J Clin Periodontol 2017; 44 (Suppl. 18): S116–S134 doi: 10.1111/jcpe.12674

Journal of Clinical Periodontology

Mechanical and chemical plaque control in the simultaneous management of gingivitis and caries: a systematic review

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Figuero E, Nóbrega DF, García-Gargallo M, Tenuta LMA, Herrera D, Carvalho JC. Mechanical and chemical plaque control in the simultaneous management of gingivitis and caries: a systematic review. J Clin Periodontol 2017; 44 (Suppl. 18): S116–S134. doi: 10.1111/jcpe.12674.

Abstract

Aim: To report the evidence on the effect of mechanical and/or chemical plaque control in the simultaneous management of gingivitis and caries.

Material and Methods: A protocol was designed to identify randomized (RCTs) and controlled (CCTs) clinical trials, cohort studies and prospective case series (PCS), with at least 6 months of follow-up, reporting on plaque, gingivitis and caries. Relevant information was extracted from full papers, including quality and risk of bias. Meta-analyses were performed whenever possible.

Results: After the screening of 1,373 titles, 15 RCTs, 10 CCTs and 2 PCS were included. Low to moderate evidence support that combined professional and self-performed mechanical plaque control significantly reduces standardized plaque index [$n = 4$; weighted mean difference (WMD) = 1.294; 95% CI (0.445; 2.144); $p = 0.003$] and gingivitis scores [$n = 4$; WMD = 1.728; 95% CI (0.631; 2.825); $p = 0.002$]. The addition of fluoride to mechanical plaque control is relevant for caries management [$n = 5$; WMD = 1.159; 95% CI (0.145; 2.172); $p = 0.025$] while chlorhexidine rinses are relevant for gingivitis.

Conclusion: Mechanical plaque control procedures are effective in reducing plaque and gingivitis. The addition of fluoride to mechanical plaque control is significant for caries management. Chlorhexidine rinse has a positive effect on gingivitis and inconclusive role in caries.

Key words: caries; mechanical plaque control; DMF; gingival index; gingivitis; chemical plaque control; meta-analyses; plaque index; systematic review

Accepted for publication 13 December 2016

Conflict of interest and source of funding statement

The authors have stated explicitly that there are no conflict of interest in connection with this article. This work was self-funded by the ETEP (Etiology and Therapy of Periodontal Diseases) Research Group, University Complutense, Madrid, Spain, and by the Catholic University of Louvain (UCL), Faculty of Medicine and Dentistry, Brussels, Belgium and by the University of Campinas (UNICAMP), Piracicaba Dental School, Piracicaba, Brazil.

Periodontal diseases (gingivitis and periodontitis) are considered inflammatory diseases of microbiological origin. Their most important risk factor is the accumulation of a plaque biofilm at and below the gingival margin, which is then associated with an inappropriate and destructive host inflammatory immune response (Chapple et al. 2015). Dental caries is an ubiquitous process defined as the result of a localized chemical dissolution of the tooth surface caused by acid production by the dental biofilm exposed frequently to sugars (Fejerskov et al. 2015). Following these concepts, it may be stated that the dental biofilm is a biological determinant associated with the development of both periodontal diseases and dental caries.

Although not all patients with gingivitis will develop periodontitis, the management of gingivitis is considered both a primary prevention strategy for periodontitis and secondary for recurrent periodontitis

(Chapple et al. 2015). Similarly, dental caries may be managed in such way that caries lesions at clinical and/or radiographic levels never form (Carvalho 2014). Inactivation of active non-cavitated lesions is the most important strategy to inhibit further caries progression (Thylstrup 1998, Nyvad et al. 2003, Carvalho & Mestrinho 2014). To some extent, this concept also applies to cavitated lesions provided that regular disorganization of the dental biofilm is possible. Fluoride has a key role in this management, reducing the rate of tooth mineral loss (Fejerskov et al. 1981, Tenuta & Cury 2010).

Recent evidence, coming from systematic reviews, supports the efficacy of mechanical (Needleman et al. 2015, Salzer et al. 2015, Van der Weijden & Slot 2015) and chemical plaque control (Serrano et al. 2015) in the reduction of plaque levels. Therefore, it seems reasonable that both procedures might have a simultaneous impact on gingivitis and caries, as there is independent evidence that both methods are effective in controlling gingivitis (Chapple et al. 2015, Tonetti et al. 2015) and professional and self-performed mechanical plaque control in combination with fluorides reduces coronal caries increment in children and adolescents (Marinho et al. 2003, Axelsson et al. 2004) as well as inactivate root caries lesions in elderly (Nyvad & Fejerskov 1986, Ekstrand et al. 2013). Therefore, the main objective of this systematic review was to answer the PICO question: *In systemically healthy patients, which is the effect of mechanical and/or chemical plaque control methods on plaque/gingivitis reduction and on caries increment?*

Material and methods

A protocol was developed in advance considering the following specific items:

- *Population:* Systemically healthy patients.
- *Intervention:* (i) mechanical plaque control procedures with or without the additional use of fluoride and/or (ii) chemical plaque control formulations adjunctive to oral hygiene procedures with or without prophylaxis.
- *Comparison:* Any mechanical or chemical plaque control regime (positive control) or placebo (negative control) or no control regime.
- *Outcome:* The primary main common outcome of the study was plaque reduction, followed by gingivitis or bleeding indices reduction (periodontal outcome) and caries increment (new caries lesions, caries outcome). The secondary outcome was change in caries lesions activity (non-cavitated or cavitated lesions).

Eligibility criteria

Inclusion criteria

- Randomized clinical trials (RCTs), controlled clinical trials (CCTs), cohort studies and prospective case series (PCS), with at least 6 months of follow-up.
- Any index related to plaque, gingivitis (or bleeding) indices and caries increment included among the outcome variables studied.
- Systemically physically and mentally healthy patients.
- In case of chemical plaque control: test product delivered as a mouthrinse, dentifrice or gel, adjunctively to mechanical oral hygiene (including toothbrushing).

Exclusion criteria

- Additional periodontal mechanical therapy, before or after baseline, excluding professional prophylaxis, supragingival scaling or tooth polishing.
- Patients wearing orthodontic appliances
- Chronically medicated with drugs that may affect gingivitis.
- Patients with untreated periodontitis.

Information sources and search

The search (Appendix S1) was independently performed (EF, JCC) in two electronic databases [National Library of Medicine (MEDLINE via PubMed) and Cochrane Central Register of Controlled Trials] until May 2016.

Study selection

Titles and abstracts were screened by two independent reviewers (DFN and MGG). Reviewers were calibrated for study screening against another experienced reviewer (EF). Full text of studies of possible relevance was obtained for independent assessment by the same reviewers. Any disagreement was resolved by discussion between reviewers.

Data extraction

Data were extracted (DFN, MGG) with specially designed data extraction forms. Any disagreement was discussed, and a third reviewer (EF) was consulted when necessary. When the study results were published more than once or were detailed in multiple publications, the most complete data set was identified and included.

Quality assessment, risk of bias in individual studies and across studies

The quality assessment was carried out by two of the authors (DFN and JCC). Disagreements were solved by discussion until a consensus was reached.

In case of RCTs and CCTs, a quality of methods analysis was performed according to Higgins et al. (2011) and Moher et al. (2012); for observational studies, a modification of the Newcastle-Ottawa scale (NOS) was used (Wells et al. 2011, Sanz-Sanchez et al. 2015).

A quality of reporting analyses was also performed (Graziani et al. 2012).

The publication bias was evaluated using the Egger′s linear regression method (Egger & Smith 1998). A sensitivity analysis of the meta-analysis results was performed (Tobias & Campbell 1999).

Data analyses

Mean values of all outcomes were directly pooled with weighted mean differences (WMDs) and 95% CIs. In the case of plaque and gingival inflammation, due to the high variability of indexes found in the literature, standardized WMDs were calculated (difference in the mean outcome between groups/standard deviation of outcome among

participants). Study-specific estimates were pooled (DerSimonian & Laird 1986), and the random-effect model results were presented. The statistical heterogeneity among studies was assessed using the Q test according to Dersimonian and Laird as well as the I2 index (Higgins et al. 2003).

STATA® (StataCorp LP, Lakeway Drive, College Station, TX, USA) intercooled software was used to perform all analyses. Statistical significance was defined as a p value <0.05.

Strength of the evidence

The quality of assessment for each procedure was rated into high, moderate, low and very low level of evidence, according to Needleman et al. (2005).

Results

Search

Figure 1 depicts the study flow chart: 1,373 titles were identified by the electronic search. Once the titles and abstracts were evaluated, 1,280 studies were discarded resulting in 93 studies that were subjected to full-text analysis. Finally, 32 papers were included. The reasons for exclusion of studies included in the full-text analysis are listed in Appendix S2.

Study characteristics

Information related to study characteristics is presented in Table 1. Schoolchildren 6–16 years old were the most frequently selected population in the included studies. The sample size at baseline for both test and control groups ranged from 16 to 574 participants. The corresponding values for the final examinations were from 16 to 383 participants. The period of follow-up for the majority of the studies ranged from 24 to 36 months. Selected indices to assess primary outcomes are presented in Table 2.

Risk of bias, quality of design and reporting in individual studies

A total of 15 RCTs, 10 CCTs and two PCS were included. The quality assessment of individual RCTs/CCTs and PCs is summarized in tables S1 and S2, respectively. Quality of design and reporting is presented in Table S3.

