Classification of Soft Tissue Grafting Materials Based on Biologic Principles

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Since periodontal plastic surgery’s recent emergence and continuous, extensive development, various treatment modalities and materials have been developed alongside it to help clinicians pursue optimal esthetics and long-term stability around natural teeth and dental implants. To achieve satisfying and predictable long-term outcomes, promote more predictable results, and reduce complications following periodontal plastic surgery procedures, the authors reviewed articles published in peer-reviewed journals to better understand the biologic principles and potential of the soft tissue grafting materials and techniques being applied. That information was used to support a new classification system. This system aims to give clinicians guidance when selecting the most appropriate grafting materials and techniques for periodontal plastic surgery, using the graft materials’ two most important features to guide the consideration/decision process: the source of blood supply and whether the grafts contain vital cells.


Using soft tissue grafts to treat localized gingival recession can be dated back as early as the 1950s. However, it was not until 1988 that Miller proposed the modern definition of mucogingival surgery and coined the term “periodontal plastic surgery.” Because autogenous grafts provide great predictability and stability, using them to correct soft tissue deformities and enhance esthetic outcomes has become one of the most advocated surgical techniques. However, a major disadvantage of harvesting autogenous tissue is the increased risk of donor-site morbidity, which may result in postoperative discomfort and limited volume of donor tissue. Recently, substitute grafting materials have been developed, aiming to avoid donor site morbidities, provide comfort, and improve patient acceptance. Though there are studies in the literature that have researched clinical applications of different grafting techniques, there is little information on the classification of grafting materials based on their biologic potential. The aim of this paper is to provide a better understanding of the different types of soft tissue grafting materials and make suggestions for material selection to best facilitate meeting treatment goals and providing long-term stability and esthetic outcomes.
Classifying Soft Tissue Grafting Materials

The aim of soft tissue grafting is to augment the zone of keratinized tissue, increase tissue thickness, and achieve root coverage. When selecting certain grafting materials for correcting soft tissue deformities, it is critical to first consider the treatment purpose. Once the surgical goals have been established, clinicians may refer to this classification of grafting materials based on their biologic features. The most important feature to classify soft tissue grafting materials is whether the material bears vital cells or not (Fig 1). Generally speaking, autogenous soft tissue grafts contain the patient’s own vital cells, such as keratinocytes and fibroblasts, while allogenic and xenogenic materials undergo the decellularization process. After reviewing the classifications, clinicians can continue to follow the decision tree for selection of grafting techniques, as proposed by Leong and Wang in 2011.

Vital Cell–Containing Grafting Materials

Autogenous soft tissue grafts contain vital cells that are mostly made up of keratinocytes in the epithelial layers and fibroblasts in the connective tissue layers. Therefore, when using autogenous grafts to correct recession defects, clinicians may anticipate creeping attachment and an increase in the width of keratinized tissue. For instance, 1 year after free gingival graft (FGG)
surgery, creeping attachment can occur with an average growth of 0.89 ± 0.46 mm. Harris also demonstrated a comparable result in patients who experienced an average creeping attachment of 0.8 mm after receiving a connective tissue graft (CTG) combined with a double pedicle flap (Fig 2).

Vital cell–containing grafting materials can be subsequently classified into two different categories based on their blood supply. The first category is autogenous grafts that maintain the blood supplied from donor sites, and this includes rotational flaps (Fig 3), pedicle sliding grafts, the coronally advanced

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**Fig 2** Connective tissue graft case in the mandibular left second premolar. (a) Preoperation. (b) Trapezoid flap design. (c) Connective tissue graft with epithelium collar harvested. (d) 1-week follow-up. (e) 12-week follow-up. (f) 24-week follow-up.

**Fig 3** Palatal rotational flap case. (a) Preoperation. (b) Extraction of the right maxillary canine. (c) Palatal-rotational flap harvested. (d) Suture. (e) 3-week follow-up. (f) 6-month follow-up.
flap (CAF), double papilla flap, apically positioned flap (APF), semilunar flap, and palatal advanced flap (Fig 1). In those cases, because the blood supply is still maintained, better postoperative healing may be anticipated. The other category is autogenous grafts that are deprived of their original blood supply, including FGG, de-epithelialized CTG, and subepithelial CTG (Fig 1). The key to ensuring the survival of these free grafts is to have sufficient areas of the grafts in close contact with the recipient tissue bed to establish revascularization between the bed and the pre-existing vessels in the graft.10

**Grafting Materials Not Containing Vital Cells**

Grafting materials that do not contain vital cells for soft tissue augmentation include allogenic material (acellular dermal matrix [ADM]) or xenogenic material (xenogenic bioabsorbable collagen matrix [XBCM]). These types of graft materials are primarily used to augment tissue thickness instead of increasing the width of keratinized tissue. ADM is the human dermis harvested from cadavers. It is decellularized, leaving only the extracellular matrix intact to act as a support for patients’ tissues to vascularize and integrate into the matrix (Fig 3). XBCM is another choice for material that does not contain vital cells. Two examples of commercially available XBCM are Mucograft (Geistlich Pharma North America), derived from porcine skin, and DynaMatrix (Keystone Dental), derived from porcine small intestine submucosa. The major advantages of ADM and XBCM are their unlimited supply of, and complete elimination of morbidity at, donor sites. However, when compared to autogenous CTG, there is less predictable creeping attachment after grafting11,12 and grafts that do not contain vital cells are less effective at increasing keratinized tissue width.13

