

# A different approach to the care of the diabetic foot

**A traumatic injury requires protection from further trauma if healing is to occur with minimal residual deformity. Diabetic patients often develop ulcerated feet, but continue to walk on them because of reduced pain perception. These people are at risk and need to be alerted early to the dangers involved.**

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The basic pathology in the diabetic foot is neuropathy; however, not all diabetic feet are anaesthetic. Many diabetic patients have a neuropathy of which they are unaware. Electrophysiological methods may detect unsuspected neuropathy.

‘Of course I can feel. My feet are not numb. I know when my foot hits the floor’, says the diabetic patient. The pressure of foot strike is appreciated by many diabetic patients, but they could be unknowingly walking on a piece of broken glass and driving it in deeper with every step. Pain fibres are often the first fibres destroyed in diabetes, leprosy and many other neuropathies.

The methods for obtaining healing after limb trauma in diabetic patients are basically the same as those used in patients with neuropathy from any other cause.

## A hot, swollen, painless foot: a diagnostic dilemma

A hot, swollen, painless foot may be the first indication of neuropathy. Doctors often assume this presentation to be osteomyelitis, even when there is no obvious break in the skin. Radiographic examination should be made as soon as

possible and preferably before starting any treatment. If the x-ray is delayed, the limb should be protected and be non-weight bearing until radiography can be done.

Some of these patients will have a bone lesion, such as a chip, a fracture (often stress) or localised osteopenia. The last indicates that a fracture or other bone damage has occurred probably within the preceding eight weeks. Osteopenia accompanied by fragmentation or disorganisation of the bone indicates the fracture occurred three to six months previously and needs urgent realignment to prevent permanent deformity and disability. If there is any bone abnormality on x-ray, further views should be taken to clarify the situation.

It is essential that any neuropathic foot with an active bone lesion be adequately immobilised in a total contact cast in a functional position. Figures A to C in the box on page 53 show progression of a neglected cuneiform fracture.

Diabetic patients may need to use a cast for many months. It is not that these patients' bone takes longer to heal than that of others, but that they are at risk of refracture and formation of

## IN SUMMARY

- Many diabetic patients have a neuropathy of which they are unaware.
- Every diabetic patient should be taught at diagnosis how to care for his or her feet.
- Most neuropathic ulcers are not infected and will heal with anything on them except the patient's weight.
- Any hot, swollen, painless foot should be treated as a neuropathic bone lesion and protected, until proved otherwise.

deformity during unprotected walking. These patients' reduced pain perception encourages them to abuse the foot and stress the fracture before healing is mature, while early walking may cause deformity of the osteopenic bone.

### Charcot foot

The diagnosis of a Charcot joint or Charcot foot strikes terror into many clinicians; however, recent work indicates that these joints will heal but need prolonged protection to prevent refracture. Charcot described a grossly hydroarthropic unstable joint in a patient with syphilis, but the term is now used loosely to describe almost any bone deformity in a neuropathic foot. Due to the fear of the term 'Charcot foot', I prefer to call it neuropathic bone disintegration or disorganisation, and I expect to obtain healing in 100% of compliant patients. Many neuropathic feet with bone lesions become deformed, but it is often possible to reshape the foot before applying the cast, in which case the final shape may be compatible with function. If the foot is grossly deformed, it is often possible to surgically reconstruct the foot so that it returns to a more functional shape.

### Neuropathic bone disintegration

Bone lesions in a neuropathic foot need to be immobilised for about two to three times as long as in a sensate foot. For example, a diabetic patient with a midtarsal fracture or arthrodesis will need eight to 10 months in a total contact walking plaster cast to ensure healing to a degree where walking will not precipitate further damage.

Many diabetic patients who present with a hot, swollen, painless foot have been walking on a fracture that has not been treated adequately (if at all) and so has progressed to deformity and disability. Figures D and E in the box on this page show the progression of an untreated 'Charcot foot'. The treatment of any neglected fracture is urgent if the foot is to be saved as a functional unit; hence, any hot, swollen, painless foot should be treated as a neuropathic bone lesion and placed in a cast, until proved otherwise.

