Original Article

MANAGEMENT OF TITANIUM MESH EXPOSURE WITH FREE GINGIVAL GRAFTING FOLLOWING IMPLANT PLACEMENT AND GUIDED BONE REGENERATION

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ABSTRACT

Successful implant therapy requires adequate bone and healthy peri-implant soft tissues to maintain stability and promote oral health and well-being. Titanium mesh is widely used in guided bone regeneration (GBR), but mesh exposure during healing is a common complication that may increase the risk of peri-implant disease. Free gingival grafting (FGG) augments keratinized mucosa; however, evidence for managing titanium mesh exposure remains limited.To evaluate changes in keratinized mucosal thickness (KMT) and width (KMW) following FGG for titanium mesh exposure after simultaneous implant placement and GBR.This prospective study included 42 patients (42 implants) with partial titanium mesh exposure in the maxillary central incisor region. Baseline KMT and KMW (T0) were recorded before FGG. Measurements were repeated at 3 months (T1), 6 months (T2), and 1 year (T3). Data were analyzed using repeated-measures ANOVA with a Bonferroni post-hoc test ($p < 0.05$). KMT increased from 1.09 ± 0.42 mm at T0 to 4.02 ± 0.61 mm at T1 ($p < 0.001$), measuring 4.97 ± 0.58 mm at T2 and 4.90 ± 0.55 mm at T3. KMW improved from 2.24 ± 0.63 mm at T0 to 5.73 ± 0.82 mm at T1 ($p < 0.001$), reaching 6.09 ± 0.74 mm at T2 and 6.10 ± 0.71 mm at T3, with stable outcomes thereafter. FGG effectively managed titanium mesh exposure, producing sustained improvements in peri-implant soft tissue dimensions and supporting oral health and disease prevention.

Key words: Dental implants, Keratinized mucosa, Peri-implant health, Peri-implant disease, Soft tissue grafting, Wellbeing.

Introduction

Dental implants have become an integral component of contemporary restorative dentistry, providing a predictable and durable solution for the rehabilitation of partially or completely edentulous patients. The long-term success of implant therapy depends on a multitude of factors, including systemic health, surgical precision, prosthetic design, and the quality and quantity of the surrounding alveolar bone [1-6]. Among these, adequate bone volume remains one of the most critical prerequisites for achieving primary stability and optimal osseointegration [7, 8]. Deficient alveolar bone—whether horizontal, vertical, or combined—poses a significant challenge, potentially compromising implant placement, emergence profile, and esthetic outcomes [9].

To address these limitations, a variety of surgical augmentation techniques have been developed, such as onlay and inlay bone grafting, distraction osteogenesis, ridge splitting, maxillary sinus floor elevation, and inferior alveolar nerve transposition [10]. Among these, guided bone regeneration (GBR) has emerged as one of the most predictable and scientifically validated approaches for reconstructing alveolar defects, particularly in conjunction with simultaneous implant placement. The principle of GBR is based on the use of a barrier membrane that isolates the bone defect from the overlying connective tissue, thereby facilitating selective migration and proliferation of osteogenic cells while maintaining space for new bone formation [11].

Barrier membranes used in GBR can be broadly categorized as resorbable or non-resorbable, each possessing distinct biological and mechanical characteristics. Non-resorbable membranes, especially those fabricated from titanium-reinforced polytetrafluoroethylene (PTFE) or pure titanium mesh, offer superior space-maintaining capacity and mechanical rigidity—attributes crucial for maintaining the regenerative contour and preventing soft tissue collapse [12]. Titanium meshes, in particular, are favored for their biocompatibility, structural stability, and ability to be precisely adapted to complex defect morphologies, while effectively containing grafting materials such as xenogeneic bone substitutes and collagen membranes [13].

Despite these advantages, titanium mesh exposure during the healing period remains one of the most common and challenging complications. Premature soft tissue dehiscence may lead to bacterial contamination, graft resorption, and impaired regenerative outcomes. The risk of exposure is particularly pronounced in areas with a thin mucosal biotype or insufficient keratinized mucosa, such as the anterior maxilla. Once exposure occurs, management becomes complex, necessitating preservation of the underlying

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grafted site while simultaneously restoring adequate soft tissue coverage [14].

Various soft tissue grafting strategies have been proposed to manage titanium mesh exposure, including the use of acellular dermal matrices, extracellular matrix membranes, and collagen membranes. Although these biomaterials have shown potential in improving mucosal coverage, their outcomes remain inconsistent, particularly in achieving long-term keratinized tissue stability. In contrast, autogenous free gingival grafts (FGG) remain the gold standard for augmenting peri-implant soft tissue, owing to their predictable integration, resilience, and superior ability to increase both mucosal thickness and width [15].

Nevertheless, evidence concerning the application of FGG specifically for managing titanium mesh exposure following simultaneous implant placement and GBR remains scarce. Most available studies focus on soft tissue augmentation around implants or preventive strategies for avoiding exposure rather than therapeutic interventions post-exposure. This highlights a distinct gap in the current literature regarding the role of FGG in enhancing peri-implant soft tissue dimensions in such clinical situations.

