

Stabilization strategies in free gingival graft surgery around dental implants: a scoping review of sutures, adhesives, and mechanical fixation techniques

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Abstract

Background. Adequate keratinized mucosa around dental implants is important for maintaining peri-implant health, facilitating plaque control, and improving patient comfort. Free gingival grafts (FGGs) are commonly used to increase keratinized tissue width; however, graft stabilization during early healing remains critical for clinical success. Various stabilization techniques have been proposed, but no consensus exists regarding the most effective method.

Aim. This scoping review aimed to identify and summarize stabilization techniques used for FGG procedures around dental implants and to evaluate their associated clinical outcomes.

Methods: The review was conducted according to PRISMA-ScR guidelines. Electronic searches were performed in PubMed/MEDLINE, Scopus, Web of Science, and the Cochrane Library, supplemented by manual screening of reference lists. Studies published in English between 2016 and 2026 were included if they involved FGG procedures around dental implants and reported stabilization techniques and/or clinical outcomes. Data were extracted and synthesized descriptively.

Results. Six studies met the inclusion criteria, including one randomized clinical trial, two observational studies, and three case reports. Conventional suturing was the most commonly used stabilization method. FGG procedures consistently increased keratinized tissue width by approximately 2–3 mm and soft tissue thickness by 1.0–1.5 mm. Stable peri-implant conditions were maintained for up to 3 years. Graft shrinkage was commonly reported and significantly associated with graft size ($P < 0.001$). Alternative techniques, including periosteal sutures, titanium tacks, and prosthesis-assisted stabilization, demonstrated favorable outcomes in individual cases.

Conclusions. FGG procedures provide predictable improvements in peri-implant soft tissue dimensions. Suturing remains the most evidence-supported stabilization method, while alternative techniques require further comparative clinical research.

Keywords: Free gingival graft; dental implants; peri-implant soft tissue; graft stabilization; keratinized mucosa; soft tissue augmentation.

1. Introduction

Peri-implant soft tissue management plays a critical role in maintaining implant health and long-term stability [1]. Adequate keratinized mucosa around dental implants has been associated with improved plaque control, reduced mucosal inflammation, and enhanced patient comfort. In cases where keratinized tissue is insufficient, surgical augmentation procedures may be required to improve peri-implant soft tissue conditions [2,3].

Free gingival grafts (FGGs) are commonly used to increase the width of keratinized tissue around dental implants and are considered a predictable technique for peri-implant soft tissue augmentation [4,5]. The success of this procedure depends on several factors, among which graft stabilization during the early healing period is particularly important. Adequate stabilization facilitates close adaptation of the graft to the recipient site, promotes revascularization, and reduces the risk of graft displacement or necrosis [3,5,6].

Several techniques have been described to stabilize FGGs. Conventional suturing methods are the most widely used approach, however, alternative techniques such as tissue adhesives and mechanical fixation devices have also been proposed to improve graft stability and simplify surgical procedures [3,6].

Despite the variety of available techniques, there is currently no clear consensus regarding the most effective method for stabilizing FGGs around dental implants. Moreover, most available studies focus on procedures around natural teeth, with limited evidence specific to implant sites. The existing literature includes different surgical approaches, outcome measures, and study designs, making it difficult to directly compare reported results.

Therefore, a scoping review is appropriate to map the available evidence and identify knowledge gaps in this field. The objective of this scoping review is to identify and summarize stabilization strategies used in free gingival graft surgery around dental implants and to describe the clinical outcomes associated with these techniques.

2. Methods

This scoping review was conducted following established methodological frameworks for scoping reviews and was reported in accordance with the PRISMA Extension for Scoping Reviews (PRISMA-ScR) guidelines [7]. The protocol for this review was registered on the Open Science Framework (OSF) (registration DOI: [10.17605/OSF.IO/NFGEC](https://doi.org/10.17605/OSF.IO/NFGEC)).