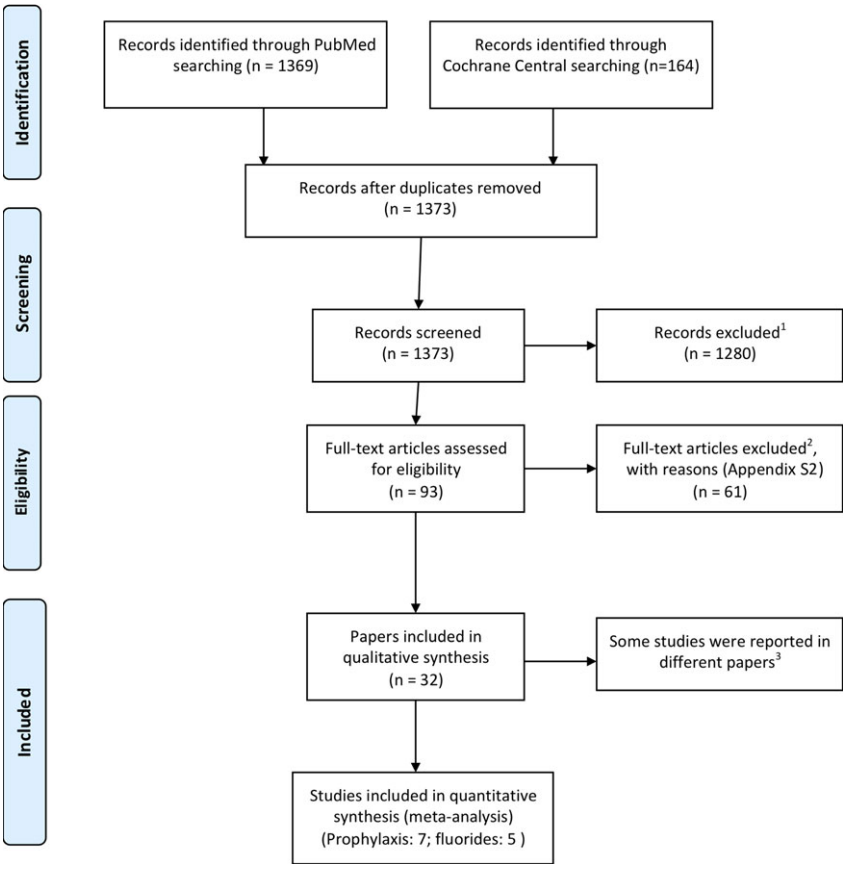

Fig. 1. Flow diagram.

1 Agreement = 95.89%; kappa = 0.45; 95% CI (0.35; 0.56); $p < 0.001$.
2 Agreement = 88.19%; kappa = 0.41; 95% CI (0.19; 0.64); $p < 0.001$.
3 Three studies were reported in more than one article:

- In two papers. (Axelsson et al. 1976, Emilson et al. 1982).
- In three papers (Horowitz et al. 1976, 1977, Horowitz 1980).
- In four papers (Lindhe & Axelsson 1973, Axelsson & Lindhe 1974, 1977, Lindhe et al. 1975).

Descriptive results

Interventions (Table 3) were categorized in mechanical (n = 23) and chemical plaque control (n = 4). Fluorides were adjunctive with either mechanical or chemical plaque control interventions. Descriptive results based on type of intervention are presented in Table 4.

Mechanical plaque control

Professional toothcleaning (PTC). The efficacy of PTC, including flossing, and using 5% monofluorophosphate (MFP) prophylactic paste compared to toothbrushing with 0.2% sodium fluoride (NaF) solution (Lindhe & Axelsson 1973, Axelsson & Lindhe 1974, 1977, Lindhe et al. 1975, Kjaerheim et al. 1980) and to mouthrinse with 0.2% NaF solution (Hamp et al. 1978) was demonstrated in a series of controlled clinical trials carried out in Scandinavian countries. Significant reductions in plaque and gingival scores, concurrently with significantly lower caries increment in the test groups, were observed at the end of the study periods. Similar findings were observed in clinical trials carried out in Germany (Klimek et al. 1985) and in Russia

Table 1. Study characteristics: follow-up, subgroups, age, sample size and gender, for each comparison, categorized by plaque control regimen: (1A) Efficacy of professional toothcleaning; (1B) frequency of professional toothcleaning; (1C) combined effect of professional tooth cleaning and OHI; (1D) combined effect of professional tooth cleaning and fluorides; (2) motivation and OHI without professionally tooth cleaning; (3A) manual vs powered toothbrushes; (3B) toothbrushing with/without fluoride; (4) chemical plaque control

Regimen	Reference	Country	Setting	Centres	Follow-up (in months)	Reason for (sub)group	Age (in years)	*n* Control		*n* Test		Gender (*n* Female)		
							Age Range (sub)groups	Baseline	Final	Baseline	Final	Overall	Control	Test
Mechanical plaque control														
1A	Lindhe & Axelsson (1973); Axelsson & Lindhe (1974); Lindhe et al. (1975); Axelsson & Lindhe (1977)	Sweden	University	1	12, 24, 36, 48	Age	7–8	46	37	49	39	NR	NR	NR
							10–11	31	26	44	33	NR	NR	NR
							13–14	23	15	23	13	NR	NR	NR
1A	Hamp et al. (1978)	Sweden	University	1	12, 24, 36	Grade	10 (3rd grade)	101	73	113	77	115	55	60
							11 (4th grade)	104	73	88	60	92	51	41
1A	Kjaerheim et al. (1980)	Norway	University	2	12, 24	Grade	7–14 (All grades)	179	139	170	154	NR	NR	NR
							7–8 (1st grade)	66	47	59	54	NR	NR	NR
							10–11 (4th grade)	55	44	58	52	NR	NR	NR
							13–14 (7th grade)	58	48	53	48	NR	NR	NR
1A	Ashley & Sainsbury (1981)	England	University	2	12, 24, 36	None	11–14	NR	102	NR	119	221	102	119
1A	Klimek et al. (1985)	Germany	University	2	24	None	12–14	167	117	115	104	119	65	54
1A	Petersen (1989)	Denmark	Private practice	1	12, 24	None	19–61	NA	NA	89	89	NA	NA	58
1A	Ekstrand et al. (2000)	Russia	University	2	12, 30	Age	All	145	145	145	145	NR	NR	NR
							3	45	45	45	45	NR	NR	NR
							6	50	50	50	50	NR	NR	NR
							11	50	50	50	50	NR	NR	NR
1A	Chambrone & Chambrone (2011)	Brazil	Private practice	1	240	None	03–13	NA	NA	50	30	NA	NA	16
1B	Hamp & Johansson (1982)	Sweden	Public Health Service	1	12, 24, 36	Treatment	16–19	NR	20	NR	29	NR	NR	NR
							16–19	NR	20	NR	32	NR	NR	NR
							16–19	NR	20	NR	25	NR	NR	NR
1B	Hamp et al. (1984)	Sweden	Public Health Service	1	12	School	13–14	NR	29	NR	33	NR	NR	NR
							13–14	NR	33	NR	37	NR	NR	NR
1C	Horowitz et al. (1976, 1977), Horowitz (1980)	USA	Public Health Service	1	8, 12, 20, 24, 32	None	10–13	234	168	236	144	209	109	100
1C	Axelsson & Lindhe (1981)	Sweden	University	1	18	None	13–14	52	NR	52	NR	NR	NR	NR
1D	Axelsson & Lindhe (1975)	Sweden	University	1	12	None	13–14	41	38	41	40	51	25	26
1D	Zickert et al. (1982)	Sweden	University	1	12, 24	Treatment	13–14	47	44	48	45	NR	NR	NR
							13–14	49	44	49	44	NR	NR	NR
							13–14	49	44	48	39	NR	NR	NR

Table 1. (continued)

Regimen	Reference	Country	Setting	Centres	Follow-up (in months)	Reason for (sub)group	Age (in years)	*n* Control		*n* Test		Gender (*n* Female)		
							Age Range (sub)groups	Baseline	Final	Baseline	Final	Overall	Control	Test
2	Fischman et al. (1977)	USA	University	1	6, 12, 18, 24, 30, 36	Treatment	11	NR	NR	NR	NR	NR	NR	NR
2	Melsen & Agerbaek (1980)	Denmark	University	1	12, 24	Grade	11–15 (6–7th grades)	NR	83	NR	81	NR	NR	NR
							11–15 (8th grade)	NR	19	NR	19	NR	NR	NR
2	van Palenstein Helderman et al. (1997)	Tanzania	University	2	3, 8, 15, 36	None	9–14	150	122	400	309	NR	NR	NR
2	Zanin et al. (2007)	Brazil	University	1	3, 6, 9, 12, 15	None	6	30	30	30	30	NR	NR	NR
2	Mbawalla et al. (2013)	Tanzania	Public Health Service & University	3	24	None	12–21	503	358	574	374	NR	229	346
2	Angelopoulou et al. (2015)	Greece	Private practice & University	3	6, 18	None	10–11,5	100	76	84	67	84	45	39
3A	Willershausen & Watermann (2001)	Germany	University	1	12, 24, 36	Treatment	6–7	40	40	24	24	NR	10	13
							6–7	40	40	26	26	NR	10	13
3B	Murray & Shaw (1980)	United Kingdom	University	1	12, 24, 36	Treatment	11–13	471	356	482	367	NR	NR	NR
3B	Andlaw & Tucker (1975)	England	University	1	12, 24, 36	None	11–12	428	376	418	364	NR	NR	NR
Chemical plaque control														
4	Lang et al. (1982)	Switzerland	University	1	3, 6	Treatment	10–13	39	37	41	41	NR	16	15
							10–13	39	37	35	35	NR	16	13
							10–13	39	37	39	37	NR	16	17
4	Johansen et al. (1975)	Norway	University	1	6, 12, 18, 24	Treatment	19–23	14	12	10	9	NR	NR	NR
							19–23	15	13	19	17	NR	NR	NR
4	Axelsson et al. (1976)†	Sweden	University	1	12, 24	Treatment	13–14	40	37	42	39	49	24	25
							13–14	40	37	41	36	49	24	25
							13–14	40	37	41	35	50	24	26
							13–14	42	39	41	36	50	25	25
							13–14	42	39	41	35	51	25	26
							13–14	41	36	41	35	51	25	26
4	Emilson et al. (1982)†	Sweden	University	1	12	Treatment	13–14	16	16	16	15	NR	NR	NR
							13–14	16	16	16	14	NR	NR	NR
							13–14	16	16	16	16	NR	NR	NR

NR, not reported; NA, not applied.
†The second study represents a subpopulation from the oldest study.

