Debridement of diabetic foot lesions

Vanessa Jones

ARTICLE POINTS

1 Debridement is an essential part of the management of diabetic foot lesions.

2 It is performed primarily to remove necrotic tissue, slough or callus, or to drain pus or exudate.

3 It is generally accepted that wounds will not heal until residual necrotic material is removed.

4 Various mechanical and non-mechanical methods of debridement are available.

5 Prior assessment of the lesion to determine its cause is essential as this will often dictate the method of debridement to be used.

KEY WORDS
- Diabetes
- Foot ulceration
- Debridement

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Introduction

Debridement is an essential part of the management of diabetic foot lesions. It may reduce the risk of infection and facilitate healing. Devitalised tissue can be removed by various methods. Clinical evidence to support one debriding agent over another is unconvincing, and the choice of method is often a matter of personal preference. This article discusses the major methods of debridement and the rationale for their use.

Wound healing is a complex dynamic process that is influenced by numerous intrinsic and extrinsic factors. Tissue that is deprived of an adequate blood supply and nutrients will die, resulting in necrotic tissue.

The literature suggests that the presence of devitalised tissue on the wound bed can delay or prevent healing (Bergstrom et al, 1994; Goode, 1995). Although this has not yet been tested in a randomised controlled trial, it is based upon clinical observation and the belief that dead tissue provides a focus for, and encourages the growth of, pathogenic organisms (Haury et al, 1980; Mulder, 1995). It is generally accepted, therefore, that healing will not take place until necrotic material is removed (Razor and Martin, 1991).

Necrosis can be caused by pressure damage, thermal injury, surgical complications and diminished blood flow. It can involve both epidermis and dermis, and necrotic tissue may range in colour and consistency from hard, black leathery eschar to soft, almost liquid, pale yellow slough (*Figures 1* and 2).

Slough consists of a mixture of leucocytes, fibrin, cell debris and bacteria (Thomas, 1990). The colour and consistency are dependent on the duration of exposure to air, which causes the wound to dry out, and the depth of tissue involved (Thomas, 1990; Bale, 1997).

The presence of devitalised tissue in diabetic foot ulcers is attributed to a number of factors:

- *Diminished or absent blood supply*: This is caused by macro- or microvascular disease, which results in occlusion of blood vessels and tissue death.
- *Pressure damage*: Hyperglycaemia produces non-enzymatic glycosylation of collagen and keratin, making these tissues more rigid, inflexible and resistant to enzymatic digestion by collagenases. This results in hyperkeratinosis, which intensifies the forces on the dermis and subcutaneous tissue (Elkeles and Wolfe, 1991).
- *Lowered immunity to infection*: Hyperglycaemia also inhibits the activity of leucocytes, thus decreasing their ability to phagocytose bacteria (Elkeles and Wolfe, 1991) and dead cells. In addition, cellular hypoxia reduces the normal ability of neutrophils to phagocytose bacteria. The result is a build-up of dead cells and the formation of slough.

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Figure 1. Slough: colours vary from dark grey to yellow.

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1 Autolysis is the spontaneous separation of devitalised tissue from healthy tissue.

2 It results from the action of proteolytic enzymes such as collagenases released from macrophages.

3 In people with diabetes, autolysis is impaired and dead cells build up, leading to the formation of slough.

It is essential for the practitioner to undertake a thorough assessment of the patient and his/her wound to determine the cause of the devitalised tissue, as this will generally dictate the method of debridement.

Natural debridement process

Autolysis — the spontaneous separation of devitalised tissue from healthy tissue — occurs naturally in a wound that is not traumatised or compromised. It is brought about by macrophages which are responsible for clearing the wound of debris and release proteolytic enzymes such as collagenases that degrade unwanted materials (Clark, 1993).

Autolysis is enhanced in the presence of moisture, and can therefore be promoted in most wounds by the use of dressings that maintain a moist environment (Mulder, 1995).