2.1 Eligibility Criteria

The eligibility criteria were defined using the Population-Concept-Context (PCC) framework.

Population: patients undergoing FGG procedures around dental implants, particularly in cases with insufficient keratinized tissue surrounding the implants.

Concept: stabilization strategies used to secure the graft, including sutures, tissue adhesives, and mechanical fixation techniques.

Context: peri-implant soft tissue augmentation procedures.

Studies reporting clinical outcomes and/or describing stabilization techniques associated with these methods were considered eligible.

Types of Evidence Sources: eligible sources of evidence included randomized clinical trials, non-randomized clinical studies, cohort studies, case-control studies, prospective and retrospective clinical studies, case series, and case reports describing stabilization techniques used in FGG procedures around dental implants.

Exclusion Criteria: studies were excluded if they:

- Involved connective tissue grafts without fggs
- Did not involve dental implants
- Did not describe stabilization methods
- Were review articles, systematic reviews, editorials, or expert opinion papers
- Were animal or in-vitro studies

2.2 Information Sources

Electronic searches were conducted in the following databases: PubMed/MEDLINE, Scopus, Web of Science, and the Cochrane Library. In addition, publisher platforms including Wiley Online Library, ScienceDirect, and Springer Nature were consulted to identify additional relevant studies.

The reference lists of all included articles were manually screened to identify further eligible studies that may not have been captured through the database search.

Only studies published in English were included. The search was limited to studies published between January 2016 and February 2026 to ensure inclusion of contemporary surgical techniques. This time restriction was applied to reflect recent developments in peri-implant surgical techniques. The final search was performed on February 20, 2026.

2.3 Search Strategy

The search strategy combined terms related to free gingival grafts, dental implants, and graft stabilization techniques. The search strategy was initially developed for PubMed/MEDLINE and subsequently adapted for the other databases.

An example of the search strategy used in PubMed is shown below:

(free gingival graft OR FGG) AND (dental implant OR implants OR peri-implant) AND (suture OR adhesive OR cyanoacrylate OR fibrin glue OR fixation OR stabilization)

Equivalent search strategies were adapted for Scopus, Web of Science, and the Cochrane Library.

The search was limited to studies published in English between January 2016 and February 2026 to ensure inclusion of contemporary surgical approaches and stabilization techniques in peri-implant soft tissue augmentation.

2.4 Selection of Sources of Evidence

All records identified through the database searches were exported to EndNote (Clarivate Analytics), and duplicate records were removed prior to screening.

Study selection was conducted in two stages. In the first stage, titles and abstracts were screened against the predefined eligibility criteria to identify potentially relevant studies. In the second stage, the full texts of the selected articles were retrieved and assessed for eligibility.

Screening was performed independently by two reviewers (R.S. and I.S.). In cases of disagreement, consensus was reached through discussion, and when necessary, a third reviewer (Ž.P.) was consulted. Studies that met the inclusion criteria were included in the final review.

The study selection process was documented using a PRISMA flow diagram, which illustrates the number of records identified, screened, excluded, and included at each stage of the review.

2.5 Data Charting Process

Data charting was performed using a standardized data extraction form developed by

the authors prior to the review process. The form was designed to systematically collect relevant information from each included study and was iteratively refined during the charting process as necessary.

The following data were extracted from each study: author and year of publication, study design, sample size, stabilization technique used, clinical outcomes related to graft stabilization (including keratinized tissue gain, graft shrinkage, healing outcomes, and complications), follow-up period, and the main findings reported by the authors.

2.6 Data Items

The data items included in the charting form were predefined to capture key characteristics of the included studies and relevant clinical information related to graft stabilization.

The following study characteristics were collected: author, year of publication, country of origin, study design, and sample size.

Information related to the surgical procedure was also extracted, including the indication for the free gingival graft, implant location, and the stabilization technique used.

Clinical outcomes reported in the studies were recorded, where available, including keratinized tissue gain, graft shrinkage, healing outcomes, postoperative complications, patient discomfort, and follow-up duration.

