

Adipose Tissue-preserved Skin Grafts for Lower Extremity Defects: Recommendations to Optimize Outcomes

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Background: Adipose tissue-preserved skin grafts (ATPSGs) are full-thickness skin grafts with inclusion of a thin layer of adipose tissue. ATPSGs are recommended for reconstruction of anatomic areas that are cosmetically sensitive and for areas that functionally benefit from additional soft tissue thickness compared to traditional skin grafts. Careful intraoperative technique and postoperative care are mandatory for ATPSG success, given the expected higher metabolic demands compared to traditional grafts. A strict postoperative protocol is especially important after reconstruction of lower extremity defects.

Methods: Detailed descriptions of intraoperative and postoperative care for ATPSG reconstructions are provided. A case is presented displaying lower extremity reconstruction with an ATPSG. The intraoperative technique includes meticulous hemostasis of the recipient site, atraumatic handling of recipient skin edges, anatomical epidermal-to-epidermal reapproximation, avoidance of tissue strangulation during inset, and careful bolster placement. The postoperative protocol after lower extremity reconstruction includes strict elevation, non-weight-bearing status, and eventual dangle protocol.

Results: An 85-year-old woman was treated with an ATSG for a middle-third leg resection of squamous cell carcinoma resulting in a 9 × 5 cm defect. The strict postoperative protocol was initiated, but the patient was noncompliant with elevation and weight-bearing restrictions. She had postoperative congestion and epidermolysis that was treated with local wound care without need for additional surgery.

Conclusions: There are many benefits to ATPSG reconstruction when chosen for the appropriate candidate. The meticulous technique and strict adherence to the postoperative protocol are crucial when these reconstructions are performed. Detailed descriptions of intraoperative and postoperative recommendations to optimize outcomes after ATPSG are presented. (*Plast Reconstr Surg Glob Open* 2020;8:e2584; doi: [10.1097/GOX.0000000000002584](https://doi.org/10.1097/GOX.0000000000002584); Published online 19 March 2020.)

INTRODUCTION

Adipose tissue-preserved skin grafts (ATPSGs) are full-thickness skin grafts with inclusion of a thin layer of adipose tissue. These composite grafts have been previously studied and supported by the senior author for

reconstruction of defects with deeper contour irregularities. A retrospective study evaluating 72 consecutive ATPSG reconstructions performed by the senior author concluded that ATPSG reconstruction is safe with low complication rates; there were no instances of graft failure in the studied sample.¹ The authors reported success in various anatomic locations for defects of various sizes, with superior contour and color match compared to traditional graft reconstruction.¹

ATPSGs are recommended for reconstruction of anatomic areas that are cosmetically sensitive and for areas that functionally benefit from additional soft tissue thickness compared with what is obtained with full or split-thickness skin grafts. Careful intraoperative technique and postoperative care are mandatory for ATPSG success, given the expected higher metabolic demands compared with

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traditional grafts. A strict postoperative protocol is especially important after reconstruction of lower extremity defects.

METHODS

Detailed descriptions of intraoperative and postoperative care for ATPSG reconstructions are provided. A case is presented displaying lower extremity reconstruction with an ATPSG.

Technique of Harvest

Before ATPSG harvest, the wound bed is prepared with meticulous hemostasis. If tourniquet is used for excision, it is released before reconstruction to ensure that hemostasis is thorough and adequate. Electrocautery is avoided along the dermis and subdermal plexus, which are handled atraumatically. A template is created from the defect and translated onto the donor site with a marking pen; typical donor sites include the lower abdomen or groin. From this template, an elliptical graft is designed to facilitate closure after harvest. An incision is made along the ellipse into the superficial subcutaneous fat, and the graft is elevated off of the underlying tissue with inclusion of a thin layer of subcutaneous adipose tissue. The final graft is evaluated and adipose tissue is trimmed as needed to ensure that the total thickness of the graft is no more than 4mm. The excess graft is trimmed as marked by the original template, drawn with exact dimensions of the defect. The initial primary contraction of the graft is expected after harvest, resulting in a graft that is slightly smaller than the defect; this is intentional, as slight stretch on the graft will return it to its original dimension and tension. Excess graft, in contrast, would increase the risk of shear.

