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TITANIUM TACKS ASSISTED SOFT TISSUE STABILIZATION: A NOVEL TECHNIQUE FOR FREE GINGIVAL GRAFT FIXATION: (CLINICAL CASE SERIES STUDY)

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ABSTRACT

Aim: The purpose of this study is to evaluate the amount of free gingival graft contraction stabilized with titanium bone tacks in patients with deficient non-keratinized gingiva in the esthetic zone.

Methods: This study is conducted on 10 patients with fifteen deficient non-esthetic keratinized gingiva, which hosted 15 free gingival graft secured with titanium tacks, the graft is photographed immediately after being fixed and after one, three and six months postoperatively. Using a software standardized surface area calibration of digital photographs, computation of the graft surface area is done and submitted to statistical analysis.

Results: The tack fixation presumed less intraoperative time and provided firm, secure, and good stretch for all the grafts, which all healed uneventfully. After six months, the shrinkage rate counted (40.97% ± 2.55), with the highest estimate during the first month (27.64% ± 3.75). The mean shrinkage rate was recorded (18.31% ± 3.77) between one to six months, (11.36% ± 3.60) between three to six months, and (7.81% ± 2.98) between one to three months.

Conclusion: Free gingival graft fixation with titanium tacks provides optimum graft fixation and spread, reduces intraoperative time and offers good clinical results; however, not statistically superior to the other techniques. The authors recommend modifying the design of the bone tacks to suit free gingival graft stabilization, where the underlying cortical plate is deficient.

KEYWORDS: Free gingival graft, Titanium bone tacks, Keratinized tissue and gingival graft contraction

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INTRODUCTION

The presence of adequate Keratinized tissue (KT) is imperative to both teeth and dental implants. It enhances proper oral hygiene and periodontal health, also it masks the metallic hue of the housed dental implants [(1)]. Being autogenous, easy to harvest and with a predictable surgical outcome concerning increasing the expanse of the attached gingiva, the free gingival graft (FGG) became the gold standard for the build-up of the KT [(2)].

However, assured graft stability remains crucial for its success. The mucosal graft must be constantly fixed throughout the initial healing phase, as even minor mobility would contribute to compromised vascularization, impaired healing, and failed integration with the underlying periosteum [(3)]. Furthermore, less than optimal preservation of graft nutrition frequently yields significant graft shrinkage. A suitable graft thickness, an atraumatic surgical maneuver, and quick and intimate stabilization are essential to guard against dehydration and vascular damage with excessive graft shrinkage [(2)].

Although graft suturing represents the traditional aim of stabilization, each suture is supposed to induce a localized hematoma between the graft and the underlying periosteum, this hinder the plasmatic circulation of the recipient bed and induce micro separations along the underside of the graft during the initial stage of healing, which adversely affects the stabilization of the blood clot and compromise the graft nutrition [(4-5)].

Various techniques tried to replace the routine suturing of the FCG; Gumus and Buduneli [(4)] in 2014 appraised the cyanoacrylate to decrease the rate of shrinkage, Moayer et al. [(6)] in 2018 utilized surgical miniscrews for stabilizing apically positioned flaps rather than being conventionally sutured. while Korkis et al. [(7)] in 2019 adapted stent to support the graft instead of sutures. In 2020 Shi et al. [(8)] punched bone tacks into an acellular dermal matrix to augment a keratinized mucosa around root-form dental implants. The authors of this study are replacing the conventional suturing of the FGG with three to four titanium bone tacks securing the graft in its place

The aim of this study is to evaluate the exact amount of free gingival graft shrinkage when secured with bone tacks by standardizing digital photographs aided by a calibrated periodontal probe at one, three, and six months postoperatively.

PATIENTS AND METHODS

Criteria of patient selection:

The current study incorporated ten patients (eight females and two males) with less than 2 mm keratinized gingiva in non- esthetic areas **(Figure: 1A)**. Five patients demonstrated bilateral affection, while the other five expressed unilateral incompetence, counting fifteen recipient sites based on a clinical inspection aided by a periodontal probe tracing that calibrates the values of the KT and assesses adjacent teeth periodontal status. The authors obtained a comprehensive medical history from the patients and digital panoramic radiographs, which served as the survey for the patient exclusion, patients who revealed presence of remaining roots, advanced periodontal affection, pathological lesions along the expanse of the recipient site or a medical condition that would interfere with the patency of free gingival grafting were excluded also excluding patients with a history of previous hard or soft tissue augmentation or failed dental implants. The ethical committee of Cairo University approved the study's purpose and design.

