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Root coverage procedures for treating localised and multiple recession-type defects (Review)

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Root coverage procedures for treating localised and multiple recession-type defects.
Cochrane Database of Systematic Reviews 2018, Issue 10. Art. No.: CD007161.
DOI: 10.1002/14651858.CD007161.pub3.

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[Intervention Review]

Root coverage procedures for treating localised and multiple recession-type defects

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Editorial group: Cochrane Oral Health Group.
Publication status and date: Edited (no change to conclusions), published in Issue 10, 2018.

Citation: Chambrone L, Salinas Ortega MA, Sukekava F, Rotundo R, Kalemaj Z, Buti J, Pini Prato GP. Root coverage procedures for treating localised and multiple recession-type defects. *Cochrane Database of Systematic Reviews* 2018, Issue 10. Art. No.: CD007161. DOI: 10.1002/14651858.CD007161.pub3.

ABSTRACT

Background

Gingival recession is defined as the oral exposure of the root surface due to a displacement of the gingival margin apical to the cemento-enamel junction and it is regularly linked to the deterioration of dental aesthetics. Successful treatment of recession-type defects is based on the use of predictable root coverage periodontal plastic surgery (RCPPS) procedures. This review is an update of the original version that was published in 2009.

Objectives

To evaluate the efficacy of different root coverage procedures in the treatment of single and multiple recession-type defects.

Search methods

Cochrane Oral Health's Information Specialist searched the following databases: Cochrane Oral Health's Trials Register (to 15 January 2018), the Cochrane Central Register of Controlled Trials (CENTRAL; 2017, Issue 12) in the Cochrane Library (searched 15 January 2018), MEDLINE Ovid (1946 to 15 January 2018), and Embase Ovid (1980 to 15 January 2018). The US National Institutes of Health Ongoing Trials Register (ClinicalTrials.gov) and the World Health Organization International Clinical Trials Registry Platform were searched for ongoing trials (15 January 2018). No restrictions were placed on the language or date of publication when searching the electronic databases.

Selection criteria

We included randomised controlled trials (RCTs) only of at least 6 months' duration evaluating recession areas (Miller's Class I or II ≥ 3 mm) and treated by means of RCPPS procedures.

Data collection and analysis

Screening of eligible studies, data extraction and risk of bias assessment were conducted independently and in duplicate. Authors were contacted for any missing information. We expressed results as random-effects models using mean differences (MD) for continuous outcomes and odds ratios (OR) for dichotomous outcomes with 95% confidence intervals (CI). We used GRADE methods to assess the quality of the body of evidence of our main comparisons.

Main results

We included 48 RCTs in the review. Of these, we assessed one as at low risk of bias, 12 as at high risk of bias and 35 as at unclear risk of bias. The results indicated a greater reduction in gingival recession for subepithelial connective tissue grafts (SCTG) + coronally advanced flap (CAF) compared to guided tissue regeneration with resorbable membranes (GTR rm) + CAF (MD -0.37 mm; 95% CI -0.60 to -0.13, P = 0.002; 3 studies; 98 participants; low-quality evidence). There was insufficient evidence of a difference in gingival recession reduction between acellular dermal matrix grafts (ADMG) + CAF and SCTG + CAF or between enamel matrix protein (EMP) + CAF and SCTG + CAF. Regarding clinical attachment level changes, GTR rm + CAF promoted additional gains compared to SCTG + CAF (MD 0.35; 95% CI 0.06 to 0.63, P = 0.02; 3 studies; 98 participants; low-quality evidence) but there was insufficient evidence of a difference between ADMG + CAF and SCTG + CAF or between EMP + CAF and SCTG + CAF. Greater gains in the keratinized tissue were found for SCTG + CAF when compared to EMP + CAF (MD -1.06 mm; 95% CI -1.36 to -0.76, P < 0.00001; 2 studies; 62 participants; low-quality evidence), and SCTG + CAF when compared to GTR rm + CAF (MD -1.77 mm; 95% CI -2.66 to -0.89, P < 0.0001; 3 studies; 98 participants; very low-quality evidence). There was insufficient evidence of a difference in keratinized tissue gain between ADMG + CAF and SCTG + CAF. Few data exist on aesthetic condition change related to patients' opinion and patients' preference for a specific procedure.

Authors' conclusions

Subepithelial connective tissue grafts, coronally advanced flap alone or associated with other biomaterial and guided tissue regeneration may be used as root coverage procedures for treating localised or multiple recession-type defects. The available evidence base indicates that in cases where both root coverage and gain in the width of keratinized tissue are expected, the use of subepithelial connective tissue grafts shows a slight improvement in outcome. There is also some weak evidence suggesting that acellular dermal matrix grafts appear as the soft tissue substitute that may provide the most similar outcomes to those achieved by subepithelial connective tissue grafts. RCTs are necessary to identify possible factors associated with the prognosis of each RCPPS procedure. The potential impact of bias on these outcomes is unclear.

PLAIN LANGUAGE SUMMARY

Root coverage procedures for the treatment of localised and multiple recession-type defects

Review question

The aim of this review was to evaluate the efficacy of different surgical procedures to cover exposed tooth roots, when the gum tissue has receded away from the tooth.

Background

Receding gums (also known as gingival recession) is the gradual loss of gum tissue, and if left untreated it can result in exposure of the tooth root, between the gum and the tooth. It can involve one tooth (single recession-type defect) or many teeth (multiple recession-type defects). It can affect the look of the teeth, and is also linked to tooth sensitivity. Exposure of the tooth root can be treated by cosmetic surgery; techniques include grafting and gum regeneration. Grafting involves taking tissue from another place in the mouth and stitching it over the area of the exposed root. With gum regeneration, biomaterials are used to regenerate gum tissue without the need for taking it from the roof of the mouth. Procedures used in gum grafting and gum regeneration include: free gingival grafts, coronally advanced flaps, acellular dermal matrix grafts, laterally positioned flaps and guided tissue regeneration. This review is an update of the original version that was published in 2009.

Study characteristics

Authors from Cochrane Oral Health carried out this review and the evidence is up to date to 15 January 2018. A total of 48 randomised controlled trials on 1227 adults were included with five studies evaluating multiple recession-type defects and the rest single gingival recessions. Most trials followed participants for 6 months to 12 months. The review looked at different interventions: free gingival grafts (FGG), coronally advanced flap (CAF) alone or associated to acellular dermal matrix grafts (ADMG), enamel matrix protein (EMP), guided tissue regeneration with resorbable membranes (GTR rm), guided tissue regeneration with non-resorbable membranes (GTR nrm), GTR rm associated with bone substitutes, platelet-rich plasma or fibrin (PRP or PRF), growth factors (rhPDGF-BB) associated to bone substitutes (b-TCP), subepithelial connective tissue grafts (SCTG) or xenogeneic collagen matrix (XCM). We did not find any trials evaluating laterally positioned flaps (LPF).

Key results

The results of this review have shown that most root coverage periodontal plastic surgery procedures led to gains in reduction of gingival recession. However, we are uncertain about which intervention is the most effective as all studies were judged to be at unclear or high risk of bias. Preferably, subepithelial connective tissue grafts, coronally advanced flap alone or associated with another graft or biomaterial and guided tissue regeneration can be used as root coverage procedures for treating recession-type defects. Limited data exist on how these interventions affect the appearance of the teeth. Adverse effects reported in the studies included discomfort and pain, but these were mainly related to the site where the tissue graft was taken, and occurred mainly within the first week after surgery with no influence on root coverage outcomes. Further research is needed on the results to be achieved from each root coverage periodontal plastic procedure.

Quality of the evidence

We judged the quality of the evidence to be low or very low mainly due to problems with the design of the studies.

Summary of findings for the main comparison. Acellular dermal matrix graft (ADMG) + coronally advanced flap (CAF) compared to subepithelial connective tissue graft (SCTG) + CAF for treating adult patients with single recession-type defects (short term)

ADMG + CAF compared to SCTG + CAF for adult patients with localised recession-type defects (short term)

Patient or population: adult patients with single recession-type defects
Setting: university dental departments
Intervention: ADMG + CAF
Comparison: SCTG + CAF

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	Number of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with SCTG + CAF	Risk with ADMG + CAF				
Aesthetic condition change related to patient's opinion	-	-	-	-	-	Not reported
Sites with complete root coverage Follow-up: range 6 months to 12 months	520 per 1000	245 per 1000 (123 to 597)	OR 0.43 (0.13 to 1.37)	50 (2 RCTs)	⊕⊕⊖⊖ LOW[1]	Only parallel-design studies were included
Gingival recession change Follow-up: range 6 months to 12 months	The mean gingival recession change ranged from 2.48 to 4.20 mm	MD 0.36 mm lower (1.03 lower to 0.3 higher)	-	100 (4 RCTs)	⊕⊕⊖⊖ LOW[2]	Subgroup analyses were undertaken for parallel-design and split-mouth studies
Clinical attachment level change Follow-up: range 6 months to 12 months	The mean clinical attachment level change ranged from 2.23 to 4.40 mm	MD 0.53 mm lower (1.14 lower to 0.08 higher)	-	100 (4 RCTs)	⊕⊕⊖⊖ LOW[2]	Subgroup analyses were undertaken for parallel-design and split-mouth studies
Keratinized tissue change Follow-up: range 6 months to 12 months	The mean keratinized tissue change ranged from -0.15 to -3.30 mm	MD 0.59 mm lower (1.27 lower to 0.10 higher)	-	100 (4 RCTs)	⊕⊖⊖⊖ VERY LOW[3]	Subgroup analyses were undertaken for parallel-design and split-mouth studies.There was a clear inconsistence in the results according to the study design

*__The risk in the intervention group__ (and its 95% CI) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

ADMG: acellular dermal matrix graft; **CAF:** coronally advanced flap; **CI:** confidence interval; **MD:** mean difference; **OR:** odds ratio; **RCT:** randomised controlled trial; **SCTG:** subepithelial connective tissue graft.

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

[1]Downgraded 2 levels for imprecision.
[2]Downgraded 1 level for inconsistency and 1 for imprecision.

[3]Downgraded 2 levels for inconsistency and 1 for imprecision.

Summary of findings 2. Acellular dermal matrix graft (ADMG) + coronally advanced flap (CAF) compared to CAF for treating adult patients with single recession-type defects (short term)

ADMG + CAF compared to CAF for adult patients with single recession-type defects (short term)

Patient or population: adult patients with single recession-type defects
Setting: university/dental hospital
Intervention: ADMG + CAF
Comparison: CAF

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	Number of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with CAF	Risk with ADMG + CAF				
Aesthetic condition change related to patient's opinion	-	-	-	-	-	Not reported
Sites with complete root coverage Follow-up: range 6 months to 12 months	280 per 1000	607 per 1000 (72 to 969)	OR 3.97 (0.20 to 80.50)	50 (2 RCTs)	⊕⊖⊖⊖ VERY LOW[1]	1 parallel-design and 1 split-mouth studies were included. There was a clear inconsistence in the results according to the study design
Gingival recession depth change Follow-up: range 6 months to 12 months	The mean gingival recession depth change	MD 0.61 mm higher (0.52 lower to 1.73 higher)	-	50 (2 RCTs)	⊕⊕⊖⊖ LOW[2]	1 parallel-design and 1 split-mouth studies were included

	ranged from 2.19 to 2.50 mm					
Clinical attachment level change Follow-up: range 6 months to 12 months	The mean clinical attachment level change ranged from 1.92 to 2.64 mm	MD 0.51 mm higher (0.25 lower to 1.27 higher)	-	50 (2 RCTs)	⊕⊕⊖⊖ LOW[2]	1 parallel-design and 1 split-mouth studies were included
Keratinized tissue width change Follow-up: range 6 months to 12 months	The mean keratinized tissue width change ranged from -0.33 to -0.46 mm	MD 0.28 mm higher (0.08 lower to 0.64 higher)	-	50 (2 RCTs)	⊕⊕⊖⊖ LOW[2]	1 parallel-design and 1 split-mouth studies were included

*__The risk in the intervention group__ (and its 95% CI) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

ADMG: acellular dermal matrix graft; **CAF:** coronally advanced flap; **CI:** confidence interval; **MD:** mean difference; **OR:** odds ratio; **RCT:** randomised controlled trial.

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

[1]Downgraded 2 levels for inconsistency and 1 level for imprecision.

[2]Downgraded 1 level for inconsistency and 1 level for imprecision.

Summary of findings 3. Enamel matrix protein (EMP) + coronally advanced flap (CAF) compared to CAF for treating adult patients with single recession-type defects (short term)

EMP + CAF compared to CAF for adult patients with single recession-type defects (short term)

Patient or population: adult patients with single recession-type defects
Setting: university/dental hospital
Intervention: EMP + CAF
Comparison: CAF

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	Number of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with CAF	Risk with EMP + CAF				

Aesthetic condition change related to patient's opinion	-	-	-	-	-	Not reported
Gingival recession depth change Follow-up: range 6 months to 12 months	The mean gingival recession depth change ranged from 2.16 to 3.80 mm	MD 0.07 mm higher (0.25 lower to 0.40 higher)	-	136 (3 RCTs)	⊕⊕⊖⊖ LOW[1]	1 parallel-design and 2 split-mouth studies were included
Clinical attachment level change Follow-up: range 6 months to 12 months	The mean clinical attachment level change ranged from 2.18 to 3.80 mm	MD 0.22 mm higher (0.02 lower to 0.45 higher)	-	136 (3 RCTs)	⊕⊕⊖⊖ LOW[1]	1 parallel-design and 2 split-mouth studies were included
Keratinized tissue width change Follow-up: range 6 months to 12 months	The mean keratinized tissue width change ranged from -0.30 to -0.53 mm	MD 0.35 mm higher (0.13 higher to 0.56 higher)	-	136 (3 RCTs)	⊕⊕⊖⊖ LOW[1]	1 parallel-design and 2 split-mouth studies were included

*__The risk in the intervention group__ (and its 95% CI) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

CAF: coronally advanced flap; **CI:** confidence interval; **EMP:** enamel matrix protein; **MD:** mean difference; **RCT:** randomised controlled trial.

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

[1]Downgraded 1 level for inconsistency and 1 level for imprecision.

Summary of findings 4. Enamel matrix protein (EMP) + coronally advanced flap (CAF) compared to subepithelial connective tissue graft (SCTG) + CAF for treating adult patients with single recession-type defects (short/medium term)

EMP + CAF compared to SCTG + CAF for adult patients with single recession-type defects (short/medium term)					
Patient or population: adult patients with single recession-type defects **Setting:** private practice **Intervention:** EMP + CAF **Comparison:** SCTG + CAF					
Outcomes	**Anticipated absolute effects* (95% CI)**	**Relative effect (95% CI)**	**Number of participants (studies)**	**Certainty of the evidence (GRADE)**	**Comments**

	Risk with SCTG + CAF	Risk with EMP + CAF				
Aesthetic condition change related to patient's opinion	-	-	-	(1 RCT)	⊕⊖⊖⊖ VERY LOW[1]	McGuire 2012 10 years after surgery asked their patients to respond to questions related to aesthetic satisfaction. 6 patients had no preference for a particular type of treatment, 2 favoured aesthetic results with the test treatment (i.e. EMD + CAF), and 1 favoured results with the control treatment (SCTG + CAF) (P = 0.564)
Sites with complete root coverage Follow-up: range 6 months to 24 months	742 per 1000	527 per 1000 (141 to 1000)	OR 0.61 (0.05 to 7.86)	62 (2 RCTs)	⊕⊖⊖⊖ VERY LOW[2]	1 of the studies provided 6-month data, while the other 24-month outcomes
Gingival recession change Follow-up: range 6 months to 12 months	The mean gingival recession change ranged from 4.01 to 4.33 mm	MD 0.39 mm lower (1.27 lower to 0.48 higher)	-	62 (2 RCTs)	⊕⊖⊖⊖ VERY LOW[2]	-
Clinical attachment change Follow-up: range 6 months to 12 months	The mean clinical attachment change ranged from 4.21 to 4.51 mm	MD 0.25 mm lower (0.69 lower to 0.20 higher)	-	62 (2 RCTs)	⊕⊕⊖⊖ LOW[3]	-
Keratinized tissue change Follow-up: range 6 months to 12 months	The mean keratinized tissue change ranged from -1.56 to -1.83 mm	MD 1.06 mm lower (1.36 lower to 0.76 lower)	-	62 (2 RCTs)	⊕⊖⊖⊖ VERY LOW[2]	-

*__The risk in the intervention group__ (and its 95% CI) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

CAF: coronally advanced flap; **CI:** confidence interval; **EMP:** enamel matrix protein; **MD:** mean difference; **RCT:** randomised controlled trial; **SCTG:** subepithelial connective tissue graft.

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

[1]Downgraded 1 level for risk of bias, 1 level for inconsistency and 2 levels for imprecision.

[2]Downgraded 1 level for inconsistency and 2 levels for imprecision.

[3]Downgraded 2 levels for imprecision.

Summary of findings 5. Guided tissue regeneration resorbable membrane (GTR rm) + coronally advanced flap (CAF) compared to subepithelial connective tissue graft (SCTG) + CAF for treating adult patients with single recession-type defects (short term)

GTR rm + CAF compared to SCTG + CAF for adult patients with localised recession-type defects (short term)

Patient or population: adult patients with single recession-type defects
Setting: university dental departments
Intervention: GTR rm + CAF
Comparison: SCTG + CAF

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	Number of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with SCTG + CAF	Risk with GTR rm + CAF				
Aesthetic condition change related to patient's opinion	-	-	-	-	-	Not reported
Sites with complete root coverage Follow-up: range 6 months to 12 months	571 per 1000	449 per 1000 (286 to 623)	OR 0.61 (0.30 to 1.24)	98 (3 RCTs)	⊕⊕⊖⊖ LOW[1]	-
Gingival recession change Follow-up: range 6 months to 12 months	The mean gingival recession change ranged from 2.80 to 5.30 mm	MD 0.37 mm lower (0.60 lower to 0.13 lower)	-	98 (3 RCTs)	⊕⊕⊖⊖ LOW[1]	-
Clinical attachment level change Follow-up: range 6 months to 12 months	The mean clinical attachment level change ranged from 2.30 to 4.70	MD 0.35 higher (0.06 higher to 0.63 higher)	-	98 (3 RCTs)	⊕⊕⊖⊖ LOW[1]	-
Keratinized tissue change Follow-up: range 6 months to 12 months	The mean keratinized tissue change ranged from -1.10 to -3.10 mm	MD 1.77 mm lower (2.66 lower to 0.89 lower)	-	98 (3 RCTs)	⊕⊖⊖⊖ VERY LOW[2]	-

*__The risk in the intervention group__ (and its 95% CI) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

CAF: coronally advanced flap; **CI:** confidence interval; **GTR rm:** guided tissue regeneration resorbable membrane; **MD:** mean difference; **OR:** odds ratio; **RCT:** randomised controlled trial; **SCTG:** subepithelial connective tissue graft.

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

[1] Downgraded 2 levels for imprecision.

[2] Downgraded 1 level for inconsistency and 2 levels for imprecision.

Summary of findings 6. Xenogeneic collagen matrix (XCM) + coronally advanced flap (CAF) compared to CAF for treating adult patients with single recession-type defects (short term)

XCM + CAF compared to CAF for adult patients with single recession-type defects (short term)

Patient or population: adult patients with single recession-type defects
Setting: university/dental hospital
Intervention: XCM + CAF
Comparison: CAF

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	Number of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with CAF	Risk with XCM + CAF				
Aesthetic condition change related to patient's opinion	-	-	-	(1 RCT)	⊕⊕⊖⊖ LOW[1]	Sangiorgio 2017 compared XCM + CAF versus CAF alone in the treatment of single gingival recessions. Root coverage aesthetics and overall aesthetic results were evaluated by each patient with the assistance of a VAS. Similar findings were found for both outcomes, irrespective of the type of treatment applied
Sites with complete root coverage Follow-up: range 6 months to 12 months	404 per 1000	762 per 1000 (614 to 866)	OR 4.73 (2.35 to 9.50)	104 (2 RCTs)	⊕⊕⊖⊖ LOW[1]	1 parallel-design and 1 split-mouth studies were included

Gingival recession depth change Follow-up: range 6 months to 12 months	The mean gingival recession depth change ranged from 2.16 to 2.36 mm	MD 0.40 mm higher (0.11 higher to 0.68 higher)	-	104 (2 RCTs)	⊕⊕⊖⊖ LOW[1]	1 parallel-design and 1 split-mouth studies were included
Clinical attachment level change Follow-up: range 6 months to 12 months	The mean clinical attachment level change ranged from 2.47 to 2.80 mm	MD 0.37 mm higher (0.09 lower to 0.83 higher)	-	104 (2 RCTs)	⊕⊕⊖⊖ LOW[1]	1 parallel-design and 1 split-mouth studies were included
Keratinized tissue width change Follow-up: range 6 months to 12 months	The mean keratinized tissue width change ranged from -0.30 to -0.51 mm	MD 0.44 mm higher (0.04 higher to 0.85 higher)	-	104 (2 RCTs)	⊕⊕⊖⊖ LOW[1]	1 parallel-design and 1 split-mouth studies were included

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

__CAF:__ coronally advanced flap; __CI:__ confidence interval; __MD:__ mean difference; __RCT:__ randomised controlled trial; __OR:__ odds ratio; __VAS:__ visual analogue scale; __XCM:__ xenogeneic collagen matrix.

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

[1]Downgraded 1 level for inconsistency and 1 level for imprecision.

BACKGROUND

Description of the condition

Gingival recession is a term that designates the oral exposure of the root surface due to a displacement of the gingival margin apical to the cemento-enamel junction (Camargo 2001; Wennström 1996). Reports from diverse epidemiological surveys revealed that gingival recession may affect most of the adult population (Richmond 2007; Susin 2004; Thomson 2006). The development of a gingival recession may be associated to diverse aetiological factors (Camargo 2001; Chambrone 2003; Khocht 1993; Yoneyama 1988), such as: a) disease-related factors (i.e. plaque-induced periodontal disease (Löe 1992; Yoneyama 1988) and viruses (Pini Prato 2002)); b) inadequate dental procedures (i.e. presence of composite/prosthetic restorations invading the biological width (Donaldson 1973; Parma-Benefati 1985)); c) tooth and periodontal anatomical features (i.e. inadequate tooth alignment (Stoner 1980), presence of muscle inserts close to margin of gingiva (Camargo 2001), lack of an adequate band of attached keratinized gingiva (Chambrone 2016; Tenenbaum 1982), and the reduced buccal-lingual thickness of the alveolar bone plate (Steiner 1981; Wennström 1987)); and d) trauma-factors (i.e. presence of lip/tongue piercings (Chambrone 2003) and incorrect toothbrushing procedures (Khocht 1993; Smukler 1984)). Gingival recession is also regularly linked to the deterioration of dental aesthetics as well as buccal cervical dentine hypersensitivity (Chambrone 2006; Chambrone 2016). In such cases, the goals of periodontal therapy should be to address the needs and wishes of each patient, and treatment options should be made available to them (Caffesse 1995).

Description of the intervention

Preferably, treatment options should be based on systematic, unbiased and objective evaluations of the literature (McGuire 1995). Moreover, the introduction of specific objectives, inclusion criteria and search strategies based on evidence and scientifically valid information may reduce the variation in clinical outcomes, establish the application and predictability of a specific procedure and improve the effectiveness of clinical practice (McGuire 1995). Consequently, scientific evidence-based information should be achieved by well delineated systematic reviews (Needleman 2002).

Currently, successful treatment of recession-type defects is based on the use of clinically predictable root coverage periodontal plastic surgery (RCPPS) procedures. As first proposed by Miller in 1988, the term periodontal plastic surgery comprises different surgical techniques intended to correct and prevent anatomical, developmental, traumatic or plaque disease-induced defects of the gingiva, alveolar mucosa or bone (AAP 1996).

Historically, these procedures originated at the beginning of the 20th century, presented by Younger in 1902, Harlan in 1906 and Rosenthal in 1911 (Baer 1981) who first described the use of pedicle or free soft tissue grafts to cover denuded root surfaces. However, these techniques were abandoned for a long time. During recent decades, different surgical procedures were proposed. Coronally advanced flaps, laterally repositioned flaps, free gingival grafts and subepithelial connective tissue grafts appeared as novel approaches to achieve improvements in recession depth, clinical attachment level and width of keratinized tissue (Bernimoulin 1975; Björn 1963; Cohen 1968; Grupe 1956; Grupe 1966; Harris 1992; Harvey 1965; Harvey 1970; Langer 1985; Nabers 1966; Patur 1958; Sullivan 1968; Sumner 1969; Wennström 1996). Concomitantly, in the mid1980s Miller's classification of recession defects (Miller 1985) appeared as an adequate and useful tool providing surgical predictability, especially for the correction of Class I and II recession (e.g. defects without loss of interproximal bone or soft tissue).

Why it is important to do this review

Different systematic reviews and overviews of systematic reviews have been published focusing on the effect of RCPPS procedures on the treatment of localised gingival recessions (Buti 2013; Chambrone 2008; Chambrone 2010b; Chambrone 2012; Chambrone 2015; Oates 2003; Pini Prato 2014; Roccuzzo 2002). These authors reported that different surgical techniques and flap designs had been described and used in an attempt to correct localised gingival recessions producing statistically significant improvements in gingival recession, clinical attachment level and in the width of keratinized tissue band (when indicated). Also, it was recommended for clinical practice that when root coverage is indicated, subepithelial connective tissue grafts, should be considered as the 'gold standard' procedures (Buti 2013; Chambrone 2008; Chambrone 2010b; Chambrone 2012; Chambrone 2015; Oates 2003; Pini Prato 2014; Roccuzzo 2002). Moreover, the use of other biomaterials of allogenous (i.e. adermal matrix grafts (Woodyard 2004)); xenogenous (i.e. collagen membranes (Roccuzzo 1996; Zucchelli 1998), enamel matrix derivative (Del Pizzo 2005) and collagen bilayer matrix (McGuire 2016)) has been broadly studied since the late 1990s to treat gingival recession.

The previous version of this Cochrane Review (Other published versions of this review) endorsed these outcomes, and also emphasised the importance of subepithelial connective tissue grafts in improving the keratinized tissue band to maintain the results achieved with therapy long term. Also, it was highlighted and demonstrated the importance of the different surgical techniques as an important tool in clinical decision making. This review is an update of the original version that was published in 2009 (Chambrone 2009b).

OBJECTIVES

To evaluate the efficacy of different root coverage procedures in the treatment of localised and multiple recession-type defects.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised controlled trials (RCTs) only of at least 6 months' duration and reporting patient-based analysis.

Types of participants

Studies were included if the participants met the following criteria.

- A clinical diagnosis of localised or multiple recession-type defects.
- Recession areas selected for treatment classified as Miller's (Miller 1985) Class I (marginal tissue recession not extending to the mucogingival junction and no loss of interproximal bone or soft tissue) or Class II (marginal tissue recession

extending to or beyond the mucogingival junction and no loss of interproximal bone or soft tissue) of at least 3 mm, and that were surgically treated by means of periodontal plastic surgery (PPS) procedures. Studies including Miller's Class III (marginal tissue recession extending to or beyond the mucogingival junction with loss of bone or soft tissue, apical to the cemento-enamel junction but coronal to the level of the recession defect), Class IV (marginal tissue recession extending to or beyond the mucogingival junction with loss of bone or soft tissue apical to the level of the recession defect), and restored root surfaces were not included.
- At least 10 participants per group at final examination.

Types of interventions

The interventions of interest were:

- free gingival grafts (FGG);
- laterally positioned flap (LPF);
- coronally advanced flap (CAF);
- subepithelial connective tissue grafts (SCTG) alone or in combination with LPF or CAF;
- CAF in association with allograft (e.g. acellular dermal matrix grafts (ADMG), others), guided tissue regeneration (GTR), enamel matrix protein (EMP), xenogeneic matrix grafts (XMG) or other biomaterial.

In addition, RCTs comparing variations of the same procedure (e.g. CAF with vertical incisions versus CAF without vertical incisions, etc.) were also considered eligible for inclusion in the review.

Types of outcome measures

Primary outcomes

- Aesthetic condition change related to patient's opinion (satisfactory, non-satisfactory or not reported, or using standardised methods of assessment (i.e. visual analogue scale (VAS)).
- Number and percentage of sites with complete root coverage, and gingival recession depth change (mm).

Secondary outcomes

- Clinical attachment level change (mm).
- Keratinized tissue width change (mm).
- Mean root coverage (%).
- Patients' preference for a specific PPS procedure (in split-mouth trials).
- Occurrence of adverse effects (yes/no) or postoperative complications (yes/no) or both.

In addition, we separated outcome measures into short term (as evaluated 6 months to 12 months following interventions), medium term (13 months to 59 months) or long term (60 or more months (≥ 5 years)).

Search methods for identification of studies

Electronic searches

Cochrane Oral Health's Information Specialist conducted systematic searches in the following databases for randomised controlled trials and controlled clinical trials without language or publication status restrictions:

- Cochrane Oral Health's Trials Register (searched 15 January 2018) (Appendix 1);
- Cochrane Central Register of Controlled Trials (CENTRAL; 2017, Issue 12) in the Cochrane Library (searched 15 January 2018) (Appendix 2);
- MEDLINE Ovid (1946 to 15 January 2018) (Appendix 3);
- Embase Ovid (1980 to 15 January 2018) (Appendix 4).

Subject strategies were modelled on the search strategy designed for MEDLINE Ovid. Where appropriate, they were combined with subject strategy adaptations of the highly sensitive search strategy designed by Cochrane for identifying randomised controlled trials and controlled clinical trials as described in the *Cochrane Handbook for Systematic Reviews of Interventions* Chapter 6 (Lefebvre 2011).

Searching other resources

The following trial registries were searched for ongoing studies:

- US National Institutes of Health Ongoing Trials Register ClinicalTrials.gov (clinicaltrials.gov; searched 15 January 2018) (Appendix 5);
- World Health Organization International Clinical Trials Registry Platform (apps.who.int/trialsearch; searched 15 January 2018) (Appendix 6).

We searched the reference lists of included studies and relevant systematic reviews for further studies.

We did not perform a separate search for adverse effects of interventions used, we considered adverse effects described in included studies only.

Data collection and analysis

Selection of studies

Details regarding screening of titles, abstracts, and full texts of papers published until October 2008 were reported previously (Chambrone 2009b; Chambrone 2010). Identification of studies conducted from November 2008 to January 2018 were similarly performed by two independent review authors (Leandro Chambrone (LC) and Maria Aparecida Salinas Ortega (MASO)) who independently screened titles, abstracts and full texts of the search results. The search was designed to be sensitive and include controlled clinical trials, these were filtered out early in the selection process if they were not randomised. Agreement between review authors was assessed calculating Kappa scores. The review authors remained unblinded regarding the author(s), their institutional affiliations and the site of publication of reports. The full report was obtained for all studies appearing to meet the inclusion criteria or in instances where there was insufficient information from the title, keywords and abstract to make a clear decision. Both review authors assessed all studies independently for eligibility. Disagreement between the review authors was resolved by discussion with the inclusion of another review author (Roberto Rotundo (RR)). In case of missing data, authors were contacted to resolve eventual doubts and provide further details from the trial. Data were excluded until further clarification was available if agreement could not be reached. The studies meeting the inclusion criteria underwent validity assessment and data

extraction. We recorded studies rejected at this or subsequent stages in a table of excluded studies.

Data extraction and management

For this update LC and MASO independently and in duplicate extracted data using specially designed data extraction forms.

Data were extracted and loaded onto Review Manager 5 software (Review Manager 2014) and checked. Data on the following issues were extracted and recorded:

- citation, publication status and year of publication;
- location of trial: country and place where the patients were treated (e.g. private practice or university dental hospitals);
- study design: randomised controlled trial;
- characteristics of participants: sample size, gender, age, local and systemic conditions;
- methodological quality of trials: patient/defect selection bias, selection of a control group, adequate inclusion criteria, statistical analysis, randomisation selection, validity of conclusions and clinical variables analysed;
- characteristics of interventions: 1) free gingival grafts (FGG); 2) laterally positioned flap (LPF); 3) coronally advanced flap (CAF); 4) subepithelial connective tissue grafts (SCTG) alone or in combination with LPF or CAF; or 5) CAF in association with acellular dermal matrix grafts (ADMG), guided tissue regeneration (GTR), enamel matrix protein (EMP), xenogeneic matrix grafts (XMG) or other biomaterial;
- source of funding and conflict of interest.

We contacted trial authors when necessary for clarification of data or, where possible, to obtain missing data. We excluded data until further clarification was available if agreement could not be reached.

Assessment of risk of bias in included studies

Two review authors (LC and MASO) independently assessed the risk of bias of each included study using the Cochrane domain-based, two-part tool as described in Chapter 8 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). We contacted study authors for clarification or missing information where necessary and feasible. We resolved any disagreements through discussion, consulting a third review author to achieve consensus when necessary.

We completed a 'Risk of bias' table for each included study. For each domain of risk of bias, we first described what was reported to have happened in the study. This provided the rationale for our judgement of whether that domain was at low, high, or unclear risk of bias.

We assessed the following domains:

- sequence generation (selection bias);
- allocation concealment (selection bias);
- blinding of participants and personnel (performance bias);
- blinding of outcome assessment (detection bias);
- incomplete outcome data (attrition bias);
- selective outcome reporting (reporting bias);
- other bias.

We categorised the overall risk of bias of individual studies. Studies were categorised as being at low, high, or unclear risk of bias according to the following criteria:

- low risk of bias (plausible bias unlikely to seriously alter the results) if all domains were at low risk of bias;
- high risk of bias (plausible bias that seriously weakens confidence in the results) if one or more domains were at high risk of bias; or
- unclear risk of bias (plausible bias that raises some doubt about the results) if one or more domains were at unclear risk of bias.

These assessments are reported in the Characteristics of included studies table and also graphically.

Data synthesis

We collated data into evidence tables and grouped them according to type of intervention. Descriptive summary was performed to determine the quantity of data, checking further for study variations in terms of study characteristics, study quality and results. This assisted in confirming the similarity of studies and suitability of further synthesis methods, including possible meta-analysis.

We used random-effects meta-analyses throughout. For continuous data, we expressed pooled outcomes as weighted mean differences (MD) with their associated 95% confidence intervals (CI). For dichotomous data, these were predominately pooled odds ratios (OR) and associated 95% CI. The analyses were conducted using the generic inverse variance statistical method where the MD or log[OR] and standard error (SE) are entered for all studies. We used the Becker-Balagtas method (Stedman 2011) to calculate log ORs, as indicated by Curtin 2002 to accommodate data pooling from split-mouth and parallel-group studies in a single meta-analysis, and facilitate data synthesis (Stedman 2011). For split-mouth trials it was assumed a intracluster correlation co-efficient of 0.05, while for parallel trials a co-efficient of 0 for the calculation of SE. Statistical heterogeneity was assessed by calculation of the Q statistic. We performed analyses using Review Manager software (Review Manager 2014).