Table 2. Study characteristics: outcome assessment, with the selected indices, sites and teeth assessed, categorized by plaque control regimen: (1A) Efficacy of professional toothcleaning; (1B) frequency of professional toothcleaning; (1C) combined effect of professional tooth cleaning and OHI; (1D) combined effect of professional tooth cleaning and fluorides; (2) motivation and OHI without professionally tooth cleaning; (3A) manual vs powered toothbrushes; (3B) toothbrushing with/without fluoride; (4) chemical plaque control

Regimen	Reference	Plaque index (PI)			Gingival/bleeding index (GI)			Caries index	
		Acronym	Site‡	Teeth	Acronym	Site‡	Teeth	Acronym	Teeth
Mechanical plaque control									
1A	Lindhe & Axelsson (1973); Axelsson & Lindhe (1974); Lindhe et al. (1975) and Axelsson & Lindhe (1977)	S&L	4	All fully erupted permanent teeth	L&S	NR	All fully erupted permanent teeth	DF-S	All permanent teeth
1A	Hamp et al. (1978)	% Plaque	4	Index teeth: 16, 12, 11, 21, 22, 26, 36, 32, 31, 41, 42, 46	% IGU	4	Index teeth: 16, 12, 11, 21, 22, 26, 36, 32, 31, 41, 42, 46	DF-S	All permanent teeth
1A	Kjaerheim et al. (1980)	VPI	4	Fully erupted incisors and first molars	GBI	4	Fully erupted incisors and first molars	DMF-S	All permanent teeth
1A	Ashley & Sainsbury (1981)	mg Plaque	NR	All teeth excluding lower incisors	IGU	3	Ramfjord teeth	DF-S	All permanent teeth
1A	Klimek et al. (1985)	S&L	NR	NR	L&S	4	Ramfjord teeth	DF-S	All permanent teeth
1A	Petersen (1989)	VPI	1	All teeth present	GBI	1	All teeth present	DMF-S	All permanent teeth
1A	Ekstrand et al. (2000)	M_VOPI	1	Index teeth: 46 (85), 22 (62), 26 (65)	M_L	1	Index teeth: 16 (55), 12 (52), 32 (72), 36 (75)	dmf-s/t DMF-S/T	Primary teeth Permanent teeth
1A	Chambrone & Chambrone (2011)	S&L	6	NR	L&S	6	NR	DMF-T	All permanent teeth
1B	Hamp & Johansson (1982)	% Plaque	4	Index teeth: 16, 12, 24, 44, 32, 36	% IGU	4	Index teeth: 16, 12, 24, 44, 32, 36	DF-S	All permanent teeth
1B	Hamp et al. (1984)	% Plaque	4	Index teeth: 16, 12, 11, 21, 22, 26, 36, 32, 31, 41, 42, 46	% IGU	4	Index teeth: 16, 12, 11, 21, 22, 26, 36, 32, 31, 41, 42, 46	DF-S	All permanent teeth
1C	Horowitz et al. (1976, 1977), Horowitz (1980)	PHP	2	Index teeth: 16, 11, 26, 36, 31, 46	DHC	2	Index teeth: 16, 11, 26, 36, 31, 46	DMF-S DMF-T	All permanent teeth
1C	Axelsson & Lindhe (1981)	% Plaque	4	All erupted permanent teeth	%IGU	2,3,4	Canines, incisors, first molars	M_Grondahl	All molars and premolars
1D	Axelsson & Lindhe (1975)	% Plaque	4	All fully erupted permanent teeth	%IGU	4	All fully erupted permanent teeth	DF-S	All permanent teeth
1D	Zickert et al. (1982)	% Plaque	4	All fully erupted permanent teeth	%IGU	4	All fully erupted permanent teeth	DMF-S	All permanent teeth
2	Fischman et al. (1977)	K-A	NR	Ramfjord teeth	PDI	NR	Ramfjord teeth	DMF-S	All permanent teeth
2	Melsen & Agerbaek (1980)	S&L	NR	NR	L&S	NR	NR	DMF-S	All permanent teeth
2	van Palenstein Helderman et al. (1997)	M_S&L	2	Ramfjord teeth	%BOP	2	Ramfjord teeth	DMF-T	All permanent teeth
2	Zanin et al. (2007)	S&L	NR	All deciduous teeth	L&S	NR	All deciduous teeth	dmf-s DMF-S	Primary teeth Permanent teeth
2	Mbawalla et al. (2013)	OHI-S	1	Index teeth: 16, 11, 26, 36, 31, 46	GBI	NR	NR	D-T	All permanent teeth
2	Angelopoulou et al. (2015)	% Plaque	3	Permanent molars and anterior teeth	GI_S	3	Permanent molars and anterior teeth	DMF-T	All permanent teeth
3A	Willershausen & Watermann (2001)	API	NR	NR	GI	NR	NR	DMF-T	All permanent teeth

Table 2. (continued)

Regimen	Reference	Plaque index (PI)			Gingival/bleeding index (GI)			Caries index	
		Acronym	Site‡	Teeth	Acronym	Site‡	Teeth	Acronym	Teeth
3B	Murray & Shaw (1980)	S&L	NR	NR	L&S	NR	NR	DMF-S	All permanent teeth
3B	Andlaw & Tucker (1975)	OHI-S	1	Index teeth: 16, 11, 26, 36, 31, 46	L&S	4	Index teeth: 16, 11, 26, 36, 31, 46	DMF-S DMF-T	All permanent teeth
Chemical plaque control									
4	Lang et al. (1982)	S&L	4	All fully erupted permanent teeth	L&S	4	All fully erupted permanent teeth	DMF-S DMF-T	All permanent teeth
4	Johansen et al. (1975)	S&L	NR	NR	L&S	NR	NR	NR	NR
4	Axelsson et al. (1976)†	% Plaque	4	All fully erupted permanent teeth	%IGU	4	All fully erupted permanent teeth	DF-S	All permanent teeth
4	Emilson et al. (1982)†	% Plaque	4	All fully erupted permanent teeth	%IGU	4	All fully erupted permanent teeth	DF-S	All permanent teeth

NR, not reported.
Plaque indices: OHI-S, Simplified Oral Hygiene Index; % Plaque, percentage number of tooth surfaces with plaque; mg Plaque, dry weight of plaque; S&L, Silness & Löe Plaque Index; M_VOPI, Visible Occlusal Plaque indices: OHI-S, Simplified Oral Hygiene Index (Greene & Vermillion 1964); % Plaque, percentage number of tooth surfaces with plaque; mg Plaque, dry weight of plaque; S&L, Silness & Löe Plaque Index (Silness & Loe 1964); M_VOPI, Visible Occlusal Plaque Index, modified from (Carvalho et al. 1989); K-A, Kobayashi & Ash Index; PHP, Patient Hygiene Performance Index (Podshadley & Haley 1968); VPI, Visible Plaque Index (Ainamo & Bay 1975); M_S&L, modified from Silness & Löe Plaque Index (Loe 1967); API, modified Approximal Plaque Index (Lange et al. 1977)
Gingival indices: L&S, Löe & Silness Gingival Index (Loe & Silness 1963); GI_S, Simplified Gingival Index (Lindhe 1982); IGU, Inflamed Gingival Units; %IGU, percentage of Inflamed Gingival Units (Axelsson & Lindhe 1975); M_L, Gingival Index, modified from S&L; PDI, Periodontal Disease Index (Ramfjord 1959); DHC, Dental Health Center Gingival Index (Suomi 1969); GBI, Gingival Bleeding Index (Ainamo & Bay 1975); GI, Gingivitis Index (Gülzow et al., 1987).
Caries indices: DMF-S, Decayed, Missing and Filled Surfaces; DMF-T, Decayed, Missing and Filled Teeth (Klein et al. 1938); DF-S Decayed and Filled Surfaces (Koch, 1967); M_Grondahl, Modified Caries Index System (Grondahl et al. 1977); dmf-s, decayed, missing and filled deciduous surfaces; dmf-t, decayed, missing and filled deciduous teeth; D-T, decayed teeth.
References are presented in Appendix S3.
Four and five sites were considered for caries examination of anterior and posterior teeth, respectively. Unless mentioned caries examination was considered as being carried out in all permanent and/or deciduous teeth.
†The second study represents a subpopulation from the oldest study.
‡Number of sites/tooth.

(Ekstrand et al. 2000) in which no interventions were offered to control groups. Moreover, PCS performing PTC and topical fluoride application at regular intervals found significant reduction in plaque and gingival scores and low caries increment in Denmark (Petersen 1989) and in Brazil (Chambrone & Chambrone 2011). Unless otherwise mentioned, dental caries was recorded at cavitation level in all studies included in this review. Two studies about the efficacy of PTC registered non-cavitated caries lesions and their fate during the study periods. In the first, in a test group of 6-year-old children, from 28 active non-cavitated lesions, 15 (53.6%) were inactivated in contrast to none in the control group (Ekstrand et al. 2000). In the second, children and adolescents developed only seven active non-cavitated lesions, which were further inactivated (Chambrone & Chambrone 2011).

The benefits of PTC with fluoride-free prophylactic paste, in comparison with oral hygiene instructions (OHI), were tested in a group of English schoolchildren. Significant reductions only in plaque and gingival scores were observed at the end of the intervention period (Ashley & Sainsbury 1981).

