video instruction: toothbrushing, floss, toothpicks and interdental brushes *No. sessions*: unclear *No. minutes*: N/R *Interval*: unclear *Performed by*: N/R *Repeat* : unclear **Test-Sc** *Description*: scaling *OHI*: none *No. sessions*: Unclear *No. minutes*: N/R *Interval*: unclear *Performed by*: N/R *Repeat* : unclear *Test-Sc+OH* *Description*: scaling *OHI*: mix of personal instruction, self-educational manual, and video instruction: toothbrushing, floss, toothpicks and interdental brushes *No. sessions*: unclear

Table 2. (Contd.)

Authors	Sample characteristics	Disease	Study design	Interventions
				No. minutes: N/R *Interval*: unclear *Performed by*: N/R *Repeat* : unclear
Listgarten et al. (1985)	**Country:** USA **Age:** 20–73 years **Setting:** university/hospital **Control group (*n*):** *Baseline:* Unclear *Finish*: 31 **Test group (*n*):** *Baseline*: unclear *Finish:* 30 **Total of 69 individuals recruited** **Smoking status:** unclear	**Type:** gingivitis **Inclusion/exclusion criteria:** no bone loss, no pockets $\geqslant$6 mm	**RCT** **Parallel** **Length of follow-up:** 3 years	**Control** *Description*: regular dental prophylaxis *OHI*: N/R *No. sessions*: 1 *No. minutes*: N/R *Interval*: N/A *Performed by*: dental hygienist *Repeat* : 6 monthly **Test** *Description*: dental prophylaxis at intervals decided by darkfield microscopy at 6 months. Prophylaxis if $\geqslant$15% spirochetes or motile rods or $\geqslant$20% spirochetes+motile rods *OHI*: N/R *No. sessions*: 1 *No. mins:* N/R *Interval:* determined by microscopy *Performed by*: dental hygienist *Repeat:* determined by microscopy
Listgarten et al. (1989)	**Country:** USA **Age:** 23–77 years **Setting:** university/hospital **Control group (*n*):** *Baseline:* unclear *Finish*: 47 *Test group (n):* *Baseline*: unclear *Finish:* 33 **Although numbers not clear greater drop outs in test group thought to be due to a perception by participants in that group that their periodontal health was being neglected** **Smoking status:** unclear	**Type:** Periodontitis, in maintenance **Inclusion/exclusion criteria:** been receiving periodontal maintenance for 3–6 months after active treatment	**RCT** **Parallel** **length of follow-u***p:* 4 years	**Control** *Description*: prophylaxis *OHI*: N/R *No. sessions*: 1 *No. minutes*: N/R *Interval*: N/A *Performed by*: dental hygienist *Repeat* : 3 monthly **Test** *Description*: prophylaxis at intervals decided by darkfield microscopy *OHI*: N/R *No. sessions*: 1 *No. mins:* N/R *Interval:* determined by microscopy *Performed by*: dental hygienist *Repeat:* determined by microscopy
Miller & Hodges (1991)	**Country:** USA **Age:** 23–63 years **Setting:** university/hospital **Control group (*n*):** *Baseline:* 30 *Finish*: 30 **Test group (*n*):** *Baseline:* 30	**Type:** Periodontitis (SPT) **Inclusion/exclusion criteria:** Comparable number of teeth contralaterally	**RCT** **Split-mouth** **Length of follow-up:** immediate post-treatment	**Control** *Description*: rubber cup polishing with pumice *OH*: N/A *No. sessions*: 1 *No. minutes*: 5 min. *Interval*: N/A *Performed by*: dental hygienist *Repeat* : N/A

	Finish: 30 **Smoking status:** unclear			**Test** *Description*: air polishing *OH*: None. *No. sessions*: 1 *No. minutes*: 5 min. *Interval*: N/A *Performed by*: Dental hygienist *Repeat*: no
Mishkin et al. (1986)	**Country:** USA **Age:** unclear **Setting:** university/hospital **Control group (*n*):** *Baseline*: 21 *Finish*: 21 **Test group (*n*):** *Baseline*: 21 *Finish:* 21 **Smoking status:** unclear	**Type:** gingivitis **Inclusion/exclusion criteria***:* Minimum of 10 teeth each side of mouth, no prostheses, no periodontitis	**RCT** **Split-mouth** **Length of follow-up:** 3 weeks	**Control** *Description*: rubber cup polish with pumice. *OHI*: N/R *No. sessions*: 1 *No. minutes*: N/R *Interval*: N/A *Performed by*: N/R *Repeat* : no *Test:* *Description*: air polishing *OHI*: N/R *No. sessions*: 1 *No. minutes:* N/R *Interval:* N/A *Performed by*: N/R *Repeat:* no
Mojon et al. (1998)	**Country:** Switzerland **Age:** Test: 83.5 years Control: 84.6 years **Setting:** Long-term care facility **Control group (*n*):** *Baseline*: 58 *Finish*: 39 **Test group (*n*):** *Baseline*: 58 *Finish:* 40 *Smoking status:* Unclear	**Type:** unclear **Inclusion/exclusion criteria:** All residents over 65 years, except with cognitive impairment	**RCT** **Parallel** **length of follow-up***:* 18 months	**Control** *Description*: only treated on request *OH*: none *No. sessions*: N/A *No. mins*: N/A *Interval*: N/A *Performed by*: dentist *Repeat* : No **Test** *Description*: comprehensive oral programme including OHI and scaling. *OHI:* to carer if needed *No. sessions*: 1 *No. minutes:* N/R *Interval*: N/A *Performed by*: dental hygienists *Repeat*: 6/12
Nyman et al. (1975)	**Country:** Sweden **Age:** Unclear **Setting:** university/hospital **Control group (*n*):** *Baseline*: 10 *Finish*: 10 **Test group (*n*):** *Baseline*: 10	**Type:** Periodontitis **Inclusion/exclusion criteria:** referred for treatment of advanced periodontitis	**RCT** **Parallel** **Length of follow-up:** unclear, stated as 24 months following initial (non-surgical) therapy but follow-up period for surgical therapy not stated	**Both groups initially received thorough non-surgical and surgical therapy.** **Control** *Description*: recall every 6 months for scaling of teeth *OHI*: no further OHI *No. sessions*: 1 *No. minutes*: N/R *Interval*: 6 months *Performed by*: hygienist

Table 2. (Contd.)

Authors	Sample characteristics	Disease	Study design	Interventions
	Finish: 10 **Smoking status:** unclear			*Repeat* : 6 months **Test** *Description*: controlled oral hygiene programme including scaling, and plaque removal with rubber cup, bristle cup, floss and interdental tips (EVA). *OHI*: bass toothbrushing and wood sticks *No. sessions*: 1 *No. minutes:* 30 *Interval*: 2 weeks *Performed by*: hygienist *Repeat:* 2 weeks
Somacarrera et al. (1997)	**Country:** Spain **Age: Mean:** 35.8 ± 11 **Setting:** university/hospital **Control group: overgrowth-no treatment (*n*):** *Baseline*: 13 *Finish*: 13 **Test group: overgrowth-PMPR (*n*):** *Baseline*: 11 *Finish:* 11 **Test group: non-overgrowth-no treatment (*n*):** *Baseline*: 17 *Finish:* 17 **Test group: non-overgrowth-PMPR(*n*):** *Baseline*: 26 *Finish:* 26 **Smoking status:** unclear	**Type:** Transplant patients **Inclusion/exclusion criteria:** Mean PD ⩽3 mm, at least one tooth in each jaw in each of the groups of teeth – incisors, canines, premolars and molars	**RCT** **Parallel** **Length of follow-up:** 1 year after transplant, 6 months after PMPR.	**Control: overgrowth-no treatment** *Description:* no treatment *OHI*: brushing and flossing *No. sessions*: N/R *No. minutes*: N/R *Interval*: N/R *Performed by*: N/R *Repeat* : N/R **Test group: overgrowth – PMPR** *Description*: ultrasonic scaling and polishing with rubber cup *OHI*: brushing and flossing *No. sessions*: N/R *No. minutes*: N/R *Interval*: N/R *Performed by*: N/R *Repeat* : N/R **Test group: non-overgrowth – no treatment** *Description*: no treatment *OHI*: brushing and flossing *No. sessions*: N/R *No. minutes*: N/R *Interval*: N/R *Performed by*: N/R *Repeat* : N/R **Test group: non-overgrowth – PMPR** *Description*: ultrasonic scaling and polishing with rubber cup *OHI*: brushing and flossing *No. sessions*: N/R *No. minutes*: N/R *Interval*: N/R *Performed by*: N/R *Repeat* : N/R
Strahan et al. (1977)	**Country:** UK **Age:** unclear **Setting:** university/hospital **Study 2** **Control group (*n*):**	**Type:** chronic gingivitis or early periodontitis **Inclusion/exclusion criteria:** chronic gingivitis or early periodontitis	**CCT*** Described as ''random alternation'' therefore reclassified as CCT* **Split-mouth**	**Study 2 data only** **Control side** *Description*: scaling and root planing **at baseline** with sickle scalers, hoes, curettes and ultrasonic instruments. No curettage. Overhangs/rough surfaces reduced and polished.

	Baseline: 12 *9 weeks*: unclear **Test group (*n*):** *Baseline*: 12 *9 weeks*: unclear **Smoking status:** unclear		**Length of follow-up:** Study 2: 9 weeks* 9-week data used since additional scaling provided after this*	*OHI*: disclose, toothbrushing & woodsticks *at baseline* *No. sessions*: OHI: 2 (15 min., 5 min.), Scaling: 40–50 min. *Performed by*: N/R *Repeat* : unclear *Test side:* *Description*: no treatment (**scaling only after week 9**) *OHI*: disclose, toothbrushing and woodsticks **at baseline** *No. sessions*: OHI: 2 (15 min., 5 min.) *Interval*: unclear *Performed by*: N/R *Repeat*: unclear
Sturzenberger et al. (1988)	**Country:** Unclear **Age:** Unclear **Setting:** unclear **Control group (*n*):** *Baseline:* 22 *Finish*: 22 **Test group (*n*):** *Baseline*: 22 *Finish*: 22 **Smoking status:** unclear	**Type:** Gingivitis **Inclusion/exclusion criteria:** ''No overt periodontal disease''	**RCT** *Cross-over trial* 3 week wash out period **Length of follow-up:** 10 days	**Control** *Description*: no treatment *OH*: N/R *No. sessions*: N/A *No. mins*: N/A *Interval*: N/A *Performed by*: N/A *Repeat* : N/A *Test:* *Description*: ''thorough dental prophylaxis'' *OH*: N/R *No. sessions*: ?1 *No. mins:* N/R *Interval*: N/R *Performed by*: N/R *Repeat*: N/R
Suomi et al. (1971a,b, 1973a)	**Country:** USA **Age:** 18–40 years **Setting:** company employees **Data abstracted only for the large study groups** **Control group (*n*):** *Baseline:* 343 *3 years*: 163 *6 years*: 88 **Test group (*n*):** *Baseline:* 343 *3 years*: 163 *6 years*: 88 **Smoking status:** unclear	**Type:** unclear **Inclusion/exclusion criteria:** N/R	**CCT-matched pairs** **Parallel** **Length of follow-up:** 6 years	**Control** *Description*: initial prophylaxis then no treatment *OH*: continue with own care *No. sessions*: 1 *No. minutes*: 50 *Interval*: N/A *Performed by*: dental hygienist *Repeat* : N/A **Test** *Description*: prophylaxis of all plaque and calculus *OH*: Individual; and film instruction on toothbrushing and floss *No. sessions*: N/R *No. minutes*: N/R *Interval*: N/A *Performed by*: dental hygienist *Repeat* :Year 1: at 2/12, 4/12, 6/12, 9/12, years 2: every 3/12, year 3: every 4/12. Years 4–6: no intervention.
Suomi et al. (1973b)	**Country:** USA **Age:** 17–22 years **Setting:** Army **1 × year prophy (*n*):** *Baseline:* unclear *3 years*: 140 *2 × year prophy (n):*	**Type:** Unclear **Inclusion/exclusion criteria:** N/R	**CCT** **Parallel** **Length of follow-up:** 3 years	**1 × year prophylaxis** *Description*: prophylaxis of all plaque and calculus *OH*: continue with own care *No. sessions*: N/R *No. minutes*: N/R *Interval*: N/A *Performed by*: dental hygienist

Table 2. (Contd.)

Authors	Sample characteristics	Disease	Study design	Interventions
	Baseline: unclear *3 years*: 143 **3 × year prophy (*n*):** *Baseline:* unclear *3 years*: 140 **Smoking status:** unclear			*Repeat* : 1 × year **2 × year prophylaxis** *Description*: prophylaxis of all plaque and calculus *OH*: continue with own care *No. sessions*: N/R *No. minutes*: N/R *Interval*: N/A *Performed by*: dental hygienist *Repeat* : 2 × year **3 × year prophylaxis** *Description*: prophylaxis of all plaque and calculus *OH*: continue with own care *No. sessions*: N/R *No. minutes*: N/R *Interval*: N/A *Performed by*: dental hygienist *Repeat* : 3 × year
Tabita et al. (1981)	**Country:** USA **Age:** Unclear **Setting:** university/hospital **Control group (*n*):** *Baseline*: 12 *Finish*: 12 **Test group (n):** *Baseline*: 12 *Finish: 12* **Smoking status:** unclear	**Type:** Periodontitis **Inclusion/exclusion criteria:** Untreated disease, Generalized pockets 4–6 mm, good general health and no current antibiotic therapy	**RCT** **Split-mouth** **Length of follow-up:** 14 days	**Control 1** *Description*: initial thorough SRP. No other treatment. *OH*: bass toothbrush technique and floss *No. sessions*: 1 *No. minutes*: N/R *Interval*: N/R *Performed by*: N/R *Repeat* : no **Control 2** *Description*: initial thorough SRP. No other treatment *OH*: No OH *No. sessions*: 1 *No. minutes*: N/R *Interval*: N/R *Performed by*: N/R *Repeat* : no **Test:** *Description*: initial thorough SRP. Daily supragingival plaque removal with floss and rubber cup for 14 days *OH*: bass toothbrush technique and floss *No. sessions*: 1 *No. minutes:* N/R *Interval*: daily *Performed by*: N/R *Repeat:* No
Tan & Saxton (1978)	**Country:** Holland **Age:** unclear **Setting:** army **Control group (*n*):** *Baseline*: 30	**Type:** Gingivitis **Inclusion/exclusion criteria:** screening identified existing gingivitis	**RCT** **Parallel – Cluster** **Length of follow-up:** 3 months	**Control** *Description*: no treatment *OHI*: no *No. sessions*: N/A *No. minutes*: N/A

	Finish: 24 **Test group: PMPR (*n*):** *Baseline*: 30 *Finish:* 27 **Test group: OH (*n*):** *Baseline*: 30 *Finish:* 22 **Test group: OH+PMPR (*n*):** *Baseline*: 30 *Finish:* 25 **Smoking status:** All test groups NS			*Interval*: N/A *Performed by*: N/A *Repeat* : N/A *Test-PMPR:* *Description*: ultrasonic scaling of calculus, fine curettes, removal of overhangs, polishing with cup and pumice *OHI*: no *No. sessions*: 1 *No. minutes:* N/R *Interval*: N/A *Performed by*: dental hygienist *Repeat:* No **Test-OH** *Description*: no treatment *OHI*: group and personal discussion+audiovisual material. Toothbrushing, floss, toothpicks and toothpaste *No. sessions*: 1 *No. minutes:* Group 30 ins, individual 10 min. *Interval*: N/A *Performed by*: dental hygienist *Repeat:* no **Test-OH+PMPR** *Description*: ultrasonic scaling of calculus, fine curettes, removal of overhangs, polishing with cup and pumice *OHI*: group and personal discussion+audiovisual; material. Toothbrushing, floss, toothpicks and toothpaste *No. sessions*: 1 *No. minutes:* Group 30 ins, individual 10 min. *Interval*: N/A *Performed by*: dental hygienist *Repeat:* no
Walsh et al. (1985a, b)	**Country:** USA **Age:** 22–45 years **Setting:** university/hospital **Control group (*n*):** *Baseline:* 30 *Finish*: 30 **Test group (*n*):** *Baseline:* 30 *Finish*: 30 **Smoking status:** unclear	**Type:** Gingivitis & periodontitis **Inclusion/exclusion criteria:** generalized inflammation, bleeding on probing, minimum 2 contralateral 4–5 mm pockets, minimum of 24 teeth	**RCT** **Split-mouth** **Length of follow-up:** 6 weeks	**Control** *Description*: scaling with hand instruments *OH*: yes, not described *No. sessions*: 1–2 *No. minutes*: 1–2 h *Interval*: within 5 days *Performed by*: dental hygienist *Repeat* : N/A **Test** *Description*: scaling with hand instruments followed by supragingival polish with rubber cup and coarse paste *OH*: yes, not described *No. sessions*: 1–2 *No. minutes*: 1–2 h *Interval*: within 5 days *Performed by*: dental hygienist *Repeat* : N/A
Weaks et al. (1984)	**Country:** USA **Age:** at least 21years	**Type:** Unclear **Inclusion/exclusion**	**RCT** **Split-mouth**	**Control (study 1 and study 2)** *Description*: rubber cup prophylaxis with pumice.