If there is an ulcer on the foot, it will heal rapidly while the limb is in the cast. An ulcer does not need frequent dressings unless it is discharging freely – in which case the cause of discharge needs to be ascertained, especially any pathology that

## Cases of bony neglect: progression of untreated fractures

### Fracture cuneiforms

A typical fracture of the cuneiforms that was neglected and progressed to a deformity. It required reconstructive surgery to prevent ulceration over the resultant deformity.



Figure A. X-ray showing a mild cuneiform bone abnormality that was not treated.



Figure B. X-ray of the same foot 12 months later showing marked deformity of the whole tarsometatarsal joint line (Lisfranc area).



Figure C. External view of the foot at time of the x-ray shown in Figure B.

### A fractured navicular

A fractured navicular in a diabetic patient that on x-ray was reported as a Charcot foot. The patient was told the lesion would not heal and no treatment was given, resulting in marked deformity and ulceration six months later. Subsequent treatment in a total contact plaster cast provided the patient with a functional foot that is still stable years later.



Figure D. X-ray of a fractured navicular that was not treated.



Figure E. X-ray six months later showing disorganisation of midfoot with a boat-shaped foot deformity.

necessitates full rest and protection, e.g. osteomyelitis. Patients should not walk unprotected on a neuropathic foot with osteomyelitis because more bony deformity may occur. All feet with osteomyelitis should be treated in a total contact walking cast as well as with antibiotics. The cast can be modified to allow dressings if needed.

### Radiography

Patients with neuropathic feet should have baseline x-rays taken of the feet at the time of diagnosis of

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the neuropathy. Recommended views are antero-postero-oblique (APO) with 15 degrees of obliquity, and standing lateral to show the whole length of the foot and the ankle joint. If there are suspicions of ankle problems, include an AP of the ankle. The APO shows the Lisfranc area, which is often fractured

and displaced in diabetes, much better than a true oblique or AP. The standing lateral should show any prominent bone that may predispose to ulceration when standing or walking. The extent and nature of any abnormal findings should be determined.

### Vascular problem?

Many diabetic patients are told they have a 'poor blood supply' and are referred to a vascular surgeon, especially if they have developed dry gangrene. Dry gangrene may certainly result from anoxia such as occurs with a 'poor blood supply', but it can also be caused by anything that produces local anoxia or hypoxia in a limb with a normal blood supply.

We are all familiar with bedsores in which tissue death results from anoxia. In the same way, gangrene may occur in diabetic patients when a bandage is wrapped around a foot, which is then jammed into the patient's usual shoe (Figure 1). Diabetic patients need to be taught not to use garters or tight bandages, and never to use elastic bandages on a neuropathic limb.

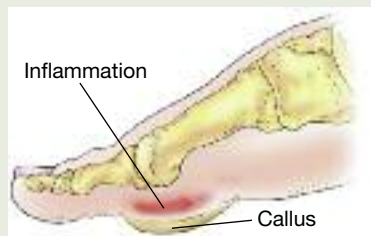
### A cold, dry foot

Before jumping to the conclusion that the blood supply is inadequate check carefully for local factors that may have caused the anoxia and then rectify the situation to obtain and maintain healing. If capillary return in the toe tips is normal, there is probably adequate blood supply for conservative treatment of ulceration and maintenance of a functional foot, eliminating the need of amputation.

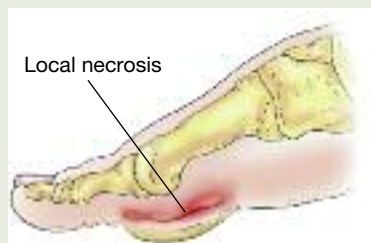
It has been shown that many diabetic patients have up to five times the blood flow of a normal nondiabetic foot, yet the foot feels cold. This results from arteriovenous shunting and failure of the capillaries to dilate secondary to autonomic neuropathy. However, when the same foot is traumatised it will respond with capillary dilatation and so the patient may present with a hot, swollen, painless foot, reflecting that it is not avascular and that the blood supply is adequate for healing.

