

REVIEW ARTICLE

Esthetic and patient-reported outcomes in immediate implants with adjunctive surgical procedures to increase soft tissue thickness/height: A systematic review

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Abstract

To explore the impact of soft tissue augmentation procedures during immediate implant placement (IIP) on clinician-assessed esthetic outcomes and patient-reported outcome measures (PROMs). A systematic literature search was conducted in PubMed, Cochrane Library, and Embase until March 2024. Two independent reviewers selected randomized and controlled clinical trials with ≥ 12 months follow-up, evaluating IIP in the premolar-to-premolar area with or without STA. Primary outcomes included esthetic assessments by clinicians (Pink Aesthetic Score, Implant Crown Aesthetic Index and mid-facial soft tissue recession) as well as PROMs. Secondary outcomes comprised post-operative morbidity, soft tissue stability, and interproximal bone changes. Data extraction was done by two independent reviewers, and the risk of bias was assessed using RoB 2.0 or ROBINS-I. Sixteen publications were included. The only relevant finding was that soft tissue augmentation significantly reduced midfacial soft tissue recession ($n=4$, WMD=0.38; 95% CI (0.15, 0.61)). No significant differences could be found between grafting and no grafting regarding the other clinician-assessed esthetic outcomes or for PROMs. Soft tissue augmentation during IIP reduces midfacial soft tissue recession. However, no other effects could be found based on clinician-assessed or patient-reported esthetic outcomes.

KEYWORDS

aesthetic outcomes, dental implant, patient satisfaction, soft tissue augmentation

1 | INTRODUCTION

In the modern dental context, the significance of dental esthetics is being recognized more and more, as is its psychological and social impact [1]. Dental implants are experiencing increased demand as a treatment option for missing teeth, particularly in esthetic zones where appearance is of critical importance [2]. Over the last decade,

implant protocols have significantly evolved, and the immediate replacement of hopeless teeth has become a common procedure. The main advantage of immediate implant placement (IIP) is a reduction in the number of required surgical interventions, thus decreasing the overall treatment time. Additionally, it has been suggested that IIP can help to maintain the architecture of the peri-implant soft tissues and improve aesthetics [3].

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Since its introduction in the 9s, IIP has been recommended with caution as it leads to higher implant failure and soft tissue recessions [4,5]. However, based on the current evidence, recent guidelines report that IIP in the anterior maxilla under favorable conditions is considered predictable and associated with high survival rates. However, technical and biological complications may still occur [6–8].

The currently available evidence indicates that during IIP, soft-tissue grafts enhance the stability of the mid-facial soft tissue level [9–11]. The specific role of adjunctive soft tissue augmentation (STA) procedures, such as connective tissue grafts or other biomaterials/techniques on the esthetic outcomes, from the perspective of both clinicians and patients, remains underexplored and merits further investigation. Addressing this knowledge gap is clinically relevant, as optimizing esthetic outcomes and patient satisfaction has become a key indicator of success in implant dentistry, especially in the highly demanding aesthetic zone.

The primary objective of this systematic review is to explore the impact of STA procedures during IIP in the esthetic zone on clinician-assessed esthetic outcomes and patient-reported outcome measures (PROMs). The secondary aim is to investigate the influence of STA procedures on post-operative morbidity and complications, as well as on clinical and radiographic parameters.

2 | MATERIALS AND METHODS

2.1 | Protocol development and focused question

The protocol of this systematic review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement [12]. It was registered in the PROSPERO International Prospective Register of Systematic Reviews hosted by the Centre for Reviews and Dissemination, University of York, National Institute for Health Research (United Kingdom).

The protocol aimed at addressing the following PICOS questions:

- PICOS 1: “In patients requiring single tooth replacement in the premolar-to-premolar area with an indication for IIP (population), what is the efficacy of any type of surgical procedure to increase soft tissue thickness/height during IIP (intervention), as compared to no augmentation during IIP (comparison) to modify clinician-assessed aesthetic outcomes or self-reported patient satisfaction on aesthetics (primary outcome), in randomized clinical trials (RCTs) or controlled clinical trials (CCT) (study design) with at least 1 year follow-up?”.
- PICOS 2: “In patients requiring single tooth replacement in the premolar-to-premolar area with an indication for IIP (population), what is the efficacy of any type of surgical procedure to increase soft tissue thickness/height during IIP (intervention), as compared to any other possible soft tissue augmentation technique or procedure (comparison) to modify clinician-assessed aesthetic outcomes

or self-reported patient satisfaction on aesthetics (primary outcome), in randomized clinical trials (RCTs) or controlled clinical trials (CCTs) (study design) with at least 1 year follow-up?”

2.1.1 | Eligibility criteria

Inclusion criteria (PICOS)

- **Population:** Patients requiring single tooth replacement in the premolar-to-premolar area, with an indication for IIP.
- **Intervention:** Any type of surgical procedure to increase soft tissue thickness/height during IIP.
- **Comparison:** No augmentation during IIP (PICOS 1) or any other soft tissue augmentation technique or procedure (PICOS 2).
- **Outcome.** *Primary outcome:* Clinician-assessed aesthetic outcomes or self-reported patient satisfaction on aesthetics. *Secondary outcomes:* postoperative morbidity and complications, other patient-reported outcome measures (PROMs), keratinized tissue gain, soft tissue thickness, interproximal marginal bone level changes, dimensional changes on the alveolar bone assessed on CBCTs, ridge contour changes assessed clinically or with intraoral impressions/scanners, plaque indexes, peri-implant tissue health status, including probing depth (PD), bleeding on probing (BoP), and incidence of biological complications (peri-implant mucositis or peri-implantitis, based on specified diagnostic criteria).
- **Study design:** randomized clinical trials (RCTs) or controlled clinical trials (CCTs) with a minimum follow-up of 12 months.
- At least 10 implants evaluated in each arm at the 12-month evaluation.

Exclusion criteria

- In vitro and preclinical studies.
- Studies focusing on surgical procedures to increase soft tissue thickness/height before or after IIP.
- Other language different to English.

2.1.2 | Type of intervention and comparisons

Studies were selected if they included any surgical procedure to increase soft tissue thickness/height during IIP. The type and origin of soft tissue grafts were documented. For autologous grafts, the harvesting site and the retrieval technique were also recorded.

The following information was gathered from each individual study if reported: (i) type of provisionalization; (ii) filling of the gap/guided bone regeneration procedures; (iii) type of restoration/abutment and prosthetic protocol/design (e.g., one-abutment one-time); (iv) thickness of the facial bone (<1 mm or ≥1 mm); (v) soft tissue recession at the time of tooth extraction; (vi) situation of the facial bone wall; (vii) type of teeth extracted; (viii) implant material; (ix) periodontal status of

the neighboring teeth, including interproximal soft tissue defect and periodontal biotype/phenotype; (x) patient characteristics, such as general health or smoking habit; (xi) use of biological agents; (xii) flap vs. flapless procedure; and (xiii) implant depth according to the planned cervical level of the future crown.

2.1.3 | Type of outcomes

The primary outcome was clinician-assessed esthetic outcomes (e.g., pink esthetic score, white esthetic score, mid-facial soft-tissue recession, interproximal soft tissue assessment, color assessment) or self-reported patient satisfaction on esthetics.

The following secondary outcomes were considered:

- Postoperative morbidity and complications
- Other patient-reported outcome measures (PROMs)
- Keratinized tissue changes
- Soft tissue thickness changes
- Interproximal marginal bone level changes
- Dimensional changes on the alveolar bone assessed on CBCTs
- Ridge contour changes assessed clinically or with intraoral impressions/scanners
- Plaque indices
- Peri-implant tissue health status, including probing depth (PD), bleeding on probing (BoP) and incidence of biological complications (peri-implant mucositis or peri-implantitis, based on specified diagnostic criteria)

2.2 | Information sources and search

2.2.1 | Electronic search

Three electronic databases were used: (1) PubMed, (2) Cochrane Library (including Cochrane Database for Systematic Reviews and Cochrane CENTRAL register for Clinical Trials), and (3) Embase. These databases were searched for studies published up until March 2024. The search was limited to human subjects and to studies reported in English. No more languages were considered due to the limited time for the preparation of this systematic review.

2.2.2 | Manual search

All reference lists of the selected studies and previously published systematic reviews were checked for cross-references.

2.2.3 | Search strategy

The whole search strategy is depicted in [Table S1](#).

2.3 | Screening methods

Two reviewers independently screened the titles and abstracts (IL and HY) using the Covidence systematic review software (Veritas Health Innovation, Melbourne, Australia). Full-text screening was done by the same reviewers for eligible or unclear studies. Disagreements were resolved by a third reviewer (FL). Reasons for exclusion during full-text screening were reported. The inter-reviewer reliability (percentage of agreement and kappa correlation coefficient) of the full-text analysis was calculated.

2.4 | Data extraction

Two different reviewers performed duplicate data extraction (IS and AC). When data were incomplete or missing, authors of studies were contacted for clarification. If agreement could not be reached, data were excluded until further clarification is available. For studies involving multiple publications or arms, only relevant and unique data were extracted.

2.5 | Quality assessment (risk of bias in individual studies)

Quality assessment of the included studies was performed by two reviewers (IL and HY) using the Cochrane RoB 2.0 tool for RCTs, and the ROBINS-I tool for nonrandomized trials.

