Offloading 101 For The Outpatient Wound Clinic

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There are many types of offloading used in the treatment of DFUs. Each has its place in the wound care clinician's repertoire. This article will discuss the option of felt.

It is well accepted that total contact casting (TCC) is the most effective method for offloading chronic wounds. As such, TCC should be used whenever possible for treating diabetic foot ulcers (DFUs). However, there are a significant number of patients, due to perfusion, infection, depth of wound, drainage, mental status, balance, and/or other reasons, for whom it would be inappropriate to utilize TCC. For these patients, alternative offloading methods must be used. One such method is adhesive-backed felt or felted foam. This article will propose guidelines for the safe, effective use of this modality for offloading neuropathic plantar foot ulcers and share clinical techniques.

The International Working Group on the Diabetic Foot recommends considering the use of felted foam in combination with appropriate footwear to offload and heal neuropathic foot ulcers when other forms of biomechanical relief are not available.[1] In practice, the use of felt for offloading neuropathic foot ulcers is widespread. Published research, however, is limited. One study of 28 patients living with diabetes and a DFU up to a Wagner Grade II found 9-mm felted foam to be as effective as offloading with a half shoe.[2] Similarly, a study of 120 patients found there was no difference in healing time between felt offloading, healing shoe, and walking splint when compared with TCC.[3] Another 47-patient prospective, randomized controlled trial compared the use

of three layers of felted foam (9-mm total thickness) to the use of a removable walking boot for the treatment of DFUs and found that the mean duration to complete healing was significantly shorter in the felted foam group as compared to the walking boot group.[4] Several studies have also looked at the effects of different thicknesses of felt and felted foam on pressure reduction. In one 15-patient, 16-ulcer, repeated-measures study, plantar pressures were reduced by 49% with the use of felt, but this number decreased to 32% after one week of wear due to felt compression. The felt (10-mm thickness) was applied using one layer to fill in the medial arch (a layer from the base of the toes to the heel) and a second layer over the same area or around the region of the wound. This presumably allowed some weight-bearing through the medial arch and provided a 20-mm thickness of felt around the area of the wound.[5] Another study examined the effect of 7-mm felt with a U-shaped cutout on the 2nd metatarsal head pressures in 10 healthy patients and found that peak pressures were reduced by 25% with the use of felt as compared with no felt.[6] Additionally, one study compared 5-mm felt, 5-mm felted foam, 7-mm felted foam, and two types of 7-mm felt with no felt in a 50-year-old male living with a recurrent 2nd metatarsal callus. Unsurprisingly, the 7-mm felts and felted foam offered better pressure relief initially (and over time) than the 5-mm felt, the 5-mm felted foam, and no padding.[7] Though these citations support pressure-reduction benefits with the use of felt, method and technique of felt application varies widely or is poorly described.

First Things First

Before thinking too much about offloading, it is essential to address all other local and systemic barriers to wound healing. For patients living with diabetes, this includes ensuring adequate vascular status, glucose management, identification and treatment of infection, and wound bed preparation — such as wound and callus debridement. Although they will not be reviewed in this article, there are several widely available consensus documents that discuss overall management of the diabetic patient in great detail.

Felt Fatigue & Felt Thickness

An important consideration when using felt is that it compresses with wear. The two aforementioned studies that looked at pressure reduction over time noted significantly reduced benefit around Day 4. For the most consistent pressure reduction, felt should be reinforced or replaced mid-week. This can be done in the wound care clinic, or patients can be given additional pre-cut pieces

of felt to apply on their own between visits. If this is not possible, felt compression over time should be taken into consideration when determining the appropriate thickness to use initially. From available literature, as well as this author's clinical experience, at least 7-mm or ¼-in thickness is needed for adequate pressure reduction. Heavier patients, or patients with exaggerated bony prominences and/or deformity, may require additional layers or thicker felt, but the footwear being used in conjunction with the felt must accommodate the added bulk without causing rubbing or pressure on the dorsal toes or foot. Interestingly, most available studies looking at reduction of pressure with felt look at felt alone versus an offloading device. Not only is this not practical (secondary should always be used), it does not take into account the synergistic effect of using felt in conjunction with another offloading device. It seems reasonable, for example, that the offloading advantages of felt would be complemented by the decreases in shear and pressure associated with a fixed ankle boot with a rocker bottom sole.

