The use of alginate dressings in the treatment of diabetic foot ulcers

Elizabeth Pendry

ARTICLE POINTS

1 Alginate dressings are highly absorbent and can be used on moderately to heavily exuding diabetic foot ulcers and sinuses.

2 Alginate dressings can be removed without causing pain or trauma to new tissue.

3 An alginate dressing is an effective haemostat and is generally well tolerated by body tissues.

4 It has been reported that alginate dressings are cost effective in that they reduce the number of dressing changes, therefore reducing nursing time.

5 Alginate dressings should not be used on low-exuding wounds or wounds with necrotic tissue present.

KEY WORDS
- **Alginate**
- **Exudate**
- **Absorbency**
- **Haemostasis**

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Introduction

Wound dressings play an important part in the management of diabetic foot ulcers. Ideally, dressings should alleviate symptoms, provide wound protection and encourage healing (Hilton et al, 2004). Dressings made from calcium alginate fibre are highly absorbent (Thomas, 1992), are less painful to remove (Thomas, 1989; Miller et al, 1993) and have haemostatic qualities (Barnett and Varley, 1987; Gupta et al, 1991). Such dressings are commonly used in the management of chronic exuding wounds such as leg ulcers and pressure areas (Fraser and Gilchrist, 1983; Gilchrist and Martin, 1983; Odugbesan and Barnett, 1987; Chapius and Dollfus, 1990). Furthermore, alginate dressings have also been successfully used in the treatment of acute wounds – for example burns and donor sites (such as skin graft sites; Groves and Lawrence, 1986; Attwood, 1989), and surgical wounds (Thomas, 1985; Gupta et al, 1991). In this article Elizabeth Pendry looks at how alginate dressings work and their use in the treatment of moderately to heavily exuding diabetic foot ulcers.

In the early 1800s, seaweed was discovered to be very effective in treating the wounds of injured sailors. In 1947 Major George Blaine reported promising results when wounds such as burns, lacerations, trophic ulcers and amputations were treated with alginate, a fibre extracted from seaweed (Thomas, 1992). Shortly thereafter, the haemostatic properties of alginates were described following their use during dental (Blockley, 1947; Rumble, 1949), aural (Passe and Blaine, 1948) and neurological (Oliver and Blaine, 1950) procedures, and compared with those of other haemostatic agents (Blaine, 1951).

However, it was not until the mid-1980s that alginates resurfaced as dressings for wounds, when Tom Gilchrist and Anthony Martin (from the Department of Medicine at Sunderland Royal Infirmary) published the first clinical report on Sorbsan (Unomedical, Redditch; Gilchrist and Martin, 1983). Alginate fibre dressings have since been found to be both non-toxic and soluble in body fluids such as exudate and blood (Williams, 1994).

Alginate fibre dressings are derived and manufactured from brown seaweeds. They possess most of the performance criteria required to treat moderately to heavily exuding wounds (Hampton, 2004). They are, principally, used in the treatment of venous leg ulceration (Thomas, 1989) but can also be safely used on diabetic foot ulcers (Williams, 1999). They are processed in such a way to be presented as sheet, rope or gel dressings (some are presented with added carbon to aid in odour control).

Alginates contain D-mannuronic and L-guluronic acid residues with a high calcium content (Segal et al, 1998). The ratio of D-mannuronic:L-guluronic residues and their relative positions on the molecule determine the physical and chemical properties of the alginate. Sorbsan, for example, is rich in D-mannuronic acid residues and produces relatively weaker and more elastic gels, whereas Kaltostat (ConvaTec, Uxbridge) is rich in L-guluronic acid

PAGE POINTS

1 Alginate dressings have been the subject of very few well-controlled, randomised and double-blinded clinical studies. However, they have been found to be superior to paraffin gauze.

2 There has been very little work done looking specifically at the efficacy of alginate dressings in the treatment of diabetic foot ulcers.

3 However, in a small randomised study, an alginate containing dressing was found to be associated with greater wound healing compared with the control dressing.

residues and tends to produce stronger yet brittle gels (Pudner, 2001). Both dressings retain their basic structure in use (Williams, 1998). Essentially, calcium ions from the alginate are replaced by sodium ions from the wound exudate, resulting in the production of a gel, via exudate absorption, at the wound surface (Thomas, 1992).

Literature review

Alginate dressings have been the subject of very few well-controlled, randomised and double-blinded clinical studies. However, they have been found to be superior to paraffin gauze (Attwood, 1989; O'Donoghue et al, 1997), porcine xenograft (Vanstraelen, 1992) and silicone coated polyamide net dressing (O'Donoghue et al, 2000) in the healing of split skin graft donor sites.