Surgical procedures:

Both donor and recipient sites were operated on after the administration of local anesthesia (Articaine 4% 1:100 000 epinephrine. Septodont, France), under aseptic conditions, aided by routine draping and scrubbing the surgical sites with Bovidine-Iodine (Betadine, Purdue Products LP, USA).

I) Recipient site preparation:

Partial-thickness mucosal flap was sculpted using a 15c surgical blade. The flap outline employed a horizontal incision; within the KT and two oblique vertical extensions mesially and distally. Blunt dissection of the epithelium, connective tissue, and muscle fibers using a periosteal elevator leaving the periosteum firmly attached to the underlying bone. The flap was then rolled and sutured apically to the underlying periosteum with 5-0 monofilaments sutures (Prolene, Assut, Switzerland). **(Figure: 1B)**. A saline-moistened gauze was then placed over the recipient site until harvesting the FGG.

II) Donor site preparation:

The Free gingival graft was harvested from the position of the palatal root of the first molar and the distal line angle of the Canine. As this area provides the thickest mucosal graft, a Teflon sheet was cut and adapted to formulate a graft template that extended from the Canine and the first molar mesiodistally and two mms apical to the gingival margin to maximumly 12 mm. apart, which represent the average safe distance that would guard against the injury of the neurovascular bundle [9]. After gentle blade demarcation of the boundaries of the graft template, the template was removed, and the palatal mucosa was sculptured to a thickness of 1.5 mm, which approximately corresponds to the length of the blade bevel, keeping the blade parallel to the epithelial surface during the mucosal separation. **(Figure 1 C)**

III) Graft stabilization:

After the recipient site is copiously irrigated and cleaned from mobile and fatty tissues, the graft is horizontally placed into the most favoured position, with its underside facin g the underlying periosteum. According to the graft size, the free gingival grafts were stabilized with 3 to 4 MCT titanium tacks of 2.5 mm diameter and 4.5 mm length (MCT bone tack master kit; MCTBIO CO, South Korea) which preceded by attempting to adhere the graft to the recipient site to minimize the dead spaces. The FGG was stretched by fixing one tack at its distal end, then another tack at its mesial one, followed by the other tacks as required. **(Figure: 2A)**

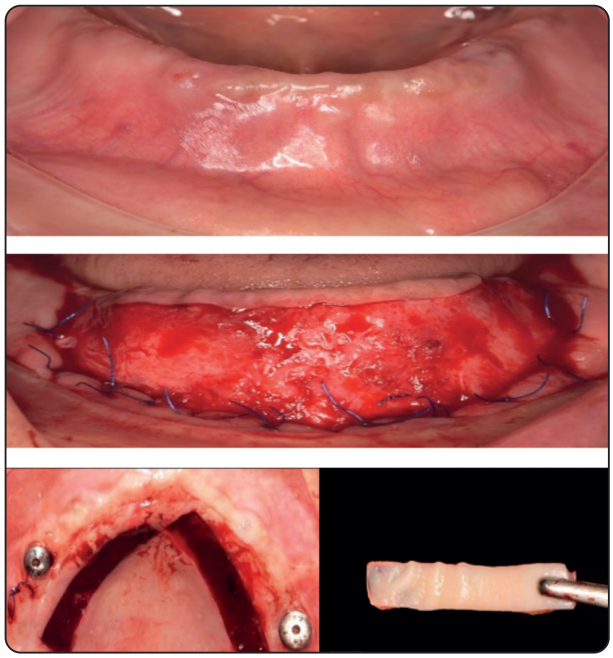

Fig. (1A): Pre-operative picture showing lack of keratinization.

Fig. (1B): Recipient sites' partial-thickness flap, positioning the flap apically by suturing to underlying periosteum.