2.6 | Risk of bias across studies

The publication bias was evaluated using a Funnel plot and the Egger's linear regression method for *mid-facial mucosal recession when comparing grafting versus no graft*. A sensitivity analysis of the meta-analysis results was also performed [13].

2.7 | Strength and quality of the evidence

The overall quality of evidence was rated using the GRADE (Grading of Recommendations, Assessment, Development and Evaluation) approach [14] following the summary of findings table format by Carrasco-Labra et al. [15]. To reach an outcome-level grading of evidence, the authors considered RoB, inconsistency, imprecision, reporting bias, publication bias, large effects, plausible confounding, and dose-response gradient as per the GRADE methodology.

2.8 | Data analyses

The statistical heterogeneity among studies was assessed using the Q test based on chi-squared statistics [16] as well as the I^2 index [17]

in order to know the percentage of variation in the global estimate that was attributable to heterogeneity. To summarize and compare studies, mean values of primary and secondary outcomes were directly pooled and analyzed with weighted mean differences (WMD) and 95% confidence intervals (CI). Study specific estimates were pooled with both the fixed and random-effect models [18]. If a significant and high heterogeneity was found, then the random-effect model results were presented. Forest plots were created to illustrate the effects of the different studies and the global estimation. STATA® (StataCorp LP, Lakeway Drive, College Station, Texas, USA) and OpenMeta [Analyst] intercooled software was used to perform all analyses. Statistical significance was set as a p -value of <0.05 .

3 | RESULTS

3.1 | Screening process

Figure 1 shows the flowchart summarizing the results of the selection process. The electronic search yielded 2763 published articles, and after title and abstract evaluation, 26 articles were selected for full-text analysis (agreement 98.73%, kappa=0.47). After full-text evaluation, 13 published articles were selected (agreement 73%, kappa=0.44). In addition, three articles were identified through citation searches [19–21]. Therefore, 16 articles were included for data extraction, representing 11 independent investigations, as the results of the same studies were reported at different time points

[19,20,22,23] or different results were reported in different publications [22,24–27]. Reasons for exclusion of the remaining studies are detailed in Table S2.

3.2 | Selection and characteristics of eligible studies

Table 1 provides a summary of the methodological characteristics of the selected studies.

3.2.1 | Interventions and relevant aspects of the study design

Of the 11 studies, 10 were randomized controlled trials (RCTs) and one was a controlled clinical trial (CCT). Ten of the 11 studies employed a parallel design, comparing two treatment groups. One RCT utilized a three-armed design [34]. All the included studies evaluated patients requiring a single immediate implant in the anterior maxilla (from the central incisor to the second premolar). Additionally, one research study included mandibular premolars [20]. The systematic review included a total of 421 patients with 421 titanium implants. At the conclusion of the follow-up period, 409 implants were evaluated. With the exception of three articles where this information was not provided [30,31,33], all implants were placed in sites without an active infection. All but three of the articles presented multiple outcomes with a

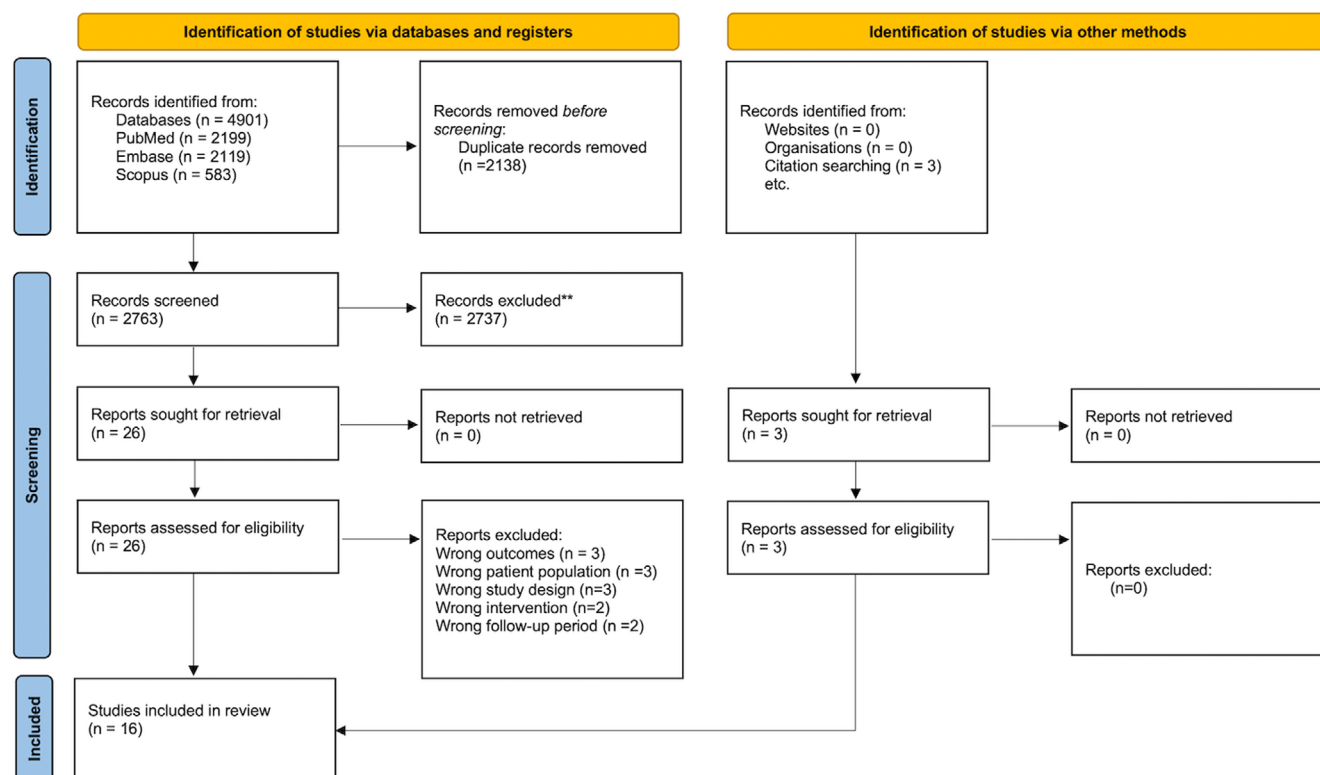


FIGURE 1 Flowchart summarizing the results of the selection process.

TABLE 1 Methodological characteristics of the included studies.

References	Study design follow-up settings	Test intervention	Control intervention	Sites treated graft characteristics	Sample baseline/ final age (mean ± SD or range) sex (% females) smoking status	Situation of the buccal bone Implant position in relation to the buccal bone	Gap fill/GBR	Soft tissue characteristics periodontal phenotype/biotype	Type of definitive prosthesis
[28]	RCT (parallel) 24 months University	Flapless IIP and immediate loading with subepithelial CTG using the partial thickness tunnel technique in the buccal area	Flapless IIP and immediate loading without the CTG	Incisors, canines & premolars De-epithelialized free graft from the posterior palate (1-2 mm thick)	T: 24/24, C: 24/23 47.5. (22-70) years 53.2% females 4.2% light smokers	Intact socket walls (78.7%) Dehiscence <3 mm (14.9%) Apical fenestration (6.4%). *Data presented together for test and control Implant position in relation to the buccal bone NR	DBBM (T & C) No GBR	No Bs papilla defect No recession at time of extraction Phenotype/biotype NR	NR
[22,26,27]	RCT (parallel) 12 months University	Flapless IIP and immediate loading with subepithelial CTG using the envelope technique in the buccal area	Flapless IIP and immediate loading without the CTG	Incisors, canines & 1st Premolars CTG from the tuberosity	T: 30/29, C 30/25 T: 45 (19.5-67.8) years C: 47.8 (20.9-82.2) years T: 46.6%, C: 43.3% females 0% smokers	Intact, <5 mm from the mucosal margin (100%) Implants placed 3 mm apical to the mucosal margin	1:1 mix of autologous + DBBM (T & C) No GBR	Complete papilla in 48.3% patients at Bs Distance from the CEJ of adjacent teeth to the facial wall <5 mm T: Thin 66.7%; Thick: 33.3% C: Thin 50%; Thick: 50%	If screw access hole was palatal, a screw-retained implant crown was fabricated by means of a veneered zirconia abutment. If the location of the screw access hole did not allow for a screw-retained implant crown, a customized zirconia abutment was fabricated, and a veneered zirconia crown was cemented

[23] (same investigation than [22])	RCT (parallel) 60 months University	Flapless IIP and immediate loading with subepithelial CTG using the envelope technique in the buccal area	Flapless IIP and immediate loading without the CTG	Incisors, canines & 1st Premolars CTG from the tuberosity	T: 30/27, C 30/27 T: 45 (19.5-67.8) years C: 47.8 (20.9-82.2) years T: 46.6%, C: 43.3% females 0% smokers	Intact, < 5 mm from the mucosal margin (100%) Implants placed 3 mm apical to the mucosal margin	1:1 mix of autologous + DBBM (T & C) No GBR	Complete papilla in 48.3% patients at Bs Distance from the CEJ of adjacent teeth to the facial wall <5 mm	If screw access hole was palatal, a screw-retained implant crown was fabricated by means of a veneered zirconia abutment. If the location of the screw access hole did not allow for a screw-retained implant crown, a customized zirconia abutment was fabricated, and a veneered zirconia crown was cemented
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TABLE 1 (Continued)