The donor site is closed in layers with absorbable, buried sutures after careful hemostasis is obtained. Skin glue is applied followed by a water-resistant dressing, which is removed on postoperative day 2.

Technique of Inset and Bolster Placement

The graft is oriented and placed onto the prepared wound bed. The graft is secured with interrupted simple sutures, placed carefully to achieve anatomical epidermal-to-epidermal reapproximation along the entire border of inset. Sutures are passed close to the tissue margins approximating the thickness of the epidermis and dermis to facilitate exact coaptation, and knots are placed without strangulation. Loupe magnification is used to confirm that sutures are placed precisely and that there is an adequate number of sutures to achieve circumferential apposition without any gapping. The inset is first completed on one side of the defect, providing stability to allow the remainder of the graft to then be pulled to reach the other side of the defect. As previously stated, graft redundancy is avoided and the graft is intentionally placed on slight stretch during inset to minimize the effect of primary contraction. Before completion of inset, an angiocatheter on a syringe is used to spray thrombin underneath the graft and onto the wound bed, followed by administration of a 1:1 mixture of 2% plain lidocaine and 0.5% bupivacaine with epinephrine.

Bacitracin is applied to the ATPSG reconstruction, followed by a single layer of petroleum impregnated gauze cut to size to extend 1 cm past the suture lines. Sequential layers of cotton under cast padding are then placed over the petroleum-impregnated gauze and wetted with saline, until there is ample cotton to provide an effective bolster. Using a laparotomy pad and gentle compression, the saline is absorbed and the cotton dressing sinks in to conform to the graft. An additional layer of petroleum-impregnated gauze is placed over the cotton to complete the bolster. 4-0 nylon sutures are placed within the native skin surrounding the reconstruction, at least 0.5cm away from the suture line. These sutures are placed symmetrically on either side of the reconstruction, and then both tails from each suture are tied as a unit to the mirrored suture on the other side; the sutures are not tied down to the native skin to facilitate eventual suture removal. Sutures are placed in this fashion until the bolster is well secured with adequate and even compression achieved over the graft. Suture placement is kept away from the reconstruction to avoid lifting of the peripheral graft margins off of the wound bed as the sutures are tied. Extremity reconstructions are further secured with splint immobilization.

Postoperative Protocol

For nonextremity reconstructions, patients can ambulate and be discharged immediately following surgery. Patients are instructed to keep the dressing clean and dry, and to avoid any strenuous activity. On postoperative day 7, the bolster is removed and the graft is inspected.

For lower extremity reconstructions, patients are admitted and placed on bed rest with strict elevation and a non-weight-bearing status of the affected extremity. Patients are kept on strict bed rest until 24 hours post-surgery, at which point they are permitted to get out of bed and into a chair with the grafted lower extremity elevated. On postoperative day 7, the dressings and splint are removed and a dangle protocol is initiated. The dangle protocol includes dependency of the extremity for 1 minute every hour while awake the first day; this is advanced to 2 minutes per dangle the second day, followed by 4 minutes the third day. The ATPSG is monitored during dangles; if graft congestion or patient discomfort occurs during a dangle, the extremity is elevated and further dangles are potentially postponed depending on the severity. Once the patient is able to tolerate 4-minute dangles, he or she can transfer to the bathroom, weight bear as tolerated, and be discharged home.

RESULTS

Case Report

An 85-year-old woman presented with a biopsy-proven invasive squamous cell carcinoma on the anterior middle-third of her leg, measuring 6 × 4 cm. The lesion had associated ulceration and cellulitis, and an adjacent solar keratosis measuring 3 × 2.5 cm. Her past medical history included chronic skin changes consistent with venous insufficiency, nonobstructive coronary artery disease,

chronic obstructive pulmonary disease, and hypertension. She was treated preoperatively with oral antibiotics until there was full resolution of cellulitis.

