The role of pressure relief in diabetic foot problems

Ann Knowles

Introduction

The insensitive diabetic foot is susceptible to tissue damage by unrelieved pressure. Pressure sores can occur under the heels of immobile patients and ulcers can form on the bony prominences. Ill-fitting shoes are the commonest cause of foot ulcerations: the toes and the sides of the foot being particularly vulnerable to shoe rubs. Casts are increasingly being used to relieve pressure and aid ulcer healing while allowing mobility. Prescribed footwear and orthoses will help to prevent ulceration, as will regular callus debridement. This article will discuss the various methods of pressure relief in the management of diabetic foot problems.

Foot lesions are the commonest cause of hospital admission for diabetes-related illness and can lead to amputation. The costs of treatment are considerable, both for the NHS, in financial terms, and for patients, who suffer loss of earnings as well as independence.

Diabetic foot ulcers can be caused by a combination of high foot pressures, peripheral vascular disease, sensory-motor neuropathy, callus, and limited joint mobility (Boulton, 1994). High foot pressures alone do not cause ulceration (Boulton, 1994) but are an important contributory factor. Any treatment plan must therefore always include some form of pressure relief. A multidisciplinary team approach with a podiatrist, doctor, nurse, orthotist and the patient is essential if pressure relief is to be achieved.

Effect of pressure on the foot

Unrelieved pressure on the insensitive diabetic foot can cause tissue damage which can result in ulceration. Tissue necrosis can occur in the deep tissues before there are any signs of damage on the epidermis (Delbridge et al, 1985).

Since pressure = force/area, injury to the foot may be caused in three ways (Brand, 1983): high pressure on a small area, e.g. standing on a nail, can cause a puncture wound; constant pressure from wearing tight shoes for several hours can cause ischaemic necrosis on the toes or side of the foot; or intermittent, repetitive, moderate stress in a neuropathic patient with elevated foot pressures can lead to callus build up, haemorrhage and ulceration. Continued weight-bearing on an injured foot may spread any infection deeper into the foot.

Bony prominences on the foot can produce abnormal pressure loads, which are continually rubbed by the shoe. Ulcers often occur on the plantar surface of the ball of the foot in the typical cavoid foot, with its prominent metatarsal heads and claw toes (*Figure 1*). The natural protective cushioning is often lost as the fat pads under the metatarsal heads shift forward and become thin (Boulton, 1987). Repeated mechanical stresses on the bony prominences of the deformed Charcot foot (neuroarthropathy) predispose it to ulceration.

It is necessary not only to treat and heal foot ulcers quickly, but also, and more importantly, to prevent them occurring. Pressure relief must always be addressed in both inpatient and outpatient departments.

High foot pressures

Plantar pressure measurement can determine who is most at risk of ulceration and highlight areas of high pressure under the foot which are susceptible to ulceration. Elevated plantar pressures have

ARTICLE POINTS

1 Ill-fitting shoes are a common cause of foot ulceration.

2 Pressure relief is essential to treat and prevent foot ulceration.

3 The use of casts can help to reduce hospital admissions for foot ulceration.

4 Ulcer prevention is better than cure.

5 Casts enable patients to be ambulant while their ulcers heal.

6 Many foot ulcers are preventable.

KEY WORDS
- **Pressure relief**
- **Neuropathy**
- **Ulceration**

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been demonstrated to contribute to foot ulceration (Veves et al, 1992a).

Pressure relief

Some patients with foot ulcers are treated by bed rest for long periods and measures to prevent the development of pressure sores are essential. Pressure sore risk assessment using a scoring system such as the Waterlow scale (Waterlow, 1985) should be done at least once a week, and be repeated if the patient's pressure risk changes.

All pressure areas should be inspected daily, and the findings recorded in the patient records. Particular attention should be paid to the heels as pressure sores will not be felt by the patient with insensitive feet. An immobile patient can quickly develop pressure sores (*Figure 2*) from resting his/her heels in one position in bed or on a stool.