Fig. (1C): FGG 1.5 mm thickness after harvesting from the palate

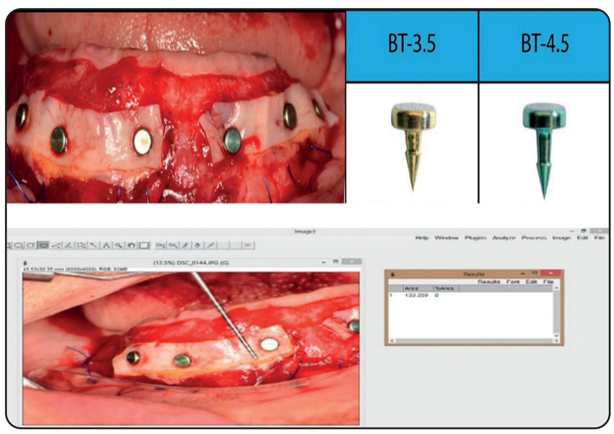

Fig. (2A): FGG fixation using titanium tacks and the used tacks in graft fixation.

Fig. (2B): Measuring the FGG surface area using the j software intraoperatively (a periodontal probe was used to standardize the measurements)

Postoperative care and follow up:

Postoperatively, all patients administrated (Amoxicillin / clavulanic acid tabs1g every 12 hours for one week), NSAIDs (ibuprofen 400mg tabs every 6 hours for four days then as needed), Antiseptic mouth wash (Chlorhexidine gluconate 0.2%) three times daily for two weeks beginning the day after the operation. The patients were instructed to avoid manual manipulation or tooth brushing of the surgical site; but removal of the biofilm gently with a cotton swab, drinking cold water and eating soft diet was allowed during the first two days, while avoiding hot, spicy, and crunchy foods. The periosteal sutures were removed after ten days, while the titanium tacks were released two weeks after surgery.

Photographs standardization and surface area calibration:

Digital photographs were taken for the fifteen free gingival grafts using (Nikon D5300 24.2MP CMOS Digital SLR Camera, Nikon AF-S VR Micro-Nikkor 105mm f /2.8G IF-ED Lens, Viltrox JY 670i-TTL Macro ring flash) immediately after being fixed; baseline, after one, three and six months postoperatively to allow for tracing the graft surface area throughout the complete healing phase. Meanwhile, calibrating the rate of graft shrinkage in the different postoperative time intervals, aided by a Java-based analysis software; the Image J software (Image J, National Institutes of Health, Bethesda, Maryland, USA), which can calculate area and pixel value statistics of user-defined selections, with an analysis and processing function available at any magnification factor [10].

All the photographs were standardized by capturing the same periodontal probe (UNC Periodontal probe, AR Instruments, Pakistan) in direct contact with the free gingival graft, which set a scale in the program by plotting a line parallel to the periodontal probe, where its length will be automatically transferred into pixels of calibrated distance and displayed in millimetres. Furthermore, the software allows for the computation of the graft surface area after marking its boundaries, which allows for precise identification of the progress of graft shrinkage by outlining the graft in the baseline, one, three- and six-months postoperative photographs, which was recorded, tabulated, and submitted for statistical analysis. **(Figure 2B)**

Statistical analysis

An independent investigator conducted the statistical analysis of this study, aided by IBM SPSS advanced statistics (Statistical Package for Social Sciences, Version23; SPSS Inc., Chicago, IL). The numerical data were presented as mean, standard deviation, and frequency. The Kolmogorov-Smirnov and the Shapiro-Wilk tests assessed the data normality. The ANOVA repeated measures were used to compare the dimensional changes of the free gingival grafts at the different evaluation times. (From the baseline to six months postoperatively) after calculating the mean surface area of the grafts grafted in the same patients, considering the bilateral grafts as a single unit graft. A p-value less than or equal to 0.05 was considered statistically significant.

RESULTS

This study evaluated titanium tacks for free gingival graft fixation as a sutureless technique for graft stabilization. The FGG shrinkage rate was assessed throughout the photographs taken from the baseline to six months postoperatively, standardized by the Image J software. A total of ten patients with fifteen FGG were included in the study. They were 8 females and 2 male patients with a mean age of (37.6) years and an age range of (36 to 48 years). All patients attended the six-month follow-up period. Five free gingival grafts were in the maxilla, and ten in the mandible, counting the bilateral grafts as a single unit graft.