References	Study design follow-up settings	Test intervention	Control intervention	Sites treated graft characteristics	Sample baseline/ final age (mean $\pm$ SD or range) sex (% females) smoking status	Situation of the buccal bone Implant position in relation to the buccal bone	Gap fill/GBR	Soft tissue characteristics periodontal phenotype/biotype	Type of definitive prosthesis
[29]	RCT (parallel) 12 months University	Flapless IIP and immediate loading with subepithelial CTG using the envelope technique in the buccal area	Flapless IIP and immediate loading without the CTG	Incisors, canines & 1st Premolars CTG from the posterior palate using a single incision (1.5 mm thick)	T: 10/10. C: 10/10 52.6. (27–87) years 64% females 0% smokers	Intact socket walls (100%) Implants placed 3 mm apical to the mucosal margin	DBBM (T & C) No GBR	Soft tissue characteristics were NR T: Thick 100% C: Thin 30%; Thick: 70%	A customized zirconia abutment was fabricated, and a veneered zirconia crown was cemented
[24,25]	RCT (parallel) 12 months Private	Flapless IIP with a porcine ADM using the envelope technique in the labial area (no immediate loading). Loading was performed with the definitive restoration at 3 months	Flapless IIP with subepithelial CTG using the envelope technique in the labial area (no immediate loading). Loading was performed with the definitive restoration at 3 months	Incisors & canines T: 2 mm thick porcine ADM C: Free gingival graft from the posterior palate (3 mm thick)	T: 10/10. C: 10/10 T: 48.5 (33–71) years C: 49.4 (21–72) years T: 50% C: 40% females T: 10% C: 20% smokers	Intact socket walls (100%) Implant position in relation to the buccal bone NR	Combination of 90% DBBM + 10% collagen (T&C) No GBR	No soft tissue recession was part of the inclusion criteria T: Thin 20%; Thick 80% C: Thin 40%; Thick: 60%	Zirconia abutments luted to a titanium base and all-ceramic single-crowns
[30]	CCT 12 months University	Flapped IIP with simultaneous GBR and a CTG (no immediate loading). Loading was performed with the definitive or provisional restoration at 3 months	Flapped IIP with simultaneous GBR and without a CTG (no immediate loading). Loading was performed with the definitive or provisional restoration at 3 months	Incisors, canines & 1st Premolars CTG from the posterior palate using a single incision (1 mm thick)	T: 21/14. C: 20/12 T: 51.6 ($\pm$ 14.5) years C: 61.6 ($\pm$ 14.5) years % females NR % smokers NR (Exclusion >10 cig/day)	Intact socket walls, including fenestration or dehiscence <3 mm Implants placed 3–4 mm apical to the mucosal margin	Freeze-dried bone allograft + resorbable collagen membrane (T&C) GBR	Soft tissue characteristics were NR T: 100% thin C: 100% thick *Decision to allocate a patient to the T or C group was based on phenotype	Left to the discretion of the referral restorative dentist
[31]	RCT (parallel) 12 months Private	Flapless IIP and immediate loading with a porcine ADM using the envelope technique in the buccal area	Flapless IIP and immediate loading with a subepithelial CTG using the envelope technique in the buccal area	Incisors & canines T: Porcine ADM C: CTG from the tuberosity	T: 23/NR. C: 22/NR (*5 patients were lost in total) T: 41 (29–66) years C: 39 (26–60) years T: 52% C: 59.1% females % smokers NR (Exclusion ≥ 10 cig/day)	Intact socket walls, including buccal bone loss $\leq 1/3$ Implants placed 4 mm apical to the mucosal margin	Cancellous bone allograft No GBR	No recession at time of extraction No periodontal bone loss of neighboring anterior teeth T: Thin 47.5%; Thick 52.5% C: Thin 59.1%; Thick: 40.9%	Screw-retained zirconia-based restoration with ceramic veneering on a 1.5-mm titanium base

TABLE 1 (Continued)

References	Study design follow-up settings	Test intervention	Control intervention	Sites treated graft characteristics	Sample baseline/ final age (mean $\pm$ SD or range) sex (% females) smoking status	Situation of the buccal bone Implant position in relation to the buccal bone	Gap fill/GBR	Soft tissue characteristics periodontal phenotype/biotype	Type of definitive prosthesis
[32]	RCT (parallel) 12 months Private	Flapless IIP with a CTG using the partial thickness tunnel technique in the buccal area (no immediate loading). Customized healing abutments were kept for 12 months	Flapless IIP without a CTG (no immediate loading). Customized healing abutments were kept for 12 months	Incisors, canines & premolars CTG from the posterior palate using a single incision (1.5 mm thick)	T: 15/15. C: 15/15 T: 36.7 ($\pm$ 9.5) years C: 35.07 ($\pm$ 8.09) years T: 86. C: 93% females 0% smokers	Intact socket wall 1.5 mm subcrestally or equirecristal to the buccal bone (3–4 mm apical to the mucosal margin)	T: no gap fill C: DBBM No GBR	Soft tissue characteristics were reported. NR No periodontal bone loss of neighboring anterior teeth Thick 100% (T & C)	Cemented crown. Materials were no reported.
[33]	Multicentre RCT (parallel) 12 months Private	Flapless IIP and immediate loading with subepithelial CTG using the partial thickness tunnel technique in the buccal area	Flapless IIP and immediate loading without the CTG. A xenograft was used to fill both, the bone, and soft tissue zones till the free gingival margin level	Incisors, canines & premolars CTG from the posterior palate or tuberosity de-epithelialized (1 mm thick)	T: 31/30. C: 28/27 T: 47.68 ($\pm$ 16.5) years C: 51.07 ($\pm$ 14.67) years T: 45.2% C: 78.6% females T: 32.3% C: 14.3% smokers	Intact socket walls, including dehiscence $\leq$ 1 mm Subcrestal placement T: -1.1 mm; C: -1.39 mm	DBBM (T & C) No GBR	No recession at time of extraction Phenotype /biotype NR	Final crowns were either made with monolithic zirconia; porcelain fused to metal or porcelain fused to zirconia, left to the discretion of the restorative dentist
[34]	RCT (parallel 3 arms) 12 months University	T1: Flapless IIP with a CTG using the partial thickness tunnel technique in the buccal area (no immediate loading). Loading at 6 months T2: Flapless IIP with a human ADM using the partial thickness tunnel technique in the buccal area (no immediate loading). Loading at 6 months	Flapless IIP without soft tissue grafting (no immediate loading). Loading at 6 months	Incisors, canines & premolars T1: CTG from the posterior (1–1.5 mm thick) T2: human ADM (0.9–1.6 mm thick)	T1: 15/14. T2: 15/14. C: 16/15 T1: 61.53 $\pm$ 9.81 years T2: 63.53 $\pm$ 13.16 years C: 58.88 $\pm$ 11.55 years T1: 47%. T2: 53%. C: 756% females T1: 6.7%. T2: 0%. C: 25% smokers	Intact socket wall. A dehiscence ($\leq$ 3 mm in width, not present in the middle region of the buccal wall) or fenestration ($\leq$ 3 mm in diameter) was allowed Implants placed 1 mm subcrestally	DBBM (T1, T2 & C) No GBR	Soft tissue recession $\leq$ 2 mm Interproximal bone levels should be $\leq$ 4 mm from the CEJ Phenotype /biotype NR	NR
[20]	RCT (parallel) 12 months University	Flapless IIP and immediate loading with a porcine ADM using the envelope technique in the buccal area	Flapless IIP and immediate loading without the porcine ADM	Incisors, premolars and mandibular premolars T: Porcine ADM	T: 10/10. C: 10/10 T: 45.2 ($\pm$ 10.3) years C: 51.8 ($\pm$ 14.3) years T: 50% / C: 50% females 0% smokers	Intact socket walls or compromised buccal bone (T: 40%; C: 10%) Implants placed 1–2 mm below the most coronal palatal bone peak	Cancellous bone allograft No GBR	Soft tissue characteristics were NR Phenotype /biotype NR	Metal-ceramic crowns

(Continues)

TABLE 1 (Continued)

References	Study design follow-up settings	Test intervention	Control intervention	Sites treated graft characteristics	Sample baseline/ final age (mean $\pm$ SD or range) sex (% females) smoking status	Situation of the buccal bone Implant position in relation to the buccal bone	Gap fill/GBR	Soft tissue characteristics periodontal phenotype/biotype	Type of definitive prosthesis
[19] (same research than [20])	RCT (parallel) 36 months University	Flapless IIP and immediate loading with a porcine ADM using the envelope technique in the buccal area	Flapless IIP and immediate loading without the porcine ADM	Incisors, premolars and mandibular premolars T: Porcine ADM	T: 10/10. C: 10/10 T: 45.2 ($\pm$ 10.3) years C: 51.8 ($\pm$ 14.3) years T: 50% / C: 50% females 0% smokers	Intact socket walls or compromised buccal bone (T: 40%; C: 10%) Implants placed 1–2 mm below the most coronal palatal bone peak	Cancellous bone allograft No GBR	Soft tissue characteristics were NR Phenotype /biotype NR	Metal-ceramic crowns
[21]	RCT (parallel) 12 months University	Flapless IIP with a CTG, Customized healing abutments were kept for 4 months	Flapless IIP without the CTG. Customized healing abutments were kept for 4 months	Incisors, canines & Premolars CTG from the posterior palate using a single incision	T: 16/16. C: 16/16 T: 44 (23–65) years C: 51 (37–69) years T: 81% C: 50% females 0% smokers	Intact socket walls Implant position in relation to the buccal bone NR	DBBM (T & C) No GBR	Soft tissue characteristics were NR T: Thin 56%; Thick: 44% C: Thin 50%; Thick: 50%	Screw-retained all-ceramic crown and a customized titanium abutment

Abbreviations: ADM, acellular dermal matrix; Bs, baseline; C, control; CEJ, cemento-enamel junction; CTG, connective tissue graft; DBBM, deproteinized bovine bone mineral; GBR, guided bone regeneration; IIP, immediate implant placement; NR, not reported; RCT, randomized controlled trial; T, test.

follow-up period of 12 months. The remaining articles reported results at 24 months [28], 36 months [19], and 60 months [23].

