

Diabetic foot ulceration

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Introduction

Despite the best efforts of screening and prevention, diabetic patients develop skin breakdown and ulceration. Every break of the skin in the diabetic foot is a possible portal of entry for bacteria, leading to overwhelming infection. We have seen patients who have come in to the clinic to have a major amputation following what seemed like an inconsequential lesion. A diabetic foot lesion should never be regarded as trivial. The instant a person with diabetes suffers a break in the skin of the foot there is an eventual risk of amputation.

The diabetic foot can be divided into two entities, the neuropathic foot and the ischaemic foot. It is essential to differentiate between ulcers on the neuropathic foot (so called “neuropathic ulceration”) and ulcers on the ischaemic foot. Ulceration of the neuropathic foot is painless and develops at the sites of high mechanical pressure on the plantar surface, often under the metatarsal heads. However, the commonest site of ulceration is the toe. A callus develops at the site of high plantar pressure, and if this is not removed it breaks down and leads to ulceration. Ulcers commonly develop on the ischaemic foot when there is an associated neuropathy, and they are thus deemed neuroischaemic ulcers. They usually develop on the margins of the foot in localised areas over bony prominences, often from friction caused by tight or ill fitting shoes.

Management

Management of ulceration of the diabetic foot demands a multidisciplinary approach, addressing important aspects of mechanical, wound, microbiological, vascular, metabolic, and educational care.¹

The aim is to heal ulcers within the first six weeks of their onset. This is the critical time for early and aggressive management, and so is a window of opportunity that should be taken seriously. Patients with diabetic foot ulcers require specialised care by a multidisciplinary team working not only in a dedicated diabetic foot clinic but also caring for the patient when they are admitted to hospital. International guidelines recommend that patients identified as having new onset foot ulcers should be referred immediately to a dedicated multidisciplinary foot team.²

Mechanical control

Ideally, ulcers should be managed with rest and avoidance of pressure. However, total non-weight bearing is rarely practical and ambulatory methods have been developed.

In the neuropathic foot, the ulcer is managed by off loading, which results in a redistribution of load bearing on the plantar surface of the foot. The most effective means of off loading is cast therapy, involving a removable cast walker such as the Aircast Walker, the Scotchcast boot, and the total contact cast.³ Their use is governed by local experience and expertise. If casting techniques are not available, temporary ready made shoes with a cushioning insole can be supplied. Felt pads may also be used. General measures such as the use of crutches, wheelchairs, and Zimmer frames may be necessary.

In the neuroischaemic foot, a high street shoe that is sufficiently long, broad, and deep, and which fastens with a lace or strap high on the foot to reduce frictional forces on the vulnerable margins of the foot may be sufficient. Alternatively, a ready made stock shoe that is wide fitting may be suitable.

After ulcers have healed, patients should be fitted with specially made shoes containing customised total contact insoles. These are designed to redistribute weight bearing away from the vulnerable pressure areas and at the same time provide a suitable cushioning.

Wound control

This includes debridement, dressings, and advanced wound healing products and techniques.

Debridement

Debridement is the most important part of wound control and the preferred method is sharp debridement, carried out with a scalpel. It allows removal of the callus and devitalised tissue, and enables the true dimensions of the ulcer to be perceived. It also diminishes the bacterial load of the ulcer, even in the absence of overt infection, as well as restoring chronic wounds to acute wounds and releasing growth factors to aid the healing process.

Dressings

Although moist wound healing is generally held to be important in the management of chronic wounds, the healing process with diabetic foot ulcers is more complex.⁴ A balance is needed to avoid maceration of tissues, whilst on the other hand encouraging conditions that prevent eschar formation. There is no firm evidence that any one dressing is better or worse than any other.⁵

Advanced wound healing products

When ulcers do not respond to basic treatment, advanced products to stimulate wound healing may need to be used. These products are expensive and should only be considered when basic treatments have

failed.⁵ Advanced wound healing products include:

- Growth factors
- Regenerative materials that facilitate and expedite wound healing:
 - Skin substitutes
 - Extracellular matrix proteins
- Protease inhibitors
- Vasoactive compounds
- Platelet therapies.

Advanced wound healing techniques

Negative pressure wound therapy

Negative pressure wound therapy (NPWT) has been used to achieve closure of wounds, including diabetic foot wounds.⁶ In this technique, negative pressure is applied to the ulcer through a tube placed within a polyurethane ether foam sponge, which is positioned on the ulcer over a dressing and sealed in place with a plastic film to create a vacuum. Exudate from the wound is sucked along the tube via a vacuum pump to a disposable collecting chamber. The negative pressure improves the vascularity and stimulates granulation of the wound.