Pressure-relieving mattresses and mattress overlays should be employed as required, and foam leg troughs or wedges used to elevate the heel from the bed. Water-filled gloves should be avoided as they do not provide sufficient pressure relief and can become dislodged (Lockyer-Stevens, 1993). Identification of at-risk patients and the provision of adequate pressure relief can help to prevent pressure sores occurring. Prevention is better than cure.

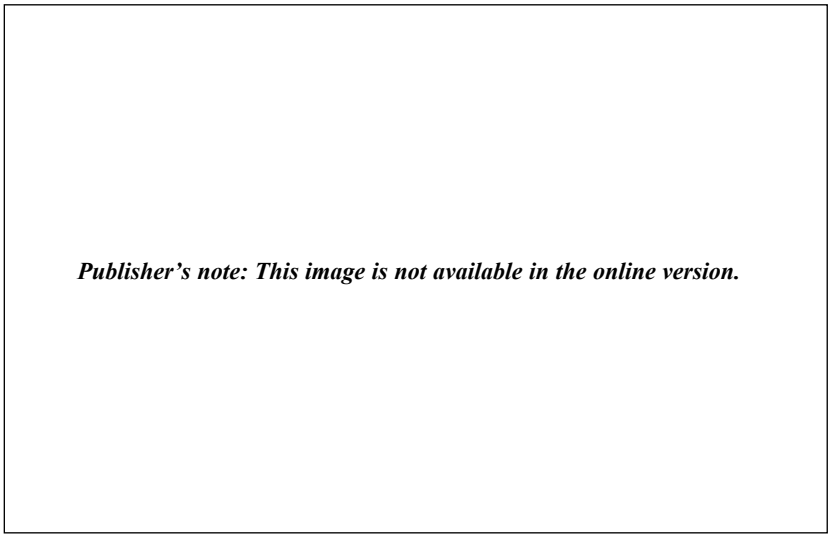

Figure 1. Ulcers under the first metatarsal phalangeal joint caused by high foot pressures.

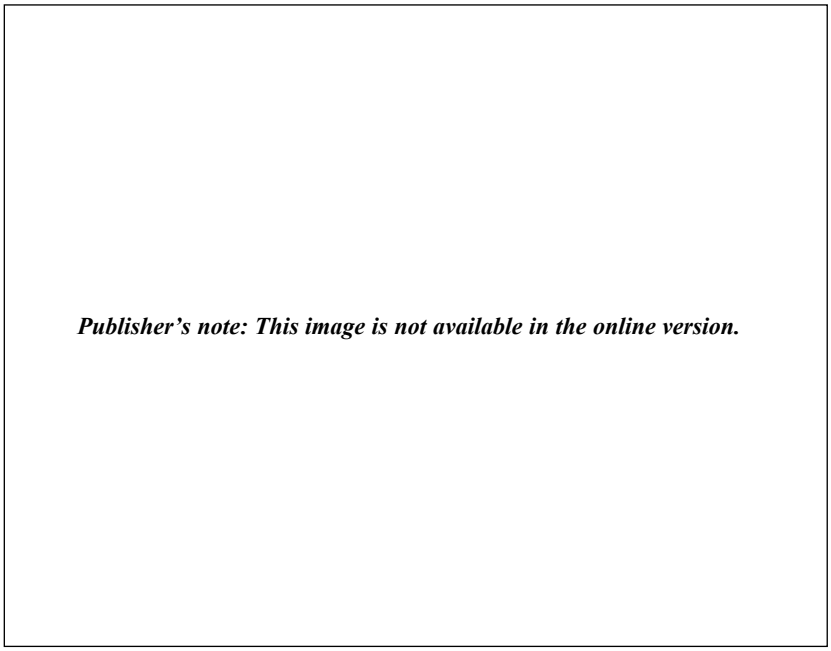

Figure 2. Pressure sore on heel.