2.7 Critical Appraisal

Because the objective of this scoping review was to map and summarize the available evidence rather than evaluate the effectiveness of specific interventions, a formal risk-of-bias assessment was not performed. This approach is consistent with the methodological purpose of scoping reviews, which aim to provide an overview of

existing literature and identify research gaps rather than critically appraise study quality.

2.8 Synthesis of Results

The included studies were grouped according to the type of stabilization method used for free gingival graft fixation. Stabilization techniques were categorized into three main groups: sutures, tissue adhesives, and mechanical fixation techniques, with additional techniques described where applicable.

The results were synthesized descriptively and presented in tables summarizing the characteristics of the included studies, stabilization techniques, and reported clinical outcomes. Findings were also described narratively, where appropriate, to highlight patterns in the literature and identify gaps in the available evidence.

3. Results

3.1 Study Selection

The database search identified 643 records. After removal of duplicates, 612 records remained and were screened based on titles and abstracts. Of these, 569 records were excluded.

The full texts of 43 articles were assessed for eligibility, of which 37 were excluded, primarily due to not meeting the inclusion criteria.

A total of six studies met the eligibility criteria and were included in the final analysis.

The study selection process is illustrated in the PRISMA flow diagram.

3.2 Characteristics of Included Studies

The included studies comprised a heterogeneous body of evidence, including one randomized clinical trial [8], two observational clinical studies [9,10], and four case reports [11–14].

Sample sizes varied considerably, ranging from single-patient case reports to studies involving

up to 53 implants [10]. The duration of follow-up also differed across studies, ranging from short-term evaluations of 6 to 9 months [8,9,13] to longer observation periods extending from approximately 12 months to up to 3 years [10–12,14].

Overall, the evidence base was characterized by variability in study design, sample size, and

outcome measures, reflecting the limited and diverse nature of the available literature on stabilization strategies in free gingival graft procedures around dental implants. The main characteristics of the included studies are summarized in Table 1. The stabilization techniques identified in the included studies are described below.

Figure 1. PRISMA flow diagram.