Clinical results:

Although the preparation of the recipient site and the mucosal graft intake were favourable throughout all the cases, the palatal neurovascular bundle was injured in two instances, which was managed by introducing distal mucosal compressing sutures and applying direct pressure, after which hemostasis was assured, and the graft harvest completed. All grafts healed uneventfully; none of them were sloughed or dehisced, and none of the patients expressed significant postoperative bleeding or edema. **(Figure 3A)**. Aided by the tack driver and the mallet tapping, all gingival grafts were firmly stabilized and properly stretched with three to four tacks, according to the graft size. The tack fixation presumed less time than that usually needed for the traditional suturing technique. However, the authors experienced more stable tacks and more firm stabilization among the mandibular grafts than the maxilla.

Digital interpretation of the photographs:

I) The FGG surface area:

The surface area of the FGG, as elaborated from the Image J software, after delineating the flap borders among the different time intervals were recorded and tabulated.

II) The rates of graft shrinkage:

The ANOVA repeated measures showed a statistically significant difference in the amount of shrinkage at different time intervals (P<0.001). The significantly highest amount of shrinkage occurred from baseline to 6 months (40.97% ± 2.55).

This was followed in descending order by that observed after one month postoperative (27.64%±3.75), then that from 1 month to 6 months postoperative (18.31%±3.77), and finally that from 3 months to 6 months postoperative (11.36%±3.60). In contrast, the significantly least amount of shrinkage occurred from 1 month to 3 months (7.81% ± 2.98). The Post-hoc pairwise comparisons showed a significant difference between the graft surface area throughout all the intervals; (P<0.001). **(Figure 3B)**

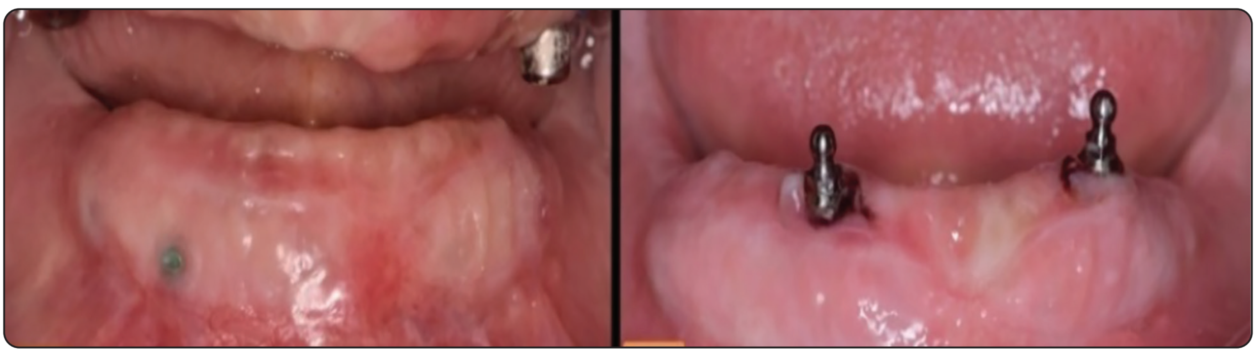

Fig. (3A): Clinical presentation of the three months and the six months follow-up period for the FGG respectively .

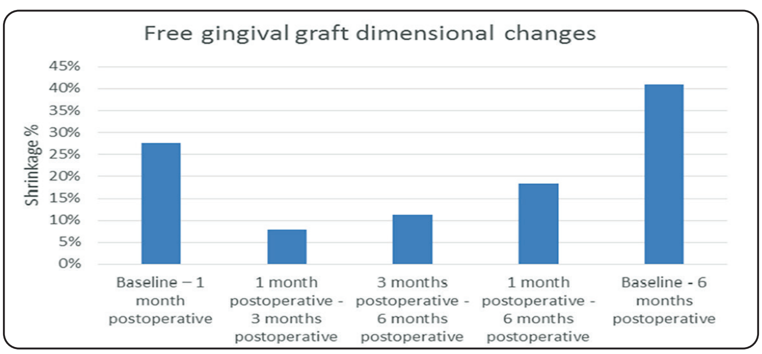

Fig. (3B): Bar chart showing percentage of free gingival graft dimensional changes at different time intervals