Table 2. (Contd.)

Authors	Sample characteristics	Disease	Study design	Interventions
	Setting: university/hospital Study 1 – efficiency **Control group (*n*):** *Baseline*: 30 *Finish*: 30 **Test group (*n*):** *Baseline*: 30 *Finish:* 30 Study 2 – trauma **Control group (*n*):** *Baseline*: 23 *Finish*: 23 **Test group (*n*):** *Baseline*: 23 *Finish:* 23 **Smoking status:** unclear	**criteria:** No pd >4 mm, minimum 20 teeth, age at least 21	**Length of follow-up:** Study 1 – immediately post-op Study 2–12 days	*OHI*: none *No. sessions*: 1 *No. minutes*: N/R *Interval*: N/A *Performed by*: N/R *Repeat* : N/A **Test (study 1 and study 2)** *Description*: Air polisher *OHI*: None *No. sessions*: 1 *No. minutes*: N/R *Interval*: N/A *Performed by*: N/R *Repeat* : N/A
Westfelt et al. (1983)	**Country:** Sweden **Age:** 32–72 **Setting:** university hospital **Control group – 12 week recall (*n*):** *Baseline:* 8 *Finish*: unclear **4 week recall interval (*n*):** *Baseline:* 8 *Finish*: unclear **2 week recall interval (*n*):** *Baseline:* 8 *Finish*: unclear **Smoking status:** unclear	**Type:** Periodontitis **Inclusion/exclusion criteria***:* unclear. Previously treated for ''moderately advanced periodontal disease''	**RCT** **Parallel group** **Length of follow-up:** 18 months. Data reported here relate to 6 months (at which stage the study design changed)	**Control** *Description*: supra and subgingival scaling (''when indicated''), polish with rubber cup and paste *OH*: disclosing, Bass technique brushing and interdental cleaning with interdental brush, floss or toothpick. *No. sessions*: 1 *No. mins*: N/R *Interval*: 12 weeks *Performed by*: dental hygienist *Repeat* : Every 12 weeks **4 week recall interval** *Description*: supra and subgingival scaling (''when indicated''), polish with rubber cup and paste *OH*: disclosing, bass technique brushing and interdental cleaning with interdental brush, floss or toothpick. *No. sessions*: 1 *No. minutes*: N/R *Interval*: 4 weeks *Performed by*: dental hygienist *Repeat* : every 4 weeks **2 week recall interval** *Description*: supra and subgingival scaling (''when indicated''), polish with rubber cup and paste *OH*: disclosing, Bass technique brushing and interdental cleaning with interdental brush, floss or toothpick. *No. sessions*: 1 *No. mins*: N/R *Interval*: 2 weeks *Performed by*: dental hygienist *Repeat* : every 2 weeks

Table 3. Study duration

Less than 1 month	1–3 months	4–6 months	7–12 months	Greater than 12 months	Actual reported follow-up
Hunter et al. (1989)					Immediate post-treatment
Miller & Hodges (1991)					Immediate post-treatment
Checchi et al. (1997)					Immediate post-treatment
Weaks et al. (1984)					Study 1 – immediately post op. Study 2 – 12 days
Sturzenberger et al. (1988)					10 days
Tabita et al. (1981)					2 weeks
Cheraskin et al. (1968)					2 weeks
Katsanoulas et al. (1992)					3 weeks
Mishkin et al. (1986)					3 weeks
Keller et al. (1963)					3 weeks
	Walsh et al. (1985a, b)				6 weeks
	Gaare et al. (1990)				2 months
	Aldridge et al. (1995)				2 months
	Lavanchy et al. (1987)				10 weeks
	Tan & Saxton (1978)				3 months
	Strahan et al. (1977)				15 weeks
		Somacarrera et al. (1997)			6 months after PMPR; 1 year after transplant
		Westfelt et al. (1983)			18 months. Data reported here relate to 6 months (at which stage the study design changed)
			Glavind (1977)		11 months
				Lim & Davies (1996)	Control 16 months. Test: 10 months Note: follow-up used for control group is different from the test groups since the test groups received additional treatment at 10 months
				Mojon et al. (1998)	18 months
				Chawla et al. (1975)	2 years
				Adachi et al. (2002)	2 years
				Kaldahl et al. (1998) (Also; Kalkwarf et al. 1989, Kalkwarf et al. 1992, [69]Kaldahl et al. 1996a, b)	2 years
				Nyman et al. (1975)	Unclear, stated as 24 months following initial (non-surgical) therapy, but follow-up period for surgical therapy not stated.
				Listgarten et al. (1985)	3 years
				Suomi et al. (1973b)	3 years
				Lightner et al. (1971)	46 months
				Listgarten et al. (1989)	4 years
				Suomi et al. (1971a, b, 1973a)	6 years
				Axelsson & Lindhe (1981b)	6 years
				Axelsson & Lindhe (1978, 1981a)	Up to 6 years. NB data also published for 15 year follow-up. These data are not included in the review as the control group was discontinued.

Table 4. Study settings

Hospital/academic	Commercial/industrial/ military/fire/police	Nursing/care homes	Public health clinics	Unclear
Aldridge et al. (1995)	Chawla et al. (1975)	Adachi et al. (2002)	Axelsson & Lindhe (1978, 1981a)	Cheraskin et al. (1968)
Axelsson & Lindhe (1981b)	Gaare et al. (1990)	Mojon et al. (1998)		Sturzenberger et al. (1988)
Checchi et al. (1997)	Keller et al. (1963)			
Glavind (1977)	Lightner et al. (1971)			
Hunter et al. (1989)	Lim & Davies (1996)			
Kaldahl et al. (1988) (also, Kalkwarf et al. 1989, Kaldahl et al. 1996a, b)	Suomi et al. (1971a, b, 1973a). Data abstracted only for the large study groups			
Katsanoulas et al. (1992)	Suomi et al. (1973b)			
Keller et al. (1963)	Tan & Saxton (1978)			
Lavanchy et al. (1987)				
Listgarten et al. (1985)				
Listgarten et al. (1989)				
Miller & Hodges (1991)				
Mishkin et al. (1986)				
Nyman et al. (1975)				
Somacarrera et al. (1997)				
Strahan et al. (1977)				
Tabita et al. (1981)				
Walsh et al. (1985a, b)				
Weaks et al. (1984)				
Westfelt et al. (1983)				

Table 5. Disease characteristics

Gingivitis	Periodontitis	Gingivitis and periodontitis	No gingivitis or periodontal disease	Unclear
Aldridge et al. 1995 – Study 1 subjects (all patients with diabetes)	Axelsson & Lindhe (1981b)		Checchi et al. (1997)	Adachi et al. (2002)
Gaare et al. (1990)	Glavind (1977)	Chawla et al. (1975)		Axelsson & Lindhe 1978, 1981a
Listgarten et al. (1985)	Kaldahl et al. (1988) (also, Kalkwarf et al. 1989, Kaldahl et al. 1996a, b)	Keller et al. (1963)		Cheraskin et al. (1968)
Mishkin et al. (1986)	Katsanoulas et al. (1992)	Strahan et al. (1977)		Hunter et al. (1989)
Sturzenberger et al. (1988)	Lavanchy et al. (1987)	Walsh et al. (1985a, b)		Lightner et al. (1971)
Tan & Saxton (1978)	Listgarten et al. (1989)			Lim & Davies (1996)
	Miller & Hodges (1991)			Mojon et al. (1998)
	Nyman et al. (1975)			Somacarrera et al. (1997)
	Tabita et al. (1981)			Suomi et al. (1971a, b, 1973a)
	Westfelt et al. (1983)			Suomi et al. (1973b)
				Weaks et al. (1984)

than 20% of subjects during follow-up (Tan & Saxton 1978, Adachi et al. 2002).

PMPR+OHI versus no treatment. CCTs (Table 10)

Plaque (three studies). PMPR+OHI produced generally greater changes in plaque than no treatment in all three studies that measured it (Suomi et al. 1971a, b, 1973a, Chawla et al. 1975, Axelsson & Lindhe 1978, 1981a). Only one of these studies presented a statistical analysis (Chawla et al. 1975) which favoured PMPR+OHI ($p<0.01$). The pattern and magnitude of change was inconsistent. One 6-year study (Axelsson & Lindhe 1978, 1981a) showed the largest effect with frequent recall, but a similar study (Suomi et al. 1971a, b, 1973a) showed an increase in plaque levels at 3 years, although these improved beyond the baseline levels at 6 years for PMPR+OHI.

Bleeding/inflammation (four studies). PMPR+OHI produced a greater change in bleeding/inflammation than no treatment in two studies (Chawla et al. 1975, Axelsson & Lindhe 1978, 1981a), although this was not analysed statistically in one (Axelsson & Lindhe 1978, 1981a). In one study, the difference between groups was not clear (Suomi et al. 1971a, b, 1973a) and inflammation levels were higher than baseline at both 3 and 6 years. In a further study, the difference between

Table 6. Intervention Characteristics

PMPR	Supra-subgingival, both, unclear	Oral hygiene instruction	Frequency of PMPR	Author
Scaling ± OHI				
Scaling	Unclear	Toothbrush	Maximum of 6 months	Mojon et al. (1998)
Scaling	Unclear	Toothbrush, floss, interdental brush/sticks as necessary (some groups)	Baseline, 10 months	Lim & Davies (1996)
Scaling	Supragingival	No	3 times per week	Katsanoulas et al. (1992)
Scaling	Supragingival	Toothbrushing and interdental	4 weeks, 10 weeks, three monthly	Kaldahl et al. (1998)
Scaling	Both	No	Once	Walsh et al. (1985b)
Scaling, +adjustment of restorative margins	Unclear	Flossing, toothbrushing	Monthly	Aldridge et al. (1995)
Scaling+prophy ± OHI				
Scaling, prophy	Unclear	No	Once	Checchi et al. (1997), Keller et al. (1963)
Scaling, prophy	Unclear	Toothbrush	Once yearly, 6 monthly, 3monthly	Lightner et al. (1971)
Scaling, prophy	Unclear	Toothbrush, floss	Baseline, 6 months, 9 months	Somacarrera et al. (1997)
Scaling, prophy	Unclear	Toothbrush, floss, sticks, disclosing	Once	Tan & Saxon (1978)
Scaling, prophy	Both	Toothbrush, floss, sticks, disclosing	2 weekly, 4 weekly, 12 weekly	Westfelt et al. (1983)
Scaling, prophy, interdental brush, sponge brush	Unclear	No	Weekly	Adachi et al. (2002)
Scaling, prophy, floss	Both	No	Once	Checchi et al. (1997), Cheraskin et al. (1968), Walsh et al. (1985b)
SRP ± OHI				
SRP	Both	Toothbrush, sticks, disclosing	Once	Strahan et al. (1977)
Prophy ± OHI				
Prophy	Unclear	N/A	Once	Miller & Hodges (1991), Mishkin et al. (1986)
Prophy	Both	N/A	Once	Hunter et al. (1989)
Prophy	Unclear	No	Once	Weaks et al. (1984)
Prophy, floss (SRP and polishing first)	Both	Toothbrush, floss (some groups)	Once	Tabita et al. (1981)
Prophy cup, floss, powered interproximal tips (initial scaling)	Unclear	No	Monthly	Glavind (1977)
Prophy cup, rotating pointed brush, floss, powered interproximal tips, occasional curettes and	Both	Disclosing, toothbrushing, floss, sticks, checked and corrected if necessary	2 monthly for 2 years, then every 3 monthly	Axelsson & Lindhe (1978)

Table 6. (Contd.)

PMPR	Supra-subgingival, both, unclear	Oral hygiene instruction	Frequency of PMPR	Author
PERIOTOR tips (SRP in multiple sessions first)				
Prophy cup, rotating pointed brush, floss, powered interproximal tips (Scaling and root planing in multiple sessions first)	Both	Disclosing, toothbrushing, floss, sticks, checked and corrected if necessary	2 weeks	Nyman et al. (1975)
Prophy cup, rotating pointed brush, floss, powered interproximal tips (SRP first)	Supragingival	No	3 times per week	Lavanchy et al. (1987)
Air polishing				
Air polishing	Supragingival	No	Once	Weaks et al. (1984)
Air polishing	Supragingival	N/A	Once	Hunter et al. (1989), Miller & Hodges (1991), Mishkin et al. (1986)
Unclear ±				
''Standard oral prophylaxis''	Unclear	Toothbrush	3 monthly	Chawla et al. (1975)
''Thorough dental prophylaxis''	Unclear	No	Once	Sturzenberger et al. (1988)
''Thorough oral prophylaxis''	Unclear	No	Yearly, 6 monthly, 4 monthly	Suomi et al. (1973b)
''Oral prophylaxis''	Unclear	Toothbrush, floss	2 monthly for 6 months, then 3 monthly	Suomi et al. (1971a)
''Periodontal prophylaxis''	Unclear	Unclear	6 monthly	Listgarten et al. (1985)
''Periodontal prophylaxis''	Unclear	Unclear	3 monthly	Listgarten et al. (1989)

groups was not statistically significant (Gaare et al. 1990). However, this population was chosen both as having no experience of ''modern oral hygiene'' and large amounts of calculus.

PD (one study). One study (Axelsson & Lindhe 1978, 1981a) demonstrated a sustained reduction in PD by PMPR+OHI compared with a sustained increase in PD by no treatment ($p < 0.01$) after 3 years of follow-up. At 6 years, these differences were maintained although no statistical analysis was presented.

AL (three studies). Two studies reported a statistically significant difference favouring PMPR+OHI for AL (Chawla et al. 1975, Axelsson & Lindhe 1978, 1981a), although in one study the magnitude is not given (Chawla et al. 1975). The third study (Suomi et al. 1971a, b, 1973a) is difficult to interpret as no analytical statistics were employed, although the results seem to favour PMPR+OHI. There is a notable difference in the magnitude of the treatment effect for AL at 6 years between the two studies employing similar methods: difference between PMPR+OHI and no treatment: Axelsson & Lindhe (1978, 1981a) 1.8 mm, Suomi et al. (1971a, b, 1973a) 0.26 mm.

Other outcomes (one study). Suomi et al. (1971a, b, 1973a) presented radiographic data at 3 years, although no analytical statistics were employed. Due to technical problems with radiographs, only a subset of the planned sample (96 per group) was available for assessment. The results show little difference between groups: 0.01 mm loss, PMPR+OHI, 0.19 mm loss, no treatment.