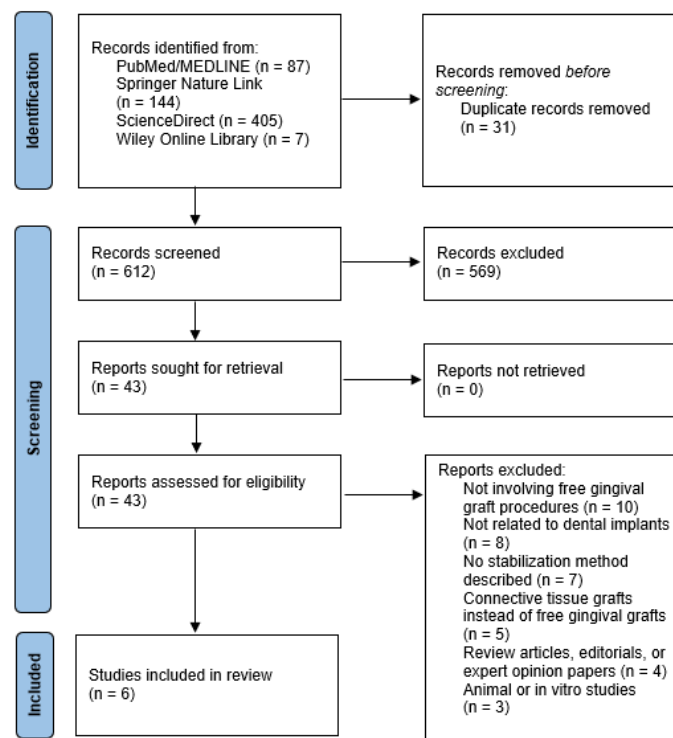


Table 1. Characteristics of Included Studies

Author (Year)	Study Design	Sample Size	Stabilization Technique	Outcomes Reported	Follow-up (months)
El-Sayed et al. (2025) [8]	Randomized clinical trial	20 patients (20 implants)	Sutures	KMW STT	9
Shah & Kothiwale (2021) [9]	Prospective clinical study	10 patients (10 implants)	Sutures	KTW gain, plaque index, gingival index, probing depth	6
Lin et al. (2022) [10]	Observational clinical study	32 patients (53 implants)	Sutures	KMW, vertical and horizontal tissue thickness, marginal bone loss	16
Liao et al. (2023) [11]	Case report	1 patient (1 implant)	Periosteum sutures	Keratinized tissue gain, graft shrinkage	36

Lee et al. (2023) [12]	Case report	1 patient (3 implants)	Titanium tacks	Keratinized mucosa gain	12
Korkis et al. (2019) [13]	Case report	2 patients (4 implants)	Acrylic/composite stents + sutures	KMW width increase, graft stability	6
Marin et al. (2017) [14]	Case report	1 patient (4 implants)	Sutures + prosthesis-assisted stabilization	Keratinized mucosa increase	12

KMW - keratinized mucosa width; STT - soft tissue thickness

3.3 Stabilization Techniques

Before describing specific stabilization methods, the general surgical approach to FGG procedures should be outlined.

The graft is typically harvested from the palatal mucosa, most commonly in the premolar region (between the canine and first molar), where sufficient tissue thickness is available [15]. A partial-thickness incision is performed, usually at a depth of approximately 1.0-1.5 mm, to obtain an epithelialized graft while preserving the underlying periosteum and minimizing donor site morbidity. The thickness of the harvested graft generally ranges from 1.0 to 1.5 mm, depending on the clinical indication and palatal tissue biotype [8,16]. Care must be taken to avoid excessive thinning, which may compromise graft survival, or excessive thickness, which may impair revascularization [15–17].

The hard palatal mucosa is primarily vascularized by the greater palatine artery (GPA), which arises from the descending palatine artery within the pterygopalatine fossa. It travels through the greater palatine canal and exits via the greater palatine foramen, typically located near the posterior aspect of the hard palate [18]. The position of the GPA varies according to the palatal region, generally lying approximately 12-17 mm from the gingival margin, with a depth ranging from 1.2 to 5.5 mm beneath the palatal surface [19]. Due to its anatomical course, inadvertent injury to this

vessel during graft harvesting may lead to significant hemorrhage. Therefore, careful assessment of the surgical site and precise control of incision depth and location are critical to minimize the risk of bleeding complications [18].

Following harvesting, the graft is transferred to the peri-implant recipient site, where a well-vascularized connective tissue bed is prepared. The graft is positioned and adapted closely to the recipient site to ensure intimate contact with the underlying tissue, which is critical for plasmatic diffusion and subsequent revascularization during the early healing phase [8,16,17].

Adequate graft stabilization during this stage is essential to prevent micromovement, promote revascularization, and support successful integration of the graft [8,12].

The included studies reported a range of stabilization strategies for FGGs around dental implants. These techniques were categorized into four main groups: conventional sutures, modified suturing techniques, mechanical fixation, and prosthesis-assisted stabilization.

3.3.1 Sutures

Conventional suturing techniques represented the predominant method of graft stabilization and were employed in all included clinical studies [8–14].

Several specific suturing approaches were described to ensure optimal graft immo-

bilization. Initially, the graft is commonly secured at its margins using interrupted sutures, placed at the mesial and distal edges, as well as along the buccal and lingual/palatal aspects. These sutures serve to stabilize the graft periphery and ensure precise adaptation to the recipient bed [8]. To further enhance stability, cross (X-shaped) sutures may be placed over the central portion of the graft, distributing tension evenly across the graft surface and minimizing micromovement during the early healing phase [10]. In addition, figure-of-eight (8-shaped) sutures are frequently used to anchor the graft directly to the underlying periosteum, improving fixation and reducing dead space between the graft and the recipient bed. This technique is particularly useful in areas where additional compression and immobilization are required.