DISCUSSION

Free gingival graft obtained from the palate, usually replaces missing or lost keratinized tissue. Although it represents the gold standard, its success relies on providing intimate and atraumatic stabilization, as maintaining the plasmatic circulation is crucial for graft healing and perfusion, Minsk [11] considered that judging the success of FGG is based on the extent of the postoperative healing contraction and the quality of graft adherence to the underlying periosteum. In the present study, the authors evaluate the amount of graft shrinkage after punching the graft to the underlying periosteum with titanium bone tacks by implementing a software standardization for the digital photographs taken at one, three, and six months postoperatively. The authors are appraising the tacks for obviously reducing the intraoperative time, which would partially contribute to the favoured postoperative patients' response. This agrees with Griffin et al. [12], who reported that for every one-minute increase of the gingival augmentation procedure time, there is a 4% likely increase for pain and a 3% for swelling. The experienced more stable fixation of the mandibular gingival grafts than those of the maxilla suggests the tacking technique is directly proportional with the thickness of the outer cortical plate and the quality of the housing bones. Therefore, the authors recommend avoiding this technique in areas with previous local infection or a history of guided bone regeneration.

In the present study, amount of the graft shrinkage from baseline to one, three and six-months post-surgery recorded 27.64%, 33.3%, 40.9% respectively, with the highest amount of shrinkage after one month, while the least was that from elapsed between one and three months; 7.81%. This coincides with the findings of Silva et al. [13] and Sculean et al. [14] that the highest shrinkage rate occurs within the first month following the graft. The one-month graft shrinkage rate after utilizing the tack fixation counted (27.64%) versus what was reported by Barbosa et al. [15] for the one-month shrinkage of the conventional suturing technique (41%) and (39.1 %) for the cyanoacrylate, which favours the size maintenance of the tacking fixation during this phase of healing. The three and six months shrinkage average rates of the graft tacking counted (33.3%) and (40.9%) respectively, which is relatively equivalent for the microsurgical suturing shrinkage rates reported by Basegmez et al. [16]; (33%), Schmitt et al. [17]; (29%), and Parvini et al. [18]; (33%) after three months, as well as Orsini et al. [19] who reported (37.2%) and Hatipo-glu et al. [20]; (35%) shrinkage rates after six months. On the other hand, the three- and six-months results of the current study exceed those reported by James and McFall [21], who counted (40%) graft shrinkage after three months and 49% after six months, and Silva et al. [22] who detected (44%) shrinkage rate after six months.

Unfortunately, most comparative studies are based on manual caliber recording of the graft surface area, lacking any means of standardization. Gumuş and Buduneli [4] in 2004, and Parvini et al. [18] appraised the digital standardization for the accurate analysis of the graft surface area. The Image J software implemented in this study can compute a (one:one) surface area of the defined field, regardless the magnification factor of the capture and its lense-object distance. We believe that the standardized digital area calculation would define more sensitive assessments for exact amount of graft contraction. Zucchelli et al. [23] in 2020 considered that the altered rates of graft contracture among the literature could be attributed to several FGG variations concerning its thickness and recipient site characteristics. Therefore, they declared that the recorded contraction rates are influenced by graft size, quality of the surgical intervention utilized to prepare the receptor region, as well as the biotype of the receptor site, keratinized mucosal thickness, preceding bone or soft tissue grafting trials and the level and magnitude of the muscle pull.

Although various thicknesses have been postulated in the literature for optimizing the graft outcomes, neither conclusive nor evidence-based data were detected, and no proportional relation has been reported between graft size and shrinkage. It is awaiting clinical trials to determine the best consistency for the FGG that provides the least shrinkage rate and the best aesthetic and functional results. Hence, the thickness of the harvested palatal tissue was not measured in the current study, and the graft thickness and its proximity to the periosteum were not assessed.

CONCLUSION

Free gingival graft fixation with titanium tacks is a predictable technique that provides optimum fixation and graft spread while reducing intraoperative time and offers good clinical results regarding graft shrinkage, postoperative pain, and complications. However, the results are not superior to most other techniques reported in the literature. The authors recommend applying modification to the regular bone tacks design to suit the FGG stabilization, even if the underlying cortical plate is deficient.

Conflict-of-interest notification:

The authors declare that they have no present or potential conflict of interest with the contents of this article.

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