A group of studies analysed the extent to which outcomes could be influenced by the frequency of PTC with either fluoride toothpaste or rinse or, alternatively, PTC followed by fluoride varnish application in both test and control groups. The frequencies ranged from once every 2 weeks up to once per year. No substantial differences in plaque and gingival scores or in caries increments were observed when the intervals of PTC increased from once a month to once every 3 months in the test groups (Zickert et al. 1982). PTC performed monthly up to once every 6 months had good effects on plaque and gingival scores in the test groups during a 3-year period. However, caries increment was greater, but not significantly, for a 6-month interval than for monthly prophylaxis sessions (Hamp & Johansson 1982). Also, prophylaxis intervals according to individual needs had a better long-term effect on plaque and gingival scores compared to

Table 3. Study characteristics: intervention, chemical agent, supervision and follow-up examinations, categorized by plaque control regimen: (1A) Efficacy of professional toothcleaning; (1B) frequency of professional toothcleaning; (1C) combined effect of professional tooth cleaning and OHI; (1D) combined effect of professional tooth cleaning and fluorides; (2) motivation and OHI without professionally tooth cleaning; (3A) manual vs powered toothbrushes; (3B) toothbrushing with/without fluoride; (4) chemical plaque control

Regimen	Reference	Intervention		Chemical Agent		Frequency	
		Control	Test	Control	Test	Control	Test
1A	Lindhe & Axelsson (1973); Axelsson & Lindhe (1974); Lindhe et al. (1975) and Axelsson & Lindhe (1977)	Brushing	Plaque Disclosing + Brushing + Flossing + Prophylaxis	0.2% NaF solution	5% MFP prophylatic paste	Every month	Different frequencies (Every month, every 2 months)
1A	Hamp et al. (1978)	Rinse	Plaque Disclosing + Brushing + Flossing + Prophylaxis + Rinse	0.2% NaF solution	Prophylatic paste (5% MFP 1st year; 0.22% 2nd and 3rd years) + 0.2% NaF solution	Every 2 weeks[ns]	Every 3 weeks
1A	Kjaerheim et al. (1980)	Brushing	Plaque Disclosing + Brushing + Flossing + Prophylaxis	0.2% NaF solution	0.8% MFP prophylatic paste	Every 3 months	Every 2 weeks
1A	Ashley & Sainsbury (1981)	OHI	Plaque Disclosing + Brushing + Flossing + Prophylaxis + OHI	None	Non F prophylatic paste	3 sessions[ns]	Every 2 weeks
1A	Klimek et al. (1985)	None	Plaque Disclosing + Brushing + Flossing + Prophylaxis + Varnish	None	Non F prophylatic paste + 5% NaF varnish + NaF toothpaste (home)	None	Every 2.5 months
1A	Petersen (1989)	NA	Prophylaxis + F application + OHE	NA	2% NaF solution	NA	Every 3–6 months
1A	Ekstrand et al. (2000)	None	Plaque Disclosing + Brushing + Prophylaxis + OHE	None	NaF toothpaste (1.100 ppm F)	None	Every 1–6 months
1A	Chambrone & Chambrone (2011)	NA	Plaque Disclosing + Brushing + Prophylaxis[†]	NA	Topical fluoride application	NA	Every 6–12 months
1B	Hamp & Johansson (1982)	Rinse (1st yr); none (2nd and 3rd years)	Plaque Disclosing + Brushing + Flossing + Prophylaxis + Rinse	0.2% NaF solution	Prophylatic paste (5% MFP 1st yr; 0.22% 2nd and 3rd years) + 0.05% NaF rinse	Every 2 weeks (1st yr)[ns]	Different frequencies (every 3 weeks, every month, every 6 months)
1B	Hamp et al. (1984)	Brushing + Flossing + Prophylaxis + Rinse + Varnish	Brushing + Flossing + Prophylaxis + Rinse	5% NaF varnish + Placebo solution	0.2% NaF solution	Biannual[ns]	Every 3 weeks
1C	Horowitz et al. (1976, 1977), Horowitz (1980)	None	OHI + Daily Plaque Disclosing + Brushing + Flossing	None	Non F toothpaste	None	11 consecutive days
1C	Axelsson & Lindhe (1981)	Prophylaxis	Prophylaxis + OHI	0.1% NaF + 0.4% MFP prophylatic paste	0.1% NaF + 0.4% MFP prophylatic paste	Every 2 weeks	Every 2 weeks

Table 3. (continued)

Regimen	Reference	Intervention		Chemical Agent		Frequency	
		Control	Test	Control	Test	Control	Test
1D	Axelsson & Lindhe (1975)	Prophylaxis + F-toothpaste for home use	Prophylaxis + Non F-toothpaste for home use	5% MFP prophylatic paste	Placebo prophylatic paste	NR	NR
1D	Zickert et al. (1982)	OHI + Prophylaxis + Different fluoride regimes	OHI + Prophylaxis + Different fluoride regimes	G1) non F; G2) MFP; G3) NaF rinses + toothpastes	G1) non F; G2) MFP; G3) NaF rinses + toothpastes	Every 3 months	Every month
2	Fischman et al. (1977)	OHI	G1) OHI + Topical fluorides and Sealants; G2) OHI + Topical fluorides and Sealants + Motivational Program	NR	NR	NR[ns]	Every 1 year
2	Melsen & Agerbaek (1980)	Rinse	Rinse + Motivational Program	0.2 NaF solution	0.2 NaF solution	Every Day[ns]	NR
2	van Palenstein Helderman et al. (1997)	None	Supervised brushing + OHE	None	NR	None	Once a week
2	Zanin et al. (2007)	Supervised brushingin groups + F gel	Individual supervised brushing + OHE	1,23% APF gel	NR	Every year	Every 3 months
2	Mbawalla et al. (2013)	None	Supervised Brushing + OHE	None	NR	None	NR
2	Angelopoulou et al. (2015)	OHE based onTraditional Lecturing	OHE based on Experimental Lecturing	None	F toothpaste	NR[ns]	NR[ns]
3A	Willershausen & Watermann (2001)	Manual Brushing + OHI	G1) Manual brushing + OHI; G2) Powered brushing + OHI	NR	NR	Once a year	Every 3 months
3B	Murray & Shaw (1980)	Brushing	Brushing	Placebo (low abrasivity toothpaste)	0.8 MFP toothpaste (G1-low abrasivity; G2-normal abrasivity)	NR[ns]	NR[ns]
3B	Andlaw & Tucker (1975)	Brushing	Brushing	Placebo toothpaste	MFP toothpaste (1000 ppm)	NR[ns]	NR[ns]
4	Lang et al. (1982)	Rinse	Rinse	Placebo	G1 and G2) 0.2% CHX; G3) 0.1% CHX	6x/week	G1) 2x/week; G2 and G3) 6x/week

Table 3. (continued)

Regimen	Reference	Intervention		Chemical Agent		Frequency	
		Control	Test	Control	Test	Control	Test
4	Johansen et al. (1975)	Brushing	Brushing	G1) Placebo toothpaste (normal abrasivity); G2) Placebo toothpaste (no abrasive)	G1) 1% CHX toothpaste (normal abrasivity); G2) 0.4% CHX toothpaste (normal abrasivity); G3) 0.4% CHX toothpaste (no abrasive)	Every 6 months[ns]	Every 6 months[ns]
4	Axelsson et al. (1976)[‡]	Chemical plaque control + OHI + Rinse + Toothpaste	Chemical plaque control + OHI + Rinse + Toothpaste	0.5% CHX gel + Placebo rinse and toothpaste	0.5% CHX gel + 2% MFP rinse + 0.8 MFP toothpaste	Every 2 weeks	Every 2 weeks
		Prophylaxis + OHI + Rinse + Toothpaste	Prophylaxis + OHI + Rinse + Toothpaste	NA	2% MFP rinse + 0.8 MFP toothpaste	Every 2 weeks	Every 2 weeks
4	Emilson et al. (1982)[‡]	None	G1) Prophylaxis; G2) Chemical plaque control; G3) F adjuvant with Chemical Plaque control	None	G2) 0.5 CHX gel; G3) 0.5 CHX gel + 2% MFP rinse	None	Every 2 weeks

NR, not reported; G, group; NA, not applied; OHE, oral health education; OHI, oral hygiene instructions; F, fluoride; MFP, sodium monofluorophosphate; NaF, sodium fluoride; CHX, chlorhexidine..
[ns]Not supervised.
[†]Supragingival scaling and tooth polishing.
[‡]The second study represents a subpopulation from the previous study.

fluoride varnish treatment every 6 months (Hamp et al. 1984).

Studies examining the effect of PTC with 0.4% MFP and 0.1% NaF prophylactic paste, combined or not with OHI, showed that both interventions reduce plaque and gingival scores, but that only the combination with PTC significantly lowers caries increments (Axelsson & Lindhe 1981). Other studies also obtained lower caries increments, but these were not significant (Horowitz et al. 1976, 1977, Horowitz 1980). In these studies, only plaque and gingival scores were significantly reduced (Horowitz et al. 1976, 1977, Horowitz 1980).

Motivational programmes and OHI. Studies examining the combined efficacy of motivational programmes and OHI, which benefited from individualized supervised toothbrushing, showed either significant reduction in plaque and gingival scores and lower caries increment in the test group compared to control (Zanin et al. 2007), or no improvement on these oral health conditions (Mbawalla et al. 2013). Also, no improvement was found when supervised toothbrushing was delivered to a group of children from a low socioeconomic background in Tanzania (van Palenstein Helderman et al. 1997). The addition of topical fluoride application or fluoride rinses had no effect either on plaque or gingival scores, or on caries increment (Fischman et al. 1977, Melsen & Agerbaek 1980). A motivational programme comparing experimental oral hygiene education *versus* traditional lecturing only improved plaque scores on the first 6 months. However, after 18 months, none of the outcomes differed from the control group (Angelopoulou et al. 2015).

Self-performed toothcleaning. A study examining the efficacy of self-performed toothcleaning with manual and powered toothbrushing failed to show any significant differences in gingival status and caries increments in children (Willershausen & Watermann 2001).

Moreover, in studies on the effect of manual toothbrushing with 0.8% MFP toothpaste *versus* that of a non-fluoride toothpaste, the impact

Table 4. Synthesis of the main results for plaque, gingival and caries index, categorized by plaque control regimen: (1A) Efficacy of professional toothcleaning; (1B) frequency of professional toothcleaning; (1C) combined effect of professional tooth cleaning and OHI; (1D) combined effect of professional tooth cleaning and fluorides; (2) motivation and OHI without professionally tooth cleaning; (3A) manual vs powered toothbrushes; (3B) toothbrushing with/without fluoride; (4) chemical plaque control