Excision and ATPSG reconstruction were performed under monitored anesthesia care with local field blocks. The 2 lesions shared a contiguous border and were excised en block under loupe magnification with a 2-mm margin, resulting in a 9×5 cm defect resulting in exposed tibia with intact periosteum (Fig. 1). Immediate reconstruction was performed to minimize trips to the operating room; negative margins were confirmed with frozen pathology evaluation before reconstruction. ATPSG reconstruction was chosen over a traditional graft to provide more robust coverage over the bone. Furthermore, the authors felt that the patient was not a good candidate for larger procedures such as locoregional or free flaps given her medical comorbidities. The superior end of the defect was closed primarily, and the remaining defect was covered with an ATPSG harvested from the flank; the donor site was closed primarily (Fig. 2). After reconstruction and bolster placement, the leg was immobilized with a posterior splint.

The patient was admitted and the postoperative dressing was removed postoperative day 7, at which time the ATPSG was found to have moderate congestion and a 2.5×1.5 cm area of epidermolysis (Fig. 3). The patient revealed that she had been noncompliant with strict elevation recommendations. Given the stressed appearance of the ATPSG, the dangle protocol was delayed until postoperative day 10. She tolerated initiation of the dangle protocol well, and was discharged on postoperative day 11 with instructions to advance dangles according to the protocol.

The patient was followed postoperatively and the areas of epidermolysis were treated with local wound care. During her postoperative course, she underwent MOHS surgery for an adjacent lesion (Fig. 4). She went on to heal without need for further surgical intervention (Fig. 5).

DISCUSSION

Understanding the process of graft take and the unique features of composite grafts is necessary to optimize chances of ATPSG survival. Initially skin grafts are ischemic after placement and receive nutrients from the underlying wound exudate via plasmatic imbibition. Inosculation begins around 48 hours after surgery, with formation of anastomoses between vessels in the wound bed and vessels in the dermis of the graft. This is followed by formation of new blood vessels supplying the graft during revascularization.² Disruption of vascular attachments to the graft can result in partial or complete graft failure, and can occur with fluid collection, infection, shear forces, or other factors. Graft loss is more common in full-thickness and composite grafts, which have more soft tissue requiring nourishment.²

Given the higher metabolic demands of composite grafts and the longer diffusion distance during imbibition, rapid revascularization is necessary for their survival.^{3,4} Early circulation to the graft can be established by formation of vessel anastomoses from the subdermal plexus of the recipient site to the subdermal plexus of the graft.² Although noncomposite skin grafts revascularize primarily from the deep surface of the graft, composite grafts require such inosculation from the wound margins to survive.⁵ For this reason, the wound edges should be handled atraumatically, electrocautery along the dermis and subdermal plexus should be avoided, and careful epidermal-to-epidermal apposition should be achieved during inset to align the dermis and subdermal plexus to encourage revascularization from the graft edges.

To maintain circulation, prevention of hematoma and shear forces is especially critical in ATPSG reconstruction; meticulous hemostasis, effective bolster placement, and strict immobilization are essential to optimize outcomes in these procedures. Relative contraindications to ATPSG reconstruction include factors that increase risk for hematoma, including coagulopathies, use of anticoagulants,