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Figure 2. Gangrene and necrosis in the same foot.

Table 1. Classification of debriding techniques

Mechanical	**Non-mechanical**
Surgical (sharp)	Enzymatic (streptokinase/streptodornase, collagenase)
Biosurgery (maggots)	
Wet-to-dry dressings (saline gauze)	Chemical (dextranomer, cadexomer iodine)
Irrigation	Autolytic (hydrogels, hydrocolloids)
Hydrotherapy	

However, caution is advised when using a colour classification system such as the red, yellow, and black (Cuzzell,1988; Stotts, 1990). It should not be assumed that all black tissue can be debrided using dressings that promote autolysis via hydration; where devitalised tissue is the result of peripheral vascular disease, it should be left dry and debridement should not be attempted until a further vascular assessment is made.

In patients with diabetes, however, the normal autolytic process is often impaired or absent for the reasons discussed above.

Reasons for debridement

Debridement of a diabetic lesion is carried out to achieve one or more of the following aims:

- Visualisation of the wound bed: to enable accurate measurement of the wound and identification of tracts and sinuses
- Drainage of exudate and pus: if exudate becomes trapped by callus, excessive tissue destruction may occur
- Decrease pressure on the capillary bed and wound edge: removal of excess callus will decrease the pressure on the wound and improve the blood supply to the area
- Increase antibiotic penetration: slough and necrotic tissue often prevent antibiotic diffusing into the infected tissue beneath.

Methods of debridement

The various methods of debridement are shown in *Table 1*. The method chosen will depend on:

- Systemic and local factors affecting the wound and patient
- Availability of materials and resources
- Expertise of the practitioner

Surgical (sharp) debridement

Sharp or surgical debridement is the dissection of devitalised tissue from the wound bed using a scalpel or scissors. It is reported to be the fastest, most efficient method of wound debridement (Fowler and Van Rijswijk 1995; Bale and Jones 1997). Where large amounts of dead tissue are present, debridement should be performed — the patient's condition permitting — in theatre by a surgeon, under general or local anaesthetic (*Figure 3*). The costs associated with using an operating theatre for this procedure are high, and often it is difficult to find space in an already overburdened theatre list. However, the risk of an infection spreading cannot be over-emphasised, and debridement should be performed before it becomes a surgical emergency.

Conservative sharp debridement is an essential part of the management of any patient with a diabetic foot ulcer, to remove not only necrotic tissue and/or slough in the wound bed but also surrounding callus (*Figure 4*). This is an advanced practice skill which should not be performed by an inexperienced practitioner. Debridement should not cause any further problems and should ideally be performed when there is a clear distinction between healthy and devitalised tissue (Bale, 1997).

Traditionally, debridement of this kind has been carried out by a chiropodist or podiatrist, but with the expansion of specialist diabetic foot clinics it is now also performed by nurses (Poston, 1996; Bale, 1997).

Sharp debridement is not without side-effects, notably pain (except in the insensate foot), bleeding, further tissue loss and risk of sepsis.

When large amounts of tissue or hard, thick eschar are present, and theatre is not an option, removal may be carried out in stages with the aid of hydrocolloids or hydrogels.

To allay alarm, the patient should be informed that the wound will appear larger following sharp debridement (*Figure 5*) and that the process may cause bleeding. Pain control with an anaesthetic should always be considered.

Biosurgery

Sterile maggots are considered to be ideal debriders, having a ferocious appetite for necrotic material while avoiding healthy tissue (Sherman et al, 1995) (*Figures 6a and b*). As yet there have been no controlled clinical trials of the use of maggots in debridement, but their use for this purpose has been reported in small numbers of patients with devitalised tissue (Thomas et al, 1996).

The larvae from adult flies can be harvested and sterilised for use on patients, the most commonly used fly being *Lucilia sericata*. The maggots are placed directly

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Figure 3 Extensive debridement down to the tendon that has been performed in theatre.

