

An overview of footwear provision for the diabetic foot

Marilyn Lord and Robert Lewis

ARTICLE POINTS

- 1 Neuropathic and ischaemic feet require different solutions.
- 2 Patient education on footwear is essential.
- 3 Redistribution of plantar pressure reduces the risk of neuropathic ulceration.
- 4 Orthotic clinics are able to offer a range of treatment options.
- 5 Balance is necessary between footwear appearance, clinical need and funding.

KEY WORDS

- Diabetic foot
- Footwear
- Orthopaedic

Introduction

Orthopaedic footwear is a topic guaranteed to raise controversial discussion, either in relation to a particular design feature or more likely to service delivery aspects. In general, footwear fitting is more an art than a science (Janisse, 1992, 1995) but there is growing research evidence as to the efficacy of orthopaedic provision. Service delivery has undergone recent NHS review and consequent changes to organisation and access (Bowker et al, 1992; Health Service Guidelines, 1995). This article outlines particular footwear problems and solutions from experience in our own diabetic foot clinic and the limited research publications in this area.

There is widespread clinical recognition of the important role of special shoes and orthotic inlays in the prevention of foot lesions, although the evidence base is scant regarding the effectiveness of specific use (Chantelau and Haage, 1994; Litzelman et al, 1997). Certainly the risk of plantar ulceration in neuropathic patients with high foot pressure is well established (Veves et al, 1992) and underfoot cushioning is strongly recommended for early preventive treatment and reduction of re-ulceration.

However, the complications of diabetes are wider than simply plantar ulceration, and a more specific analysis of the problems can inform better management.

Foot type

Diabetic foot problems are generally described as either neuropathic or ischaemic (most often with concomitant neuropathy, described as neuroischaemic). Aspects of the clinical presentation that should be taken into account when choosing footwear are outlined below.

The neuropathic foot

The neuropathic foot has an obvious loss of sensation, and the patient cannot determine normally occurring tightness, rubbing, protrusions or trauma. It is typified by warm 'doughy' skin that is prone to maceration, and may have

deformity due to motor neuropathy.

Possible complications include:

- Plantar ulceration, related to high pressure, requiring redistribution (Edmonds, 1987; Young et al, 1992)
- Claw toes and consequent dorsal ulcers if the toes rub on the shoe upper, and apical ulcers if the toes butt the end or press on the sole of the shoe
- Oedematous volumetric fluctuations, which make shoes tight or loose as the extent of oedema changes
- Charcot joints, which can leave substantial midfoot deformity leading to midfoot plantar ulceration and in-shoe accommodation problems, and rearfoot/ankle deformity leading to altered biomechanics.

The ischaemic foot

Typified by a poor blood supply, the ischaemic foot may be painful, cold, with fragile anhydrotic skin that is prone to fissures.

Complications include:

- Ulcers on the margins of the foot
 - Ulcers on the dorsum and tips of the toes as for neuropathic feet
 - Interdigital ulcers from toe cramping.
- Plantar ulceration is rarely seen, although pressures may be as high as for the neuropathic foot (Pieti et al, 1995) and require redistribution mainly for comfort.

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Table 1. Footwear advice for patients provided with orthopaedic shoes

- **Always wear the footwear provided, fasten firmly and never walk barefoot, even at home: slippers offer little protection or underfoot support and are no substitute**
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- **'Break in' a new pair of shoes gradually over a few weeks**
- **Check the inside of your shoes frequently by hand to feel for development of rough edges, ridges or creases in upper or insole**
- **Repair shoes before worn out or broken down, and keep clean and supple with a good leather polish**
- **Inspect feet daily and return if any callus build-up or skin lesion is noticed**
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- **Make sure you have two pairs of shoes and wear on alternate days to allow perspiration to dry out**
- **Put shoes on carefully: make sure that socks fit well and do not crease, that there is nothing inside the shoe to begin with, and that the tongues are straight**
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- **Contact the orthotist who issued the shoes as soon as possible if there are any problems**
- **Your clinic can arrange for free shoe repair, although a simple repair may be undertaken by a good cobbler — ask the orthotist first whether or not this is suitable.**