**Acellular Dermal Matrix**

ADM was first developed to replace FGG and CTG with the intent to eliminate a secondary wound resulting from harvesting autogenous grafts. When comparing tissue thickness and recession improvement, most of the short-term follow-ups in clinical studies (up to 6 months) indicated comparable results for ADM and autogenous grafts.13–16 However, regarding graft shrinkage, one study indicated that even with a wider ADM graft (average width = 8.81 mm) applied to the treatment sites to increase the width of keratinized gingiva, the keratinized
gingival gain was significantly lower (2.59 mm) compared to the FGG group (5.57 mm gain; average graft width = 6.70 mm), and the graft shrinkage was significantly greater in the ADM group than in the FGG group (71% vs 16%, respectively).²² Most clinical studies presented short-term follow-ups (up to 1 year); however, long-term follow-ups are more critical for evaluating the performance of grafting materials. As a 4-year follow-up report to his study in 2000 on root coverage using ADM or CTG, Harris reported results in 2004 that demonstrated that CTG tends to present more predictable and stable outcomes (97% root coverage vs 65.8% in ADM).¹⁷ When comparing the results of CAF with ADM grafting (CAF+ADM) to CAF alone, CAF+ADM had significantly higher root coverage (99%) than CAF alone (67%). Also, marginal soft tissue thickness was increased 0.4 mm in CAF+ADM with almost no gain in the CAF-alone group.¹¹

Histologic evaluations supported that, despite having a slightly different appearance under a microscope, both CTG and ADM could be used to successfully cover roots with similar attachments.¹⁶ However, no creeping attachment could predictably be anticipated when using ADM in cases of denuded roots or implant-associated soft tissue defects.⁶,¹¹,¹⁵ Indeed, ADM can be anticipated to increase tissue thickness when used in combination with CAF or tunneling techniques; however, there is no adequate evidence to support the concept that ADM can predictably increase the zone of the keratinized gingiva.

**Xenogeneic Bioabsorbable Collagen Matrix**

Similar to ADM, XBCM demonstrated comparable short-term results compared to autogenous grafts (ie, CTG) when used to augment thin tissue or for recession treatments.¹⁶–²¹ However, when long-term (5 years) follow-up results were compared, CTG+CAF had an average of 95.5% root coverage vs 77.6% in XBCM+CAF group.²² A systematic review concluded that there is no sufficient evidence to demonstrate the effectiveness of XBCM in increasing root coverage or gain in keratinized tissue compared to CTG+CAF.²³ However, superior short-term results are possible for treating root coverage using XBCM compared with CAF alone, and a previous study demonstrated mature keratinized epithelium when a biopsy was performed after the XBCM was healed for 12 months.²⁰,²¹ Despite this, there is still a lack of sufficient and conclusive evidence to support stable long-term clinical outcomes.²³

Though ADM and XBCM could be used for augmenting gingival thickness, these grafts do not contain vital cells and therefore have limited potential to achieve creeping attachment or increase the width of keratinized tissue. In short-term follow-ups, ADM and XBCM might present comparable results to autogenous grafting materials, but long-term stability still favors CTG or FGG (Fig 4).

According to the AAP regeneration workshop, CTG-based procedures have shown the best outcomes for root coverage and increased keratinized tissue width, especially when treating Miller Class I and II gingival recessions.²⁴ When considering treatment to increase tissue thickness, ADM or XBCM would be the potential materials to replace autogenous tissue harvesting and eliminate a secondary wound. However, ADM and XBCM are viable options only if considering augmenting the tissue thickness, given that these grafting materials do not contain vital cells and thus have limited potential for creeping attachment and increasing keratinized tissue width. Soft tissue grafts that contain vital cells pose a better chance of creeping attachment and have a better potential of increasing keratinized tissue width. Furthermore, better long-term stability is expected of the treatment outcome (Fig 1).

**Conclusions**

This article is one of the first to describe a classification of soft tissue grafting materials based on the current available evidence and the authors’ clinical experience. When selecting soft tissue grafting materials and techniques for periodontal plastic surgery, it is most important to consider the source of blood supply for the grafts and whether the grafts contain vital cells or not. Based on these two major biologic features, clinicians can select a most-optimal material to achieve the surgery goal. This clinical guideline of soft tissue grafting materials aims to provide an understanding of different grafting types and their biologic basics. As the most appropriate procedures and materials are selected based on treatment needs
and goals to achieve better and more predictable clinical outcomes and maintain long-term stability, this guide facilitates the clinicians’ decision process.

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