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Figure 4. Sharp debridement to remove callus with a scalpel.

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Figure 5. After debridement wound dimensions can be visualised.

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1 Larvae are suitable for debriding dry gangrenous areas.

2 Wet-to-dry dressings are commonly used for debridement in Europe and the USA, but not in the UK.

3 Debridement using wet-to-dry dressings causes pain to the patient and trauma to the wound.

4 There are several enzyme preparations available for digesting slough and necrotic tissue.

5 Enzymatic debridement is quick and effective and may be a useful alternative to surgery.

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Figure 6a (left), 6b (right). Maggots have a ferocious appetite for necrotic material while avoiding healthy tissue.

onto the wound surface and the surrounding skin is protected with a hydrocolloid dressing to avoid excoriation from proteolytic enzymes secreted by the maggots. The maggots are held in place with a gauze mesh, which is secured firmly using a waterproof adhesive tape to prevent the live maggots escaping from the wound (Bale, 1997).

The number of larvae applied will depend on the size of the wound. The maggots should be left on the wound for 3 days (Thomas et al, 1996).

Larvae are suitable for debriding dry gangrenous areas and avoid the problems of maceration that occur with autolytic debridement (Rayman et al, 1998).

Wet-to-dry dressings

Wet-to-dry debridement is infrequently used in the UK, but is common in many European countries and the USA. This technique involves the application of moistened saline to devitalised tissue before the application of gauze. As the devitalised tissue dries, it rehardens and becomes attached to the gauze. When the dressing is changed, the dead tissue (and presumably healthy tissue also) is removed (Poston, 1996). The technique is both painful for the patient and traumatic to the wound (Baxter and Rodeheaver, 1990).

Irrigation and hydrotherapy

High pressure irrigation and whirlpool hydrotherapy are other methods in common use in the USA. Like wet-to-dry methods, they are not recommended for debridement of diabetic foot ulcers.

Enzymatic debridement

Several different enzyme preparations are available for digesting slough and necrotic tissue. In the UK, Varidase, a formulation containing streptokinase and streptodornase, is licensed for use as a debriding agent (Thomas, 1990). Enzymatic debridement is quick and effective and may be a useful alternative to surgery (Berger, 1993; Bale, 1997).

If enzymes are to be used on hard necrotic tissue, cross-hatching and the use of an occlusive dressing are advisable (Marquez, 1995). It could be argued that it is the moist environment, rather than the enzyme, that is achieving debridement.

Other proteolytic enzymatic debriding agents agents include collagenases derived from crab (Glyvanstev et al, 1997) and from krill (Mekkes et al, 1998). However, at present, the use of these agents is confined mainly to selected patients in specialist units.

Chemical methods

Many chemical agents have been used to effect debridement, including eusol, hydrogen peroxide and Aserbine, but these are no longer popular in modern practice.

Dextranomer (Debrisan) is presented as a paste or anhydrous porous beads. It is capable of rapidly absorbing exudate from a necrotic sloughy wound, which is thus removed when the wound is cleansed.

The most commonly used cadexomer dressing is cadexomer iodine (Iodosorb) (Thomas, 1990). This dressing consists of a three-dimensional network of cadexomer (modified starch gel) and tiny beads

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1 The choice of debridement is often dictated by the availability of resources and products.

2 However, it is also greatly influenced by the skill of the practitioner.

3 As always, assessment of the vascular and neurological status of the patient's foot is essential.

(microspheres) containing 0.9% iodine, which is released only in a moist wound environment. This dressing has the ability to remove debris and bacteria from a wound bed and to reduce the number of viable organisms, although the major indication for the use of this product is to effect debridement (Thomas, 1990).

Autolytic debridement

Hydrocolloids and hydrogels are frequently used as a means of stimulating autolytic debridement. Their mode of action and the results of clinical trials will be covered in a subsequent article in this series.