Callus

Callus is the body's natural protection against pressure. However, it must be regularly debrided with a scalpel to prevent it from building up and pressing into the foot. Removal of callus reduces high foot pressures (Young et al, 1992). Callus can be a predictor of plantar foot ulceration and ulcers are more likely to form under areas of hyperkeratosis (Murray et al, 1994). Thorough debridement is needed to expose the floor of any ulcer.

Hosiery

Foot examination should include removal of and inspection of the shoes and socks. Holes or ridges in the socks can cause foot damage. Turning the socks inside out can help to prevent a ridge from digging into the foot, and socks with ridges should be avoided.

Specially designed padded hosiery provides pressure relief and may help to reduce shearing and protect the feet from callus build-up. Protection is maintained after 6 months' regular use (Veves et al, 1992b). A larger shoe may be needed to accommodate the thicker sock and foot. Peak plantar pressures under the feet of patients wearing padded socks were reduced by 26% in one study (Veves et al, 1992b).

Shoes

When ulcers have healed, patients are gradually weaned out of their casts (see later section) into appropriate shoes and

PAGE POINTS

1 Patients who do not wear their prescribed footwear are more likely to re-ulcerate.

2 Shoes must be the correct fit.

3 New shoes should always be broken in slowly.

insoles to prevent re-ulceration. Correctly fitted shoes should protect the feet from injury, whereas ill-fitting shoes are the commonest cause of diabetic foot ulceration (Edmonds et al, 1986). People with neuropathy may wear shoes that are too small as they perceive them to be a good fit (Boulton, 1994). A pair of ill-fitting shoes worn for only a short period of time can quickly damage the foot. Shoes should always be the correct width, length and depth.

Shoes should be made of soft leather uppers with no seams or ridges inside. They should have a broad, square toe box and be fastened with a lace or strap. Patients with claw toes and prominent metatarsal heads will require an extra-depth shoe (*Figure 3*) to accommodate the foot and any pressure-relieving insole.

Patients with odd-sized or misshapen feet may need a bespoke (made-to-measure) shoe. Footwear is usually prescribed by a hospital consultant and supplied by an orthotist. Doctors who prescribe shoes should be aware of the type of footwear required for the at-risk diabetic foot and know what is available. Patients should be allowed a choice of colour and style of shoe to encourage compliance (Knowles and Boulton, 1996).

The wearing of slippers should be discouraged as they do not support the foot and will not have sufficient room to accommodate pressure-relieving insoles.

Patients who do not wear their prescribed footwear are more likely to suffer re-ulceration (Edmonds et al, 1986; Ucciolli et al, 1995; Chanteleau et al, 1990). Education of patients regarding foot care and choice of shoes helps to prevent re-ulceration (Laing et al, 1991).

Shoes are only effective if they are worn. If we do not provide patients with a choice of footwear, they are more likely to wear their own unsuitable shoes. Insoles should be checked for signs of wear and renewed if they are worn, as worn insoles will not provide sufficient pressure relief. Feet can alter in shape and shoes that were once a good fit may need to be replaced. Follow-up of high-risk patients with healed ulcers must include inspection of shoes and insoles to check for signs of wear.

A bulky dressing will take up room in a shoe and exert pressure on the ulcer. Cutting a hole in the shoe will provide temporary pressure relief for some ulcers, as will the use of post-operative sandals. It is important that patients do not wear the shoes that have caused the ulcer.

New shoes should be broken in slowly by wearing them for no more than half an hour each day and gradually increasing the time they are worn. The feet should be inspected for any rubbing or reddening of the skin.

Patients without a foot deformity may be able to purchase footwear from a high street shoe shop, but should always have their shoes fitted. Trainers are ideal as they have cushioned soles, but must be the correct fit. Unfortunately, many retail shoe shops do not measure feet or fit shoes (Knowles et al, 1989).

Brand (1983) advocates the 5-hour shoe change to prevent pressure necrosis and reduce shoe-induced lesions. For this, the patient will require three pairs of shoes. The first pair is worn in the morning and changed at lunch-time. The second pair is worn until tea-time and the third pair is worn in the evening. Patients who work would need to keep a pair of shoes at work. Each pair of shoes will exert a different pressure on the feet.

