

Offloading the diabetic foot ulcer

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Ulcers develop on insensate feet due to trauma the patient does not feel, and it makes sense that ulcers cannot heal if mechanical trauma is ongoing.¹ Andrew Boulton³ has repeatedly stated that it is not what you put on a diabetic foot ulcer that heals it but rather what you take off it. Ideally then, ulcers must be managed with rest and avoidance of all pressure. However, total non-weight bearing is rarely practical and is difficult to achieve. In the neuropathic foot, the overall aim is to redistribute plantar pressures evenly, thus avoiding areas of high pressure that will prevent or delay healing. In the neuro-ischaemic foot, the aim is to protect the vulnerable margins of the foot.² Patients usually prefer devices that are light and easy to walk with, but in reality the most effective treatment strategy requires a device that will severely disrupt normal activity for 6–8 weeks.³ De Block and colleagues found that if a plantar foot ulcer fails to heal by approximately 8 weeks, either it is being ineffectively treated or the patient is not being compliant with the treatment regimen.¹ It must always be remembered that heel raisers should be applied to the contralateral limb when using any device that raises the heel of the ulcerated limb to avoid limb length discrepancy that may result in postural insecurity and lower back pain. This article will discuss the variety of offloading options, keeping patient adherence in mind.

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Total contact cast (TCC)

The total contact cast is a close fitting plaster of Paris and/or fibreglass cast applied over minimal padding.² This is considered the gold standard of offloading for the management of the diabetic foot.³ The total contact cast works according to the following mechanisms:

- It transfers 30% of the load from the leg directly to the cast walls
- 28% of the pressure is relieved due to the 'void' created under the ulcer area with soft foam in the construction of the device
- It reduces midfoot pressures by 28% and heel pressure by 49%, but increases overall heel impulse by 52% because of the increased time of loading¹

The TCC should be removed every week or two. Where the extremity is severely swollen, a compression dressing should be applied for 2–5 days before reapplication of the cast.³ The use of the TCC is contraindicated in the acutely infected or ischaemic foot.⁴ This should not be applied by an inexperienced person due to the complications that may occur.^{1,2,3,4} The most common mistakes applying the TCC are:²

- The cast comes too high up on the leg, so that when the knee is bent the cast presses on the back of the thigh
- The cast is wrapped too tightly around the toes and borders of the foot, causing pressure lesions
- Rough fibreglass outside layer is not covered with stockinet and rubs occur on the contralateral limb
- The cast is too lightweight for heavier patients and collapses
- Fibreglass is dented by pressure from fingertips (The cast should only be handled with the flat of the hands)

 The foot is insufficiently dorsiflexed. If the cast is applied to a rigid plantar flexed foot there should be compensatory building up of the heel area of the cast.

Complications include:2

- · latrogenic lesions
- · Muscle wasting
- Osteopenia
- · Leg length disparity
- Danger of fracture and the development of a Charcot foot when the cast is discontinued without careful rehabilitation
- · Increased risk of falls in frail patients
- · Complications arising from patients failing to care for the cast

The above listed complications are appropriate to all irremovable casts used for the management of diabetic ulcers.

Nabuurs-Franssen and colleagues reported 90% of patients without infection or ischaemia healed and 87% of infected ulcers healed within 6–8 weeks. In patients with vascular impairment 69% healed. However in patients with peripheral vascular disease (PVD) and infection only 36% healed.³

(Application of the total contact cast can be seen at http://diabeticfootonline.com/CLEAR/Clinicians.html).