				Plaque Index					
				Control			Test		
References	Subgroup control	Subgroup test	Index	Baseline Mean (SD)	Final Mean (SD)	Final – Baseline Mean (SD)	Baseline Mean (SD)	Final Mean (SD)	Final – Baseline Mean (SD)
Mechanical plaque control									
(1A) Lindhe & Axelsson (1973)	Group 1: 7–8 years			1.21	1.24	NR	1.11	0.39***	NR
	Group 2: 10–11 years		S&L	0.96	1.25	NR	1.03	0.35***	NR
	Group 3: 13–14 years			1.25	1.60	NR	1.36	0.36***	NR
(1A) Axelsson & Lindhe (1974)	Group 1: 7–8 years		S&L	1.19	1.09	NR	1.12	0.34***	NR
	Group 2: 10–11 years			0.94	0.99	NR	1.06	0.30***	NR
	Group 3: 13–14 years			1.26	1.00	NR	1.29	0.27***	NR
(1A) Lindhe et al. (1975)	Group 1: 7–8 years			NR	NR	NR	NR	NR	NR***
	Group 2: 10–11 years		S&L	NR	NR	NR	NR	NR	NR***
	Group 3: 13–14 years			NR	NR	NR	NR	NR	NR***
(1A) Axelsson & Lindhe (1977)	Group 1: 7–8 years		S&L	NR	NR	NR	NR	NR	NR
	Group 2: 10–11 years			NR	NR	NR	NR	NR	NR
	Group 3: 13–14 years			NR	NR	NR	NR	NR	NR
(1A) Hamp et al. (1978)	Group 1: 10 years		% Plaque	34.4 (10.51)	35	NR	31.5 (10.53)	13.1*** (9.92)	NR
	Group 2: 11 years			34.3 (9.06)	32.4	NR	30 (10.69)	14.9*** (8.37)	NR
(1A) Kjaerheim et al. (1980)	Grade 1		VPI	90.5	66.7	NR	90.5	34.5**	NR
	Grade 4			83.3	57.1	NR	85.7	21.4**	NR
	Grade 7			78.6	52.4	NR	75	20.2**	NR
(1A) Ashley & Sainsbury (1981)	None		mg Plaque	3.23 (1.84)	2.2 (1.32)	NR	3.38 (1.96)	1.29*** (0.99)	NR
(1A) Klimek et al. (1985)	None		S&L	1.3 (0.5)	1.3 (0.4)	NR	1.5 (0.4)	0.5 (0.2)	NR
(1A) Petersen (1989)	None		VPI	NA	NA	NA	29	10	NR
(1A) Ekstrand et al. (2000)	Group A: 3 years old		M_VOPI	NR	NR	NR	NR	NR	NR***
	Group B: 6 years old			NR	NR	NR	NR	NR	NR***
	Group C: 11 years old			NR	NR	NR	NR	NR	NR***
(1A) Chambrone & Chambrone (2011)	Parents with G		S&L	NA	NA	NA	NR	0.5 (0.3)	NR
	Parents with AgP			NA	NA	NA	NR	0.4 (0.2)	NR
	Parents with ChP			NA	NA	NA	NR	0.5 (0.3)	NR
(1B) Hamp & Johansson (1982)	Control	Test A	% Plaque	NR	70.0	NR	NR	30.1***	NR
	Control	Test B		NR	70.0	NR	NR	33.2***	NR
	Control	Test C		NR	70.0	NR	NR	45.5***	NR
(1B) Hamp et al. (1984)	Munkhagen school		% Plaque	7.9 (10.2)	17.7 (13.4)	NR	8.7 (9.2)	14.5 (10.3)	NR
	Osterberga school			25.6 (9.7)	19.3 (10.8)	NR	28.7 (10.9)	19.5 (8.0)	NR
(1C) Horowitz et al. (1976)	None		PHP	3.11 (0.61)	3.36 (0.58)	0.25 (0.88)	3.16 (0.61)	3.22 (0.69)	0.06^{NS} (0.82)
(1C) Horowitz et al. (1977)	None		PHP	3.11 (0.56)	3.26 (0.56)	0.15 (0.56)	3.18 (0.48)	3.21 (0.72)	0.0^{NS} (0.63)
(1C) Horowitz (1980)	Overall		PHP	NR	NR	NR	NR	NR	NR
	Girls			3.01 (0.76)	2.93 (0.65)	−0.08 (0.91)	3.13 (0.77)	2.25 (0.53)	−0.88** (0.95)
	Boys			3.17 (0.61)	3.11 (0.54)	−0.06 (0.78)	3.23 (0.77)	2.93 (0.63)	0.30^{NS} (0.74)
(1C) Axelsson & Lindhe (1981)	*No* prophylaxis and *no* OHI	Prophylaxis	% Plaque	77 (12.85)	38 (20.71)	NR	78 (12.14)	22 (17.14)	NR
		OHI		77 (12.85)	38 (20.71)	NR	82 (12.85)	46 (17.85)	NR
		OHI + prophylaxis		77 (12.85)	38 (20.71)	NR	81 (12.14)	25 (15)	NR
(1D) Axelsson & Lindhe (1975)	Prophylaxis + F-toothpaste	Prophylaxis + Non F-toothpaste	% Plaque	76.4 (11.71)	33.2 (16.6)	NR	72.8 (11.38)	28^{NS} (13.91)	NR
(1D) Zickert et al. (1982)	Non F + prophylaxis	Non F + prophylaxis	% Plaque	76.5	35.3	NR	70.5	32.3	NR
	MFP + prophylaxis	MFP + prophylaxis		76.5	32.2	NR	76.5	29.4	NR
	NaF + prophylaxis (4×/year)	NaF + prophylaxis (12×/year)		70.5	32.3	NR	70.5	35.3	NR
(2) Fischman et al. (1977)	Control	Group A	K-A	3.46	3.04	NR	3.47	3.02	NR
	Control	Group B		3.46	3.04	NR	3.49	2.98	NR
(2) Melsen & Agerbaek (1980)	6–7th grade		S&L	1.36	0.94	NR	1.16	0.82*	NR
	8th grade			1.36	0.94	NR	1.16	0.65	NR
(2) van Palenstein Helderman et al. (1997)	None		M_S&L	18.90 (0.4)	NR	NR	20.5 (1.2)	NR	-4.3^{NS} (2.5)
(2) Zanin et al. (2007)†	None		S&L	1.29	0.93	NR	1.33	0.60*	NR
(2) Mbawalla et al. (2013)	None		OHI-S	3.3 (2.6)	2.2 (2.5)	−1.10	3.3 (2.7)	2 (2.5)	-1.30^{NS}
(2) Angelopoulou et al. (2015)†	None		% Plaque	57.7 (30.6–80.6)	66.7 (37.6–83.3)	NR	64.6 (38.0–83.3)	55.6^{NS} (29.2–79.2)	NR
(3A) Willershausen & Watermann (2001)	Manual Brushing + OHI (1x/yr)	Manual Brushing + OHI (4x/yr)	API	NR	NR	NR	NR	NR	NR
		Powered brushing + OHI (4x/yr)		NR	NR	NR	NR	NR	NR
(3B) Murray & Shaw (1980)	Placebo low abrasivity toothpaste	0.8 MFP low abrasivity toothpaste	S&L	16.22 (7.27)	15.27 (6.25)	NR	16.2 (7.28)	15.19^{NS} (6.13)	NR
		0.8 MFP normal abrasivity toothpaste		16.22 (7.27)	15.27 (6.25)	NR	15.21 (7.34)	13.73^{NS} (6.53)	NR