In some cases, periosteal anchoring sutures are applied by passing the needle through the graft and engaging the periosteum, which enhances graft stability and promotes closer contact with the vascularized recipient site [11]. The periosteal suturing technique is illustrated in Figure 2, demonstrating graft stabilization through anchorage to the underlying periosteum (adapted from Liao et al. [11]). Continuous or sling sutures may also be used around adjacent

teeth or implant abutments to further secure the graft and protect it from displacement. From a surgical perspective, proper suturing technique aims to achieve passive, tension-free adaptation of the graft. Excessive tension may compromise blood supply, while insufficient fixation may lead to graft micromovement, both of which can negatively affect plasmatic diffusion and revascularization.

Clinically, the use of sutures resulted in predictable graft stabilization and favorable outcomes. The randomized clinical trial by El-Sayed et al. [8] demonstrated increases in keratinized mucosa width to approximately 4.0-4.5 mm, along with improvements in soft tissue thickness over a 9-month follow-up period. Similarly, Shah and Kothiwale [9] reported an increase in keratinized tissue width to approximately 3 mm, accompanied by improvements in peri-implant clinical parameters.

In the observational study, Lin et al. [10] reported stable peri-implant soft tissue dimensions with a mean keratinized mucosa width of approximately 4.08 mm at 16.7 months. These findings indicate that suturing provides reliable immobilization of the graft, supporting stable integration and maintenance of augmented tissue dimensions.

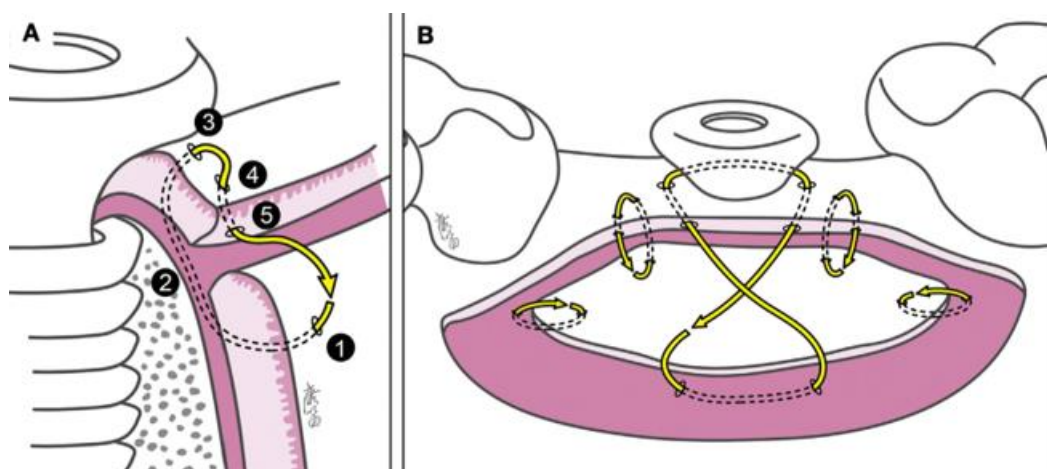


Figure 2. Periosteal suturing technique for free gingival graft stabilization. (A) Step-by-step illustration of graft fixation using periosteal sutures. (B) Schematic representation of the operative procedure. Adapted from Liao et al. [11].

3.3.2 Mechanical Fixation

Mechanical fixation using titanium tacks was identified as an alternative graft stabilization strategy. In this approach, the graft is secured directly to the recipient site using fixation tacks, allowing firm immobilization without the need for extensive suturing [12] (Figure 3). This method provides immediate mechanical stabilization by compressing the graft against the underlying periosteal bed, thereby minimizing micromovement and enhancing contact with the vascularized recipient site.

From a clinical perspective, this technique may simplify the surgical procedure and reduce operative time, while ensuring stable graft positioning during the early healing phase. Adequate immobilization achieved through mechanical fixation may facilitate plasmatic diffusion and subsequent revascularization.