Variance imputation methods were conducted to estimate appropriate variance estimates in some split-mouth studies, where the appropriate standard deviation of the differences was not included in the trials (Follmann 1992). The significance of discrepancies in the estimates of the treatment effects from the different trials was assessed by means of Cochran's test for heterogeneity and the I^2 statistic.

Publication bias

Publication bias would be investigated, especially as its presence was detected in a previous review (Roccuzzo 2002), by graphical methods and via the Begg and Mazumdar (Begg 1994) adjusted rank correlation test and the Egger regression asymmetry test (Egger 1997). However, the available number of studies and heterogeneity of reported procedures prevented such evaluation.

Summary of findings

We produced 'Summary of findings' tables for our main comparisons on single recession defects involving the 'gold-standard' procedure (i.e. SCTG-based procedures versus other root

coverage procedures) (Buti 2013; Chambrone 2008; Chambrone 2009b; Chambrone 2010; Chambrone 2010b; Chambrone 2012; Chambrone 2015; Oates 2003; Pini Prato 2014; Richardson 2015; Roccuzzo 2002; Tatakis 2015) and the currently used alternative approaches (i.e. CAF, CAF + ADMG, CAF + enamel matrix derivative (EMD) and CAF + xenogeneic collagen matrix (XCM) indicated by the American Academy of Periodontology (Chambrone 2015; Richardson 2015; Tatakis 2015) for the following outcomes: aesthetic condition change related to patient's opinion, sites with complete root coverage, gingival recession depth change; clinical attachment level change; and keratinized tissue width change.

We used GRADE methods (GRADE 2004), and the GRADEproGDT online tool for developing 'Summary of findings' tables (gradepro.org/). We assessed the quality of the body of evidence for each comparison and outcome by considering the overall risk of bias of the included studies, the directness of the evidence, the inconsistency of the results, the precision of the estimates, and the risk of publication bias. We categorised the quality of each body of evidence as high, moderate, low, or very low.

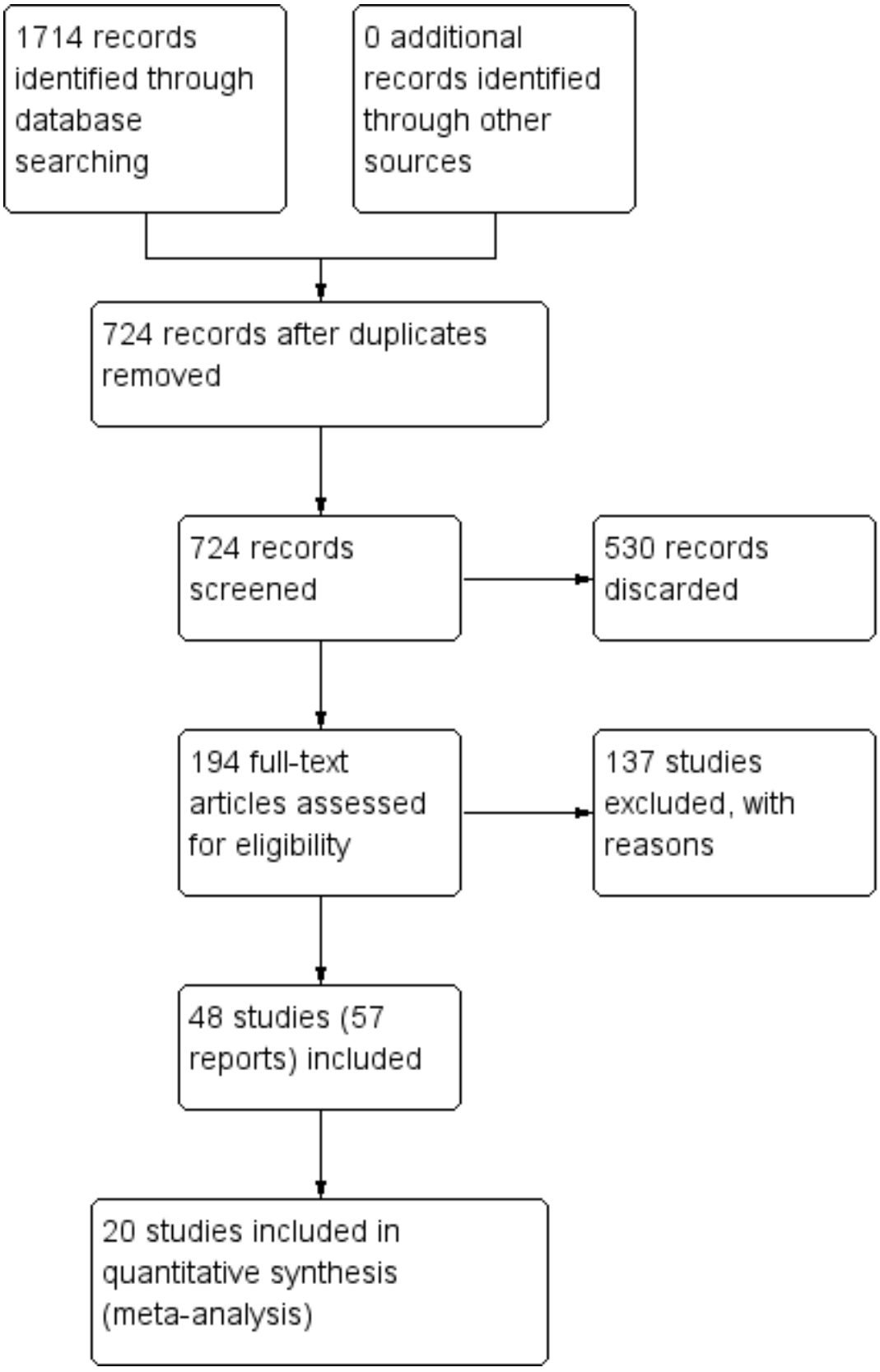
RESULTS

Description of studies

Results of the search

A total of 1714 records were retrieved from the electronic searches. After the removal of duplicates, 724 records were screened for eligibility. 530 records were discarded, and the full-texts of 194 articles were assessed. From the 194 papers, 137 did not meet the criteria of eligibility and the reasons for exclusion were reported in the Characteristics of excluded studies table. 48 studies (reported in 57 papers) were included in the review, with 20 providing data for meta-analyses (Figure 1). Kapa scores for the searches conducted up to 2008 are described in the previous version of this review (Chambrone 2009b). Kappa scores for inter-reviewer agreement for title or abstract review or both, and full texts screening were 0.88 (95% confidence interval (CI) 0.83 to 0.94) and 0.87 (95% CI 0.75 to 0.99), respectively.

Figure 1. Study flow diagram.



Included studies

We included 48 randomised controlled trials (RCTs) reported in 57 papers in this review. Nine RCTs had their data reported in two articles each (i.e. according to the follow-up period or type of data (i.e. clinical or patient-reported outcomes). Consequently, the papers with a shorter follow-up period were included under the one study name (e.g. papers with the longer follow-up) (Costa 2016; de Queiroz 2006; Leknes 2005; McGuire 2012; McGuire 2014; McGuire 2016; Rosetti 2013; Spahr 2005), while one article reporting patient-reported outcomes was included under the name of the clinical outcomes paper (Sangiorgio 2017).

Out of the 48 included RCTs, 28 trials were conducted according to a split-mouth design (Abolfazli 2009; Ayub 2012; Babu 2011; Barros 2015; Costa 2016; da Silva 2004; de Queiroz 2006; Del Pizzo 2005; Dodge 2000; Henderson 2001; Jankovic 2010; Jepsen 2013; Joly 2007; Leknes 2005; McGuire 2012; McGuire 2014; McGuire 2016; Öncü 2017; Reino 2012; Reino 2015; Roccuzzo 1996; Rosetti 2013; Spahr 2005; Trombelli 1996; Tunali 2015; Wang 2001; Zucchelli 2003; Zucchelli 2009), and 20 according to a parallel design (Ahmedbeyli 2014; Bouchard 1994; Bouchard 1997; Jaiswal 2012; Keceli 2008; Keceli 2015; Matarasso 1998; Ozenci 2015; Paolantonio 1997; Paolantonio 2002; Paolantonio 2002b; Pendor 2014; Rasperini 2011; Sangiorgio 2017; Shori 2013; Tozum 2005; Woodyard 2004; Zucchelli 1998; Zucchelli 2014; Zucchelli 2014b). In total, 1227 patients were treated and all studies were published in full.

Eight RCTs were private practice based (Abolfazli 2009; Bouchard 1994; Bouchard 1997; Dodge 2000; McGuire 2012; McGuire 2014; McGuire 2016; Paolantonio 1997), 35 were based in universities or dental hospitals (Ahmedbeyli 2014; Ayub 2012; Babu 2011; Barros 2015; Costa 2016; da Silva 2004; de Queiroz 2006; Henderson 2001; Jaiswal 2012; Jankovic 2010; Joly 2007; Keceli 2008; Keceli 2015; Leknes 2005; Matarasso 1998; Öncü 2017; Ozenci 2015; Paolantonio 2002; Paolantonio 2002b; Pendor 2014; Reino 2012; Reino 2015; Roccuzzo 1996; Rosetti 2013; Shori 2013; Tozum 2005; Trombelli 1996; Tunali 2015; Wang 2001; Woodyard 2004; Zucchelli 1998; Zucchelli 2003; Zucchelli 2009; Zucchelli 2014; Zucchelli 2014b), and five were multicentre studies (Del Pizzo 2005; Jepsen 2013; Rasperini 2011; Sangiorgio 2017; Spahr 2005).

Thirteen trials were conducted in Italy (Del Pizzo 2005; Matarasso 1998; Paolantonio 1997; Paolantonio 2002; Paolantonio 2002b; Rasperini 2011, Roccuzzo 1996; Trombelli 1996; Zucchelli 1998; Zucchelli 2003; Zucchelli 2009; Zucchelli 2014; Zucchelli 2014b), 10 in Brazil (Ayub 2012; Barros 2015; Costa 2016; da Silva 2004; de Queiroz 2006; Joly 2007; Reino 2012; Reino 2015; Rosetti 2013; Sangiorgio 2017), seven in USA (Dodge 2000; Henderson 2001; McGuire 2012; McGuire 2014; McGuire 2016; Wang 2001; Woodyard 2004), seven in Turkey (Ahmedbeyli 2014; Keceli 2008; Keceli 2015; Öncü 2017; Ozenci 2015; Tozum 2005; Tunali 2015), four in India (Babu 2011; Jaiswal 2012; Pendor 2014; Shori 2013), two in France (Bouchard 1994; Bouchard 1997), one in Germany (Spahr 2005), one in Iran (Abolfazli 2009), one in Norway (Leknes 2005), one in Serbia (Jankovic 2010), and one in multiple countries: Germany, Italy, Sweden and Spain (Jepsen 2013).

Nine trials were supported, totally or in part, by governmental agencies or university programs (Ayub 2012; Keceli 2008; Paolantonio 2002; Paolantonio 2002b; Reino 2012; Reino 2015; Rosetti 2013; Sangiorgio 2017; Trombelli 1996), and 10 by companies who sponsored or provided products or both that were used as interventions in the RCTs (Ayub 2012; Henderson 2001; Jepsen 2013; Leknes 2005; McGuire 2012; McGuire 2014; McGuire 2016; Reino 2015; Spahr 2005; Wang 2001).

Five studies evaluated multiple recession-type defects (Ahmedbeyli 2014; Jaiswal 2012; Öncü 2017; Ozenci 2015; Tunali 2015), whereas the others single gingival recessions. Two studies (Costa 2016; Reino 2012) evaluated exclusively outcomes of smokers (i.e. 10 or more cigarettes per day for more than 5 years). In addition, the majority of trials followed participants during a short-term period (6 months to 12 months). Only five publications with medium-term follow-up (Abolfazli 2009; Del Pizzo 2005; de Queiroz 2006; Rosetti 2013; Spahr 2005) and five with long-term follow-up (Leknes 2005; McGuire 2012; McGuire 2014; McGuire 2016; Paolantonio 1997) were included.

Treatment modalities

Different interventions have been evaluated: free gingival grafts (FGG), coronally advanced flap (CAF) alone or associated to acellular dermal matrix grafts (ADMG), enamel matrix protein (EMP), guided tissue regeneration with resorbable membranes (GTR rm), guided tissue regeneration with non-resorbable membranes (GTR nrm), GTR rm associated with bone substitutes, platelet-rich plasma or fibrin (PRP or PRF), growth factors (rhPDGF-BB) associated to bone substitutes (b-TCP), subepithelial connective tissue grafts (SCTG) or xenogeneic collagen matrix (XCM). We did not find any RCTs evaluating laterally positioned flaps (LPF).

Excluded studies

We excluded 137 studies, 28 on the grounds that they were not randomised controlled trials (Berlucchi 2005; Daniel 1990; Dembowska 2007; Erley 2006; Gunay 2008; Gupta 2006; Harris 1997; Harris 2000; Harris 2002; Harris 2005; Hirsch 2005; Jovicic 2013; Moses 2006; Muller 1998; Muller 1999; Nemcovsky 2004; Pini Prato 1992; Pini Prato 1996; Pini Prato 1999; Pini Prato 2005; Sallum 2003; Sbordone 1988; Scabbia 1998; Schlee 2011; Trombelli 1995; Trombelli 1997; Trombelli 2005; Wennström 1996).

One hundred and nine papers were classified as randomised trials; however, they did not fulfil the inclusion criteria. 77 articles included patients with recession defects < 3 mm (Abou-Arraj 2017; Aichelmann Reidy 2001; Alexiou 2017; Alkan 2011; Alkan 2013; Andrade 2008; Aroca 2009; Aroca 2013; Azaripour 2016; Bajic 2014; Bansal 2016; Berlucchi 2002; Bherwani 2014; Bittencourt 2006; Bittencourt 2009; Borghetti 1999; Bozkurt Dogan 2015; Byun 2009; Caffesse 2000; Cairo 2016; Cardaropoli 2009; Cardaropoli 2012; Cardaropoli 2014; Castellanos 2006; Cheung 2004; Cordaro 2012; Cortellini 2009; Deshpande 2014; Dilsiz 2010; Dilsiz 2010b; Felipe 2007; Fernandes-Dias 2015; Gholami 2013; Griffin 2009; Haghighati 2009; Han 2008; Huang 2005; Jahnke 1993; Jain 2017; Jankovic 2012; Jepsen 1998; Jepsen 2017; Jhaveri 2010; Kennedy 1985; Kuis 2013; Köseoglu 2013; Lins 2003; M 2016; Mazzocco 2011; Modica 2000; Moka 2014; Moslemi 2011; Nazareth 2011; Ozcelik 2011; Ozturan 2011; Pilloni 2006; Pini Prato 2011; Pourabbas 2009; Rebele 2014; Ricci 1996; Roman 2013; Salhi 2014; Santana 2010; Santana 2010b; Santamaria 2017; Santamaria 2017b; Singh 2015; Stefanini 2016; Tatakis 2000; Thombre 2013; Trabulsi 2004; Trombelli 1998; Wang 2014; Wang 2015; Zucchelli 2010; Zucchelli 2012; Zuhr 2013).

Five articles did not present a patient-based analysis (Barros 2004; Barros 2005; Cetiner 2003; Cordioli 2001; Rahmani 2006) and

two included both single and multiple recessions in the analyses (Milinkovic 2015; Ricci 1996b). Studies including Miller's Class III or Class IV recessions (Andrade 2010; Borghetti 1994), a follow-up period < 6 months (Baghele 2012; Lafzi 2007), patients under 18 years of age (Mahajan 2012), interventions not of interest for this review (Wilson 2005; Yilmaz 2014) and that had counted less than 10 participants per group at final examination (Burkhardt 2005; Kimble 2004; Mahajan 2007; Tal 2002; Trombelli 1995b) were excluded as well.

The remaining papers were excluded due to the combination of two or more factors such as the treatment of recession < 3 mm and a follow-up period < 6 months (Laney 1992; Pini Prato 2000); less than 10 patients per group at final examination and patient-based analysis not presented (Banihashemrad 2009); inclusion of patients with recession depth < 3 mm, patient-based analysis not presented (Khobragade 2016; Kumar 2017; Uzun 2018) and patients with Miller's Class III recessions (Ghahroudi 2013); inclusion of both single and multiple defects in the estimates and defects < 3 mm (Gobbato 2016); inclusion of gingival recession < 3 mm and defects not classified according to the Miller Classification System (Tonetti 2018); and less than 10 patients per group at final examination, recessions < 3 mm and patient-based analysis not presented (Duval 2000; Ito 2000).

In addition, the author from one study was contacted to resolve doubts and provide further details from her trial (Romagna-Genon 2001). However, this author did not provide the requested explanations, consequently, her paper was excluded from the review.

Risk of bias in included studies

Risk of bias in the included studies was evaluated using the data extracted from each trial (Figure 2; Figure 3). Moreover, all authors were contacted to provide complementary information by means of a questionnaire regarding the methodological quality of their trials.

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

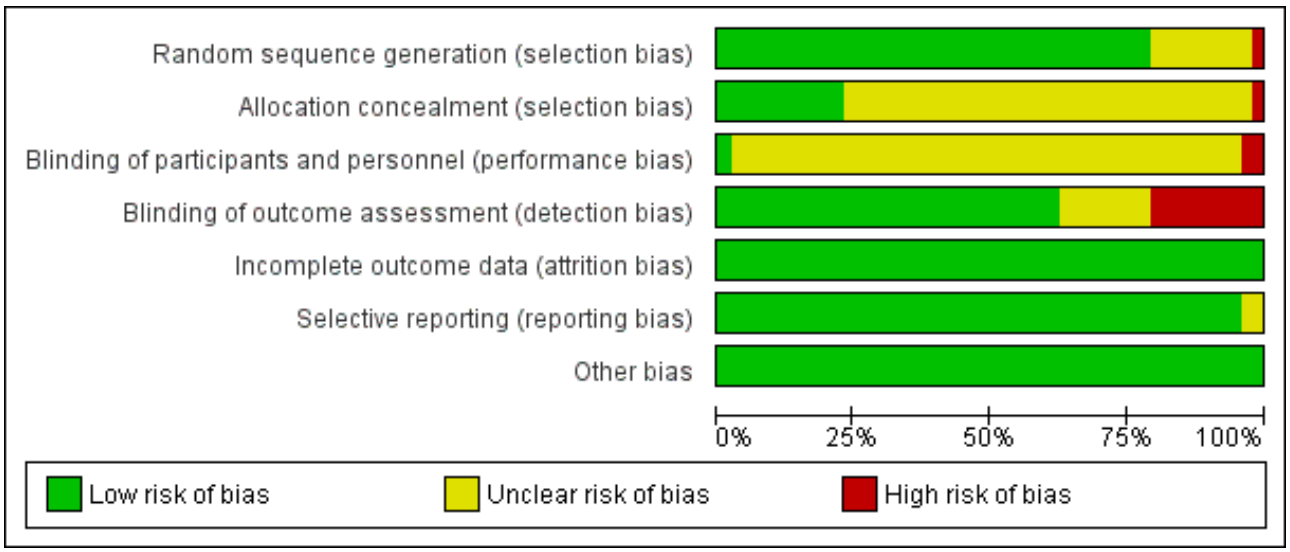


Figure 3. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

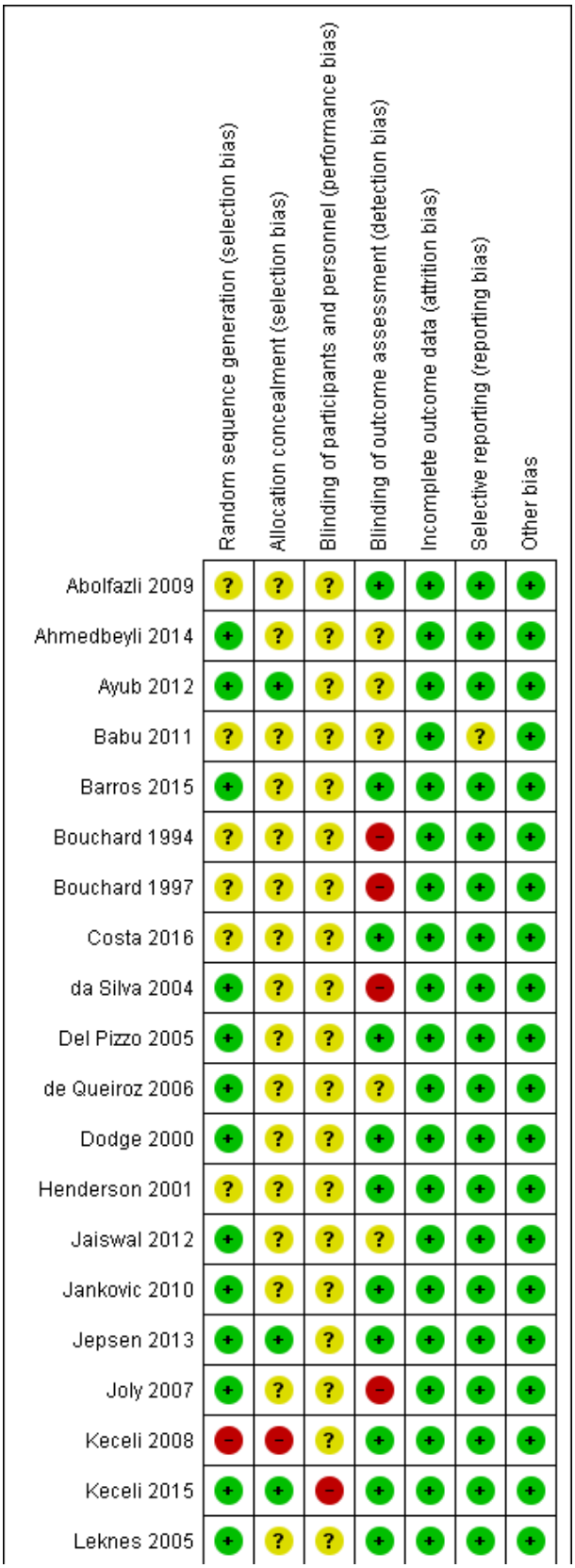
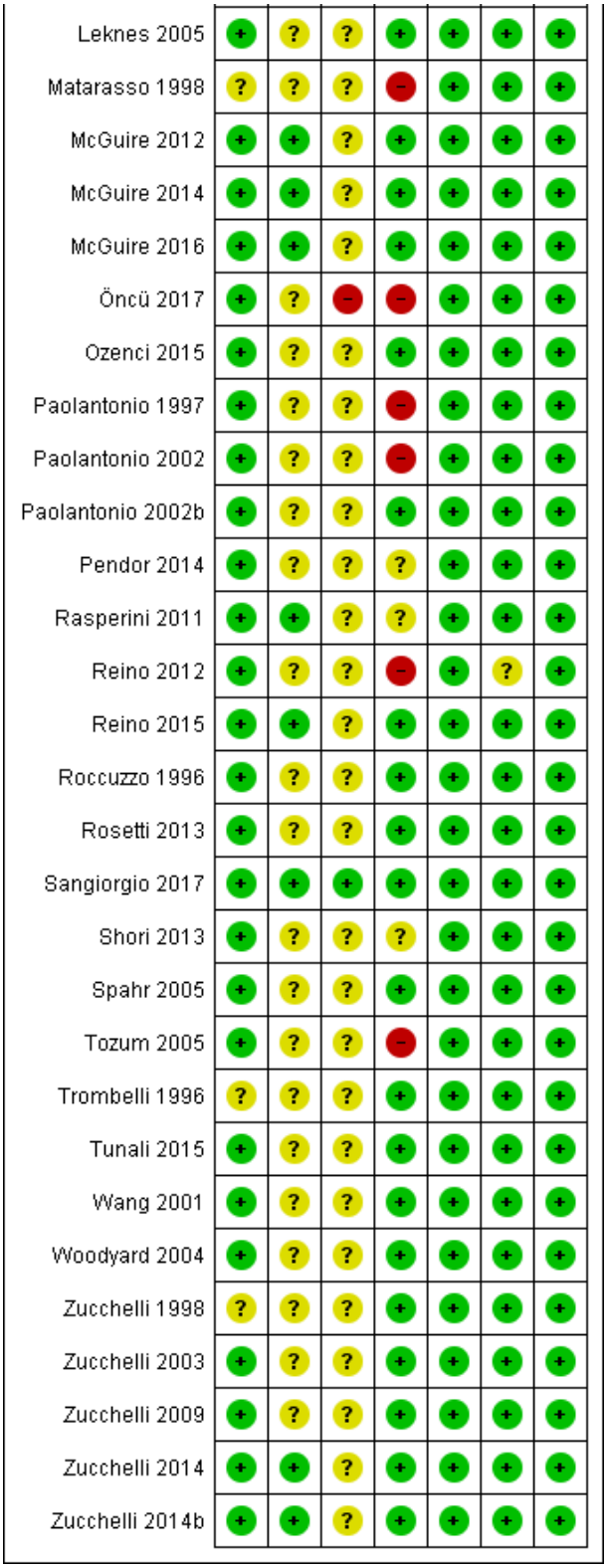


Figure 3. (Continued)



One study was assessed as at low overall risk of bias (Sangiorgio 2017), whereas 35 as at unclear overall risk of bias (Abolfazli 2009; Ahmedbeyli 2014; Ayub 2012; Babu 2011; Barros 2015; Costa 2016; Del Pizzo 2005; de Queiroz 2006; Dodge 2000; Henderson 2001; Jaiswal 2012; Jankovic 2010; Jepsen 2013; Leknes 2005; McGuire 2012; McGuire 2014; McGuire 2016; Ozenci 2015; Paolantonio 2002b; Pendor 2014; Rasperini 2011; Reino 2015; Roccuzzo 1996; Rosetti 2013; Shori 2013; Spahr 2005; Trombelli 1996; Tunali 2015; Wang

2001; Woodyard 2004; Zucchelli 1998; Zucchelli 2003; Zucchelli 2009; Zucchelli 2014; Zucchelli 2014b), and 12 as at high overall risk of bias (Bouchard 1994; Bouchard 1997; da Silva 2004; Joly 2007; Keceli 2008; Keceli 2015; Matarasso 1998; Öncü 2017; Paolantonio 1997; Paolantonio 2002; Reino 2012; Tozum 2005).

Sequence generation

All the trials were described as RCTs, but not all reported randomisation and allocation methods in detail. Thirty-eight trials (Ahmedbeyli 2014; Ayub 2012; Barros 2015; da Silva 2004; de Queiroz 2006; Del Pizzo 2005; Dodge 2000; Jaiswal 2012; Jankovic 2010; Jepsen 2013; Joly 2007; Keceli 2015; Leknes 2005; McGuire 2012; McGuire 2014; McGuire 2016; Öncü 2017; Ozenci 2015; Paolantonio 1997; Paolantonio 2002; Paolantonio 2002b; Pendor 2014; Rasperini 2011; Reino 2012; Reino 2015; Roccuzzo 1996; Rosetti 2013; Sangiorgio 2017; Shori 2013; Spahr 2005; Tunali 2015; Wang 2001; Woodyard 2004; Tozum 2005; Zucchelli 2003; Zucchelli 2009; Zucchelli 2014; Zucchelli 2014b) presented an adequate method of randomisation, while one reported an inadequate method (Keceli 2008). In nine, the method of randomisation was considered unclear (Abolfazli 2009; Babu 2011; Bouchard 1994; Bouchard 1997; Costa 2016; Henderson 2001; Matarasso 1998; Trombelli 1996; Zucchelli 1998).

Allocation (selection bias)

Only 11 trials presented an adequate method of allocation concealment (Ayub 2012; Keceli 2015; Jepsen 2013; McGuire 2012; McGuire 2014; McGuire 2016; Rasperini 2011; Reino 2015; Sangiorgio 2017; Zucchelli 2014; Zucchelli 2014b). One trial reported an inadequate method of allocation concealment (Keceli 2008). All other trials were classified as unclear because the method of allocation was not described (Characteristics of included studies table).

Blinding (performance bias and detection bias)

Examiners were considered blinded in 30 studies (Abolfazli 2009; Barros 2015; Costa 2016; Del Pizzo 2005; Dodge 2000; Henderson 2001; Jankovic 2010; Jepsen 2013; Keceli 2008; Keceli 2015; Leknes 2005; McGuire 2012; McGuire 2014; McGuire 2016; Ozenci 2015; Paolantonio 2002b; Reino 2015; Roccuzzo 1996; Rosetti 2013; Sangiorgio 2017; Spahr 2005; Trombelli 1996; Tunali 2015; Wang 2001; Woodyard 2004; Zucchelli 1998; Zucchelli 2003; Zucchelli 2009; Zucchelli 2014; Zucchelli 2014b), not blinded in ten studies (Bouchard 1994; Bouchard 1997; da Silva 2004; Joly 2007; Matarasso 1998; Öncü 2017; Paolantonio 1997; Paolantonio 2002; Reino 2012; Tozum 2005), and unclear in eight studies (Ahmedbeyli 2014; Ayub 2012; Babu 2011; de Queiroz 2006; Jaiswal 2012; Pendor 2014; Rasperini 2011; Shori 2013). Blindness of participants/patients was considered unclear for all the included trials, except for two trials (Keceli 2015; Öncü 2017) where the patients were considered not blinded to the surgical procedure and for Sangiorgio 2017 who reported that patients remained masked regarding which treatment they received

Whilst authors from three trials (Paolantonio 1997; Paolantonio 2002; Tozum 2005) have responded to the review enquiry (i.e. questionnaire regarding the methodological quality of each trial) that their study had blinded examiners, in practical terms this might have been impossible to achieve with very different interventions (i.e. SCTG versus free gingival grafts, GTR rm versus GTR rm with bone substitutes versus SCTG and modified tunnel procedures + SCTG versus SCTG + CAF). Consequently, where the intervention was very different and where the examiner could therefore guess the group allocation, the study was interpreted to be not blinded.

Incomplete outcome data (attrition bias), selective reporting (reporting bias), and potential sources of bias

Only seven studies (Costa 2016; Keceli 2008; Leknes 2005; McGuire 2012; McGuire 2014; McGuire 2016; Spahr 2005) reported withdrawals and dropouts (see Characteristics of included studies table). Overall, all studies were at low risk of bias for this domain. Selective reporting was considered low for the majority of studies, except for two RCTs (Babu 2011; Reino 2012). In the first trial (Babu 2011) between-groups comparisons regarding baseline recession depth were not reported (control group (SCTG): 4.00 mm; test group (GTRs): 4.50 mm). In the second trial (Reino 2012) baseline and follow-up means regarding recession depth, clinical attachment level and keratinized tissue width were not reported in the study. Other sources of bias were not identified within all the included trials.

Effects of interventions

See: **Summary of findings for the main comparison** Acellular dermal matrix graft (ADMG) + coronally advanced flap (CAF) compared to subepithelial connective tissue graft (SCTG) + CAF for treating adult patients with single recession-type defects (short term); **Summary of findings 2** Acellular dermal matrix graft (ADMG) + coronally advanced flap (CAF) compared to CAF for treating adult patients with single recession-type defects (short term); **Summary of findings 3** Enamel matrix protein (EMP) + coronally advanced flap (CAF) compared to CAF for treating adult patients with single recession-type defects (short term); **Summary of findings 4** Enamel matrix protein (EMP) + coronally advanced flap (CAF) compared to subepithelial connective tissue graft (SCTG) + CAF for treating adult patients with single recession-type defects (short/medium term); **Summary of findings 5** Guided tissue regeneration resorbable membrane (GTR rm) + coronally advanced flap (CAF) compared to subepithelial connective tissue graft (SCTG) + CAF for treating adult patients with single recession-type defects (short term); **Summary of findings 6** Xenogeneic collagen matrix (XCM) + coronally advanced flap (CAF) compared to CAF for treating adult patients with single recession-type defects (short term)

See Summary of findings for the main comparison; Summary of findings 2; Summary of findings 3; Summary of findings 4; Summary of findings 5; Summary of findings 6.

Aesthetic condition change, gingival recession depth change, clinical attachment level change and keratinized tissue width change

Aesthetic condition change related to patient's opinion was reported in 10 RCTs (Ahmedbeyli 2014; Bouchard 1994; McGuire 2012; McGuire 2014; McGuire 2016; Ozenci 2015; Rosetti 2013; Zucchelli 2003; Zucchelli 2014; Zucchelli 2014b). Given the heterogeneity of methods/criteria used to assess this outcome and types of procedures compared, formal pooling of data via meta-analysis was precluded. Therefore, the individual studies results' are depicted below under the appropriate pooled estimates/comparisons or at Additional Table 1.

Of the 48 included trials, 20 evaluating single and multiple recession-type defects were included into the following meta-analyses:

1. ADMG + CAF versus SCTG + CAF - short term (Barros 2015; Joly 2007; Paolantonio 2002b; Shori 2013);
2. ADMG + CAF versus CAF - short term (de Queiroz 2006; Woodyard 2004);
3. EMP + CAF versus CAF - short term (Del Pizzo 2005; Sangiorgio 2017; Spahr 2005);
4. EMP + CAF versus CAF - short/medium term (Del Pizzo 2005; Sangiorgio 2017; Spahr 2005);
5. EMP + CAF versus SCTG + CAF - short/medium term (Abolfazli 2009; McGuire 2012);
6. GTR rm + CAF versus SCTG + CAF - short term (Paolantonio 2002; Wang 2001; Zucchelli 1998);
7. GTR rm + CAF versus GTR nrm + CAF - short term (Roccuzzo 1996; Zucchelli 1998);
8. GTR rm associated with bone substitutes + CAF versus SCTG + CAF - short term (Paolantonio 2002; Rosetti 2013);
9. GTR rm associated with bone substitutes + CAF versus GTR rm + CAF - short term (Dodge 2000; Paolantonio 2002);
10. XCM + CAF versus CAF - short term (Jepsen 2013; Sangiorgio 2017); and
11. PRF + CAF versus SCTG + CAF - short term (Öncü 2017; Tunali 2015).

(See Additional Table 2; Summary of findings for the main comparison; Summary of findings 2; Summary of findings 3; Summary of findings 4; Summary of findings 5; Summary of findings 6.)