Four studies evaluated an IIP procedure with immediate loading, comparing a connective tissue graft (CTG) to the same procedure without soft tissue augmentation [22,28,29,33], while two studies evaluated the same comparison but using custom healing abutments for 1 year [21,32]. Two studies evaluated an IIP procedure comparing an acellular dermal matrix (ADM) with a CTG, one with immediate loading [31] and the other with delayed loading 3 months after surgery [24,25]. The three-arm study compared an IIP procedure with immediate loading and a CTG, an ADM, or without soft tissue augmentation [34]. One study compared an IIP procedure with immediate loading and ADM with the same procedure but without ADM [20]. Nine out of ten included trials placed flapless immediate implants. The exception was one study that compared flapped IIP with simultaneous GBR and CTG (no immediate loading) to the same procedure without soft tissue augmentation [30].

In five studies [21,22,25,29,32], intact socket walls were always a prerequisite, while the remaining allowed different degrees of buccal dehiscence and/or fenestration. Most studies placed the implants at a distance of 3–4 mm from the level of the mucosal margin and/or 1–2 mm subcrestally. All but one study [32] filled the remaining gap with either deproteinized bovine bone mineral (DBBM) or an allograft in both the test and control groups. In the study by Fettouh et al. [32], patients in the test group received a CTG without gap filling, and patients in the control group did not receive the CTG, but gaps were filled with DBBM.

Most studies that reported baseline soft tissue characteristics included teeth that exhibited no soft tissue recession at the time of extraction. The periodontal phenotype was reported in seven investigations, five of which included both thin and thick phenotypes [21,22,25,29,31]. One study included only thick phenotypes [32], while another employed a test procedure in patients with a thin phenotype and a control treatment in patients with a thick phenotype/biotype [30].

The final restorations were reported to have been fabricated as screw-retained or cemented implant crowns, with a veneered zirconia abutment [22,25,29,31] or as metal-ceramic crowns [20,21]. In two studies, the decision regarding the type of crown fabrication was left to the discretion of the referral restorative dentist [30,33]. In one study, cemented crowns were employed, yet the material utilized was not disclosed [32]. It is notable that none of the studies provided information regarding the transmucosal shape or emergence angle of the prosthesis. Only one study reported the height of the abutment, noting that 1.5 mm Ti-bases were utilized [31]. Another study indicated that the height was at the discretion of the restorative dentist [30]. Table 2 reports the outcomes evaluated in each individual manuscript.

3.3 | Risk of bias in individual studies

Of the 15 RCTs included in this systematic review, six were deemed to have a low risk of bias [22,23,27,28,31,32,34]. The remaining studies

TABLE 2 Outcomes evaluated in each study.

References	Outcomes assessed
[28]	PES, complications, soft tissue recession (crown length in clinical pictures), KM width, soft tissue thickness, MBL, plaque levels, BOP, PD, papilla level
[22]	PES, patient satisfaction (VAS, OHIP-14), complications, soft tissue recession (crown length in clinical pictures), KM (absence, 1–2 mm, >2 mm), MBL, plaque level, GI, PD, papilla level
[26]	PES, patient satisfaction (VAS), complications, soft tissue recession (crown length in clinical pictures), soft tissue thickness, linear and volumetric ridge changes, plaque levels, gingival index, PD, biological complications (mucositis), biological complications (peri-implantitis)
[27]	Soft tissue recession (crown length in clinical pictures), MBL, CBCT (buccal bone thickness)
[23]	PES, patient satisfaction, complications, soft tissue recession (crown length in clinical pictures), MBL, PD, papilla level, BOP
[29]	Complications, soft tissue recession (study cast with a customized stent), MBL, plaque levels, GI, papilla level, biological complications (mucositis)
[24]	PES, color, complications
[25]	PROMs (VAS), complications, linear and volumetric ridge changes
[30]	PES, soft tissue recession (crown length in clinical pictures), MBL, plaque levels, mSBI, PD, papilla level
[31]	PES, complications, MBL
[32]	PES, PROMs (VAS), complications, soft tissue recession (STL files), volumetric ridge changes, CBCT (buccal bone thickness, bone width), plaque levels, BOP, papilla level
[33]	ICAI, complications, plaque levels, BOP, papilla level
[34]	Soft tissue recession (customized stent), complications, KM width, soft tissue thickness, MBL, ridge changes
[20]	PES, complications, KM width, MBL, volumetric ridge changes
[19]	PES, complications, KM width, MBL
[21]	Complications, biological and technical complications, soft tissue recession (STL files), papilla level, volumetric ridge changes, PROMs (VAS-pain)

exhibited at least one potential concern in one of the five domains evaluated. The included CCT was rated as having a serious risk of bias [30]. A summary of the results of the risk of bias assessment for RCTs and CCTs is presented in Figures 2 and 3, respectively. The domain with the highest level of uncertainty was domain 5 of the RoB 2, risk of bias in selection of the reported study results. For seven of the included studies [19,20,24,25,28,29,33], the article did not reference a prestudy registration, making it impossible to verify whether the analyses were conducted in accordance with a prespecified plan.

3.4 | Risk of bias across studies

No significant publication bias was observed for the primary outcome measure for mid-facial mucosal recession when considering studies reporting grafting versus no graft [21,22,29,34] ($p > 0.10$). The sensitivity analysis showed that the exclusion of a single study did not substantially alter any estimate.

3.5 | Effects of interventions: Primary outcomes

3.5.1 | PES

Three different clinically assessed esthetic scores were used in the included studies: (i) the Pink Esthetic Score (PES) according to [35],

containing seven items and a score ranging from 0 to 14; (ii) the Pink Esthetic Score (PES)/White Esthetic Score (WES) according to Belser et al. [36], comprising 5 items and a score from 0 to 10 for each of the two components (PES and WES); and (iii) the Implant Crown Esthetic Index (ICAI) as developed by Meijer, Stellingsma, Meijndert, & Raghoobar [37] considering four items regarding the aesthetic of the mucosa (ICAI-mucosa) and five items regarding the aesthetic appearance of the crown separately (ICAI-crown).

Five studies employed the original PES [19,20,25,26,31,32], four the PES/WES [22,23,28,30] and one the ICAI index [33].

Due to the heterogeneity among the scores, data pooling for the different indices was not possible.

However, two meta-analyses were conducted for the PES. The first meta-analysis permitted the comparison of grafting (either with a CTG or a xenograft) versus no graft, demonstrating no significant differences between groups ($n=2$, WMD = -0.27 ; 95% CI $(-0.95, 0.41)$; $I^2=0.0\%$; $p=0.546$; Figure 4). The other meta-analysis focused on the comparison between grafting with a CTG versus a xenograft, with no significant differences among these interventions ($n=2$, WMD = -0.14 mm; 95% CI $(-1.60, 1.32)$; $I^2=74.3\%$; $p=0.049$, Figure 5). Most studies did not present the data for the individual items of the index. Of those that did, only [26] identified significant differences between interventions, with better results observed for sites where a CTG was placed for the mucosal margin item and significantly worse results for the 'texture' item.

