Adipose Tissue Transfer for Pressure Shielding in Problematic Wounds

Here's another tool to help achieve wound healing and prevent further ulcerations in the diabetic foot.

BY ADAM R. JOHNSON, DPM

Standard care in wound healing demands off-loading of wounds when abnormal pressures exist. Diabetic foot ulcerations commonly exist in the plantar forefoot due to abnormal pressures that develop as a result of the disease process. It has been well established now that, in addition to the vasculopathy and neuropathy commonly found in patients with diabetes mellitus affecting wounds of the feet, disorders of the skin, ligaments, tendons, and muscles also are present and are progressive with uncontrolled blood glucose. Uncontrolled blood glucose leads to the malformation of proteins due to the binding of glucose, a product otherwise known as advanced glycation end-products (AGEs).[1] AGEs within the proteins that make up skin, ligament, and tendon result in a generalized loss of elasticity and integrity of these structures leading to a diabetic foot with poor shock absorption and higher peak pressures.

When standard wound care with standard off-loading techniques fails to heal diabetic foot ulcerations, surgical off-loading is often implemented to obtain healing. The simplest method of surgical off-loading includes basic ostectomy procedures to remove bone prominences directly underlying the areas of ulcerations. A simple partial metatarsal head resection is one of the most commonly selected procedures for the plantar forefoot ulceration given its ease to accomplish, limited dissection to perform, and effectiveness in reducing pressure directly at the site of ulceration. More advanced options include the non-direct off-loading techniques. These non-direct procedures are used to change the way the foot functions to reduce pressure. Procedures of this category include bone osteotomies and tendon transfers and lengthening procedures. An Austin-Youngswick modifed bunionectomy and Moberg osteotomy may reduce hallux pressure by altering first metatarsophalangeal joint function and hallux position. Jones' tenosuspension, gastrocnemius recession and tibialis anterior lengthening procedures may rebalance a foot with abnormal loading patterns. These procedures may reduce pressure across a broader area rather than only in the direct proximity of resected bone as in the former group. While directed and non-direct procedures can be used in isolation, they may be more powerful when used in conjunction with each other.

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However, occasionally, even these advanced surgical methods fail to provide the pressure reduction that is desired or impact absorption that is required. This may result in recurrent ulceration in the same location or transfer lesions in a new, adjacent location to the initial ulceration. One possible explanation for these recurrent and transfer lesions may be a lack of cushion and shock absorption quality in the foot. Research utilizing magnetic resonance imaging has shown that qualitative structural changes are extensive in the diabetic neuropathic foot. This change causes fibrotic atrophy of the plantar fat pad and leads to the hypothesis that there is a lack of ability to dissipate the increased weight-bearing forces associated with the diabetic foot.[2] Furthermore, the adipose atrophy process that is caused by diabetes mellitus may be locally accelerated

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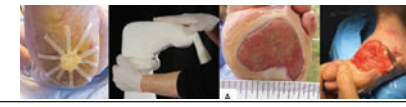

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in the presence of chronic wounds and infections, creating a self-feeding cycle further diminishing the ability to absorb and transfer pressure at the locations where it is needed most. When this difficult situation presents, adipose tissue transfers may be useful to restore the lost cushion and shock absorption to the foot.

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Technical Aspects

My preferred location in harvesting adipose tissue is at the posterior calf. This harvesting may be performed in conjunction with a gastrocnemius recession, or as a standalone procedure through a small incision in the medial, lateral and/or posterior mid-calf level. Most individuals with diabetic foot complications present with ankle equinus of the primarily gastrocnemius nature and require a gastrocnemius recession procedure anyway. The posterior calf often contains more than adequate amounts of adipose cells for collection and transfer. Clinically, one is able to palpate the posterior calf to determine in advance if the tissue would provide the needed cells. Other harvest sites would also include the thigh and abdomen; however, performing a harvest at these sites may be limited by local practice scopes and hospital privileging. When making the skin incision for gastrocnemius recession, adipose will be seen immediately under the skin (Figure 1). These cells are loosened and teased out of the incision with freer elevator and atraumatic forceps, gently handled and removed, placed in a saline bath and then held on the back table for later transfer to the desired location (Figure 2).

Figure 1: Adipose tissue cell located directly under skin incision at posterior medial calf.