Comparisons 1 to 10 evaluated single defects, while comparison 11 multiple recession-type defects. Moreover, analyses were performed according to the follow-up evaluation (i.e. short term (6 months follow-up preferably) in the majority of comparisons, except for two comparisons: EMP + CAF versus CAF (Comparison 4) where the data were derived from short term (6 months, Sangiorgio 2017) and medium term (24 months, Del Pizzo 2005; Spahr 2005) measurements; and EMP + CAF versus SCTG + CAF (Comparison 5) where the data from mean changes from baseline (i.e. gingival recession, clinical attachment level and keratinized tissue width) were derived from short-term measurements, whereas sites with complete root coverage the data were derived from 6-month (McGuire 2012) and 24-month (Abolfazli 2009) measurements.

The study by Babu 2011 was not included into Comparison 6 because it was not clear whether test (GTR rm + CAF) and control (SCTG + CAF) displayed similar baseline recession depth, clinical attachment level and keratinized tissue means. In addition, data from studies not included in meta-analyses are presented in Additional Table 1.

ADMG + CAF versus SCTG + CAF - short term (Comparison 1)

- Aesthetic condition change was not reported for this comparison.
- Gingival recession depth, clinical attachment level and keratinized tissue width changes (Outcomes 1.1 to 1.3): there were four trials (Barros 2015; Joly 2007; Paolantonio 2002b; Shori 2013) reporting these outcomes measured as changes from the baseline values and there was insufficient evidence of a difference in these outcomes between ADMG + CAF and SCTG + CAF.
  - ADMG + CAF versus SCTG + CAF (Comparison 1, Outcome 1.1; Analysis 1.1): P = 0.28, mean difference -0.36 mm (95% confidence interval (CI) -1.03 to 0.30, Chi^2 = 15.06, degrees of freedom (df) = 3, P = 0.002, I^2 = 80%).
  - ADMG + CAF versus SCTG + CAF (Comparison 1, Outcome 1.2; Analysis 1.2): P = 0.09, mean difference -0.53 mm (95% CI -1.14 to 0.08, Chi^2 = 9.73, df = 3, P = 0.02, I^2 = 69%).
  - ADMG + CAF versus SCTG + CAF (Comparison 1, Outcome 1.3; Analysis 1.3): P = 0.10, mean difference -0.59 mm (95% CI -1.27 to 0.10, Chi^2 = 17.17, df = 3, P = 0.0007, I^2 = 83%).

ADMG + CAF versus CAF - short term (Comparison 2)

- Aesthetic condition change was not reported for this comparison.
- Gingival recession depth, clinical attachment level and keratinized tissue width changes (Outcomes 2.1 to 2.3): there were two trials (de Queiroz 2006; Woodyard 2004) reporting these outcomes measured as changes from the baseline values and there was insufficient evidence of a difference in these outcomes between ADMG + CAF and CAF.
  - ADMG + CAF versus CAF (Comparison 2, Outcome 2.1; Analysis 2.1): P = 0.29, mean difference 0.61 mm (95% CI -0.52 to 1.73, Chi^2 = 7.45, df = 1, P = 0.006, I^2 = 87%).
  - ADMG + CAF versus CAF (Comparison 2, Outcome 2.2; Analysis 2.2): P = 0.19, mean difference 0.51 mm (95% CI -0.25 to 1.27, Chi^2 = 2.32, df = 1, P = 0.13, I^2 = 57%).
  - ADMG + CAF versus CAF (Comparison 2, Outcome 2.3; Analysis 2.3): P = 0.13, mean difference 0.28 mm (95% CI -0.08 to 0.64, Chi^2 = 0.30, df = 1, P = 0.59, I^2 = 0%).

EMP + CAF versus CAF - short term (Comparison 3)

- Aesthetic condition change: Sangiorgio 2017 reported the results of root coverage aesthetics and overall aesthetic results evaluated by each patient with the assistance of a visual analogue scale (VAS). In terms of root coverage aesthetics both treatment approaches showed evidence of similar improvements between baseline and 6-month evaluation. Regarding overall aesthetic results following treatment, there was evidence of equivalent outcomes for both groups (i.e. similar aesthetics).
- Gingival recession depth and clinical attachment level changes (Outcomes 3.1 and 3.2): there was insufficient evidence of a difference in outcomes between EMP + CAF and CAF (three trials: Del Pizzo 2005; Sangiorgio 2017; Spahr 2005).
  - EMP + CAF versus CAF (Comparison 3, Outcome 3.1; Analysis 3.1): P = 0.67, mean difference 0.07 mm (95% CI -0.25 to 0.40, Chi^2 = 5.62, df = 2, P = 0.06, I^2 = 64%).
  - EMP + CAF versus CAF (Comparison 3, Outcome 3.2; Analysis 3.2): P = 0.07, mean difference 0.22 mm (95% CI -0.02 to 0.45, Chi^2 = 1.57, df = 2, P = 0.46, I^2 = 0%).
- Keratinized tissue width change (Comparison 3, Outcome 3.3; Analysis 3.3): there was evidence of greater gain in the width of keratinized tissue for EMP + CAF when compared to CAF alone of 0.35 mm (95% CI 0.13 to 0.56, Chi^2 = 0.64, df = 2, P = 0.73, I^2 = 0%) (three trials: Del Pizzo 2005; Sangiorgio 2017; Spahr 2005).

EMP + CAF versus CAF - short/medium term (Comparison 4)

- Aesthetic condition change: Sangiorgio 2017 reported the results of root coverage aesthetics and overall aesthetic results evaluated by each patient with the assistance of a VAS. In terms of root coverage aesthetics both treatment approaches showed evidence of similar improvements between baseline and 6-month evaluation. Regarding overall aesthetic results following treatment, there was evidence of equivalent outcomes for both groups (i.e. similar aesthetics).
- Gingival recession depth, clinical attachment level and keratinized tissue width changes (Outcomes 4.1 and 4.3): there was evidence of greater reduction of gingival recession depth with concomitant gain in the clinical attachment level and width of keratinized tissue for EMP + CAF when compared to CAF alone (three trials: Del Pizzo 2005; Sangiorgio 2017; Spahr 2005).
  - EMP + CAF versus CAF (Comparison 4, Outcome 4.1; Analysis 4.1): P = 0.005, mean difference 0.32 mm (95% CI 0.10 to 0.55, Chi^2 = 2.10, df = 2, P = 0.35, I^2 = 5%).
  - EMP + CAF versus CAF (Comparison 4, Outcome 4.2; Analysis 4.2): P = 0.009, mean difference 0.35 mm (95% CI 0.09 to 0.61, Chi^2 = 1.25, df = 2, P = 0.53, I^2 = 0%).
  - EMP + CAF versus CAF (Comparison 4, Outcome 4.3; Analysis 4.3): P = 0.0005, mean difference 0.40 mm (95% CI 0.17 to 0.62, Chi^2 = 1.63, df = 2, P = 0.44, I^2 = 0%).

EMP + CAF versus SCTG + CAF - short term (Comparison 5)

- Aesthetic condition change: McGuire 2012 10 years after surgery asked their patients to respond to questions related to aesthetic satisfaction. Six patients had no preference for a particular type of treatment, two favoured aesthetic results with the test treatment (i.e. EMD + CAF), and one favoured results with the control treatment (SCTG + CAF) (P = 0.564).
- Gingival recession depth and clinical attachment level changes (Outcomes 5.1 and 5.2): there was insufficient evidence of a difference between EMP + CAF and the SCTG + CAF (two trials: Abolfazli 2009; McGuire 2012).
  - EMP + CAF versus SCTG + CAF (Comparison 5, Outcome 5.1; Analysis 5.1): P = 0.38, mean difference -0.39 mm (95% CI -1.27 to 0.48, Chi^2 = 25.79, df = 1, P < 0.00001, I^2 = 96%).
  - EMP + CAF versus SCTG + CAF (Comparison 5, Outcome 5.2; Analysis 5.2): P = 0.28, mean difference -0.25 mm (95% CI -0.69 to 0.20, Chi^2 = 2.95, df = 1, P = 0.09, I^2 = 66%).
- Keratinized tissue width changes (Comparison 5, Outcomes 5.3; Analysis 5.3): there was evidence of a difference between the EMP + CAF and the SCTG + CAF in keratinized tissue changes (P < 0.00001, mean difference -1.06 mm (95% CI -1.36 to -0.76, Chi^2 = 2.47, df = 1, P = 0.12, I^2 = 59%)) (two trials: Abolfazli 2009; McGuire 2012).

GTR rm + CAF versus SCTG + CAF - short term (Comparison 6)

- Aesthetic condition change was not reported for this comparison.
- Gingival recession depth and keratinized tissue changes (Outcomes 6.1 and 6.3): there were three trials (Paolantonio 2002; Wang 2001; Zucchelli 1998) for this outcome measured as change from the baseline values. There was evidence of a difference between GTR rm + CAF versus SCTG + CAF.
  - GTR rm + CAF versus SCTG + CAF (Comparison 6, Outcome 6.1; Analysis 6.1): P = 0.002, mean difference -0.37 mm (95% CI -0.60 to -0.13, Chi^2 = 0.25, df = 2, P = 0.88, I^2 = 0%).
  - GTR rm + CAF versus SCTG + CAF (Comparison 6, Outcome 6.3; Analysis 6.3): P < 0.0001, mean difference -1.77 mm (95% CI -2.66 to -0.89, Chi^2 = 15.84, df = 2, P = 0.0004, I^2 = 87%).
- Clinical attachment level change (Comparison 6, Outcome 6.2; Analysis 6.2): there was evidence of a difference between GTR rm + CAF versus SCTG + CAF (mean difference of 0.35 mm, P = 0.02 (95% CI 0.06 to 0.63, Chi^2 = 0.93, df = 2, P = 0.63, I^2 = 0%)) (three trials: Paolantonio 2002; Wang 2001; Zucchelli 1998).

GTR rm + CAF versus GTR nrm + CAF - short term (Comparison 7)

- Aesthetic condition change was not reported for this comparison.
- Gingival recession depth, clinical attachment level and keratinized tissue width changes (Outcomes 7.1 to 7.3): there were two trials (Roccuzzo 1996; Zucchelli 1998) reporting these outcomes measured as changes from the baseline values and there was insufficient evidence of a difference in these outcomes between GTR rm + CAF and GTR nrm + CAF treatment.
  - GTR rm + CAF versus GTR nrm + CAF (Comparison 7, Outcome 7.1; Analysis 7.1): P = 0.32, mean difference 0.23 mm (95% CI -0.22 to 0.68, Chi^2 = 1.59, df = 1, P = 0.21, I^2 = 37%).
  - GTR rm + CAF versus GTR nrm + CAF (Comparison 7, Outcome 7.2; Analysis 7.2): P = 0.64, mean difference 0.12 mm (95% CI -0.37 to 0.60, Chi^2 = 0.28, df = 1, P = 0.60, I^2 = 0%).
  - GTR rm + CAF versus GTR nrm + CAF (Comparison 7, Outcome 7.3; Analysis 7.3): P = 0.50, mean difference 0.12 mm (95% CI -0.23 to 0.48, Chi^2 = 0.03, df = 1, P = 0.86, I^2 = 0%).

GTR rm associated with bone substitutes + CAF versus SCTG + CAF - short term (Comparison 8)

- Aesthetic condition change: Rosetti 2013 compared the GTR rm procedure associated with demineralized freeze-dried bone allografts to SCTG in patients with bilateral gingival recessions. Similarly, aesthetical evaluation was performed by five examiners who were not participating in the study. In this study, the authors have mentioned only that the patient satisfaction survey indicated that all patients were satisfied with the aesthetic results achieved by both procedures at 18 months post-surgery. In addition, no significant differences were identified between the 18 and 30 months assessments.
- Gingival recession depth and clinical attachment level changes (Outcomes 8.1 and 8.2): two trials (Paolantonio 2002; Rosetti 2013) were evaluated and there was insufficient evidence of a difference between these procedures.
  - GTR rm + CAF associated with bone substitutes versus SCTG + CAF (Comparison 8, Outcome 8.1; Analysis 8.1): P = 0.22, mean difference -0.82 mm (95% CI -2.13 to 0.49, Chi^2 = 9.92, df = 1, P = 0.002, I^2 = 90%).
  - GTR rm + CAF associated with bone substitutes versus SCTG + CAF (Comparison 8, Outcome 8.2; Analysis 8.2): P = 0.21, mean difference -0.52 mm (95% CI -1.34 to 0.30, Chi^2 = 2.72, df = 1, P = 0.10, I^2 = 63%).
- Keratinized tissue width change (Comparison 8, Outcome 8.3; Analysis 8.3): there was evidence of greater gain in keratinized tissue for SCTG + CAF when compared to GTR rm + CAF associated with bone substitutes of -2.38 mm (95% CI -2.84

to -1.92, Chi^2 = 1.86, df = 1, P = 0.17, I^2 = 46%) (two trials: Paolantonio 2002; Rosetti 2013).

GTR rm associated with bone substitutes + CAF versus GTR rm + CAF - short term (Comparison 9)

- Aesthetic condition change was not reported for this comparison.
- Gingival recession depth change (Comparison 9, Outcome 9.1; Analysis 9.1): there was evidence of a difference between GTR rm + CAF associated with bone substitutes and GTR rm + CAF favouring GTR rm + CAF associated with bone substitutes (P = 0.02, mean difference 0.48 mm (95% CI 0.09 to 0.88, Chi^2 = 0.10, df = 1, P = 0.76, I^2 = 0%)) (two trials: Dodge 2000; Paolantonio 2002).
- Clinical attachment level and keratinized tissue width changes (Outcomes 9.2 and 9.3): there were two trials (Dodge 2000; Paolantonio 2002) reporting these outcomes measured as changes from the baseline values and there was insufficient evidence of a difference in these outcomes between GTR rm + CAF associated with bone substitutes and GTR rm + CAF.
  - GTR rm + bone substitutes + CAF versus GTR rm + CAF (Comparison 9, Outcome 9.2; Analysis 9.2): P = 0.05, mean difference 0.76 mm (95% CI -0.01 to 1.54, Chi^2 = 2.83, df = 1, P = 0.09, I^2 = 65%).
  - GTR rm + bone substitutes + CAF versus GTR rm + CAF (Comparison 9, Outcome 9.3; Analysis 9.3): P = 0.31, mean difference 0.23 mm (95% CI -0.21 to 0.68, Chi^2 = 1.63, df = 1, P = 0.20, I^2 = 39%).

XCM + CAF versus CAF - short term (Comparison 10)

- Aesthetic condition change: Sangiorgio 2017 reported the results of root coverage aesthetics and overall aesthetic results evaluated by each patient with the assistance of a VAS. In terms of root coverage aesthetics both treatment approaches showed evidence of similar improvements between baseline and 6-month evaluation. Regarding overall aesthetic results following treatment, there was evidence of equivalent outcomes for both groups (i.e. similar aesthetics).
- Gingival recession depth and keratinized tissue level changes (Outcomes 10.1 and 10.3): there was evidence of a difference between XCM + CAF and the CAF alone favouring XCM + CAF (two trials: Jepsen 2013; Sangiorgio 2017).
  - XCM + CAF versus CAF (Comparison 10, Outcome 10.1; Analysis 10.1): P = 0.006, mean difference 0.40 mm (95% CI 0.11 to 0.68, Chi^2 = 0.86, df = 1, P = 0.35, I^2 = 0%).
  - XCM + CAF versus CAF (Comparison 10, Outcome 10.3; Analysis 10.3): P = 0.03, mean difference 0.44 mm (95% CI 0.04 to 0.85, Chi^2 = 1.16, df = 1, P = 0.28, I^2 = 14%).
- Clinical attachment level change (Comparison 10, Outcome 10.2; Analysis 10.2): there was insufficient evidence of a difference between the XCM + CAF and the CAF alone (P = 0.11, mean difference 0.37 mm (95% CI -0.09 to 0.83, Chi^2 = 1.70, df = 1, P = 0.19, I^2 = 41%)) (two trials: Jepsen 2013; Sangiorgio 2017).

PRF + CAF versus SCTG + CAF - short term (Comparison 11)

- Aesthetic condition change was not reported for this comparison.
- Gingival recession depth and keratinized tissue width changes (Outcomes 11.1 and 11.3): there were two trials (Öncü 2017; Tunali 2015) reporting these outcomes measured as changes from the baseline values and there was insufficient evidence of a difference in these outcomes between PRF + CAF and SCTG + CAF in the treatment of multiple recession-type defects.
  - PRF + CAF versus SCTG + CAF (Comparison 11, Outcome 11.1; Analysis 11.1): P = 0.98, mean difference -0.01 mm (95% CI -0.89 to 0.86, Chi^2 = 14.71, df = 1, P = 0.0001, I^2 = 93%).
  - PRF + CAF versus SCTG + CAF (Comparison 11, Outcome 11.3; Analysis 11.3): P = 0.47, mean difference -0.26 mm (95% CI -0.98 to 0.45, Chi^2 = 13.41, df = 1, P = 0.0003, I^2 = 93%).
- Clinical attachment level change (Comparison 11, Outcome 11.2; Analysis 11.2): there was evidence of a difference between PRF + CAF and SCTG + CAF favouring SCTG + CAF (P = 0.02, mean difference -0.37 mm (95% CI -0.69 to 0.06, Chi^2 = 0.58, df = 1, P = 0.45, I^2 = 0%)) (two trials: Öncü 2017; Tunali 2015).

Results from trials not included in meta-analyses

Twenty-eight trials could not be included into meta-analyses because of the heterogeneity of root coverage procedures compared. Thus, their results (i.e. mean difference and 95% confidence intervals) are presented in additional Table 1. Likewise, some important issues of some of these studies are depicted bellow.

- Babu 2011: although the authors of this study reported that "patients presented lesions with similar preoperative clinical parameters as shown by paired t test: RD (1.04), KG (1.08), and PD (1.09)", P values were not reported (Note of the review authors: the restricted number of defects included in the study suggests the need of non-parametric analyses.).
- Keceli 2008: the results from this study were reported as median values. The median value regarding the amount of root coverage achieved was 3.0 mm for both procedures, i.e. SCTG + platelet-rich plasma and SCTG (Friedman test, within-groups comparison P < 0.05). Differences between groups were not statistically significant (Mann–Whitney test - P > 0.05). The median value regarding attachment gains values were 2.5 mm for SCTG + platelet-rich plasma and 3.0 mm for SCTG (Friedman test, within-groups comparison P < 0.05). Differences between groups were not statistically significant (Mann–Whitney test - P > 0.05). The results from this study were reported as median values. However, the median values regarding keratinized tissue gains values were not reported. Only baseline and 12-month medians values were reported. Differences within-groups were considered statistically significant (Friedman test, P < 0.05). Conversely, differences between groups were not statistically significant (Mann–Whitney test - P > 0.05).
- McGuire 2016: with respect to the 5-year follow-up, changes from baseline were not reported. Overall, mean clinical attachment levels were of 2.35 mm and 1.65 mm for the test and control groups. Mean width of keratinized tissue of 3.41 mm and 4.12 mm were recorded for the test and control groups, respectively.
- Pendor 2014: differences between groups in terms of keratinized tissue increase could not be accurately evaluated because baseline means were not statistically similar (Student *t* Test, P < 0.001).

- Rasperini 2011: differences between groups in terms of keratinized tissue increase could not be accurately evaluated because baseline means were not statistically similar (Mann–Whitney U-test, P = 0.01).
- Reino 2012: baseline and final mean values regarding recession depth, clinical attachment level and width of keratinized tissue were not reported. Overall, both groups presented similar pre-treatment clinical values (P > 0.05) for these outcome measures. There was a significant decrease in mean gingival recession and mean clinical attachment level for both SCTG + CAF (extended flap) and SCTG + CAF (ANOVA Two Way Test, within-groups comparison P < 0.05). Differences between groups for both parameters were not statistically significant (ANOVA One Way Test, P < 0.01).The mean width of keratinized tissue increased for both SCTG + CAF (extended flap) and SCTG + CAF (ANOVA Two Way Test, within-groups comparison P < 0.05). Differences between groups were not statistically significant (ANOVA One Way Test, P > 0.05).
- Reino 2015: the mean gingival recession decreased from 3.47 mm to 0.63 mm for XCM + CAF (extended flap) and from 3.49 mm to 1.28 mm for XCM + CAF (Mann Whitney Test, intra-group comparisons P < 0.001, comparison between groups P = 0.014). The mean clinical attachment level decreased from 5.29 mm to 2.63 mm for XCM + CAF (extended flap) and from 5.31 mm to 3.46 mm for XCM + CAF (ANOVA Two Way Test, intra-group comparisons P < 0.01). Differences between groups were not statistically significant (P > 0.05). The mean width of keratinized tissue changed from 1.74 mm to 1.71 mm for XCM + CAF (extended flap) and from 1.66 mm to 2.01 mm for XCM + CAF (ANOVA Two Way Test, intra-group comparisons P > 0.05). Differences between groups were not statistically significant (P > 0.05).

Sites with complete root coverage and percentage of complete root coverage

Data from the number and percentage of sites with complete root coverage were reported in 34 studies (Abolfazli 2009; Ahmedbeyli 2014; Ayub 2012; Bouchard 1994; Bouchard 1997; Costa 2016; da Silva 2004; de Queiroz 2006; Del Pizzo 2005; Dodge 2000; Henderson 2001; Jankovic 2010; Jepsen 2013; Leknes 2005; McGuire 2014; McGuire 2016; Ozenci 2015; Paolantonio 1997; Paolantonio 2002; Paolantonio 2002b; Pendor 2014; Rasperini 2011; Reino 2012; Roccuzzo 1996; Shori 2013; Trombelli 1996; Tunali 2015; Wang 2001; Woodyard 2004; Zucchelli 1998; Zucchelli 2003; Zucchelli 2009; Zucchelli 2014; Zucchelli 2014b). One study (Spahr 2005) reported only the percentage of sites with complete root coverage at 12- and 24-month follow-ups. Another trial (McGuire 2012) reported the percentage of sites with complete root coverage at 12-month and 10-year follow-ups, whereas the number of sites was presented only at the final evaluation (Additional Table 3).

Among the included RCTs designed to evaluate single recession type-defects (excluding the data from the studies by Costa 2016 and Reino 2012 who included only heavy smokers) the percentage of complete root coverage varied from 0% (Ayub 2012) to 91.6% (Woodyard 2004) for ADMG; 18.1% (da Silva 2004) to 95.6% (McGuire 2016) for SCTG; 25% (Abolfazli 2009) to 89.5% (McGuire 2012) for EMP; 7.7 % (de Queiroz 2006) to 81.8% (Zucchelli 2009) for CAF; 33.3% (Dodge 2000) to 53.3% (Paolantonio 2002) for GTR rm; and 28% (Zucchelli 1998) to 41.6% (Roccuzzo 1996) for GTR nrm (Additional Table 3).

In addition, odds ratio (OR) analyses were available for six comparisons.

- ADMG + CAF versus SCTG + CAF - short term (Analysis 1.4), ADMG + CAF versus CAF - short term (Analysis 2.4), EMP + CAF versus SCTG + CAF - short/medium term (Analysis 5.4), GTR rm + CAF versus SCTG + CAF- short term (Analysis 6.4), GTR rm + CAF versus GTR nrm + CAF - short term (Analysis 7.4), and GTR rm + bone substitutes + CAF versus GTR rm + CAF - short term (Analysis 9.4): no statistical differences were found between procedures.
- XCM + CAF versus CAF - short term (Analysis 10.4): the combined therapy improved the achievement of sites displaying complete root coverage compared to the use of CAF alone (OR of 4.73 (95% CI 2.35 to 9.50; P < 0.0001; Chi^2 = 0.16; I^2 = 0%)).

Mean root coverage

All included trials reported the mean root coverage. Within studies evaluating single recession type-defects (excluding the data from Costa 2016 and Reino 2012 who included only heavy smokers), this outcome varied from 50% (Joly 2007) to 96% (Woodyard 2004) for ADMG, 64.7% (Bouchard 1994) to 99.3% for SCTG (McGuire 2016), 70.5% (Jankovic 2010) to 95.1% (McGuire 2012) for EMP, 55.9% (de Queiroz 2006) to 95.4% (Zucchelli 2009) for CAF, 62.5% (Matarasso 1998) to 73.7% (Dodge 2000) for GTR rm, 84.2 % (Rosetti 2013) to 89.9% (Dodge 2000) for GTR rm associated with bone substitutes, and 80.5% (Zucchelli 1998) to 82.4% (Roccuzzo 1996) for GTR nrm (Additional Table 3).

Patients' preference for a specific periodontal plastic surgery (PPS) procedure

Patients' preference for a specific PPS procedure (in split-mouth trials) was reported in three trials (Roccuzzo 1996; Wang 2001; Zucchelli 2003).

In the first study (Roccuzzo 1996), all patients preferred the GTR treatment only because it was a single-step procedure.

The second trial (Wang 2001) comparing patient satisfaction with aesthetics (i.e. amount of root coverage, colour match and overall satisfaction) obtained by SCTG and GTR rm showed that the participants reported greater overall satisfaction with the GTR procedures, probably explained by the reduction in treatment time and elimination of the need for a second surgical intervention.

In the third (Zucchelli 2003), 12 patients (80%) preferred the treatment with reduced size SCTG (i.e. graft dimension equal to the depth of the bone dehiscence) due to the better aesthetics achieved.

Occurrence of adverse effects or postoperative complications or both

Occurrence of adverse effects and/or postoperative complications during the postsurgical period was reported in 15 trials (Ahmedbeyli 2014; Costa 2016; Dodge 2000; Jankovic 2010; Jepsen 2013; Keceli 2008; McGuire 2012; McGuire 2014; McGuire 2016; Roccuzzo 1996; Spahr 2005; Wang 2001; Zucchelli 2003; Zucchelli 2014; Zucchelli 2014b).

- Ahmedbeyli 2014: patients rated ADMG + CAF and CAF equally in terms of the following conditions: pain during surgery, discomfort associated to the duration of procedure and

handling by the operator, postsurgical pain/swelling and complications.

- Ayub 2012: exposure of ADMG was reported in two cases (ADMG + CF group).
- Dodge 2000; Roccuzzo 1996: reported membrane exposure between the first and second weeks of healing.
- Jankovic 2010: recording based on a "healing index" showed statistically significantly superior results for EMP + CAF compared to platelet-rich fibrin + CAF ($P < 0.05$) 1 week after surgery. Also, three patients in the EMP group and one in the platelet-rich fibrin group experienced "severe pain". All patients in the EMP group indicated "greater discomfort", as well as pain intensity was "statistically significantly different between groups for the first 5 days" favouring the platelet-rich fibrin group.
- Jepsen 2013: patient evaluations via VAS exclusively for GR => 3 mm were not available. However, for all defects, there were no differences regarding pain and discomfort between XCM + CAF versus CAF.
- Keceli 2008: there were minor complications related to postoperative swelling occurring within the first days after surgery, and immediate postoperative bleeding in one donor site of SCTG.
- McGuire 2012: patient-reported discomfort was considered statistically significantly higher for SCTG when compared to EMP + CAF, only at 1 month postoperatively.
- McGuire 2014: all patients had mild or no discomfort due to bleeding, swelling, and sensitivity between the first and the fourth week after treatment. VAS did not identify statistically significant differences in pain scores between beta-tricalcium phosphate (b-TCP) + recombinant human platelet-derived growth factor-B with a bioabsorbable collagen wound-healing dressing + CAF and SCTG + CAF. 6 months after treatment, 97% of the patients "commented that they experienced no difference in discomfort between the two treatment sites". 25 patients (78.1%) experienced 75 adverse events within the first 6 months (the most common ones were mild contusion (50%) and face swelling (40.6%)).
- McGuire 2016: two subjects had trauma (a seizure) at 1 week, and 3 weeks (subject could not recall a specific injury) at test sites (XCM + CAF). There were no statistically significant differences between groups (XCM + CAF versus SCTG + CAF) in VAS in terms of pain score/discomfort scores at 1 week, 4 weeks or 6 months.
- Öncü 2017: VAS showed evidence of less discomfort during the first postoperative week for PRF + CAF compared to SCTG + CF.
- Spahr 2005: six patients felt moderate discomfort postoperatively, without differences between treatment modalities (CAF + EMP versus CAF).
- Wang 2001: two patients treated with SCTG experienced adverse effects: one patient experienced postsurgical swelling and the other postsurgical ecchymosis.
- Zucchelli 2003: greater covering flap dehiscence, more painful palate wound healing and necrosis of the primary palatal flap during the first period of healing was detected in patients treated with SCTG showing graft dimension 3 mm greater than the depth of the bone dehiscence.
- Zucchelli 2014: 2 weeks after treatment, there was a statistically superior shrinkage of the covering flap with graft exposure at control sites (de-epithelialized free gingival graft: graft height equal to the depth of bone dehiscence and thickness ≥ 2 mm) than at test sites (de-epithelialized free gingival graft: graft height of 4 mm thickness < 2 mm).
- Zucchelli 2014b: 2 weeks after surgery, shrinkage of the covering flap with graft exposure was noticed in 36% of control sites (SCTG + CAF without removal of the labial submucosal tissue) and 4% of test sites (SCTG + CAF with removal of the labial submucosal tissue). The difference was statistically significant ($P < 0.01$). VAS did not identify difference in patient pain and morbidity between the two procedures.

DISCUSSION

Summary of main results

The objectives of the root coverage periodontal plastic surgery (RCPPS) procedures are to improve patients' aesthetic conditions and other clinical outcomes (e.g. clinical attachment level and the width of keratinized tissue) through the coverage of previously denuded root surfaces. Reported as primary and secondary outcomes, a summary of the main results is depicted below.

Primary outcomes

In spite of aesthetics being considered the primary goal of root coverage procedures, few studies had evaluated aesthetic condition change related to patients' opinion (Ahmedbeyli 2014; Bouchard 1994; McGuire 2012; McGuire 2014; McGuire 2016; Ozenci 2015; Rosetti 2013; Zucchelli 2003; Zucchelli 2014; Zucchelli 2014b). In these studies, the majority of the patients were satisfied with the final aesthetic result achieved. Also, procedures that make a reduction in the operatory time possible, that eliminate the need for a second surgical site and their associated morbidity (guided tissue regeneration with resorbable membranes (GTR rm)) (Wang 2001) and that use smaller palatal grafts (Zucchelli 2003; Zucchelli 2014) were better accepted by the patients.

In terms of recession depth reduction, results from meta-analyses demonstrated evidence that at short term: subepithelial connective tissue grafts (SCTG) + coronally advanced flap (CAF) promoted additional gains to those achieved by GTR rm + CAF; xenogeneic collagen matrix (XCM) + CAF improved the gains obtained by CAF alone; enamel matrix derivative (EMD) + CAF led to better stability of the gingival margin after treatment than CAF alone; and GTR rm + bone substitutes + CAF provided better outcomes than GTR rm + CAF. While statistical analyses (i.e. meta-analyses) did not reveal sufficient evidence of differences between other group comparisons, it was possible to demonstrate that the evaluated procedures were similarly efficient in reducing baseline mean gingival recession.

There was a marked variation between procedures in terms of the achievement of complete root coverage at short term (Additional Table 3): 0% to 95.6%. Odds ratio analyses on complete root coverage did not reveal evidence of differences between procedures in none of the available comparisons, except for XCM + CAF versus CAF (i.e. the combined therapy promoted better outcomes). In addition, some studies showed a decrease in the number of sites displaying complete root coverage over time (de Queiroz 2006; McGuire 2012; McGuire 2014; McGuire 2016).

Secondary outcomes

With respect to secondary outcomes, four comparisons showed evidence that SCTG + CAF promoted additional gains in the width of keratinized tissue compared to EMP + CAF, GTR rm + CAF, or GTR rm + bone substitutes + CAF. Similarly, the use of EMP + CAF or XCM + CAF promoted additional gains in the keratinized tissue compared to the use of CAF alone (Additional Table 2). Regarding clinical attachment level changes, there was evidence that SCTG + CAF promoted additional gains to those achieved by platelet-rich fibrin (PRF) + CAF, and that GTR rm + CAF promoted additional gains compared to SCTG + CAF.

Only one trial reported results from free gingival grafts compared to SCTG after a follow-up period of 5 years (Paolantonio 1997). The results of this study evidenced the superiority of connective grafts in terms of gains in root coverage and similarities in the amount of keratinized tissue achieved.

Also, there was a markedly variation in the amount of root coverage achieved. Mean root coverage varied from 44% to 99.3% (Additional Table 3). Additionally, data from some medium- and long-term trials (de Queiroz 2006; McGuire 2012; McGuire 2014; McGuire 2016) showed that both mean and complete root coverage decreased over time.

Patients' preference for a specific periodontal plastic surgery procedure followed the same pattern as aesthetics condition change (Roccuzzo 1996; Zucchelli 2003).

Occurrence of an early discomfort with or without pain was related to donor sites of SCTG (McGuire 2012; Öncü 2017; Wang 2001; Zucchelli 2003). This aspect may be related to the size of the graft obtained from the palate and the surgical approach used (Zucchelli 2003). Moreover, 'bigger grafts' were more associated to shrinkage of the covering flap with graft exposure when compared to 'small grafts' (Zucchelli 2003; Zucchelli 2014). In terms of flap preparation, the removal of the labial submucosal tissue, in the area of lower incisors, led to a reduction in the number of sites experiencing covering flap shrinkage than sites where the submucosal tissue was not removed (Zucchelli 2014b).

With respect to guided tissue regeneration techniques, membrane exposure during healing was associated with primary postoperative complications (Dodge 2000; Roccuzzo 1996).

Overall findings and conditions

Although 48 randomised controlled trials (RCTs) were included in this Cochrane Review, it was difficult to combine data from these trials due to a great variability of comparisons between the various RCPPS procedures and the inexistence of a unique gold standard control group in all studies. Consequently, only 20 trials were incorporated into meta-analyses (Abolfazli 2009; Barros 2015; de Queiroz 2006; Del Pizzo 2005; Dodge 2000; Jepsen 2013; Joly 2007; McGuire 2012; Öncü 2017; Paolantonio 2002; Paolantonio 2002b; Roccuzzo 1996; Rosetti 2013; Sangiorgio 2017; Shori 2013; Spahr 2005; Tunali 2015; Wang 2001; Woodyard 2004; Zucchelli 1998) in 11 different group comparisons (i.e. five analyses consisted of two studies, one of three studies, and one of four trials) (Additional Table 2). These aspects prevent us from drawing formal definitive conclusions.

Few studies reported a follow-up period superior to 12 months (Abolfazli 2009; de Queiroz 2006; Del Pizzo 2005; Leknes 2005; McGuire 2012; McGuire 2014; McGuire 2016; Paolantonio 1997; Rosetti 2013; Spahr 2005). In six of these studies a chronological evaluation of the results evidenced loss in the amount of root coverage obtained (e.g. mean root coverage and sites with complete root coverage) between the 6 months to 12 months period of evaluation (de Queiroz 2006; Del Pizzo 2005; Spahr 2005) and between the first year and 5- and 10-year follow-ups (McGuire 2012; McGuire 2014; McGuire 2016). This assumption was evidenced by the findings of pooled estimates (Comparison 3, Outcome 3.1 and Comparison 4, Outcome 4.1). Long-term period evaluations are probably linked to individual conditions such as changes in the periodontal health status, toothbrushing, habits and genetic and systemic conditions.