Eventually, the autonomic neuropathy causes alteration of sweat and sebum production so that the neuropathic limb is often excessively dry. It is accepted that a cold, dry foot is one at risk of undetected trauma, because of the likelihood of accompanying sensory neuropathy.

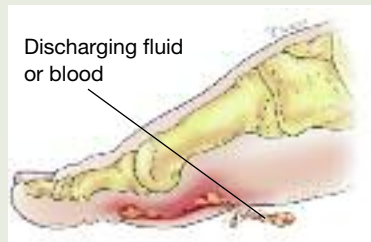
### How callus causes ulceration



1. Pressure during walking forces the callus into the subdermal tissues and traumatises them, causing inflammation and oedema.



2. The oedema increases the anoxia in the subdermal tissues and causes local necrosis.



3. When the pressure of the necrotic fluid and/or blood increases, the fluid ruptures out through or beside the callus revealing the ulcer.

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Figure 1. Typical area of gangrene caused by wrapping a bandage around an ulcer on the sole and jamming the foot into a fitted shoe.

### Today's callus is tomorrow's ulcer

The natural response of skin to stress and excessive pressure is the production of hard skin or callus to protect the softer, more vulnerable, tissues underneath. In normally sensate skin, the mass of callus causes discomfort so that the patient acts to alleviate the stress or removes the callus. In the patient with sensory neuropathy the callus builds up until a mass is formed. Local hypoxia and anoxia caused by walking on this mass result in death of the underlying tissues and ulcer formation (see the box on this page and Figures 2a and b).

A well-hydrated callus is soft, supple and resilient and less likely to cause pressure problems than a dry callus, such as occurs in autonomic neuropathy. The

hard callus may become like a pebble and split, with the hard edges of the resulting crack acting as a splint, which tear the split apart and make the ulcer deeper with every movement.

### In practice

The management and care of neuropathic ulcers is the same irrespective of the cause; however, it is desirable that the underlying cause (e.g. diabetes) be diagnosed, so that it can be correctly treated or controlled.

### Initial assessment

A patient walks into your surgery on an ulcerated foot without any obvious discomfort. You must assume that the ulcerated area has absent or reduced pain perception. What is the underlying diagnosis? What will you do to help?

- **Assess severity.** Examine the lesion and the foot – is sensation reduced on all or only part of the foot? Check the history, including any previous episodes or accidents and, if available, previous x-rays.
- **Try and establish the immediate cause of the ulcer.** Is it due to direct trauma, such as a cut, blister, foreign body or jumping onto a sharp object? Is there excessive pressure in the shoe due to a tight bandage or stocking, a foreign body or build up of callus? Is any urgent care needed to compensate for this cause?
- **Check the patient's shoes.** Do they fit without excessive pressure? Most diabetic patients do not need special shoes if the foot is still basically anatomically normal, but resilient insoles are important (see the box on this page).
- **Local treatment of the ulcer.** Most neuropathic ulcers are not infected and do not need antibiotics, but if there is evidence of inflammation around the ulcerated area take swabs for culture and sensitivity, and in the diabetic patient prescribe antibiotics. Do not assume heat and swelling are due to osteomyelitis, but get an x-ray as soon as possible. If in doubt, treat at once for the worst

### Characteristics of suitable shoes for diabetic feet

- Easily available and socially acceptable.
- Sufficiently large.
- Reliable means of fixation firmly to the foot – by laces, buckles or velcro – to prevent falling off or excessive slipping during walking.
- Resilient insoles – not soft (see Figure G); preferably also a resilient sole that is thick enough to protect from stones and the like during walking.
- Smooth internal linings with no roughness. Shoes should be stitched or glued, not nailed or tacked.
- Able to be worn all the time – patients should be instructed not to take one step without shoes (or slippers, which need to have similar characteristics).



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Figure G. The diabetic patient can check the resilience of shoe insoles by squeezing the insole between the pulps of the index finger and thumb. If the insole compresses to less than half its original thickness, it is too soft; but if it does not compress to near half, it is too hard.



Figure 2a. Typical forefoot of a diabetic patient showing two callus patches. The one at the base of the first metatarsal is typically dry and cracked.



Figure 2b. The same foot after blood has discharged from what is now an ulcer.

possible scenario, i.e. a disintegrating bone lesion, until proved otherwise.