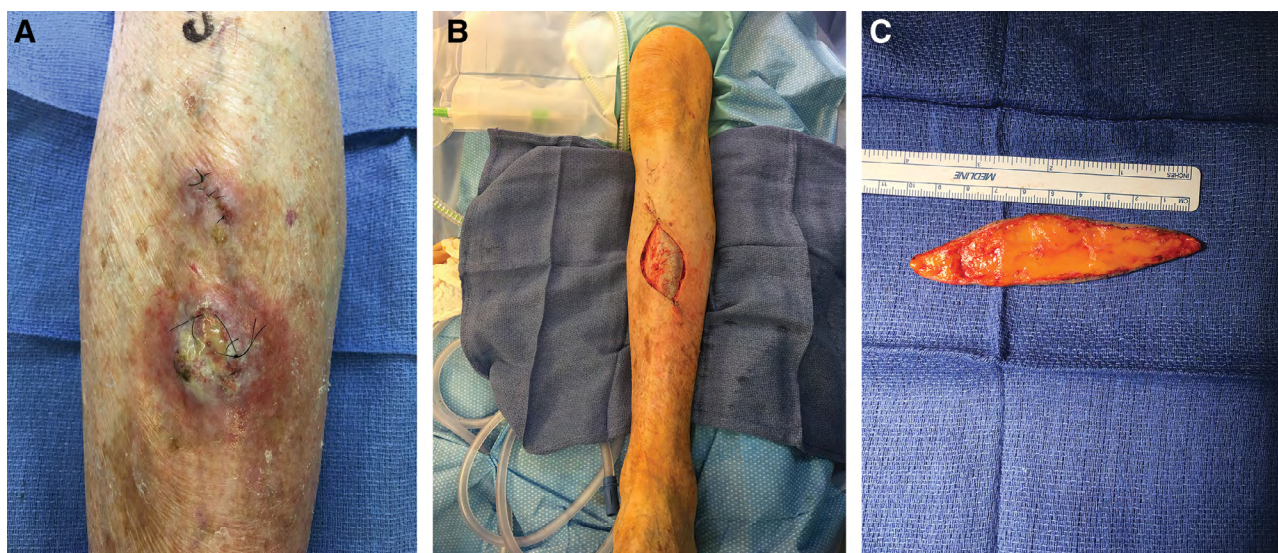


Fig. 1. Intraoperative photographs showing initial lesion (A), postexcisional defect (B), and harvested adipose tissue-preserved skin graft (C).

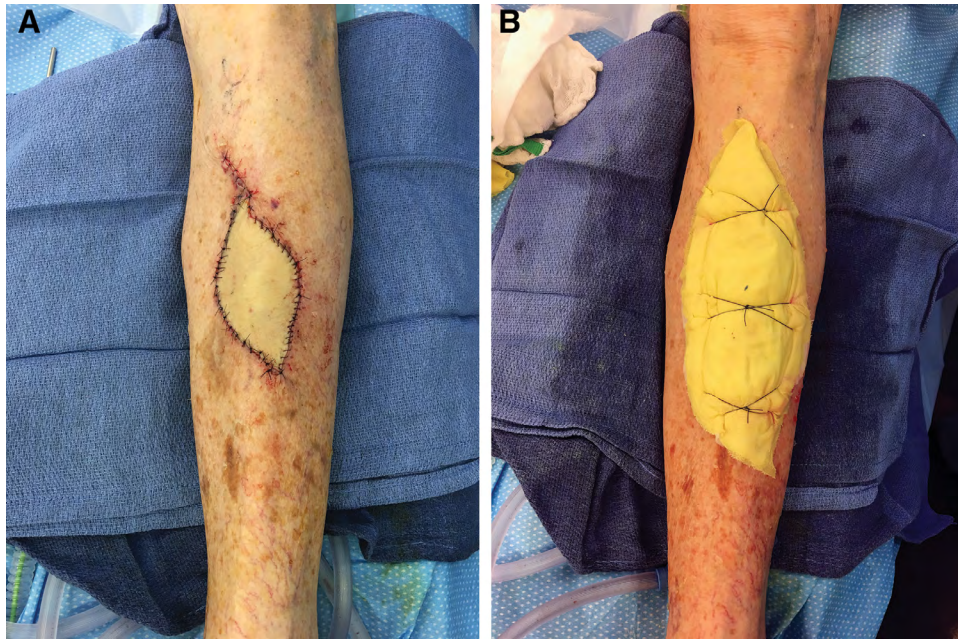


Fig. 2. Intraoperative photographs showing inset of adipose tissue-preserved skin graft (A) and bolster placement (B).



Fig. 3. Postoperative photograph taken seven days after surgery, showing partial epidermolysis of adipose tissue-preserved skin graft.

and hypertension. Other relative contraindications include factors that can inhibit revascularization and wound healing, such as tobacco use, diabetes mellitus, vascular disease, nutritional deficiency, corticosteroid use, immunosuppression, active chemotherapy, or history of recipient site irradiation. Furthermore, adequate wound bed preparation and a well-vascularized recipient site are required.