Table 2. Features that may be required in diabetic footwear

Feature	Purpose
Extra-depth shoe	To accommodate flat layers, preformed footbeds and customised inlays (<i>Figure 1</i>) to distribute pressure more evenly
Extra height in toe box or reduced stiffeners (Tovey and Moss, 1987)	To prevent rubbing and pressure on dorsum and tips of the toes
Extra-width shoe	To accommodate broad feet, reduce lateral pressure and ensure that sole of foot is not overhanging edge of shoe
Retaining mechanism (laces or Velcro strap)	To hold the foot back firmly into hindpart, thereby protecting forefoot from pressure and rubbing due to sliding during gait (<i>Figure 2</i>)
Safe construction method	To prevent intrusions developing with wear (e.g. no tacks)
Minimal and carefully placed seams	To keep seams away from pressure-sensitive areas in forefoot
Leather material	To allow moisture to escape and generally protect the foot from trauma
Lightweight and durable soling materials	To provide adequate grip and slip resistance; also contribute to cushioning
Rigid rocker-bottom sole	To effect immobilisation and redistribute additional pressure away from the metatarsal head region (Postema et al, 1995) (<i>Figure 3</i>)
Inlays	To redistribute pressure, provide support or biomechanically correct foot
Swell socks	To allow for oedematous volume fluctuations; often cork layers which can be removed
Orthotic additions and shoe adaptations	To account for biomechanical disruptions, e.g. ankle supports, sole floats and wedges (Tollafield and Merriman, 1997)

Activity level

Neuropathic patients without major complications of diabetes may lead a normal lifestyle. In ischaemic patients, however, the vascular disease restricts activity, and this has implications for footwear construction (Rozema et al, 1996). Diabetic patients who develop foot complications are often in the older age groups, and so footwear may not always be subjected to heavy wear.

Other special considerations

Footcare education including advice on footwear use is vital, especially in view of potential neuropathic neglect (*Table 1*). A good clinic will provide an information leaflet regarding foot and shoe care.

Bulky dressings on lesions or oedema may require temporary accommodation, and timing for footwear supply may be sensitive to the state of the oedema.

Obesity can stress the foot's longitudinal

arch and break down the support of shoes; obese patients may require sturdy shoes and inserts with biomechanical correction.

Patients with arthritis or poor eyesight may be unable to do up lace-up shoes, in which case a Velcro fastening might be substituted.

As for all orthopaedic footwear, social issues such as special requirements for sport and work, personal perceptions, self-image, attitude and fashion trends (particularly for younger patients) need to be considered.

Suitable footwear

The guiding principles for diabetic footwear are to provide: adequate accommodation for the deformities outlined earlier and for orthoses; plantar pressure relief; and in some cases biomechanical support. General guidance on footwear can be found in Hughes (1983), Condie et al (1996), and Tollafield and Merriman (1997). There is

evidence that poorly fitting footwear can precipitate ulcers (Macfarlane and Jeffcoate, 1997).

Good footwear is a primary management tool. Specific features required in diabetic footwear are shown in Table 2. The shoe choices are patient's own, stock orthopaedic and bespoke, with possible adaptations to the first two; all may be provided with special orthotic inlays, such as those shown in Figure 1.

Ordinary trainers

Ordinary trainers with a good cushioning sole and enough space for foot and deep inlays can usually be acceptable own-shoes (Perry et al, 1995; Lavery et al, 1997). However, they do tend to make the foot hot, may form creases across the dorsum of the forefoot which can press down on toes, and have a multitude of seams. Consequently, they must be of plainer, quality construction (i.e. less complex and well constructed to avoid exposed rough seam edges — stiff upper materials and poor design lead to creases) and carefully monitored. Cosmetically, they now appeal to both younger and older age groups, which is important.

Stock shoes

These are now the mainstay of orthopaedic provision; approximately 50% of patients are supplied with these at our hospital. These shoes are typically a lace-up Gibson-style (Figures 2 and 3) with few seams and room to accommodate at least 6 mm of flat inlays and a contoured footbed. Popular sizes, colours and styles are available off the shelf and others can be made to order quickly from standard components.