Protection from bias. Examiner blinding: one study was clearly examiner blind (Suomi et al. 1971a, b, 1973a), one study was unclear (Chawla et al. 1975) and two studies did not employ blinding (Axelsson & Lindhe 1978, 1981a, Gaare et al. 1990). Two studies lost more than 20% of subjects during follow-up (Suomi et al. 1971a, b, 1973a, Chawla et al. 1975).

Summary PMPR+OHI *versus* no treatment

- Evidence for PMPR achieving more favourable changes in plaque and

Table 7. Protection from bias: randomized controlled trials

Authors	Randomization	Allocation concealment	Examiner blinding	Losses to follow-up	Other
Adachi et al. (2002)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Unclear	*Accounted for?* Yes *Intention to treat analysis?* N/A	*Comparable groups – disease status:* unclear *Comparable groups – confounders:* unclear *Adjustment for smoking: N/R* *Power calculation: N/R* *Statistical analysis clearly inappropriate:* no
Aldridge et al. (1995)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Yes	*Accounted for?* Yes *Intention to treat analysis?* No	*Comparable groups – disease status:* yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Checchi et al. (1997)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Unclear	*Accounted for?* N/A *Intention to treat analysis?* N/A	*Comparable groups – disease status:* N/A *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/A *Power calculation: N/R* *Statistical analysis clearly inappropriate:* no
Cheraskin et al. (1968)	*Method:* N/R *Adequacy:* Unclear	*Method:* N/R *Adequacy:* Unclear	Unclear	*Accounted for?* Yes *Intention to treat analysis?* N/A	*Comparable groups – disease status:* yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Glavind (1977)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Unclear	*Accounted for?* Unclear *Intention to treat analysis?* No	*Comparable groups – disease status:* yes *Comparable groups – confounders:* yes *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Hunter et al. (1989)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Unclear	*Accounted for?* Yes *Intention to treat analysis?* N/A	*Comparable groups – disease status:* yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/A *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Kaldahl et al. (1988) (also, Kalkwarf et al. 1989, 1992, Kaldahl et al. 1996a, b)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Unclear	*Accounted for?* Yes *Intention to treat analysis?* No	*Comparable groups – disease status:* yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Katsanoulas et al. (1992)	*Method:* N/R *Adequacy:* Unclear	*Method:* N/R *Adequacy:* unclear	Yes	*Accounted for?* Yes *Intention to treat analysis?* N/A	*Comparable groups – disease status:* yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* NO *Statistical analysis clearly inappropriate:* no
Keller et al. (1963)	*Method:* random number table *Adequacy:* adequate	*Method:* N/R unclear	Unclear	*Accounted for?* Yes *Intention to treat analysis?* N/A	*Comparable groups – disease status:* yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* unclear
Lightner et al. (1971)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Yes	*Accounted for?* Yes *Intention to treat analysis?* No	*Comparable groups – disease status:* unclear *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Lim & Davies (1996)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Unclear	*Accounted for?* Yes *Intention to treat analysis?* No	*Comparable groups – disease status:* yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no

Table 7. (Contd.)

Authors	Randomization	Allocation concealment	Examiner blinding	Losses to follow-up	Other
Listgarten et al. (1985)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Unclear	*Accounted for?* Unclear *Intention to treat analysis?* Unclear	*Comparable groups – disease status:* unclear *Comparable group – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Listgarten et al. (1989)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Unclear	*Accounted for?* Unclear *Intention to treat analysis?* Unclear	*Comparable groups – disease status:* unclear *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Miller & Hodges (1991)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Yes	*Accounted for?* Yes *Intention to treat analysis?* N/A	*Comparable groups – disease status:* yes *Comparable groups – confounders:* Unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Mishkin et al. (1986)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Yes	*Accounted for?* Unclear *Intention to treat analysis?* Unclear	*Comparable groups – disease status:* Yes *Comparable group – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Mojon et al. (1998)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Yes	*Accounted for?* Yes *Intention to treat analysis?* N/A	*Comparable groups – disease status:* unclear *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* no *Statistical analysis clearly inappropriate:* no
Nyman et al. (1975)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Unclear	*Accounted for?* unclear *Intention to treat analysis?* unclear-	*Comparable groups – disease status:* Yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Somacarrera et al. (1997)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Yes	*Accounted for?* Yes *Intention to treat analysis?* N/A	*Comparable groups – disease status:* no *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* yes
Sturzenberger et al. (1988)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Unclear	*Accounted for?* Yes *Intention to treat analysis?* N/A	*Comparable groups – disease status:* unclear *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* unclear
Tabita et al. (1981)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Unclear	*Accounted for?* Yes *Intention to treat analysis?* N/A	*Comparable groups – disease status:* unclear *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* no *Statistical analysis clearly inappropriate:* no
Tan & Saxton (1978)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Unclear	*Accounted for?* Yes *Intention to treat analysis?* No	*Comparable groups – disease status:* yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* unclear if site-based analysis

Table 7. (Contd.)

Authors	Randomization	Allocation concealment	Examiner blinding	Losses to follow-up	Other
Walsh et al. (1985a, b)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Unclear	*Accounted for?* Yes *Intention to treat analysis?* N/A	*Comparable groups – disease status:* yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Weaks et al. (1984)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Yes	*Accounted for?* Unclear *Intention to treat analysis?* Unclear	*Comparable groups – disease status:* yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Westfelt al. (1983)	*Method:* N/R *Adequacy:* unclear	*Method:* N/R *Adequacy:* unclear	Unclear	*Accounted for?* Unclear *Intention to treat analysis?* Unclear	*Comparable groups – disease status:* yes *Comparable groups – confounders:* Unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no

Table 8. Protection from bias: controlled clinical trials

Authors	Examiner blinding	Losses to follow-up	Other
Axelsson & Lindhe (1978, 1981a)	No	*Accounted for?* Yes *Intention to treat analysis?* No	*Comparable groups – disease status:* yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* unclear
Axelsson & Lindhe (1981b)	Unclear	*Accounted for?* Yes *Intention to treat analysis?* No	*Comparable groups – disease status:* yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Chawla et al. (1975)	Unclear	*Accounted for?* No *Intention to treat analysis?* No Note 54% drop-out overall	*Comparable groups – disease status:* yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Gaare et al. (1990)	No	*Accounted for?* Yes *Intention to treat analysis?* No	*Comparable groups – disease status:* yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Lavanchy et al. (1987)	Unclear	*Accounted for?* Yes *Intention to treat analysis?* N/A	*Comparable groups - disease status:* yes *Comparable groups–confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Strahan et al. (1977)	Unclear	*Accounted for?* Unclear *Intention to treat analysis?* Unclear	*Comparable groups – disease status:* yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* no
Suomi et al. (1971a, b, 1973a)	Unclear	*Accounted for?* No *Intention to treat analysis?* No	*Comparable groups – disease status:* yes *Comparable groups – onfounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* only descriptive statistics used.
Suomi et al. (1973b)	Yes	*Accounted for?* No *Intention to treat analysis?* No	*Comparable groups – disease status:* yes *Comparable groups – confounders:* unclear *Adjustment for smoking:* N/R *Power calculation:* N/R *Statistical analysis clearly inappropriate:* only descriptive statistics used.

bleeding/inflammation in both RCTs and CCTs.
- In RCTs:

  - *o* There is no evidence of a difference between groups for PD change and no available evidence for and effect on AL.
  - *o* There is evidence for reduction in fever, death and aspiration pneumonia in a vulnerable group resulting from PMPR+OHI.
  - *o* No evidence of a difference resulting from PMPR+OHI for diabetes metabolic markers.

- In CCTs:

  - *o* There is evidence for PMPR+OHI achieving more favourable changes in PD and AL than no treatment.

- For both RCTs and CCTs there is weak evidence: inconsistent effects, risk of bias, risk of confounding or non-randomized design.

PMPR+OHI versus OHI. RCTs (Table 11)

Plaque (three studies). PMPR-OHI produced reductions in plaque levels in all three studies (including the non-overgrowth group in Somacarrera et al. 1997). This was statistically significant in two studies (Lim & Davies 1996, Tan & Saxton 1978) and could not be determined in the third (Somacarrera et al. 1997). Oral hygiene produced a statistically significant change in one study (Lim & Davies 1996) and not for the other (Tan & Saxton 1978). The difference between PMPR+OHI and OHI alone could only be properly evaluated in one study (Lim & Davies 1996) and this showed a statistically significant difference favouring PMPR-OHI, although the difference was small ($\sim$ 2%).

Bleeding/inflammation (three studies). - Both treatment groups resulted in statistically significant reductions in bleeding in one study (Lim & Davies 1996) and little change (Somacarrera et al. 1997) or non-significant change in another (Tan & Saxton 1978). The difference between PMPR+OHI and OHI alone could only be properly evaluated in one study (Lim & Davies 1996) and this showed a statistically significant difference favouring PMPR – OHI.

Other (one study). Reduction in cyclosporin induced gingival overgrowth was examined in one study (Somacarrera et al. 1997). This demonstrated a reduction in overgrowth of the PMPR – OHI group but not the OHI alone group. Differences between groups could not be evaluated due to a problem with the statistical methods.

Protection from bias. Randomization and allocation concealment were unclear in all three studies. Examiner blinding was only clearly adequate for one study (Somacarrera et al. 1997) and losses to follow-up exceeding 20% were present in one study (Tan & Saxton 1978).

PMPR+OHI versus OHI. CCT (Table 12)

Plaque (one study: split-mouth). Both treatment groups produced a reduction in plaque (Strahan et al. 1977). The difference between groups was not statistically significant.

Bleeding/inflammation (one study). - Both treatment groups produced a reduction in bleeding. The difference between groups was not statistically significant.

Protection from bias. It was unclear whether the examiner was blind to treatment allocation. The completeness of follow-up at 9 weeks was also unclear.

Summary PMPR+OHI *versus* OHI

In RCTs:

- Evidence favouring PMPR+OHI for improvements in plaque, bleeding/inflammation and reduction of gingival overgrowth. The inconsistent effects of OHI alone should be noted.
- Weak evidence: inconsistent effects, risk of bias and lack of appropriate statistical analysis in two studies.

In CCTs:

- No evidence of a difference comparing PMPR+OHI *versus* OHI for improvements in plaque or bleeding as OHI alone produced improvements.
- Weak evidence: risk of bias, non-randomized study, single study, small and possibly underpowered to detect differences.

PMPR+OHI versus SRP+OHI. RCT (Table 13)

Plaque (one study). Both treatments produced a statistically significant improvement in plaque levels (Kaldahl et al. 1988, 1992, 1996a, Kalkwarf et al. 1989) ($p<0.05$). The difference between groups was not statistically significant.
Bleeding/inflammation (one study). - Bleeding on probing reduced in both groups. This was statistically significantly greater for SRP+OHI for all initial PD categories ($p<0.05$).

PD (one study). Both treatments produced statistically significant reductions in PD with the exception of PMPR in PDs initially 1–4 mm. The decrease in PD was statistically significantly greater for SRP+OHI for sites $\geqslant$5 mm.

AL (one study). Both treatments produced statistically significant gains in attachment for sites with initial PD of $\geqslant$5 mm ($p<0.05$). The gain in attachment depth was statistically significantly greater for SRP+OHI than PMPR+OHI for sites $\geqslant$5 mm ($p<0.05$).

Other (one study). There were a greater number of abscesses in the PMPR+OHI group (23) than in the SRP+OHI group (3). It is not clear if the follow-up for both was identical. If not, follow-up will have been longer in the SRP – OHI group, as more than 50% of sites of the PMPR+OHI group had been root planed and exited from the group by 3 years. There was no evidence of a difference for patient preferences between treatments at 3 years.

Protection from bias. Randomization, allocation concealment, and blinding were unclear in this study.

Summary

PMPR+OHI versus SRP+OHI in periodontitis from RCT

- Evidence favouring SRP+OHI *versus* PMPR+OHI.
- No evidence of a difference between treatments for patient preferences.
- Moderate evidence: risk of bias, single study, consistent findings.

Table 9. Professional mechanical plaque removal with oral hygiene instruction vs. no treatment: randomized controlled trials

Authors	Plaque	GI/bleeding	PD (mm)	CAL (mm)	Other
Adachi et al. (2002)					**% with fever (body temperature $>37.8^{\circ}$)** **Mean (SD)** No RX: 7.0% (4.0) $n=48$ PMPR: 3.8% (3.0) $n=40$ Difference between groups $p<0.05$ **Death, aspiration pneumonia** No RX: Total: 15 16.7% PMPR: Total: 10 5.0%
Aldridge et al. (1995)	**PI** **% within categories (SD)** **Baseline** No RX: PI = 0 36.5 (25.0) PI = 1 35.7 (16.0) PI = 2–3 38.2 (25.0) PMPR: PI = 0 36.9 (13.0) PI = 1 34 8 (9.0) PI = 2–3 41.3 (22.0) Difference between groups P = NS **2 months** No RX: PI = 0 56.1 (29.0) PI = 1 25.2 (9.0) PI = 2–3 28.3 (24.0) PMPR: PI = 0 64.7 (21.0) PI = 1 26.8 (11.0) PI = 2–3 21.3 (14.0) Difference within groups $p<0.05$ Difference between groups P = NS	**BOP*** **% within categories (SD)** **Baseline** No RX: BOP = 0 84.3 (18.0) BOP = 1 23.1 (13.0) BOP = 2 2.5 (2.0) PMPR: BOP = 0 89.9 (12.0) BOP = 1 20.9 (9.0) BOP = 2 2.0 (5.0) Difference between groups P = NS **2 months** No RX: BOP = 0 87.9 (14.0) BOP = 1 18.1 (9.0) BOP = 2 2.7 (5.0) PMPR: BOP = 0 94.8 (10.0) BOP = 1 16.5 (10.0) BOP = 2 1.4 (2.0) Difference within groups $p<0.05$ Difference between groups P = NS	**PD** **% within categories (SD)** **Baseline** No RX: PD = 1–3 6.3 (13.0) PD = 4–5 8.6 (11.0) PMPR: PD = 1–3 52.3 (6.0) PD = 4–5 4.1 (6.0) Difference between groups P = NS **2 months** No RX: PD = 1–3 47.3 (13.0) PD = 4–5 7.5 (12.0) PMPR: PD = 1–3 53.3 (4.0) PD = 4–5 3.1 (3.0) Difference within groups P = NS Difference between groups P = NS		**% glycated haemoglobin** **Mean % (SD)** **Baseline** No RX: 10.1 (2.0) PMPR : 9.4 (2.0) Difference between groups P = NS **2 months** No RX: 10.1 (2.0) PMPR : 9.1 (2.0) Difference between groups P = NS Difference within groups P = NS **% Fructosamine** **Mean % (SD)** **Baseline** No RX: 3.9 (1.0) PMPR : 3.7 (1.0) Difference between groups P = NS **2 months** No RX: 3.6 (1.0) PMPR : 3.6 (1.0) Difference between groups P = NS Difference within groups P = NS
Lim & Davies (1996)	**Presence. Mean % (SD)** **Baseline** No RX: 49.9 (18.6) Test – OH: 52.1 (21.4) Test – Sc: 56.2 (18.2) Test – Sc+OH: 6.2 (20.8) **10 months** Test – OH: 29.7 (15.3) Test – Sc: 34.5 (16.4) Test – Sc+OH: 27.4 (14.6) Differences between groups: Test – OH and Test – Sc and Test – OH and Test – Sc+OH at 10 months $p<0.05$ **16 months** No RX: 40.2 (18.0)	**BOP (presence). Mean % (SD)** **Baseline** No RX: 33.0 (15.4) Test – OH: 33.5 (20.1) Test – Sc: 33.0 (20.6) Test – Sc+OH: 5.4 (21.1) **10 months** Test – OH: 24.6 (17.6) Test – Sc: 17.7 (11.9) Test – Sc+OH: 4.4 (10.8) Differences between Test – OH and Test – Sc and Test-OH and Test – Sc+OH at 10 months $p<0.05$ **16 months** No RX: 2.0 (15.2)			

Table 9. (Contd.)