Adaptations such as rocker soles can be added to footwear to reduce pressure when walking and can help to compensate for a limited joint mobility due to, for

Publisher's note: This image is not available in the online version.

Figure 3. Extra depth shoes.

example, hallux rigidus.

The half shoe has been shown to reduce healing rates of neuropathic forefoot lesions, but must be carefully fitted to prevent rubbing (Chanteleau et al, 1993).

Orthoses

Insoles can help to compensate for the loss of protective cushioning and relieve pressure under the foot. Custom-moulded insoles conform to the shape of the foot and cradle it, thereby redistributing pressure loads (Rome, 1998).

Sufficient room is needed in the shoes to accommodate the foot and any insoles. Semi-compressed felt padding is used by podiatrists to offload pressure areas.

Otoform K (PC Werth Ltd, London) is a silicone-based putty made from two compounds kneaded together. It is moulded and used under the toes to relieve pressure.

Casts

Many patients with foot ulcers can be treated on an outpatient basis, using a plaster or fibreglass cast to relieve pressure on the ulcer.

The total contact cast was developed in the 1930s to heal the foot ulcers of patients with leprosy (Boulton, 1990). The treatment of patients with leprosy and foot lesions has influenced the care of diabetic-neuropathic patients with foot problems, and casts are increasingly being used to treat diabetic foot ulcers.

Casts help to redistribute the weight load under the foot and protect the ulcer from undue pressure while allowing the patient to be ambulant while the ulcer heals. Casting enables some patients with ulcers to continue working and remain mobile.

Casts are predominantly used to treat neuropathic ulcers, although some centres use them for some neuro-ischaemic and ischaemic lesions (Jones, 1991; Laing et al, 1991; Borsenn and Lithner, 1989). Casts are also used in the treatment of diabetic neuroarthropathies to try to reduce further joint destruction.

The total contact cast

The total contact cast (*Figure 4*) is a plaster of Paris cast that extends from the knee to the toes. It is applied with the patient lying prone with the knee bent. The toes are protected with padding and are completely enclosed in the cast. This type of cast is only padded along the front of the tibia, below the knee, around the toes and over the malleolli. Careful removal of the total contact cast is essential as it should not be bivalved in the conventional way.

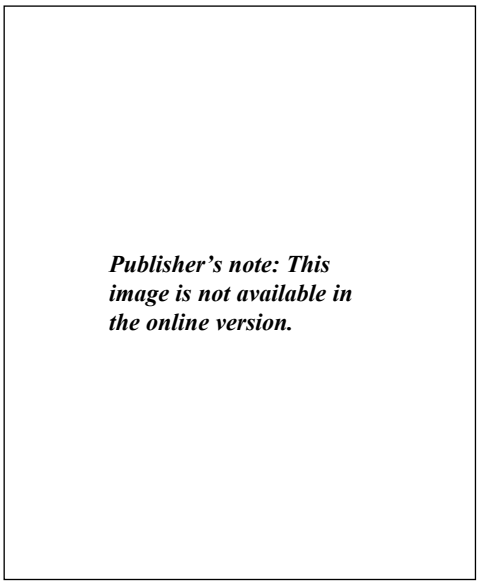

Figure 4. Total contact cast.

A layer of fibreglass casting tape can be applied over the plaster of Paris to strengthen the cast to allow earlier ambulation. A small rubber rocker is added for walking. A raise under the shoe of the other foot may be required to balance the hips and back.

The cast is initially changed after one week for inspection of the foot and ulcer, and then less frequently. It is worn until the ulcer has healed.

A non-removable cast such as the total contact cast is ideal for the non-compliant patient, but great care must be taken when applying a cast in any patient with an insensitive foot as skin rubs may go unnoticed. Abrasions and ulceration can occur under the cast (Boulton et al, 1986) and casts should only be applied by trained, skilled personnel. A total contact cast should not be used if there is severe ischaemia, cellulitis or a sinus. Patients should be given written and verbal instructions about how to care for and recognise any problems with the cast or foot, and be given an emergency contact number.

