Comparative evaluation of free gingival graft and AlloDerm® in enhancing the width of attached gingival: A clinical study

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Abstract

Background: The presence of an adequate width of keratinized tissue is important to maintain a healthy dentogingival junction. In case of inadequate width of attached gingiva, the gingival augmentation procedure has been performed classically using the patient's own masticatory mucosa and more recently, using an acellular dermal allograft as the donor material. Aims: The aim of the clinical study was to evaluate and compare the effectiveness of free gingival graft (FGG) and acellular dermal matrix (ADM) allograft in the ability to increase the zone of attached gingiva. Materials and Methods: Fifteen patients with 30 sites showing the inadequate width of attached gingiva (≤ 1 mm) were enrolled for the split-mouth study. The width of keratinized gingiva and other clinical parameters were recorded at baseline and 12th month postoperatively. Statistical Analysis: The difference in clinical parameters within the group was assessed by Wilcoxon signed rank test. However, Mann–Whitney U-test was used to analyze the differences between test and control groups. Results: The width of attached gingiva increased significantly (P < 0.01) following both the treatments but comparatively lesser gain with ADM allograft (2.13 mm vs. 4.8 mm). ADM site had significantly more shrinkage (76.6%) than FGG site (49.7%). Though FGG was found to be more effective, clinicians can prefer ADM allograft because of its certain advantages over the FGG. Conclusion: ADM allograft has resulted in sufficient increase in width of attached gingiva although lesser than FGG. Considering the disadvantages of FGG, it can be concluded that ADM allograft can be used as an alternative to FGG in increasing width of attached gingival in certain clinical situations.

Keywords: Acellular dermal matrix, allograft, autograft, comparison studies, gingival grafts, soft tissue grafts

Introduction

The presence of an intact mucogingival complex including an adequate width of attached gingiva has been considered as a critical component to the protective function of mucogingival complex. Though a number of studies suggest that a minimum of 2 mm width of keratinized gingiva, corresponding to 1 mm of attached gingiva is necessary for maintaining a good periodontal health, others claim that 1 mm or less of keratinized tissue is sufficient to guarantee a healthy periodontium in the presence of good oral hygiene. The healthy keratinized nature of gingival tissue acts as a protective barrier against physical trauma caused by tooth brushing; it also facilitates plaque control and helps in the maintenance of gingival health around teeth subjected to restoration and orthodontic tooth movement. Evidence-based data also suggest that a healthy band of keratinized gingiva is necessary for the maintenance of health of the peri-implant tissues and survival of the implant.

Since the establishment of the adequate width of attached gingiva is one of the important goals of periodontal surgery, several techniques have been developed to widen the zone of keratinized gingiva and obtain the predictable outcome in improving the periodontal health. Though free gingival graft (FGG) is considered as a gold standard for the gingival augmentation procedures, several other techniques such as acellular dermal matrix (ADM) allograft, modified apically repositioned flap, tissue engineered human gingival fibroblast-derived dermal substitute, DynaMatrix extracellular rmembrane, tissue-engineered bilayered cell therapy, and mucograft collagen matrix, have been tried in periodontal plastic surgery with varying rates of success.

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The autogenous FGG has been considered the most predictable and popular procedure for increasing the width of keratinized tissue around a tooth\cite{13-16} associated with any mucogingival defect. Even though this technique shows a high degree of predictability in achieving the satisfactory final outcome, it has certain disadvantages such as procurement of FGG procedure requires an additional donor surgical site, availability of limited amount of donor tissue, leaves a wound of considerable size in the palatal donor area to heal by secondary intention causing postoperative pain, and other complications. Similarly, at the recipient site, FGG may be associated with esthetic problems due to discrepancies of color and texture between the healed graft and surrounding mucosa as well as a bulky appearance. These disadvantages of FGG have forced investigators to seek a better alternative for the gingival augmentation procedure.

The ADM allograft, which was originally used for treating the burn wounds\cite{17-19} was recently introduced in Periodontics as an alternative to FGG in increasing the width of attached gingival around the teeth\cite{20}, implants\cite{21} and in the treatment of gingival recession (GR).\cite{22} This allograft is a freeze-dried, cell free, dermal matrix comprised a structurally integrated basement membrane complex (BM C) and extracellular matrix in which collagen bundles and elastic fibers are the main components. The ADM allograft is able to act as a bioactive scaffold for migration of fibroblasts, epithelial and endothelial cells and could consistently integrate into the host tissue.\cite{23} The structural integrity of the material is maintained and it revascularizes via preserved vascular channels of the receptor site.

The purpose of this study was to evaluate and compare the clinical efficacy of autogenous FGG and ADM allograft in increasing the width of attached gingiva.