Irremovable or instant total contact cast (ITCC)

This is a prefabricated pneumatic walking brace (removable cast walker (RCW) or aircast) which has been 'locked' onto the affected limb. (Methods of locking the cast on may be seen at http://diabeticfootonline.com/CLEAR/Clinicians.html) It is used in

conjunction with a protective innersole. The advantages are that the compliance levels are similar to those of the TCC and therefore the healing times are comparable. As the RCW is locked onto the foot, care must be taken to prevent some of the complications i.e. over inflating the bladders. The advantage is that it is relatively inexpensive and less labour intensive to use. It also does not require a skilled technician to apply a new plaster cast weekly. It is also easy to remove to examine the wound. The mean healing time in the ITCC is 5.1 weeks.³

Removable cast walker (RCW)

The removable cast walker is essentially the same as the TCC, but it is not locked on. Research has shown that patients remove the device for 72% of their daily activity on average. Although a total of 30% of the patients in the study recorded more daily activity while wearing the device, this subgroup wore the RCW only for 60% of their total daily activity. Those patients who increased their activity levels with the RCW probably did so due to a false sense of security with



Figure 1: Removable Cast Walker (RCW)

regards to the ulcer. This highlights the need for patient education; reduction in activity is an integral part of wound healing.

Charcot restraint orthotic walker (CROW), Patellar tendon weight relieving orthoses and/or pressure relief ankle-foot orthosis (PRAFO)

These devices transfer the weight bearing from the foot to the knee where it is transferred through the cast walls to the ground. They allow for a moderate degree of mobility while still allowing non-weight bearing status to the limb.² The primary draw back of the CROW walker is the manufacture time and the expense. Should the limb size change due to oedema or muscle atrophy the device will no longer fit properly and cannot be used. The PRAFO is used in heel offloading. It has a washable fleeced liner with an aluminium and polypropylene adjustable frame and a non-slip walking neoprene base. The patient can wear this orthosis both lying down and walking to avoid pressure on the back of the heel.²

(Instructions on the manufacture of the CROW walker are available on http://www.delphiortho.com/CROWdelphipandgnotes.pdf)

Healing sandals and half shoes

There are many types of healing sandals, half shoes and wedged shoes available to reduce pressure on the forefoot. Half shoes are not very well accepted by patients as they are difficult to walk in.³ When compared with TCC, ITCC and RCW they had the lowest proportion of healed wounds and slowest rates of healing with an average healing

time of 61 days compared to 33.5 days in the TCC group and 50.4 days in the RCW group. 3

Felted foam dressings

Padding techniques that use adhesive paddings to secure a pad around or over an ulcer on the sole of the foot have also been reported in the medical literature as being successful. This type of technique can be used in the patients' shoes if there is adequate space in the toe box, with healing sandals or in IRCW/RCW. The technique involves two materials: orthopaedic felt (i.e. Paragon Felt) and foam (i.e. Reston foam) (These products are also available from podiatry suppliers.) The non-ulcerated skin is usually prepared with a standard skin adherent for protection and to assist in keeping the felt in place. The felt is cut to support the areas around the ulcer site taking into account the bony prominences. Additional pieces of felt can be added as needed to affect a flat plantar surface.3 The wound dressing material may be used in place of the foam over the ulcer site. Care must always be taken to ensure that the wound dressing material is not as thick as the protective felt. Foam is then cut to cover the entire dressing including the felt and ulcer site. A hypoallergenic fabric tape is then use to secure the edges of the dressing.

Healing with this offloading approach is usually less successful than with more aggressive immobilisations. Healing time was on average 79.6 days.³

Therapeutic shoes and innersoles

Therapeutic shoes and innersoles provide only a fraction of the pressure reduction at the site of ulceration provided by casts, RCW or even padded dressings or healing sandals. In randomised clinical trials of Dermagraft, only 18% of patients healed in 12 weeks in a control group that was offloaded with extra depth shoes with custom made innersoles. When they were compared to TCCs, only 32 % of subjects treated with therapeutic shoes and innersoles healed compared to 90% treated with TCCs.³

Crutches, walking sticks, Zimmer frame walkers and wheelchairs

All of these may be used as an adjunct to other pressure relieving techniques. Care must be taken when using crutches in patients