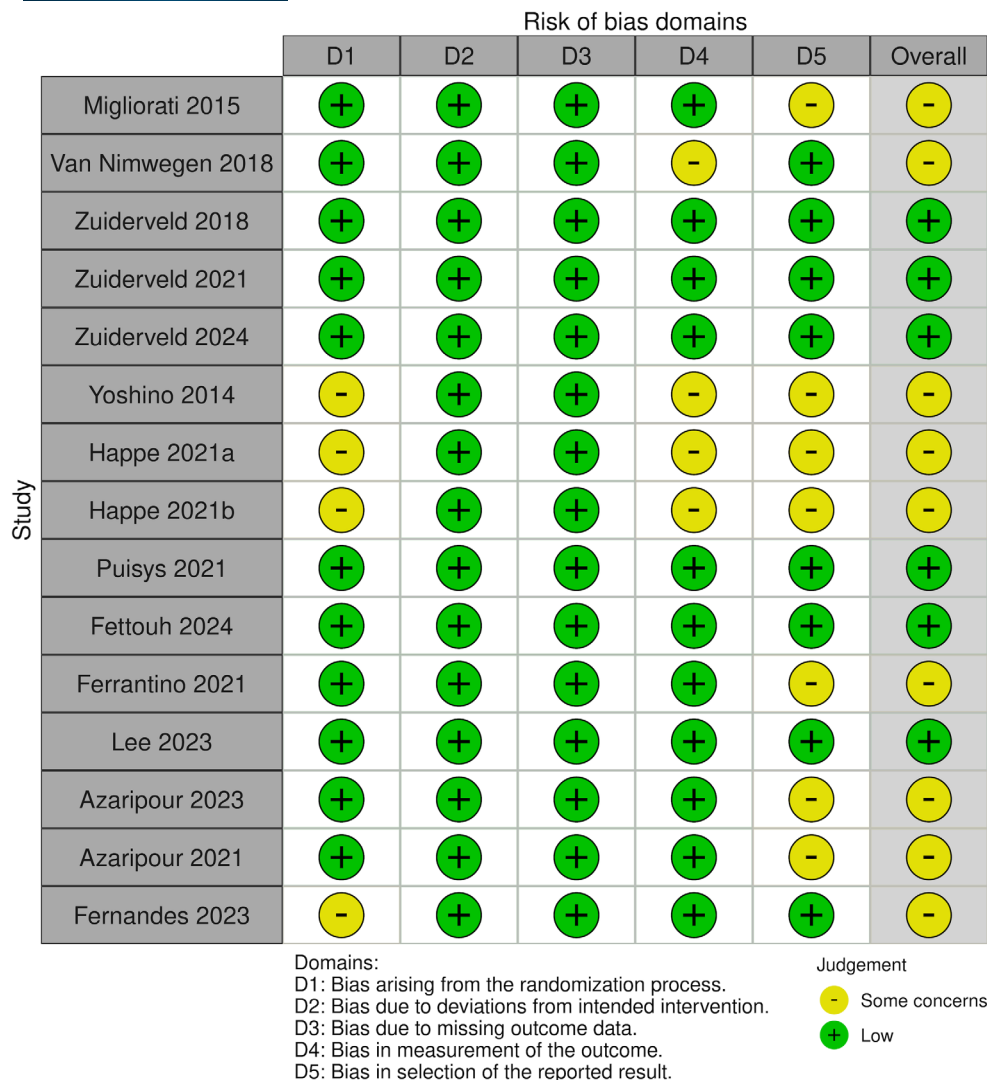


FIGURE 2 Risk of bias analysis for randomized clinical trials.

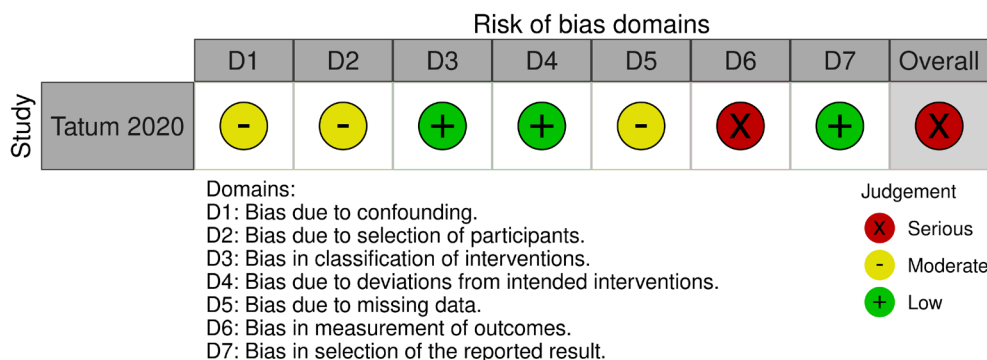


FIGURE 3 Risk of bias analysis for controlled clinical trials.

For the PES/WES score a meta-analysis could not be performed due to the following reasons: (i) Migliorati et al. [28] did not report the data as means for each intervention group, but as the percentage of cases in

each group with a score over specific thresholds; (ii) Tatum et al. [30] is a CCT, and the interventions were not randomized (CTGs were applied only to patients with a thin phenotype); and (iii) Zuiderveld et al. [23]

reported data at 60 months. Among the studies evaluating this index, the only one reporting superior aesthetic results for the test group was [28]. The other reports did not prove any difference between the intervention groups, regardless of the periodontal/peri-implant phenotype.

For the ICAI or the ICAI-mucosa index, no significant differences between groups were found. However, the ICAI-crown demonstrated a statistically significant advantage for the test group (use of a CTG).

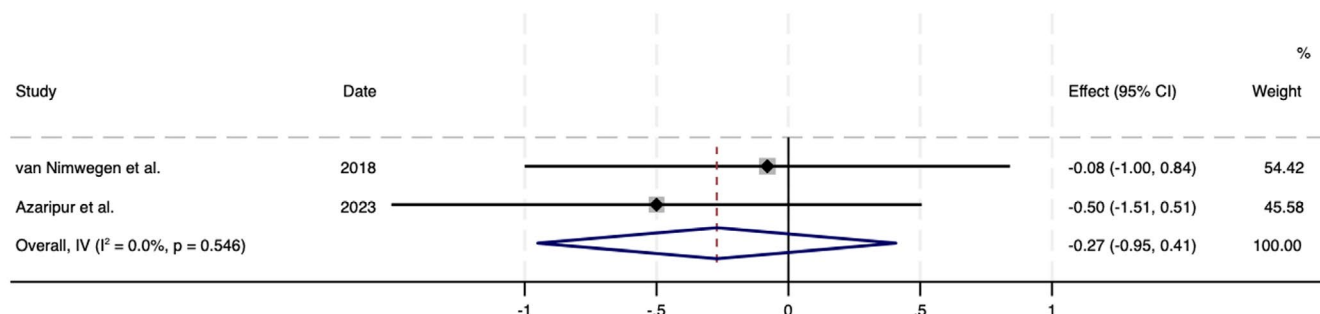


FIGURE 4 Fixed effect meta-analysis for pink aesthetic score comparing immediate implant placement with grafting (either with a CTG or a xenograft) versus immediate implant placement with no graft.

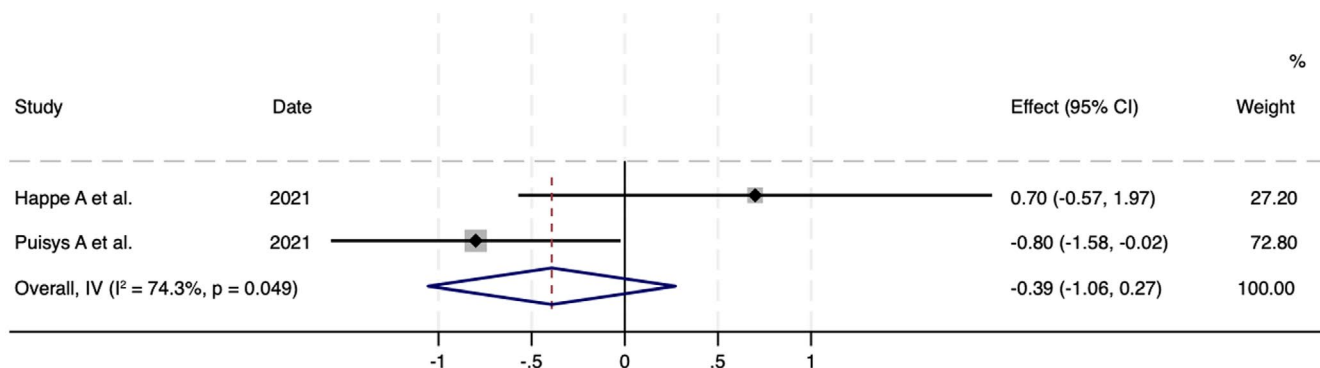


FIGURE 5 Random-effect meta-analysis for pink aesthetic score comparing immediate implant placement with a CTG versus immediate implant placement with a xenograft.

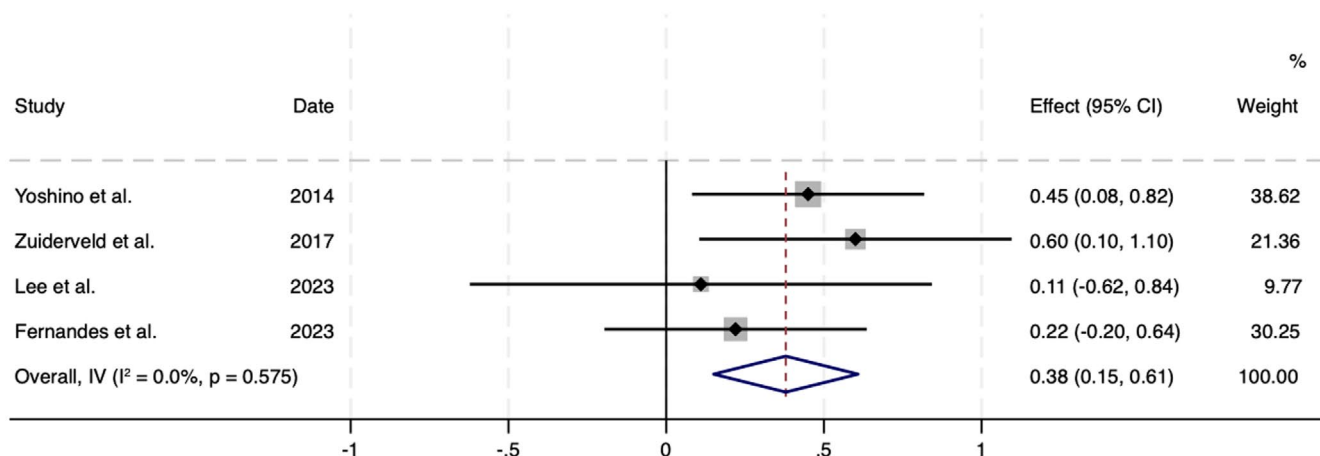


FIGURE 6 Fixed-effect meta-analysis for soft tissue recession comparing immediate implant placement with a CTG versus immediate implant placement with no graft at 12 months.