**Materials and Methods**

Fifteen patients (seven females and eight males) aged 20–55 years, having two sites with attached gingiva ≤1 mm bilaterally on the facial aspect of the mandibular teeth were selected from the out-patient Department of Periodontics. The study was approved by the Institutional Ethical Committee in accordance with the Helsinki declaration of 1975, as revised in 2000. The study was carried out on subjects having a limited amount of attached gingiva and had to fulfil the following selection criteria: (1) Good oral hygiene; (2) facial probing depths (P Ss) ≤2 mm; (3) no removable partial denture in the area to be treated; (4) not allergic to any antibiotics or any other drug to be prescribed for the patient; (5) No systemic, autoimmune or dermal diseases; and (6) nonsmoker. The procedure to be used and the potential risks and complications were discussed, and an informed consent form was signed by every participating patient. Preoperative photographs were taken for every selected patient [Figures 1a and 2a].

**Clinical assessment**

The clinical parameters including plaque index (PI); gingival index (GI), PD; GR; and the width of attached gingiva were measured at the mid-buccal point of the teeth. The junction of the attached and movable tissue was determined by rolling the alveolar mucosa coronally with the side of a probe. During surgery, the extents of the recipient bed and the graft were measured in both the mesio-distal and corono-apical directions. Both pre and postsurgical measurements were made by one examiner (C.A.) only. Measurements were made to the nearest 0.5 mm using a University of North Carolina-15 periodontal probe (Hu-Friedy) and occlusal stent (with guiding grooves). For each variable, a patient mean was calculated which was finally subjected for statistical analysis.
Gingival augmentation procedure

Both surgical procedures were performed by the same operator. Initial periodontal therapy included scaling, root planing, and oral hygiene instructions. Surgery was performed only when satisfactory plaque control was achieved and the selected surgical site was completely free from any inflammation. At the time of surgical procedure, after extra-oral scrubbing and presurgical mouth rinse, local anesthesia (xyloaine HCl, 2%) with adrenaline 1:80,000 was administered in the prepared site. A surgical blade (no. 15) was held perpendicular to the gingival surface, and a superficial horizontal incision was made just coronal to the mucogingival junction. The lips were retracted firmly as the incision was made. Two vertical incisions were made at either end of the horizontal incision. The periosteal recipient bed was then prepared by sharp dissection in an apical direction with the no. 15 blade held nearly parallel to the alveolar process. Muscles and loose connective tissue fibers were thoroughly scraped with a scalpel to prevent subsequent graft mobility. Following preparation, the FGG or ADM allograft treatments were randomly assigned to the recipient site.

Autogenous free gingival graft

A FGG from the right posterior hard palate was harvested 1 mm apical to the gingival margin of adjacent teeth with a no. 15 scalpel blade. After the donor tissue had been released, the pressure was applied with damp gauze at the donor site. The adipose and glandular tissues on the graft were removed using a scraping motion with a no. 15 scalpel blade. After the donor tissue had been shaped appropriately, it was placed on the recipient bed and fixed with periosteal sutures [Figure 1b-d]. An acrylic palatal stent was placed to cover the wound.

Acellular dermal matrix allograft

A piece of ADM allograft was prepared according to the manufacturer’s instructions and was then rehydrated in a Petridish with 50 mL of sterile saline solution for 5 min. After the protective backing paper had been floated, the ADM allograft was transferred to another dish with 50 mL of sterile saline solution for 5 min. Clinically, the connective tissue surface adsorbs blood immediately, but the BMC does not. The allograft was placed with the connective tissue surface toward the recipient bed and the basement membrane surface facing externally. The allograft was fixed on the recipient beds by periosteal sutures, and the gentle digital pressure was applied for 3–5 min to maintain the graft in close contact with the underlying periosteum [Figure 2b-d]. Finally, the periodontal dressing was applied to the operated site.

Postsurgical care

Antibiotics (amoxicillin, 500 mg, three times a day (t.i.d), for 7 days), analgesics (ibuprofen, 400 mg, t.i.d for 3 days) and chlorhexidine (0.12%) mouthwash twice daily for 6 weeks was prescribed to every patient. The patient was advised to refrain from retracting the lips and cheeks and to avoid brushing or flossing in the grafted area for 6 weeks. After 15 days, periodontal dressing and remaining sutures were removed, and the area was thoroughly irrigated with normal saline [Figures 3a and 4a]. The patient was recalled at regular intervals and followed for 12 months postoperatively and at every visit, patient’s oral hygiene status was monitored [Figures 3b and 4b].