Authors	Plaque	GI/bleeding	PD (mm)	CAL (mm)	Other
	Differences within groups from baseline $p<0.05$ except No RX (NS)	Differences within groups from baseline-final $p<0.05$ except No Rx (NS)			
Mojon et al. (1998)	**PI** **Baseline** No RX: 2.75 PMPR: 2.57 **18 months** No RX: 3.00 PMPR: 2.63 Difference between groups at 18 months: P = 0.06				
Tan & Saxton (1978)	**PS mean (SE)** **Baseline** No RX: 2.16 Test – PMPR: 2.30 Test – OH: 2.17 Test – OH+PMPR: 2.34 **3 months** No RX: 1.94 Test-PMPR: 2.05 Test-OH: 2.25 Test – OH+PMPR: 2.01 Differences within groups at baseline and 3 months: No RX and test – OH: NS Test – PMPR: $p<0.05$ Test – PMPR+OH: $p<0.01$	**BS mean** **Baseline** No RX: 0.31 Test– PMPR: 0.26 Test – OH: 0.24 Test – OH+PMPR: 0.21 *3 months* No RX: 0.37 Test – PMPR: 0.30 Test – OH: 0.30 Test –OH+PMPR: 0.30 Differences within groups at baseline and 3 months: No RX $p = 0.05$ (worse) All test groups: N			

- The time scale was adequate to demonstrate effects.

PMPR versus no treatment. RCTs (Table 14)

Plaque (two studies). PMPR produced reductions in plaque in both studies (Tan & Saxton 1978, Lim & Davies 1996), and this was statistically significant. No change was reported with the no treatment groups. Statistical comparisons between the treatment groups were unclear in both studies, as groups had different follow-up duration in one study (Lim & Davies 1996) and in the other study; it was not stated which groups were statistically significantly different (Tan & Saxton 1978).

Bleeding/inflammation (three studies). The PMPR group in two studies (Keller et al. 1963, Lim & Davies 1996), resulted in a statistically significant reduction in inflammation or bleeding, but not in the third study (Tan & Saxton 1978). No change was reported with the no treatment groups in two studies (Keller et al. 1963, Lim & Davies 1996) and an increase in bleeding in the third (<, 0.05) (Tan & Saxton 1978). The difference between treatment groups was statistically significant in one study (Keller et al. 1963) and unclear in the others for the reasons detailed above for plaque.

PD/AL (one study). In this 3-week study (Katsanoulas et al. 1992), no statistically significant changes were observed either within or between treatment groups for either probing parameter.

Protection from bias. Two studies were clearly examiner blind (Katsanoulas et al. 1992, Keller et al. 1963), one employed an adequate randomization method (Keller et al. 1963) but an unclear allocation method, and the rest were unclear with respect to these parameters. Losses to follow-up were greater than 20% in one, three month study (Tan & Saxton 1978).

Summary

PMPR versus no treatment in RCTs:

- Evidence for plaque and bleeding/inflammation favouring PMPR.
- No evidence of a difference for PD/AL.

Table 10. Professional mechanical plaque removal with oral hygiene instruction *versus* no treatment: controlled clinical trials

Authors	Plaque	GI/Bleeding	PD (mm)	CAL (mm)	Other
Axelsson & Lindhe (1978, 1981a)	**Full-mouth plaque score % (SE)** **Baseline** **Age <35 years** No Rx: 58 (1.0) PMPR: 60 (2.0) **Age 36–50 years** No Rx: 57 (1.0) PMPR: 60 (1.0) **Age >50 years** No Rx: 62 (2.0) PMPR: 62 (2.0) **3 years** **Age <35 years** No Rx: 55 (1.0) PMPR: 17 (1.0) **Age 36–50 years** No Rx: 55 (2.0) PMPR: 18 (1.0) **Age >50 years** No Rx: 60 (2.0) PMPR: 17 (1.0) **6 years** **Age <35 years** No Rx: 55 (N/R) PMPR: 15 (N/R) Age 36–50 years No Rx: 60 (N/R) PMPR: 15 (N/R) **Age >50 years** No Rx: 62 (N/R) PMPR: 15 (N/R))	**Full-mouth BOP % (SE)** **Baseline** **Age <35 years** No Rx: 22 (5.0) PMPR: 23 (2.0) **Age 36–50 years** No Rx: 20 (5.0) PMPR: 20 (3.0) **Age >50 years** No Rx: 26 (3.0) PMPR: 25 (8.0) **3 years** **Age <35 years** No Rx: 24 (5.0) PMPR: 1 (0.1) **Age 36–50 years** No Rx: 26 (3.0) PMPR: 1 (0.1) **Age >50 years** No Rx: 26 (3.0) PMPR: 2 (0.1) **6 years** **Age <35 years** No Rx: 24 (N/R) PMPR: 2 (N/R) **Age 36–50 years** No Rx: 30 (N/R) PMPR: 2 (N/R) **Age >50 years** No Rx: 28 (N/R) PMPR: 2 (N/R))	**PD change from baseline mean (SE)** **3 years** **Age <35 years** No Rx: 0.5 (0.1) PMPR: −0.5 (0.1) **Age 36–50 years** No Rx: 0.5 (0.1) PMPR: −0.6 (0.1) **Age >50 years** No Rx: 0.7 (0.1) PMPR: −0.5 (0.1) Difference between PMPR and No Rx for each age group $p<0.001$ **6 years (estimated from figure)** **Age <35 years** No Rx: 0.9 (N/R) PMPR: −1.0 (N/R) **Age 36–50 years** No Rx: 1.0 (N/R) PMPR: −1.1 (N/R) **Age >50 years** No Rx: 1.4 (N/R) PMPR: −1.0 (N/R) **% of PD ⩾3 mm baseline** **Age <35 years** No Rx: 2.2 PMPR: 3.5 **Age 36–50 years** No Rx: 6.6 PMPR: 8.3 **Age >50 years** No Rx: 10.6 PMPR: 8.4 **6 years** **Age <35 years** No Rx: 7.6 PMPR: 0.4 **Age 36–50 years** No Rx: 11.7 PMPR: 0.2 **Age >50 years** No Rx: 18.8 PMPR: 0.6	**CAL change from baseline mean (SE)** **3 years** **Age <35 years** No Rx: −0.5 (0.12) PMPR: 0.1 (0.05) **Age 36–50 years** No Rx: −0.8 (0.16) PMPR: 0.1 (0.05) **Age >50 years** No Rx: −0.9 (0.15) PMPR: 0.1 (0.05) Difference between PMPR and No Rx for each age group $p<0.001$ **6 years (estimated from figure)** **Age <35 years** No Rx: −0.7 (N/R) PMPR: 0.2 (N/R) **Age 36–50 years** No Rx: −1.4 (N/R) PMPR: 0.2 (N/R) **Age >50 years** No Rx: −1.6 (N/R) PMPR: 0.2 (N/R)	

Table 10. (Contd.)

Authors	Plaque	GI/Bleeding	PD (mm)	CAL (mm)	Other
Chawla et al. (1975)	PI/PDI **2 years** Difference between PMPR and No Rx $p<0.01$	**GI/PDI** **2 years** Difference between PMPR and No Rx $p<0.01$		**PDI** **2 years** Difference between PMPR and No Rx $p<0.05$	
Gaare et al. (1990)		**BI** **% (SE)** **Baseline**[e] No Rx: 61 (2.3) PMPR: 63 (1.4) **2 months** No Rx: 36 (2.4) PMPR: 34 (1.5) Difference within groups $p<0.001$ Differences between groups P = NS			
Suomi et al. (1971a, b, 1973a)	**OHI** **Mean (SD)** **Baseline** No Rx: 1.06 (0.26) PMPR: 1.13 (0.28) **3 years** No Rx: 2.33 (0.89) PMPR: 1.43 (0.64) **6 years** No Rx: 1.30 (0.78) PMPR: 0.77 (0.48)	**GI/PDI** **Mean (SD) Baseline** No Rx: 0.46 (0.31) PMPR: 0.53 (0.33) **3 years** No Rx: 1.00 (0.34) PMPR: 0.75 (0.34) **6 years** No Rx: 1.00 (0.26) PMPR: 0.71 (0.32)		**Mean (SD)** **Baseline** No Rx: 0.41 (0.47) PMPR: 0.40 (0.51) **3 years** No Rx: 0.71 (0.54) PMPR: 0.48 (0.50) *6 years* No Rx: 0.78 (0.78) PMPR: 0.52 (0.53)	**Radiographic. Mean CEJ–alveolar crest (mm)** **Baseline** No Rx: 1.25 PMPR: 1.33 **3 years** No Rx: 1.44 PMPR: 1.34

- Weak evidence: inconsistent effects, risk of bias.

PMPR versus OHI. RCTs (Table 15)

Plaque (two studies). In one study (Lim & Davies 1996), both treatments reduced plaque levels ($p<0.05$), although this was statistically significantly superior for OHI ($p<0.05$). In the other study (Tan & Saxton 1978), the effect was surprisingly only statistically significant for PMPR and not OHI. Differences between groups in this study are unclear.

Bleeding/inflammation (two studies). In one study (Lim & Davies 1996) both treatments reduced bleeding levels ($p<0.05$), although this was statistically significantly superior for PMPR ($p<0.05$). In the other study (Tan & Saxton 1978) the effect was not statistically significant for either treatment group. Differences between groups in this study are unclear.

Protection from bias. Randomization, allocation concealment, and blinding were unclear in both studies. Losses to follow-up were greater than 20% in one study (Tan & Saxton 1978).

Summary

PMPR versus OHI in RCTs

- No evidence of a difference between PMPR *versus* no treatment for plaque and bleeding/inflammation.
- Weak evidence: inconsistent effects, risk of bias.
- The time scale was adequate to demonstrate effects.

PMPR OHI status unclear versus no treatment. RCTs (Table 16)

Bleeding/inflammation (two studies). - Neither study (Cheraskin et al. 1968, Sturzenberger et al. 1988) showed an effect of treatment on gingival inflammation. This was not statistically significant either within groups (Cheraskin et al. 1968) or between experimental groups (Sturzenberger et al. 1988).

Protection from bias. Randomization, allocation concealment, and blinding were unclear in both studies.

Table 11. Professional mechanical plaque removal with oral hygiene instruction versus oral hygiene instruction: randomized controlled trials

Authors	Plaque	GI/bleeding	PD (mm)	CAL (mm)	Other
Lim & Davies (1996)	**Presence. Mean % (SD)** **Baseline** No Rx: 49.9 (18.6) Tes – -OH: 52.1 (21.4) Test – Sc: 56.2 (18.2) Test – Sc+OH: 56.2 (20.8) **10 months** Test – OH: 29.7 (15.3) Test – Sc: 34.5 (16.4) Test – Sc+OH: 27.4 (14.6) Differences between groups: Test – OH and Test – Sc: $p<0.05$ Test – Sc and Test – Sc+OH: $p<0.05$ **16 months** No Rx: 40.2 (18.0) Differences within groups from baseline $p<0.05$ except No RX (NS)	**BOP (presence). Mean % (SD)** **Baseline** No Rx: 33.0 (15.4) Test-OH: 33.5 (20.1) Test-Sc: 33.0 (20.6) Test-Sc+OH: 35.4 (21.1) **10 months** Test-OH: 24.6 (17.6) Test-Sc: 17.7 (11.9) Test-Sc+OH: 14.4 (10.8) Differences between groups: test-OH & test-sc:$p<0.05$ test-OH & test-sc+OH: $p<0.05$ **16 months** No Rx: 32.0 (15.2) Differences within groups from baseline-final $p<0.05$ except No Rx (NS)			
Somacarrera et al. (1997)	**PI⁎ % (SD)** **Baseline (6 months)** Overgrowth-OH: 70.53 (7.47) Overgrowth-PMPR: 61.63 (3.23) Non-overgrowth- OH: 50.94 (14.34) Non-overgrowth-PMPR: 55.57 (10.58) **Final (12 months)** Overgrowth- OH: 68.38 (9.36) Overgrowth-PMPR: 37.72 (7.49) Non-overgrowth- OH: 48.64 (17.12) Non-overgrowth-PMPR: 37.15 (9.57)	**GI* % (SD)** **Baseline (6 months)** Overgrowth – OH: 56.46 (11.32) Overgrowth – PMPR: 57.00 (4.58) Non-overgrowth – OH: 39.70 (9.68) Non-overgrowth – PMPR: 49.34 (11.37) **Final (12 months)** Overgrowth- OH: 51.84 (10.99) Overgrowth-PMPR: 29.54 (8.84) Non-overgrowth- OH: 36.17 (12.22) Non-overgrowth-PMPR: 29.92 (10.08)			**Gingival overgrowth (mean height from CEJ mm and SD)** **Baseline (6 months)** Overgrowth – OH: 4.54 (1.20) Overgrowth – PMPR: 4.77 (1.26) **Final (12 months)** Overgrowth- OH: 4.66 (1.20) Overgrowth-PMPR: 4.19 (1.27)
	NB. Summary data are presented, but not statistical analysis. The authors' conclusions were based on between group differences when only within group differences were tested.				
Tan & Saxton (1978)	**PS mean (SE)** **Baseline** No Rx: 2.16 Test – PMPR: 2.30 Test – OH: 2.17 Test – OH+PMPR: 2.34 **3 months** No Rx: 1.94 Test – PMPR: 2.05 Test – OH: 2.25 Test – OH+PMPR: 2.01 Differences within groups at baseline and 3 months: No Rx and Test – OH: NS Test – PMPR: $p<0.05$ Test – PMPR+OH: $p<0.01$ Differences between groups $p<0.05$ but not identified which groups were different.	**BS mean** **Baseline** No Rx: 0.31 Test – PMPR: 0.26 Test – OH: 0.24 Test – OH+PMPR: 0.21 **3 months** No Rx: 0.37 Test-PMPR: 0.30 Test-OH: 0.30 Test-OH+PMPR: 0.30 Differences within groups at baseline and 3 months: No Rx $p=0.05$ (worse) All test groups: NS Differences between groups $p<0.05$ but not identified which groups were different.			

Summary

PMPR oral hygiene status unclear versus no treatment in RCTs

- No evidence of a difference between PMPR OHI status unclear *versus* no treatment for plaque and bleeding/inflammation.
- Weak evidence: nature of intervention unclear, risk of bias.
- The time scale was adequate to demonstrate effects.

PMPR+SRP versus SRP. CCT (Table 17)

Plaque (one study). Statistically significant reductions in plaque were observed both for PMPR ($p<0.001$) and no treatment ($p<0.05$) at ten weeks (Lavanchy et al. 1987). No between groups comparisons were conducted.

Bleeding/inflammation: (one study). No statistically significant reduction in gingival inflammation was observed for either group (Lavanchy et al. 1987).

Table 12. Professional mechanical plaque removal with oral hygiene instruction *versus* oral hygiene instruction: controlled clinical trials

Authors	Plaque	GI/bleeding	PD (mm)	CAL (mm)	Other
Strahan et al. (1977)	**PI mean** **(Study 2 data only)** **Baseline** OHI: 1.49 PMPR+OHI: 1.52 **9 weeks** OHI: 0.32 PMPR+OHI: 0.24 Difference between groups at 9 weeks: $p > 0.05$ **Note: 9 week data selected since further scaling was provided at 9 weeks**	**GI mean** **(Study 2 data only)** **Baseline** OHI: 1.71 PMPR+OHI: 1.77 **9 weeks** OHI: 0.58 PMPR+OHI: 0.22 Difference between groups: at 9 weeks $p > 0.01$ **Note: 9 week data selected since further scaling was provided at 9 weeks**			

PD/AL (one study). Statistically significant reductions in PD (both groups $p < 0.001$) and AL (PMPR+SRP $p < 0.05$, SRP $p < 0.01$) were observed (Lavanchy et al. 1987). No between groups comparisons were conducted.