The present study aimed to evaluate changes in keratinized mucosal thickness and width following FGG performed to manage titanium mesh exposure after simultaneous implant placement and guided bone regeneration.

Materials and Methods

This prospective clinical study was conducted in the Department of Periodontology, Saveetha Dental College and Hospital, Chennai, following approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrollment.

A total of 42 patients (42 implants), aged between 30 and 55 years and of both genders, who had previously undergone implant placement in the maxillary central incisor region with simultaneous ridge augmentation using titanium mesh (Oss-Builder®), particulate xenograft (Bio-Oss®), and resorbable collagen membrane (Creos®) were included. Patients reporting mesh exposure between January and December 2024 were recruited. Inclusion criteria comprised systemically healthy, non-smoking adults with good oral hygiene compliance and partial mesh exposure during the healing period, without acute infection or implant mobility. Exclusion criteria included systemic diseases, untreated periodontal disease, bisphosphonate therapy, or recent head and neck radiotherapy.

Before surgery, all participants received professional prophylaxis and reinforcement of oral hygiene measures. At baseline (T0), both keratinized mucosal thickness (KMT) and keratinized mucosal width (KMW) were recorded. KMT was measured 1.5 mm apical to the mid-buccal gingival margin at the site of mesh exposure, while KMW was measured as the distance between the mucogingival junction and the free gingival margin at the mid-buccal region using a UNC-15 periodontal probe. The FGG procedure was performed once inflammation and local irritation had subsided, generally within one to two weeks following exposure identification.

All surgical procedures were performed under local anesthesia by the same experienced periodontist (SG) to minimize inter-operator variability. The recipient site was debrided gently to remove granulation tissue and prepared as a partial-thickness bed to accommodate the graft. If necessary, the sharp edges of the exposed mesh were smoothed. A free epithelialized graft approximately 1.5 mm thick was harvested from the palatal mucosa (left premolar region) using a template. Hemostasis at the donor site was achieved with a hemostatic agent (AbGel®) and secured using 3-0 silk sutures (Mersilk®). The graft was trimmed slightly larger than the recipient site to compensate for postoperative contraction and was stabilized with interrupted and sling sutures using 5-0 non-resorbable polypropylene sutures (Ethicon®). A non-eugenol periodontal dressing (COE-PAK®) was placed over the surgical site.

Postoperative care included antibiotic and analgesic therapy, rinsing twice daily with 0.12% chlorhexidine for one week, adherence to a soft diet, and avoidance of trauma at the grafted site. Sutures and dressings were removed after 10 days, and graft viability was assessed clinically.

Follow-up evaluations were conducted at 3 months (T1), 6 months (T2), and 1 year (T3) postoperatively. The primary outcome, KMT, was measured under topical anesthesia using a No. 25 endodontic spreader with a rubber stopper inserted perpendicular to the mucosal surface until bone contact, and the distance was measured using a digital caliper. The secondary outcome, KMW, was re-evaluated at each interval using a UNC-15 probe. All measurements were recorded at baseline, 3 months, 6 months, and 1 year by an examiner (AR). Postoperative complications, including graft necrosis, infection, or donor-site morbidity, were also documented.

Statistical analysis

All data were analyzed using SPSS software (Version 23.0; IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD). Data normality was verified using the Shapiro–Wilk test. Since data were normally distributed, parametric tests were applied. Changes in KMT and KMW across the three time points were evaluated using repeated measures ANOVA. Pairwise comparisons between time points were conducted using the Bonferroni post-hoc test. The level of significance was set at $p < 0.05$.

Results and Discussion

A total of 42 patients (42 implants) presenting with partial titanium mesh exposure were included in the study. The mean age of the participants was 39.3 ± 6.1 years, comprising 25 females (59.5%) and 17 males (40.5%). All surgical sites demonstrated uneventful healing, and no postoperative complications such as graft necrosis, infection, or donor-site morbidity were observed during the follow-up period.

A significant change in KMT was observed following the FGG procedure. The mean KMT increased from 1.09 ± 0.42 mm at baseline (T0) to 4.02 ± 0.61 mm at 3 months (T1) ($p < 0.001$). KMT measured 4.97 ± 0.58 mm at 6 months (T2) and 4.90 ± 0.55 mm at 1 year (T3). Although a slight reduction was observed between T2 and T3, the differences between follow-up visits were not statistically significant ($p > 0.05$). However, KMT values at all follow-up periods remained significantly higher than baseline ($p < 0.001$).

Similarly, KMW showed marked improvement after the FGG procedure. The mean KMW increased from 2.24 ± 0.63 mm at baseline (T0) to 5.73 ± 0.82 mm at 3 months (T1) ($p < 0.001$). KMW measured 6.09 ± 0.74 mm at 6 months (T2) and 6.10 ± 0.71 mm at 1 year (T3), with no statistically significant differences between the follow-up visits ($p > 0.05$). Nevertheless, all follow-up values remained significantly greater than baseline ($p < 0.001$) **(Table 1)**.