Gingival Index							Caries Index						
	Control			Test				Control			Test		
Index	Baseline Mean (SD)	Final Mean (SD)	Final – Baseline Mean (SD)	Baseline Mean (SD)	Final Mean (SD)	Final – Baseline Mean (SD)	Index	Baseline Mean (SD)	Final Mean (SD)	Final – Baseline Mean (SD)	Baseline Mean (SD)	Final Mean (SD)	Final – Baseline Mean (SD)
	0.75	NR	NR	0.71	0.32***	NR		3.2 (0.43)	NR	NR	4.69 (0.45)	NR	NR***
L&S	0.74	NR	NR	0.66	0.34***	NR	DF-S	6.9 (0.47)	NR	NR	7.51 (0.44)	NR	NR***
	0.92	NR	NR	0.99	0.18***	NR		23.6 (2.1)	NR	NR	24.78 (2.12)	NR	NR***
L&S	0.73	0.79	NR	0.70	0.22***	NR		3.23 (2.9)	NR	4.24	4.46 (3.01)	NR	0.27***
	0.74	0.71	NR	0.67	0.28***	NR	DF-S	7 (2.2)	NR	5.83	7.69 (3.05)	NR	0.12***
	0.89	0.78	NR	0.93	0.19***	NR		24.4 (10.4)	NR	8.15	25.5 (11.5)	NR	0.17***
	NR	NR	NR	NR	NR	NR***		NR	NR	5.75	NR	NR	0,33***
L&S	NR	NR	NR	NR	NR	NR***	DF-S	NR	NR	9.44	NR	NR	0,54***
	NR	NR	NR	NR	NR	NR***		NR	NR	13.18	NR	NR	0,5***
L&S	NR	NR	NR	NR	NR	NR		3.21 (2.68)	NR	7.19 (5.29)	4.44 (3.12)	NR	0.43 (0.75)
	NR	NR	NR	NR	NR	NR	DF-S	7.08 (2.24)	NR	13.96 (11.22)	7.70 (2.7)	NR	1.09 (1.55)
	NR	NR	NR	NR	NR	NR		22.8 (8.71)	NR	15.4 (7.87)	22.23 (8.87)	NR	0.77 (1.08)
% IGU	19.6 (10.08)	33.8 (10.68)	NR	19.5 (10.09)	10.4*** (11.14)	NR	DF-S	5.5 (3.42)	NR	12.8 (7.43)	6.3 (3.33)	NR	5.9*** (5.7)
	18.7 (11.19)	31.8 (11.88)	NR	20 (11.15)	7.6*** (8.13)	NR		7.9 (4.19)	NR	12.9 (5.98)	8.6 (5.5)	NR	6.8*** (5.42)
GBI	24.4	26.66	NR	26.6	14.44**	NR		NR	NR	0.51	NR	NR	0.22*
	22.2	28.9	NR	21.1	11.1**	NR	DMFS	NR	NR	1.32	NR	NR	0.29*
	22.2	28.9	NR	22.2	8.9**	NR		NR	NR	2.96	NR	NR	1.32*
IGU	6.43 (3.98)	4.16 (3.48)	NR	6.69 (3.74)	3.4*** (2.78)	NR	DF-S	10.25 (7.68)	NR	4.66 (3.69)	10.11 (7.04)	NR	4.97^{NS} (4.27)
L&S	0.9 (0.4)	1.1 (0.4)	NR	1.1 (0.4)	0.5 (0.3)	NR	DF-S	8.13 (6.6)	NR	5.02 (4.2)	8.81 (7.6)	NR	2.71*** (2.8)
GBI	NA	NA	NA	37	10	NR	DMFS	NA	NA	NA	62.8	NR	69.2
M_L	NR	NR	NR	NR	NR*	NR*	dmf-s	NR	8,6 (5,90)	NR	NR	4.91 (3.82)	NR***
	NR	NR	NR	NR	NR***	NR***	DMFS	0.19 (0.57)	2.24 (2.12)	NR	0.06 (0.28)	0.28 (0.64)	NR***
	NR	NR	NR	NR	NR**	NR**	DMFS	2.84 (2.4)	6.35 (5.8)	NR	2.4 (1.98)	3.12 (2.9)	NR***
L&S	NA	NA	NA	NR	0.2 (0.1)	NR		NA	NA	NA	NR	NR	1.1 (1.5)
	NA	NA	NA	NR	0.3 (0.2)	NR	DMFT	NA	NA	NA	NR	NR	0.8 (1.4)
	NA	NA	NA	NR	0.4 (0.5)	NR		NA	NA	NA	NR	NR	1.2 (1.5)
%IGU	NR	49.3	NR	NR	9.0	NR		25 (10.6)	NR	3.3 (4.2)	20 (11.74)	NR	1.0* (1.51)
	NR	49.3	NR	NR	13.8	NR	DF-S	25 (10.6)	NR	3.3 (4.2)	21 (10.35)	NR	1.2* (1.41)
	NR	49.3	NR	NR	31.8	NR		25 (10.6)	NR	3.3 (4.2)	21.6 (9.9)	NR	2.0^{NS} (2.4)
%IGU	7.9 (10.8)	11.9 (12.9)	NR	2.7 (3.4)	4 (4.6)	NR	DF-S	17.9 (11.3)	NR	2.3 (3.2)	16.2 (10.3)	NR	1.3 (2.3)
	15.8 (12.6)	14 (13.8)	NR	25.6 (13.4)	15 (11.6)	NR		15.1 (8.6)	NR	1.6 (2.9)	18.6 (9.7)	NR	2.3 (2.4)
DHC	1.13 (0.31)	1.11 (0.44)	−0.02 (0.58)	1.13 (0.31)	0.99 (0.27)	-0.14^{NS} (0.55)	DMFS	7.53 (7.34)	7.61 (7.44)	2.15 (2.63)	7.89 (7.68)	7.27 (7.40)	2.17^{NS} (3.43)
DHC	1.12 (0.28)	0.89 (0.42)	0.23	1.14 (0.36)	0.82 (0.39)	-0.32^{NS} (0.36)	DMFS	7.53 (6.67)	7.65	3.68 (4.03)	7.89 (6)	6.15 (6.12)	2.96^{NS} (3.96)
DHC	NR	NR	NR	NR	NR	NR	DMFS	5.96 (8.57)	NR	4.89 (4.67)	7.88 (9.37)	NR	4.27^{NS} (4.64)
	1.09 (0.46)	1.14 (0.26)	+0.05 (0.39)	1.12 (0.46)	0.67 (0.32)	−0.45** (0.32)		NR	NR	NR	NR	NR	NR
	1.14 (0.31)	1.22 (0.26)	+0.08 (0.26)	1.18 (0.46)	0.97 (0.32)	-0.21^{NS} (0.32)		NR	NR	NR	NR	NR	NR
%IGU	48 (29.28)	27 (22.85)	NR	47 (29.28)	11 (11.43)	NR		3 (3.03)	NR	2.6 (3.53)	3 (3.32)	NR	0.9 (2.16)
	48 (29.28)	27 (22.85)	NR	55 (25.71)	35 (23.57)	NR	M_Grondahl	3 (3.03)	NR	2.6 (3.53)	3.3 (3.61)	NR	2.5 (3.32)
	48 (29.28)	27 (22.85)	NR	54 (25.71)	14 (11.43)	NR		3 (3.03)	NR	2.6 (3.53)	3.5 (3.53)	NR	0.6 (1.73)
%IGU	24.3 (12.3)	7.4 (6.8)	NR	25.2 (35.4)	5.6 (5.7)	NR	DF-S	13.1	NR	0.26 (0.43)	13.9	NR	0.7^{NS} (2.2)
%IGU	36.0	9.0	NR	36.0	9.0	NR		NR	NR	7 (6.3)	NR	NR	5.4 (4.7)
	33.0	12.0	NR	36.0	6.0	NR	DMFS	NR	NR	4.2 (4.5)	NR	NR	3.2 (2.8)
	30.0	12.0	NR	36.0	9.0	NR		NR	NR	3.8 (3.2)	NR	NR	3.2 (3.2)
PDI	NR	0.88	NR	NR	0.86	NR	DMFS	NR	8.9	NR	NR	7.69	NR
	NR	0.88	NR	NR	0.92	NR		NR	8.9	NR	NR	7.54	NR
L&S	1.53	1.26	NR	1.42	1.21^{NS}	NR	DMFS	8.66 (15.56)	NR	1.79 (1.96)	8.7 (13.09)	NR	2.85^{NS} (2.91)
	1.53	1.26	NR	1.42	1.08	NR		14.47 (33.38)	NR	2.44 (22.23)	17.57 (28.94)	NR	1.83^{NS} (20.62)
%BOP	4.2 (0.3)	NR	+0.7 (0.2)	4.9 (0.9)	NR	−0.1 (0.5)*	DMFT	0.5 (0.2)	0.9 (0.3)	NR	0.4 (0.2)	0.9 (0.3)	NR
L&S	0.16	0.12	NR	0.16	0.00*	NR	dmfs DMFS	NR	NR	23	NR	NR	8^{NS}
GBI	0.4 (0.7)	0.5 (1.1)	0.1	0.5 (0.9)	0.3 (0.6)	−0.2***	D-T	1.2 (1.9)	1.7 (2.2)	0.5	1.0 (1.5)	1.7 (2.2)	0.7^{NS}
GI_S	34.4 (17.7–48.7)	26 (8.3–41.1)	NR	31.2 (19.4–41.7)	22.2^{NS} (12.5–43.8)	NR	DMFT	0.55 (1.16)	0.87 (1.3)	NR	0.77 (1.13)	1.0^{NS} (1.45)	NR
GI	NR	NR	NR	NR	NR	NR	DMFT	0.38	1.08	NR	0.57	0.91	NR
	NR	NR	NR	NR	NR	NR		0.38	1.08	NR	0.49	1.12	NR
L&S	15.36 (4.53)	16.31 (4.83)	NR	15.31 (5.20)	16.07^{NS} (4.67)	NR	DMFS	10.02	NR	6.43 (6.02)	9.57	NR	4.22*** (5.01)
	15.36 (4.53)	16.31 (4.83)	NR	14.83 (4.96)	15.88^{NS} (4.78)	NR		10.02	NR	6.43 (6.02)	9.91	NR	4.72** (5.47)

Table 4. (Continued)

References	Subgroup control	Subgroup test	Index	Plaque Index					
				Control			Test		
				Baseline Mean (SD)	Final Mean (SD)	Final – Baseline Mean (SD)	Baseline Mean (SD)	Final Mean (SD)	Final – Mean (SD)
(3B) Andlaw & Tucker (1975)	Placebo toothpaste	MFP toothpaste	OHI-S	0.85 (0.39)	0.89 (0.53)	NR	0.84 (0.4)	0.90^{NS} (0.5)	NR
Chemical plaque control									
(4) Lang et al. (1982)	Placebo rinse 6x/week	0.2% CHX rinse 6x/week	S&L	1.54 (0.33)	1.53	NR	1.48 (0.33)	1.24*	NR
		0.2% CHX rinse 2x/week		1.54 (0.33)	1.53	NR	1.34 (0.43)	1.34*	NR
		0.1% CHX rinse 6x/week		1.54 (0.33)	1.53	NR	1.48 (0.33)	1.29*	NR
(4) Johansen et al. (1975)	Placebo toothpaste (no abrasive)	Placebo toothpaste + abrasive	S&L	0.98	0.29	NR	0.93	0.28^{NS}	NR
		0.4% CHX toothpaste + abrasive		0.98	0.29	NR	0.93	0.24^{NS}	NR
		1% CHX toothpaste + abrasive		0.98	0.29	NR	0.93	0.21^{NS}	NR
(4) Axelsson et al. (1976)‡	CHX + OHI + MFP	CHX + OHI + Placebo	% Plaque	67.2 (13.9)	22.4 (14.6)	NR	60.9 (13.1)	22.9 (15.6)	NR
	CHX + OHI + MFP	Prophylaxis + OHI + MFP		67.2 (13.9)	22.4 (14.6)	NR	69 (11.4)	23.3 (13.8)	NR
	CHX + OHI + MFP	Prophylaxis + OHI + Placebo		67.2 (13.9)	22.4 (14.6)	NR	67.9 (10.6)	35.3 (13.6)	NR
	CHX + OHI + Placebo	Prophylaxis + OHI + MFP		60.9 (13.1)	22.9 (15.6)	NR	69 (11.4)	23.3 (13.8)	NR
	CHX + OHI + Placebo	Prophylaxis + OHI + Placebo		60.9 (13.1)	22.9	NR	67.9 (10.6)	35.3 (13.6)	NR
	Prophylaxis + OHI + MFP	Prophylaxis + OHI + Placebo		69 (11.4)	23.3	NR	67.9 (10.6)	35.3 (13.6)	NR
(4) Emilson et al. (1982)‡	Control	Prophylaxis	% Plaque	73.1 (16)	67.2 (18)	NR	75.9 (10.4)	26.3*** (13.9)	NR
		CHX gel		73.1 (16)	67.2 (18)	NR	71.8 (8.9)	74.3^{NS} (11.9)	NR
		CHX gel + MFP rinse		73.1 (16)	67.2 (18)	NR	69.8 (19.6)	70^{NS} (16.4)	NR