In the reported case, the use of titanium tacks resulted in successful graft integration and an increase in keratinized mucosa, with stable outcomes observed at 12-month follow-up [12]. However, evidence regarding mechanical fixation remains limited to case reports, and no comparative studies have evaluated its effectiveness relative to conventional suturing techniques. Consequently, the clinical advantages of this approach remain uncertain.

3.3.4 Prosthesis-Assisted Stabilization

Prosthesis-assisted stabilization techniques were also described as alternative approaches to graft fixation. In one case report, customized acrylic or composite stents were fabricated and attached

to implant components to stabilize the graft during the healing phase [13] (Figure 4). These stents provided additional mechanical support by maintaining constant pressure over the graft, thereby improving adaptation to the recipient site and protecting the graft from displacement.

In another case, prosthesis-assisted stabilization was used in combination with conventional suturing [14]. This combined approach allowed for secure graft fixation while simultaneously shielding the graft from mechanical disruption during early healing.

Clinically, these techniques may be particularly advantageous in complex cases, such as areas with limited access, mobile soft tissues, or where suturing alone does not provide sufficient graft stability.

However, similar to other alternative stabilization methods, prosthesis-assisted techniques have been reported only in case reports, and their effectiveness has not been evaluated in controlled clinical studies.



Figure 3. Mechanical fixation of a free gingival graft using titanium tacks. The graft is stabilized directly to the periosteal recipient bed, ensuring firm immobilization and close adaptation to the underlying tissue. Adapted from Lee et al. [12].

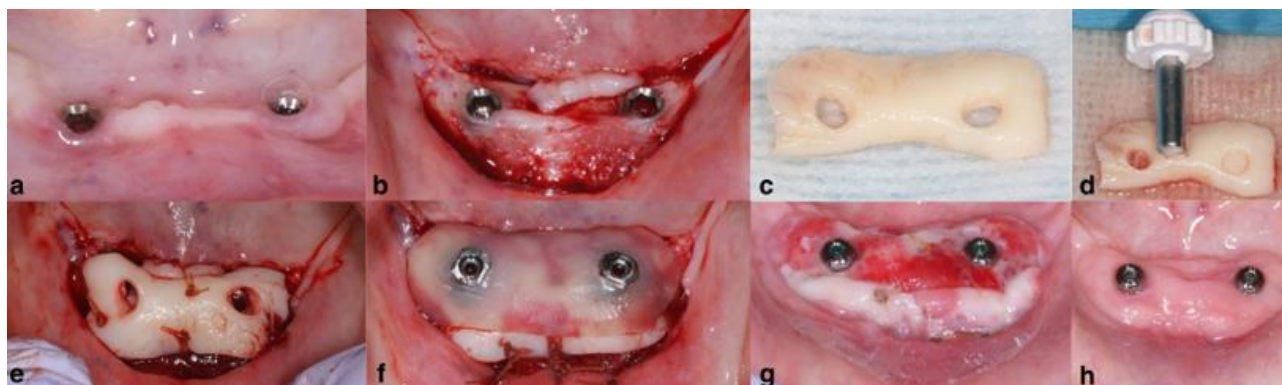


Figure 4. Prosthesis-assisted stabilization of a free gingival graft around dental implants.

(a) Initial clinical presentation showing insufficient keratinized tissue; (b) preparation of partial-thickness flaps; (c–d) preparation of the graft with fenestrations to accommodate implants; (e) graft positioned and sutured; (f) stabilization using an acrylic stent secured to implant components; (g) healing at 2 weeks; (h) clinical outcome at 2 months demonstrating increased keratinized tissue width and thickness. Adapted from Korkis et al. [13].

3.4 Clinical Outcomes

Across all included studies, FGG procedures around dental implants demonstrated generally favorable clinical results, although the type and extent of reported findings varied depending on study design. The clinical outcomes of the included studies are summarized in Table 2.