Protection from bias. The study had no losses to follow-up and examiner blinding status was unclear.

Summary

PMPR+SRP versus SRP in CCT in periodontitis

- No evidence in non-randomized studies of a difference between PMPR+SRP and SRP.
- Weak evidence: risk of bias, lack of between group comparison, short-term follow-up.

PMPR+OHI+SRP versus SRP or SRP+OHI. RCT (Table 18)

Bleeding/inflammation (one study). Gingival inflammation reduced in PMPR+SRP+OHI and SRP+OHI groups (Tabita et al. 1981). This was statistically significantly greater for PMPR+SRP+OHI than SRP ($p < 0.01$) but not *versus* SRP+OHI. SRP+OHI was statistically significantly superior to SRP, $p < 0.01$.

Protection from bias. Randomization, allocation concealment, and blinding were unclear in this study.

Summary

PMPR+SRP+OHI versus SRP+OHI in periodontitis from RCT

- Evidence for superiority of PMPR+SRP over SRP+OHI for reduction in gingival inflammation.
- Superiority over SRP was indicated but needs to be viewed in the context of short duration (14 days) and risk of bias.
- Weak evidence: risk of bias, short duration of follow-up and single study.

PMPR in SPT following periodontitis treatment versus no PMPR or SPT. RCTs (Table 19)

Plaque (two studies). The two studies produced conflicting results. One (Glavind 1977) showed stability during the study, with low plaque levels already present at baseline (having completed periodontal therapy). There were no statistically significant differences between the groups at 11 months. The other study (Nyman et al. 1975) showed a marked difference between study groups at 2 years favouring PMPR, although no statistical analysis was employed. Since baseline values were prior to initial periodontal therapy, no comparison within groups for this study can be made.

Bleeding/inflammation (two studies). The two studies produced conflicting results. One (Glavind 1977) showed stability during the study, with low inflammation levels already at baseline (having completed periodontal therapy). There were no statistically significant differences between the groups at 11 months. The other study (Nyman et al. 1975) showed a marked difference between study groups at 2 years, although no statistical analysis was employed. Since baseline values were prior to initial periodontal therapy, no comparison within groups for this study can be made.

PD (one study). Differences in PDs at 2 years were marked in one study (Nyman et al. 1975) favouring PMPR ($p < 0.01$).

AL (two studies). Similar to plaque and inflammation results above, Glavind (1977) showed stability during the study. There were no statistically significant differences between the groups at 11 months. The other study (Nyman et al. 1975) showed a marked difference between study groups at 2 years, with the PMPR group maintaining stable ALs, but the no treatment group losing attachment ($p < 0.01$).

Protection from bias. Randomization, allocation concealment and blinding were unclear in both studies. Follow-up was complete in both.

PMPR in SPT following periodontitis treatment versus no PMPR or SPT. CCT (Table 20)

Plaque (one study). This study (Axelsson & Lindhe 1981b) showed maintenance of low plaque levels in the PMPR group and an increase in plaque for the no PMPR group. Within group changes were not analysed statistically although the increase in plaque in the control group was marked. PMPR and no PMPR groups were statistically, significantly different from each other at 3 and 6 years ($p < 0.01$)

Bleeding (one study). This study (Axelsson & Lindhe 1981b) showed maintenance of low bleeding levels in the PMPR group and an increase in bleeding for the no PMPR group. Within group changes were not analysed statistically although the increase in bleeding

Table 13. Professional mechanical plaque removal with oral hygiene instruction vs. scaling and root planing with oral hygiene instruction: Randomised controlled trials

Authors	Plaque	GI/bleeding	PD (mm)	CAL (mm)	Other
Kaldahl et al. (1988) (also, Kalkwarf et al. 1989, Kalkwarf et al. 1992, Kaldahl et al. 1996a, b)	**PI** **% within categories (SD)** **Baseline** SRP: PI = 0 36 5 (25.0) PI = 1 35.7 (16.0) PI = 2–3 38.2 (25.0) PMPR : PI = 0 36.9 (13.0) PI = 1 34.8 (9.0) PI = 2–3 41.3 (22.0) Difference between groups P = NS **Two years** SRP: PI = 0 56.1 (29.0) PI = 1 25.2 (9.0) PI = 2–3 28.3 (24.0) PMPR : PI = 0 64.7 (21.0) PI = 1 26.8 (11.0) PI = 2–3 21.3 (14.0) Difference within groups $p<0.05$ Difference between groups $p = NS$	**BOP*** **BOP: presence/absence** **Mean %.** **Initial probing depth 1–4 mm:** **Baseline:** SRP: 70% PMPR: 70% **Two years** SRP: 35% PMPR: 45% Difference between groups $p<0.05$ **Initial probing depth 5–6 mm:** **Baseline:** SRP: 88% PMPR: 88% **Two years** SRP: 52% PMPR: 66% Difference between groups $p<0.05$ **Initial probing depth $\geqslant$7 mm:** **Baseline:** SRP: 91% PMPR: 91% **Two years** SRP: 63% PMPR: 73% Difference between groups $p<0.05$	**Mean change (SE) at 2 years** **Initial probing depth 1–4 mm:** SRP: − 0.23 (0.04) PMPR: − 0.12 (0.04) Differences within groups: SRP: $p<0.05$ PMPR: $p = NS$ Difference between groups $p = NS$ **Initial probing depth 5–6 mm:** SRP: − 1.26 (0.07) PMPR: − 0.66 (0.09) Differences within groups: SRP: $p<0.05$ PMPR: $p<0.05$ Difference between groups $p<0.05$ **Initial probing depth $\geqslant$7 mm:** SRP: − 2.31 (0.15) PMPR: − 1.09 (0.18) Differences within groups: SRP: $p<0.05$ PMPR: $p<0.05$ Difference between groups $p<0.05$	**Mean change (SE) at 2 years** **Initial probing depth 1–4 mm:** SRP: − 0.03 (0.07) PMPR: − 0.07 (0.07) Difference between groups $p = NS$ Differences within groups: SRP: $p = NS$ PMPR: $p = NS$ **Initial probing depth 5–6 mm:** SRP: 0.82 (0.08) PMPR: 0.41 (0.10) Differences within groups: SRP: $p<0.05$ PMPR: $p<0.05$ Difference between groups $p<0.05$ **Initial probing depth $\geqslant$7 mm:** SRP: 1.59 (0.17) PMPR: 0.51 (0.22) Differences within groups: SRP: $p<0.05$ PMPR: $p<0.05$ Difference between groups $p<0.05$	**Number of abscesses:** SRP (7 year follow-up) Initial PD 1–4 mm: 0 Initial PD 5–6 mm: 2 Initial PD $\geqslant$7 mm: 1 PMPR (2 year follow-up) Initial PD 1–4 mm: 3 Initial PD 5–6 mm: 6 Initial PD $\geqslant$7 mm: 14 **Patient preferences at 3 years of maintenance** **Difficulty in cleaning: % responding moderately easy** SRP: 59 PMPR: 58 **Sensitivity to temperature: % with no sensitivity** SRP: 48 PMPR: 41 **General mouth feeling: % absolutely normal** SRP: 24 PMPR: 27 **Frequency of localized symptoms: % never** SRP: 51 PMPR: 59 **Food retention: % nevver** SRP: 9 PMPR: 10 **Willingness to repeat procedure: % agree and prefer to** SRP: 90 PMPR: 90

Table 14. Professional mechanical plaque removal without oral hygiene instruction *versus* no treatment: randomized controlled trials

Authors	Plaque	GI/Bleeding	PD (mm)	CAL (mm)
Katsanoulas et al. (1992)			**Mean (SD)** **Baseline** No Rx: 4.81 (0.67) PMPR: 4.85 (0.69) *3 weeks* No Rx: 4.67 (0.64) PMPR: 4.65 (0.59) Difference within groups at 3 weeks: $p = 1.00$ Difference between groups at 3 weeks: $p = 0.294$	**Mean (SD)** **Baseline** No Rx: 8.23 (2.0) PMPR: 8.60 (2.01) **3 weeks** No Rx: 8.27 (1.99) PMPR: 8.62 (1.99) Difference within groups at 3 weeks: $p = 1.00$ Difference between groups at 3 weeks: $p = 0.505$
Keller et al. (1963)		**GI$^+$ Mean (SD)** **Baseline** No Rx: 0.605 (0.394) PMPR: 0.579 (0.350) Differences between groups $p = 0.5$ 21 days No Rx: 0.618 (0.371) PMPR: 0.386 (0.273) Differences between groups $p < 0.05$ Differences within groups: No RX, $p = 0.5$ PMPR, $p < 0.05$		
Lim & Davies (1996)	**Presence. Mean % (SD)** **Baseline** No Rx: 49.9 (18.6) Test – OH: 52.1 (21.4) Test – Sc: 56.2 (18.2-) Test – Sc+OH: 56.2 (20.8) **10 months** Test – OH: 29.7 (15.3) Test – Sc: 34.5 (16.4) Test – Sc+OH: 27.4 (14.6) Differences between groups: Test – OH and Test – Sc: $p < 0.05$ Test– Sc and Test – Sc+OH: $p < 0.05$ **16 months** No Rx: 40.2 (18.0) Differences within groups from baseline $p < 0.05$ except No RX (NS)	**BOP (presence). Mean % (SD)** **Baseline** No Rx: 33.0 (15.4) Test – OH: 33.5 (20.1) Test – Sc: 33.0 (20.6) Test –. Sc+OH: 35.4 (21.1) **10 months** Test – OH: 24.6 (17.6) Test – Sc: 17.7 (11.9) Test – Sc+OH: 14.4 (10.8) Differences between groups: Test – OH and Test – Sc: $p < 0.05$ Test – OH and Test – Sc+OH: $p < 0.05$ **16 months** No Rx: 32.0 (15.2) Differences within groups from baseline-final $p < 0.05$ except No Rx (NS)		
Tan & Saxton (1978)	**PS mean (SE)** **Baseline** No Rx: 2.16 Test – PMPR: 2.30 Test – OH: 2.17	**BS mean** **Baseline** No Rx: 0.31 Test – PMPR: 0.26 Test – OH: 0.24		

Test – OH+PMPR: 2.34
3 months
No Rx: 1.94
Test – PMPR: 2.05
Test – OH: 2.25
Test – OH+PMPR: 2.01
Differences within groups at baseline and 3 months:
No Rx and Test – OH: NS
Test – PMPR: $p < 0.05$
Test – PMPR+OH: $p < 0.01$
Differences between groups $p < 0.05$ but not identified which groups were different.

Test – OH+PMPR: 0.21
3 months
No Rx: 0.37
Test – PMPR: 0.30
Test – OH: 0.30
Test – OH+PMPR: 0.30
Differences within groups at baseline and 3 months:
No Rx $p = 0.05$ (worse)
All test groups: NS
Differences between groups
$p < 0.05$ but not identified which groups were different.

in the control group was marked. PMPR and no PMPR groups were statistically significantly different from each other at 3 and 6 years ($p < 0.01$).

PD (one study). This study (Axelsson & Lindhe 1981b) showed maintenance of low PD values in the PMPR group and an increase in PD for the no PMPR group. Within group changes were not analysed statistically although the increase in PD in the control group was marked. PMPR and no PMPR groups were statistically significantly different from each other at 3 and 6 years ($p < 0.01$). A marked difference in proportion of sites with shallow PD ($\leqslant 3$ mm) at 3 and 6 years was evident between groups.

AL (one study). This study (Axelsson & Lindhe 1981b) showed maintenance of AL in the PMPR group and a loss in AL for the no PMPR group. Within group changes were not analysed statistically although the loss of attachment in the control group was marked. PMPR and no PMPR groups were statistically significantly different from each other at 3 and 6 years ($p < 0.01$). A marked difference in proportion of sites losing 2–5 mm attachment at 3 and 6years was evident between groups.

Other (one study). The number of teeth present was essentially unchanged in the PMPR group and showed a slight reduction in the no PMPR group (Axelsson & Lindhe 1981b). No analytical statistics were employed to examine the difference.

Protection from bias. It was not clear if the examiner(s) was blind to treatment allocation. Losses to follow-up were modest.

Summary PMPR/SPT versus no SPT following treatment of periodontitis

RCTs:

- Conflicting evidence for superiority of PMPR for SPT. Oral hygiene instructions were only part of the experimental protocol of one study (Nyman et al. 1975). In the other study which did not reinforce plaque control (Glavind 1977), clinical measures indicated stable, healthy periodontal status in both groups.
- The study showing no difference between groups had the larger sample size.
- Weak evidence: risk of bias conflicting results.

CCT:

- Evidence of superiority of PMPR/SPT over no treatment for plaque, bleeding, PD and AL.
- Weak evidence: non-randomized study, risk of bias, consistent findings and single study.
- Follow-up was adequate for probing outcomes but is unlikely to have been adequate to test effect on tooth retention.

Different types of plaque control. Prophy versus air polishing. RCTs (Table 21)

Plaque (two studies). Both studies showed large reductions in plaque immediately following treatment (Weaks et al. 1984, Miller & Hodges 1991). Differences between treatments were not statistically significant.

Bleeding (one study). Immediately following treatment, this study (Weaks et al. 1984) showed no change in bleeding with prophy and an increase in bleeding with air polishing. The difference between groups was statistically significant. Bleeding had returned close to baseline values at 12 days and with no statistically significant difference between treatment groups.