NR, not reported; NA, not applied.
Plaque indices: OHI-S, Simplified Oral Hygiene Index (Greene & Vermillion 1964); % Plaque, percentage number of tooth surfaces with plaque; mg Plaque, dry weight of plaque; S&L, Silness & Löe Plaque Index (Silness & Loe 1964); M_VOPI, Visible Occlusal Plaque Index, modified from (Carvalho et al. 1989); K-A, Kobayashi & Ash Index; PHP, Patient Hygiene Performance Index (Podshadley & Haley 1968); VPI, Visible Plaque Index (Ainamo & Bay 1975); M_S&L, modified from Silness & Löe Plaque Index (Loe 1967); API, modified Approximal Plaque Index (Lange et al. 1977).
Gingival indices: L&S, Löe & Silness Gingival Index (Loe & Silness 1963); GI_S, Simplified Gingival Index (Lindhe et al.1982); IGU, Inflamed Gingival Units; %IGU, percentage of Inflamed Gingival Units (Axelsson & Lindhe 1975); M_L, Gingival Index, modified from S&L; PDI, Periodontal Disease Index (Ramfjord 1959); DHC, Dental Health Center Gingival Index (Suomi 1969); GBI, Gingival Bleeding Index (Ainamo & Bay 1975); GI, Gingivitis Index (Gülzow et al., 1987).
Caries indices: DMF-S, Decayed, Missing and Filled Surfaces; DMF-T, Decayed, Missing and Filled Teeth (Klein et al. 1938); DF-S Decayed and Filled Surfaces (Koch, 1967); M_Grondahl, Modified Caries Index System (Grondahl et al. 1977); dmf-s, decayed, missing and filled deciduous surfaces; dmf-t, decayed, missing and filled deciduous teeth; D-T, Decayed Teeth.
Four and five sites were considered for caries examination of anterior and posterior teeth, respectively. Unless mentioned caries examination was considered as being carried out in all permanent and/or deciduous teeth.
†Results are presented as median and interquartile range.
‡The second study represents a subpopulation from the oldest study; G, gingivitis; AgP, aggressive periodontitis; ChP, chronic periodontitis.
Statistical significant differences between control and test groups are presented as * ($p < 0.05$); ** ($p < 0.01$) and *** ($p < 0.001$); ^{NS}, non-significant difference.

was the same on plaque and gingival scores, but significantly higher for the fluoride intervention regarding reduction in caries increment (Murray & Shaw 1980), while contradictory results for plaque and gingival scores were registered in the study by Andlaw & Tucker (1975).

Chemical plaque control

The use of mouthrinses with 0.1% or 0.2%, chlorhexidine (CHX) in children, for 6 months, achieved significant reductions for plaque and gingival indices, and no differences for caries increment, compared with a placebo (Lang et al. 1982). With the concurrent application of PTC and a 0.4% or 1% CHX toothpaste in dental students over a 2-year period, no differences were found in plaque and gingival scores, with the placebo group, while a lower caries increment was observed in the 1% CHX group, when compared to all other groups, concomitantly with a higher number of active non-cavitated lesions becoming inactive (Johansen et al. 1975). The combination of a 0.5% CHX gel, rinsing with 2% MFP solution or 0.8% MFP toothpaste, failed to significantly reduce plaque accumulation and gingival scores and to reduce the rate of caries development (Axelsson et al. 1976, Emilson et al. 1982).

Meta-analyses

Regarding the efficacy of OHI and PTC, the standardized WMDs revealed a reduction in plaque levels favouring OHI and PTC [$n = 4$; WMD = 1.294; 95% CI (0.445; 2.144); $p = 0.003$] (Table 5). In terms of gingivitis levels, OHI and PTC resulted in statistically significant higher reductions in standardized gingival index [$n = 4$; WMD = 1.728; 95% CI (0.631; 2.825); $p = 0.002$].

Gingival Index							Caries Index						
	Control			Test				Control			Test		
Index	Baseline Mean (SD)	Final Mean (SD)	Final – Baseline Mean (SD)	Baseline Mean (SD)	Final Mean (SD)	Final – Baseline Mean (SD)	Index	Baseline Mean (SD)	Final Mean (SD)	Final – Baseline Mean (SD)	Baseline Mean (SD)	Final Mean (SD)	Final – Baseline Mean (SD)
L&S	0.10 (0.11)	0.11 (0.14)	NR	0.10 (0.11)	0.11^{NS} (0.14)	NR	DMFS	9.7 (7.55)	NR	8.81 (5.72)	9.18 (6.48)	NR	7.14*** (5.72)
L&S	0.96 (0.44)	0.74	NR	0.88 (0.43)	0.15**	NR		8.03 (6.51)	NR	0.89	7.81 (6.0)	NR	0.93^{NS}
	0.96 (0.44)	0.74	NR	0.78 (0.35)	0.38*	NR	DMFS	8.03 (6.51)	NR	0.89	9.27 (6.82)	NR	0.71^{NS}
	0.96 (0.44)	0.74	NR	0.80 (0.37)	0.25**	NR		8.03 (6.51)	NR	0.89	7.82 (5.96)	NR	0.89^{NS}
L&S	1.12	1.18	NR	1.26	1.14^{NS}	NR		20.0	26.9	NR	NR	NR	NR
	1.12	1.18	NR	1.09	1.18^{NS}	NR	NR	20.0	26.9	NR	19	23.1	NR
	1.12	1.18	NR	1.13	1.14^{NS}	NR		20.0	26.9	NR	16	13.7	NR
%IGU	22.4 (15.2)	3.2 (4.8)	NR	18.4 (12.4)	3.5 (3.1)	NR	DF-S	14.2 (7.6)	NR	5.9 (5.5)	13.2 (7.8)	NR	4.3^{NS} (5.0)
	22.4 (15.2)	3.2 (4.8)	NR	22.5 (11.4)	4.1 (4.2)	NR		14.2 (7.6)	NR	5.9 (5.5)	13.1 (7.6)	NR	0.3*** (0.6)
	22.4 (15.2)	3.2 (4.8)	NR	23.5 (11.2)	6.4 (4.7)	NR		14.2 (7.6)	NR	5.9 (5.5)	12.8 (7.7)	NR	0.4*** (1.2)
	18.4 (12.4)	3.5 (3.1)	NR	22.5 (11.4)	4.1 (4.2)	NR		13.2 (7.8)	NR	4.3 (5.0)	13.1 (7.6)	NR	0.3*** (0.6)
	18.4 (12.4)	3.5 (3.1)	NR	23.5 (11.2)	6.4 (4.7)	NR		13.2 (7.8)	NR	4.3 (5.0)	12.8 (7.7)	NR	0.4*** (1.2)
	22.5 (11.4)	4.1 (4.2)	NR	23.5 (11.2)	6.4 (4.7)	NR		13.1 (7.6)	NR	0.3 (0.6)	12.8 (7.7)	NR	0.4*** (1.2)
%IGU	29.3 (17.2)	33.3 (19.2)	NR	30.4 (14.7)	7.1*** (8.9)	NR	DF-S	23.6 (10.8)	NR	10.1 (8)	19.1 (9.68)	NR	1.3*** (3.49)
	29.3 (17.2)	33.3 (19.2)	NR	25.5 (13.8)	24.8^{NS} (14.9)	NR		23.6 (10.8)	NR	10.1 (8)	18.9 (8.61)	NR	5.7^{NS} (5.24)
	29.3 (17.2)	33.3 (19.2)	NR	31.1 (20.4)	35.9^{NS} (25.2)	NR		23.6 (10.8)	NR	10.1 (8)	19.3 (9.2)	NR	8.4^{NS} (8)

The meta-analysis on the efficacy of fluorides on caries management showed statistically significant lower caries increment favouring the test group [$n = 5$; WMD = 1.159; 95% CI (0.145; 2.172); $p = 0.025$] and a lack of statistically significant effect on plaque [$n = 4$; WMD = 0.145; 95% CI (−0.142; 0.433); $p = 0.323$] or gingival scores [$n = 4$; WMD = 0.018; 95% CI (−0.079; 0.116); $p = 0.715$].

Risk of bias across studies

There was no evidence of publication bias among the studies for the main common outcome (standardized plaque) [$t = -0.16$; 95% CI (−14.18; 12.37); $p = 0.879$], and the sensitivity analyses for this outcome showed that the exclusion of a single study did not substantially alter any estimate.

Strength of the evidence

Information reporting the strength of the evidence for each intervention on each outcome is presented in Table 6. As a general trend, the strength of the evidence ranges between low and moderate.

Discussion

The present systematic review analysed the effect of mechanical and chemical plaque control procedures in the simultaneous management of periodontal diseases and caries. The primary outcomes were reduction in plaque and gingival scores and the mean caries increment. Low to moderate evidence is available to support that combined professional and self-performed mechanical plaque control significantly reduce plaque and gingivitis scores during the intervention period. Also, there is moderate evidence on the efficacy of

fluoride toothpaste and rinse on caries management. The use of CHX rinses is relevant for gingivitis management.

Mechanical plaque control

Periodontal diseases and caries are both biofilm-related diseases; however, while gingivitis is a reversible disease, and therefore could be successfully treated, by means of control of supragingival biofilm (Chapple et al. 2015), in case of caries, the main therapeutic goal would be to reduce lesions progression or reverse the activity of the existing ones, being the biofilm control only part of the disease control strategy, along with rational use of sugar and fluorides (Tenuta & Cury 2013).

The results of PTC showed its efficacy in terms of significant reductions in plaque and gingivitis scores in addition to lower caries increment, when compared to toothbrushing, to mouthrinsing or to no intervention. These results are in agreement with previous publications, demonstrating that there is moderate evidence that professional mechanical plaque removal (PMPR) combined with OHI results in greater reduction in plaque and gingival bleeding, when compared with no treatment (Needleman et al. 2015). In terms of caries, the wide variety of fluoride regimens being used in the test and control groups (Tables 3 and 4) provoked a degree of heterogeneity that precluded a meta-analytic approach.

In this context, it is important to clarify that in periodontology, PMPR includes supragingival and submarginal plaque and calculus removal (Tonetti et al. 2015), which was applied in only two studies in the present review (Lang et al. 1982, Chambrone & Chambrone 2011). In cariology, PMPR signifies only supragingival plaque removal and it is used as synonym to PTC.

The frequency of PTC has been reported as significant if comparing organized *versus* non-organized PTC frequencies, but not if organized PTC were reduced from once per month to once every 3 or 6 months, except for one study (Hamp et al. 1984). This indicates low-strength evidence that the main issue is the existence of a regular pattern of PTC, without relevant information to define the optimal interval. Within the periodontal outcomes, these results are partly in agreement with previous studies, that a single episode of PMPR followed by repeated OHI is as effective as repeated PMPR in reducing gingivitis (Needleman et al. 2015). Within caries outcomes, the frequency of PTC followed by various fluoride regimens only showed increased caries increment, but not statistically significantly, when the interval was extended to 6 months (Hamp & Johansson 1982). There is insufficient evidence to determine whether more extended intervals would significantly increase caries increment, in accordance with Riley et al. (2013).