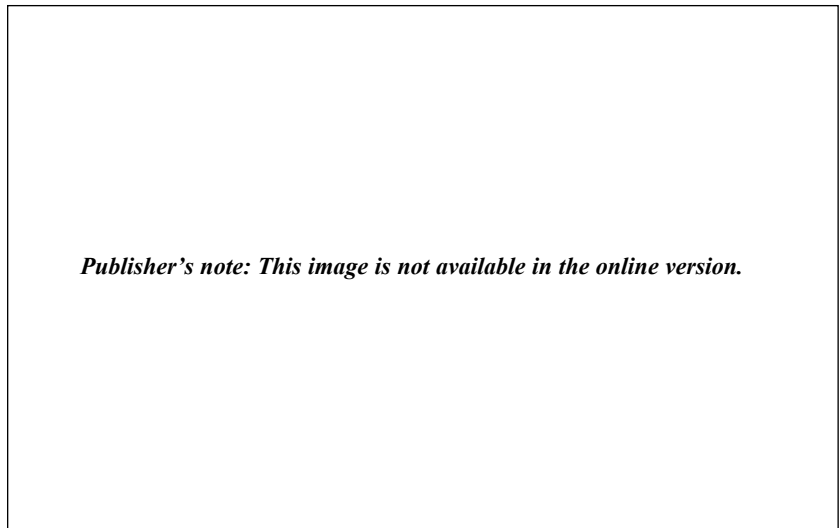
Possibilities exist for minor specification modifications in made-to-order stock shoes, such as extra allowance for a bunion; this absorbs requirements that would otherwise demand bespoke footwear, and such shoes are known as 'adapted stocks'.

Many stock shoes have a layer of foam rubber inside the shoe upper (known as 'cossetting' in the shoe trade). This makes the shoe feel comfortable on first try-on, but quickly flattens, making the foot hot, and is no substitute for a good internal finish.

A word of caution regarding shoe soles on stock shoes: some of the lightweight

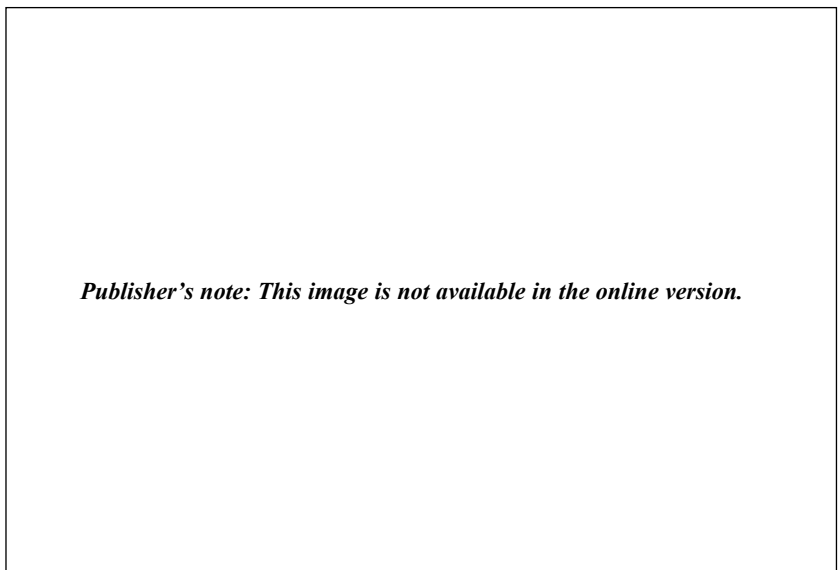


Figure 1. A custom-moulded inlay comprising a moulded top layer of ethyl vinyl acetate, a layer of shock-absorbing Poron™, and hard Plastazote™ to match the shoe insole shape.



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Figure 2. A stock orthopaedic shoe popular in UK clinics for diabetic use.



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Figure 3. A continental stock shoe with a rigid rocker-bottom design of the sole, which requires the typical high toe-spring of the clog in order to roll-off forward during gait.

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Figure 4. Effort has been made with the styling of these bespoke boots for a patient with Charcot deformities.

materials rapidly wear smooth and are slippery, so inspect the shoes for adequate tread pattern on review!

Bespoke shoes or boots

These (Figure 4) are required for feet that perhaps need a deeper inlay, a rocker-bottom sole, an ankle foot orthosis accommodated, or some other special feature such as sockets for callipers. This footwear takes longer to make — ideally no more than 6 weeks from measurement to fitting — because it first requires a custom shoe last to be made and matching patterns designed.

Orthotic inlays (also termed inserts or insoles) are a major component of orthopaedic footwear which can only be described briefly here. Custom-moulded inlays (Figure 1) are increasingly provided in all types of footwear as these may be superior, in terms of reducing metatarsal pressure, to a standard flat inlay or preformed footbed (Lord and Hosein, 1994; Reiber et al, 1997).