Other

(i) *Bacteraemia incidence* (*one study*). Although the incidence appeared higher in the Prophy group the difference was not statistically significant (Hunter et al. 1989). This may have been related to the small sample size ($n = 20$)

(ii) *Trauma* (*three studies*). One study showed little increase in gingival trauma immediately following treatment from either groups (Miller & Hodges 1991) and with no statistically significant difference between groups. Two other studies (Weaks et al. 1984, Mishkin et al. 1986) found a greater increase in trauma immediately following use

Table 15. Professional mechanical plaque removal without oral hygiene instruction *versus* oral hygiene instruction: randomized controlled trials

Authors	Plaque	GI/bleeding	PD (mm)	CAL (mm)	Other
Lim & Davies (1996)	**Presence. Mean % (SD)** **Baseline** No Rx: 49.9 (18.6) Test-OH: 52.1 (21.4) Test-Sc: 56.2 (18.2) Test-Sc+OH: 56.2 (20.8) **10 months** Test-OH: 29.7 (15.3) Test – Sc: 34.5 (16.4) Test – Sc+OH: 27.4 (14.6) Differences between groups: Test – OH and Test – Sc: $p<0.05$ Test – Sc and Test – Sc+OH: $p<0.05$ **16 months** No Rx: 40.2 (18.0) Differences within groups from baseline-final $p<0.05$ except No Rx (NS)	**BOP (presence). Mean % (SD)** **Baseline** No Rx: 33.0 (15.4) Test – OH: 33.5 (20.1) Test – Sc: 33.0 (20.6) Test – Sc+OH: 35.4 (21.1) **10 months** Test – OH: 24.6 (17.6) Test – Sc: 17.7 (11.9) Test – Sc+OH: 14.4 (10.8) Differences between groups: Test – OH and Test – Sc: $p<0.05$ Test – OH and Test – Sc+OH: $p<0.05$ **16 months** No Rx: 32.0 (15.2) Differences within groups from baseline-final $p<0.05$ except No Rx (NS)			
Tan & Saxton (1978)	**PS mean (SE)** **Baseline** No Rx: 2.16 Test-PMPR: 2.30 Test – OH: 2.17 Test – OH+PMPR: 2.34 **3 months** No Rx: 1.94 Test – PMPR: 2.05 Test – OH: 2.25 Test – OH+PMPR: 2.01 Differences within groups at baseline and 3 months: No Rx and Test – OH: NS Test – PMPR: $p<0.05$ Test – PMPR+OH: $p<0.01$ Differences between groups $p<0.05$ but not identified which groups were different	**BS Mean** **Baseline** No Rx: 0.31 Test-PMPR: 0.26 Test-OH: 0.24 Test-OH+PMPR: 0.21 **3 months** No Rx: 0.37 Test-PMPR: 0.30 Test-OH: 0.30 Test-OH+PMPR: 0.30 Differences within groups at baseline and 3 months: No Rx P = 0.05 (worse) All test groups: NS Differences between groups $p<0.05$ but not identified which groups were different			

Table 16. Professional mechanical plaque removal oral hygiene instruction status unclear *versus* no treatment: randomized controlled trials

Authors	Plaque	GI/bleeding	PD (mm)	CAL (mm)	Other
Cheraskin et al. (1968)		**GI#** **Baseline:** No Rx: 1.2 PMPR: 1.1 **Two weeks** No Rx: 1.0 PMPR: 1.8 Difference within groups $p>0.2$			
Sturzenberger et al. (1988)		**PMGI mean** **Baseline (measured from graph)** No Rx: 0.35 PMPR: 0.36 **10 days (measured from graph)** No Rx: 0.36 PMPR: 0.31 Difference between groups p = NS			

Table 17. Mechanical professional plaque removal+SRP *versus* SRP: controlled clinical trials

Authors	Plaque	GI/bleeding	PD (mm)	CAL (mm)	Other
Lavanchy et al. (1987)	**PI mean (SD)** **Baseline** SRP: 2.0 (0.4) PMPR+SRP: 1.9 (0.5) **10 weeks** SRP: 1.5 (0.3) PMPR+SRP 0.4 (0.4) Difference within groups at 10 weeks: $p<0.05$ SRP; $p<0.001$ PMPR+SRP	**GI mean (SD)** **Baseline** SRP: 1.7 (0.5) PMPR+SRP 1.6 (0.5) **10 weeks** SRP: 1.4 (0.3) PMPR+SRP 1.1 (0.4) Difference within groups at 10 weeks: NS SRP; NS PMPR+SRP	**Mean (SD)** **Baseline** SRP: 7.1 (0.8) PMPR+SRP 6.9 (0.6) **10 weeks** SRP: 4.4 (0.8) PMPR+SRP 4.6 (0.2) Difference within groups at 10 weeks: $p<0.001$ SRP; $p<0.001$ PMPR+SRP	**Mean (SD)** **Baseline** SRP: 9.1 (1.1) PMPR+SRP 9.1 (0.6) **10 weeks** SRP: 6.6 (1.3) PMPR+SRP: 7.3 (0.5) Difference within groups at 10 weeks: $p<0.01$ SRP; $p<0.05$ PMPR+SRP	

Table 18. Mechanical professional plaque removal+OHI+SRP *versus* SRP or SRP+OHI: randomized controlled trial

Authors	Plaque	GI/bleeding	PD (mm)	CAL (mm)	Other
Tabita et al. (1981)	N/R (plaque weight recorded)	**GI** **Mean change (SD)** SRP+OHI: -0.99 (0.97) SRP: 0.09 (0.62) SRP+PMPR: -1.33 (0.57) SRP+PMPR *versus* SRP+OHI: $p>0.05$, SRP+PMPR *versus* SRP: $p<0.01$, SRP+OHI *versus* SRP: $p<0.01$			

Table 19. Professional mechanical plaque removal during supportive periodontal therapy *versus* no treatment: randomized controlled trials

Authors	Plaque	GI/Bleeding	PD (mm)	CAL (mm)	Other
Glavind (1977)	**PI. Mean (SE)** **Baseline** No Rx: 0.42 (0.04) PMPR: 0.46 (0.05) **11 months** No Rx: 0.43 (0.08) Test-OH: 0.42 (0.07) Differences between groups at baseline and 11 months ''NS''	**GI. Mean (SE)** **Baseline** No Rx: 0.34 (0.05) PMPR: 0.31 (0.04) *11 months* No Rx: 0.34 (0.05) PMPR: 0.32 (0.04) Differences between groups at baseline and 11 months ''NS''		**Mean (SE)** **Baseline** No Rx: 2.3 mm (0.21) PMPR: 2.6 mm (0.21) **11 month*s*** No Rx: 2.3 mm (0.21) PMPR: 2.5 mm (0.21) Differences between groups at baseline and 11 months ''NS''	
Nyman et al. (1975)	**PI. Mean (SE)** **Baseline** No Rx: 1.3 (0.16) PMPR: 1.4 (0.10) **24 months** No Rx: 1.5 (0.14) PMPR: 0.1 (0.04) **Note: baseline is pre-non-surgical and surgical therapy**	**GI. Mean (SE)** **Baseline** No Rx: 1.6 (0.12) PMPR: 1.5 (0.16) **24 months** No Rx: 1.7 (0.10) PMPR: 0.1 (0.04) **Note: baseline is pre-non-surgical and surgical therapy**	**Mean (SE)** **Baseline** No Rx: 4.7 mm (0.22) PMPR: 4.3 mm (0.40) **24 months** No Rx: 4.0 mm (0.27) PMPR: 2.5 mm (0.05) Difference between groups at 24 months $p<0.01$ **Note: baseline is pre-non-surgical and surgical therapy**	**Mean change (SE)** **Baseline-24 months** No Rx: -2.2 mm (0.39) PMPR: 0.1 mm (0.25) Difference between groups $p<0.01$ **Note: baseline is pre-non-surgical and surgical therapy**	

of air polishing ($p<0.01$) although these values returned towards baseline levels at 12 days (Weaks et al. 1984) and were no longer statistically significantly different from prophy.

(iii) *Stain removal* (*one study*). This study (Miller & Hodges 1991) found no significant difference in stain removal between treatment groups immediately after completion.

Protection from bias. Randomization and allocation concealment were unclear in all studies. Follow-up was complete in all studies and examiner blinding was adequate in three studies (Weaks et al. 1984, Mishkin et al. 1986, Miller & Hodges 1991).

Summary

Prophy cup versus air polishing. RCTs

- No evidence of a difference between treatments for plaque reduction and

Table 20. Professional mechanical plaque removal during supportive periodontal therapy *versus* no treatment: controlled clinical trial

Authors	Plaque	GI/bleeding	PD (mm)	CAL (mm)	Other
Axelsson & Lindhe (1981b)	**Full-mouth plaque score % (SD)** **Baseline** No Rx: 20 (6.8) PMPR: 21 (14.6) **3 years** No Rx: 56 (16.7) PMPR: 18 (16.6) **6 years** No Rx: 66 (14.4) PMPR: 16 (10.7) Differences between groups at 3 and 6 years $p<0.001$	**Full-mouth bleeding score % (SD)** **Baseline** No Rx: 4 (2.7) PMPR: 7 (4.8) *6 years* No Rx: 37 (17.7) PMPR: 2 (3.7) **6 years** No Rx: 55 (23.0) PMPR: 2 (4.0) Differences between groups at 3 and 6 years $p<0.001$	**Mean (SD)** **Baseline** No Rx: 1.8 (0.20) PMPR: 1.9 (0.32) **3 years** No Rx: 2.9 (0.51) PMPR: 1.6 (0.35) **6 years** No Rx: 2.6 (0.38) PMPR: 1.5 (0.35) Differences between groups at 3 and 6 years $p<0.001$ **% sites probing depth $\leqslant$3 mm (SD)** **Baseline** No Rx: 99 (N/R) PMPR: 99 (N/R) **6 years** No Rx: 80 (13.3) PMPR: 99 (N/R)	**Mean (SD)** **Baseline** No Rx: 3.7 (1.11) PMPR: 4.2 (0.90) **3 years** No Rx: 5.0 (0.86) PMPR: 4.1 (0.88) **6 years** No Rx: 5.5 (1.13) PMPR: 4.0 (0.93) Differences between groups at 3 and 6 years $p<0.001$ **% sites losing 2–5 mm attachment (SD)** **6 years** No Rx: 55 (14.7) PMPR: 1.0 (N/R)	**Number of teeth present, mean (SD)** **Baseline** No Rx: 18.0 (5.05) PMPR: 19.6 (7.02) **6 years** No Rx: 17.3 (5.48) PMPR: 19.4 (7.02)

stain removal immediately post-treatment. Moderate evidence: consistency of findings, risk of bias.

- Bleeding and trauma may be greater immediately following the use of the air polisher, although these values returned to baseline within a few days. Moderate evidence, risk of bias, single study.
- No statistical differences were found between treatments in a small study investigating the incidence of bacteraemia. Weak evidence: small sample size, single study.
- Risk of bias – randomization, allocation concealment.
- Small sample size and likely low study power in some studies.

Different types of plaque control. Scaling versus scaling+prophy. RCT

Bleeding, PD and AL (one study). Both groups in this study (Walsh et al. 1985a, b) showed a statistically significant improvement in these probing parameters ($p<0.01$). This was statistically significantly greater for scaling+prophy than scaling alone at six weeks ($p<0.05$).

Other (one study). Patient responses/preferences:

- Differences favouring scaling+prophy were: teeth felt rougher (i.e. less rough with scaling+prophy), teeth looked cleaner, teeth felt better, teeth looked better and gums felt better ($p<0.01$).
- Eighty-three per cent of subjects expected polishing of teeth.
- Fifty-three per cent of subjects would feel dissatisfied/cheated if not polished.
- One hundred per cent of subjects reported polished side felt better than unpolished side.

Protection from bias. Randomization, allocation concealment and blinding were unclear in this study. Follow-up was complete.

Summary

Scaling and scaling+prophy cup. RCT

- Evidence favouring scaling+prophy for clinical outcomes and patient preferences.
- Moderate evidence: risk of bias, consistent findings, single study.
- The patient preferences of this sample from a USA population are particularly notable
- Clearer indication regarding protection from bias would strengthen conclusions especially examiner blinding for probing measures and care-giver blinding for patient preferences
- The split-mouth design might have reduced such concerns.
- Risk of bias – randomization, allocation concealment and blinding.

Different types of plaque control. Ultrasonic scaling+prophy versus ultrasonic scaling+prophy+floss versus curettes+prophy. RCT

Plaque (one study). All three treatments produced large reductions in plaque immediately post-treatment (Checchi et al. 1997). Ultrasonic scaling+prophy was statistically significantly less effective than ultrasonic scaling+prophy+floss or curettes+prophy ($p<0.05$). There was no statistically significant difference between ultrasonic scaling+prophy+floss or curettes+prophy

Protection from bias. Randomization, allocation concealment and blinding were unclear in this study.

Summary

Three methods of PMPR. RCTs

- Evidence from a single study suggesting that ultrasonic scaling+prophy+floss or curettes+prophy are more effective in plaque removal as assessed immediately following treatment than ultrasonic scaling+prophy.
- Weak evidence: risk of bias, consistent findings, single study.
- Unclear randomization, allocation concealment and blinding.

Table 21. Different types of mechanical professional plaque removal: randomized controlled trials

Author	Plaque	GI/bleeding	PD (mm)	AL (mm)	Other
Checchi et al. (1997)	**PI*** **Mean %** **Baseline** US/prophy: 100 US/prophy/floss: 100 GR//prophy: 100 *Immediate post-RX* US/prophy: 55.8 US/prophy/floss: 22.8 GR//prophy: 21.6 Difference between US/Prophy and either US/prophy/floss or GR//prophy, $p < 0.05$. Difference between US/prophy/floss and GR//prophy p = NS.	N/R	N/R	N/R	
Hunter et al. (1989)					Bacteraemia incidence Prophy: 7/20 Air polish: 3/20 Difference between groups NS
Miller & Hodges (1991)	**PI#: mean (SD)** **Baseline** Prophy: 10.8 (6.3) Air polish: 9.9 (5.5)) **Immediate post-RX** Prophy: 3.5 (3.0) Air polish: 2.4 (1.9) Differences between groups $p = 0.369$				**SI: mean (SD)** **Baseline** Prophy: 12.9 (6.6) Air polish: 12.8 (5.5) **Immediate post-RX** Prophy: 6.8 (4.4) Air polish: 7.5 (4.3) Differences between groups $p = 0.741$ **TI: mean (SD)** **Baseline** Prophy: 0.3 (0.8) Air polish: 0.2 (1.1) **Immediate post-RX** Prophy: 0.5 (1.0) Air polish: 1.2 (2.6) Differences between groups $p = 0.275$
Mishkin et al. (1986)					**Trauma index (TI).** % quadrants with TI 1 or 2 **Baseline** Prophy: 12 Air polish: 13 **Immediate post-treatment** Prophy: 36

Table 21. (Contd.)

Author	Plaque	GI/bleeding	PD (mm)	AL (mm)	Other
					Air polish: 56 **3 weeks** Prophy: 3 Air polish: 3 Differences between groups immediate post-treatment $p < 0.001$ Differences between groups at 3 weeks $p = 0.750$
Walsh et al. (1985a, b)		**BT: mean** **Baseline** Sc: 1.64 Sc+prophy: 1.65 **Mean change (SD) at 6 weeks** Sc: 0.12 (0.202) Sc+prophy: 0.19 (0.227) Differences within groups: $p < 0.01$ Differences between groups $p < 0.05$	**Mean** **Baseline** Sc: 2.63 Sc+prophy: 2.60 **Mean change (SD) at 6 weeks** Sc: 0.12 (0.215) Sc+prophy: 0.08 (0.177) Differences within groups: $p < 0.01$ Differences between groups $p < 0.05$	**Mean** **Baseline** Sc: 2.63 Sc+prophy: 2.60 **Mean change (SD) at 6 weeks** Sc: 0.12 (0.215) Sc+prophy: 0.08 (0.177) Differences within groups: $p < 0.01$ Differences between groups $p < 0.05$	**Patient responses at 6 weeks** **% subjects feeling:** ***Teeth felt cleaner*** Sc: 3 Sc+prophy: 47 **Teeth felt rougher** Sc: 43* Sc+prophy: 71 **Teeth looked cleaner** Sc: 0* Sc+prophy: 37 **Gums felt more sensitive** Sc: 13 Sc+prophy: 10 **Gums felt rougher** Sc: 10 Sc+prophy: 0 **Teeth felt better** Sc: 0* Sc+prophy: 57 **Teeth looked better** Sc: 3* Sc+Prophy: 47 **Gums felt better** Sc: 0* Sc+prophy: 17 **Gums looked better** Sc: 0 Sc+prophy: 10 **Teeth more sensitive** Sc: 13 Sc+prophy: 17 *Differences between groups $p < 0.01$ 83% of subjects expected polishing of teeth

			53% of subjects would feel ''dissatisfied or cheated'' if their dental cleaning did not include polishing 100% subjects identified the polished side as feeling better than the unpolished side
Weaks et al. (1984)	**PI* Study 1** **Mean % (SD)** **Baseline** Prophy: 48.5 (30.3) Air polish: 44.7 (25.5) **Immediate post-treatment** Prophy: $\sim$ 0 (N/R) Air polish: $\sim$ 0 (N/R) **OHI:S, Study 1** **Mean (SD)** **Baseline** Prophy: 1.8 (0.8) Air polish: 1.8 (0.8) **Immediate post-treatment** Prophy: $\sim$ 0 (N/R) Air polish: $\sim$ 0 (N/R)	**Presence of bleeding, Study 2** **Mean % (SD)** **Baseline** Prophy: 8.8 (6.0) Air polish: 8.9 (6.4) **Immediate post-treatment** Prophy: 8.8 (6.0) Air polish: 23.0 (11.0) Between group difference $p<0.01$ **12 days** Prophy: 9.2 (7.1) Air polish: 10.1 (7.2) Between group difference $p=$ NS	**Presence of redness, Study 2** **Mean % (SD)** **Baseline** Prophy: 3.7 (2.9) Air polish: 4.2 (3.8) **Immediate post-treatment** Prophy: 5.1 (5.0) Air polish: 13.4 (6.0) Between group difference $p<0.01$ **12 days** Prophy: 3.4 (2.3) Air polish: 4.7 (5.3) Between group difference $p=$ NS **Trauma index (TI). Study 2** **Mean (SD)** **Baseline** Prophy: 0.21 (0.13) Air polish: 0.22 (0.15) **Immediate post-treatment** Prophy: 0.23 (0.16) Air polish: 0.75 (0.37) Between group difference $p<0.01$ Within group differences: Prophy: $p=$ NS Air polish: $p<0.01$ **12 days** Prophy: 0.22 (0.16) Air polish: 0.24 (0.18) Between group difference $p=$ NS