Two trials (Costa 2016; Reino 2012) evidenced the detrimental impact of smoking on root coverage outcomes (i.e. mean root coverage and complete root coverage decrease) within patients who smoke ≥ 10 cigarettes per day for more than 5 years.

Overall, both the individual studies' outcomes (i.e. within-group comparisons reported by each individual trial) and findings of pooled estimates clearly demonstrated that all root coverage procedures included in this Cochrane Review promoted reduction in the extent of gingival recession and concomitant gain in the clinical attachment level for both single and multiple recession-type defects. Likewise, it was evidenced that keratinized tissue augmentation of these sites was associated to the use of SCTG or allogenous (ADMG)/xenogenous (XCM) soft tissue substitutes.

Quality of the evidence

Based on the information contained in each individual article and on the details regarding the methodological quality of the trials provided after contact with original authors (e.g. method of randomisation, allocation concealment, blinding of examiners/patients and completeness of the follow-up period), only one study was considered to be at a low overall risk of bias. Therefore the lack of allocation concealment or blinding or both and inadequate methods of randomisation, as well as the lack of similar inclusion criteria between trials and baseline characteristics of defects (as reported by some studies), can act as source of biases and can affect the accuracy of the results (Needleman 2002; Needleman 2005). GRADE methods (GRADE 2004) were used to assess the quality of the body of evidence of our main comparisons and our assessment is presented in the Summary of findings for the main comparison; Summary of findings 2; Summary of findings 3; Summary of findings 4; Summary of findings 5; Summary of findings 6 with all evidence considered to be of low to very low quality, mainly for imprecision and inconsistency.

Potential biases in the review process

In this review, only defects ≥ 3 mm were included in order to minimize heterogeneity between the trials. However, this inclusion criterion could have eliminated data from studies that could be incorporated into meta-analyses (see Agreements and disagreements with other studies or reviews). In addition, the limited number of studies included in the meta-analyses prevented formal testing for publication bias.

Agreements and disagreements with other studies or reviews

Data from the included studies in this review have shown that the percentage of success achieved by RCPPS procedures was regularly associated with improvements in the clinical parameters (i.e. outcomes measures), mainly evaluated by gains in the clinical attachment level and in the width of keratinized tissue and achieved mean root coverage. Nevertheless, different authors have pointed out that these currently used parameters only reflect the final clinical results expected and not the changes that had occurred in patient-centred outcomes, such as changes in the aesthetic condition, functional limitations (e.g. limitations in chew and deglutition of food), discomfort, pain, alterations in the level of sociability after surgery (e.g. psychological and behavioural impact), and patients' preference for a specific RCPPS procedure in trials with a split-mouth design (Needleman 2005b; Ng 2006; Ozcelik 2007; Roccuzzo 2002). Consequently, patients and professionals can present different points of view regarding the performed procedures and the achieved final result.

With respect to patient-centred evaluations, some studies evaluated aesthetics and pain/discomfort through the use of visual scales or similar instruments (Ahmedbeyli 2014; Jankovic 2010; Jepsen 2013; McGuire 2014; McGuire 2016; Zucchelli 2014; Zucchelli 2014b). The visual analogue scale (VAS) is a tool that has been used to evaluate the levels of discomfort and pain subsequent to different modalities of periodontal treatment (Checchi 1993; Fardal 2002; Karadottir 2002; Matthews 1993). This resource can be applied to evaluate various aesthetic and functional individual outcomes. In another study (Jørnung 2007) the use of VAS showed that the opinion of the patients with respect to their own smile was statistically significantly better than the opinion of two different clinicians, highlighting that the patient's individual perception can influence clinical decision making choice. On the other hand, both patients and clinicians (i.e. general dentists and periodontists) seem to agree that, in terms of aesthetic perception, complete root coverage is perceived as the primary 'successful outcome' of a RCPPS procedure (Rotundo 2008). Another interesting scale developed for professional aesthetical evaluation, the root-coverage esthetic score (RES) (Cairo 2009), might be adapted to assist patients in performing more accurate assessments of five important items: gingival margin, soft tissue texture, gingival colour, and marginal tissue contour. In addition, it is important to highlight that patients' perception of buccal recessions is not high (approximately half of the patients with one gingival recession do not perceive them), as well as that the majority of those defects do not lead to functional or aesthetic concerns (Nieri 2013).

The great variability in the percentages of sites with complete and mean root coverage is probably associated with a set of factors such as the type of defect, amount and quality of adjacent gingival tissue, sample size and the applied inclusion criteria (e.g. patients' selection, methodological quality, type of technique, devices used for measurements and differences between operators). It seems that the amount of root coverage obtained is associated with initial recession anatomy. Better results in terms of percentage of complete and mean root coverage can be expected when baseline recession defects are < 4 mm (Berlucchi 2005), at the same time flaps with < 1 mm thickness can harm the achievement of complete root coverage (Baldi 1999; Berlucchi 2005). It has been demonstrated by an individual patient data meta-analysis of 602 Miller Class I and II recession defects (Chambrone 2012) that the greater the baseline recession depth, the smaller the chance of achieving complete root coverage. Moreover, another couple of studies (Nieri 2009; Pini Prato 2005) demonstrated that sites in which the gingival margin was sutured at the level of the cemento-enamel junction the achievement of complete root coverage was inferior to those sites where the flap was sutured coronal (approximately 1 mm to 2 mm) (i.e. the more apical the gingival margin after surgery, the smaller the chance of complete root coverage). Thick and wide interproximal dental papillae can positively influence the percentage of complete root coverage (Berlucchi 2005; Saletta 2001), however, their baseline anatomy is directly associated with the distance from the contact point to the bone crest. When the measurement from the contact point to the bone crest is 5 mm or less, the papilla is present almost 100% of the time, whereas, when the distance is 6 mm, the papilla is present 56% of the time (Tarnow 1992). When this distance is between 7 mm to 10 mm the papilla is missing most of the time (Tarnow 1992). It should also be noted that the inclusion of studies with recession defects ≥ 4 mm tends to show greater differences between baseline and follow-up means (i.e. outcome change), a factor that may influence the calculation of meta-analyses.

With respect to flap tension, it has been suggested that the higher the flap tension, the lower the recession reduction (Pini Prato 2000). Consequently, all theses factors make comparisons and combination of data from different trials a critical issue. In this way, trials investigating the treatment of gingival recession with similar baseline characteristics or which have included baseline and final individual defects measurements will allow more effective evaluations of each surgical technique, as well as facilitating future meta-analyses.

It has been shown that smoking can affect the results obtained by RCPPS procedures (Chambrone 2009). Two RCTs (Costa 2016; Reino 2012) evaluated only patients who smoked ≥ 10 cigarettes per day for at least 5 years, and their showed that heavy smokers may be benefited by root coverage therapy, as well. On the other hand, mean root coverage and complete root coverage were clearly inferior to the outcomes achieved by trials evaluating non-smokers (Additional Table 3). Eight trials reported the inclusion of smokers (Bouchard 1994; Bouchard 1997; Jepsen 2013; McGuire 2012; Spahr 2005; Zucchelli 2009; Zucchelli 2014; Zucchelli 2014b) who smoked less than 10 cigarettes per day. None of them performed comparisons between smokers and non-smokers. Zucchelli 1998 commented only that patients who smoke more than 10 cigarettes a day presented the worst percentage of root coverage. This is in line with included RCTs on smokers (Costa 2016; Reino 2012) and the data from other studies that have compared the amount of root coverage obtained by smokers and non-smokers through CAF (Silva 2007) and SCTG (Erley 2006; Martins 2004). Similarly, root modification agents (e.g. tetracycline solution and citric acid) and the type of mechanical root scaling associated to the RCPPS procedure (i.e. CAF) were evaluated in few studies. Nevertheless, these RCTs have suggested that there is no significant clinical benefit of root conditioning in conjunction with root coverage procedures (Additional Table 1; Table 3).

Since 2002, some extensive systematic reviews have evaluated the effects of PPS procedures in the treatment of recession

defects. Roccuzzo 2002 used stringent inclusion criteria, but it also included non-randomised trials, gingival recessions < 3 mm and did not evaluate changes in the width of keratinized tissue or the use of biomaterial such as acellular dermal matrix grafts. Oates 2003 included only RCTs and its inclusion criteria were only based on the terms 'human study, English language, and therapeutic study including the use of a gingival surgical procedure to treat gingival recession'. Chambrone 2008 focused mainly on the treatment of recession defects with SCTG. These reviews did not include searches for unpublished data (i.e. grey literature), papers published in all languages (Chambrone 2008; Oates 2003; Roccuzzo 2002) or evaluation of the risk of bias (Oates 2003; Roccuzzo 2002). However, their results were similar to ours. Additionally, the present version of this Cochrane Review is also in completely line with data from the recent American Academy of Periodontology Regeneration Workshop systematic review that concluded that: 1. "all RCPPS procedures can provide significant reduction in recession depth and clinical attachment level gain without alteration of probing depth for Miller Class I and II localized recession-type defects, but multiple recession-type defects seems to be benefit as well despite the reduced quantity of information available;" 2. "SCTG-based procedures provided the best outcomes for clinical practice because of their superior percentages of mean root coverage and complete root coverage and the significant increase of keratinized tissue when compared with most of the other procedures" (as reported by the individual studies' outcomes, additional Table 3); 3. "the use of CAF with ADMG, EMP, and XCM also provided gains, many of them similar to SCTG-based procedures, and thus these may be considered as adequate substitute treatment approaches"; and 4. "smoking may decrease the expected results" (Chambrone 2015).

It is also important to highlight that recent evidence from two long-term non-randomised studies that followed patients for at least 20 years found that gingival recessions recurrence/relapse appears to be more associated to sites lacking an attached keratinized tissue band of at least 2 mm (Agudio 2017; Pini Prato 2018). Similarly, a recent systematic review (Chambrone 2016) evaluating the long-term outcomes of untreated buccal recession-type defects (in terms of associated reported aesthetic and functional alterations and factors influence the progression/worsening of dental and periodontal tissue conditions) found that: 1. untreated buccal recession defects in individuals with good oral hygiene are highly likely to experience recession depth increase during long-term follow-up (≥ 5 years) - 78% of the defects displayed clinical worsening; and 2. the presence of keratinized tissue band and/or greater keratinized tissue width decrease the chance of recession depth increase or the development of new recessions. Nonetheless, individual data from some of the studies included in the systematic review suggest that SCTG promoted better stability of the gingival margin/some degree of creeping attachment over time, compared to other surgical approaches (Abolfazli 2009; Jepsen 2013; McGuire 2012; McGuire 2016; Tunali 2015).

Several trials on periodontal plastic surgery have been performed evaluating different procedures as control groups. They have evidenced the lack of a standard procedure that could be considered as gold standard (i.e. control group) for the majority of trials. In this review, the exclusion of non-randomised studies and the use of stringent inclusion criteria may have led to the loss of evidence-based information since only studies which compared two (or more) active treatments were studied (since a placebo or no control treatment group were not possible). Studies that evaluated recession defects < 3 mm were also excluded. Overall, data from the included studies indicate that the SCTG is the procedure that can become this gold standard; however, further research on this matter is needed.

In addition, similar to another Cochrane Review (Esposito 2005), the majority of included RCTs were often performed on patients presenting different clinical and systemic conditions from those currently found in a conventional private practice. These conditions can cause more variability of the results when extrapolated to daily practice.

AUTHORS' CONCLUSIONS

Implications for practice

- All the analysed root coverage periodontal plastic surgery (RCPPS) procedures led to gains in gingival recession (i.e. recession depth decrease and clinical attachment level gain) and thus can be used in clinical practice. However, there was a great variability in the percentages of complete root coverage and mean root coverage.
- The available evidence base indicates that subepithelial connective tissue grafts (SCTG) plus coronally advanced flap (CAF), CAF alone or associated with biomaterial (e.g. acellular dermal matrix grafts (ADMG), enamel matrix protein (EMP) and xenogeneic collagen matrix (XCM) and guided tissue regeneration (GTR)) may be used as root coverage procedures for the treatment of recession-type defects. The available information on the use of platelet-rich fibrin associated to CAF is very scarce and it precludes formal accurate comparisons with CAF alone or CAF plus SCTG or other biomaterial. In case where both root coverage and gain in the width of keratinized tissue are expected, the available evidence base suggests the use of SCTG seems to be more adequate.
- Individual studies' outcomes and some weak evidence obtained by the available pooled estimates suggest that SCTG plus CAF may be considered as 'gold standard' procedure for the treatment of recession-type defects. Moreover, evidence suggests that SCTG promoted better stability of the gingival margin/some degree of creeping attachment over time, compared to other surgical approaches.
- Acellular dermal matrix grafts (primarily) and XCM (secondly) may be considered as alternatives in cases where SCTG harvested from the palate could not be used.
- Outcome measures of the evaluated surgical techniques were not improved by the use of root modification agents (e.g. citric acid or tetracycline solution) or the type of mechanical root scaling (i.e. ultrasonic or manual) during surgery. Overall, outcomes from few individual studies indicated equivalent improvements for sites treated with these chemical/mechanical procedures or not.
- The incidence of adverse effects, such as discomfort with or without pain, was mainly related to donor sites of SCTG. However, these conditions occurred mainly within the first week after surgery and did not influence on root coverage outcomes.
- The potential impact of bias on these outcomes (primary and secondary) is unclear.

Implications for research

- Limited data exist on aesthetic condition change related to patient's opinion, thus further randomised controlled trials (RCTs) are still required to evaluate this primary outcome variable.
- Future split-mouth trials should focus on patients' preference for a specific periodontal plastic surgery procedure.
- Precise and objective aesthetic evaluations should be included in future studies. The use of the visual analogue scale (VAS) will allow more precise evaluations of patient-based outcomes.
- The inclusion of baseline and final individual defect measurements will allow more precise evaluations, as well as subgroup evaluations (e.g. patients presenting similar defects) and future comparisons via meta-analyses. These outcome measures should include gingival recession depth and width, clinical attachment level, width and thickness of keratinized tissue, and root surface conditions (i.e. presence of caries, abrasions or restorations).
- Comparisons between different operators (i.e. with respect to the degree of operator's experience) remain necessary to evaluate differences in the expected outcome measures.
- Multicentre studies may favour the inclusion and evaluation of larger samples of patients and therefore the achievement of statistical power.
- Considering the proposed inclusion criteria, no data were available for lateral positioned flaps and there is limited information for free gingival grafts and platelet-rich fibrin. These procedures might be evaluated by future research.
- More long-term RCTs are necessary to adequately confirm and identify possible factors associated with the prognosis and indications of each root coverage periodontal plastic surgery procedure. CONSORT should be considered when designing and reporting future studies (www.consort-statement.org/) .

ACKNOWLEDGEMENTS

The review authors would like to acknowledge Anne Littlewood for her assistance on the search strategy section and Helen Worthington, Ian Needleman, Luisa Fernandez Mauleffinch and Marco Esposito from Cochrane Oral Health for their help with the preparation of the protocol and full text of the review. We would like to thank Professor Kevin Seymour from Division of Dentistry, School of Medical Sciences, Faculty of Biology, Medicine and Health, the University of Manchester for providing comments on this update.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Abolfazli 2009

Methods	RCT, split-mouth design, 2 treatment groups, 24 months' duration
Participants	12 individuals, 8 females, aged 28 to 51 years, with 2 bilateral Miller Class I buccal gingival recessions of at least 3 mm
Interventions	1. EMD + CAF 2. SCTG + CAF
Outcomes	GRC*(2) CALC*(2) KTC*(2) SCRC PCRC*(2) MRC*(2) (Manual probe)
Notes	Practice-based

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method not reported
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Ahmedbeyli 2014

Methods	RCT, parallel design, 2 treatment groups, 12 months' duration
Participants	24 individuals, 12 females, aged 22 to 40 years, with Miller Class I multiple buccal gingival recessions of at least 3 mm
Interventions	1. ADMG + CAF 2. CAF
Outcomes	ACC GRC*(1) CALC*(1) KTC*(1) SCRC PCRC MRC (Manual probe)
Notes	University/hospital-based

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computerized randomisation table
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Information not reported
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other types of bias was not detected

Ayub 2012

Methods	RCT, split-mouth design, 2 treatment groups, 6 months' duration
Participants	15 individuals, number of females not reported, aged 20 to 56 years, with 2 bilateral Miller Class I or II buccal gingival recessions of at least 3 mm
Interventions	1. ADMG (positioned 1 mm apical to the cemento-enamel junction) + CAF (extended flap) 2. ADMG + CAF (extended flap)
Outcomes	GRC*(1) CALC*(1) KTC SCRC PCRC MRC (Automated controlled force probe and manual probe)
Notes	University/hospital-based and supported by the State of São Paulo Research Foundation and BioHorizons Inc

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomly permuted block
Allocation concealment (selection bias)	Low risk	Adequate - sealed envelope
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Information not reported
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Babu 2011

Methods	RCT, split-mouth design, 2 treatment groups, 6 months' duration

Babu 2011 *(Continued)*

Participants	10 individuals, number of females not reported, age not reported, with 2 Miller Class I or II buccal gingival recessions of at least 3 mm
Interventions	1. GTR + CAF (collagen membrane - Bioproducts Lab) 2. SCTG + CAF
Outcomes	GRC CALC KTC MRC (Manual probe)
Notes	University/hospital-based

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method not reported
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Information not reported
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Unclear risk	Between groups comparisons regarding baseline recession depth were not reported
Other bias	Low risk	Evidence of other bias was not detected

Barros 2015

Methods	RCT, split-mouth design, 2 treatment groups, 12 months' duration
Participants	15 individuals, 10 females, aged 23 to 54 years, with 2 bilateral Miller Class I or II buccal gingival recessions of at least 3 mm
Interventions	1. ADMG + CAF (extended flap) 2. SCTG + CAF (extended flap)

Barros 2015 *(Continued)*

Outcomes	GRC CALC KTC MRC (Automated controlled force probe - 0.50 N)
Notes	University/hospital-based

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Bouchard 1994

Methods	RCT, parallel design, 2 treatment groups, 6 months' duration
Participants	30 individuals, 24 females, aged 21 to 62 years, with 1 Miller Class I or II buccal gingival recession of at least 3 mm
Interventions	1. SCTG + CAF + CA (graft without epithelial collar) 2. SCTG (graft with epithelial collar)
Outcomes	ACC GRC CALC KTC

Bouchard 1994 *(Continued)*

	SCRC PCRC MRC (Automated controlled force probe - 0.50 N)
Notes	Practice-based

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method not reported
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	High risk	All measurements were performed by 1 examiner aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Bouchard 1997

Methods	RCT, parallel design, 2 treatment groups, 6 months' duration
Participants	30 individuals, 25 females, aged 21 to 70 years, with 1 Miller Class I or II buccal gingival recession of at least 3 mm
Interventions	1. SCTG + CAF + TTC-HCl 2. SCTG + CAF + CA
Outcomes	GRC CALC KTC SCRC PCRC

Bouchard 1997 *(Continued)*

	MRC (Automated controlled force probe - 0.50 N)
Notes	Practice-based

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method not reported
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	High risk	All measurements were performed by 1 examiner aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Costa 2016

Methods	RCT, split-mouth design, 2 treatment groups, 6 months' duration
Participants	20 individuals (heavy smokers - 10 or more cigarettes/day for over 5 years), 12 females, aged 30 to 50 years, with 2 bilateral Miller Class I or II buccal gingival recessions of at least 3 mm
Interventions	1. ADMG + EMD + CAF (extended flap) 2. ADMG + CAF (extended flap)
Outcomes	GRC*(1) CALC KTC SCRC PCRC MRC (Automated controlled force probe and compass)

Costa 2016 *(Continued)*

Notes	University/hospital-based

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "method of randomly allocating by simple draw"
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	1 patient did not return for clinical evaluation at 6 months Data are equally missing in both intervention groups (split-mouth design), but reasons for these are both reported and balanced across groups, then important bias is not be expected
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

da Silva 2004

Methods	RCT, split-mouth design, 2 treatment groups, 6 months' duration
Participants	11 individuals, 5 females, aged 18 to 43 years, with 2 bilateral Miller Class I or II buccal gingival recessions of at least 3 mm
Interventions	1. SCTG + CAF 2. CAF
Outcomes	GRC CALC KTC*(1) SCRC PCRC MRC (Automated controlled force probe)
Notes	University/hospital-based

da Silva 2004 *(Continued)*

	Unpublished data were included following contact with author

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	High risk	All measurements were performed by 1 examiner aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

de Queiroz 2006

Methods	RCT, split-mouth design, 2 treatment groups, 24 months' duration
Participants	13 individuals, 7 females, mean age 32.8 years, with 2 bilateral Miller Class I buccal gingival recessions of at least 3 mm
Interventions	1. ADMG + CAF 2. CAF
Outcomes	GRC CALC KTC SCRC PCRC MRC (Manual probe)
Notes	University/hospital-based Data from earlier article (de Queiroz 2004) were reported as part of this trial

de Queiroz 2006 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Information not reported
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Del Pizzo 2005

Methods	RCT, split-mouth design, 2 treatment groups, 24 months' duration
Participants	15 individuals, 11 females, aged 18 to 56 years, with 2 bilateral Miller Class I or II buccal gingival recessions of at least 3 mm
Interventions	1. EMP + CAF 2. CAF
Outcomes	GRC CALC KTC*(1) SCRC PCRC MRC (Manual probe)
Notes	University/hospital-based

Risk of bias

Del Pizzo 2005 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Dodge 2000

Methods	RCT, split-mouth design, 2 treatment groups, 12 months' duration
Participants	12 individuals, 8 females, aged 23 to 51 years, with 2 Miller Class I or II buccal gingival recessions of at least 3 mm
Interventions	1. GTR (polylactic acid membrane - Guidor) + TTC-HCl + DFDBA 2. GTR (polylactic acid membrane - Guidor) + TTC-HCl
Outcomes	GRC CALC*(1) KTC*(1) SCRC PCRC MRC (Manual probe)
Notes	Practice-based

Risk of bias

Bias	Authors' judgement	Support for judgement

Dodge 2000 *(Continued)*

Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Henderson 2001

Methods	RCT, split-mouth design, 2 treatment groups, 12 months' duration
Participants	10 individuals, 5 females, aged 24 to 68 years, with 2 Miller Class I or II buccal gingival recessions of at least 3 mm
Interventions	1. ADMG (connective tissue side against the tooth) + CAF 2. ADMG (basement membrane side against the tooth) + CAF
Outcomes	GRC CALC KTC MRC (Manual probe)
Notes	University/hospital-based and supported by Lifecore Biomedical

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method not reported
Allocation concealment (selection bias)	Unclear risk	Method not reported

Henderson 2001 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Jaiswal 2012

Methods	RCT, parallel design, 2 treatment groups, 6 months' duration
Participants	20 individuals, 8 females, aged 25 to 56 years, with Miller Class II multiple buccal gingival recessions of at least 3 mm
Interventions	1. EMD + CAF 2. CAF
Outcomes	GRC*(1) CALC*(1) KTC MRC (Automated controlled force probe - 15g)
Notes	University/hospital-based

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported

Jaiswal 2012 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Information not reported
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Jankovic 2010

Methods	RCT, split-mouth design, 2 treatment groups, 12 months' duration
Participants	20 individuals, 12 females, aged 21 to 48 years, with bilateral Miller Class I and II maxillary buccal gingival recessions of at least 3 mm
Interventions	1. Platelet-rich fibrin + CAF 2. EMD + CAF
Outcomes	GRC KTC*(2) SCRC PCRC MRC (Manual probe)
Notes	University/hospital-based

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure

Jankovic 2010 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Jepsen 2013

Methods	RCT, split-mouth design, 2 treatment groups, 6 months' duration
Participants	35 individuals, age > 18 years, with 2 Miller Class I or II buccal gingival recessions of at least 3 mm
Interventions	1. XCM + CAF 2. CAF
Outcomes	GRC*(1) CALC KTC*(1) SCRC PCRC MRC (Manual probe)
Notes	University/hospital-based and supported by Geistlich Pharma AG

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation list
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period

Jepsen 2013 *(Continued)*

Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Joly 2007

Methods	RCT, split-mouth design, 2 treatment groups, 6 months' duration
Participants	10 individuals, 4 females, aged 24 to 68 years, with 2 Miller Class I or II maxillary buccal gingival recessions of at least 3 mm
Interventions	1. ADMG + CAF (flap without vertical incisions) 2. SCTG + CAF (flap without vertical incisions)
Outcomes	GRC*(2) CALC*(2) KTC MRC (Manual probe)
Notes	University/hospital-based

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	High risk	All measurements were performed by 1 examiner aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Keceli 2008

Methods	RCT, parallel design, 2 treatment groups, 12 months' duration
Participants	40 individuals, 30 females, aged 18 to 60 years, with 1 Miller Class I or II buccal gingival recession of at least 3 mm. 36 individuals completed the study
Interventions	1. SCTG + platelet-rich plasma + CAF 2. SCTG + CAF
Outcomes	GRC CALC KTC SCRC PCRC MRC (Manual probe)
Notes	University/hospital-based and supported by The Research Foundation of Hacettepe University

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quote: "The first patient was selected in one of the two experimental groups by coin toss, and the next patient was consecutively added to the opposite group by one of the authors"
Allocation concealment (selection bias)	High risk	Quote: "The first patient was selected in one of the two experimental groups by coin toss, and the next patient was consecutively added to the opposite group by one of the authors"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	Data are missing in both intervention groups (4 patients discontinued the study between 6- to 12-month evaluations due to moving to another city). Thus, decision to move house away from the geographical location to another is unlikely to be connected with their subsequent outcome
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Keceli 2015

Methods	RCT, parallel design, 2 treatment groups, 6 months' duration
Participants	40 individuals, 27 females, aged 22 to 50 years, with 1 Miller Class I or II buccal gingival recession of at least 3 mm
Interventions	1. SCTG + platelet-rich fibrin + CAF 2. SCTG + CAF
Outcomes	GRC CALC KTC SCRC PCRC MRC*(1) (Manual probe)
Notes	University/hospital-based

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer generated randomisation list
Allocation concealment (selection bias)	Low risk	Number-labeled opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Patients were not blinded to the root coverage procedure
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Leknes 2005

Methods	RCT, split-mouth design, 2 treatment groups, 72 months' duration

Leknes 2005 *(Continued)*

Participants	20 individuals, 10 females, mean age 38.4 years, with 2 Miller Class I or II buccal gingival recessions of at least 3 mm. 11 individuals completed the study
Interventions	1. GTR (polylactic acid membrane - Guidor) 2. CAF
Outcomes	GRC CALC KTC SCRC PCRC MRC (Automated controlled force probe and manual probe)
Notes	University/hospital-based and membranes provided by Guidor AB Unpublished data were included following contact with author Data from earlier article (Amarante 2000) were reported as part of this trial

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	11 out of 20 subjects were available for the final evaluation (6 subjects rejected to complete the study and 3 moved to other part of Norway) Data are equally missing in both intervention groups (split-mouth design), but reasons for these are both reported and balanced across groups, then important bias is not expected
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other was not detected

Matarasso 1998

Methods	RCT, parallel design, 2 treatment groups, 12 months' duration
Participants	20 individuals, 8 females, aged 18 to 42 years, with 1 Miller Class I or II buccal gingival recession of at least 3 mm
Interventions	1. GTR (polylactic acid membrane - Guidor) + double papilla flap 2. GTR (polylactic acid membrane - Guidor) + CAF
Outcomes	GRC CALC KTC MRC (Manual probe)
Notes	University/hospital-based Unpublished data were included following contact with author

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method not reported
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	High risk	All measurements were performed by 1 examiner aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

McGuire 2012

Methods	RCT, split-mouth design, 2 treatment groups, 5 years' duration

McGuire 2012 *(Continued)*

Participants	20 individuals, 10 females, aged 23 to 62 years, with 2 Miller Class II maxillary buccal gingival recessions of at least 4 mm. 19 individuals completed the 6-month follow-up, 17 completed the 12-month follow-up, and 9 the 5-year follow-up
Interventions	1. EMP + CAF 2. SCTG + CAF
Outcomes	GRC CALC KTC*(2) PCRC MRC (Manual probe)
Notes	Practice-based and supported by BIORA AB (currently Straumann) Unpublished data were included following contact with author

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer generated randomisation list
Allocation concealment (selection bias)	Low risk	Adequate - sealed envelope
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	3 patients did not complete the 12-month follow-up: 1 participant dropped out because he had moved out of the country (where the RCT was conducted), 1 had a change in job and could not comply with study schedule and 1 was not compliant and was exited from the trial. Moreover, at the 10-year final evaluation, just 9 out 17 patients available at short-term assessment were available/agreed to be re-evaluated (reasons were not reported) Data are equally missing in both intervention groups (split-mouth design), but reasons for these are both reported and balanced across groups, then important bias is not to be expected
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

McGuire 2014

Methods	RCT, split-mouth design, 2 treatment groups, 5 years' duration
Participants	30 individuals, 26 females, aged 18 to 70 years, with 2 Miller Class II buccal gingival recessions of at least 3 mm. 30 individuals completed the 6 months follow-up, whereas 20 the 5 years follow-up
Interventions	1. Beta-tricalcium phosphate (b-TCP) + recombinant human platelet-derived growth factor-B with a bioabsorbable collagen wound-healing dressing + CAF 2. SCTG + CAF
Outcomes	ACC GRC*(2) CALC KTC*(2) SCC PCRC MRC (Manual probe)
Notes	Practice-based and supported by Osteohealth Unpublished data were included following contact with author

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer generated randomisation list
Allocation concealment (selection bias)	Low risk	Adequate - sealed envelope
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the initial 6-month evaluation, but 20 out 30 were available for follow-up 5 years after the original recession-related surgery (reasons were not reported) Data are equally missing in both intervention groups (split-mouth design), but reasons for these are both reported and balanced across groups, then important bias is not to be expected
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected

McGuire 2014 *(Continued)*

Other bias	Low risk	Evidence of other bias was not detected

McGuire 2016

Methods	RCT, split-mouth design, 2 treatment groups, 5 years' duration
Participants	25 individuals, 17 females, aged 18 to 70 years, with 2 Miller Class II buccal gingival recessions of at least 3 mm. 23 individuals completed the 12 months follow-up, whereas 17 the 5 years follow-up
Interventions	1. XCM + CAF 2. SCTG + CAF
Outcomes	ACC GRC*(2) CALC*(2) KTC SCC PCRC MRC (Manual probe)
Notes	Practice-based and supported by Giestlich Pharma AG Unpublished data were included following contact with author

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer generated randomisation list
Allocation concealment (selection bias)	Low risk	Adequate - sealed envelope
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	The 25 patients included in the study completed the initial 6-month follow-up, whereas 17 were available for a 5-year recall (quote: "seven patients unavailable for recall had moved, were not reachable, or had conflicting engagements, and one had received a class 5 restoration that eradicated the baseline measurement reference point")

McGuire 2016 *(Continued)*

		Data are equally missing in both intervention groups (split-mouth design), but reasons for these are both reported and balanced across groups, then important bias is not to be expected
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Ozenci 2015

Methods	RCT, parallel design, 2 treatment groups, 12 months' duration
Participants	20 individuals, 13 females, aged 22 to 42 years, with Miller Class I multiple buccal gingival recessions of at least 3 mm
Interventions	1. ADMG + Tunnel (CAF) 2. ADMG + CAF
Outcomes	ACC*(2) GRC*(2) CALC*(2) KTC*(2) SCC PCRC MRC (Manual probe)
Notes	University/hospital-based

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure

Ozenci 2015 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Paolantonio 1997

Methods	RCT, parallel design, 2 treatment groups, 60 months' duration
Participants	70 individuals, 38 females, aged 25 to 48 years, with 1 Miller Class I or II buccal gingival recession of at least 3 mm
Interventions	1. SCTG + double papilla flap 2. FGG
Outcomes	GRC*(1) KTC SCRC PCRC MRC (Manual probe)
Notes	Practice-based Unpublished data were included following contact with author

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	High risk	All measurements were performed by 1 examiner aware of the type of surgical procedure
Incomplete outcome data (attrition bias)	Low risk	All patients completed the follow-up period

Paolantonio 1997 *(Continued)*

All outcomes		
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Paolantonio 2002

Methods	RCT, parallel design, 3 treatment groups, 12 months' duration
Participants	45 individuals, 31 females, aged 27 to 51 years, with 1 Miller Class I or II buccal gingival recession of at least 3 mm
Interventions	1. GTR (polylactic acid membrane - Guidor) 2. GTR (polylactic acid membrane - Paroguide) + hydroxyapatite/collagen/chondroitin-sulfate graft 3. SCTG + double papilla flap
Outcomes	GRC CALC KTC*(3) SCRC PCRC MRC (Manual probe)
Notes	University/hospital-based and supported by Italian Ministry of University and Scientific Research Unpublished data were included following contact with author

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	High risk	All measurements were performed by 1 examiner aware of the type of surgical procedure

Paolantonio 2002 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Paolantonio 2002b

Methods	RCT, parallel design, 2 treatment groups, 12 months' duration
Participants	30 individuals, 19 females, aged 29 to 51 years, with 1 Miller Class I or II buccal gingival recession of at least 3 mm
Interventions	1. ADMG + CAF 2. SCTG + CAF
Outcomes	GRC CALC KTC*(2) SCRC PCRC MRC (Automated controlled force probe - 20 g and calliper)
Notes	University/hospital-based and supported by Italian Ministry of University and Scientific Research Unpublished data were included following contact with author

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure

Paolantonio 2002b *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Pendor 2014

Methods	RCT, parallel design, 2 treatment groups, 6 months' duration
Participants	20 individuals, 6 females, aged 25 to 46 years, with 1 Miller Class I or II buccal gingival recession of at least 3 mm
Interventions	1. SCTG + double pedicle flap 2. SCTG + CAF
Outcomes	GRC CALC KTC SCRC PCRC MRC (Automated controlled force probe - 15 g and calliper)
Notes	University/hospital-based

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Information not reported
Incomplete outcome data (attrition bias)	Low risk	All patients completed the follow-up period

Pendor 2014 *(Continued)*

All outcomes		
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Rasperini 2011

Methods	RCT, parallel design, 2 treatment groups, 12 months' duration
Participants	56 individuals, 39 females, mean 35.5 years, with 1 Miller Class I or II buccal gingival recession of at least 3 mm
Interventions	1. EMD + SCTG + CAF 2. SCTG + CAF
Outcomes	GRC CALC KTC SCRC PCRC MRC (Manual probe)
Notes	University/hospital-based