Most of these are laboratory made to a foot cast, although some commercial systems are available for production in the clinic direct from foot-shape capture, e.g. the Irving Insole device (Taylor Therapy, Walsall). Alternatively, customised inlays are made by adding pre-shaped components to a flat inlay.

Footwear prescription

Footwear provision is largely the remit of orthotists working in hospital clinics. Limited footwear items, but not a complete service, are provided elsewhere, e.g. inlays may be provided by podiatrists in the community. Referral to the orthotics service is traditionally made via a hospital consultant, but patients can now also be referred directly by the GP in some areas, enabling faster access in uncomplicated cases. Footwear provision is often made in conjunction with chiropodial treatment.

Two serviceable pairs of orthopaedic shoes are recommended — more if they are subject to hard wear or for a specific need. Patients will usually see an orthotist at their first appointment, when their foot problem will be assessed and a decision concerning the type of footwear will be made.

For stock footwear, there would ideally be an opportunity to try on samples of the shoe model at the first visit, although the shoe can be selected from measures, and a cast or impression may be taken to make a moulded insert for the shoe. The shoe and insert will then be ordered, and the patient will be required to attend again for delivery and ideally followed-up a month or so later.

For custom-made footwear, the orthotist will take measures and probably cast the feet at the first visit, and discuss the style required. The patient will be asked to attend next for a trial fitting — note that the shoes will only be part-finished at this stage. Another visit will be required for delivery of the finished shoe.

What you want and what you get!

There are occasionally outbursts from patients and professionals alike about NHS-provided orthopaedic footwear, prompting research into the causes (Fisher and McLellan, 1989).

It is in the nature of the requirement that the footwear resembles a sturdy walking shoe and will be larger in size to prevent cramping and provide cushioning. Orthopaedic shoes may sometimes look 'home-made' and not up to the standards of design and fabrication that we now expect of a quality high-street equivalent: this is largely due to the economics of low volume

PAGE POINTS

1 Orthopaedic footwear is largely provided by orthotists working in hospital clinics.

2 Patients are usually referred via a hospital consultant, but GPs can now refer in some areas.

3 A minimum of two serviceable pairs of orthopaedic shoes is recommended.

4 NHS cost constraints and low volume combine to keep the design of orthopaedic shoes below the standard of quality high-street equivalents.

and NHS cost constraints, and not to limitations of manufacturers' capabilities.

Stock shoes typically cost between £65 and £110 per pair, excluding service. Compare a stock shoe (Figure 2), typical of those supplied in the UK, with an alternative continental shoe at about double the cost which has better styling and a moulded sole unit (Figure 3). A basic bespoke shoe costs about £270 to manufacture; add to this a moulded inlay at £70–115 and any other special features, and the cost can easily go over £400, and then there is the orthotic service cost. However, if the fit and cosmesis are lacking, the shoes may not be worn (Knowles and Boulton, 1996) and so economy may be false. More evidence is needed on cost-effectiveness.

The range of stock shoes available is improving, and the patient should be shown the catalogue of at least one manufacturer from which to choose a style and colour, with some options on design features. For custom-made shoes, we suggest that patients should take along a picture of a style they like, which can be copied, subject to the constraints of clinical needs, economics and copyright (note that copying a Nike flash is not strictly allowed!).

Conclusion

Provision of footwear to manage diabetic foot problems demands a clear understanding of the particular problems of the individual foot, and selection of the best shoe and inlay combination to alleviate these. Orthotists have a spectrum of solutions for specific problems. The use of stock orthopaedic shoes and custom-moulded inlays both continue to increase.

The diabetic foot clinic should provide patient education and continuing support; this is particularly important in this group where the presentation is far from static. Although orthopaedic footwear for the diabetic foot cannot be as cosmetically pleasing as normal shoes, choice and styling are improving. ■

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PAGE POINTS

1 Orthopaedic shoes are expensive, but cheaper ones that do not fit well or are cosmetically unacceptable may not be worn, and so economy may be false.

2 The range of stock orthopaedic shoes available is improving and patients should be able to choose from a number of styles and colours.

3 Orthotists have a spectrum of solutions for specific diabetic foot problems.

4 The diabetic foot clinic should provide patient education and continuing support.