

# The diabetic foot: considerations for pressure reduction and off-loading

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## Introduction

The development of foot ulcers in diabetics has been associated with numerous intrinsic and extrinsic risk factors leading to tissue compromise and deterioration<sup>1</sup>. The primary contributing factors most frequently referenced are repetitive trauma and neuropathy<sup>2</sup>. Decreased sensation in the diabetic foot and decreased ability to perceive injury allow for repetitive tissue trauma to proceed to ulceration that may go unnoticed by the diabetic until extensive and visibly obvious damage has occurred. Once present, the treatment of ulceration includes addressing the wound environment with appropriate treatment modalities, controlling the underlying disease, and reducing or eliminating trauma to the tissue by off-loading the foot.

The focus of this manuscript is on the means of decreasing repetitive trauma through reducing or relieving pressure at

Off-Loading	
⌘ Bed rest	⌘ Healing shoe
⌘ Wheelchair	⌘ Total contact cast
⌘ Insoles	⌘ Removable cast walker
⌘ Extra depth or custom shoes	
⌘ Felt and foam padding	

Table 1. Off-Loading Modalities.

either a site of previous injury and ulceration or preventing tissue injury to the high risk foot. The reader interested in learning about risk and mechanisms of diabetic foot injury, is referred to the extensive publications on risk factors for the development of ulcers. It is important to note that off-loading has the dual function of reducing risk of tissue damage and assisting with tissue repair, after damage has occurred, by the reduction or elimination of pressure.

## Off-Loading

### Complete Offloading

The various modalities available to assist with off-loading are listed in Table 1. The specific treatment choice is tailored to the physical and social needs of the individual. Complete off-loading or pressure relief is best attained through complete bed rest. While remaining non-ambulatory guarantees the reduction of pressure, it is neither practical nor always medically advisable. Ambulatory and otherwise healthy patients are often not willing to remain in bed until the wound is healed. Even when willing, hospitalising patients

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and/or restricting them to bed rest becomes cost prohibitive. Immobility and complete bed rest may also place patients at risk for embolisation and other complications associated with immobility. Wheelchairs and crutches also allow for complete pressure relief. Success of these modalities is directly related to patient compliance with ongoing use. Social and working environments also become a critical consideration particularly where stairs, living environment and daily activity makes use of these devices difficult. Crutches require physical therapy training as well as the ability of the patient to use the device.

The most effective off-loading devices, while successful in theory, become impractical and fail in the reality of the diabetic patient's environment. When the most effective treatment is not an option, clear and extensive patient education must be integrated into the treatment plan as healing with other modalities may take longer periods of time and may not be effective. Options that are closest to complete off-loading include total contact casts (TCC) and specialised walkers.

**Pressure Relief and Reduction**

A TCC offers the advantages of significantly reduced pressure on the plantar aspect of the foot<sup>3-5</sup> and inability of the patient to disrupt the wound site (see Figure 1). As with all modalities,



Figure 1. Total Contact Cast.

<b>Total Contact Cast</b>	
Pros	Cons
⌘ excellent pressure reduction/rdief	⌘ requires experience and expertise to apply
⌘ prevents disruption of wound	⌘ expense
⌘ compliance	⌘ potential for iatrogenic lesions
	⌘ frequent removal and reapplication
	⌘ strict indications and contraindications

Table 2. Advantages and Disadvantages of TCC.

individual needs and ability to effectively use the device are critical to treatment outcomes. A TCC is appropriate for patients able to physically ambulate with the device in their daily environment. Elderly, frail or weak patients may not do well with a TCC. The wound environment must also be considered. Infected wounds require control of the infection



Figure 2. Removable Walker.

Removable   Walkers	
Pros	Cons
⌘ significant pressure reduction	⌘ no significant edema control
⌘ can be modified	⌘ may allow shear forces
⌘ acceptable to most patients	⌘ expensive
	⌘ compliance

Table 3. Advantages and Disadvantages of Walkers.

prior to application as wound deterioration and progress of infection cannot be followed under a cast. Use of ‘windowing’ the cast at the ulcer site may affect the effectiveness of the TCC and pressure distribution. Wounds that are heavily exudating and require frequent daily changes may not benefit from a TCC. The ideal patient for this device would be an otherwise ambulatory patient with a low to moderately low exudating wound without clinical signs of infection. The cast is usually changed weekly or occasionally fortnightly when minimal drainage is present and the wound is progressing to closure. Application of a TCC requires skill and training to prevent further tissue damage.

Removable walking casts are acceptable alternatives to a TCC. Data published by Lavery et al<sup>6</sup> suggest that pressure relief under the metatarsals is almost equivalent when comparing a removable walking cast to a TCC. Removable walkers (see Figure 2), available from different manufacturers, are easy to fit, relatively comfortable and can be removed to allow for daily dressing changes or for when patients are not



Figure 3. Custom Moulded Shoes.

ambulating for extended periods of time. The disadvantages of these devices are reflected in their name; ‘removable’ walkers. Patients who remove the device when ambulating negate the advantages accrued from plantar pressure reduction and may easily re-traumatise the wound site in a matter of hours or even minutes. Recommendations have been made<sup>7</sup> to apply an outer wrap similar to a stretch bandage over the walker and have the patient wear the device 24 hours a day.