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Random permuted blocks
Allocation concealment (selection bias)	Low risk	Central registration
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Information not reported
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period

Rasperini 2011 *(Continued)*

Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Reino 2012

Methods	RCT, split-mouth design, 2 treatment groups, 6 months' duration
Participants	12 individuals (heavy smokers - 20 or more cigarettes per day for more than 5 years), 10 females, aged 35 to 50 years, with 2 bilateral Miller Class I or II buccal gingival recessions of at least 3 mm
Interventions	1. SCTG + CAF (extended flap) 2. SCTG + CAF
Outcomes	SCRC PCRC MRC (Automated controlled force probe and manual probe)
Notes	University/hospital-based and supported by the State of São Paulo Research Foundation, São Paulo, Brazil

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	High risk	All measurements were performed by 1 examiner aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Unclear risk	Baseline and follow-up means regarding recession depth, clinical attachment level and keratinized tissue width were not reported in the study
Other bias	Low risk	Evidence of other bias was not detected

Reino 2015

Methods	RCT, split-mouth design, 2 treatment groups, 6 months' duration
Participants	20 individuals, 14 females, aged 26 to 46 years, with 2 bilateral Miller Class I or II buccal gingival recessions of at least 3 mm
Interventions	1. XCM + CAF (extended flap) 2. XCM + CAF
Outcomes	GRC*(1) CALC KTC MRC (Automated controlled force probe and calliper)
Notes	University/hospital-based and supported by the State of São Paulo Research Foundation, São Paulo, Brazil and Geistlich Pharma AG

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomly permuted block
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Roccuzzo 1996

Methods	RCT, split-mouth design, 2 treatment groups, 6 months' duration

Roccuzzo 1996 *(Continued)*

Participants	12 individuals, 3 females, aged 21 to 31 years, with 2 Miller Class I or II buccal gingival recessions of at least 4 mm
Interventions	1. GTR (polylactic acid membrane - Guidor) 2. GTR (ePTFE membrane - Gore-Tex)
Outcomes	GRC CALC KTC SCRC PCRC MRC (Manual probe)
Notes	University/hospital-based

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Rosetti 2013

Methods	RCT, split-mouth design, 2 treatment groups, 30 months' duration
Participants	12 individuals, 9 females, aged 25 to 60 years, with 2 Miller Class I or II buccal gingival recessions of at least 3 mm

Rosetti 2013 *(Continued)*

Interventions	1. GTR (collagen membrane) + TTC-HCl + DFDBA 2. SCTG + HCl
Outcomes	ACC GRC CALC KTC*(2) MRC (Manual probe)
Notes	University/hospital-based and supported by Brazilian National Council for Scientific and Technologic Development

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Sangiorgio 2017

Methods	RCT, parallel design, 4 treatment groups, 6 months' duration
Participants	68 individuals, aged 18 to 60 years, with 1 maxillary Miller Class I or II buccal gingival recession of at least 3 mm
Interventions	1. XCM + CAF 2. EMD + CAF

Sangiorgio 2017 *(Continued)*

	3. XCM + EMD + CAF
	4. CAF
Outcomes	ACC
	GRC*(Groups 1, 2 and 3 were superior to 4)
	CALC
	KTC
	SCRC
	PCRC*(Groups 2 and 3 were superior to 4)
	MRC*(Groups 1, 2 and 3 were superior to 4)
	(Manual probe and digital calliper)
Notes	University/hospital-based and supported by the State of São Paulo Research Foundation, São Paulo, Brazil

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation table
Allocation concealment (selection bias)	Low risk	Sealed and opaque envelopes
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Patients remained unaware of the type of surgical procedures they received
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Shori 2013

Methods	RCT, parallel design, 2 treatment groups, 6 months' duration
Participants	20 individuals, aged 18 to 50 years, with 1 Miller Class I or II buccal gingival recessions of at least 3 mm
Interventions	1. ADMG + CAF

Shori 2013 *(Continued)*

	2. SCTG + CAF
Outcomes	GRC CALC KTC*(2) SCR PCRC MRC (Automated controlled force probe)
Notes	Universite/hospital-based

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Information not reported
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Spahr 2005

Methods	RCT, split-mouth design, 2 treatment groups, 24 months' duration
Participants	37 individuals, 17 females, aged 22 to 62 years, with 2 Miller Class I or II buccal gingival recessions of at least 3 mm. 30 individuals completed the study
Interventions	1. EMP + CAF 2. Placebo (propylene glycol alginate) + CA
Outcomes	GRC

Spahr 2005 *(Continued)*

	CALC KTC PCRC MRC (Automated controlled force probe, calliper and manual probe)
Notes	University/hospital-based and supported by BIORA AB (currently Straumann) Data from earlier article (Hagewald 2002) were reported as part of this trial

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomly permuted blocks
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	6 patients could not be recalled after the follow-up period (they moved with address unknown) and 1 patient was excluded after enrolment in the study due to injuries of gingival tissues in the course of dental treatment by the referring dentist Data are equally missing in both intervention groups (split-mouth design), but reasons for these are both reported and balanced across groups, then important bias is not to be expected
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Tozum 2005

Methods	RCT, parallel design, 2 treatment groups, 6 months' duration
Participants	31 individuals, 21 females, aged 16 to 59 years, with 1 Miller Class I or II buccal gingival recession of at least 3 mm
Interventions	1. SCTG + modified tunnel procedure 2. SCTG + CAF

Tozum 2005 *(Continued)*

Outcomes	GRC*(1) CALC*(1) MRC (Manual probe)
Notes	University/hospital-based Unpublished data were included following contact with author

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	High risk	All measurements were performed by 1 examiner aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Trombelli 1996

Methods	RCT, split-mouth design, 2 treatment groups, 6 months' duration
Participants	15 individuals, 3 female, aged 25 to 51 years, with 2 Miller Class I or II maxillary buccal gingival recessions of at least 3 mm
Interventions	1. CAF (fibrin glue + TTC-HCl) 2. CAF (TTC-HCl)
Outcomes	GRC CALC KTC SCRC

Trombelli 1996 *(Continued)*

	PCRC
	MRC
	(Manual probe)
Notes	University/hospital-based and supported by Italian Ministry of University and Scientific Research

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method not reported
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Tunali 2015

Methods	RCT, split-mouth design, 2 treatment groups, 12 months' duration
Participants	10 individuals, 6 female, aged 25 to 52 years, with 2 Miller Class I or II multiple buccal gingival recessions of at least 3 mm
Interventions	1. Leukocyte- and platelet-rich fibrin + CAF
	2. SCTG + CAF
Outcomes	GRC
	CALC
	KTC
	SCRC
	PCRC
	MRC

Tunali 2015 *(Continued)*

	(Manual probe)
Notes	University/hospital-based Unpublished data were included following contact with author

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Wang 2001

Methods	RCT, split-mouth design, 2 treatment groups, 6 months' duration
Participants	16 individuals, 10 females, aged 30 to 54 years, with 2 Miller Class I or II buccal gingival recessions of at least 3 mm
Interventions	1. GTR (reabsorbable double thickness collagen membrane - Sulzer Dental Inc) 2. SCTG + CAF
Outcomes	ACC GRC CALC KTC MRC (Manual probe)

Wang 2001 *(Continued)*

Notes	University/hospital-based and supported by Sulzer Calcitek Inc

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Woodyard 2004

Methods	RCT, parallel design, 2 treatment groups, 6 months' duration
Participants	24 individuals, 14 females, mean age 34.6 years, with 1 Miller Class I or II buccal gingival recession of at least 3 mm
Interventions	1. ADMG + CAF 2. CAF
Outcomes	GRC*(1) CALC*(1) KTC SCRC PCRC MRC (Manual probe)
Notes	University/hospital-based

Woodyard 2004 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Zucchelli 1998

Methods	RCT, parallel design, 3 treatment groups, 12 months' duration
Participants	54 individuals, 29 females, aged 23 to 33 years, with 1 Miller Class I or II buccal gingival recession of at least 3 mm
Interventions	1. GTR (polylactic acid membrane - Guidor) 2. GTR (ePTFE membrane - Gore-Tex) 3. SCTG + CAF
Outcomes	GRC CALC KTC*(3) SCRC PCRC MRC (Manual probe)
Notes	University/hospital-based

Zucchelli 1998 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method not reported
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Zucchelli 2003

Methods	RCT, split-mouth design, 2 treatment groups, 12 months' duration
Participants	15 individuals, aged 18 to 35 years, with 2 Miller Class I or II maxillary buccal gingival recessions of at least 3 mm
Interventions	1. SCTG (graft size equal to the bone dehiscence) + CAF 2. SCTG (graft size 3 mm greater than the bone dehiscence) + CAF
Outcomes	ACC GRC CALC*(1) KTC*(2) SCRC PCRC MRC (Manual pressure sensitive probe)
Notes	University/hospital-based

Zucchelli 2003 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Zucchelli 2009

Methods	RCT, split-mouth design, 2 treatment groups, 6 months' duration
Participants	11 individuals, aged 18 to 40 years, with 2 Miller Class I maxillary buccal gingival recessions of at least 3 mm
Interventions	1. Ultrasonic instrumentation - CAF 2. Hand instrumentation - CAF
Outcomes	GRC CALC KTC SCRC PCRC MRC (Manual pressure sensitive probe)
Notes	University/hospital-based

Risk of bias

Zucchelli 2009 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Zucchelli 2014

Methods	RCT, parallel design, 2 treatment groups, 12 months' duration
Participants	60 individuals, aged > 18 years, with 1 Miller Class I or II maxillary buccal gingival recession of at least 3 mm
Interventions	1. SCTG (de-epithelialized free gingival graft: graft height equal to the depth of bone dehiscence and thickness ≥ 2 mm) + CAF 2. SCTG (de-epithelialized free gingival graft: graft height of 4 mm thickness < 2 mm) + CAF
Outcomes	ACC GRC CALC KTC SCRC PCRC MRC (Manual probe)
Notes	University/hospital-based
Risk of bias	

Zucchelli 2014 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation table
Allocation concealment (selection bias)	Low risk	Sealed envelope
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Zucchelli 2014b

Methods	RCT, parallel design, 2 treatment groups, 12 months' duration
Participants	50 individuals, 28 females, age > 18 years, with 1 Miller Class I or II gingival recession of at least 3 mm at the buccal aspect of lower incisors
Interventions	1. SCTG + CAF - with removal of the labial submucosal tissue 2. SCTG + CAF - without removal of the labial submucosal tissue
Outcomes	ACC*(1) GRC*(1) CALC KTC*(2) SCRC PCRC MRC (Manual probe and calliper)
Notes	University/hospital-based
Risk of bias	

Zucchelli 2014b *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation table
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Information not reported
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measurements were performed by 1 examiner not aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

Öncü 2017

Methods	RCT, split-mouth design, 2 treatment groups, 6 months' duration
Participants	20 individuals, 11 females, age > 18 years, with maxillary bilateral multiple Miller Class I or II buccal gingival recession of at least 3 mm
Interventions	1. Platelet-rich fibrin + CAF without vertical incisions 2. SCTG + CAF without vertical incisions
Outcomes	GRC CALC KTC*(2) SCRC PCRC MRC (Manual probe)
Notes	University/hospital-based

Risk of bias

Bias	Authors' judgement	Support for judgement

Öncü 2017 *(Continued)*

Random sequence generation (selection bias)	Low risk	Coin toss
Allocation concealment (selection bias)	Unclear risk	Method not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Patients remained unblinded to the root coverage procedure
Blinding of outcome assessment (detection bias) All outcomes	High risk	All measurements were performed by 1 examiner aware of the type of surgical procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients completed the follow-up period
Selective reporting (reporting bias)	Low risk	Evidence of selective reporting of outcomes was not detected
Other bias	Low risk	Evidence of other bias was not detected

ACC: aesthetic condition change; ADMG: acellular dermal matrix graft; CA: citric acid; CAF: coronally advanced flap; CALC: clinical attachment change; DFDBA: demineralized freeze-dried bone allograft; EMD: enamel matrix derivative; EMP: enamel matrix protein; ePTFE: expanded polytetrafluorethylene; FGG: free gingival graft; GRC: gingival recession change; GTR: guided tissue regeneration; KTC: keratinized tissue change; MRC: mean root coverage; PCRC: percentage of complete root coverage; RCT: randomised controlled trial; SCRC: sites with complete root coverage; SCTG: subepithelial connective tissue graft; TTC-HCl: tetracycline hydrochloride; XCM - xenogeneic collagen matrix.
*statistically significant between-groups (superior group).

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Abou-Arraj 2017	Inclusion of patients with recession depth < 3 mm
Aichelmann Reidy 2001	Inclusion of patients with recession depth < 3 mm
Alexiou 2017	Inclusion of patients with recession depth < 3 mm
Alkan 2011	Inclusion of patients with recession depth < 3 mm
Alkan 2013	Inclusion of patients with recession depth < 3 mm
Andrade 2008	Inclusion of patients with recession depth < 3 mm
Andrade 2010	Inclusion of patients with Miller's Class III recessions
Aroca 2009	Inclusion of patients with recession depth < 3 mm
Aroca 2013	Inclusion of patients with recession depth < 3 mm
Azaripour 2016	Inclusion of patients with recession depth < 3 mm

Study	Reason for exclusion
Baghele 2012	Follow-up period < 6 months
Bajic 2014	Inclusion of patients with recession depth < 3 mm
Banihashemrad 2009	Less than 10 patients per group at final examination and patient-based analysis not presented
Bansal 2016	Inclusion of patients with recession depth < 3 mm
Barros 2004	Patient-based analysis not presented
Barros 2005	Patient-based analysis not presented
Berlucchi 2002	Inclusion of patients with recession depth < 3 mm
Berlucchi 2005	Inclusion of patients with recession depth < 3 mm
Bherwani 2014	Inclusion of patients with recession depth < 3 mm
Bittencourt 2006	Inclusion of patients with recession depth < 3 mm
Bittencourt 2009	Inclusion of patients with recession depth < 3 mm
Borghetti 1994	Inclusion of patients with Miller's Class III or IV recession defects
Borghetti 1999	Inclusion of patients with recession depth < 3 mm
Bozkurt Dogan 2015	Inclusion of patients with recession depth < 3 mm
Burkhardt 2005	Less than 10 patients per group at final examination
Byun 2009	Inclusion of patients with recession depth < 3 mm
Caffesse 2000	Inclusion of patients with recession depth < 3 mm
Cairo 2016	Inclusion of patients with recession depth < 3 mm
Cardaropoli 2009	Inclusion of patients with recession depth < 3 mm
Cardaropoli 2012	Inclusion of patients with recession depth < 3 mm
Cardaropoli 2014	Inclusion of patients with recession depth < 3 mm
Castellanos 2006	Inclusion of patients with recession depth < 3 mm
Cetiner 2003	Patient-based analysis not presented
Chakraborthy 2015	Randomised non-controlled trial
Cheung 2004	Inclusion of patients with recession depth < 3 mm
Cordaro 2012	Inclusion of patients with recession depth < 3 mm
Cordioli 2001	Patient-based analysis not presented
Cortellini 2009	Inclusion of patients with recession depth < 3 mm

Study	Reason for exclusion
Daniel 1990	Not a randomised controlled trial
Dembowska 2007	Not a randomised controlled trial
Deshpande 2014	Inclusion of patients with recession depth < 3 mm
Dilsiz 2010	Inclusion of patients with recession depth < 3 mm
Dilsiz 2010b	Inclusion of patients with recession depth < 3 mm
Duval 2000	Inclusion of patients with recession depth < 3 mm, less than 10 patients per group at final examination and patient-based analysis not presented
Erley 2006	Not a randomised controlled trial
Felipe 2007	Inclusion of patients with recession depth < 3 mm
Fernandes-Dias 2015	Inclusion of patients with recession depth < 3 mm
Ghahroudi 2013	Inclusion of patients with recession depth < 3 mm, patient-based analysis not presented, and patients with Miller's Class III recessions
Gholami 2013	Inclusion of patients with recession depth < 3 mm
Gobbato 2016	Inclusion of both single and multiple defects in the estimates and patients with recession depth < 3 mm
Griffin 2009	Inclusion of patients with recession depth < 3 mm
Gunay 2008	Not a randomised controlled trial
Gupta 2006	Not a randomised controlled trial
Haghighati 2009	Inclusion of patients with recession depth < 3 mm
Han 2008	Inclusion of patients with recession depth < 3 mm
Harris 1997	Not a randomised controlled trial
Harris 2000	Not a randomised controlled trial
Harris 2002	Not a randomised controlled trial
Harris 2005	Not a randomised controlled trial
Hirsch 2005	Not a randomised controlled trial
Huang 2005	Inclusion of patients with recession depth < 3 mm
Ito 2000	Inclusion of patients with recession depth < 3 mm, less than 10 patients per group at final examination and patient-based analysis not presented
Jahnke 1993	Inclusion of patients with recession depth < 3 mm
Jain 2017	Inclusion of patients with recession depth < 3 mm

Study	Reason for exclusion
Jankovic 2012	Inclusion of patients with recession depth < 3 mm
Jepsen 1998	Inclusion of patients with recession depth < 3 mm
Jepsen 2017	Inclusion of patients with recession depth < 3 mm
Jhaveri 2010	Inclusion of patients with recession depth < 3 mm
Jovicic 2013	Not a randomised controlled trial
Kennedy 1985	Inclusion of patients with recession depth < 3 mm
Khobragade 2016	Patient-based analysis not reported and inclusion of patients with recession depth < 3 mm
Kimble 2004	Less than 10 patients per group at final examination
Kuis 2013	Inclusion of patients with recession depth < 3 mm
Kumar 2017	Patient-based analysis not reported and inclusion of patients with recession depth < 3 mm
Köseoglu 2013	Inclusion of patients with recession depth < 3 mm
Lafzi 2007	Follow-up period < 6 months
Laney 1992	Inclusion of patients with recession depth < 3 mm and follow-up period < 6 months
Lins 2003	Inclusion of patients with recession depth < 3 mm
M 2016	Inclusion of patients with recession depth < 3 mm
Mahajan 2007	Less than 10 patients per group at final examination
Mahajan 2012	Inclusion of patient with age < 18 years
Mazzocco 2011	Inclusion of patients with recession depth < 3 mm
Milinkovic 2015	Patient-based analysis not presented
Modica 2000	Inclusion of patients with recession depth < 3 mm
Moka 2014	Inclusion of patients with recession depth < 3 mm
Moses 2006	Not a randomised controlled trial
Moslemi 2011	Inclusion of patients with recession depth < 3 mm
Muller 1998	Not a randomised controlled trial
Muller 1999	Not a randomised controlled trial
Nazareth 2011	Inclusion of patients with recession depth < 3 mm
Nemcovsky 2004	Not a randomised controlled trial
Ozcelik 2011	Inclusion of patients with recession depth < 3 mm

Study	Reason for exclusion
Ozturan 2011	Inclusion of patients with recession depth < 3 mm
Pilloni 2006	Inclusion of patients with recession depth < 3 mm
Pini Prato 1992	Not a randomised controlled trial
Pini Prato 1996	Not a randomised controlled trial
Pini Prato 1999	Not a randomised controlled trial
Pini Prato 2000	Inclusion of patients with recession depth < 3 mm and follow-up period < 6 months
Pini Prato 2005	Not a randomised controlled trial
Pini Prato 2011	Inclusion of patients with recession depth < 3 mm
Pourabbas 2009	Inclusion of patients with recession depth < 3 mm
Rahmani 2006	Not a randomised controlled trial
Rebele 2014	Inclusion of patients with recession depth < 3 mm
Ricci 1996	Inclusion of patients with recession depth < 3 mm
Ricci 1996b	Patient-based analysis not presented
Romagna-Genon 2001	Study author did not provide requested explanations
Roman 2013	Inclusion of patients with recession depth < 3 mm
Salhi 2014	Inclusion of patients with recession depth < 3 mm
Sallum 2003	Not a randomised controlled trial
Santamaria 2017	Inclusion of patients with recession depth < 3 mm
Santamaria 2017b	Inclusion of patients with recession depth < 3 mm
Santana 2010	Inclusion of patients with recession depth < 3 mm
Santana 2010b	Inclusion of patients with recession depth < 3 mm
Sbordone 1988	Not a randomised controlled trial
Scabbia 1998	Not a randomised controlled trial
Schlee 2011	Not a randomised controlled trial
Singh 2015	Inclusion of patients with recession depth < 3 mm
Stefanini 2016	Inclusion of patients with recession depth < 3 mm
Tal 2002	Authors did not provide requested explanations
Tatakis 2000	Inclusion of patients with recession depth < 3 mm

Study	Reason for exclusion
Thombre 2013	Inclusion of patients with recession depth < 3 mm
Tonetti 2018	Inclusion of patients with recession depth < 3 mm and defects were not classified according the Miller Classification System
Trabulsi 2004	Inclusion of patients with recession depth < 3 mm
Trombelli 1995	Not a randomised controlled trial
Trombelli 1995b	Less than 10 patients per group at final examination
Trombelli 1997	Not a randomised controlled trial
Trombelli 1998	Inclusion of patients with recession depth < 3 mm
Trombelli 2005	Not a randomised controlled trial
Uzun 2018	Patient-based analysis not reported and inclusion of patients with recession depth < 3 mm
Wang 2014	Inclusion of patients with recession depth < 3 mm
Wang 2015	Inclusion of patients with recession depth < 3 mm
Wennström 1996	Not a randomised controlled trial
Wilson 2005	Intervention not of interest
Yilmaz 2014	Intervention not of interest
Zucchelli 2010	Inclusion of patients with recession depth < 3 mm
Zucchelli 2012	Inclusion of patients with recession depth < 3 mm
Zuhr 2013	Inclusion of patients with recession depth < 3 mm

DATA AND ANALYSES

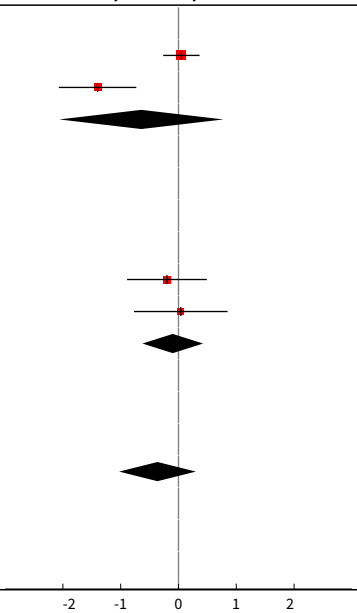
Comparison 1. ADMG + CAF versus SCTG +CAF - short term

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Gingival recession depth change	4	100	Mean Difference (Random, 95% CI)	-0.36 [-1.03, 0.30]
1.1 Split-mouth design	2	50	Mean Difference (Random, 95% CI)	-0.64 [-2.06, 0.78]
1.2 Parallel design	2	50	Mean Difference (Random, 95% CI)	-0.10 [-0.62, 0.43]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2 Clinical attachment level change	4	100	Mean Difference (Random, 95% CI)	-0.53 [-1.14, 0.08]
2.1 Split-mouth design	2	50	Mean Difference (Random, 95% CI)	-0.92 [-1.78, -0.06]
2.2 Parallel design	2	50	Mean Difference (Random, 95% CI)	-0.04 [-0.63, 0.55]
3 Keratinized tissue width change	4	100	Mean Difference (Random, 95% CI)	-0.59 [-1.27, 0.10]
3.1 Split-mouth design	2	50	Mean Difference (Random, 95% CI)	0.07 [-0.40, 0.53]
3.2 Parallel design	2	50	Mean Difference (Random, 95% CI)	-1.11 [-1.59, -0.63]
4 Sites with complete root coverage	2	50	Odds Ratio (Random, 95% CI)	0.43 [0.13, 1.37]
4.1 Parallel design	2	50	Odds Ratio (Random, 95% CI)	0.43 [0.13, 1.37]

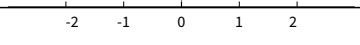
Analysis 1.1. Comparison 1 ADMG + CAF versus SCTG +CAF - short term, Outcome 1 Gingival recession depth change.

Study or subgroup	Favours SCTG + CAF N	Control ADMG + CAF N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
1.1.1 Split-mouth design						
Barros 2015	15	15	0.1 (0.161)		30.05%	0.05[-0.26,0.36]
Joly 2007	10	10	-1.4 (0.342)		24.26%	-1.4[-2.07,-0.73]
Subtotal (95% CI)					**54.31%**	**-0.64[-2.06,0.78]**
Heterogeneity: Tau^2=0.98; Chi^2=14.73, df=1(P=0); I^2=93.21%						
Test for overall effect: Z=0.89(P=0.37)						
1.1.2 Parallel design						
Paolantonio 2002b	15	15	-0.2 (0.352)		23.91%	-0.2[-0.89,0.49]
Shori 2013	10	10	0 (0.413)		21.78%	0.04[-0.77,0.85]
Subtotal (95% CI)					**45.69%**	**-0.1[-0.62,0.43]**
Heterogeneity: Tau^2=0; Chi^2=0.2, df=1(P=0.66); I^2=0%						
Test for overall effect: Z=0.37(P=0.71)						
Total (95% CI)					**100%**	**-0.36[-1.03,0.3]**
Heterogeneity: Tau^2=0.36; Chi^2=15.06, df=3(P=0); I^2=80.08%						
Test for overall effect: Z=1.07(P=0.28)						
Test for subgroup differences: Chi^2=0.5, df=1 (P=0.48), I^2=0%						



Analysis 1.2. Comparison 1 ADMG + CAF versus SCTG +CAF - short term, Outcome 2 Clinical attachment level change.

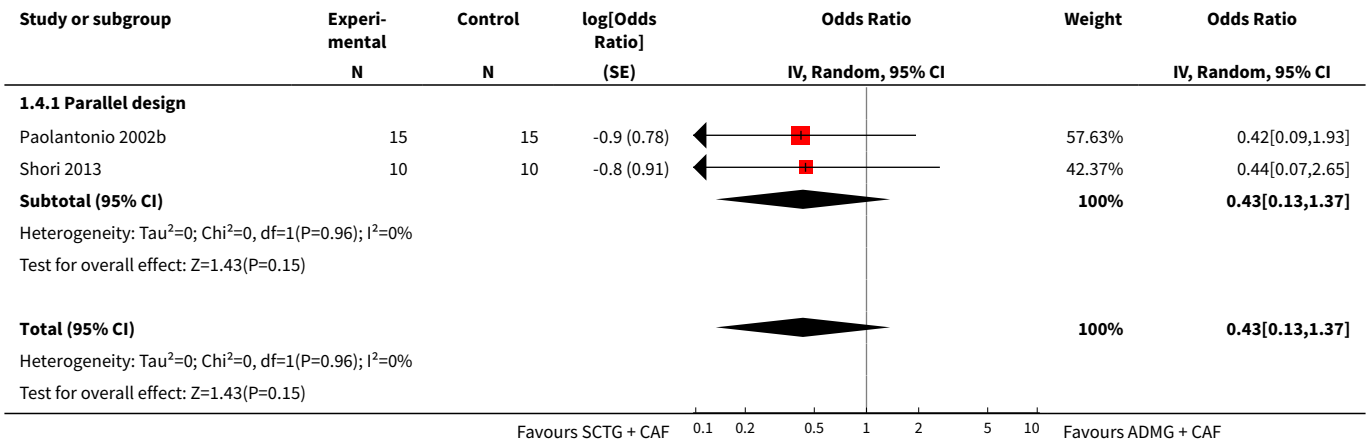
Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
1.2.1 Split-mouth design						
Barros 2015	15	15	-0.5 (0.227)		30.94%	-0.52[-0.96,-0.08]
Joly 2007	10	10	-1.4 (0.342)		25.57%	-1.4[-2.07,-0.73]
Subtotal (95% CI)					**56.51%**	**-0.92[-1.78,-0.06]**
Heterogeneity: Tau^2=0.3; Chi^2=4.6, df=1(P=0.03); I^2=78.25%						
Test for overall effect: Z=2.1(P=0.04)						
1.2.2 Parallel design						
Paolantonio 2002b	15	15	-0.3 (0.408)		22.6%	-0.27[-1.07,0.53]
Shori 2013	10	10	0.2 (0.449)		20.89%	0.24[-0.64,1.12]
Subtotal (95% CI)					**43.49%**	**-0.04[-0.63,0.55]**
Heterogeneity: Tau^2=0; Chi^2=0.71, df=1(P=0.4); I^2=0%						
Test for overall effect: Z=0.13(P=0.9)						
Total (95% CI)					**100%**	**-0.53[-1.14,0.08]**
Heterogeneity: Tau^2=0.26; Chi^2=9.73, df=3(P=0.02); I^2=69.18%						
Test for overall effect: Z=1.7(P=0.09)						
Test for subgroup differences: Chi^2=2.75, df=1 (P=0.1), I^2=63.7%						



Analysis 1.3. Comparison 1 ADMG + CAF versus SCTG +CAF - short term, Outcome 3 Keratinized tissue width change.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
1.3.1 Split-mouth design						
Barros 2015	15	15	0.2 (0.289)		25.51%	0.15[-0.42,0.72]
Joly 2007	10	10	-0.1 (0.411)		21.68%	-0.1[-0.91,0.71]
Subtotal (95% CI)					**47.19%**	**0.07[-0.4,0.53]**
Heterogeneity: Tau^2=0; Chi^2=0.25, df=1(P=0.62); I^2=0%						
Test for overall effect: Z=0.29(P=0.78)						
1.3.2 Parallel design						
Paolantonio 2002b	15	15	-1.4 (0.296)		25.29%	-1.4[-1.98,-0.82]
Shori 2013	10	10	-0.9 (0.219)		27.51%	-0.9[-1.33,-0.47]
Subtotal (95% CI)					**52.81%**	**-1.11[-1.59,-0.63]**
Heterogeneity: Tau^2=0.06; Chi^2=1.84, df=1(P=0.17); I^2=45.74%						
Test for overall effect: Z=4.5(P<0.0001)						
Total (95% CI)					**100%**	**-0.59[-1.27,0.1]**
Heterogeneity: Tau^2=0.4; Chi^2=17.17, df=3(P=0); I^2=82.53%						
Test for overall effect: Z=1.66(P=0.1)						
Test for subgroup differences: Chi^2=11.88, df=1 (P=0), I^2=91.58%						

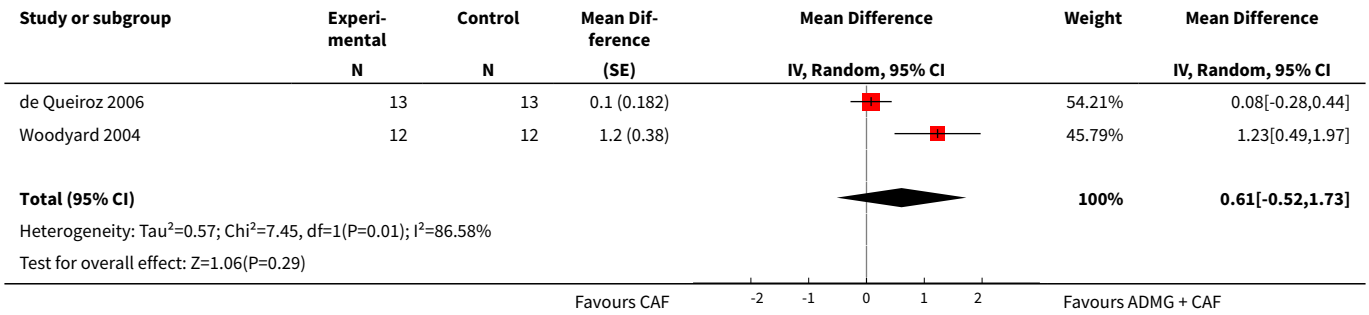
Analysis 1.4. Comparison 1 ADMG + CAF versus SCTG +CAF - short term, Outcome 4 Sites with complete root coverage.



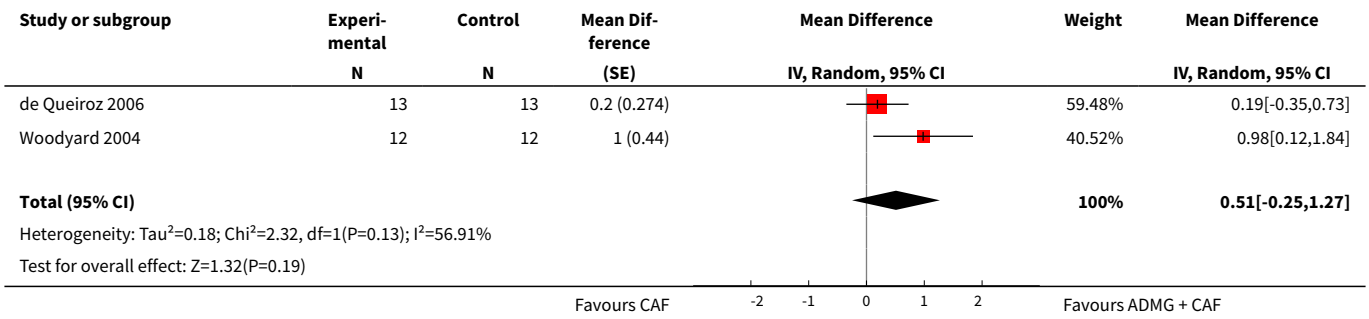
Comparison 2. ADMG + CAF versus CAF - short term

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Gingival recession depth change	2	50	Mean Difference (Random, 95% CI)	0.61 [-0.52, 1.73]
2 Clinical attachment level change	2	50	Mean Difference (Random, 95% CI)	0.51 [-0.25, 1.27]
3 Keratinized tissue width change	2	50	Mean Difference (Random, 95% CI)	0.28 [-0.08, 0.64]
4 Sites with complete root coverage	2	50	Odds Ratio (Random, 95% CI)	3.97 [0.20, 80.50]

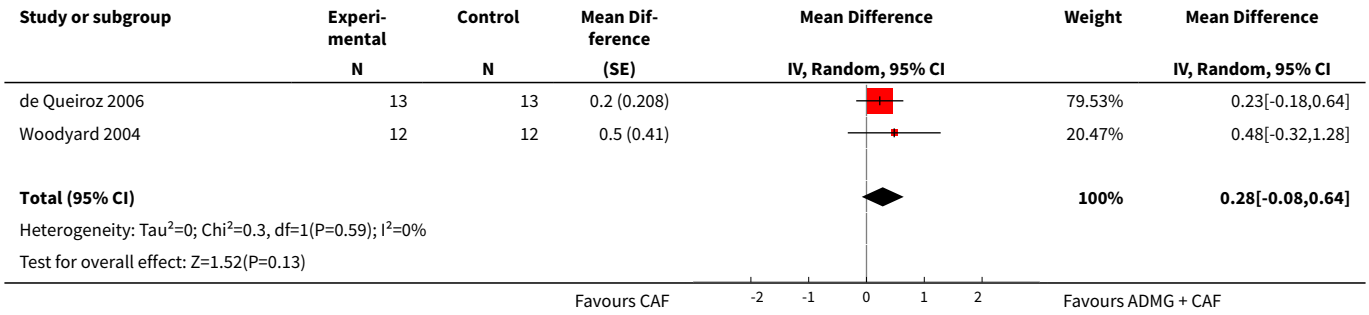
Analysis 2.1. Comparison 2 ADMG + CAF versus CAF - short term, Outcome 1 Gingival recession depth change.