Table 22. Different frequencies of mechanical professional plaque removal: randomized controlled trials

Authors	Plaque	GI/bleeding	PD (mm)	CAL (mm)	Other
Lightner et al. (1971)	**PI¶: Mean** **Baseline** 1 × yearly: 2.27 1 × yearly+OH: 2.28 2 × yearly+OH: 2.30 4 × yearly+OH: 2.31 4 × yearly: 2.34 **46 months** 1 × yearly: 1.93 1 × yearly+OH: 1.53 2 × yearly+OH 1.47 4 × yearly:+OH 1.48 4 × yearly: 1.75 SD: between group comparisons = 0.412 SD: within group comparisons = 0.315 **Mean change** 1 × yearly: −0.336 1 × yearly+OH: −0.749 2 × yearly+OH −0.828 4 × yearly+OH: −0.831 4 × yearly: −0.597 Differences between groups **1 × yearly and 4 × yearly statistically significantly less change than test groups with OH ($p < 0.05$)**	**GI¥: Mean** **Baseline** 1 × yearly: 1.89 1 × yearly+OH: 1.88 2 × yearly+OH: 1.87 4 × yearly OH: 1.88 4 × yearly+: 1.82 **46 months** 1 × yearly: 1.55 1 × yearly+OH: 1.40 2 × yearly+OH 1.34 4 × yearly+OH: 1.25 4 × yearly: 1.34 SD: between group comparisons = 0.314 SD: within group comparisons = 0.254 **Mean change** 1 × yearly: −0.338 1 × yearly+OH: −0.481 2 × yearly+OH −0.530 4 × yearly+OH: −0.627 4 × yearly: −0.478 Differences between groups **1 × yearly+OH & 4 × yearly statistically significantly less change than 4 × yearly+OH & 2 × yearly+OH ($p < 0.05$)** **1 × yearly statistically significantly less change than all other groups $p < 0.05$**	**N/R**	**Mean loss** **46 months** 1 × yearly: 1.23 1 × yearly+OH: 0.94 2 × yearly+OH 0.83 4 × yearly+OH: 0.58 4 × yearly: 0.78 No data on statistical significance.	**PeI: mean** Baseline 1 × yearly: 0.19 1 × yearly+OH: 0.20 2 × yearly+OH: 0.23 4 × yearly+OH: 0.21 4 × yearly: 0.19 **46 months** 1 × yearly: 0.22 1 × yearly+OH: 0.20 2 × yearly+OH 0.22 4 × yearly+OH: 0.23 4 × yearly: 0.23 SD: between group comparisons = 0.261 SD: within group comparisons = 0.149 Differences between groups NS Differences within groups NS
Listgarten et al. (1985)	**PI#, Mean** **Baseline** 6/12 PMPR: 0.59 Variable PMPR: 0.40 **3 years** 6/12 PMPR: 0.75 Variable PMPR: 0.65 Differences within groups: $p < 0.01$ Differences between groups NS	**GI¶, Mean** **Baseline** 6/12 PMPR: 0.28 Variable PMPR: 0.25 **3 years** 6/12 PMPR: 0.75 Variable PMPR: 0.70 Differences within groups: $p < 0.01$ Differences between groups NS	**Mean** **Baseline** 6/12 PMPR: 1.8 Variable PMPR: 1.75 **3 years** 6/12 PMPR: 1.76 Variable PMPR: 1.70 Differences between groups NS		

Listgarten et al. (1989)	**PI, mean (SE)** **4 years** 3/12 PMPR:0.50 (0.03) Variable PMPR: 0.48 (0.03) Differences within groups $p<0.05$ (increase) Differences between groups NS	**GI, mean (SE)** **4 years** 3/12 PMPR: 0.61 (0.03) Variable PMPR: 0.62 (0.03) Differences within groups $p<0.05$ (increase) Differences between groups NS	**Mean (SE)** **4 years** 3/12 PMPR: 2.40 (0.04) Variable PMPR: 2.36 (0.05) Differences within groups $p<0.05$ (increase) Differences between groups NS	**Mean (SE)** **4 years** 3/12 PMPR: 3.19 (0.13) Variable PMPR: 2.90 (0.14) Differences within groups $p<0.05$ (increase) Differences between groups NS
Westfelt et al. (1983)	**PI % within categories** **6 months** 12 week recall interval: PI = 0 56% PI = 1 28% PI = 2,3 16% 4 week recall interval: PI = 0 67% PI = 1 24% PI = 2,3 9% 2 week recall interval: PI = 0 78% PI = 1 15% PI = 2,3 7%	**GI % within categories** **6 months** 12-week recall interval: GI = 0 43% GI = 1 42% GI = 2,3 15% 4-week recall interval: GI = 0 56% GI = 1 40% GI = 2,3 4% 2-week recall interval: GI = 0 65% GI = 1 32% GI = 2,3 3%	**% within categories** **6 months** 12-week recall interval: PD <4 mm 70% PD4-6 mm 25% PDI >6 mm 5% 4 week recall interval: PD <4mm 81% PD 4-6 mm 18% PDI >6 mm 1% 2 week recall interval: PD <4 mm 85% PD4-6 mm 15% PDI >6 mm 0%	**Mean (SD)** **6 months (change from baseline)** 12-week recall interval: − 0.58 (1.8) 4-week recall interval: − 0.39 (1.5) 2-week recall interval: − 0.03 (1.5)

Different frequencies of mechanical professional plaque removal. Fixed frequencies. RCTs (Table 22)

Plaque (two studies). Within group comparisons were only presented in one study (Lightner et al. 1971), showing decreased values after 46 months in all groups. These results were not analysed statistically. Increased frequency of PMPR appears to be associated generally with a reduction in plaque levels whether comparing 3 monthly, 6 monthly or yearly, PMPR after 46 months in one study (Lightner et al. 1971), or every 2 weeks, 4 weeks or 12 weeks after 6 months in the other (Westfelt et al. 1983). However, increased frequency of PMPR was statistically more effective if OHI was provided; indeed, three monthly PMPR without OHI produced statistically significantly less plaque reduction than once yearly PMPR with OHI ($p<0.05$).

Bleeding (two studies). Similar comments can be made as for plaque. However, with regard to Lightner et al. 1971, PMPR alone had a greater effect on reduction of inflammation.

PD (one study). Only data comparing groups is available (Westfelt et al. 1983). While no statistical analysis is available, an increasing frequency of PMPR was associated with an increased frequency of shallow pockets.

AL (two studies). Neither study (Lightner et al. 1971, Westfelt et al. 1983) provided statistical analysis of their data. However, increasing PMPR frequency appeared to be associated with increasing attachment loss.

Protection from bias. Randomization and allocation concealment were unclear in both studies. Examiner blinding and accounting for losses was reported in one study (Lightner et al. 1971) and unclear in the other (Westfelt et al. 1983)

Different frequencies of mechanical professional plaque removal. Fixed frequencies. CCT (Table 23)

Plaque/inflammation (one study). All groups (once yearly, twice yearly and three times yearly) improved plaque and inflammation levels (Suomi et al. 1973b). No analytical statistics were

Table 23. Different frequencies of mechanical professional plaque removal: Controlled clinical trials

Authors	Plaque	GI/bleeding	PD (mm)	CAL (mm)
Suomi et al. (1973b)	**DI: mean change (SE) 0–3 years**	**GIØ: mean (SE)**	**Mean (SE)**	**Mean (SE)**
	1 × year: 0.80 (0.03)	**Baseline**	**Baseline**	**Baseline**
	2 × year: 0.75 (0.03)	1 × year: 0.13 (0.02)	1 × year: 1.87 (0.02)	1 × year: 0.03 (0.01)
	3 × year: 0.69 (0.02)	2 × year: 0.14 (0.02)	2 × year: 1.90 (0.02)	2 × year: 0.03 (0.01)
	CI: mean change (SE) 0–3 years	3 × year: 0.12 (0.01)	3 × year: 1.90 (0.02)	3 × year: 0.04 (0.01)
	1 × year: 0.28 (0.03)	**3 years**	**3 years**	**3 years**
	2 × year: 0.20 (0.02)	1 × year: 0.37 (0.03)	1 × year: 1.76 (0.02)	1 × year: 0.10 (0.01)
	3 × year: 0.19 (0.02)	2 × year: 0.35 (0.02)	2 × year: 1.76 (0.01)	2 × year: 0.08 (0.01)
		3 × year: 0.32 (0.02)	3 × year: 1.78 (0.02)	3 × year: 0.09 (0.01)

presented, and, therefore, while there appears to be greater improvement comparing yearly *versus* three times yearly, the validity of this observation is unclear.

PD/AL (one study). Little change was evident in either probing parameter, either within groups or between groups (Suomi et al. 1973b). Again no statistical analysis was offered.

Protection from bias. Adequate blinding and the disease status of the participants (gingivitis/periodontitis) are unclear.

Different frequencies of mechanical professional plaque removal. Variable frequency. RCTs

Plaque (two studies). Plaque levels were statistically significantly increased in both treatment groups and in both studies during follow-up (Listgarten et al. 1985, 3 years, $p < 0.01$, Listgarten et al. 1989, 4 years $p < 0.05$). Differences between groups were not statistically significant. The fixed PMPR interval was six monthly in one study (Listgarten et al. 1985) and three monthly in the other (Listgarten et al. 1989). The variable frequency was determined by the composition of the microflora, assessed by microscopy.

Bleeding (two studies). Similar comments can be made as for plaque.

PD (two studies). One study on a gingivitis sample suggested no statistically significant change in PD during the study (Listgarten et al. 1985). The other study, conducted on periodontitis patients, indicated a statistically significant increase in PD after 4 years (Listgarten et al. 1989). In neither study was there a statistically significant difference between the treatment groups.

AL (one study). This study demonstrated a statistically significant loss of attachment in both groups ($p < 0.05$), although there was no difference between groups with regard to this effect.

Protection from bias. Randomization, allocation concealment and blinding were unclear in both studies.

Summary: Different PMPR frequencies

RCTs:

- Evidence for increasing frequency of PMPR producing improved clinical outcomes particularly if combined with OHI.
- Moderate evidence: risk of bias, consistency of findings, lack of statistical analysis of some outcomes, and consistency across the outcomes of studies.
- The lack of statistical analysis of some outcomes limits conclusions, and randomization and allocation concealment were unclear. Examiner blinding was present in one study (Lightner et al. 1971). One study was conducted on treated periodontitis patients (Westfelt et al. 1983), and the type of patient was unclear in the other study (Lightner et al. 1971).

CCT:

- Evidence for increasing frequency of PMPR producing improved clinical outcomes.
- Weak evidence: non-randomized study, lack of statistical analysis, examiner blind, losses to follow-up

Summary

Variable versus fixed frequency of PMPR from RCTs

- No evidence of a difference between two methods of scheduling PMPR frequency.
- Weak evidence, risk of bias, losses to follow-up, neither protocol effective at maintaining periodontal health, consistency of results across the outcomes of the studies despite two different types of patient groups, i.e. gingivitis only and treated periodontitis only.
- The authors of one study (Listgarten et al. 1985) commented that losses were greater in the variable frequency group due to patient's perception that their periodontal health was being neglected.

Discussion

Summary of main results

As reported more fully in the results section (Table 5), a substantial difficulty in this investigation has been the variety of procedures, which might be termed PMPR. It might be tempting to dichotomize studies into those employing supragingival plaque removal only or studies that conducted both supra- and subgingival plaque removal. However, both the lack of complete reporting of procedural detail and the variability in procedures even within this grouping means that such a dichotomy would be misleading. A further challenge to the synthesis of these results was the variability in the disease type of the samples (gingivitis and or periodontitis) or the lack of this description in the reports.

There is some evidence that PMPR+OHI provides more favourable clinical outcomes than no treatment. A

reduction in plaque and bleeding or inflammation was common to both RCTs and CCTs, however, evidence for improvements in PD and maintenance or gain in AL was only found in CCTs. Overall, the evidence is weak in strength due to methodological issues and inconsistencies in outcomes. The evidence for a benefit from PMPR+OHI over that achieved by OHI alone is even less clear. In RCTs, PMPR+OHI appeared superior to OHI alone for measures of plaque and bleeding. However, the lack of an appropriate statistical analysis, inconsistent effects and risk of bias makes this comparison difficult to evaluate (Tan & Saxton 1978, Lim & Davies 1996, Somacarrera et al. 1997). In a CCT, no evidence of a difference was found between these interventions (Strahan et al. 1977). Improvements resulting from OHI alone may have been responsible for nullifying the differences between groups. Comparing PMPR+OHI with SRP+OHI in the non-surgical management of chronic periodontitis, SRP+OHI produced greater clinical improvements than PMPR+OHI (Kaldahl et al. 1988, Kalkwarf et al. 1989, Kaldahl et al. 1996a). Regarding systemic health effects, PMPR+OHI appeared to reduce the incidence of fever, death and aspiration pneumonia in a Japanese long-term care facility (Adachi et al. 2002). However, with losses to follow-up of more than 50%, the validity of these observations is unclear and the results may have been confounded by the general health status of the subjects.

PMPR alone (without OHI) had some evidence of a benefit over no treatment in terms of plaque and inflammation, but no evidence of a difference compared with OHI alone. This was also the case with PMPR when the status of OHI was unclear. In each of these comparisons, the strength of the evidence was judged to be weak, mainly due to inconsistent effects and risk of bias.

The effect of PMPR in the management of periodontitis was investigated in several comparisons. When comparing PMPR+SRP with SRP alone in a non-randomized study, and in the absence of oral hygiene instruction, no evidence of a difference between interventions was seen (Lavanchy et al. 1987). The follow-up was 10 weeks making conclusions regarding probing changes difficult to interpret. Another short-term study (2 weeks) indicated a greater reduction in gingival inflammation resulting from SRP+PMPR+OHI (Tabita et al. 1981) than SRP, but no evidence of a difference between PMPR+SRP+OHI and SRP+OHI, suggesting that OHI may have a stronger effect than PMPR alone in controlling gingival inflammation. The added value of PMPR in SPT for periodontitis is unclear since the two studies investigating the comparison of PMPR *versus* no treatment as RCTs produced conflicting findings. One study, which emphasized OHI, demonstrated a substantial difference favouring repeated PMPR (Nyman et al. 1975) while the other study, which did not provide further OHI, showed no evidence of a difference (Glavind 1977). However, in the latter, the lack of a difference appeared to be due to the no PMPR group maintaining low plaque and inflammation values. The subjects in both studies had received OHI as part of their initial periodontal therapy and follow-up appeared to be adequate to detect changes in outcomes. When this comparison was examined in a CCT, PMPR offered an advantage over no PMPR for all clinical outcomes during the supportive phase of therapy (Axelsson & Lindhe 1981b). The difference in tooth loss was small and not tested for statistical significance. The strength of evidence in all these studies was considered weak for a number of reasons, including risk of bias, non-randomized study design, conflicting outcomes and short-term follow-up.