Secondary Offloading

A variety of secondary offloading devices can be used in conjunction with felt. One study provides a nice summary of different types of devices and corresponding percentage of pressure reduction. (See **Table** at right.) The clinician should always use the best secondary offloading device available that is appropriate to the patient. If a diabetic walking boot with a rocker bottom can't be used, perhaps felt could be used with an offloading sandal. If the patient is unable to afford a specialized sandal, a postoperative shoe will at least limit push-off forces with gait. Felt can even be used with the patient's own shoes in many cases, if gait stability or work-requirement compliance is an issue. Considerations in offloading method should include functionality for the patient's activities of daily living, patient compliance and ability to follow instruction, mobility and balance, vision, range of motion and deformity, family/caregiver support, vascular status, presence of infection, amount of wound drainage, and periwound skin integrity.

Technique

As with any tool, results vary depending on the skill and expertise of the practitioner. In the appropriate hands, felt can be a highly effective, customizable adjunct to standard offloading. If applied improperly, it can cause additional tissue damage. If followed, these general guidelines for felt offloading should help minimize risk with the use of this adaptable modality:

- Ensure skin integrity and vascular status.
- Use skin prep when felting on skin.
- Always bevel edges of felt.
- Shift weight to other, intact, weight-bearing areas of the foot.
- No edges over bony prominences.

Needed materials include:

- skin prep,
- transparent film dressing,
- lipstick
- ¼-in (or thicker) felt or felted foam,
- sharp, heavy-duty scissors, and
- secondary offloading footwear.

The idea of offloading is to redistribute weight and shear forces away from the wound area to the other weight-bearing areas of the foot. A good way to think about where these areas are is to visualize a footprint. The goal is to provide relief in the area of the footprint where the wound is present and shift the pressure/forces to the rest of the footprint in that region of the foot. The region of the foot — the forefoot, midfoot, or heel — will determine how this is done. When felt offloading, it's important to understand plantar foot anatomy, namely bony prominence location and regions of the foot (**Figure 1**). Bony prominences are the areas within the footprint that receive the most pressure/shear. In the heel or rearfoot, the bony prominence will be the plantar surface of the calcaneus. This may be influenced by bony changes, such as a bone spur, but will generally be in the central to posterior-central portion of the heel. In the midfoot, the bony prominence will be the 5th tarsal metatarsal (TMT) joint. In the forefoot, the bony prominences will be over the metatarsal phalangeal (MTP) joints and at the interphalangeal joint of the hallux (**Figure 1**).

When Charcot arthropathy is present, the architecture of the midfoot is dramatically changed. In this case, arch collapse can cause a bony prominence in the mid to medial midfoot. Additionally, if the patient has undergone previous amputation(s) or severe deformity is present, there may be new or missing areas of bony prominence. The best way to determine areas of weight-bearing, both with normal anatomy and with altered foot architecture, is to

note areas of callus formation (both visually and by palpation). Callus formation is the body's way of protecting against repetitive forces, and its presence signifies the areas that undergo the most pressure/shear with ambulation. When offloading, there should never be any felt edges over bony prominences. The nature of the bony prominence makes a difference in the way offloading should be approached. When the wound is over the calcaneus, offloading occurs at an area over a single, large bone, and it is most effective to isolate the area circumferentially. When offloading a wound over an MTP joint, offloading occurs at the distal end of a long bone and a small mobile joint. In this case, it is not necessary (and may be detrimental) to place felt circumferentially around the wound. The way to remove the most pressure and shear from the area is to felt the entire forefoot, with the exception of the wound and the area distal to the wound. This results in a "lifting up" of the distal end of the tarsal bone versus creating a hole for the MTP joint to piston into, causing increased pressure and shear to the area (**Figure 2** and **Figure 3**). The size and mobility of the prominence changes the technique for redistributing forces. Utilization of felt for offloading also requires all felt edges to be beveled — reduced to a sloping edge. This creates a gradient of change in pressure between the offloaded and non-offloaded areas. Ideally, the bevel should be a 45° angle. A dramatic edge at the periwound puts added stress on the tissues, sometimes causing a "pucker" edge effect or even blistering (**Figure 4**). This can also have a detrimental effect on blood flow to the area. Beveling, on the other hand, can allow felt to be placed closer to the wound edge, therefore allowing better isolation of the wound area. Skin preparation should always be used prior to applying adhesive-backed felt directly to the skin. What follows is a review of the most common areas of DFUs and the corresponding technique for felt offloading.

