The Diabetic Foot Special Section

Wound Closure Surgery for DFU's

Split-thickness skin grafting is a viable option for rapid wound healing.

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Introduction

Diabetes affects 387 million people worldwide and this is estimated to increase to 642 million by 2040.[1] Of those diagnosed with diabetes, the lifetime incidence of diabetic foot ulcers is 25% with a lower extremity amputation rate of 25%. The five-year mortality rate in complicated diabetic foot ulcers ranges from 39-80%.[2,3] Financially, diabetic foot complications have been a major public burden around the world and they add an additional $9 to $13 billion to the $245 billion spent annually on diabetic patients in the United States.[1]

Many factors contribute to wound healing, including vascular supply, pressure, glycemic control, wound care, nutrition, and other co-morbidities. Many modalities have been described to assist in wound closure—including negative pressure wound therapy (NPWT), bio-engineered tissue, off-loading devices and split-thickness skin grafting (STSG), and a myriad of topical wound dressings. At Southern Arizona Limb Salvage Alliance, we routinely utilize STSG to achieve closure, including the plantar aspect of the foot, as it has been shown to successfully and rapidly heal diabetic foot wounds.[4-8]

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Approach to STSG in People with Diabetes: Toward Wound Closure Surgery

We strongly believe in getting to "closure" as soon as is safe, allows for foot function, and is possible in many people with lower extremity tissue loss. To that end, when we have achieved a healthy wound bed, we will almost always consider a skin graft as a possible option.[6] Our approach to any diabetic foot wound is multi-disciplinary. We evaluate the patient's wounds, vascular status, co-morbidities, glycemic control, and social conditions. If a patient has a diabetic foot infection, we perform aggressive debridement, incision and drainage with resection

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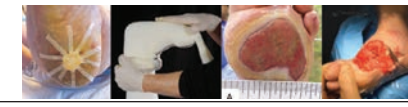

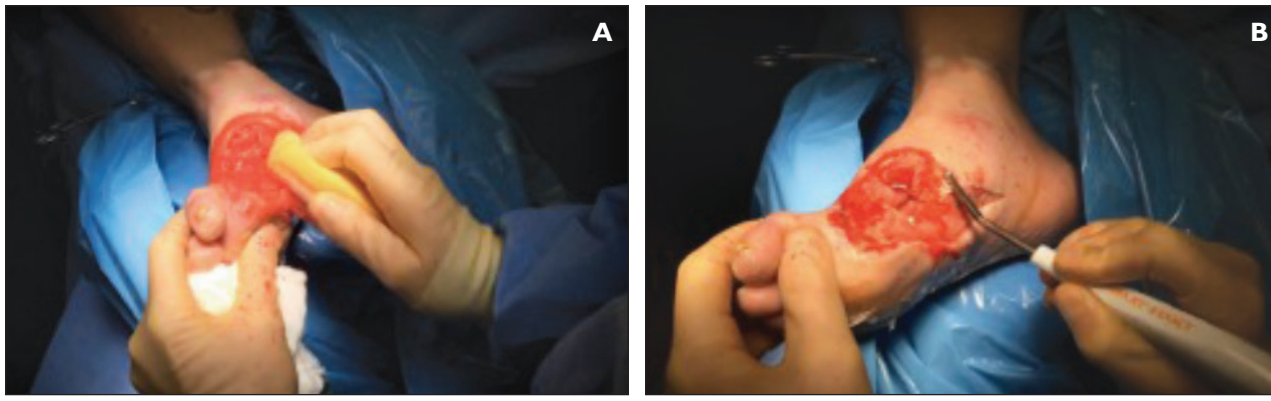

Figure 1: (A) Wound bed preparation with chlorhexidine scrub. (B) Debridement of a superficial wound with hydroscalpel down to the granular tissue.

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of nonviable tissue, and give antibiotics that are tailored to wound tissue cultures. If the patient has an inadequate vascular supply to wounds, we immediately get our vascular team involved, and revascularization is performed as indicated.

We routinely get an endocrinology consult if the patient's HbA1c has not been adequately controlled. We have an orthotist in our clinic to consult with if the patient's wound needs further off-loading. In contaminated deep tissue wounds, we have had great success with negative pressure wound therapy (NPWT) with instillation. We then continue traditional NPWT, and regularly discharge the patient to a skilled nursing facility if indicated. We continue NPWT until virtually all bone, tendon, and deep tissue are covered with granulation tissue. Typically this takes four weeks.