The total contact cast reduces shearing

PAGE POINTS

1 Insoles help to redistribute pressure loads under the foot.

2 Casts protect the ulcer from undue pressure and speed ulcer healing.

3 Casts should only be applied by trained, skilled personnel.

PAGE POINTS

1 Manufactured casts may be cheaper than the overall costs of the materials for other casts.

2 Compliance can be a problem with a removable cast which may not always be worn.

3 When an ulcer has healed patients should be provided with orthoses and prescribed footwear.

forces and redistributes the vertical pressure under the plantar surface of the foot (Laing et al, 1991). The sides of the cast contribute to the reduction in vertical pressures by transferring about 30% of the weight load to the leg (Shaw et al, 1997). Swelling of the leg can be reduced by a total contact cast.

A modified version of the total contact cast is the bivalved cast. This is a padded cast cut down the sides and held in place with bandages (Foster, 1997). This type of cast is easily removed, enabling the foot to be examined for rubs and providing easier access to the wound for dressings. Compliance can be a problem as a removable cast may not always be worn.

Manufactured casts

The Aircast (Aircast Ltd Partnership, London) works on a similar principle to the total contact cast and is a removable, manufactured, lightweight cast. Inside the cast are four air bags. These run vertically up the cast and are inflated so that a constant equal pressure is exerted on the foot and leg. A special sock which can be changed and washed is worn inside the cast and there is a removable insole. This cast requires careful fitting to ensure that the patient and carer know how to apply and remove the cast and inflate the airbags.

Manufactured casts are ideal for clinics that do not have trained personnel with plastering experience, and may be cheaper overall than the total costs of the materials used in casts that require regular renewal.

The Scotchcast boot

The Scotchcast boot (*Figure 5*) (Burden et al, 1983; Jones et al, 1989) is a lightweight, well-padded fibreglass cast that extends from just beyond the toes to the ankle and is worn with a cast sandal. It can be made as a removable or non-removable cast; an additional heel cap provides extra pressure relief for heel ulcers.

The cast is worn at all times when walking, and is used in bed if the ulcer is on the heel or the side of the foot. Compliance can be a problem with a removable cast, and a soiled, grubby cast is a sign that it has been worn.

As with the total contact cast, skill is required to make a Scotchcast boot. It

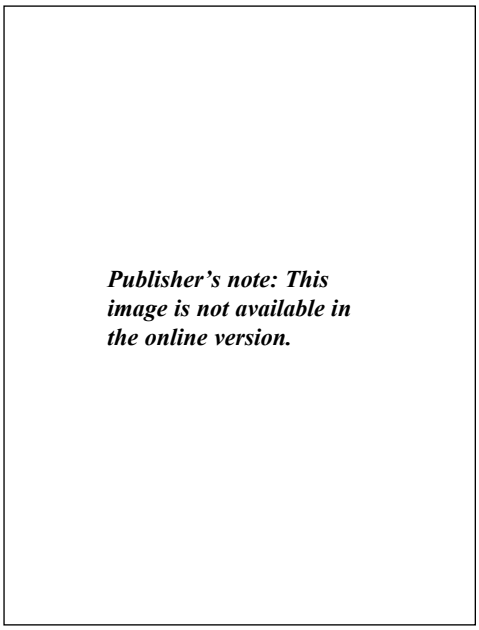

Figure 5. Scotchcast boot.

is less time-consuming to produce and maintain than the total contact cast and can be relined or repaired as required. It is only necessary to make a new cast if it is broken, badly soiled, too big or a smaller window is needed. The orthopaedic felt in the cast can compress, and an extra felt insole can be added or a cushioned insole material or orthosis incorporated into the cast.