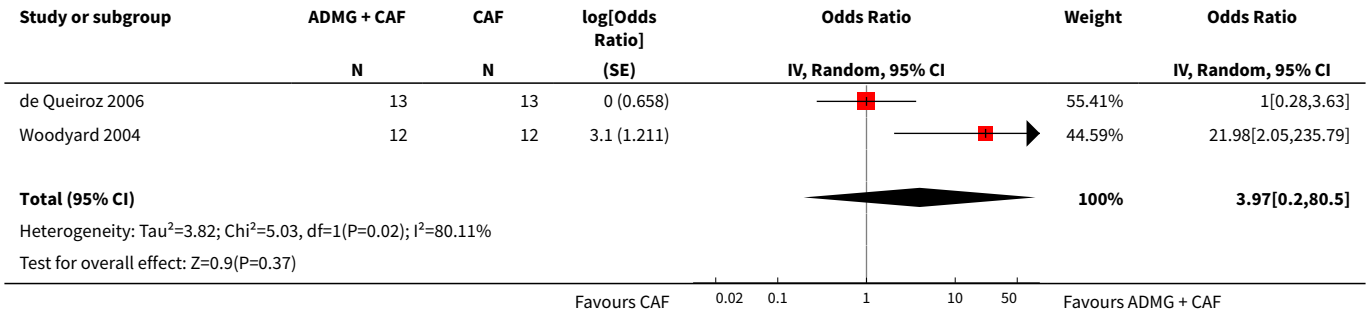
Analysis 2.2. Comparison 2 ADMG + CAF versus CAF - short term, Outcome 2 Clinical attachment level change.



Analysis 2.3. Comparison 2 ADMG + CAF versus CAF - short term, Outcome 3 Keratinized tissue width change.



Analysis 2.4. Comparison 2 ADMG + CAF versus CAF - short term, Outcome 4 Sites with complete root coverage.



Comparison 3. EMP + CAF versus CAF - short term

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Gingival recession depth change	3	136	Mean Difference (Random, 95% CI)	0.07 [-0.25, 0.40]
2 Clinical attachment level change	3	136	Mean Difference (Random, 95% CI)	0.22 [-0.02, 0.45]

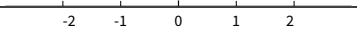
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3 Keratinized tissue width change	3	136	Mean Difference (Random, 95% CI)	0.35 [0.13, 0.56]

Analysis 3.1. Comparison 3 EMP + CAF versus CAF - short term, Outcome 1 Gingival recession depth change.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
Del Pizzo 2005	15	15	-0.1 (0.156)		35.87%	-0.07[-0.38,0.24]
Sangiorgio 2017	17	17	0.5 (0.229)		26.28%	0.51[0.06,0.96]
Spahr 2005	36	36	-0.1 (0.142)		37.85%	-0.1[-0.38,0.18]
Total (95% CI)					**100%**	**0.07[-0.25,0.4]**
Heterogeneity: Tau^2=0.05; Chi^2=5.62, df=2(P=0.06); I^2=64.42%						
Test for overall effect: Z=0.43(P=0.67)						

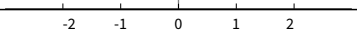
Analysis 3.2. Comparison 3 EMP + CAF versus CAF - short term, Outcome 2 Clinical attachment level change.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
Del Pizzo 2005	15	15	0.1 (0.166)		52.22%	0.09[-0.23,0.41]
Spahr 2005	36	36	0.3 (0.202)		35.1%	0.3[-0.1,0.7]
Sangiorgio 2017	17	17	0.5 (0.336)		12.68%	0.52[-0.14,1.18]
Total (95% CI)					**100%**	**0.22[-0.02,0.45]**
Heterogeneity: Tau^2=0; Chi^2=1.57, df=2(P=0.46); I^2=0%						
Test for overall effect: Z=1.82(P=0.07)						



Analysis 3.3. Comparison 3 EMP + CAF versus CAF - short term, Outcome 3 Keratinized tissue width change.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
Del Pizzo 2005	15	15	0.3 (0.174)		39.63%	0.33[-0.01,0.67]
Sangiorgio 2017	17	17	0.1 (0.403)		7.35%	0.06[-0.73,0.85]
Spahr 2005	36	36	0.4 (0.15)		53.02%	0.4[0.11,0.69]
Total (95% CI)					**100%**	**0.35[0.13,0.56]**
Heterogeneity: Tau^2=0; Chi^2=0.64, df=2(P=0.73); I^2=0%						
Test for overall effect: Z=3.18(P=0)						

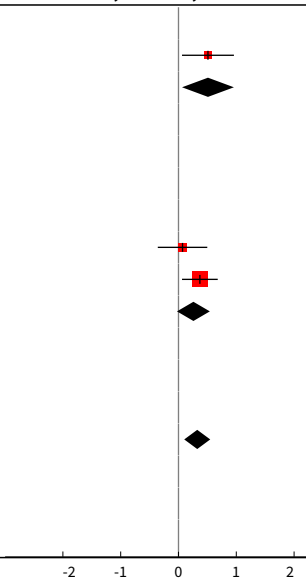


Comparison 4. EMP + CAF versus CAF - short/medium term

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Gingival recession depth change	3	124	Mean Difference (Random, 95% CI)	0.32 [0.10, 0.55]
1.1 6 months (short term)	1	34	Mean Difference (Random, 95% CI)	0.51 [0.06, 0.96]
1.2 24 months (medium term)	2	90	Mean Difference (Random, 95% CI)	0.26 [-0.03, 0.54]
2 Clinical attachment level change	3	124	Mean Difference (Random, 95% CI)	0.35 [0.09, 0.61]
2.1 6 months (short term)	1	34	Mean Difference (Random, 95% CI)	0.52 [-0.14, 1.18]
2.2 24 months (medium term)	2	90	Mean Difference (Random, 95% CI)	0.32 [0.03, 0.61]
3 Keratinized tissue width change	3	124	Mean Difference (Random, 95% CI)	0.40 [0.17, 0.62]
3.1 6 months (short term)	1	34	Mean Difference (Random, 95% CI)	0.06 [-0.73, 0.85]
3.2 24 months (medium term)	2	90	Mean Difference (Random, 95% CI)	0.43 [0.19, 0.66]

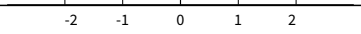
Analysis 4.1. Comparison 4 EMP + CAF versus CAF - short/medium term, Outcome 1 Gingival recession depth change.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
4.1.1 6 months (short term)						
Sangiorgio 2017	17	17	0.5 (0.229)		24.22%	0.51[0.06,0.96]
Subtotal (95% CI)					**24.22%**	**0.51[0.06,0.96]**
Heterogeneity: Not applicable						
Test for overall effect: Z=2.23(P=0.03)						
4.1.2 24 months (medium term)						
Del Pizzo 2005	15	15	0.1 (0.218)		26.54%	0.07[-0.36,0.5]
Spahr 2005	30	30	0.4 (0.158)		49.24%	0.37[0.06,0.68]
Subtotal (95% CI)					**75.78%**	**0.26[-0.03,0.54]**
Heterogeneity: Tau^2=0.01; Chi^2=1.24, df=1(P=0.27); I^2=19.44%						
Test for overall effect: Z=1.78(P=0.08)						
Total (95% CI)					**100%**	**0.32[0.1,0.55]**
Heterogeneity: Tau^2=0; Chi^2=2.1, df=2(P=0.35); I^2=4.65%						
Test for overall effect: Z=2.83(P=0)						
Test for subgroup differences: Chi^2=0.86, df=1 (P=0.35), I^2=0%						



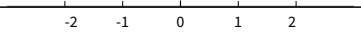
Analysis 4.2. Comparison 4 EMP + CAF versus CAF - short/ medium term, Outcome 2 Clinical attachment level change.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
4.2.1 6 months (short term)						
Sangiorgio 2017	17	17	0.5 (0.336)		15.9%	0.52[-0.14,1.18]
Subtotal (95% CI)					**15.9%**	**0.52[-0.14,1.18]**
Heterogeneity: Not applicable						
Test for overall effect: Z=1.55(P=0.12)						
4.2.2 24 months (medium term)						
Del Pizzo 2005	15	15	0.2 (0.191)		49.32%	0.2[-0.17,0.57]
Spahr 2005	30	30	0.5 (0.227)		34.78%	0.49[0.04,0.94]
Subtotal (95% CI)					**84.1%**	**0.32[0.03,0.61]**
Heterogeneity: Tau^2=0; Chi^2=0.96, df=1(P=0.33); I^2=0%						
Test for overall effect: Z=2.19(P=0.03)						
Total (95% CI)					**100%**	**0.35[0.09,0.61]**
Heterogeneity: Tau^2=0; Chi^2=1.25, df=2(P=0.53); I^2=0%						
Test for overall effect: Z=2.63(P=0.01)						
Test for subgroup differences: Chi^2=0.3, df=1 (P=0.59), I^2=0%						



Analysis 4.3. Comparison 4 EMP + CAF versus CAF - short/medium term, Outcome 3 Keratinized tissue width change.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
4.3.1 6 months (short term)						
Sangiorgio 2017	17	17	0.1 (0.403)		7.87%	0.06[-0.73,0.85]
Subtotal (95% CI)					**7.87%**	**0.06[-0.73,0.85]**
Heterogeneity: Not applicable						
Test for overall effect: Z=0.15(P=0.88)						
4.3.2 24 months (medium term)						
Del Pizzo 2005	15	15	0.5 (0.17)		44%	0.54[0.21,0.87]
Spahr 2005	30	30	0.3 (0.163)		48.14%	0.32[0,0.64]
Subtotal (95% CI)					**92.13%**	**0.43[0.19,0.66]**
Heterogeneity: Tau^2=0; Chi^2=0.87, df=1(P=0.35); I^2=0%						
Test for overall effect: Z=3.61(P=0)						
Total (95% CI)					**100%**	**0.4[0.17,0.62]**
Heterogeneity: Tau^2=0; Chi^2=1.63, df=2(P=0.44); I^2=0%						
Test for overall effect: Z=3.51(P=0)						
Test for subgroup differences: Chi^2=0.76, df=1 (P=0.38), I^2=0%						

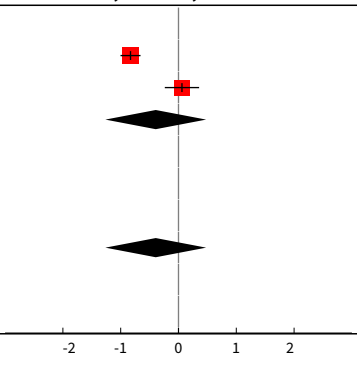


Comparison 5. EMP + CAF versus SCTG + CAF - short/medium term

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Gingival recession depth change	2	58	Mean Difference (Random, 95% CI)	-0.39 [-1.27, 0.48]
1.1 Split-mouth design	2	58	Mean Difference (Random, 95% CI)	-0.39 [-1.27, 0.48]
2 Clinical attachment level change	2	62	Mean Difference (Random, 95% CI)	-0.25 [-0.69, 0.20]
2.1 Split-mouth design	2	62	Mean Difference (Random, 95% CI)	-0.25 [-0.69, 0.20]
3 Keratinized tissue width change	2	62	Mean Difference (Random, 95% CI)	-1.06 [-1.36, -0.76]
3.1 Split-mouth design	2	62	Mean Difference (Random, 95% CI)	-1.06 [-1.36, -0.76]
4 Sites with complete root coverage	2	62	Odds Ratio (Random, 95% CI)	0.61 [0.05, 7.86]
4.1 Split-mouth design	2	62	Odds Ratio (Random, 95% CI)	0.61 [0.05, 7.86]

Analysis 5.1. Comparison 5 EMP + CAF versus SCTG + CAF - short/medium term, Outcome 1 Gingival recession depth change.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
5.1.1 Split-mouth design						
Abolfazli 2009	12	12	-0.8 (0.088)		50.95%	-0.83[-1,-0.66]
McGuire 2012	17	17	0.1 (0.151)		49.05%	0.06[-0.24,0.36]
Subtotal (95% CI)					**100%**	**-0.39[-1.27,0.48]**
Heterogeneity: Tau^2=0.38; Chi^2=25.79, df=1(P<0.0001); I^2=96.12%						
Test for overall effect: Z=0.88(P=0.38)						
Total (95% CI)					**100%**	**-0.39[-1.27,0.48]**
Heterogeneity: Tau^2=0.38; Chi^2=25.79, df=1(P<0.0001); I^2=96.12%						
Test for overall effect: Z=0.88(P=0.38)						

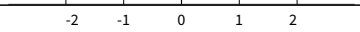


Analysis 5.2. Comparison 5 EMP + CAF versus SCTG + CAF - short/ medium term, Outcome 2 Clinical attachment level change.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
5.2.1 Split-mouth design						
Abolfazli 2009	12	12	-0.4 (0.095)		62.88%	-0.42[-0.61,-0.23]
McGuire 2012	19	19	0.1 (0.257)		37.12%	0.05[-0.45,0.55]
Subtotal (95% CI)					**100%**	**-0.25[-0.69,0.2]**
Heterogeneity: Tau^2=0.07; Chi^2=2.95, df=1(P=0.09); I^2=66.14%						
Test for overall effect: Z=1.08(P=0.28)						
Total (95% CI)					**100%**	**-0.25[-0.69,0.2]**
Heterogeneity: Tau^2=0.07; Chi^2=2.95, df=1(P=0.09); I^2=66.14%						
Test for overall effect: Z=1.08(P=0.28)						

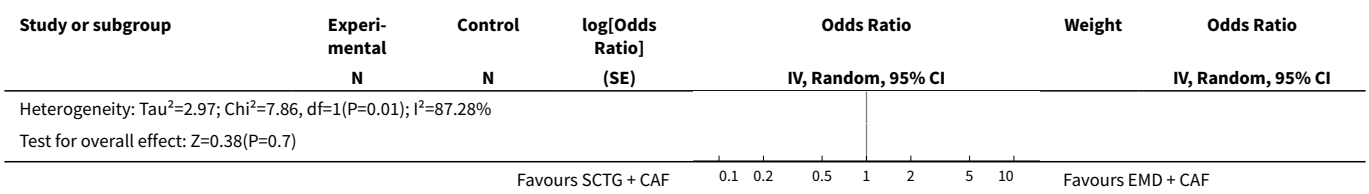
Analysis 5.3. Comparison 5 EMP + CAF versus SCTG + CAF - short/ medium term, Outcome 3 Keratinized tissue width change.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
5.3.1 Split-mouth design						
Abolfazli 2009	12	12	-1.2 (0.075)		64.75%	-1.17[-1.32,-1.02]
McGuire 2012	19	19	-0.8 (0.189)		35.25%	-0.85[-1.22,-0.48]
Subtotal (95% CI)					**100%**	**-1.06[-1.36,-0.76]**
Heterogeneity: Tau^2=0.03; Chi^2=2.47, df=1(P=0.12); I^2=59.45%						
Test for overall effect: Z=6.92(P<0.0001)						
Total (95% CI)					**100%**	**-1.06[-1.36,-0.76]**
Heterogeneity: Tau^2=0.03; Chi^2=2.47, df=1(P=0.12); I^2=59.45%						
Test for overall effect: Z=6.92(P<0.0001)						



Analysis 5.4. Comparison 5 EMP + CAF versus SCTG + CAF - short/ medium term, Outcome 4 Sites with complete root coverage.

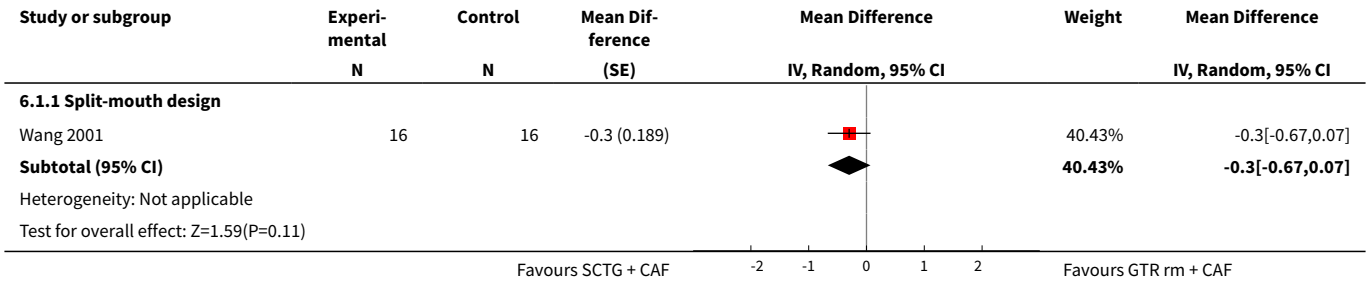
Study or subgroup	Experimental N	Control N	log[Odds Ratio] (SE)	Odds Ratio IV, Random, 95% CI	Weight	Odds Ratio IV, Random, 95% CI
5.4.1 Split-mouth design						
Abolfazli 2009	12	12	-1.8 (0.641)		50.32%	0.17[0.05,0.59]
McGuire 2012	19	19	0.8 (0.674)		49.68%	2.27[0.6,8.49]
Subtotal (95% CI)					**100%**	**0.61[0.05,7.86]**
Heterogeneity: Tau^2=2.97; Chi^2=7.86, df=1(P=0.01); I^2=87.28%						
Test for overall effect: Z=0.38(P=0.7)						
Total (95% CI)					**100%**	**0.61[0.05,7.86]**

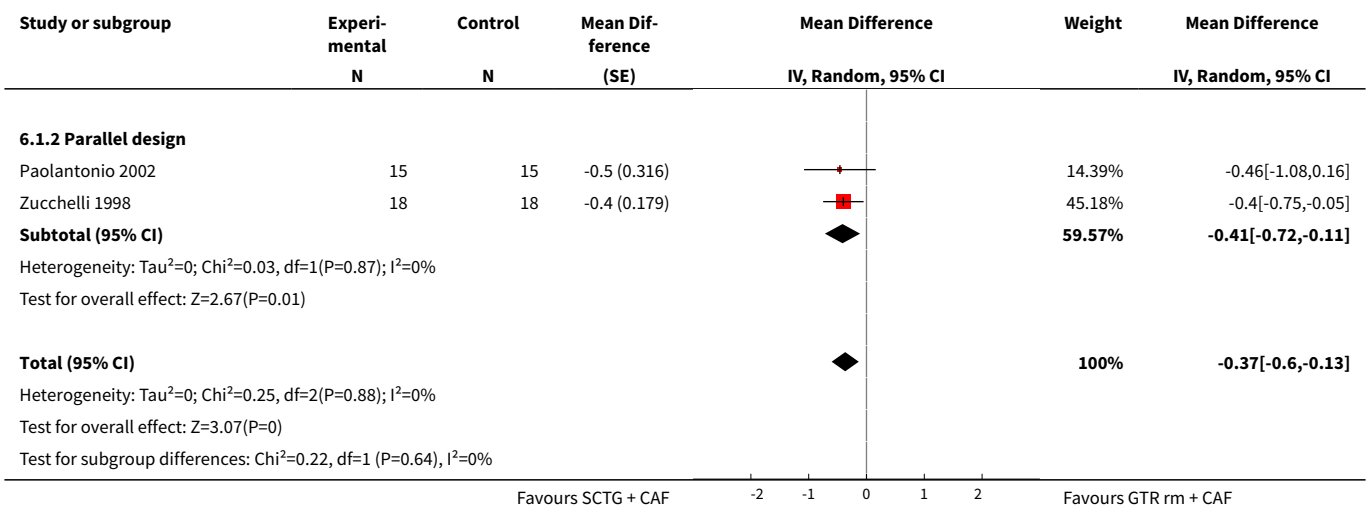


Comparison 6. GTR rm + CAF versus SCTG + CAF - short term

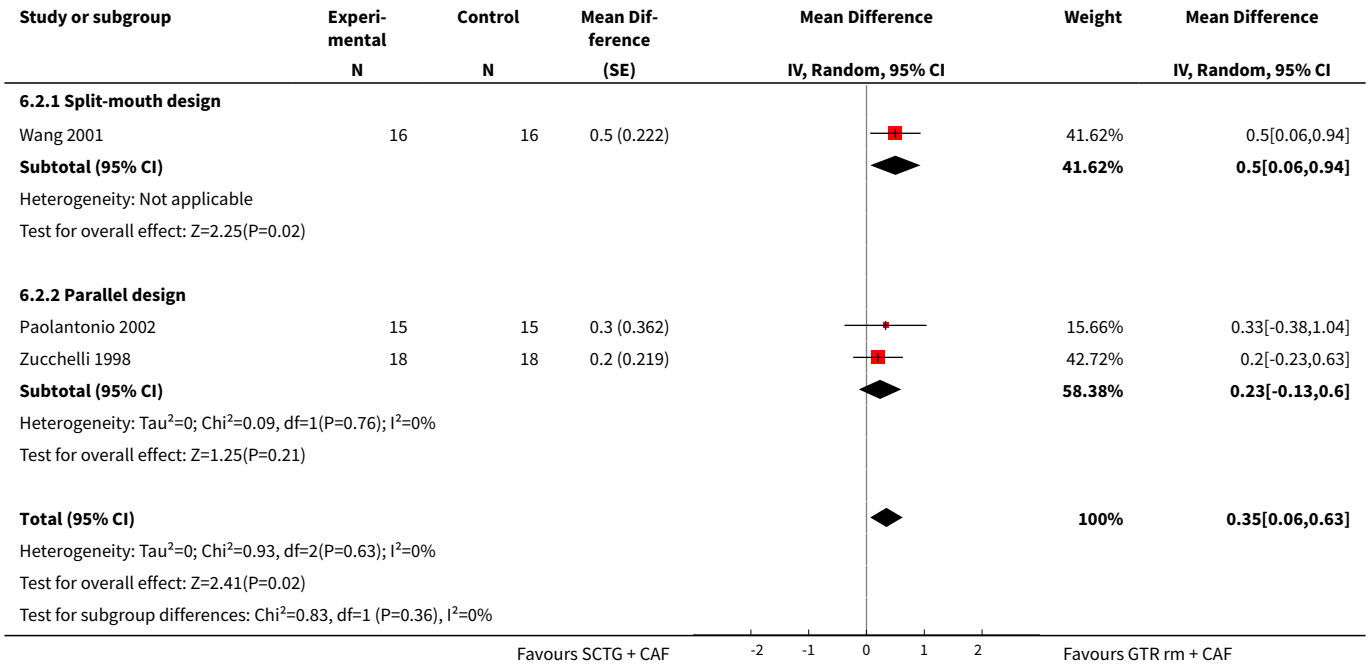
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Gingival recession depth change	3	98	Mean Difference (Random, 95% CI)	-0.37 [-0.60, -0.13]
1.1 Split-mouth design	1	32	Mean Difference (Random, 95% CI)	-0.3 [-0.67, 0.07]
1.2 Parallel design	2	66	Mean Difference (Random, 95% CI)	-0.41 [-0.72, -0.11]
2 Clinical attachment level change	3	98	Mean Difference (Random, 95% CI)	0.35 [0.06, 0.63]
2.1 Split-mouth design	1	32	Mean Difference (Random, 95% CI)	0.5 [0.06, 0.94]
2.2 Parallel design	2	66	Mean Difference (Random, 95% CI)	0.23 [-0.13, 0.60]
3 Keratinized tissue width change	3	98	Mean Difference (Random, 95% CI)	-1.77 [-2.66, -0.89]
3.1 Split-mouth design	1	32	Mean Difference (Random, 95% CI)	-0.4 [-1.32, 0.52]
3.2 Parallel design	2	66	Mean Difference (Random, 95% CI)	-2.33 [-2.62, -2.03]
4 Sites with complete root coverage	3	98	Odds Ratio (Random, 95% CI)	0.61 [0.30, 1.24]
4.1 Split-mouth design	1	32	Odds Ratio (Random, 95% CI)	1.0 [0.37, 2.68]
4.2 Parallel design	2	66	Odds Ratio (Random, 95% CI)	0.37 [0.14, 1.01]

Analysis 6.1. Comparison 6 GTR rm + CAF versus SCTG + CAF - short term, Outcome 1 Gingival recession depth change.

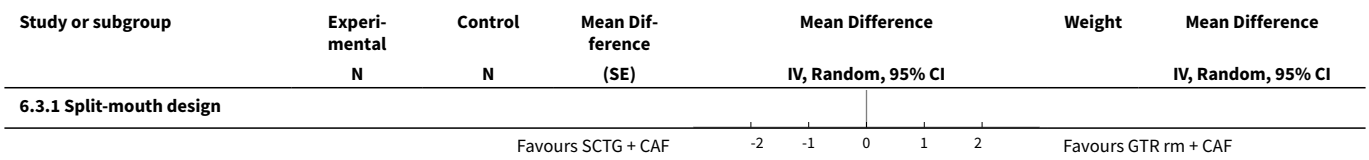


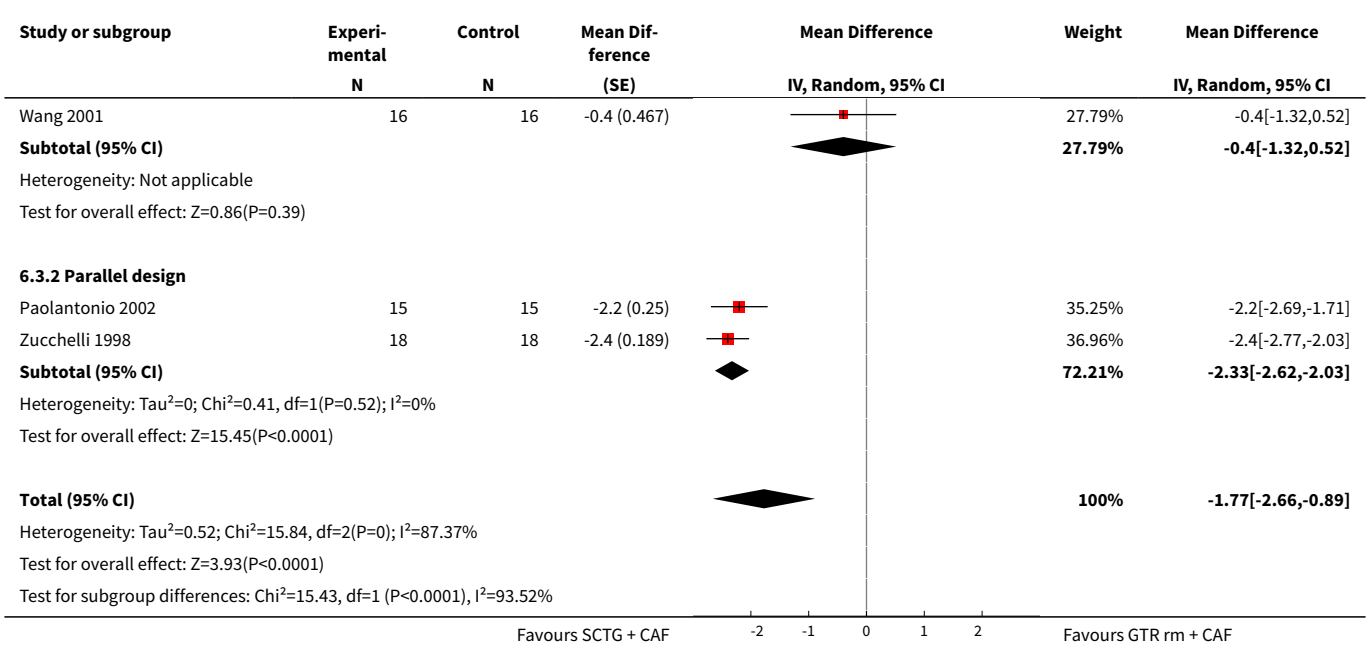


Analysis 6.2. Comparison 6 GTR rm + CAF versus SCTG + CAF - short term, Outcome 2 Clinical attachment level change.

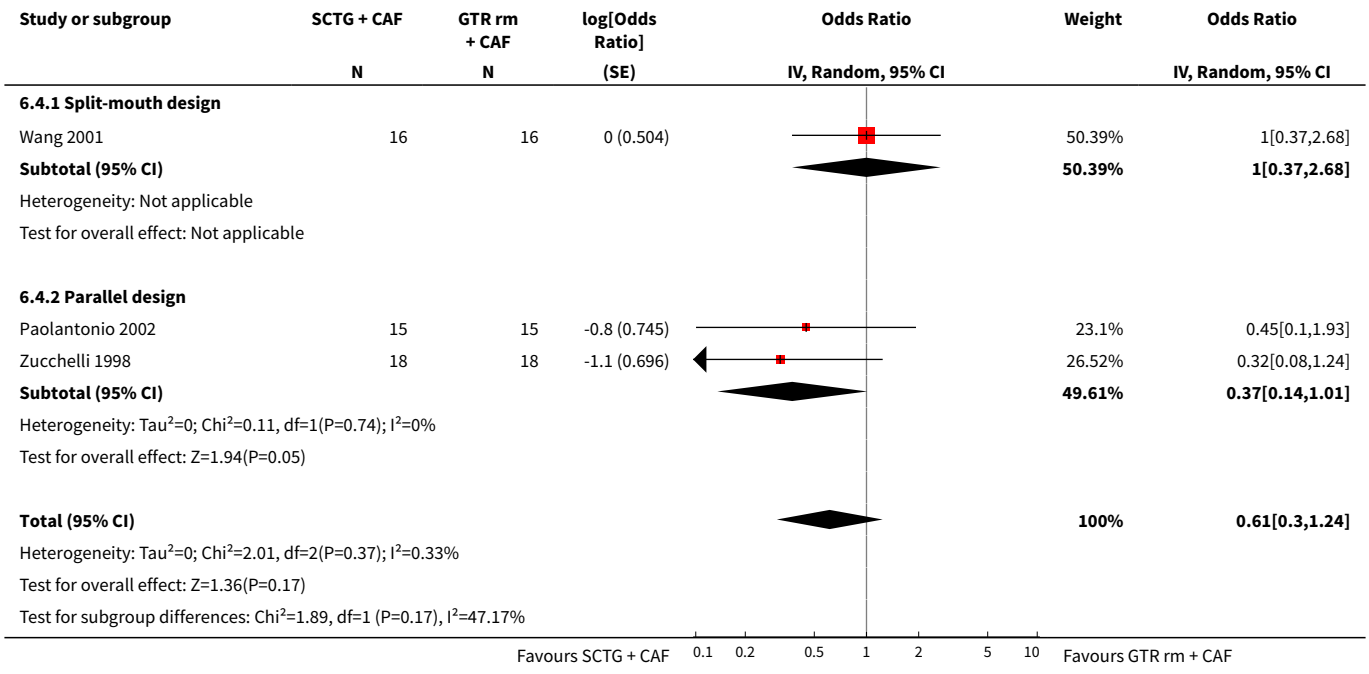


Analysis 6.3. Comparison 6 GTR rm + CAF versus SCTG + CAF - short term, Outcome 3 Keratinized tissue width change.





Analysis 6.4. Comparison 6 GTR rm + CAF versus SCTG + CAF - short term, Outcome 4 Sites with complete root coverage.

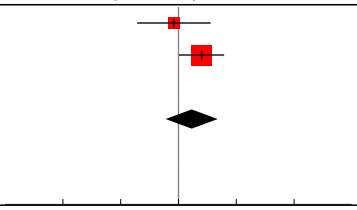


Comparison 7. GTR rm + CAF versus GTR nrm + CAF - short term

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Gingival recession depth change	2	60	Mean Difference (Random, 95% CI)	0.23 [-0.22, 0.68]
2 Clinical attachment level change	2	60	Mean Difference (Random, 95% CI)	0.12 [-0.37, 0.60]
3 Keratinized tissue width change	2	60	Mean Difference (Random, 95% CI)	0.12 [-0.23, 0.48]
4 Sites with complete root coverage	2	60	Odds Ratio (Random, 95% CI)	1.33 [0.46, 3.85]

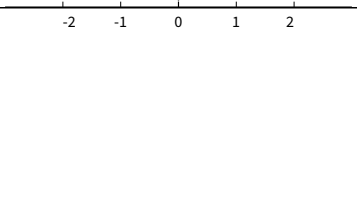
Analysis 7.1. Comparison 7 GTR rm + CAF versus GTR nrm + CAF - short term, Outcome 1 Gingival recession depth change.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
Roccuzzo 1996	12	12	-0.1 (0.324)		35.78%	-0.08[-0.72,0.56]
Zucchelli 1998	18	18	0.4 (0.199)		64.22%	0.4[0.01,0.79]
Total (95% CI)					**100%**	**0.23[-0.22,0.68]**
Heterogeneity: Tau^2=0.04; Chi^2=1.59, df=1(P=0.21); I^2=37.21%						
Test for overall effect: Z=0.99(P=0.32)						

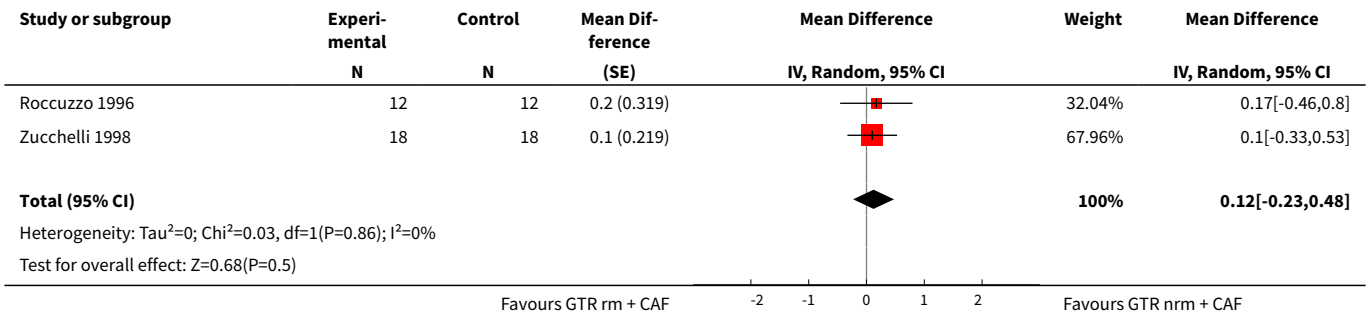


Analysis 7.2. Comparison 7 GTR rm + CAF versus GTR nrm + CAF - short term, Outcome 2 Clinical attachment level change.