Figure 2: Half shoe



with impaired joint position sense which often occurs in the patient with neuropathy. It is important to check for Romberg's sign before dispensing crutches. This is performed by asking the patient to stand with a narrow base of support and then close their eyes. Neuropathic patients may lose their sense of balance. If this is the case the test is positive and the patient should not be given crutches. In addition, patients with neuropathy of the hands or Dupuytren's contracture may find hand-held crutches difficult to manage. Diabetic patients need to be monitored for nerve compression injuries to the arms. Walking sticks must be measured to determine that they are of the correct length.2 Wheelchairs are often unavoidable in those patients with ulcerations on both limbs. Leg rests are available which are useful to prevent oedema but care must be taken that the patient does not place the foot rest under the Achilles tendon. Occupational therapists are useful for determining the viability of using the wheelchair in the home and can help with adjusting the home and providing skills to enable the patient to perform their daily tasks.

Pressure relieving socks

Socks should be considered as part of the cushioning system. This is especially appropriate once the wound is healed and prevention of further ulceration on the same site is important. Veves and colleagues have shown that special padded socks can significantly reduce plantar pressures in patients with diabetes. Ten neuropathic subjects with plantar pressures greater than 980 kPa wore specially padded socks for 6 months. Reductions of 31.3% in peak forefoot pressures were found when the socks were new. After 3 and 6 months the socks had lost some of their efficacy and offered reductions in peak pressure of only 15.5% and 17.6% respectively. The socks were well accepted by the patients and no patients developed wounds during this time. Padded sports socks only offered 17% reduction of plantar pressures when new.

Surgical interventions and foot ulcerations

Metatarsal head resection may be used to accelerate wound healing in the forefoot. Although pressure reduction was evident in a series of 16 cases at 6–8 weeks following surgery, it is not known whether this procedure may result in a transfer of peak pressure to other areas in the foot in the long term.⁴ This may result in higher ulceration risk in those areas. Dorsiflexion metatarsal osteotomy has been suggested as an alternative to metatarsal head resection as this procedure does not violate the metatarsal phalangeal joint (MTPJ). It elevates prominent metatarsal heads, thereby balancing the metatarsals, and redistributes weight bearing forces more evenly across the forefoot. Unfortunately no pressure data is available to confirm the theory. Offloading of the hallux is often achieved using a metatarsal phalangeal athroplasty. Recently Achilles tendon lengthening procedures have been performed to increase the dorsiflexion range of motion. Comprehensive gait analysis has shown that the initial decrease in forefoot pressure is caused by reduced plantar flexion power during gait rather than increased range of ankle motion. The most important complication of the Achilles tendon-lengthening procedure is the development of transfer lesions to the heel.4 This procedure has currently fallen into disfavour as heel ulcerations are more difficult to offload and therefore heal.

Offloading the ulcerated patient in hospital

It is often forgotten that whilst the patient is hospitalised to manage the complications of foot ulceration offloading must still occur. It is important not only to protect the ulcerated area but to prevent new ulceration sites. All too often new pressure wounds develop in the insensate foot due to misplaced pillows and lack of attention to the heels and margins of the foot. Using air mattresses, foam foot protectors (Limbo), heel guards (Allevyn, Biatain and many others) and correct skin care are all critical in the management of these patients. The patient's family need to be educated regarding the dangers before they leave the hospital.

Conclusion

There are many ways to offload the diabetic foot ulceration but all of them require ongoing negotiation with the patient. Offloading has the tendency to reduce social interaction and productivity in the work place and at home. The patient's perceptions of quality of life need to be constantly monitored and encouragement regarding the benefits of the offloading devices highlighted to prevent patient rebellion to the offloading measures. In highly exudating wounds the offloading devices can become malodorous which patients find humiliating. Management of this is important through providing washable coverings etc. It has been my experience that all offloading devices must be used for some time after wound healing to prevent reulceration over the same site. They may also be used to alternate with offloading innersoles and new extra depth shoes in the early stages after healing whilst the ability of the new devices in offloading is evaluated.

References

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