Like other composite grafts, ATPSGs progress through phases of vascularity as they heal. Initially, composite grafts appear white due to ischemia. Typically, the graft will transition to a pale pink color by 6 hours, followed by a blue congested appearance after 1–2 days. After about a week, congestion resolves as venous drainage develops, and the graft takes on a pink color demonstrating successful revascularization.⁴ Patients should be counseled that discoloration may still be present at time of bolster take-down, and may take several weeks to fully resolve. Soon after revascularization, new vessels and anastomoses are tenuous and vulnerable to excessive hydrostatic pressure or disruption from mild trauma. For this reason, it is critical that patients are compliant with postoperative activity restrictions, including the dangle protocol which is utilized to avoid overwhelming the newly developed venous system. If an eschar does develop, it should initially be left in place to prevent further injury to the graft until the underlying dermis can be inspected for viability.

Presented is a case in which an anterior leg oncologic defect was reconstructed with an ATPSG. The case was complicated by insufficient revascularization and delayed healing after patient noncompliance, illustrating

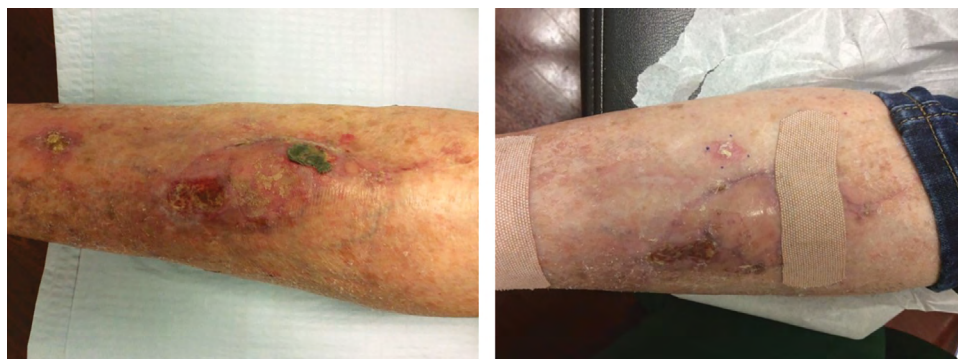


Fig. 4. Postoperative photographs taken before MOHS excision of adjacent defect, showing healing areas of epidermolysis.

the importance of strict adherence to the postoperative protocol following ATPSG reconstruction; her history of venous insufficiency likely contributed as well. Despite



Fig. 5. Postoperative photograph taken 7 months after ATPSG reconstruction. ATPSG, adipose tissue-preserved skin grafts.

focal areas of epidermolysis, the reconstruction went on to heal successfully without need for further surgical intervention. Given the high metabolic demand of the ATPSG, delayed healing and epidermolysis can be expected in a portion of patients. Other authors have reported similar phases of composite graft epidermolysis, followed by healing without further intervention and without effect on final outcome.^{6,7} To minimize these risks, extensive counseling and close patient monitoring is required to promote patient compliance. Patients are kept inpatient for an extended period of time to optimize adherence to activity restrictions, given the early fragility of ATPSGs. Despite lengthy duration of hospitalization, ATPSG reconstruction has many benefits over locoregional and free flap reconstructions in patients who are appropriate candidates. Benefits include comparatively less operative time, improved patient safety in those who cannot tolerate longer procedures, and preservation of other reconstructive options if needed. ATPSG reconstruction also offers benefits over traditional skin grafts, with improved contour, color, and durability once healing is completed. Another alternative is staged reconstruction with application of a dermal regenerative template followed by subsequent grafting; however, this requires multiple trips to the operating room. Limitations to ATPSG include need for careful patient selection, absolute compliance, and lengthy hospitalization. Although ATPSG has sparked much discussion, the authors recommend consideration when more robust coverage than traditional graft is warranted in patients who cannot tolerate larger procedures or staged reconstructions.⁸⁻¹²

CONCLUSIONS

The authors present detailed descriptions of intraoperative and postoperative recommendations to optimize chances of ATPSG survival. A case is presented illustrating the need for meticulous technique and strict adherence to the postoperative protocol when these reconstructions are performed. The authors feel that there are many benefits to ATPSG reconstruction, and it should be considered as an option in the appropriately selected patient. Early graft fragility can be overcome with detail-oriented care, as illustrated by the senior author's success performing these procedures.

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