Heel

Felt should be cut long enough to extend from the heel to just proximal to the base of the 5th metatarsal or TMT joint, and should be cut as wide as the width of the rearfoot. (Hold the felt up to the patient's foot to ensure proper sizing.) When measuring for proper fit, ensure the backing side is toward the patient and the felt side is facing toward the provider, as this is how it will be applied.

The posterior heel portion can then be rounded to match the shape of the heel (**Figure 5**). Next, cut a hole in the felt to correspond with wound location. The most accurate way to determine placement is to use the "lipstick technique," in which the wound is covered with transparent film and the wound area is marked with lipstick. The felt can then be placed on the plantar foot and pressure applied. (The lipstick mark on the felt backing indicates the area that needs to be cut away.) Cut the felt to leave an approximately 2-3-mm margin around the periwound and ensure all felt edges are beveled (both around the periwound and around the entire perimeter of the felt). Apply skin prep to the rearfoot, remove the backing of the felt, and apply (**Figure 6**). Apply the wound dressing over the felt, ensuring to limit bulkiness of the dressing directly over the wound area, as this can decrease the offloading effect. Foam dressings or cadexomer iodine work well to fill wound space without adding undue pressure. Hold in place with roll gauze or tape.

MTP Joints

Cut the felt long enough to cover from the base of the toes, to just distal, to the 5th TMT, laterally. Then, cut it wide enough to accommodate the widest part of the forefoot. Using the patient's foot as a guide, cut the distal end of the felt in a slope-like fashion so that it will cover just to the base of the toes (**Figure 7**) and use lipstick to mark the wound area. If the ulcer is over the 2nd, 3rd, or 4th MTP, cut from the distal end of the felt, around the marked area, and back to the distal end in a "U" shape (**Figure 8**). If the ulcer is over the 5th MTP, cut from the distal end of the felt, around the marked area, and to the lateral edge of the felt in an "L" shape (**Figure 9**). If the ulcer is over the 1st MTP, cut from the distal end of the felt, around the marked area, and to the medial edge of the felt (**Figure 10**). Bevel all felt edges, and apply felt and dressing as noted for the heel.

Midfoot

The most common midfoot DFU is one that develops after Charcot arthropathy. Disruption of normal foot architecture, such as TMT joint destruction and arch collapse, can lead to abnormal areas of bony prominence over the mid to medial midfoot. There are several approaches to offloading in this circumstance based on careful observation of the plantar foot. Considerations include areas of callus formation and stability of the foot. If the DFU is located more medially, it may be sufficient to localize felt to the medial arch area of the midfoot. The advantage here is the avoidance of pressure over the 5th TMT joint. To use this approach, cut felt long enough to cover from midway between the heel and the 5th TMT to midway between the 5th TMT and the 5th MTP (and wide enough to cover the entire arch; **Figure 11 and Figure 12**).

A more centrally located midfoot ulcer will require felt over the entire width of the midfoot. In this case, the felt will need to be cut long enough to cover from just proximal to the MTPs, to just distal, to the calcaneus, and wide enough to accommodate the widest part of the midfoot (**Figure 13**). Once the shape is cut, mark with the lipstick technique. A circular aperture would then be cut at the marked area on the felt (**Figure 14**). Another alternative is to felt the entire foot from the heel to the base of the toes (**Figure 15**). This works well for patients living with wounds in multiple regions (**Figure 16**), a very flat Charcot foot, or for patients who have undergone a transmetatarsal amputation or midfoot amputation (**Figure 17**).

It's less common for a DFU to develop over the 5th TMT. Although this weight-bearing area is over a joint, it's a minimally mobile joint; thus, felt can be cut to cover both proximal and distal to the wound without much risk of the joint "pistoning" into the relief area. Ulcers that develop here will often extend to the

lateral surface of the foot. Because of this, and in order to preserve best possible perfusion, it is best to cut the felt in a manner that leaves the lateral portion open in a “U” shape (**Figure 18**).