The results from the present systematic review were scarce in terms of the effect of the combined effect of PTC and OHI *versus* PTC alone, reporting a pronounced effect on plaque and gingivitis for the combined procedure, without a significant effect on caries, except the study by Axelsson & Lindhe (1981). For periodontal outcomes, these results are in agreement with previous systematic reviews, where a little value in providing PMPR without OHI to reduce gingivitis was reported (Needleman et al. 2015, Tonetti et al. 2015). For caries outcomes, an earlier systematic review showed evidence for the combined effect of PTC including fluoride and OHI in adolescents (Axelsson et al. 2004), but not without the inclusion of fluoride.

Regarding the effect of motivation and OHI, a tendency to slight improvement on gingival bleeding was observed for individual toothbrushing training (Zanin et al. 2007, Mbawalla et al. 2013), in agreement with Chapple et al. (2015), reporting that a single episode of OHI leads to small but statistically significant reduction in plaque and gingivitis after 6 months. A possible effect of these interventions in caries management seemed very low to be clinically measured in accordance with Mejare et al. (2015), who observed very low quality of evidence for the effect of several interventions.

No study addressing the efficacy of self-performed toothbrushing or interdental cleaning in periodontal and caries outcomes was found for the present review. From a periodontal point of view, a recent meta-review has demonstrated that toothbrushes are able to reduce plaque scores (Van der Weijden & Slot 2015), and individual studies indicate that they are able to reduce gingival inflammation (Chapple et al. 2015). In addition, interproximal cleaning by means of different devices is essential to maintain interproximal gingival heath (Chapple et al. 2015), suggesting that interdental brushes are the most effective method for plaque removal (Salzer et al. 2015). In cariology, a systematic review by Kumar et al. (2016) reported that infrequent toothbrushing was linked to higher caries increments than frequent toothbrushing. This finding is in agreement with that the use of fluoride toothpastes is, by far, the most successful measure for caries control (Marinho et al. 2003), by combining the mechanical plaque removal by brushing and the chemical effect of the fluoride ion in reducing caries progression (Tenuta & Cury 2010, 2013). Combined with previous systematic reviews assessing the role of fluoride toothpastes on caries control (Marinho et al. 2003), the present review confirms that the adjunction of fluoride in any plaque control regimen aiming to manage dental caries is significantly important.

Chemical plaque control

Only four of the included studies evaluated the direct effect of chemical plaque control, with CHX combined or not with fluorides, in the prevention of gingivitis and caries. None of the studies reported significant benefits for caries, and only one identified statistically significant differences in terms of gingivitis and plaque control, favouring the test group, when CHX was delivered as a mouthrinse (Lang et al. 1982). This positive effect of a CHX mouthrinses is in agreement with previous findings in gingivitis management (Gunsolley 2006, Serrano et al. 2015). In contrast, a CHX gel did not demonstrate significant benefits. Difficulties in formulating CHX in dentifrices are well known, due to the high risk of inactivation, and may be explained the contradictory results. In addition, an

Table 5. Meta-analysis on the efficacy of oral hygiene instructions and prophylaxis and the use of fluorides in the reduction in plaque, gingivitis and caries increments

Intervention	Outcome	*n*	Weighted mean difference (WMD)				Heterogeneity	
			DL	95% CI		*p*-value	I2 (%)	*p*-value
				Upper	Lower			
Prophylaxis & OHI	Plaque[†]	4	1.294	0.445	2.144	0.003	68.5	<0.001
	Gingivitis[†]	4	1.728	0.631	2.825	0.002	97.4	<0.001
Fluorides[‡]	Plaque[†]	4	0.145	−0.142	0.433	0.323	82.7	0.001
	Gingivitis[†]	4	0.018	−0.079	0.116	0.715	0	0.876
	DMFS	5	1.159	0.145	2.172	0.025	83.7	<0.001

[†]Standardized. OHI, oral hygiene instructions; DL, Dersimonian & Laird method; CI, confidence interval.
[‡]Fluoride applications: toothpastes and rinse, containing sodium fluoride (NaF) and monofluorophosphate (MFP).
Studies included in each analysis:
Prophylaxis & OHI: Plaque: Ashley & Sainsbury (1981), Axelsson & Lindhe (1974) (two protocols), Klimek et al. (1985), Gingivitis: Ashley & Sainsbury (1981), Hamp & Johansson (1982) (two arms), Klimek et al. (1985).
Fluorides: Plaque and gingivitis: Andlaw & Tucker (1975), Axelsson et al. (1976), Axelsson & Lindhe (1975), Murray & Shaw (1980). DMFS: Andlaw & Tucker (1975), Axelsson & Lindhe (1975), Murray & Shaw (1980), Axelsson et al. (1976), Zickert et al.(1982).

Table 6. Strength of the evidence for each reported procedure based on Needleman et al. (2005)

	Plaque		Gingivitis		Caries	
	Benefit[§]	Evidence[¶]	Benefit	Evidence	Benefit	Evidence
Prophylaxis[†]						
Efficacy	Positive	Moderate	Positive	Moderate	Positive	Moderate
Frequency	No benefit	Low	No benefit	Low	No benefit	Low
With or without OHI	Positive	Moderate	Positive	Moderate	Unclear	Low
Motivation alone	No benefit	Moderate	No benefit	Moderate	No benefit	Low
Toothbrushing (powered vs manual[‡])	No benefit	Low	No benefit	Low	No benefit	Low
Fluoride	No benefit	Moderate	No benefit	Moderate	Benefit	Moderate
Chlorhexidine[‡]	Benefit	Low	Benefit	Low	No Benefit	Low

OHI, oral hygiene instructions or education.
[†]Fluoride included.
[‡]Only one study.
[§]Benefit could be: (1) positive (test better than control); (2) negative (control better than test); (3) no benefit (test equal to control); and (4) unclear (controversy among studies).
Evidence could be (Needleman et al. 2005): (1) High-strength evidence (overall low risk of bias and consistent results between outcomes within and between studies); (2) moderate-strength evidence: overall unclear risk of bias, consistent results between outcomes within and between studies; (3) low-strength evidence: overall high risk of bias, consistent or conflicting/inconsistent results between outcomes either within or between studies.

active agent applied in mouthrinses tends to be more effective than when applied as gel/dentifrice (Serrano et al. 2015).

In the management of dental caries, CHX has been limited to high caries risk patients (Hayes 2015, Restrepo et al. 2016). The use of CHX varnish or gel in children and adolescents with regular exposure to fluoride led to inconclusive evidence (Twetman 2004, Richards 2015, Walsh et al. 2015). In the elderly, CHX varnish four times per year was reported to decrease initiation and progression of root caries lesions (Syrjala et al. 2001, Hayes 2015, Wierichs & Meyer-Lueckel 2015). The present review is not able to add information in this regard.

Strengths and limitations

Apart from two previous Cochrane systematic reviews, which addressed the efficacy of specific mechanical plaque control procedures (flossing and interdental brushing) in the management of caries and gingivitis in adults (Sambunjak et al. 2011, Poklepovic et al. 2013), from our knowledge, this is the first systematic review addressing the effect of various mechanical and chemical plaque control procedures in the simultaneous management of caries of gingivitis.

However, different limitations are evident: 1) language restriction leading to inclusion only of studies in English; 2) most of the evidence was gathered from trials carried out in the 1970s and the 1980s, when caries prevalence was higher than today; 3) high risk on bias in some studies; 4) variety of indices used, leading to a need for further combination in order to interpret results; 5) limited number of trials for each intervention regimen applied; and 6) limited number of studies available for MA, with some comparisons coming from the same studies, which resulted in a high degree of heterogeneity.

However, despite these limitations, it can be concluded that

mechanical plaque control procedures are effective in reducing plaque and gingivitis. Mechanical plaque control using fluoride is significant for reduction in caries increment. CHX rinses have a positive effect on gingivitis and an inconclusive role in caries.

Implications for future research

The simultaneous long-term effects, from childhood to adulthood, of mainly chemical plaque control interventions on reductions in gingivitis and caries management need to be substantiated by further evidence through well-designed controlled clinical trials.

For the management of dental caries, interventions should also be evaluated on their ability to interfere with caries activity, particularly of non-cavitated lesions which represent an important component of individual caries experience and are able to undergo transitions without the need of operative treatment.

Implications for clinical practice

Reductions in plaque and gingivitis scores may be obtained by mechanical plaque control. The combined use of chemical agents with mechanical plaque control in the simultaneous management of gingivitis and caries is still limited in evidence. The indication of either intervention should be based on individual needs and risk assessment. In any case, the use of fluoride vehicles is indicated to control caries progression.

Acknowledgements

Authors would like to acknowledge to Mª Angeles López de Barrio, Head Librarian from the Faculty of Dentistry, University Complutense, Madrid (Spain), and to Christine Lanners, Head Librarian of the Health Sciences Library, Catholic University of Louvain (Belgium), for their help in the electronic search and in the retrieval of full-text references.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1 Search strategy.
Appendix S2. Excluded studies after full-text analysis and main reason for exclusion.
Table S1. Evaluation of the risk of bias in individual studies, as suggested by the Cochrane reviewers' handbook and by the CONSORT statement: study design, selection bias, performance bias, detection bias, attrition bias, reporting bias and other potential source of bias, categorized by plaque control regimen.
Table S2. Evaluation of risk of bias in prospective case series. Modification of the Newcastle-Ottawa Scale (NOS). Total score obtained by the sum of stars.
Table S3. Study characteristics: ethical aspects, registration of the clinical trial, sample size calculation and/or power analysis, calibration and reproducibility of examiners, categorized by plaque control regimen.

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Clinical Relevance

Scientific rationale for study: The independent efficacy of mechanical and chemical plaque control procedures on caries and on gingivitis has been widely evaluated. However, there is a scarcity of systematic reviews reporting their simultaneous effect on both outcomes.

Principal findings: Mechanical plaque control procedures are effective in reducing plaque and gingivitis. Fluorides are mainly significant for caries management, while chlorhexidine rinse has a positive effect on gingivitis.
Practical implications: Reductions in plaque and gingivitis may be obtained by mechanical plaque control. Its combination with fluorides is essential caries management. The indication of either intervention should be based on individual needs and risk assessment.