Conclusion

There are many methods of debriding necrotic or sloughy tissue. The choice is often dictated by the availability of resources and products, but is greatly influenced by the skill of the practitioner.

Sharp debridement is generally the method of choice for the removal of callus, but the inexperienced practitioner may cause more harm than good if he/she attempts to remove too much tissue with a scalpel.

As always, assessment of the vascular and neurological status of the patient's foot is essential, and will often clarify the amount of tissue that is to be removed and the method of debridement to use. ■

Bale S (1997) A guide to wound debridement. *Journal of Wound Care* **6**:179-82.

Bale S, Jones V (1997) Assessment and planning of individualised care. In: *Wound Care Nursing: A Patient Centred Approach.* Baillière Tindall, London

Baxter CR, Rodeheaver GT (1990) Interventions. In: *New Directions in Wound Healing.* ER Squibb and Sons, New York

Berger M (1993) Enzymatic debriding preparations. *Ostomy and Wound Management* **39**(5): 61-9

Bergstrom N, Bennett MA, Carlston CE et al (1994) *Treatment of pressure ulcers. Clinical Practice Guideline 15*. Public Health Service Agency for Health Cares Policy and Research (Publication 95-0652)

Clark RAF (1993) Mechanisms of cutaneous wound repair. In: Fitzpatrick TB, Eisen AZ et al, eds. *Haematology in General Medicine.* McGraw-Hill Inc, New York

Cuzzell JZ (1988) Wound Care Forum: The new R Y B Colour Code. *American Journal of Nursing* **10**: 1342-6

Elkeles RS, Wolfe JHN (1991) The diabetic foot. *British Medical Journal* **303**: 1053-5

Fowler E, van Rijswijk L (1995) Using wound debridement to help achieve goals of care. *Ostomy and Wound Management* **41** (Suppl) 235-365

Glyvanstev SP, Adamyan AA, Sakharov I (1997) Crab collagenase in wound debridement. *Journal of Wound Care* **6**(1): 13-6

Goode PS (1995) Consensus on wound debridement. A United States perspective. *European Tissue Repair Society* **2**:(4) 104

Haury B, Rodeheaver G, Vensko J, Edgerton MT, Edlich RF (1980) Debridement: an essential component of traumatic wound care. In: Hunt TK, ed. *Wound Practice.* Appleton-Century-Crofts, New York: 229-40

Marquez RR (1995) Wound Debridement and Hydrotherapy. In: (ed) Gorgia PP *Clinical Wound Management.* Slack, New Jersey

Mekkes JR, Le Poole IC, Das PK, Bos JD and Westerhof W (1998) Efficient debridement of necrotic wounds using proteolytic enzymes derived from Antarctic Krill: a double-blind placebo-controlled study in a standardised animal wound model. *Wound Repair and Regeneration* **6**(1): 50-7

Mulder GD (1995) Cost-effective management care Gel vs wet-to-dry debridement. *Ostomy and Wound Management* **41**(15): 896-900

Poston J (1996) Sharp debridement of devitalised tissue: the nurses' role. *British Journal of Nursing* **5**(11): 655-62

Rayman A, Stansfield G, Woollard T, Mackie A, Rayman G (1998) Use of larvae in the treatment of the diabetic necrotic foot. *The Diabetic Foot* **1**(1): 7-13

Razor B and Martin L (1991) Validating sharp wound debridement. *Journal of Enterostomal Nursing* **18**: 105-10

Sherman RA, Wyte F, Vulpe M (1995) Maggot therapy for treating pressure ulcers in spinal cord injury patients. *Spinal Cord Medicine* **18**(2): 71-4

Stotts NA (1990) Seeing red, yellow and black: the three colour concept of wound care. *Nursing* **90**(20): 59-61

Thomas S (1990) *Wound Management and Dressings*. The Pharmaceutical Press, London

Thomas S, Jones M, Shutler S, Jones S (1996) Using larvae in modern wound management. *Journal of Wound Care* **5**(2): 60-9