Larval therapy

The larvae of the green bottle fly are sometimes used to treat ulcers, especially on the neuroischaemic foot. Only sterile maggots should be used. Larvae can achieve relatively rapid atraumatic physical removal of necrotic material.⁷

Hydrotherapy

It is possible to debride wounds using a water jet powered surgical tool known as

the Versajet Hydrosurgery System, which propels a razor thin high velocity stream of sterile saline. A localised vacuum effect is created across the operating window. The Versajet system holds and cuts targeted tissue, while aspirating debris from the site.

Microbiological control

When the skin of the foot is broken, the patient is at great risk of infection. The diabetic ulcerated foot should be examined regularly for local signs of infection, cellulitis, or osteomyelitis. In the presence of neuropathy and ischaemia, the inflammatory response is impaired and classic signs of infection may not be obvious. It is important therefore to look for more subtle initial signs of infection, including:

- Friable granulation tissue
- Base of the ulcer changing from healthy pink granulations to yellowish or grey tissue
- Unpleasant smell
- Sinuses developing in an ulcer
- Edges of the ulcer becoming undermined.⁸

At no other stage in the natural history of the diabetic foot is early diagnosis and intervention so important. Twenty four hours of undiagnosed and untreated infection can lead to severe necrosis. The critical factor in saving limbs is making a rapid diagnosis of infection and administering the appropriate treatment early to prevent tissue destruction.

Vascular control

When a patient presents with an ulcer, it is important to establish whether the foot is ischaemic or not. The diabetic ischaemic lower limb presents differently from the

non-diabetic ischaemic lower limb. Often the patient has no history of claudication, and because of a coexisting neuropathy, rest pain may be absent.

Ischaemia is diagnosed when both foot pulses are absent. Initially, both the brachial and ankle systolic blood pressures can be measured and the ankle brachial pressure index (ABPI), which is the ratio of ankle systolic pressure to brachial systolic pressure, can be calculated. In normal subjects, the ABPI is usually >1, but in the presence of ischaemia it is <1. If the arteries are calcified it may be artifactually raised, but the test is still important as long as one understands its interpretation. Thus, if the ABPI is 0.5 then it is low and indicates severe ischaemia, whether the foot arteries are calcified or not. Indeed, if there is medial arterial calcification in the foot the true ABPI may be lower and even more urgent action is required. Further tests, such as the measurement of transcutaneous oxygen tension and toe blood pressure, may be useful to help decide when to perform invasive investigations with a view to revascularisation.

The modern approach to the ischaemic foot is to encourage early referral to allow rapid diagnosis and intervention. A fast track service to receive patients with ischaemic ulcers and quickly assess them with modern non-invasive investigations should be a feature of modern diabetic foot care.⁹ This is best carried out in a diabetic foot clinic, where a specialist can see the ischaemic patient without delay and investigate and treat them in a joint diabetic/vascular surgical clinic which has access to day case and inpatient angiography, and ultimately angioplasty if indicated. If lesions are too widespread for angioplasty then arterial bypass surgery may be necessary. Distal bypass to the infrapopliteal arteries was

previously thought to be unduly risky with a poor patency rate, counterbalancing any expected clinical benefit, but recently has been shown to be an important and successful part of diabetic limb salvage.⁹ However, distal bypass surgery is not without risk. It is therefore more usually reserved to treat extensive tissue destruction in the foot which cannot be managed without a distal bypass restoring pulsatile blood flow to the foot.

Metabolic control

It is important to make sure that there is no systemic, metabolic, or nutritional disturbance to retard healing of the ulcer. Full blood count, serum electrolytes, and creatinine and liver function tests should be carried out. Wound healing and neutrophil function are impaired by hyperglycaemia, which should be controlled as tightly as possible. Type 2 diabetic patients on oral hypoglycaemic therapy with suboptimal glycaemic control which cannot be corrected should be started on insulin. A diabetic foot ulcer is an important marker of systemic disease that leads to a 50% mortality rate, mainly from cardiovascular disease, at the end of five years.¹⁰ Therefore, hyperlipidaemia and hypertension should be actively treated, and smoking strongly discouraged.

Educational control

Patients should be instructed on the principles of ulcer care, stressing the importance of rest, comfortable footwear, regular dressings, and frequent observation for signs of infection.

Conclusion

Successful management of the diabetic foot ulcer needs the expertise of a multidisciplinary care team, which provide integrated care focused within the diabetic foot clinic. Members of the team will include a physician, podiatrist, diabetes liaison nurse, orthotist, microbiologist, radiologist, and orthopaedic and vascular surgeon. The diabetic foot clinic should provide rapid access, early diagnosis, and prompt help for patients with urgent foot problems. Diabetic foot patients who experience repeated crises from the rapid onset infection should receive urgent attention in the multidisciplinary diabetic foot clinic to prevent them from proceeding to eventual gangrene and amputation.

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