Use With Multilayer Wraps, NPWT

Most lower extremity wounds present with associated lower-leg edema, and the edema should be addressed for optimal outcomes. As long as vascular status is adequate, multilayer wraps work nicely with felt offloading, holding everything together and giving an added layer of protection to the foot. Negative pressure wound therapy (NPWT) can also be used in conjunction with felt offloading, as long as the tubing attachment device is bridged away from the plantar surface of the foot. (NPWT is applied first and felt offloading can be applied over it.) An example of an NPWT, felt offloading, multilayer wrap and a walking boot is shown in **Figure 19**).

Great Toe/Hallux

Effectively offloading the hallux is difficult due to large pressure and shear forces created during the push-off phase of gait. A felt “U” cut to fit around the wound area offers reduction in forces (**Figure 20**); however, to be effective, this should be combined with the use of a fixed-ankle, rocker bottom boot, which essentially eliminates push-off during gait.

Distal 2nd, 3rd, & 4th Toes

With hammertoe deformity, which is common in patients living with diabetes due to neuropathy-related intrinsic muscle atrophy, DFUs can develop on the distal toes. The best approach for this area is use of a crest pad that can be constructed with thin felt, tape, and gauze. First, fold a gauze 4x4 in half and roll lengthwise into a cylinder about 7 mm thick and 2 in wide. Wrap this with paper tape to hold together tightly. Cut a 2-in x 7-in strip of thin (1-mm), adhesive-backed felt, remove backing, and fold in half over gauze roll with corners aligned. Round the corners of felt and cut a 2 cm aperture next to the gauze cylinder into a “U” shape. (This can be fitted over two toes, with the cylinder portion under the toes and the flat, tab portion on the dorsal surface of the foot; **Figure 21**.) The cylinder essentially lifts up the distal ends of the toes. The crest pad only works for the 2nd, 3rd, and 4th toes because a toe is needed on either side of the pad to stabilize and hold it in place. If further stabilization is needed, the tab portion can be taped in place on the dorsum of the foot. The

patient should be instructed to check periodically to ensure the pad stays in place. The principles of custom felt offloading can be applied to the modification of offloading sandals, shoes, or boots. This type of felting can be used in addition to felt applied directly to the skin.

Custom Offloading of Footwear

Felt can be applied according to the region of the wound itself or to the entire foot bed. The same rules apply about always beveling edges under weight-bearing areas, shifting weight to other weight-bearing areas of the foot, and never having an edge under a bony prominence. It is not necessary to bevel the edges against the sides of the boot/shoe since there will be no gap between the felt edge and boot/shoe side. Cut the felt to the desired shape to fit in the foot bed. With the backing still in place, place the felt in position in the foot bed (backing side down). The film dressing and lipstick technique should be used. The boot/shoe can then be applied with careful attention to ensure the heel is all the way back in the footwear. In order to ensure proper positioning of the foot in relation to offloading, the patient should be instructed to make sure the heel is all the way back in the footwear each time it is applied. The patient can then stand and ideally take a few steps, allowing the lipstick to mark the desired area of relief on the felt. The felt can then be removed and cut. With felt that is applied to footwear rather than the foot, the area of relief should be cut a bit larger to allow for foot movement in the footwear (5-mm margin versus 2-3-mm margin when applied to the foot) (**Figure 22**). When felting in footwear to offload the hallux, it is helpful to add an extra layer of felt just proximal to the offloaded area to prevent bottoming out (**Figure 23**). The most effective footwear to offload the hallux is a fixed-ankle boot with a rocker bottom. It is important to note that using felt to modify footwear is a temporary measure and must be replaced or reinforced frequently due to felt compression. Patients should be referred to an orthotist and/or podiatrist for definitive custom-molded inserts after wound closure.

Conclusion

Although felt offloading is not appropriate in every circumstance, it has its place in the clinician's repertoire and offers unique advantages for offloading. Felt can be used with a variety of offloading devices, thereby enhancing effectiveness. Felt applied directly to skin is relatively non-removable, helping

to facilitate improved patient compliance. It allows for visualization of the wound and more frequent dressing changes than other non-removable devices. Felt is easily customizable, allowing it to be used in the presence of unusual anatomy or deformity, and can be used safely in infinitely creative ways.

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