Statistical analysis

The difference in clinical parameters such as PI, GI, PD, GR, and Attached tissue (AT) width at baseline and 12 months postoperative data within each group were assessed by Wilcoxon signed rank test. However, Mann–Whitney U-test was used to analyze the differences between test and control groups in mean PI, GI, PD, GR, AT width and the shrinkage of the graft.

Results

Clinical observations

The wound healing was uneventful without any graft-related adverse effects. The postoperative examination after
12 months revealed increased zone of attached gingiva both in FGG and ADM allograft groups though FGG showed far superior results than the ADM group. On the other, there was an excellent blending of color and texture with the adjacent native tissues at the ADM-treated sites though FGG-treated sites were associated with the slightly different color of the healed tissues with visible borders demarcating the adjacent areas. In ADM allograft group, the epithelization appeared at 4 weeks and keratinization of newly formed attached tissue was not obvious until 6–8 weeks postoperatively. Maturation and stability of the attached gingiva were achieved at 12 weeks and were maintained till 12 months postoperatively. However, the healing period appeared slightly longer for ADM allograft than the FGG.

**Clinical measurements**

On comparison between baseline and 12 months postoperative evaluation, no statistically significant difference ($P > 0.05$) was found for any of the variables (PI, GI, PD, and GR) between FGG and ADM allograft groups (Mann–Whitney U-test) [Table 1]. The width of attached gingiva increased significantly ($P < 0.01$) following both the treatments. However, the sites treated with ADM allograft demonstrated a comparatively lesser gain in the width of attached gingiva than the FGG-treated sites at 12 months of postsurgery (2.13 mm vs. 4.8 mm, respectively) [Table 2]. This difference in increased width of attached gingiva between the two treatment modality was statistically significant ($P < 0.01$). Comparison of the percentage shrinkage of the grafts between the two groups at baseline and 12 months showed that ADM site had significantly more shrinkage (76.6%) than FGG site (49.7%) [Table 3].

**Discussion**

It has been postulated that the presence of an inadequate width of keratinized gingiva around the teeth and implants is often associated with difficult plaque control, persistent gingival inflammation, and GR. For decades, one of the main goals of mucogingival surgical procedures was to widen the zone of attached gingiva in areas where it is deficient to improve the periodontal health. The controversy continues to exist regarding the philosophy of determining how much attached gingiva, if any, was required for maintaining good gingival health. Though some authors advocated the requirement of a minimum of 2 mm width of attached gingiva sufficient to guarantee a healthy periodontium, other observations indicated that even < 1 mm of attached gingiva is adequate when marginal inflammation is under control. However, evidence-based data seem to suggest that an intact mucogingival complex including an adequate band of keratinized gingiva is necessary for maintaining the sustained periodontal health.

Though the technique of FGG is in the practice since its introduction in 1963, it is still considered as gold standard and the most predictable gingival augmentation procedure. The term “Free gingival graft” seems to be misleading because “free gingiva” is the unattached gingiva surrounding the teeth and this tissue is not used in the grafting procedure. In addition, the palatal tissue used for grafting is not actually “free gingiva but technically masticatory mucosa.” However, these terminologies are routinely in practice despite their ambiguous meaning and description. The clinical performance of autogenous FGG is always considered superior to other

### Table 1: Pre and postsurgery (12 months) clinical measurements in the ADM and FGG

| Parameters | FGG | ADM |
|---|---|---|
| PI | Mean±SD | Mean±SD |
| Presurgery | 1.53±0.40 | 1.82±0.86 |
| Postsurgery | 0.82±0.20 | 0.85±0.23 |
| GI | Mean±SD | Mean±SD |
| Presurgery | 1.82±0.32 | 1.81±0.27 |
| Postsurgery | 0.33±0.44 | 0.35±0.21 |
| PD | Mean±SD | Mean±SD |
| Presurgery | 1.40±0.66 | 1.50±0.71 |
| Postsurgery | 0.20, NS | 0.12, NS |

*Wilcoxon’s signed rank test; Mann–Whitney test. ADM: Acellular dermal matrix; FGG: Free gingival graft; PI: Plaque index; GI: Gingival index; PD: Probing depth; SD: Standard deviation; NS: Not significant

### Table 2: Pre and postsurgery (12 months) measurements of gingiva in the ADM and FGG groups

| Parameters | FGG (site A) | Alloderm (site B) | A versus B |
|---|---|---|---|
| Keratinized gingiva | Mean±SD | Mean±SD | Mean differences | P* |
| Baseline (mm) | 1.62 | 1.62 | 3.14 | <0.01 S |
| 12 months (mm) | 3.09 | 2.27 | 2.68 | <0.01 S |
| Differences (mm) | 1.27 | 0.81 | <0.01 S | 0.14 |
| Attached gingiva | Mean±SD | Mean±SD | Mean differences | P* |
| Baseline (mm) | 0.05 | 0.14 | 2.68 | <0.01 S |
| 12 months (mm) | 4.86 | 2.27 | 3.14 | <0.01 S |
| Differences (mm) | 4.81 | 2.13 | 2.68 | <0.01 S |

*Wilcoxon’s signed rank test; Mann–Whitney test. ADM: Acellular dermal matrix; FGG: Free gingival graft; S: Significant
contemporary gingival augmentation procedures in terms of its effectiveness, reliability, and a high degree of predictability, as also was evident in the present study.