Table 1. Changes in Keratinized Mucosal Thickness (KMT) and Keratinized Mucosal Width (KMW) at Different Time Points

Parameter	Timepoint	Mean ± SD (mm)	p-value[a]	Pairwise comparisons (p-value)[b]
KMT	T0	1.09 ± 0.42	<0.001*	T0 vs T1: <0.001* T0 vs T2: <0.001* T0 vs T3: <0.001* T1 vs T2: 0.08 T1 vs T3: 0.11 T2 vs T3: 0.42
	T1	4.02 ± 0.61		
	T2	4.97 ± 0.58		
	T3	4.90 ± 0.55		
KMW	T0	2.24 ± 0.63	<0.001*	T0 vs T1: <0.001* T0 vs T2: <0.001* T0 vs T3: <0.001* T1 vs T2: 0.09 T1 vs T3: 0.10 T2 vs T3: 0.76
	T1	5.73 ± 0.82		
	T2	6.09 ± 0.74		
	T3	6.10 ± 0.71		

[a]Repeated measures ANOVA; [b]Bonferroni post-hoc test; *Statistically significant at $p < 0.05$

Titanium mesh is widely used in GBR because of its superior mechanical stability, ability to maintain space, and effectiveness in supporting bone graft materials, particularly during simultaneous implant placement. However, mesh exposure remains a frequent complication, which can compromise bone regeneration, increase the risk of infection, and challenge the maintenance of peri-implant soft tissue. Timely and effective management of exposed titanium mesh is therefore critical to preserve regenerative outcomes and ensure long-term implant success. Among the available approaches, FGG has proven to reliably augment keratinized mucosa, restore soft tissue integrity, and facilitate improved plaque control around implants.

The present study evaluated the clinical outcomes of FGG in increasing KMT and KMW at sites of titanium mesh exposure following simultaneous implant placement and GBR. Our findings demonstrated a significant increase in both KMT and KMW from baseline to 3 months postoperatively. At 6 months, a further increase was observed, followed by a slight reduction at 1 year; however, these differences were not statistically significant between follow-up visits, and the values remained substantially higher than baseline. These results indicate stable and sustained soft tissue augmentation up to one year after the procedure.

These findings are in agreement with prior literature. Kılıç *et al*. [16] reported that in cases where keratinized tissue around implants was insufficient, FGG effectively increased tissue dimensions. In their case report, the keratinized mucosa increased from 1.5 mm before surgery to 5 mm at 2 weeks and 4 mm at 3 months, providing stable coverage and facilitating oral hygiene maintenance. Shao *et al*. [17] evaluated 29 patients (37 implant sites and 33 tooth sites) over 2–5 years and observed that FGG significantly increased keratinized tissue width at both tooth and implant sites. A slight reduction occurred after the third month, but the gains were maintained long-term, demonstrating the medium-term stability of FGG.

Güler *et al*. [18] highlighted the importance of adequate keratinized gingiva for peri-implant health, reporting that FGG performed before prosthetic rehabilitation significantly improved soft tissue dimensions in a patient with insufficient keratinized gingiva. Postoperative results showed notable gains at 1 and 3 months, which enhanced plaque control and contributed to implant longevity. Zheng *et al*. [19] conducted a comparative study in 26 patients receiving implants with or without FGG before placement. They found that the FGG group had significantly larger width and thickness of buccal keratinized mucosa, with a minor reduction in thickness after the third month,

supporting FGG as a viable method to maintain peri-implant soft tissue.

Ramanauskaite *et al*. [20] compared free gingival grafts with porcine-derived collagen matrices in 32 patients and demonstrated that while both methods produced comparable changes in tissue thickness, FGG achieved significantly greater keratinized tissue gain at 1, 3, and 6 months. Lin *et al*. [21] also concluded that FGG is a predictable technique for augmenting keratinized mucosa around posterior implants when grafts of adequate size are used, ensuring functional and esthetic stability.

Collectively, these studies support the effectiveness of FGG in increasing keratinized mucosal dimensions around implants. The present study further contributes to this evidence by demonstrating that FGG can successfully manage titanium mesh exposure, providing significant and stable improvements in both KMT and KMW up to one year postoperatively, even in compromised healing situations.

Study limitations

The strengths of this study include its clinical relevance and the use of a standardized surgical protocol performed by a single experienced operator. However, certain limitations should be acknowledged, including the relatively small sample size and the absence of histological evaluation or patient-reported outcome measures. Future studies involving larger patient cohorts, digital soft tissue analysis, and patient-centered outcomes would further enhance the understanding of the clinical benefits of FGG in managing titanium mesh exposure.

Conclusion

Free gingival grafting is an effective and predictable approach for managing titanium mesh exposure following simultaneous implant placement and guided bone regeneration. The procedure significantly increased keratinized mucosal thickness and width, with stable outcomes maintained up to one year postoperatively. These findings support the clinical utility of FGG as a reliable intervention for enhancing peri-implant soft tissue dimensions and maintaining peri-implant health in compromised sites.

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Conflict of interest: None

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