In summary, the studies yielded positive aesthetic results, with approximately 20% of cases demonstrating acceptable or sufficient outcomes. There were only a few cases with unsatisfactory aesthetic results, representing less than 10% of the total.

3.5.2 | Soft tissue recession

The change in the level of the mid-buccal mucosa was used to assess soft-tissue recession in 11 manuscripts. In all but one case, the reference point for the change in mid-buccal mucosal recession was the position prior to extraction. It was evaluated using a variety of methods, including standardized photographs, STL file superimposition, or customized stents.

A meta-analysis combining 149 implants from four investigations, including [21,22,29,34], was conducted based on the presentation of similar intervention groups (connective tissue graft versus no graft) and follow-ups (12 months). The results demonstrated that the simultaneous placement of a CTG with immediate implant placement resulted in a statistically significant reduction in soft tissue recession. The weighted mean difference (WMD) was 0.38 mm, with a 95% confidence interval (CI) of (0.15, 0.61) and an I^2 statistic of 0.0% ($p = 0.575$) (Figure 6).

Even though the general term "soft tissue recession" was used within the manuscript, it must be highlighted that it was assessed heterogeneously. Table 2 shows how this outcome was assessed in each individual study.

In summary, the simultaneous grafting of connective tissue with immediate implant placement resulted in a slight reduction in the change in position of the mucosal margin (approximately 0.5 mm), with these results being sustained over time. While these discrepancies may be deemed clinically inconsequential, the two studies that delineated subgroups based on the baseline periodontal phenotype (i.e., thin or thick) [28,30] reported more favorable outcomes for grafting, particularly in thin phenotypes. The only study to assess the impact of an acellular dermal matrix reported the less favorable outcomes for this group in comparison to the control [34].

3.5.3 | Papilla level

The level of the interproximal papilla was evaluated in several different ways in eight studies. Unfortunately, the data could not be combined into a meta-analysis due to significant heterogeneity in the measurement and reporting methods. Three studies employed the papilla index [38], demonstrating that by the conclusion of the study, a greater number of sites exhibited full papilla filling [22,29,33]. Furthermore, the height of the papilla was quantified in photographic images in three studies. One study indicated an increase in papilla height of between 0.2 and 0.5 mm [28], while two other studies demonstrated a reduction in papilla height of between 0.2 and 0.95 mm [23,30]. Finally, two studies evaluated interdental papilla height through the superimposition of STL files. One study indicated

a loss of tissue between 0.66 and 0.86 mm [32], while the other study reported a loss between 0.07 and 0.38 mm [21]. No significant differences were observed between the mesial and distal papillae. However, one study reported significant differences among patients with thin or thick biotypes (assessed by probe visibility through the sulcus), with the latter (those not receiving any soft tissue augmentation procedure) exhibiting a loss of papilla height four times greater at three months and five times greater at 12 months [30]. No differences between groups were reported by any other included study.

3.5.4 | Patient satisfaction

Patient satisfaction was assessed in different ways and with different questionnaires in four studies, so data could not be pooled into a meta-analysis. The level of patient satisfaction with regard to general satisfaction, aesthetic outcomes, and the treatment procedure was assessed in one article, which demonstrated comparable and positive results in both groups [22]. Two additional articles from the same investigation demonstrated that overall satisfaction (0 to 10) was high and comparable in both groups at one- (8.37 in the test and 8.7 in the control) and five-year (9.4 in the test and 8.7 in the control) post-treatment intervals [23,26]. Additionally, a single study encompassed general satisfaction, aesthetic satisfaction, and queries pertaining to function, complications, and cost, demonstrating that all patients were markedly satisfied irrespective of the treatment group (the overall satisfaction rating for CTG was 100%, while ADM and the control group received ratings of 91% and 86%, respectively) [34].

3.6 | Effects of interventions: Secondary outcome

3.6.1 | Postoperative morbidity and complications

The assessment of complications related to osseointegration, healing, and/or prosthesis was conducted in all publications except two [27,30,32,34]. Overall, the incidence of complications was low or negligible (0%–5% in most of the studies). Four implants were lost during osseointegration, four patients exhibited delayed healing without any adverse consequences, and two provisional restorations experienced mechanical complications.

Aesthetic complications were assessed in 4 studies. One study reported that suboptimal aesthetic results using the PES were achieved in 17.3% and 0% of the implants in the control and test groups, respectively [28]. Three studies reported the percentage of cases with midfacial recession over different thresholds. One of them reported that two of 25 patients (8%) displayed advanced cases of mid-facial mucosa recession (≥ 1 mm) in the test group against eight of 25 patients (32%) in the control group [26]. Also, one study reported that the prevalence of having > 1 mm mid-buccal peri-implant mucosal recession was 7.14%, 20%, and 7.14% in the immediate implant + CTG, immediate implant + ADM, and immediate implant without graft,

respectively [34]. Another study reported that midfacial recession was >1.3 mm in one patient presenting a thick phenotype and three patients presenting a thin phenotype [30].

Three studies evaluated self-reported pain following surgery using the visual analogue scale (VAS). One study demonstrated that patients who received a CTG experienced greater pain in comparison to an ADM one (4.0 vs. 1.3, for CTG and ADM groups, respectively) and two weeks (0.5 vs. 0.0, for CTG and ADM groups, respectively) after implant placement [24]. In contrast, another study did not identify any significant difference in pain perception (0 to 100) when comparing IIP with or without a CTG (40 vs. 37 at 3 days, and 6 vs. 4 at 7 days, for test and control groups, respectively) [32]. Moreover, another study reported similar levels of pain perception (0–10) when comparing IIP with or without a CTG and a customized healing abutment at 2 and 10 days (2.38 vs. 2.00 and 0.19 vs. 0.13, for test and control groups, respectively) [21].

3.6.2 | Other patient-reported outcome measures (PROMs)

The assessment of PROMs that are distinct from patient satisfaction or self-reported pain was conducted in one study, which reported that the aggregate score for the Oral Health Impact Profile (OHIP-14) questionnaire did not demonstrate notable discrepancies between the groups. Intragroup comparisons revealed a statistically significant enhancement in satisfaction between T0 (prior to extraction) and T1 (one month following the placement of a definitive crown) [22].

3.6.3 | Keratinized tissue changes

The change in the width of keratinized mucosa was assessed in four publications. Two studies demonstrated slight reductions in the width of KM at the conclusion of the study, with no discernible differences between groups [28,34]. Conversely, two publications from the same investigation exhibited stable values over time [19,20].

3.6.4 | Soft tissue thickness changes

The thickness of buccal soft tissue was evaluated in two studies employing an endodontic file. The findings of one study indicated that patients who received a CTG exhibited an increase of 0.4 mm, whereas patients who did not receive it demonstrated a decrease of 0.2 mm two years after therapy [28]. Similarly, the other study demonstrated that patients who received a CTG or an ADM exhibited an increase of 0.8 mm in soft tissue thickness, whereas patients who did not undergo soft tissue augmentation demonstrated a thickness that was comparable to the baseline measurement [34].

3.6.5 | Interproximal marginal bone levels changes

Interproximal marginal bone levels were assessed in periapical x-rays in ten studies. Five manuscripts reported marginal bone levels combining measurements for mesial and distal sites [19,20,27–29], and 6 studies reported the data separately for mesial and distal sites [22,23,28,30,31,34].

Since some studies reported data as medians and interquartile ranges (IQRs) [22,31] instead of means and standard deviations (SDs), it was not possible to perform any meta-analysis.

In summary, marginal bone loss was lower than 0.5 mm in most of the studies at the end of the follow-up period (ranging from 12 to 60 months), with two studies even reporting bone level gains around ≈0.1 mm from crown placement or 1 month later to the last observation [23,31]. No relevant differences between study groups were reported in any investigation.

3.6.6 | Dimensional changes on the alveolar bone, assessed on CBCTs

Two studies superimposed baseline CBCTs before tooth extraction and another one taken at the end of the study. One of the studies demonstrated that the mean buccal bone thickness reduction was significantly greater in the group that received the CTG compared to the group that did not (−0.84 mm vs. −0.46 mm) [27]. Another study reported that the bucco-palatal bone reduction was similar in patients receiving a CTG as compared to the control group without the soft tissue augmentation at 0 and 2 mm from the buccal bone crest. Nevertheless, at a depth of 5 mm, the test group exhibited significantly greater bone reductions, as well as vertical crestal bone-level changes of −1.1 mm compared to the control group's −0.2 mm [32].

3.6.7 | Ridge contour changes

A total of seven articles superimposed STL files in the context of tooth extraction, with assessments conducted both prior to the procedure and at the conclusion of the follow-up period. Unfortunately, the data could not be combined into a meta-analysis due to significant heterogeneity in the measurement and reporting methods.