In the present study, though there was a significant improvement in clinical parameters, in both the gingival augmentation procedures when baseline parameters were compared with 12-month follow-up data. However on the inter-group comparison, a significant difference was found between the two treatment modalities in terms of the key variables such as increase in the amount and resultant width of keratinized gingiva; the ADM allograft was found comparatively less effective and less predictable than the autogenous FGG. These results are in agreement with that of other studies[7,8] and may be attributed to the cumulative effects of significant structural differences that exist between FGG and ADM allograft. Since the nonvital matrix of ADM allograft has no blood vessels or cells, its incorporation is slower and depends exclusively on cell and blood vessel infiltration from the periosteum and the gingival corium that covers it. The ADM allograft may eventually be replaced by surrounding tissues manifesting unfavorable healing characteristics and inconsistent quality of gained attached gingiva. The lack of ability of epithelial differentiation predominantly explain the more shrinkage in ADM than FGG (76% vs. 49%) and thus less gain in the width of attached gingiva than the autogenous FGG in 12-month follow-up[7,28] though other studies reported the comparable outcome in both the treatment groups.[29]

Despite its clinical superiority and more predictability, certain disadvantages associated with FGG continue to spur interest for the less invasive alternatives. In the present study also, the esthetic results varied greatly in both the groups; the FGG tended to create a more “patch-like” appearance whereas the ADM allograft yielded better color and tissue blending than the FGG. Similar observations were made by other authors in their respective studies.[7,19,22] This phenomenon of “patch-like” appearance can readily be explained by the fact that by retaining viable cellular components, the FGG remains vital at an ectopic site and stubbornly expresses the characteristics of palatal mucosa. On the other, ADM allograft being biologically compatible with the oral tissues is replaced by invading tissue from the adjacent areas and is most likely incorporated into the site and finally remodeled; it seems that the ADM graft itself had little influence on epithelial differentiation. The type of epithelium that covered the allograft seems to have been determined by the surrounding tissues. In addition, this nonimmunogenic freeze-dried allograft demonstrates no anti-human leukocyte antigen antibody activity following its placement in humans.[8]

Though, the ADM allograft is slightly less predictable and effective in gingival augmentation procedure, it is sufficient to maintain good oral hygiene and resolve persistent gingival inflammation. It also has certain advantages such as (1) not requiring second surgical site for graft procurement, (2) less invasive surgical procedure with reduced morbidity (3) it provides a uniform thickness; easily trimmed, well adaptable material, and requires a short time (<10 min) to rehydrate before it can be used. (4) Minimal postoperative pain without any adverse complications (5) seems to be easily handled material (6) complete integration with the host tissues (7) ADM sites have subjectively demonstrated better esthetics and blending with the surrounding tissue and (8) unlimited supply to treat the larger and multiple sites. These features suggested that ADM can be effectively used as an alternative to autogenous gingival graft for gingival augmentation procedures. However, further studies are necessary with larger sample size and long-term follow-up to validate the results and for further insight into the use of tissue engineering in gingival augmentation procedure and also compare it with other recent advances in this field.

**Conclusion**

The results of the present clinical investigation comparing the effectiveness of FGG and ADM allograft support further studies in this direction to explore the possibility of using ADM allograft as a substitute to FGG in augmenting the areas deficient in keratinized gingiva.

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**Conflicts of interest**

There are no conflicts of interest.

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**Table 3: Comparison of graft shrinkage in FGG and ADM groups**

| Group | Graft width (mm) | AG increase (mm) | Shrinkage rate (%) |
|-------|------------------|------------------|--------------------|
| FGG   | Mean±SD 9.53±0.74 | 4.7±1.8          | 49±19              |
| ADM   | Mean±SD 9.53±0.99 | 7.2±1.25         | 75±8               |
| P     | 0.70             | 0.001*           | 0.001*             |

*Mann–Whitney U-test. ADM: Acellular dermal matrix; FGG: Free gingival graft; SD: Standard deviation; AG: Attached gingiva*
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