3.4.1 Keratinized Tissue Width

All included studies reported an increase in keratinized tissue width following FGG procedures.

In the randomized clinical trial, keratinized mucosa width increased from baseline values of approximately 1.5–2.0 mm to approximately 4.0–4.5 mm at 9 months, corresponding to a mean gain of approximately 2.0–3.0 mm [8]. These improvements were observed regardless of whether the graft was performed before or after implant placement, indicating that graft timing did not significantly influence the magnitude of keratinized tissue gain.

Similarly, the prospective clinical study by Shah and Kothiwale [9] reported an increase in keratinized tissue width to approximately 3.0–3.2 mm at 3 and 6 months postoperatively, suggesting that most of the tissue gain occurs during the early healing phase and remains stable over time.

Observational data reported by Lin et al. [10] reported a mean keratinized mucosa width of approximately 4.08 mm at a mean follow-up of 16.7 months, demonstrating sustained stability of the augmented tissue. In addition, this study suggested that increased keratinized tissue width was associated with improved peri-implant soft tissue conditions and reduced plaque accumulation.

Case reports further supported these findings, demonstrating increases in keratinized tissue following FGG procedures across different stabilization techniques [11–14]. However, these results were primarily descriptive and lacked standardized quantitative measurements, limiting direct comparison with clinical studies. Overall, the available evidence indicates that FGG is an effective and predictable procedure for increasing keratinized tissue width around dental implants, with gains of approximately 2–3 mm and stable outcomes maintained for up to 16 months and longer in individual cases.

3.4.2 Soft Tissue Thickness

Improvements in soft tissue thickness were reported primarily in clinical studies. The randomized clinical trial by El-Sayed et al. [8] demonstrated a statistically significant increase

in soft tissue thickness, with mean gains of approximately 1.0-1.5 mm over a 9-month follow-up period ($p < 0.05$). These changes were observed in both treatment groups, indicating consistent enhancement of peri-implant soft tissue volume following FGG procedures.

Similarly, Lin et al. [10] reported vertical soft tissue thickness values ranging from approximately 2.5 to 3.7 mm around implant sites at a mean follow-up of 16.7 months, with statistically significant improvements compared to baseline ($p < 0.05$).

From a clinical perspective, increased soft tissue thickness may contribute to improved resistance to mechanical trauma, enhanced tissue stability, and a more favorable peri-implant phenotype. In addition, thicker soft tissues may reduce susceptibility to mucosal recession and peri-implant inflammation.

Overall, the available evidence indicates that FGG not only increases keratinized tissue width but also enhances soft tissue thickness, with measurable gains maintained over short- to medium-term follow-up periods.

3.4.3 Graft Shrinkage

Graft shrinkage was reported as a common postoperative phenomenon across the included studies. The observational study by Lin et al. [10] demonstrated that larger grafts were associated with a significantly higher shrinkage ratio ($P < 0.001$), indicating that graft dimensions may influence postoperative dimensional stability. This finding suggests that graft size is an important factor in predicting the extent of shrinkage following FGG procedures. The case report by Liao et al. [11] also described graft shrinkage despite successful graft integration and increased keratinized tissue. In this case, the use of periosteal sutures was

proposed to enhance graft stability and potentially reduce the degree of postoperative shrinkage by improving fixation and minimizing micromovement.

From a clinical perspective, graft shrinkage may partially reduce the initial gain in keratinized tissue width, emphasizing the importance of appropriate graft sizing and stabilization techniques during surgery.

However, quantitative data on graft shrinkage were inconsistently reported across studies, and standardized measurement protocols were lacking. This limits the ability to directly compare outcomes and evaluate the impact of different stabilization methods on graft shrinkage.

3.4.4 Healing Outcomes and Complications

Healing outcomes were generally favorable across all included studies. Clinical studies reported uneventful postoperative healing and stable peri-implant soft tissue conditions, with no major complications such as graft failure, infection, or necrosis observed [8-10]. In addition, improvements in clinical parameters, including plaque index and gingival index, were reported, indicating enhanced peri-implant tissue health following FGG procedures.