Once we know that the patient has adequate blood flow, off-loading, and infection control, we proceed to perform STSG application to the wound. First, we aggressively debride the wound with chlorhexidine scrub, scalpel, hydroscalpel (Versajet, Smith and Nephew), and curette as needed down to healthy, granular, bleeding tissue (Figure 1). Wound bed preparation is an important step of the procedure. It is paramount to rid the wound of biofilm and non-viable or fibrotic tissue in order to have full take of the graft. Electrocautery is used to achieve appropriate hemostasis as hematoma can lead to graft failure.

In contaminated deep tissue wounds, we have had great success with negative pressure wound therapy (NPWT) with instillation.

Figure 2: Pie-crusted STSG applied to wound and secured with skin staples.

Figure 3: Multi-layered white and black foam NPWT dressing over the STSG.

Harvest and Application

We generally harvest grafts from the ipsilateral anterior thigh. The graft harvest site is anesthetized with 1% lidocaine with epinephrine. Mineral oil is used for lubrication as it facilitates smooth motion of the dermatome. We prefer a 0.018inch thickness graft, especially for plantar wound coverage, as it has higher visco-elastic strength. The skin graft is harvested by introducing the dermatome to the harvest site at a 45-degree angle with consistent pressure maintained throughout the harvesting process.

The skin graft is then meshed or pie-crusted with a

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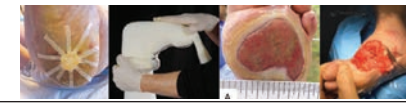

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1:1 ratio and applied with the dermis side down against the wound bed (Figure 2). Skin staples or chromic gut sutures can be used to adhere and secure the graft against the wound bed. A non-adherent dressing or white polyvinyl alcohol foam followed by a standard black foam for NPWT dressing are applied to bolster the graft with 125mm of continuous pressure for three to seven days (Figure 3). Many colleagues will use a lower pressure to bolster, but we have found no functional difference, and we are unaware of any data to guide us in that specific choice.

The bolstering action of low pressure NPWT prevents fluid accumulation beneath the skin graft site while increasing contact of the graft with the wound bed. One should dress the donor site with a petroleum-based dressing. At our facility, we have also noticed some decreased pain during the post-operative period with the placement of platelet-rich plasma at the donor site in the operating room (Figure 4).

The donor site dressing should remain intact for 72 hours for optimal results.

Figure 4: Platelet-rich plasma dressing applied to donor site.

Post-Operative Care

The donor site dressing should remain intact for 72 hours for optimal results. We apply a posterior splint to decrease ankle motion and shearing forces to the graft. We keep the patient non-weight-bearing until the graft takes. We have also used a "football" dressing along with a posterior splint to protect the graft from shearing. The first dressing change occurs in the clinic, where NPWT is discontinued and a wet to dry gauze dressing with a non-adherent barrier between the graft and gauze is applied. This dressing can be changed every other day. If pseudomonas infection is present, we apply this dressing using acetic acid.

Contraindications

In general, STSG should not be applied on wounds that are fibrotic, profoundly ischemic, have an active infection, or are tunneling.

Complications

STSGs are at risk of infection, especially in the first week, as the graft may not fully incorporate or become vascularized. STSGs may not incorporate due to a seroma or hematoma. Other complications include non-healing or delayed healing of the donor site; however, it is rare. Donor site pain is also a common complaint from patients; however, we have noticed minimal pain with use of a platelet-rich plasma dressing.

Literature on STSGs in Diabetic Wounds

Several studies have reported on STSG placement in diabetic wounds. A meta-analysis of STSG placement of diabetic wounds computed a graft take rate of >90% in 78% of patients by eight weeks.[9] Ramanujam, et al. found a 65% initial graft take in seven weeks in 83 patients.[10] They found more revisions and failures in smokers and patients with wound or graft infection. A large retrospective study by the same group found that co-morbidities associated with diabetes, such as peripheral vascular disease, retinopathy, nephropathy, and cardiovascular disease, conferred more risk of graft failure than the diabetes itself.[11]

A recent study by Rose, et al. showed a 67% rate of complete skin graft incorporation and healing with initial application when applied to a diabetic foot wound in a population of very high-risk patients, including those with end stage renal disease.[6] Anderson, et al. in a review of 107 patients undergoing STSG found mean time to heal was 5.1 weeks with a low complication rate of 2.8%.[12] A recent Cochrane review concluded that skin grafting with standard care had improved healing rate and decreased amputation rates compared to standard care alone.[8]

Conclusion

Our experience and the literature support the fact that split-thickness skin grafts are an effective and viable option for rapid wound healing. The learning curve and complication rates are relatively low. The data also support the use of such grafts as a viable option irrespective of plantar or dorsal foot wounds. We also believe that the use of post-operative NPWT facilitates incorporation and healing. **PM**

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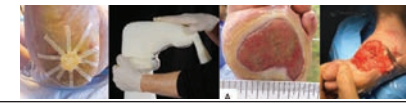

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