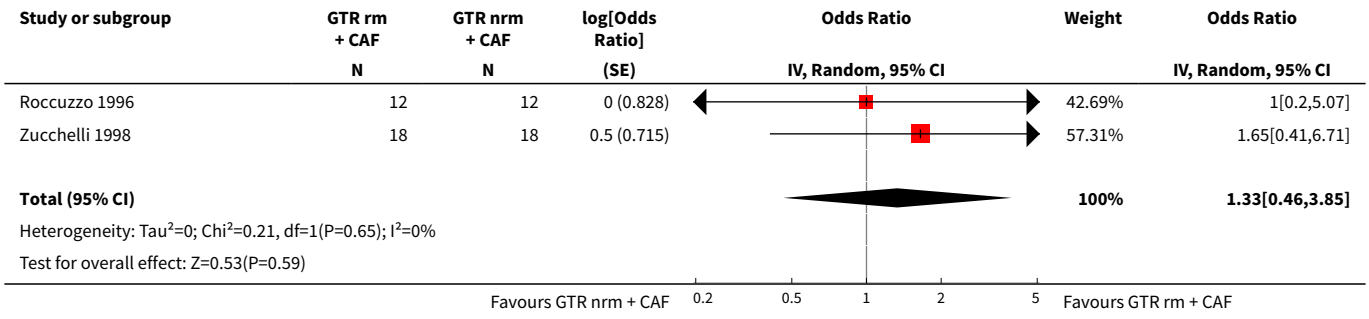
Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
Roccuzzo 1996	12	12	-0.1 (0.46)		29.24%	-0.09[-0.99,0.81]
Zucchelli 1998	18	18	0.2 (0.296)		70.76%	0.2[-0.38,0.78]
Total (95% CI)					**100%**	**0.12[-0.37,0.6]**
Heterogeneity: Tau^2=0; Chi^2=0.28, df=1(P=0.6); I^2=0%						
Test for overall effect: Z=0.46(P=0.64)						



Analysis 7.3. Comparison 7 GTR rm + CAF versus GTR nrm + CAF - short term, Outcome 3 Keratinized tissue width change.



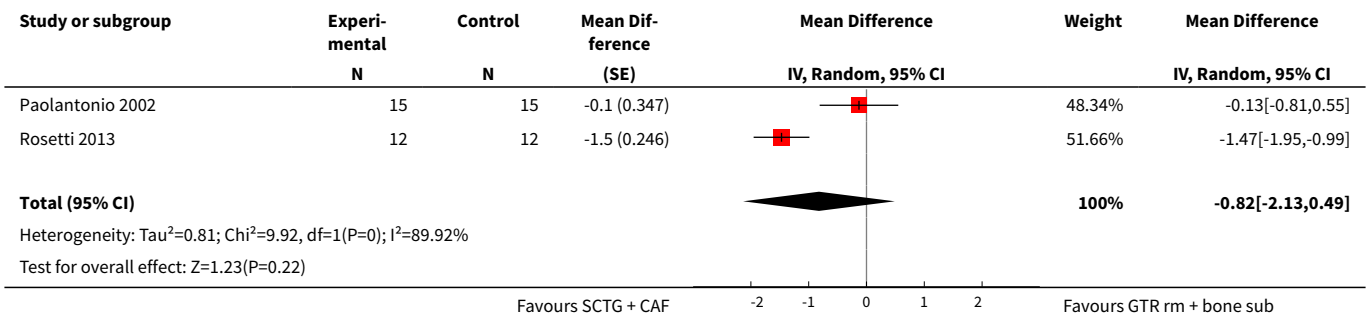
Analysis 7.4. Comparison 7 GTR rm + CAF versus GTR nrm + CAF - short term, Outcome 4 Sites with complete root coverage.



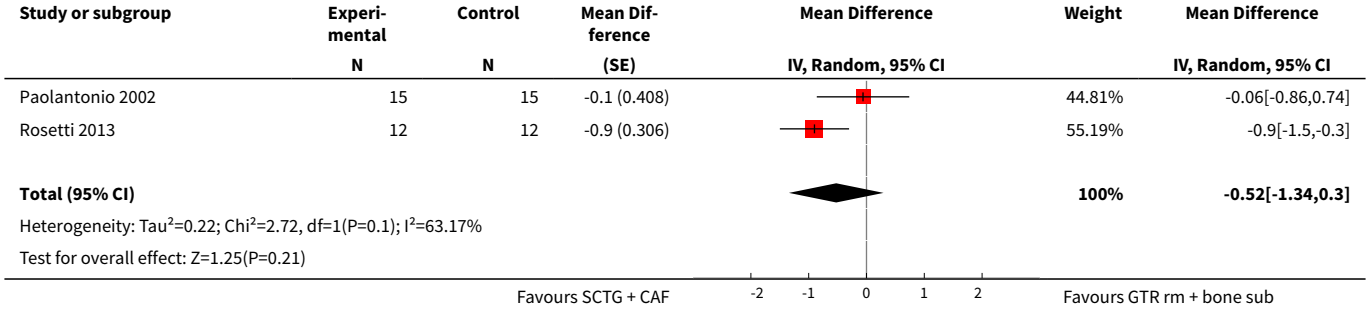
Comparison 8. GTR rm + bone substitutes + CAF versus SCTG + CAF - short term

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Gingival recession depth change	2	54	Mean Difference (Random, 95% CI)	-0.82 [-2.13, 0.49]
2 Clinical attachment level change	2	54	Mean Difference (Random, 95% CI)	-0.52 [-1.34, 0.30]
3 Keratinized tissue width change	2		Mean Difference (Random, 95% CI)	-2.38 [-2.84, -1.92]

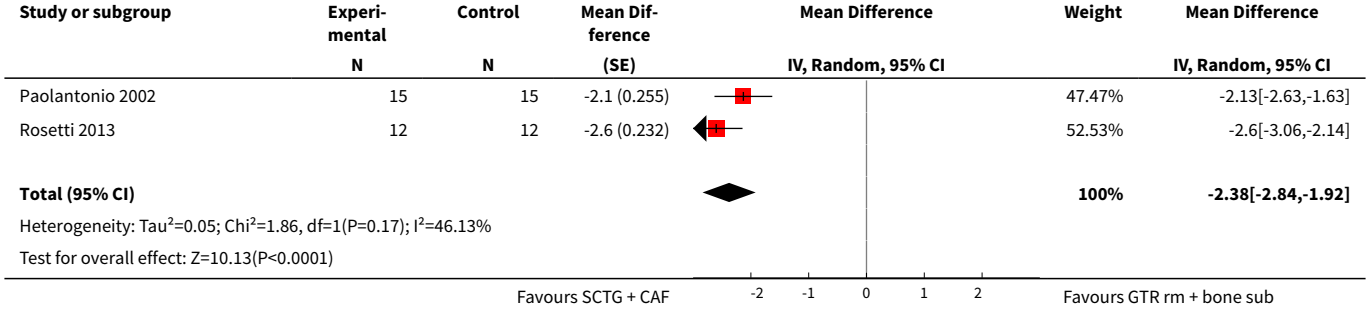
Analysis 8.1. Comparison 8 GTR rm + bone substitutes + CAF versus SCTG + CAF - short term, Outcome 1 Gingival recession depth change.



Analysis 8.2. Comparison 8 GTR rm + bone substitutes + CAF versus SCTG + CAF - short term, Outcome 2 Clinical attachment level change.



Analysis 8.3. Comparison 8 GTR rm + bone substitutes + CAF versus SCTG + CAF - short term, Outcome 3 Keratinized tissue width change.



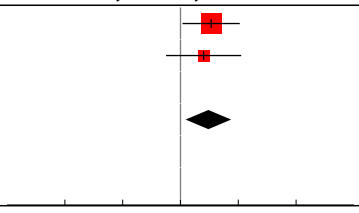
Comparison 9. GTR rm + bone substitutes + CAF versus GTR rm + CAF - short term

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Gingival recession depth change	2	54	Mean Difference (Random, 95% CI)	0.48 [0.09, 0.88]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2 Clinical attachment level change	2	54	Mean Difference (Random, 95% CI)	0.76 [-0.01, 1.54]
3 Keratinized tissue width change	2	54	Mean Difference (Random, 95% CI)	0.23 [-0.21, 0.68]
4 Sites with complete root coverage	2	54	Odds Ratio (Random, 95% CI)	1.87 [0.75, 4.64]

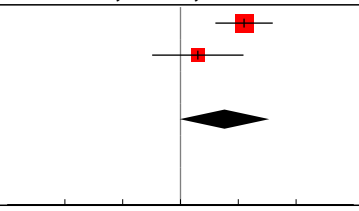
Analysis 9.1. Comparison 9 GTR rm + bone substitutes + CAF versus GTR rm + CAF - short term, Outcome 1 Gingival recession depth change.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
Dodge 2000	12	12	0.5 (0.253)		63.26%	0.53[0.03,1.03]
Paolantonio 2002	15	15	0.4 (0.332)		36.74%	0.4[-0.25,1.05]
Total (95% CI)					**100%**	**0.48[0.09,0.88]**
Heterogeneity: Tau²=0; Chi²=0.1, df=1(P=0.76); I²=0%						
Test for overall effect: Z=2.4(P=0.02)						



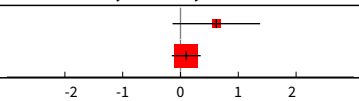
Analysis 9.2. Comparison 9 GTR rm + bone substitutes + CAF versus GTR rm + CAF - short term, Outcome 2 Clinical attachment level change.

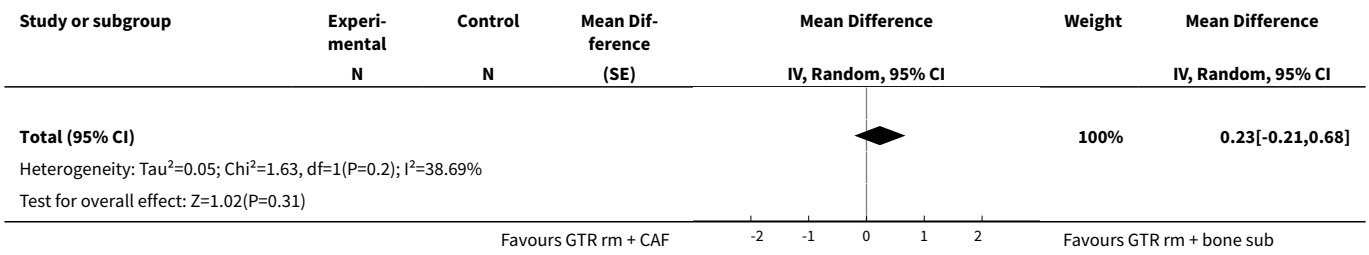
Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
Dodge 2000	12	12	1.1 (0.253)		57.68%	1.1[0.6,1.6]
Paolantonio 2002	15	15	0.3 (0.403)		42.32%	0.3[-0.49,1.09]
Total (95% CI)					**100%**	**0.76[-0.01,1.54]**
Heterogeneity: Tau²=0.21; Chi²=2.83, df=1(P=0.09); I²=64.61%						
Test for overall effect: Z=1.93(P=0.05)						



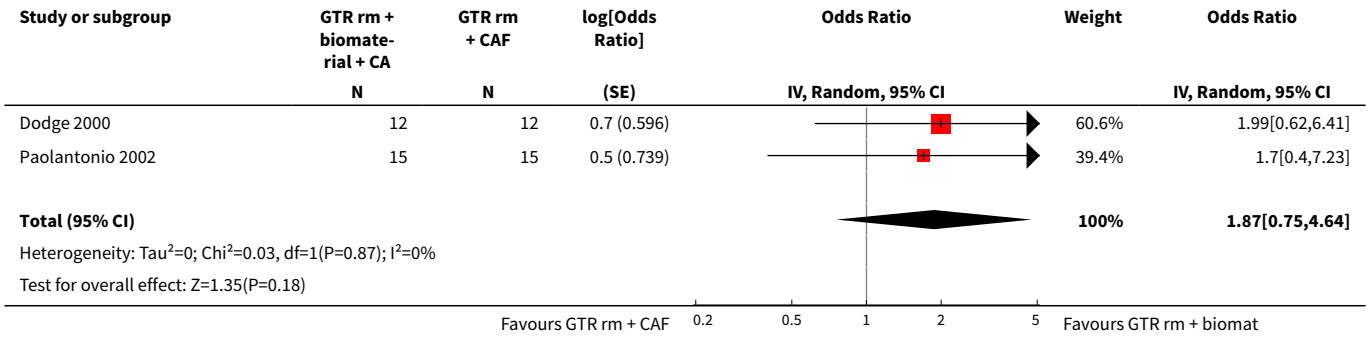
Analysis 9.3. Comparison 9 GTR rm + bone substitutes + CAF versus GTR rm + CAF - short term, Outcome 3 Keratinized tissue width change.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
Dodge 2000	12	12	0.6 (0.387)		25.35%	0.62[-0.14,1.38]
Paolantonio 2002	15	15	0.1 (0.128)		74.65%	0.1[-0.15,0.35]





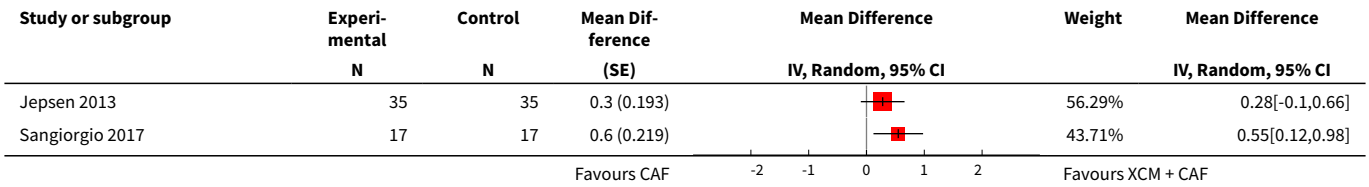
Analysis 9.4. Comparison 9 GTR rm + bone substitutes + CAF versus GTR rm + CAF - short term, Outcome 4 Sites with complete root coverage.

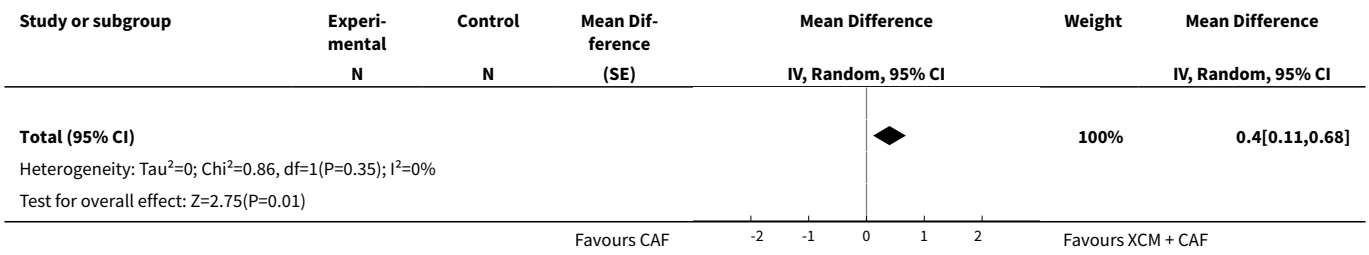


Comparison 10. XCM + CAF versus CAF - short term

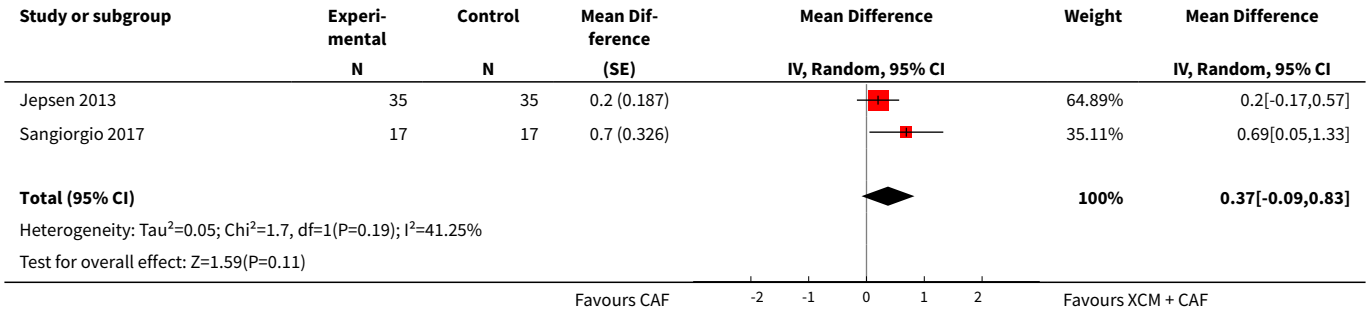
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Gingival recession depth change	2	104	Mean Difference (Random, 95% CI)	0.40 [0.11, 0.68]
2 Clinical attachment level change	2	104	Mean Difference (Random, 95% CI)	0.37 [-0.09, 0.83]
3 Keratinized tissue width change	2	104	Mean Difference (Random, 95% CI)	0.44 [0.04, 0.85]
4 Sites with complete root coverage	2	104	Odds Ratio (Random, 95% CI)	4.73 [2.35, 9.50]

Analysis 10.1. Comparison 10 XCM + CAF versus CAF - short term, Outcome 1 Gingival recession depth change.

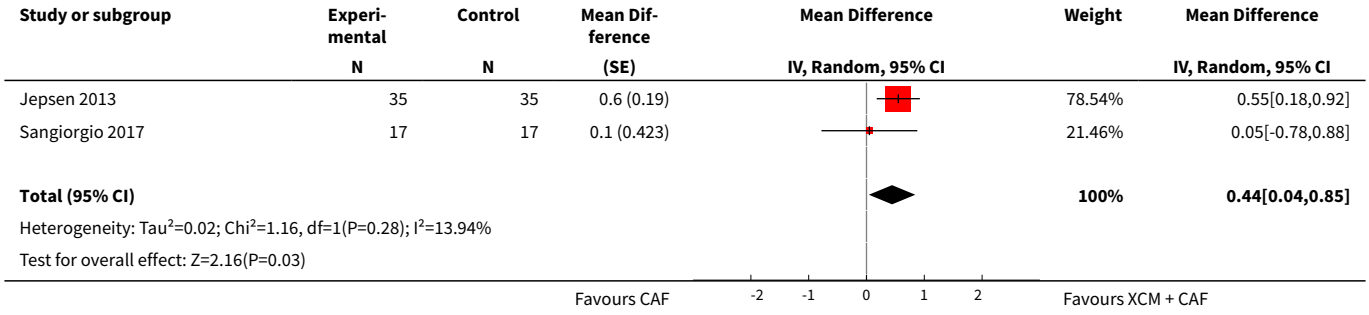




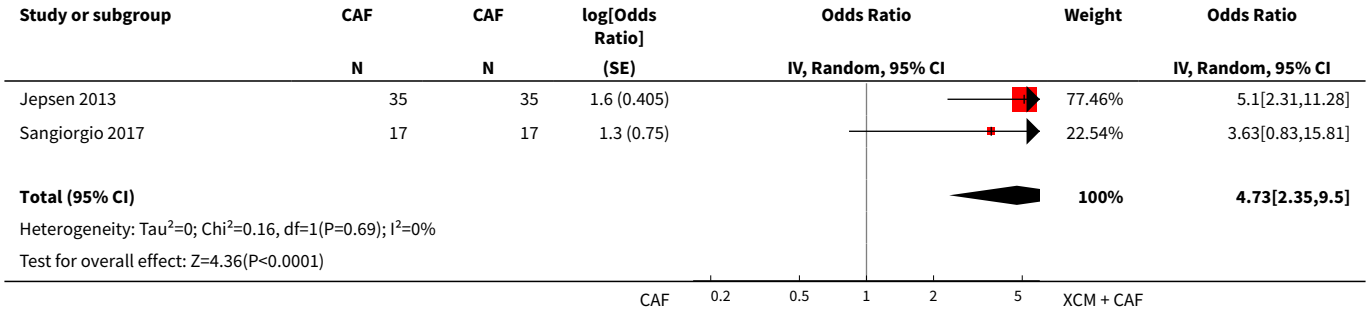
Analysis 10.2. Comparison 10 XCM + CAF versus CAF - short term, Outcome 2 Clinical attachment level change.



Analysis 10.3. Comparison 10 XCM + CAF versus CAF - short term, Outcome 3 Keratinized tissue width change.



Analysis 10.4. Comparison 10 XCM + CAF versus CAF - short term, Outcome 4 Sites with complete root coverage.



Comparison 11. PRF + CAF versus SCTG +CAF - short term

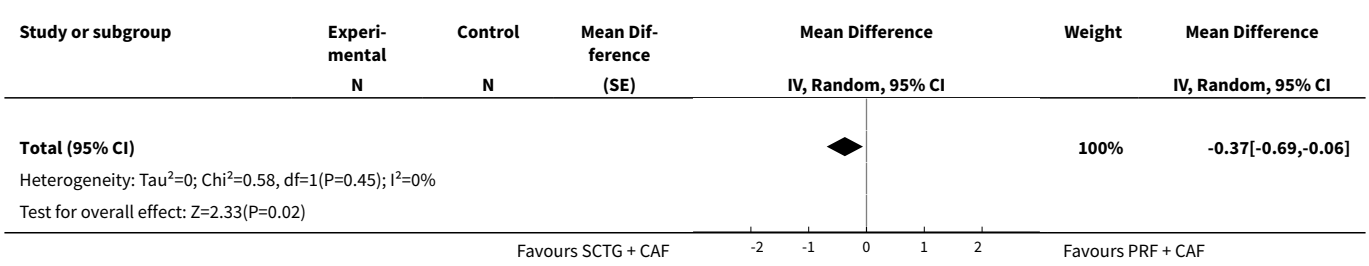
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Gingival recession depth change	2		Mean Difference (Random, 95% CI)	-0.01 [-0.89, 0.86]
1.1 Split-mouth design	2		Mean Difference (Random, 95% CI)	-0.01 [-0.89, 0.86]
2 Clinical attachment level change	2		Mean Difference (Random, 95% CI)	-0.37 [-0.69, -0.06]
2.1 Split-mouth design	2		Mean Difference (Random, 95% CI)	-0.37 [-0.69, -0.06]
3 Keratinized tissue width change	2		Mean Difference (Random, 95% CI)	-0.26 [-0.98, 0.45]
3.1 Split-mouth design	2		Mean Difference (Random, 95% CI)	-0.26 [-0.98, 0.45]

Analysis 11.1. Comparison 11 PRF + CAF versus SCTG +CAF - short term, Outcome 1 Gingival recession depth change.

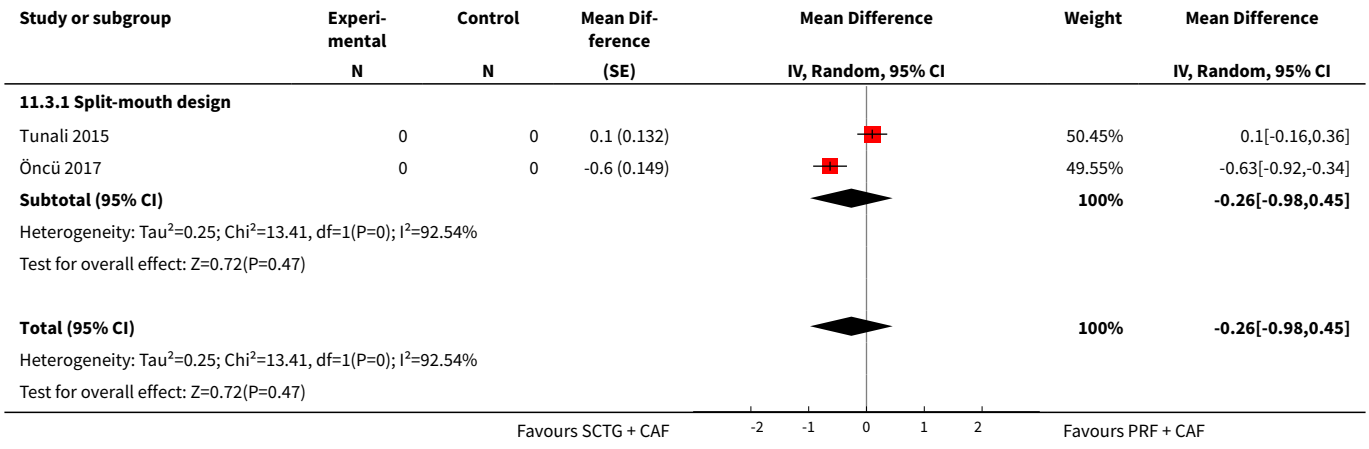
Study or subgroup	Favours SCTG + CAF N	Control PRF + CAF N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
11.1.1 Split-mouth design						
Tunali 2015	0	0	0.4 (0.159)		50.19%	0.43[0.12,0.74]
Öncü 2017	0	0	-0.5 (0.169)		49.81%	-0.46[-0.79,-0.13]
Subtotal (95% CI)					**100%**	**-0.01[-0.89,0.86]**
Heterogeneity: Tau^2=0.37; Chi^2=14.71, df=1(P=0); I^2=93.2%						
Test for overall effect: Z=0.03(P=0.98)						
Total (95% CI)					**100%**	**-0.01[-0.89,0.86]**
Heterogeneity: Tau^2=0.37; Chi^2=14.71, df=1(P=0); I^2=93.2%						
Test for overall effect: Z=0.03(P=0.98)						

Analysis 11.2. Comparison 11 PRF + CAF versus SCTG +CAF - short term, Outcome 2 Clinical attachment level change.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Random, 95% CI	Weight	Mean Difference IV, Random, 95% CI
11.2.1 Split-mouth design						
Tunali 2015	0	0	-0.2 (0.28)		32.89%	-0.2[-0.75,0.35]
Öncü 2017	0	0	-0.5 (0.196)		67.11%	-0.46[-0.84,-0.08]
Subtotal (95% CI)					**100%**	**-0.37[-0.69,-0.06]**
Heterogeneity: Tau^2=0; Chi^2=0.58, df=1(P=0.45); I^2=0%						
Test for overall effect: Z=2.33(P=0.02)						



Analysis 11.3. Comparison 11 PRF + CAF versus SCTG +CAF - short term, Outcome 3 Keratinized tissue width change.



ADDITIONAL TABLES

Table 1. Outcome changes of trials not incorporated into meta-analyses

Study	Interventions	MD RD decrease (95% CI)	MD CAL gain (95% CI)	MD KTW gain (95% CI)	Aesthetic condition change
Ahmedbeyli 2014	ADMG + CAF	3.08 (2.79 to 3.37)[a, b]	2.74 (2.44 to 3.06)[a, b]	1.21 (1.08 to 1.34)[a, b]	The authors asked each patient about different patient-reported outcomes (i.e. root coverage attained, colour of gums, shape and contour of gums), and both procedures were rated equally in all aspects
	CAF	2.37 (1.90 to 2.84)[a]	2.17 (1.71 to 2.63)[a]	0.60 (0.40 to 0.80)[a]	
Ayub 2012	ADMG (positioned 1 mm apical to the CEJ) + CAF (extended flap)	2.92 (2.73 to 3.11)[a, b]	3.07 (2.70 to 3.44)[a, b]	1.07 (0.82 to 1.32)[a]	Not reported
	ADMG + CAF (extended flap)	2.18 (2.00 to 2.36)[a]	2.01 (1.73 to 2.29)[a]	0.93 (0.59 to 1.27)[a]	
Babu 2011	GTR (collagen membrane) + CAF	3.80 (3.25 to 4.35)[a]	Not reported	1.50 (1.07 to 1.93)[a]	Not reported

Table 1. Outcome changes of trials not incorporated into meta-analyses *(Continued)*

	SCTG + CAF	3.40 (2.85 to 3.95)[a]	Not reported	2.30 (1.88 to 2.72)[a]	
Bouchard 1994	SCTG + CAF + citric acid (graft without epithelial collar)	2.93 (NA)[a]	2.74 (NA)[a]	1.00 (NA)[a]	Aesthetic evaluation was performed by 2 independent examiners who were blinded to the given treatment. Additionally, the authors commented that no patient was dissatisfied with the aesthetical results obtained
	SCTG (graft with epithelial collar)	2.93 (NA)[a]	2.86 (NA)[a]	0.93 (NA)[a]	
Bouchard 1997	SCTG + CAF + tetracycline hydrochloride	3.80 (NA)[a]	2.66 (NA)[a]	1.00 (NA)[a]	Not reported
	SCTG + CAF + citric acid	3.47 (NA)[a]	3.20 (NA)[a]	0.93 (NA)[a]	
Costa 2016	ADMG + EMD + CAF (6 months)	1.94 (1.45 to 2.43)[a, b]	1.35 (0.90 to 1.80)[a]	1.61 (1.03 to 2.19)[a]	Not reported
	ADMG + CAF (6 months)	1.52 (1.18 to 1.86)[a]	1.07 (0.84 to 1.30)[a]	1.55 (1.11 to 1.99)[a]	
	ADMG + EMD + CAF (12 months)	2.17 (1.64 to 2.70)[a, b]	1.64 (1.06 to 2.22)[a]	1.61 (1.10 to 2.12)[a]	
	ADMG + CAF (12 months)	1.83 (1.49 to 2.17)[a]	1.43 (0.98 to 1.88)[a]	1.63 (1.14 to 2.12)[a]	
da Silva 2004	SCTG + CAF	3.16 (2.65 to 3.67)[a]	2.53 (1.86 to 3.20)[a]	0.55 (0.01 to 1.09)[a, b]	Not reported
	CAF	2.73 (2.14 to 3.32)[a]	2.30 (1.68 to 2.92)[a]	-0.21 (-0.58 to 0.16)	
Henderson 2011	ADMG (basement membrane side against the tooth) + CAF	3.95 (2.59 to 5.31)[a]	4.15 (2.78 to 5.52)[a]	0.80 (0.23 to 1.37)[#]	Not reported
	ADMG (connective tissue side against the tooth) + CAF	3.55 (2.89 to 4.21)[a]	3.65 (2.75 to 4.55)[a]	0.80 (0.09 to 1.51)[a]	
Jaiswal 2012	EMD + CAF	3.40 (2.80 to 4.00)[a, b]	3.70 (3.08 to 4.32)[a, b]	2.95 (2.60 to 3.30)[a]	Not reported
	CAF	2.81 (2.56 to 3.06)[a]	2.79 (2.54 to 3.04)[a]	2.66 (2.31 to 3.01)[a]	
Jankovic 2010	Platelet-rich fibrin + CAF	3.05 (2.72 to 3.38)[a]	Not reported	0.17 (0.05 to 0.29)	Not reported
	EMD + CAF	2.75 (2.48 to 3.02)[a]	Not reported	0.60 (0.42 to 0.78)[b]	

Table 1. Outcome changes of trials not incorporated into meta-analyses *(Continued)*

Keceli 2008	SCTG + platelet-rich plasma + CAF	Data not reported in the trial (the results from this study were reported as median values (within-groups comparisons $P < 0.05$; between-groups comparison $P > 0.05$)	Data not reported in the trial (the results from this study were reported as median values (within-groups comparisons $P < 0.05$; between-groups comparison $P > 0.05$)	Data not reported in the trial (the results from this study were reported as median values (within-groups comparisons $P < 0.05$; between-groups comparison $P > 0.05$)	Not reported
	SCTG + CAF				
Keceli 2015	SCTG + platelet-rich fibrin + CAF	3.00 (2.78 to 3.22)[a, b]	3.10 (2.75 to 3.45)[a, b]	1.23 (0.94 to 1.52)[a]	Not reported
	SCTG + CAF	2.55 (2.33 to 2.77)	2.50 (2.15 to 2.85)[a]	0.83 (0.59 to 1.07)[a]	
Leknes 2005	GTR (polylactide membrane - Guidor) (6 months) + CAF	2.00 (1.52 to 2.48)[a]	1.30 (0.55 to 2.05)[a]	0.50 (0.19 to 0.81)	Not reported
	CAF (6 months)	2.30 (1.75 to 2.85)[a]	1.50 (0.75 to 2.25)[a]	0.40 (0.18 to 0.62)[a]	
	GTR (polylactide membrane - Guidor) (12 months) + CAF	2.00 (1.52 to 2.48)[a]	1.50 (0.80 to 2.20)[a]	0.60 (0.32 to 0.88)[a]	
	CAF (12 months)	2.20 (1.65 to 2.75)[a]	1.80 (1.10 to 2.50)[a]	0.40 (0.18 to 0.62)[a]	
	GTR (polylactide membrane - Guidor) (72 months) + CAF	1.40 (0.63 to 2.17)	1.70 (0.64 to 2.76)[a]	0	
	CAF (72 months)	1.30 (0.53 to 2.07)[a]	1.50 (0.41 to 2.59)[a]	0	
Matarasso 1998	GTR (polylactide membrane - Guidor) + double papilla flap	3.40 (3.16 to 3.64)[a]	3.10 (2.84 to 3.36)[a]	2.00 (1.77 to 2.23)[a]	Not reported
	GTR (polylactide membrane - Guidor) + CAF	2.50 (2.22 to 2.78)[a]	2.80 (2.50 to 3.10)[a]	0.90 (0.49 to 1.31)	
McGuire 2014	B-TCP + CD + rh-PDGF-BB + CAF (6 months)	2.90 (2.71 to 3.09)[a]	2.90 (2.71 to 3.09)[a]	1.00 (0.81 to 1.19)[a]	At 6 months, patients aesthetic rating by 10 cm visual analogue scale did not identify differences in the clinical rating of colour/texture of the tissues observed between the treatments. At 5 years, of the 20 test and 20 control sites, "14 sites for each were rated as 'very satisfied.'
	SCTG + CAF (6 months)	3.30 (3.11 to 3.49)[a, b]	2.90 (2.51 to 3.29)[a]	1.30 (1.11 to 1.49)[a]	

Table 1. Outcome changes of trials not incorporated into meta-analyses *(Continued)*