This approach approximates a TCC, which may be a better choice unless the patient cannot tolerate the cast. Patients may also express concern about sleeping in a walker that has been soiled from daily use. Advantages and disadvantages of TCCs and walkers are listed in Tables 2 and 3 respectively.

**Footwear**

Accommodative and customised footwear is the preferred but not the most optimal treatment modality for diabetic foot ulcers. Custom and semi-custom footwear is important for wound prophylaxis and reducing the risk of repetitive trauma to the foot. Once an ulcer occurs, customisation of inserts and footwear may be necessary to assist with pressure redistribution. However, complete pressure relief cannot be expected with these devices.

Different shoes are available for the diabetic foot with the most optimal being the custom moulded shoe (see Figure 3). The patient financial status and medical coverage dictate the choice of product unless other means are available. Custom moulded shoes are very expensive and not available to all patients. Diabetics with limited incomes and resources may be forced to buy semi-custom shoes or off-the-shelf shoes that accommodate their foot deformities.

A relatively inexpensive temporary shoe designed for use when treating diabetic foot ulcers is the diabetic healing shoe (see Figure 4). These rubber and foam shoes come with inserts composed of multiple rubber hexagonals designed to assist with pressure redistribution. Manufacturers recommend removal of the hexagonals under the site of the ulcer. However, this may result in collapse of the surrounding hexagonals creating sites of increased pressure causing rapid breakdown of the shoe insert. The advantages and disadvantages of this type of device are listed in Table 4. It is imperative that the



Figure 4. Diabetic Healing Shoe.

patient and the healthcare provider understand that shoes, even temporary healing shoes, are not designed to directly heal an ulcer as they do not adequately relieve pressure.

The majority of over-the-counter shoes are not designed for custom inserts or modifications, thereby requiring an understanding of shoe anatomy and construction for optimal shoe selection (see Figures 5 and 6). Diabetic patients should be referred to their podiatrist or pedorthotist who may assist them with appropriate shoe selection.

Custom shoes, when available and financially achievable for

the patient, are recommended for all diabetic patients with significant foot deformities once wound healing has been attained. While shoes may not prevent the occurrence of a wound, they significantly reduce the risk. Shoes and their custom inserts need to be inspected by a qualified healthcare professional once every three months to determine wear and ongoing proper fitting.

When custom moulded shoes are not available, extra depth prefabricated shoes may be an affordable alternative (see Figure 7). The patient’s podiatrist or pedorthist should exam

Healing Shoe	
Pros:	Cons:
⌘ inexpensive	⌘ biomechanical support is poor
⌘ higher compliance availability	⌘ lateral instability
⌘ can be modified	⌘ fitting/ slippage
	⌘ shear forces exist

Table 4. Advantages and Disadvantages of Healing Shoe.

What Type of Shoe Should I Recommend?
⌘ Should be tailored to foot risk
⌘ Foot Category 0: well -fitting, over the counter
⌘ Foot Category 1: over the counter with molded inlay
⌘ Foot Category 2 & 3: depth inlay shoe vs. custom molded shoe

Table 5. Guide to Proper Shoe Selection.

# Anatomy of a Shoe



Figure 5. Anatomy of a Shoe.

any prefabricated shoes for correct fitting prior to application, especially when custom inserts are used in the shoe. A simple and efficient guide to selecting the correct shoe has been previously presented by Armstrong et al (see Table 5). This guide is based on the Diabetic Foot Risk Classification where Foot Category 0 consisted of individuals with no neuropathy, Category 1 neuropathy without deformity or peripheral vascular disease (PVD), Category 2 neuropathy with deformity or PVD and Category 3 a history of foot ulceration or a lower- extremity amputation<sup>8</sup>.

## Inserts, Padding and Accommodative Devices

Additional but not optimal options for pressure redistribution include the use of custom and over-the-counter inserts, custom made pads and other devices that assist with decreasing pressure at a site at high risk for ulcer development . Clinicians must always remember that when these devices are not

correctly applied they will not provide pressure relief and may even contribute to tissue breakdown. As with all orthotic and prosthetic devices, skill and training are required to select and apply the best customised device. When uncertain of which

### Over the Counter Shoes

- Soft Upper and Insole
- Thumbnail's width between the longest toe and the tip of the shoe
- Break at the Ball of the Foot. "Heel to Ball" length
- Buy shoes at the end of the day

Figure 6. Shoe Construction.



Figure 7. Extra Depth Prefabricated Shoes.

device to choose, referral to a skilled professional is advised.

## Summary

Off-loading is an integral and necessary component of treating the diabetic foot in both the presence and absence of tissue compromise or ulceration. Modalities providing complete pressure relief should always be the first choice. Educating the patient on the relationship between pressure relief off-loading and wound healing and prevention should also be a standard part of the treatment visit. Additional modalities

that may provide significant pressure reduction but not relief are available. Choice of the most appropriate modality is based on multiple factors including the patient medical and diabetic status, social and living environment, and ability to use the device prescribed. The clinician prescribing footwear for the diabetic patient is responsible for researching and understanding the various devices available prior to administering or prescribing care.

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