### Allowing the ulcer to heal

Neuropathic ulcers will heal with anything on them except the patient's weight. The sooner the ulcer heals, the better the quality of the scar and the less likely that it will break down again. If the ulcer is a minor break in the epithelium it will probably heal with a simple

dressing, provided that the dressing is not thick enough to cause pressure on the ulcer when the patient walks. Many people use donuts around the ulcer or extra double thickness insoles with sinks cut in the lower layer beneath the ulcer, which relieve the local pressure without allowing the healing tissue to protrude into the sink like a mushroom. However, the extra insole may increase pressures inside the shoe, producing more problems unless a larger shoe is used. The use



continued



Figures 3a and b. The severity of the lesion cannot be established until callus is removed. a. (left) A rather neglected forefoot – note loss of most toes with large masses of callus and an apparently small ulcer. b. (right) After a thorough soak and scrape. The two thick plugs of callus are laid on the forefoot skin to show their size and allow comparison with the size of the ulcers beneath.

### Modified total contact cast

A specially modified total contact plaster cast has been devised that can be bivalved and removed, and then reapplied with velcro straps. This allows access to any acute lesion for debridement and dressings.

These casts are also useful for trial walking, when a patient is returning to walking without a cast. The duration of walking without the cast is gradually increased, until the patient can walk all day without any signs of inflammation developing on the affected foot.



Figure H. A patient standing in reappplied bivalved total contact casts. Football socks are worn inside as liners; they are ideal for filling any dead space and protecting the toes.



Figure I. The two sections of the cast opened – an optional, suitable insole has been added in the sole.

of postoperative shoes is not recommended unless they have extra resilient insoles added, because the soles are usually not resilient and this may cause additional problems.

An important method of reducing anoxia in the affected tissues and encouraging healing is the removal of callus, (see section on callus removal) and this should be done as soon as possible, preferably before the patient leaves the doctor's surgery. Every doctor who treats patients with neuropathy should be able to remove callus or employ someone who can, because correct treatment cannot be started until the callus is removed and the severity of the lesion is established (Figure 3). Unfortunately, it is a time consuming procedure and may take half an hour or longer. However, recommending the patient attend a podiatrist may mean that the patient walks on the callus for six to eight weeks while waiting for an appointment, forcing the callus mass deeper into the foot and causing further trauma.

### Chronic ulcers

Chronic ulcers, often claimed to be non-healing, should be treated in a total contact walking cast for at least six to eight weeks before considering surgical intervention. Most neuropathic ulcers will heal with adequate rest and protection.

A correctly made total contact plaster cast spreads the patient's body weight over the whole of the inside of the cast. Up to 40% of the patient's weight is taken by the leg piece, and the sole's rigidity eliminates the high pressure points that occur during walking. Hence, there are no patches of anoxia, and traumatised areas do not move so are rested, even during walking.

A specially modified total contact plaster cast has been devised that can be bivalved and removed for debridement and dressings, and then reapplied with velcro straps (see the box on this page). Wearing such a cast day and night – not one step without the cast – will do much to hasten healing. Some doctors are

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afraid of applying a plaster cast to a neuropathic limb; the bivalving enables checking for fit, pressure and rubs each time the foot is dressed.

For a seriously infected ulcer, bed rest with a splint to eliminate limb movement is needed until the gross swelling has subsided. The patient can then be treated in a total contact cast at home. Bivalved casts minimise hospitalisation, and its complications. However, they are not suitable for the long term treatment of neuropathic bone disorganisation because the damaged bone's position can be compromised during removal and reapplication. Also, the patient may remove the cast at home and walk on the unprotected limb. Once the ulcer is relatively dry and swelling has decreased in the limb with a bone lesion, the bivalved cast can be fixed on (with thick socks worn to fill any gap) or a new total cast can be applied. This allows the position of the healing bones to be undisturbed for the next three to six months.