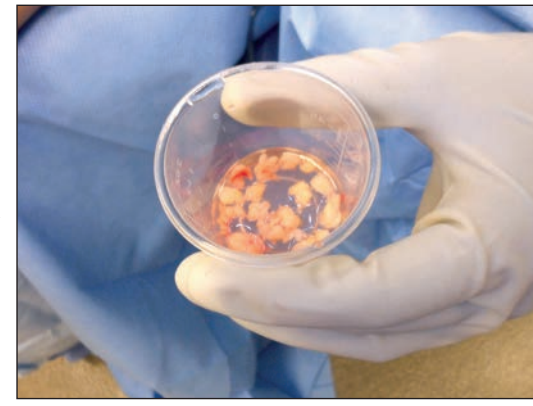

Figure 2: Adipose tissue cell collection in saline bath.

When the direct off-loading procedure is performed at the foot, and bone is removed, the deficit created is filled with the collected adipose cells. If it is determined at the time of implantation that not enough adipose tissue is available, a collagen xenograft may be placed into the deficit in addition to the adipose cells. I also place vancomycin powder into the surgical wound with the adipose cells before closure. Wukich and colleagues demonstrated that the use of vancomycin powder with surgical procedures decreased their rate of surgical site infections.[3] Given that the adipose transfer procedure is often performed on high-risk diabetic patients who have pre-ulcerative or ulcerative lesions in the proximity of the surgical site, any ability to help prevent infection is ideal. In my experience, the use of vancomycin powder in conjunction with the adipose transfer has had no anecdotal adverse effects on procedure.

Post-operatively, an ankle immobilizing CAM boot and/or crutches are recommended to limit trauma to the newly implanted cells. Initially, the site will be prone to swelling in the post-operative stage; this

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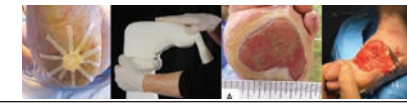
Figure 3: An unstable foot with abnormal pressures and pre-ulcerative lesion formation.

Figure 4: Restored skin integrity at previous ulceration site.



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will subside with time. While immediate improvement will be seen, it may take up to six months to appreciate final result of the integrated adipose cell.

Case Scenarios

Case 1: Recurrent ulceration due to abnormal foot pressures after hallux amputation

A 60-year old female with type 2 diabetes mellitus, significant peripheral neuropathy, and previous left foot hallux and 2nd digit amputations presented with a new ulceration under the 1st metatarsal head. Clinically, gastrocnemius equinus was present along with increased loading under the 1st metatarsal head due to valgus rotation of the forefoot. With prior hallux amputation, the 1st metatarsal was left intact and sesamoids were still present. Standard wound care failed to achieve the desirable result, and surgery was performed. Initial surgery consisted of sesamoidectomy, partial 1st metatarsal head resection, and gastrocnemius recession and resulted in closure of the ulceration three weeks after the procedure. However, three months later, a recurrent pre-ulcerative lesion began to develop. Standard care with diabetic shoes failed to resolve this hyperkeratotic lesion and restore integrity to the skin. Clinically, it was noted that instability in the medial column of the foot was likely an underlying factor in continued pressure at this location (Figure 3). Rather than major reconstruction, a less invasive revisional surgery, including additional 1st metatarsal head resection and adipose tissue transfer was planned and implemented. Adipose tissue was collected from the posterior medial calf, making an incision at the previous gastrocnemius recession incision site from the prior surgery. One year later, the patient continues with excellent skin integrity (Figure 4).

Case 2: Chronic ulceration after burn injury and scar tissue formation

A 53 year old male with diabetes mellitus, complicated by peripheral neuropathy and with previous 5th digit amputation, presented with ulceration of the left foot after a burn injury and infection. The initial wound was expansive, covering the plantar aspect of the forefoot (Figure 5-A). A wound plan was initiated, but the patient did not return for follow-up visits. Luckily, this patient did eventually return just over one year later for care as the wound failed to heal. While the wound was smaller, extensive scar tissue had formed and the plantar forefoot tissues lacked shock absorption and mobility (Figure 5-B). Off-loading was initiated with an ankle immobilizing CAM boot, and surgery was planned. A gastrocnemius recession was performed and through a dorsal approach, the second, third, and fourth metatarsal heads were partially resected and scar tissue adhesions in the plantar forefoot were freed with dissection. Once pockets were created under the metatarsal heads, adipose tissue harvested from the posterior calf during the gastrocnemius recession, along with an additional fetal bovine-based dermal matrix, were implanted to bolster the