	B-TCP + CD + rh-PDGF-BB + CAF (5 years)	2.35 (1.82 to 2.88)[a]	1.95 (1.53 to 2.37)[a]	1.00 (0.6 to 1.40)[a]	In the test group, 4 sites were rated as 'satisfied,' 1 as 'unsatisfied,' and 1 as 'very unsatisfied.' In the control group, the remaining 6 sites were rated as 'satisfied'
	SCTG + CAF (5 years)	3.05 (2.67 to 3.43)[a, b]	2.35 (1.89 to 2.81)[a]	1.63 (1.17 to 2.09)[a, b]	
McGuire 2016	XCM + CAF (6 months)	2.62 (2.33 to 2.91)[a]	2.28 (1.95 to 2.71)[a]	1.34 (0.92 to 1.76)[a]	Patients rated equivalent aesthetic changes from baseline to 6 months for XCM + CAF versus SCTG + CAF (overall, "for both test and control treatments, > 90% of subjects recorded improvement"). Similarly, approximately 90% of patients (15 XCM + CAF and 16 SCTG + CAF) remained "satisfied or very satisfied" 5 year after root coverage therapy and no statistical difference in satisfaction was reported
	SCTG + CAF (6 months)	3.10 (2.91 to 3.29)[a, b]	2.70 (2.42 to 2.98)[a]	1.26 (0.63 to 1.89)[a]	
	XCM + CAF (12 months)	2.78 (2.51 to 3.06)[a]	2.26 (1.76 to 2.76)[a]	1.11 (0.77 to 1.45)[a]	
	SCTG + CAF (12 months)	3.17 (3.01 to 3.33)[a, b]	2.85 (2.59 to 3.11)[a, b]	1.09 (0.43 to 1.75)[a]	
	XCM + CAF (5 years)	Not reported	Not reported	Not reported	
	SCTG + CAF (5 years)	Not reported	Not reported	Not reported	
Ozenci 215	ADMG + CAF (tunnel)	2.45 (2.33 to 2.57)[a]	2.33 (2.07 to 2.59)[a]	0.87 (0.61 to 1.13)[a]	A similar overall patient satisfaction was recorded for patients with multiple recession-type defects treated by ADMG + coronally advanced tunnel flap or ADMG + CAF (without vertical releasing incisions) (P > 0.05)
	ADMG + CAF (without vertical realising incisions)	3.10 (2.75 to 3.45)[a, b]	2.75 (2.38 to 3.12)[a, b]	1.25 (1.1. to 1.40)[a, b]	
Paolantonio 1997	SCTG + double papilla flap	2.85 (2.71 to 2.99)[a, b]	Not reported	3.51 (3.28 to 3.74)[a]	Not reported
	FGG	1.61 (1.50 to 1.72)[a]	Not reported	3.66 (3.52 to 3.80)[a]	
Pendor 2014	SCTG + double papilla flap	3.80 (2.75 to 4.85)[a]	3.80 (2.64 to 4.96)[a]	3.80 (2.76 to 4.84)[a]	Not reported
	SCTG + CAF	3.34 (2.91 to 3.77)[a]	3.74 (3.27 to 4.21)[a]	3.30 (3.00 to 3.60)[a]	
Rasperini 2011	SCTG + EMD + CAF	3.90 (3.59 to 4.21)[a]	3.90 (3.63 to 4.17)[a]	2.00 (1.62 to 2.38)[a]	Not reported
	SCTG + CAF	3.60 (3.06 to 4.14)[a]	3.50 (2.96 to 4.04)[a]	2.00 (1.46 to 2.54)[a]	
Reino 2012	SCTG + CAF (extended flap)	Not reported	Not reported	Not reported	Not reported
	SCTG + CAF	Not reported	Not reported	Not reported	

Table 1. Outcome changes of trials not incorporated into meta-analyses *(Continued)*

Reino 2015	XCM + CAF (extended flap)	2.84 (2.54 to 3.14)[a, b]	2.66 (2.20 to 3.12)[a]	-0.03 (-0.34 to 0.28)	Not reported
	XCM + CAF	2.21 (1.95 to 2.47)[a]	1.85 (1.41 to 2.29)[a]	0.35 (0.03 to 0.67)	
Tozum 2005	SCTG + modified tunnel procedure	3.36 (3.03 to 3.69)[a, b]	3.93 (3.40 to 4.46)[a, b]	Not reported	Not reported
	SCTG + CAF	2.56 (2.19 to 2.93)[a]	2.44 (1.77 to 3.11)[a]	Not reported	
Trombelli 1996	CAF + fibrin glue + tetracycline hydrochloride	2.40 (2.10 to 2.70)[a]	2.40 (1.93 to 2.87)[a]	-0.40 (-0.75 to -0.05)	Not reported
	CAF + tetracycline hydrochloride	1.80 (1.21 to 2.39)[a]	1.90 (1.43 to 2.37)[a]	-0.5 (-1.21 to 0.21)	
Zucchelli 2003	SCTG (graft size equal to the bone dehiscence) + CAF	3.90 (3.54 to 4.26)[a]	3.90 (3.55 to 4.25)[a, b]	2.30 (2.00 to 2.60)[a]	The results obtained at the 12-month follow-up visit showed that patients were more satisfied with the appearance of test-treated recessions (i.e. graft dimension equal to the depth of the bone dehiscence), as well as, less satisfied with poor colour blending and excessive thickness of the control-treated recessions (i.e. graft dimension 3 mm greater than the depth of the bone dehiscence)
	SCTG (graft size 3 mm greater than the bone dehiscence) + CAF	3.60 (3.24 to 3.96)[a]	3.10 (2.73 to 3.47)[a]	3.30 (2.94 to 3.66)[a, b]	
Zucchelli 2009	Ultrasonic scaling + CAF	3.18 (2.74 to 3.62)[a]	2.90 (2.49 to 3.31)[a]	0.36 (-0.04 to 0.76)[a]	Not reported
	Manual/hand scaling + CAF	3.54 (3.06 to 4.02)[a]	3.36 (2.82 to 3.90)[a]	0.55 (0.24 to 0.86)[a]	
Zucchelli 2014	SCTG (de-epithelialized FGG (graft height of 4 mm and thickness < 2 mm)) + CAF	3.66 (3.31-4.02)[a]	3.26 (2.97-3.56)[a]	2.17 (1.94 to 2.39)[a]	Based on a visual analogue scale, the authors did not identify differences in terms of patient root coverage aesthetic assessment 12 months after surgery between sites treated with SCTG (de-epithelialized FGG (graft height of 4 mm and thickness < 2 mm)) + CAF versus SCTG (de-epithelialized FGG (graft height > 4 mm and thickness ≥ 2 mm)) + CAF. Overall, both procedures led to high aesthetic results, but colour match scores were higher for patients receiving reduced size grafts ($P < 0.01$)
	SCTG (de-epithelialized FGG (graft height > 4 mm and thickness > 2 mm) + CAF	3.80 (3.45-4.14)[a]	3.60 (3.23-4.03)[a]	2.50 (2.22-2.77)[a]	

Table 1. Outcome changes of trials not incorporated into meta-analyses *(Continued)*

Zucchelli 2014b	SCTG + CAF (removal of the labial submucosal tissue)	3.68 (3.24 to 4.12)[a, b]	5.24 (4.55 to 5.93)[a]	1.56 (1.13 to 1.99)[a]	The outcomes achieved with a visual analogue scale did not show differences between procedures in terms of root coverage, but colour match was identified by patients as better when the labial submucosal tissue was removed
	SCTG + CAF	3.08 (2.64 to 3.52)[a]	4.60 (4.05 to 5.15)[a]	2.20 (1.51 to 2.89)[a, b]	

ADMG: acellular dermal matrix graft; B-TCP + CD + rhPDGF-BB: Beta-tricalcium phosphate + recombinant human platelet-derived growth factor-BB with a bioabsorbable collagen wound-healing dressing; CAF: coronally advanced flap; CAL: clinical attachment level; CEJ: cemento-enamel junction; CI: confidence interval; EMD: enamel matrix derivative; EMP: enamel matrix protein; FGG: free gingival graft; GR: gingival recession; GTR: guided tissue regeneration; KTW: keratinized tissue width; MD: mean difference; NA: CI are not available or could not be calculated; RD: recession depth; SCTG: subepithelial connective tissue graft; XCM: xenogeneic collagen matrix.

[a]Statistically significant within-groups.

[b]Statistically significant between-groups (superior group).

[c]Within-group comparisons not evaluated.

Table 2. Summary of meta-analyses

Comparison	Studies	Outcome	Statistical method	Effect size	Chi²	P value (Q)	I² (%)
ADMG + CAF versus SCTG + CAF	Barros 2015; Joly 2007; Paolantonio 2002b; Shori 2013	GR depth change	MD 95% CI	-0.36 (-1.03, 0.30)	15.06	0.002	80.0
		CAL change	MD 95% CI	-0.53 (-1.14, 0.08)	9.73	0.02	69.0
		KT width change	MD 95% CI	-0.59 (-1.27, 0.10)	17.17	0.0007	83.0
		SCRC	OR 95% CI	0.43 (0.13, 1.37)	0.00	0.96	0
ADMG + CAF versus CAF	de Queiroz 2006; Woodyard 2004	GR depth change	MD 95% CI	0.61 (-0.52, 1.73)	7.45	0.006	87.0
		CAL change	MD 95% CI	0.51 (-0.25, 1.27)	2.32	0.13	57.0
		KT width change	MD 95% CI	0.28 (-0.08, 0.64)	0.30	0.59	0
		SCRC	OR 95% CI	3.97 (0.20, 80.50)	5.03	0.02	80.0
EMP + CAF versus CAF (1)	Del Pizzo 2005; Sangiorgio 2017; Spahr 2005	GR depth change	MD 95% CI	0.07 (-0.25, 0.40)	5.62	0.06	64.0
		CAL change	MD 95% CI	0.22 (-0.02, 0.45)	1.57	0.46	0
		KT width change	MD 95% CI	0.35 (0.13, 0.56)	0.64	0.73	0
EMP + CAF versus CAF (2)	Del Pizzo 2005; Sangiorgio 2017; Spahr 2005	GR depth change	MD 95% CI	0.32 (0.10, 0.55)	2.10	0.35	5.0
		CAL change	MD 95% CI	0.35 (0.09, 0.61)	1.25	0.53	0
		KT width change	MD 95% CI	0.40 (0.17, 0.62)	1.63	0.44	0
EMP + CAF versus SCTG + CAF	Abolfazli 2009; McGuire 2012	GR depth change	MD 95% CI	-0.39 (-1.27, 0.48)	25.79	<0.00001	96.0
		CAL change	MD 95% CI	-0.25 (-0.69, 0.20)	2.95	0.09	66.0
		KT width change	MD 95% CI	-1.06 (-1.36, -0.76)	2.47	0.12	59.0
		SCRC	OR 95% CI	0.61 (0.05, 7.86)	7.86	0.005	87.0
GTR rm + CAF versus SCTG + CAF	Paolantonio 2002; Wang 2001; Zucchelli 1998	GR depth change	MD 95% CI	-0.37 (-0.60, -0.13)	0.25	0.88	0
		CAL change	MD 95% CI	0.35 (0.06, 0.63)	0.93	0.63	0

Table 2. Summary of meta-analyses *(Continued)*

		KT width change	MD 95% CI	-1.77 (-2.66, -0.89)	15.84	0.0004	87.0
		SCRC	OR 95% CI	0.61 (0.30, 1.24)	2.01	0.37	0
GTR rm + CAF versus GTR nrm + CAF	Roccuzzo 1996; Zucchelli 1998	GR depth change	MD 95% CI	0.23 (-0.22, 0.68)	1.59	0.21	37.0
		CAL change	MD 95% CI	0.12 (-0.37, 0.60)	0.28	0.60	0
		KT width change	MD 95% CI	0.12 (-0.23, 0.48)	0.03	0.86	0
		SCRC	OR 95% CI	1.33 (0.46, 3.85)	0.21	0.65	0
GTR rm associated with bone substitutes + CAF versus SCTG + CAF	Paolantonio 2002; Rosetti 2000	GR depth change	MD 95% CI	-0.82 (-2.13, 0.49)	9.92	0.002	90.0
		CAL change	MD 95% CI	-0.52 (-1.34, 0.30)	2.72	0.10	63.0
		KT width change	MD 95% CI	-2.38 (-2.84, -1.92)	1.86	0.17	46.0
GTR rm associated with bone substitutes + CAF versus GTR rm + CAF	Dodge 2000; Paolantonio 2002	GR depth change	MD 95% CI	0.48 (0.09, 0.88)	0.10	0.76	0
		CAL change	MD 95% CI	0.76 (-0.01, 1.54)	2.83	0.09	65.0
		KT width change	MD 95% CI	0.23 (-0.21, 0.68)	1.63	0.20	39.0
		SCRC	OR 95% CI	1.87 (0.75, 4.64)	0.03	0.87	0
XCM + CAF versus CAF	Jepsen 2013; Sangiorgio 2017	GR depth change	MD 95% CI	0.40 (0.11, 0.68)	0.86	0.35	0
		CAL change	MD 95% CI	0.37 (-0.09, 0.83)	1.70	0.19	41.0
		KT width change	MD 95% CI	0.44 (0.04, 0.85)	1.16	0.28	14.0
		SCRC	OR 95% CI	4.73 (2.35, 9.50)	0.16	0.69	0
PRF + CAF versus SCTG + CAF	Tunali 2015; Öncü 2017	GR depth change	MD 95% CI	-0.01 (-0.89, 0.86)	14.71	0.0001	93.0
		CAL change	MD 95% CI	-0.37 (-0.69, -0.06)	0.58	0.45	0
		KT width change	MD 95% CI	-0.26 (-0.98, 0.45)	13.41	0.0003	93.0

ADMG: acellular dermal matrix graft; CAF: coronally advanced flap; CAL: clinical attachment level; CI: confidence interval; EMP: enamel matrix protein; GR: gingival recession; GTR rm: guided tissue regeneration resorbable membrane; GTR nrm: guided tissue regeneration non-resorbable membrane; KT: keratinized tissue; MD: mean difference; OR: odds ratio; PRF: platelet-rich fibrin; RR: risk ratio; SCRC: sites with complete root coverage; SCTG: subepithelial connective tissue graft; XCM: xenogeneic collagen matrix.

Table 3. Root coverage outcomes - complete root coverage and mean root coverage

Study	Interventions	SCRC	PCRC	MRC
Abolfazli 2009	EMD + CAF (12 months)	NR	NR	77.7
	SCTG + CAF (12 months)	NR	NR	83.4
	EMD + CAF (24 months)	3/12	25.0	76.9
	SCTG + CAF (24 months)	8/12	66.6	93.1
Ahmedbeyli 2014	ADMG + CAF	11/12	83.3	94.8
	CAF	6/12	50.0	74.9
Ayub 2012	ADMG (positioned 1 mm apical to the CEJ) + CAF (extended flap)	4/15	26.6	88.4
	ADMG + CAF (extended flap)	0/15	0	65.8
Babu 2011	GTR (collagen membrane) + CAF	NR	NR	84.0
	SCTG + CAF	NR	NR	84.8
Barros 2015	ADMG + CAF (extended flap)	NR	NR	80.7
	SCTG + CAF (extended flap)	NR	NR	78.7
Bouchard 1994	SCTG + CAF + citric acid (graft without epithelial collar)	3/15	20.0	69.7
	SCTG (graft with epithelial collar)	5/15	33.3	64.7
Bouchard 1997	SCTG + CAF + tetracycline hydrochloride	6/15	40.0	79.3
	SCTG + CAF + citric acid	8/15	53.3	84.0
Costa 2016	ADMG + EMD + CAF (6 months)	3/19	15.8	55.4
	ADMG + CAF (6 months)	1/19	5.3	44.0
	ADMG + EMD + CAF (12 months)	3/19		59.7
	ADMG + CAF (12 months)	1/19		52.8
da Silva 2004	SCTG + CAF	2/11	18.1	75.3
	CAF	1/11	9.0	68.8
de Queiroz 2006	ADMG + CAF (6 months)	3/13	23.0	76.0
	CAF (6 months)	3/13	23.0	71.0
	ADMG + CAF (12 months)	2/13	15.3	71.0
	CAF (12 months)	2/13	15.3	66.7
	ADMG + CAF (24 months)	1/13	7.7	68.4
	CAF (24 months)	1/13	7.7	55.9
Del Pizzo 2005	EMD + CAF	11/15	73.3	90.7

Table 3. Root coverage outcomes - complete root coverage and mean root coverage *(Continued)*

	CAF	9/15	60.0	86.7
Dodge 2000	GTR (polylactide membrane - Guidor) + tetracycline hydrochloride + DFDBA + CAF	6/12	50.0	89.9
	GTR (polylactide membrane - Guidor) + tetracycline hydrochloride + CAF	4/12	33.3	73.7
Henderson 2001	ADMG (basement membrane side against the tooth) + CAF	7/10	70.0	94.9
	ADMG (connective tissue side against the tooth) + CAF	8/10	80.0	95.5
Jaiswal 2012	EMD + CAF	NR	NR	86.3
	CAF	NR	NR	79.6
Jankovic 2010	Platelet-rich fibrin + CAF	12/20	60.0	72.1
	EMD + CAF	13/20	65.0	70.5
Jepsen 2013	XCM + CAF	29/35	82.8	72.0
	CAF	17/35	48.6	66.2
Joly 2007	ADMG + CAF (without vertical incisions)	NR	NR	50.0
	SCTG + CAF (without vertical incisions)	NR	NR	79.5
Keceli 2008	SCTG + platelet-rich plasma + CAF	6/17	35.3	86.4
	SCTG + CAF	8/19	42.1	86.4
Keceli 2015	SCTG + platelet-rich fibrin + CAF	11/20	55.0%	89.6
	SCTG + CAF	7/20	35.0%	79.9
Leknes 2005	GTR (polylactide membrane - Guidor) (6 months) + CAF	5/20	25.0	51.2
	CAF (6 months)	10/20	50.0	63.8
	GTR (polylactide membrane - Guidor) (12 months) + CAF	4/20	20.0	51.2
	CAF (12 months)	6/20	30.0	61.1
	GTR (polylactide membrane - Guidor) (72 months) + CAF	2/11	18.2	35.0
	CAF (72 months)	1/11	9.1	34.2
Matarasso 1998	GTR (polylactide membrane - Guidor) + double papilla flap	NR	NR	73.9
	GTR (polylactide membrane - Guidor) + CAF	NR	NR	62.5
McGuire 2012	EMD + CAF (6 months)	17/19	89.5	95.1
	SCTG + CAF (6 months)	15/19	79.0	93.8
	EMD + CAF (10 years)	5/9	55.6	83.3

Table 3. Root coverage outcomes - complete root coverage and mean root coverage *(Continued)*

	SCTG + CAF (10 years)	7/9	77.8	89.8
McGuire 2014	B-TCP + CD with rhPDGF-BB + CAF (6 months)	NR	NR	90.8
	SCTG + CAF (6 months)	NR	NR	98.6
	B-TCP + CD with rhPDGF-BB + CAF (5 years)	12/20	60.0	74.1
	SCTG + CAF (5 years)	15/20	75.0	89.3
McGuire 2016	XCM + CAF (6 months)	15/25	60.0	83.5
	SCTG + CAF (6 months)	23/25	92.0	97.0
	XCM + CAF (12 months)	17/23	73.9	88.5
	SCTG + CAF (12 months)	22/23	95.6	99.3
	XCM + CAF (5 years)	9/17	52.9	77.6
	SCTG + CAF (5 years)	15/17	88.2	95.5
Öncü 2017	Platelet-rich fibrin + CAF (6 months)	15/30(t)	50.0	77.1
	SCTG + CAF (6 months)	18/30(t)	60.0	84.0
Ozenci 2015	ADMG + CAF (tunnel)	12/31(t)	37.4(t)	75.7
	ADMG + CAF (without vertical realising incisions)	23/27(t)	85.0(t)	93.8
Paolantonio 1997	SCTG + double papilla flap	17/35	48.6	85.2
	FGG	3/35	8.6	53.2
Paolantonio 2002	GTR (polylactide membrane - Guidor) + CAF	6/15	40.0	81.0
	GTR (polylactic acid membrane - Paroguide) + hydroxyapatite/collagen/chondroitin-sulphate graft + CAF	8/15	53.3	87.1
	SCTG + double papilla flap	9/15	60.0	90.0
Paolantonio 2002b	ADMG + CAF	4/15	26.6	83.3
	SCTG + CAF	7/15	46.6	88.8
Pendor 2014	SCTG + double papilla flap	6/10	60.0	88.0
	SCTG + CAF	6/10	60.0	84.7
Rasperini 2011	SCTG + EMD + CAF	16/26	61.5	90.7
	SCTG + CAF	14/30	46.6	76.6
Reino 2012	SCTG + CAF (extended flap)	2/20	10.0	44.5
	SCTG + CAF	0/20	0	43.2
Reino 2015	XCM + CAF (extended flap)	NR	NR	81.9
	XCM + CAF	NR	NR	62.8
Roccuzzo 1996	GTR (polylactic acid membrane - Guidor) + CAF	5/12	41.6	82.4

Table 3. Root coverage outcomes - complete root coverage and mean root coverage *(Continued)*

	GTR (ePTFE membrane - Gore-Tex) + CAF	5/12	41.6	82.4
Rosetti 2013	GTR (collagen membrane) + tetracycline hydrochloride + DFDBA + CAF (18 months)	NR	NR	84.2
	SCTG + tetracycline hydrochloride (18 months)	NR	NR	95.6
	GTR (collagen membrane) + tetracycline hydrochloride + DFDBA + CAF (30 months)	NR	NR	87.0
	SCTG + tetracycline hydrochloride (30 months)	NR	NR	95.5
Sangiorgio 2017	XCM + CAF	9/17	52.9	87.2
	EMD + CAF	12/17	70.6	88.8
	XCM + EMD + CAF	10/17	58.8	91.6
	CAF	4/17	23.5	68.0
Shori 2013	ADMG + CAF	NR	NR	86.9
	SCTG + CAF	NR	NR	84.7
Spahr 2005	EMP + CAF (6 months)	NR	NR	80.0
	Placebo (propylene glycol alginate) + CAF (6 months)	NR	NR	79.0
	EMP + CAF (12 months)	NR	NR	80.0
	Placebo (propylene glycol alginate) + CAF (12 months)	NR	NR	79.0
	EMP + CAF (24 months)	NR	53.0	84.0
	Placebo (propylene glycol alginate) + CAF (24 months)	NR	23.0	67.0
Tozum 2005	SCTG + modified tunnel procedure	NR	NR	96.4
	SCTG + CAF	NR	NR	77.1
Trombeli 1996	CAF + fibrin glue + tetracycline hydrochloride	1/11	9.1	63.1
	CAF + tetracycline hydrochloride	2/11	18.2	52.9
Tunali 2015	Leukocyte- and platelet-rich fibrin + CAF (6 months)	4/22(t)	18.2	74.6
	SCTG + CAF (6 months)	2/22(t)	9.1	74.1
	Leukocyte- and platelet-rich fibrin + CAF (12 months)	3/22(t)	13.6	76.6
	SCTG + CAF (12 months)	4/22(t)	18.2	77.4
Wang 2001	GTR (reabsorbable double thickness collagen membrane - Sulzer Dental Inc) + CAF	7/16	43.8	73.0
	SCTG + CAF	7/16	43.8	84.0
Woodyard 2004	ADMG + CAF	11/12	91.6	96.0

Table 3. Root coverage outcomes - complete root coverage and mean root coverage *(Continued)*

	CAF	4/12	33.3	67.0
Zucchelli 1998	GTR (polylactic acid membrane - Guidor) + CAF	7/18	39.0	85.7
	GTR (ePTFE membrane - Gore-Tex) + CAF	5/18	28.0	80.5
	SCTG + CAF	12/18	66.0	93.5
Zucchelli 2003	SCTG (graft size equal to the bone dehiscence) + CAF	13/15	86.7	97.3
	SCTG (graft size 3 mm greater than the bone dehiscence) + CAF	12/15	80.0	94.7
Zucchelli 2009	Ultrasonic scaling + CAF	6/11	54.5	84.2
	Manual/hand scaling + CAF	9/11	81.8	95.4
Zucchelli 2014	SCTG (de-epithelialized FGG (graft height of 4 mm and thickness < 2 mm)) + CAF	25/30	83.3	96.3
	SCTG (de-epithelialized FGG (graft height > 4 mm and thickness ≥ 2 mm)) + CAF	24/30	80.0	96.7
Zucchelli 2014b	SCTG + CAF (removal of the labial submucosal tissue)	22/25	88.0	97.8
	SCTG + CAF	12/25	48.0	82.8

ADMG: acellular dermal matrix graft; B-TCP: Beta-tricalcium phosphate; CAF: coronally advanced flap; CEJ: cemento-enamel junction; DFDBA: demineralized freeze-dried bone allograft; EMD: enamel matrix derivative; EMP: enamel matrix protein; ePTFE: expanded polytetrafluorethylene; FGG: free gingival graft; GTR: guided tissue regeneration; MRC: mean root coverage; PCRC: percentage of complete root coverage; rhPDGF-BB: recombinant human platelet-derived growth factor-BB; SCRC: sites with complete root coverage; SCTG: subepithelial connective tissue graft; t: teeth; XCM: xenogeneic collagen matrix.

APPENDICES

Appendix 1. Cochrane Oral Health's Trials Register search strategy

1 ((recession and gingiva*) or (recession and defect*) or "recession-type defect*"):ti,ab
2 ((exposure near root*) or (exposed near root*)):ti,ab
3 (denude* near "root surface*"):ti,ab
4 (gingiva* near defect*):ti,ab
5 #1 or #2 or #3 or #4
6 (tissue near regenerat*):ti,ab
7 ((gingiva* near esthetic*) or (gingiva* near aesthetic*)):ti,ab
8 (periodont* and "plastic surgery"):ti,ab
9 ("soft tissue graft" or "coronally advanced flap*"):ti,ab
10 ("laterally positioned flap*" or "laterally-positioned flap*"):ti,ab
11 ("connective tissue graft*" or "connective-tissue graft*"):ti,ab
12 (gingiva* near transplant*):ti,ab
13 ("dermal matrix" near graft*):ti,ab
14 "enamel matrix protein":ti,ab
15 #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14
16 (#5 and #15) AND (INREGISTER)

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

#1 [mh ^"gingival recession"]
#2 ((recession near gingiva*) or (recession near defect*) or "recession-type defect*")

#3 ((exposure near root*) or (exposed near root*))
#4 (gingiva* near defect*)
#5 (denude* near "root surface*")
#6 {or #1-#5}
#7 [mh ^"Guided tissue regeneration"]
#8 (tissue near regenerat*)
#9 ((gingiva* near esthetic*) or (gingiva* near aesthetic*))
#10 (periodont* and "plastic surgery")
#11 ("soft tissue graft" or "coronally advanced flap*")
#12 ("laterally positioned flap*" or "laterally-positioned flap*")
#13 ("connective tissue graft*" or "connective-tissue graft*")
#14 (gingiva* near transplant*)
#15 ("dermal matrix" near graft*)
#16 "enamel matrix protein"
#17 {or #7-#16}
#18 #6 and #17

Appendix 3. MEDLINE Ovid search strategy

1. Gingival recession/
2. ((recession adj5 gingiva$) or (recession adj5 defect$) or "recession-type defect$").ti,ab.
3. ((exposure adj5 root$) or (exposed adj5 root$)).ti,ab.
4. (gingiva$ adj5 defect$).ti,ab.
5. (denude$ adj5 "root surface$").ti,ab.
6. or/1-5
7. exp Guided tissue regeneration/
8. (tissue adj5 regenerat$).ti,ab.
9. ((gingiva$ adj5 esthetic$) or (gingiva$ adj5 aesthetic$)).ti,ab.
10. (periodont$ and "plastic surgery").ti,ab.
11. ("soft tissue graft$" or "coronally advanced flap$").ti,ab.
12. "laterally positioned flap$".ti,ab.
13. "connective tissue graft$".ti,ab.
14. (gingiva$ adj5 transplant$).ti,ab.
15. ("dermal matrix" adj5 graft$).ti,ab.
16. "enamel matrix protein".ti,ab.
17. or/7-16
18. 6 and 17

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

1. randomized controlled trial.pt.
2. controlled clinical trial.pt.
3. randomized.ab.
4. placebo.ab.
5. drug therapy.fs.
6. randomly.ab.
7. trial.ab.
8. groups.ab.
9. or/1-8
10. exp animals/ not humans.sh.
11. 9 not 10

Appendix 4. Embase Ovid search strategy

1. Gingiva disease/
2. ((recession adj5 gingiva$) or (recession adj5 defect$) or "recession-type defect$").ti,ab.
3. ((exposure adj5 root$) or (exposed adj5 root$)).ti,ab.
4. (gingiva$ adj5 defect$).ti,ab.
5. (denude$ adj5 "root surface$").ti,ab.
6. or/1-5
7. Tissue regeneration/

8. (tissue adj5 regenerat$).ti,ab.
9. ((gingiva$ adj5 esthetic$) or (gingiva$ adj5 aesthetic$)).ti,ab.
10. (periodont$ and "plastic surgery").ti,ab.
11. ("soft tissue graft$" or "coronally advanced flap$").ti,ab.
12. "laterally positioned flap$".ti,ab.
13. "connective tissue graft$".ti,ab.
14. (gingiva$ adj5 transplant$).ti,ab.
15. ("dermal matrix" adj5 graft$).ti,ab.
16. "enamel matrix protein".ti,ab.
17. or/7-16
18. 6 and 17

The above subject search was linked to adapted version of the Cochrane Embase Project filter for identifying randomised controlled trials in Embase Ovid (see http://www.cochranelibrary.com/help/central-creation-details.html for information):

1. Randomized controlled trial/
2. Controlled clinical study/
3. Random$.ti,ab.
4. randomisation/
5. intermethod comparison/
6. placebo.ti,ab.
7. (compare or compared or comparison).ti.
8. ((evaluated or evaluate or evaluating or assessed or assess) and (compare or compared or comparing or comparison)).ab.
9. (open adj label).ti,ab.
10. ((double or single or doubly or singly) adj (blind or blinded or blindly)).ti,ab
11. double blind procedure/
12. parallel group$1.ti,ab.
13. (crossover or cross over).ti,ab.
14. ((assign$ or match or matched or allocation) adj5 (alternate or group$1 or intervention$1 or patient$1 or subject$1 or participant $1)).ti,ab.
15. (assigned or allocated).ti,ab.
16. (controlled adj7 (study or design or trial)).ti,ab.
17. (volunteer or volunteers).ti,ab.
18. trial.ti.
19. or/1-18
20. (exp animal/ or animal.hw. or nonhuman/) not (exp human/ or human cell/ or (human or humans).ti.)
21. 19 not 20

Appendix 5. US National Institutes of Health Ongoing Trials Register (ClinicalTrials.gov) search strategy

recession AND tissue regeneration

Appendix 6. World Health Organization International Clinical Trials Registry Platform search strategy

recession AND tissue regeneration

root coverage

WHAT'S NEW

Date	Event	Description
11 October 2018	Amended	Co-author name correction.

HISTORY

Protocol first published: Issue 2, 2008
Review first published: Issue 2, 2009

Date	Event	Description
25 September 2018	New citation required and conclusions have changed	• New review authors. • Risk of bias assessment was updated and GRADE methods were used to assess the quality of the body of evidence of our main comparisons (i.e. subepithelial connective tissue graft (SCTG)-based procedures versus other root coverage procedures and coronally advanced flap (CAF) versus other biomaterials). • Inclusion of 24 new randomised controlled trials (RCTs) (50% of the total number of included studies). • 74 new excluded studies. • Outcomes on smokers were provided by 2 RCTs. • Data from 10 RCTs were included in the meta-analyses. • Inclusion of outcomes from multiple recession-type defects and data from xenogeneic collagen matrix (XCM). • 3 new comparisons added: enamel matrix derivative (EMD) + CAF versus SCTG + CAF and XCM + CAF versus CAF for treating single gingival recessions, and platelet-rich fibrin (PRF) + CAF versus SCTG + CAF for treating multiple recession-type defects.
15 January 2018	New search has been performed	Searches were updated up to 15 January 2018.

CONTRIBUTIONS OF AUTHORS

- Leandro Chambrone: conceiving the review, designing the protocol, designing the review, undertaking searches, obtaining and screening data on unpublished studies, data collection and extraction for the review, writing to authors of papers for additional information, entering data into RevMan 5, analysis of data, interpretation of data and writing the review.
- Maria Aparecida Salinas Ortega: undertaking searches, data collection and extraction for the review.
- Flávia Sukekava: undertaking searches, data collection and extraction for the review, and analysis of data.
- Roberto Rotundo: interpretation of data and writing the review.
- Kalemaj Zamira: analysis and interpretation of data.
- Jacopo Buti: designing the review, analysis of data, co-ordinating and writing the review.
- Giovan Paolo Pini Prato: interpretation of data and writing the review.

DECLARATIONS OF INTEREST

Leandro Chambrone, Giovan Paolo Pini Prato, Jacopo Buti and Roberto Rotundo acted as investigators of some trials considered in this review, but none of the authors report conflicts of interest related to this review.
Maria Aparecida Salinas Ortega: no interests to declare.
Flávia Sukekava: no interests to declare.
Kalemaj Zamira: no interests to declare.

SOURCES OF SUPPORT

Internal sources

- None, Other.

External sources

- Cochrane Oral Health Global Alliance, Other.

The production of Cochrane Oral Health reviews has been supported financially by our Global Alliance since 2011 (oralhealth.cochrane.org/partnerships-alliances). Contributors over the past year have been the American Association of Public Health Dentistry, USA; AS-Akademie, Germany; the British Association for the Study of Community Dentistry, UK; the British Society of Paediatric Dentistry, UK; the Canadian Dental Hygienists Association, Canada; the Centre for Dental Education and Research at All India Institute of Medical Sciences, India; the National Center for Dental Hygiene Research & Practice, USA; New York University College of Dentistry, USA; and the Swiss Society for Endodontology, Switzerland.

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

  This project was supported by the NIHR, via Cochrane Infrastructure funding to Cochrane Oral Health. The views and opinions expressed herein are those of the authors and do not necessarily reflect those of the Systematic Reviews Programme, NIHR, NHS or the Department of Health.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Changes to the original protocol.

- Title: inclusion of 'multiple.'
- Objectives: 'effectiveness' was changed to 'efficacy.'
- Type of interventions: assessment of coronally advanced flap (CAF) + different biomaterial.
- Type of outcomes: 'number/percentage of sites achieving complete root coverage' became a primary outcome.
- Type of outcomes: studies with follow-up > 12 months and ≤ 60 months were considered as medium-term trials, whereas randomised controlled trials with follow-up > 60 months as long term.

INDEX TERMS

Medical Subject Headings (MeSH)

Acellular Dermis; Dental Enamel Proteins [therapeutic use]; Gingival Recession [*surgery]; Gingivoplasty [*methods]; Guided Tissue Regeneration, Periodontal [methods]; Randomized Controlled Trials as Topic; Surgical Flaps [transplantation]

MeSH check words

Humans