Five studies evaluated volumetric changes in a selected area of interest. One study demonstrated that implants treated with CTG exhibited reduced volume loss in comparison to those not receiving CTG, with a mean difference of −15.6 mm³ versus −36.04 mm³ [32]. Conversely, two studies reported comparable volume loss between groups, one of them with a mean difference of −9.32 mm³ for CTG versus −7.77 mm³ for the control [26] and the other with a mean difference of −6.71 mm³ for CTG versus −8.36 mm³ for the control group [21]. A comparative study of ADM and CTG demonstrated comparable volume loss, with a mean of −27.70 mm³ for ADM and −18.30 mm³ for CTG [24]. Finally, a single study compared ADM to a control group

without soft tissue augmentation and found similar volume loss at 12 months (6.21 mm³ for ADM vs. 7.31 mm³ without ADM) [20].

The linear buccal contour dimensional changes were evaluated in three studies. No meta-analyses could be performed due to the heterogeneity in treatment protocols and study design. One study demonstrated that the reduction in ridge contours was comparable between a CTG and a control group without it (−0.68 and −0.49 mm, respectively) [26]. Similarly, another study showed that the reduction in ridge contours was 0.55 and 0.60 mm, respectively, in the ADM and CTG groups [24]. In contrast, another study demonstrated that reductions in buccal contours were significantly greater for the group not receiving soft tissue augmentation, at a distance of 3 mm or below from the initial soft tissue margin, in comparison to the CTG of the ADM groups [34].

3.6.8 | Plaque indexes

A total of seven studies evaluated the extent of dental plaque accumulation. These studies employed a range of indices and reported the findings in a variety of ways. This made it impossible to combine the data.

The indices used included the modified plaque index [39], which was utilized in five studies [22,26,28–30], the full mouth plaque score [40], which was employed in one study [32], and the plaque index from [41], which was employed in another [33]. Overall, the studies demonstrated that plaque levels remained relatively low throughout the observation period.

3.6.9 | Peri-implant tissue health status, including probing depth (PD), bleeding on probing (BoP) and incidence of biological complications (peri-implant mucositis or peri-implantitis, based on specified diagnostic criteria)

The health status of the peri-implant area was evaluated in a variety of ways, using several indices, and reporting the results

differently. This made it impossible to combine the data in different meta-analyses. The probing depth was evaluated in five studies, all of which demonstrated consistent values over time with minimal fluctuations. The mean values at the conclusion of the study ranged from 2 to 3.2 mm [22,23,26,28,30].

The evaluation of soft tissue inflammation was conducted using either a gingival or bleeding index in five studies [22,26,29,30,33]. In two studies, the assessment of inflammation was based on BoP [23,28]. Additionally, one study employed a full mouth bleeding score [32]. Overall, the levels of inflammation were observed to be relatively low, with the majority of the mean values falling below 0.5 for gingival indices and below 15% for bleeding scores.

The occurrence of biological complications, as defined by a specific peri-implant mucositis or peri-implantitis criteria, was not documented in any of the included studies. However, three studies from the same investigation reported the percentage of patients presenting no bleeding at all, a spot-like punctual bleeding, or confluent lines of bleeding [22,23,26]. Furthermore, a study reported that GI scores of 0 were observed in 70% of the test patients and 100% of the control patients [29]. Additionally, another study demonstrated that at 12 months, no bleeding was evident in 76.6% of the test patients and 63% of the control patients [33]. Finally, one study reported that none of the implants presented biological complications [21].

3.7 | Quality of evidence

The quality of evidence and confidence in the results are presented in Table 3. Looking at the impact on professional aesthetic scores, the quality of evidence was very low due to the risk of bias (at least one of the studies considered presented an unclear risk of bias), inconsistency (i.e., variability of results across studies) and imprecision (i.e., uncertainty due to wide CI). Looking at marginal soft tissue recession, the quality of evidence was low due to the risk of bias of the included studies and inconsistency.

TABLE 3 Summary of findings using the grading of recommendation assessment, development, and evaluation (GRADE) approach.

Outcome	Study results and comparison	Number of patients (studies)	Certainty of evidence
Professional aesthetic scores	Graft vs. No-graft (WMD = −0.27; 95% CI −0.95, 0.41) CTG vs. Xenograft (WMD = −0.14 mm; 95% CI −1.60, 1.32)	70 (2 RCTs) 65 (2 RCTs)	VERY LOW due to risk of bias, inconsistency and imprecision VERY LOW due to risk of bias, inconsistency and imprecision
Soft tissue recession	CTG vs. No-graft (WMD = 0.38 mm; 95% CI 0.15, 0.61)	149 (4 RCTs)	LOW due to risk of bias and inconsistency

Note: Patient or population: Patients requiring single tooth replacement in the premolar-to-premolar area, with an indication for IIP. **Setting:** University/private clinics. **Intervention:** Any type of surgical procedure to increase soft tissue thickness/height during IIP. **Control:** No augmentation during IIP (PICOS 1) or any other soft tissue augmentation technique or procedure (PICOS 2). **Outcomes:** Professional Aesthetic Scores, Soft tissue recession.

Abbreviations: CTG, connective tissue graft; IIP, immediate implant placement; RCT, randomized clinical trial; WMD, weighted mean difference.

4 | DISCUSSION

The objective of this systematic review was to evaluate the impact of soft tissue augmentation techniques as an adjunct to IIP on aesthetic outcomes and PROMs. The results demonstrated that soft tissue augmentation did not significantly impact the overall professional aesthetic scores or patient-reported outcomes regarding the aesthetic results. The meta-analyses showed that CTG is beneficial in reducing the risk of mid-facial recession. The general aesthetic satisfaction among both professionals and patients remained high across the included studies, which highlights the efficacy of immediate implant procedures in favorable and well-selected cases.

4.1 | Clinician-assessed aesthetic outcomes (primary variable)

The clinician-assessed aesthetic outcomes, evaluated using indices such as PES according to Furhauser et al. [35] or Belser et al. [36], yielded favorable results across all included studies, with the majority of the cases achieving high aesthetic standards. The results of the meta-analysis, based on a limited number of studies, showed no significant differences between the use of soft tissue augmentation (either CTG or acellular dermal matrix, ADM) and control groups in both short- and long-term follow-ups. This suggests that while soft tissue augmentation may enhance mid-facial soft tissue stability, its overall effect on aesthetic outcomes is limited and may not justify the added complexity or morbidity of grafting in every case.

It should be noted that most of the included studies employed flapless implant placement in sites without significant baseline soft tissue discrepancies. Furthermore, most of the studies placed anatomical provisional crowns or abutments immediately, which supported transmucosal soft tissues. This likely contributed to the positive aesthetic outcomes, as previously suggested by some authors [42,43]. These findings are in line with those of previous systematic reviews and recent consensus reports, which indicate that immediate implant procedures can achieve satisfactory aesthetic outcomes under favorable local conditions and strict site and patient selection criteria [7,44]. It is also important to consider the cost-effectiveness and time benefits of immediate implant procedures compared to a delayed approach.

It is regrettable that most of the included studies lacked sufficient detail in their clinician-assessed aesthetic outcomes, as individual items were not reported separately. Consequently, a more comprehensive analysis of the impact of CTG on, for example, soft tissue texture, color, or buccal convexity (horizontal volume) was not feasible. CTG may positively influence the peri-implant soft tissue dimension, particularly the buccal soft tissue profile, as evidenced by the findings of the recent multicenter RCT conducted by [45]. Therefore, the overall score of the clinician-assessed aesthetic outcomes may mitigate any potential differences regarding the individual items of these indexes (e.g. buccal convexity, color, texture, etc.).

4.2 | Mid-facial vertical soft

4.2.1 | Tissue recession and interproximal soft tissue height

Mid-facial vertical soft tissue recession is a critical parameter for assessing the success of IIP in the aesthetic zone [46,47]. The present meta-analyses explored the effect of a CTG in terms of the reduction of soft tissue recessions on the basis of 4 RCTs reporting on 149 implants after an observation period of 12 months [22,29,34]. The results highlighted that the use of CTG in conjunction with IIP was associated with less recession of the mucosal margin when compared to non-grafted sites (mean difference of 0.38 mm). This effect aligns with those of previous meta-analyses on the same topic [9,48], which reported significant mean differences of 0.41 and 0.59 mm, respectively, in favor of soft tissue grafting. Despite the similarities in outcomes, it is important to note that our systematic review specifically focused on clinician- and/or patient-reported aesthetic outcomes, whereas the aforementioned reviews primarily assessed objective measures such as vertical mid-facial soft tissue changes. Furthermore, De Angelis and co-workers included retrospective studies in their analyses, while our review applied stricter inclusion criteria, limiting eligibility to randomized controlled trials and controlled clinical trials. These methodological differences likely account for some discrepancies in the included studies.