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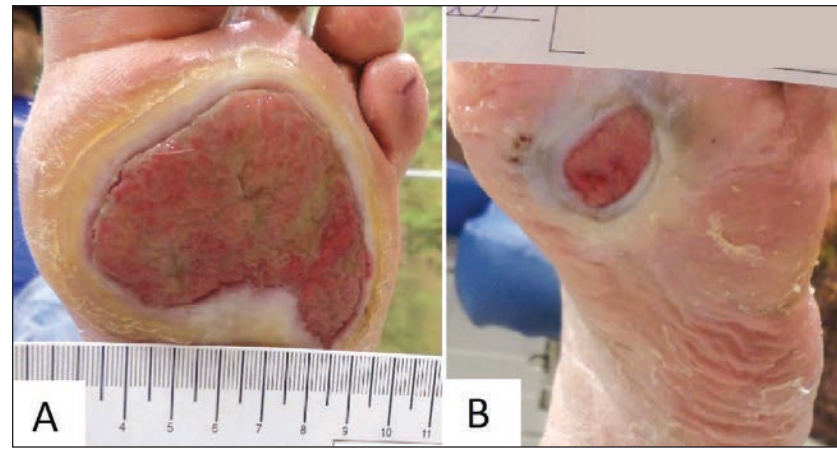
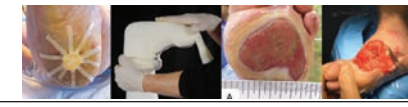


Figure 5: (A) Initial wound after severe burn and infection. (B) Wound one year later, failing to heal, with extensive scar tissue formation.

Figure 6: Closure of wound after freeing of scar tissue and implantation of autogenous adipose tissue intermixed with fetal bovine collagen matrix.

Figure 7: Chronic pressure ulceration due to medial arch collapse and local bone exostosis formation.

Figure 8: Implantation of adipose tissue into surgical site after resection of prominent bone.



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tissues. The wound on the plantar foot healed with continued off-loading three weeks after surgery (Figure 6).

Case 3: Unstable pes valgus requiring brace leading to chronic pressure over bone prominence and skin breakdown

An 83 year-old male with severe pes valgus and possible diabetic neuroarthopathy collapse of the foot presented with ulceration over the medial foot at the 1st tarsal metatarsal joint (Figure 7). Abnormal pressure existed at this location due to collapse of the medial arch and exostosis formation. Initial wound care and off-loading with a custom AFO brace was utilized. The wound improved with use of the brace, but ultimately healing could not be obtained. Surgery was performed, and bone under the ulceration was resected. Adipose tissue harvested from the posterior medial calf through a small incision was implanted in the foot (Figure 8). Three weeks after surgery, the wound healed. The patient passed away six months later from separate issues without any reoccurrence of ulceration in that time.

Final Considerations

Adipose tissue transfers should not be performed in the presence of active soft tissue and osseous infections. While vancomycin powder may be placed into the surgical wound with closure, this does not replace the need to treat any active infection first before performing the procedure.

In my practice, the adipose tissue transfers are reserved for individuals with an obvious lack of plantar fat padding, recurrent ulcerations in the same location, and when transfer lesions are present. It is typically not performed as a first line of therapy, but rather as an adjunct coupled with other surgical off-loading techniques that are utilized when standard wound care fails to achieve results.

Some additional benefits of the procedure include that harvested fat may be more hormone and weight-sensitive than the native tissues of the foot. Thus, with weight gain, these cells may also enlarge. This effect may be beneficial in the diabetic foot. Additionally, adipose tissue has become recently harvested in other areas of medicine for stem cells therapy. While the rate of stem cells found in adipose is low, some studies suggesting only one per 20,000 cells,[4] this may provide an additional benefit if a stem cell is coincidently harvested with the collection.

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While adipose tissue transfers may not be right for every patient, the procedure does offer another tool to help achieve wound healing and prevent further ulcerations in the diabetic foot. **PM**

References

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