The cast is worn until the ulcer has healed. Patients are then gradually weaned out of the cast into appropriate shoes and insoles. The cast and sandal may be re-used if ulceration recurs. Whether the Scotchcast boot provides better pressure relief than the total contact cast has not yet been established, although Laing et al (1991) suggest that healing rates are better with the latter.

Other casts

The Hope walking cast (Williams, 1994) is constructed of Hexalite (a heat-mouldable material) which is built around a total contact insole with a rubber outer sole. It is fastened with Velcro straps and is quite durable. The skills of a podiatrist or orthotist are needed to make the casted orthosis. It has been successfully used to heal plantar-neuropathic ulcers (Williams, 1994).

The Neofract boot (Page et al, 1995) is another smaller cast. It is made from a rigid polyurethane foam fashioned around a

PAGE POINTS

1 Prompt treatment will minimise the severity of a foot ulcer.

2 Surgery may be needed to correct a bony deformity.

3 Pressure relief must be provided to prevent ulcer recurrence.

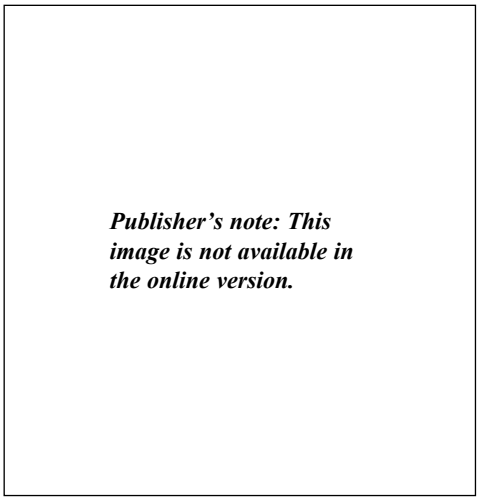

Figure 6. Orthopaedic scooter.

moulded insole. There is a windowed area in the insole under the ulcer site, and the cast is fastened with zip fasteners and worn with a cast sandal. It is moulded to the contours of the foot and the top of the cast is stiff compared with the softer-topped Scotchcast boot.

The Neofract boot has been used successfully to treat plantar ulcers and postoperative wounds. It is lightweight and waterproof, but needs regular replacement. It is difficult to accommodate heel ulcers with this cast (Page et al, 1995).

Crutches

Crutches will keep pressure off one foot but may put additional strain on the other foot. Patients with neuropathy may still weightbear on an ulcerated foot and balance can also be a problem.

Wheelchairs

Wheelchairs can be borrowed, bought or hired. They enable housebound patients to be taken out for shopping and social events while totally avoiding weight bearing. However, adaptations to the home may be needed.

The orthopaedic scooter

The orthopaedic scooter (John Reid & Sons, Christchurch) (*Figure 6*) is a useful alternative for patients who cannot manage crutches (Roberts and Carnes, 1990). It consists of an electroplated light steel frame mounted on four swivelling castors which carries a padded aluminium channel support for the knee and shin. It is ideal for use on smooth surfaces and when standing, but can be difficult to use on rough areas or stairs.

Surgery

Some patients may require surgical treatment to achieve adequate pressure relief. Metatarsal head resection will reduce high pressures under the ball of the foot. In some patients with a rocker-bottom deformity of the plantar surface of the foot, the bony lump can be shaved or removed.

Conclusion

Pressure relief must be addressed when treating diabetic foot ulcers and diabetic neuroarthropathies. Bed rest will be required for some patients, but the various casts and appliances make it easier to treat more patients on an outpatient basis. Some casts require specialist skills for their construction, although manufactured casts enable more centres to treat patients. Inpatient treatment is expensive, and the prompt treatment of any foot problem will help to minimize the severity of any lesion. Early referral to a podiatrist for callus debridement, wound management, and the use of specialist diabetic foot wear, orthoses and hosiery can help to prevent and heal foot lesions. For the patient with a healed foot ulcer, prevention of recurrence is essential and some form of continued pressure relief must be provided. ■

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