Regarding the effect of different methods of PMPR, clinical efficacy appeared similar comparing prophy cup and air polishing. Bleeding and trauma were greater for air polishing immediately post-treatment, but differences with prophy cup were not evident after a few days. There was no evidence of a difference between these interventions for the incidence of bacteraemia (Hunter et al. 1989). It should be noted that bacteraemia did occur with both treatments, and the sample size may have been too small to detect a statistically significant difference between them. Low study power and risk of bias limits the strength of these conclusions.

Comparing scaling+prophy cup with scaling alone, there was evidence favouring the combined approach both for clinical outcomes and patient preferences. Indeed, the patient preference for prophy cup polishing of teeth following scaling was striking in this sample from a USA population (Walsh et al. 1985a, b). The evidence for these findings was graded as moderate in view of the consistency of findings, risk of bias and derivation from a single study. One further study indicated that plaque removal for ultrasonic scaling and prophy cup polishing was more effective if combined with professionally applied flossing than without and was no different from that achieved by Gracey curettes and polishing (Checchi et al. 1997). This was considered weak evidence due to risk of bias and being a small, single study.

The question of the effectiveness of different PMPR frequencies has been addressed by comparison with a variety of fixed frequencies and by a comparison of fixed with a variable frequency (determined by bacterial composition and microscopy). These studies did not however set out to determine which was the optimum PMPR frequency. In addition, the disease characteristics of the subjects (gingivitis, periodontitis) were not always clear. Overall, the evidence suggested that increased frequency was associated with better clinical outcomes. These conclusions were weakened by factors including, unclear disease status, risk of bias, non-randomized designs and lack of appropriate statistical analysis of some outcomes. Comparing fixed *versus* variable PMPR frequency, there was no evidence of a difference in clinical outcomes whether the comparison was to 6 monthly PMPR in non-periodontitis subjects (Listgarten et al. 1985) or 3 monthly PMPR in periodontitis patients (Listgarten et al. 1989). It should be noted that clinical outcomes in both groups of patients deteriorated during maintenance, questioning the effectiveness of either modality. The strength of the evidence was considered to be weak due to risk of bias, differential losses to follow-up and deteriorating clinical outcomes, but with a consistency of findings.

Overall completeness and applicability of evidence

The major comparisons that are needed to provide evidence for the effect of PMPR on primary and secondary prevention of periodontal diseases are randomized designs that compare PMPR with no PMPR or with OHI. These studies should be conducted in the setting that they are likely to be delivered in, i.e. primary care and in diverse populations and cultures. Other study

characteristics that should be considered essential are multi-year duration of follow-up, since periodontal diseases are typically slowly progressing, and large sample sizes (in the hundreds to thousands) to allow for the expected heterogeneity in response to prevention and to investigate determinants of favourable outcomes. Whether OHI should be an integral part of PMPR is contentious. The link between supragingival plaque control and the development of gingivitis is very clear (Loe et al. 1963). However, the evidence for self-performed plaque control and prevention of periodontal diseases is much less clear (Hujoel et al. 2005). Since resource implications are different for PMPR and OHI, this would argue for separate evaluation of effect.

In the context of what evidence would be ideal, the completeness of current evidence can therefore be seen to be limited. Only 12 studies provided data for more than 12 months of follow-up with the longest duration (with the comparison group intact) of 6 years (Suomi et al. 1971a, b, 1973a, Axelsson & Lindhe 1981b, 1978, 1981a). Of these three studies, two provided data for primary/secondary prevention (Suomi et al. 1971a, b, 1973a, Axelsson & Lindhe 1978, 1981b) and one for secondary/tertiary prevention (Axelsson & Lindhe 1981a). A further challenge to wider applicability of the data is the setting for studies since most were conducted in hospital/academic settings, which may not represent the effect of an intervention in primary care. In one large study (Axelsson & Lindhe 1978, 1981b) recruitment was limited to those individuals who had sought or received treatment annually in the previous 5 years. To what extent these individuals are representative of the wider population is unclear. The majority of studies likely represent populations with higher socioeconomic characteristics. Some diversity of populations was found including long-term care residents in Switzerland (Mojon et al. 1998) and Japan (Adachi et al. 2002), Indian factory workers (Chawla et al. 1975) and Indonesian soldiers with no experience of industrialized-style oral hygiene (Gaare et al. 1990).

There are two major aspects that have not been considered in this review. One aspect is the effect of PMPR in children, and the second aspect is economic implications of the intervention. We limited this review to adults (participants aged 18 years or greater) and therefore, the results cannot be generalized to all age groups. We recommend that separate investigation be undertaken to address the question of the effect of PMPR in children. Similar comments can be made regarding the economic implications of PMPR. Such an evaluation is particularly pertinent to the topic of this review since prevention is likely to be a public health consideration rather than an individual treatment. We would recommend that an economic evaluation of PMPR in prevention should be integral to future invesigations of efficacy of these interventions.

Overall quality, strength and consistency of evidence

Thirty-two studies were found in this investigation of the effect of PMPR from 1963 to 2002. Of these, 24 were RCTs and eight were CCTs with no cohort studies found. The majority of studies being published 15 or more years ago. Therefore, quality evaluation of these studies is not intended as criticism, as understanding of conduct and reporting of trials has changed markedly. Challenges to quality and interpretation of the data included a lack of reporting of fundamental aspects of methodology known to protect against bias. These include, randomization methods, concealment of allocation code, examiner blinding and losses to follow-up. We have previously reported that these aspects are not reported well in the periodontal literature (Montenegro et al. 2002, Needleman et al. 2005a). Lack of reporting may not indicate inadequate methodology, but evidence exists that shows an association with unclear reporting with methodological problems (Schulz et al. 1995). Overall, where these aspects of protection from bias are clearly inadequate, an overestimation of treatment effect has been a consistent finding (Schulz et al. 1995, Moher et al. 1998, Juni et al. 2001), and this can be as high as 40%. We have found evidence of such an effect in the literature on guided tissue regeneration, although it is possible that this effect was due to confounders (Needleman et al. 2005b).

Other problems with the data were a lack of appropriate statistical analyses in several studies. In these reports, both within group and between group differences were difficult to judge. Since meta-analysis was not possible for these comparisons, the importance of findings from individual studies was sometimes diminished.

The interpretation of evidence for an effect when only a single study exists is not clear. Where a large enough single study exists and with reasonable protection from bias, such a study could be expected to be influential in decision making. However, even in this example, confirmatory studies would be needed not least to include different populations. In these comparisons, single study evaluations were in the main small and not adequately protected from bias. Only two out of five of these single study comparisons had experimental groups with more than 50 subjects (Axelsson & Lindhe 1981b), Kaldahl et al. 1998), and two studies were non-randomized (Strahan et al. 1977, Axelsson & Lindhe 1981b). Furthermore, the contradiction in findings between some studies in these comparisons suggests that confirmatory studies are important to inform decision making.

A further limitation to these data was the lack of reporting of smoking status of participants in all studies. Since smoking is a recognized risk factor for periodontitis (Bergstrom 1989, Ramseier 2005) and has a negative effect on the response to mechanical periodontal therapy (Labriola 2005), the potential impact of this confounding factor could not be estimated in this systematic review.

Potential biases in the review process

There are several potential biases in this review and these should be taken into account when interpreting our findings. Firstly, we made changes to the protocol after reviewing titles and abstracts. Initially, we planned to limit the interventions to those that were applied supragingivally only. This was to try to distinguish the effect of PMPR from the effect of scaling and root planing. In the event, this proved too restrictive, as many PMPR regimens included an element of subgingival instrumentation. As a compromise, we excluded studies that were clearly investigating the effect of scaling and root planing alone in the management of periodontitis.

One substantial challenge with this review was that PMPR is not a defined intervention. Indeed, there appeared to be as many different types of PMPR as there were studies. Furthermore,

descriptions of components, frequencies, etc. were sometimes unclear. Our strategy to make sense of this has been to group studies by the major characteristic of the interventions and comparisons. Since groupings were to an extent imposed on the included studies and were decided post hoc, the result could have been inclusion of heterogeneous and potentially dissimilar studies under the same comparison and bias.

The search was limited to OLDMEDLINE, MEDLINE, CENTRAL and EMBASE. While these are the most popular databases to search, our strategy did not include other databases such as LILACS (Latin–American literature) or unpublished or grey literature. Furthermore, the search was limited to English language only due to limitations in resources. Thus, data may exist for PMPR that were not included in this review. A further source of bias may have been publication bias. Typically, publication bias manifests itself as the tendency for studies with positive outcomes to have preferential publication (Deeks 1998). The presence of publication bias can be tested in meta-analysis, which was not available to this review. Since the results of individual studies appeared to be spread across conclusions of effective and ineffective, it is possible that publication bias might not be exerting a strong influence on these conclusions.

Multiple steps were taken to minimize bias within this review. These included: production of a protocol prior to data collection (although with changes as indicated above), duplicate and independent screening of titles/abstracts and full-text articles and duplicate and independent data abstraction. In all cases, disagreement was resolved by reference to the study document.

The use of a subjective grading system for strength of evidence could have introduced bias due both to its subjective nature and that it was constructed post hoc. We have attempted to be as explicit as possible in the reasons for grading each comparison, and this overall grade has been kept separate from the effect of the interventions and may be ignored if preferred. While investigation of individual components that protect from bias is the preferred method in meta-analysis, we have attempted to provide a narrative synthesis of evidence strength to aid the reader given the volume of data presented.

Agreements and disagreements with other studies or reviews

Several narrative reviews have included aspects of PMPR. Axelsson has comprehensively reviewed PMPR (Axelsson 1994, Axelsson 2002). These reviews provide excellent detail of methods of PMPR and outline the results of clinical evaluation. The conclusions from these reviews are more positive than the current systematic review. The reasons for this could include the focus on methods in these reviews and the consideration of studies without control groups. Without concurrent controls, the effect of an intervention is difficult to validate since bias is likely to exert a larger effect and determining causation is not possible. Similarly, for the controlled and randomized studies, no formal appraisal of quality of evidence was reported. A recent systematic review of comprehensive and systematic reviews of non-surgical periodontal therapy (Suvan 2005) was focused on effectiveness of periodontitis therapy. The review employed systematic methods to identify, appraise and report data. Despite the focus of the review on a different question, similarities with the current review were the emphasis on study quality issues and the need for investigation of differences in outcomes between patients.

Prevention *versus* health promotion

From a public health perspective, future research on periodontal diseases prevention should also be informed by the Ottawa Charter on health promotion (WHO 1986, 2003). Health promotion takes a broader approach to public health, investigating the impact of a wide range of interventions some of which will be ''professionally applied'' and many not. These include; interventions aimed at building a healthy public policy, interventions that create supportive environments, interventions that strengthen community actions, interventions that develop personal skills (where much of the data in this review would fit) and interventions that reorient health services to promote health. These interventions would be conducted in diverse settings such as clinics, communities, school and work-places, as well as those undertaken in a broader socio-political environment. Thus, periodontal disease prevention should not be studied in isolation, but within the context of general health promotion (Watt & Marinho 2005). Since little is known about studies on health promotion for periodontal diseases in this broader context, an initial step should be a series of systematic reviews investigating the questions:

What is the effect of health promotion on periodontal diseases?

What are the barriers to health promotion and prevention of the periodontal diseases?

These systematic reviews will provide a much-needed evidence-base for current data and should contribute to the design of the future research agenda in this field.

Conclusions

Within the limitations of this investigation we suggest the following conclusions:

- Limited evidence suggests that in adults, PMPR, particularly if combined with OHI, may be more effective than no treatment in surrogate measures of periodontal disease prevention, including the reduction of dento-gingival plaque, gingival bleeding/inflammation and PD and the maintenance of ALs.
- The evidence for a benefit of PMPR+OHI when compared with OHI alone is less clear. In other words, it is unclear whether professionally or patient-performed plaque control (or a combination) is important to primary or secondary prevention of periodontal diseases.
- Conflicting evidence exists as to the value of PMPR in secondary/tertiary prevention of periodontitis. Some studies show a profound benefit on surrogate outcomes but not tooth loss and others suggest no difference between interventions.
- There is no evidence of a difference between the effect of rubber cup polishing and air polishing in efficacy outcomes although bleeding and trauma will be transiently greater with air polishing. Bacteraemia can be caused by both, and there is no evidence of a difference between them in this respect.
- One study suggests greater clinical benefits if scaling is combined with rubber cup prophy, and these patients preferred the combined treatment.
- More frequent PMPR is associated with higher levels of periodontal

health, although the optimal frequency is undetermined.
- The strength of evidence for these conclusions ranges from weak to moderate due to factors including risk of bias, inconsistent results, lack of appropriate analytical statistics and small sample size.

Implications for practice/policy

- There is little value in providing PMPR without oral hygiene instruction. Repeated oral hygiene instructions for personally applied plaque control appear as influential as PMPR on periodontal health.
- PMPR might provide additional gains to some individuals and might achieve greater patient satisfaction with treatment.
- There is little difference in the beneficial or adverse effects of different methods of PMPR. Patients at risk of infective endocarditis are at risk of bacteraemia with rubber cup polishing or air polishing.
- Although more frequent PMPR favours greater health gains for surrogate outcomes of prevention, there is little to guide the frequency of PMPR applications. This should therefore be judged by a needs and risk assessment, although such an approach should be tested in a rigorously designed study.

Implications for research

- Research is needed to clarify the relative contributions of PMPR, OHI or a combination of the two interventions for periodontal disease prevention.
- These studies should form part of an overall health promotion strategy and be conducted in diverse settings with a wide range of interventions.
- Such studies will require a new approach to designing research on periodontal diseases and should encompass carefully conducted experimental, observational and qualitative designs
- While such studies are expensive to perform, the current cost to health services globally of providing such treatment or in managing the effects of periodontal disease suggest that such an investment is timely.
- Outcome evaluation should reflect this broader approach and evaluate outcomes important to individuals and communities, including tooth loss, quality of life, morbidity, economic outcomes, and utilization of health services and adverse effects of treatment.
- It is critical that studies are meticulously designed and reported in order to contribute to future systematic reviews and meta-analyses. Guidelines such as the CONSORT statement for reporting RCTs (several other guidelines exist for other study designs) should be followed
- An initial step should be a series of systematic reviews of all experimental, observational and qualitative research to determine the evidence for the effect of health promotion on periodontal health and to determine the barriers to achieving health.

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Appendix A: Basic Search Strategy (Ovid Medline)

(modified from Beirne et al. 2005)

1. exp DENTAL SCALING/
2. (''dental scaling'' or ''scale and polish$'' or ''dental prophylaxis'' or ''oral prophylaxis'' or ((periodont$ or dental or tooth) and scaling)).mp. [mp = title, original title, abstract, name of substance, mesh subject heading]
3. RANDOMIZED CONTROLLED TRIAL.pt.
4. CONTROLLED CLINICAL TRIAL.pt.
5. RANDOMIZED CONTROLLED TRIAL.sh.
6. RANDOM ALLOCATION.sh.
7. DOUBLE BLIND METHOD.sh.
8. SINGLE BLIND METHOD.sh.
9. latin square.ti,ab.
10. crossover.ti,ab.
11. (split adj (mouth or plot)).ti,ab.
12. CLINICAL TRIAL.pt.
13. exp CLINICAL TRIALS/
14. (clin$ adj25 trial$).ti,ab.
15. ((singl$ or doubl$ or trebl$ or tripl$) adj25 (blind$ or mask$)).ti,ab.
16. PLACEBOS.sh.
17. placebo$.ti,ab.
18. random$.ti,ab.
19. RESEARCH DESIGN.sh.
20. CROSS-OVER STUDIES/
21. MULTICENTER STUDY.pt.
22. exp Follow-Up Studies/
23. exp Cohort studies/
24. 1 or 2
25. 3 or 4 or 6 or 7 or 8 or 9 or 10 or 11
26. 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19
27. 22 or 23 or 25 or 26
28. 24 and 27
29. limit 28 to english language