### **Long term daily care of the neuropathic foot**

Every diabetic patient should be taught how to care for his or her feet, at diagnosis and at repeated refresher sessions. They need to inspect their feet daily, soak the limbs in water at room temperature, remove any forming callus and then oil the skin. Patients with cold feet should wear suitable socks and avoid extreme temperatures from radiators and hot water bottles. All diabetic patients need to know how to select suitable shoes, which are to be worn at all times.

### **Inspection**

Inspection for rubs, blisters, cuts or red areas is preferable in the evening. Any break in the skin needs immediate treatment, and the patient should try to assess what caused the lesion to prevent recurrence. A foot that is hot and swollen at the end of the day needs to be checked in the morning. Normal travel heat and swelling should settle overnight. If the symptoms

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do not subside overnight, pathology of deeper tissues must be suspected, e.g. a bone lesion, and the limb should be rested and protected to allow healing.

### Soaking

Soaking compensates for the autonomic neuropathy and consequent reduction in sweat and sebum production. It is not clear how much water permeates beyond the epidermis, but the superficial hydration will prevent water loss from the subepidermis where hydration is most needed. Patients with diabetes should be specifically warned not to use hot water as they are at risk of burning themselves. If desired, antiseptic solution can be added to the water, but it is usually not indicated.

### Oiling

Moisturising creams are usually based on



Figure 4. Typical dry callused heel. This will tend to split and crack, but this is easy to prevent by regular soaking and scraping.

mineral oils, which are not absorbed to any appreciable degree by the skin. Vegetable oils are absorbed a little, animal and fish oils are absorbed more, and regular applications of these will improve the skin's texture and suppleness. After soaking, applying any oil will prevent evaporation, by forming a film with the surface keratin. Urea containing creams are often advised as they reduce the production of callus where applied as well as serving as the oil.

### Callus removal

Some health workers believe that only podiatrists should remove callus, but a once weekly podiatry visit is the minimum needed for care, is rarely available and can become quite costly. Hence, the patient should maintain his or her feet, and the podiatrist can check the feet and attend to nail care at regular visits. A regular visit to a podiatrist is desirable, but many patients, once taught how to do so, have looked after their own feet for years and have kept them ulcer free, even patients with a long prior history of ulcers.

All patients who do not have ulceration should be taught some simple method of callus removal. I teach all my patients to do this for themselves and have literally hundreds of patients who have learnt to do this using a surgical scalpel or a safety razor. Many clinicians are afraid of suggesting that a blade of any sort be used; however, it is a matter of how well the

patient is taught. For the sight impaired and those who cannot reach their feet, a relative or carer should be taught to do it for them. A preferably dry, green nylon pot-scaper can also remove the flakes of callus that soften and loosen when the limb is soaked in water. If a little callus is removed every day, a mass should never build up sufficiently to cause problems. Figure 4 shows a typical callused heel, easily improved by soaking and scraping.

### When ulceration is present

Ulcers should be covered with any suitable dressing to keep the area clean and encourage healing. 'High-tech' dressings are usually not necessary; advise something simple, affordable and easily available. Magnesium sulphate and glycerol paste (Magnoplasm) is a very effective for ulcers and infected wounds. Simple syrup is also affordable and effective for many patients.

Ensure adequate protection of any ulcerated area for two to three weeks after any lesion is fully healed, and remember that a bulky dressing and a postoperative shoe do not really provide the best protection.

### Conclusion

Neuropathy should be considered in the feet of all diabetic patients, even those who are unaware of any sensory loss, and all patients should be taught to care for and monitor their feet. In the event of ulceration, the mainstay of treatment is rest and protection from further trauma, noting that most neuropathic ulcers are not infected.

A hot, swollen, painless foot in a diabetic patient should be treated as neuropathic bone lesion until an x-ray proves otherwise. MT

### Consultant's comment

Dr Warren has written an excellent article containing many very practical tips for the management of the diabetic foot. Her experience in the surgical management of neuropathic feet was derived from many years experience working in Asia and, in short, relies on a dorsal approach to the foot rather than an approach through the plantar aspect with consequent development of scarring. The surgical approach has been adopted by many foot surgeons and is clearly of major benefit in the management of diabetic foot disease.

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### Further reading

1. Warren G, Nade S. The care of neuropathic limbs: a practical manual. London: Parthenon, 1999.