Although the mean reduction in midfacial recession observed (0.38 mm) is modest, there are several factors that should be taken into consideration: (i) the upper limit of the 95% CI was 0.61 mm, exceeding the 0.5 mm threshold that has been considered to be perceptible by patients and esthetically relevant in the anterior zone [49] and (ii) another systematic review with meta-analysis on the topic identified that these mean changes in the mid-buccal position of the mucosal margin correlate with a relative risk of 12 to experience an asymmetry ≥ 1 mm in the apico-coronal position of the mucosal margin [48]. Thus, while the absolute values are small, they may hold clinical significance in selected cases, such as in patients with a thin phenotype or high aesthetic demands. Studies that stratified patients by phenotype found greater benefit from STA in thin biotypes [28,30], supporting the notion that phenotype is a critical effect modifier. However, inconsistencies across studies regarding implant positioning, grafting protocols, and gap management limit the strength of these conclusions.

This finding is consistent with the results of previous studies that have demonstrated a correlation between a thin gingival phenotype and a higher incidence of recession following IIP [50,51]. It should be noted that in these studies the remaining socket was not filled with bone substitute. The present review identified two studies [28,30] that advocated an advantage of performing a CTG to reduce the risk of recession in patients with a thin periodontal phenotype. However, in the study of Tatum and co-workers, the buccal socket was also left empty when a CTG was used. Further research is needed to determine the effect of CTG combined with IIP specifically in patients with a thin periodontal phenotype.

It should be noted that none of the studies included in the present review consider the 3D implant positioning (bucco-lingual and vertical position, buccal angulation). This is despite evidence suggesting that this may also be a factor influencing the occurrence of mid-facial recessions [52,53]. Finally, the present review did not retrieve any information regarding the transmucosal profile/angle or the size of the buccal gap. However, these aspects may influence the level of the midfacial margin after IIP [44,54–57]. In other words, this review identified some heterogeneity in intervention types, measurement methods, and outcome reporting. Important variables such as tissue phenotype, buccal bone thickness, implant position, flap design, and graft material may act as effect modifiers but were inconsistently reported or analyzed. This heterogeneity likely contributed to the mixed results and limited the ability to draw firm conclusions. Stratified analyses in future studies are needed to isolate these effects.

After analyzing the data from the included studies, it was found that there were no significant differences between the grafted and non-grafted sites in terms of papilla height stability and interproximal soft tissue levels. This was despite the variation in measurement methods across the studies. In contrast with the findings of some authors [58], the combination of CTG and IIP did not appear to affect the loss of papilla. The mean loss remained relatively low. However, it should be noted that the majority of the included studies combined IIP with socket gap filling and anatomical transmucosal support, which may have contributed to maintaining papilla height.

4.3 | Ridge contour changes and soft tissue thickness

The assessment of ridge contour changes, whether volumetric or linear, was carried out in a heterogeneous manner, preventing a direct comparison. However, the majority of studies included in the review demonstrated similar changes in soft tissue profiles when IIP were performed with or without soft tissue grafting.

4.4 | Patient-reported aesthetic outcomes and satisfaction

Patient-reported outcomes, including satisfaction with aesthetic results and overall treatment experience, demonstrated consistently positive outcomes across different studies, regardless of whether soft tissue augmentation was performed or not. It has been suggested that patients may be less critical than professionals in their aesthetic perceptions [59]. However, in this case, these outcomes tend to align with the clinician-assessed aesthetic outcomes.

4.5 | Postoperative morbidity and complications

The assessment of postoperative morbidity and complications revealed a generally low incidence of adverse events across the studies included

in this review. While some studies indicated that CTGs may be associated with increased pain and discomfort during the early postoperative period, this effect was transient and did not significantly impact long-term patient satisfaction. Pain perception following soft tissue grafting was evaluated in only three studies, with heterogeneous results. Happe et al. [24] reported that patients receiving CTG experienced greater pain during the first two weeks post-surgery compared to those receiving ADM. This aligns with previous findings indicating that autologous grafts may induce more postsurgical discomfort and increased consumption of painkillers due to the harvesting procedure [60–63]. In contrast, two other studies [32,42] reported no significant differences in pain perception between autogenous grafts and substitutes, suggesting that CTG does not always result in increased discomfort. Findings from systematic reviews, such as that conducted by [64], support this conclusion. This review concluded that soft tissue grafting with a CTG can improve patient satisfaction and aesthetic outcomes compared to non-grafted sites or sites grafted with a soft tissue substitute, without a significantly worse postoperative morbidity or painkiller consumption. It should also be noted that soft tissue substitutes entail additional costs.

4.6 | Limitations

Key issue was the heterogeneity in intervention and control group protocols (such as differences in graft type, flap design, and loading protocols), which limited comparability across studies. This lack of uniformity prevented data pooling in several meta-analyses, particularly when only one or two studies shared sufficiently similar designs. The diversity in outcome assessment methods also posed challenges. Various aesthetic indices were used (e.g., PES, PES/WES, ICAI), and reporting formats differed, which reduced the potential for quantitative synthesis in certain cases.

The absence of subgroup stratification (e.g., by graft type, phenotype, or surgical approach), combined with inconsistent reporting of baseline tissue characteristics, restricted the analysis of potential effect modifiers on soft tissue outcomes. Follow-up periods were typically limited to 12 months, hindering the assessment of long-term soft tissue stability, aesthetic evolution, and late complications. Non-standardized PROMs represented an additional limitation. Patient satisfaction was assessed using diverse tools (e.g., VAS, OHIP-14, or custom questionnaires), many of which were not validated or not specifically designed to measure aesthetic outcomes. This variability limited the ability to meaningfully compare or synthesize patient-reported outcomes and to assess subtle, patient-perceived differences. Finally, most studies were conducted under ideal clinical conditions, such as intact sockets and the absence of baseline recession, which limits the applicability of the findings to more complex clinical scenarios.

4.7 | Clinical implications

The findings of this review indicate that while soft tissue augmentation during IIP may eventually provide some benefits in terms of

soft tissue stability, the clinical significance of these improvements is limited. In many cases, IIP without soft tissue grafting may achieve satisfactory aesthetic and functional outcomes, reducing the need for additional surgical procedures and associated morbidity.

However, STA during IIP appears to reduce the risk of midfacial recession but does not consistently improve overall aesthetic or patient-reported outcomes. In cases with favorable conditions, grafting may not be necessary. However, in the following clinical scenarios, where the risk of mucosal recession is elevated or aesthetic outcomes are critical, performing STA during IIP may be suggested:

- Patients with a thin buccal soft tissue phenotype are more prone to midfacial recession, and several studies support applying STA in these cases to improve soft tissue stability [50,51,65,66].
- Minor buccal bone dehiscence would benefit from the simultaneous placement of a connective tissue graft (CTG) to reduce soft tissue collapse [65,67,68].
- Thin buccal bone plate (<0.5 mm) is associated with greater post-extraction remodeling. In such cases, STA can help maintain contour and minimize recession [69].
- When minor midfacial recession (<2 mm) is initially present, a CTG at the time of IIP can improve the condition [6,44].
- Tooth is positioned facially, with the root and buccal bone outside the alveolar envelope; regenerative capacity is limited, and STA may improve outcomes or lead to reconsideration of IIP [6,44].

It is therefore important for clinicians to carefully evaluate the individual patient's periodontal phenotype, aesthetic expectations, and risk factors before deciding on the use of soft tissue augmentation.

4.8 | Future research recommendations

This systematic review identifies key gaps in the evidence on aesthetic and patient-reported outcomes (PROs/PREs) following soft tissue augmentation (STA) at immediate implant sites. Few studies have examined how site-specific factors or IIP-related procedures influence STA outcomes. Most existing studies were not designed to assess aesthetic or patient-centered outcomes, resulting in small sample sizes and limited power to detect meaningful differences. Moreover, the assessment tools used (whether clinician- or patient-based) were not tailored to evaluate the specific impact of STA. Incomplete baseline reporting further limits the interpretation of results. To address these issues, future studies should be adequately powered and use sensitive, validated tools, and rigorously developed patient questionnaires. High-quality randomized controlled trials with standardized outcome measures, longer follow-up, and stratification by variables such as soft tissue phenotype, buccal bone conditions, or graft types are essential. The use of refined PROMs and aesthetic indices targeting parameters like buccal volume and

tissue texture would improve the precision and clinical relevance of outcome evaluation.

5 | CONCLUSION

The findings of this systematic review suggest that soft tissue augmentation (STA) techniques, such as connective tissue grafts (CTG) or acellular dermal matrices (ADM), appear to have a minimal impact on clinician-assessed or patient-reported aesthetic outcomes in the context of immediate implant placement (IIP). However, the strength of this conclusion is limited by heterogeneity in study designs, risk of bias, and the relatively short follow-up periods in most included studies. IIP without adjunctive soft tissue augmentation may still lead to satisfactory aesthetic outcomes in carefully selected cases, specifically, those presenting a thick, soft tissue phenotype, intact socket walls, and no pre-existing gingival recession. Under these favorable conditions, graft-free procedures may help reduce treatment complexity and patient morbidity.

Notably, the included evidence indicates that CTG can reduce mid-facial mucosal recession, which may be particularly relevant in patients with a thin biotype or in esthetically demanding sites. To better inform clinical decision-making, future studies should aim to provide long-term data, apply standardized and aesthetic-specific PROMs, and incorporate stratified analyses based on relevant clinical risk factors. High-quality trials addressing these aspects will be essential to refine clinical guidelines for soft tissue management in immediate implant placement.

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CONFLICT OF INTEREST STATEMENT

The authors report no conflicts of interest related to this study.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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