Case reports similarly demonstrated successful graft integration and stable healing outcomes [11-14]. Alternative stabilization techniques, including titanium tacks and prosthesis-assisted approaches, resulted in stable graft positioning and uneventful healing during the postoperative period [12-14].

Patient-related outcomes, where reported, indicated good tolerance of the procedure, with reduced discomfort and improved oral hygiene following augmentation [13-14].

Overall, the available evidence suggests that FGG procedures around dental implants are associated with predictable healing and a low

incidence of complications, regardless of the stabilization technique used.

Table 2. *Summary of Clinical Outcomes*

Study	Keratinized Tissue Gain	Soft Tissue Thickness	Graft Shrinkage	Key Clinical Findings
El-Sayed et al. (2025) [8]	~1.5-2.0 → 4.0-4.5 mm	1.0-1.5 mm	N/R	Significant increases in KTW and tissue thickness
Shah & Kothiwale (2021) [9]	~3.0-3.2 mm	N/R	N/R	Improved KTW and peri-implant clinical indices
Lin et al. (2022) [10]	Mean 4.08 mm	2.5-3.7 mm	Higher in larger grafts ($P < 0.001$)	Stable peri-implant tissue; graft size influences shrinkage
Liao et al. (2023) [11]	Increased (not quantified)	N/R	Present	Successful graft integration; periosteal sutures may enhance stability
Lee et al. (2023) [12]	Increased (not quantified)	N/R	N/R	Stable graft fixation using titanium tacks
Korkis et al. (2019) [13]	Increased (not quantified)	N/R	N/R	Improved stability using stent-assisted fixation
Marin et al. (2017) [14]	Increased (not quantified)	N/R	N/R	Prosthesis-assisted stabilization supported graft protection

4. Limitations

This scoping review has several limitations that should be considered when interpreting the findings.

First, the included studies were heterogeneous in design, sample size, and outcome measures, which limited direct comparison between studies. The evidence base consisted of a combination of randomized clinical trials, observational studies, and case reports, resulting in variability in the level of evidence.

Second, a substantial proportion of the included studies were case reports describing alternative stabilization techniques. While these studies provide valuable clinical insights, they offer limited generalizability and do not allow for robust conclusions regarding the effectiveness of these methods.

Third, quantitative data on certain outcomes, particularly graft shrinkage and soft tissue thickness, were inconsistently reported across studies. The lack of standardized outcome

measures further limited the ability to synthesize and compare results.

Fourth, no included study directly compared different graft stabilization techniques. As a result, it was not possible to determine the relative effectiveness of sutures versus alternative fixation methods.

Finally, the search was limited to studies published in English and within a defined time period, which may have resulted in the exclusion of relevant studies and introduced potential selection bias.

5. Conclusions

Free gingival graft procedures around dental implants are associated with favorable clinical outcomes, including consistent increases in keratinized tissue width and improvements in soft tissue thickness. Across the included studies, gains of approximately 2-3 mm in keratinized tissue were observed, with stable peri-implant

soft tissue conditions maintained over follow-up periods of up to 3 years.

Conventional suturing techniques remain the most commonly used and best-supported method for graft stabilization, demonstrating predictable and reproducible outcomes across clinical studies. In contrast, alternative approaches, including periosteal sutures, mechanical fixation with titanium tacks, and prosthesis-assisted stabilization, have been described as potential adjuncts to improve graft immobilization, particularly in complex clinical situations.

However, the current evidence is limited by the lack of comparative clinical studies evaluating different stabilization methods. As a result, it remains unclear whether alternative techniques provide clinically meaningful advantages over conventional suturing.

Future research should focus on well-designed randomized clinical trials to compare stabilization strategies and to establish evidence-based guidelines for optimizing graft stability and long-term peri-implant soft tissue outcomes.

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