In terms of research on the use of alginate dressings in general podiatry practice, Smith (1992) examined the effects on healing time and post-operative complications of two post-operative dressing regimens (Sorbsan versus a standard treatment of polynoxylin powder [Anaflex; Geistlich Pharma, Chester] with a low adherent dressing [Melolin; Smith & Nephew, Hull]) upon toenail removal. The results from this small study of 61 individuals found that Sorbsan used after toenail matrix phenolisation reduced the median healing time and the number of patient complaints when compared with polynoxylin powder/melolin treatment.

Alginates and diabetic foot ulcers

There has been very little work done looking specifically at the efficacy of alginate dressings in the treatment of diabetic foot ulcers.

Donaghue and colleagues (1998) performed a study looking at the efficacy and safety of a collagen–alginate topical wound dressing (Fibracol Plus; Johnson & Johnson, San Angelo, Texas, US) in the treatment of diabetic foot ulcers compared with that of regular gauze moistened with saline. Seventy-five participants were assigned randomly in a 2:1 ratio to the collagen–alginate test dressing or the gauze dressing. Thirty-nine (78%) people treated with the collagen–alginate dressing achieved greater than or equal to a 75% reduction in wound surface area, compared with 15 (60%) of the gauze-treated group. Complete healing was achieved in 24 (48%) of the collagen–alginate dressing group and nine (36%) of the gauze dressing group. Wound size reduced significantly in the collagen–alginate dressing group. This study's findings could be attributed to the dressing's collagen content. The gradual breakdown of the collagen has been reported to contributre to wound healing (Jones, 1999). Therefore, the true validity of this study can be questioned. Although the study size was small at 75 participants, they were randomly assigned.

Bale and colleagues (2001) performed a non-comparative, two-centre study investigating the performance of SeaSorb (an alginate-containing hydrocolloid dressing; Coloplast, Peterborough) in people with diabetic foot ulcers. This was an exploratory safety study to determine the potential use of this dressing and not a large randomised controlled trial and was not specifically designed to investigate healing times. Thirty-nine individuals were enrolled and 28.2% (11 of 39) of the ulcers healed within a 6-week period. There was a significant reduction in mean ulcer area: from 2.8 cm^2 to 1.02 cm^2 from week 0 to week 6. Relative ulcer area showed a significant decrease from 100% to 33%. For 11 patients who suffered ulcer pain, its intensity decreased over the 6 weeks. Twelve adverse events were reported but none of these were attributed to the study dressing.

Lalau and colleagues (2002) compared the efficacy and tolerance of an alginate wound dressing with a vaseline gauze dressing in the treatment of diabetic foot lesions. This was an open-label, multicenter, randomised controlled study lasting 6 weeks. The 77 participants were treated with either a calcium alginate-based dressing or a vaseline gauze dressing. Analysis of the granulation tissue at the wound sites at week 4 showed the calcium alginate dressing to be significantly better at aiding wound healing (P=0.04). Pain experienced by the study

Table 1. A range of alginate-based dressings available, with some select properties (adapted from Jones, 1999).

Product	Composition	Manufacturer
Algisite M	Calcium alginate	Smith & Nephew
Algosteril	Calcium alginate	Beiersdorf
Curasorb	Calcium alginate	Tyco
Kaltogel	Calcium and sodium alginate	ConvaTec
Kaltostat	Calcium and sodium alginate	ConvaTec
Melgisorb	Calcium and sodium alginate	Mölnlycke
Seasorb	Calcium and sodium alginate	Coloplast
Sorbsan	Calcium alginate	Unomedical
Tegagen	Calcium alginate	3M Health Care

participants during dressing changes was significantly lower in the calcium alginate group (P=0.047) and the total number of dressing changes tended also to be lower (P=0.07; non-significant). However, owing to the premature cessation of treatment in 13 individuals, the study period was reduced from 6 weeks to 4 weeks, without revising the criteria of efficacy.

Hilton and colleagues (2004) looked at wound dressings in diabetic foot disease and reported that alginate dressings are highly absorbent and effective for heavily exuding wounds.

Stevens and Chaloner (2005) performed a very small, underpowered study that prospectively looked at 10 patient cases and evaluated the use of Urgosorb (a calcium alginate and hydrocolloid dressing; Urgo, Loughborough) and its effectiveness in managing exudate levels, its effect on the integrity of the surrounding tissue, its ease of removal, patient comfort, and its effectiveness in odour control. They found dressing removal was easy in the majority of cases and patients experienced no or very mild discomfort. Levels of exudates were well managed and there were no reports of any adverse events. Healing was not a primary objective in this study; however, 50% of the cases did fully heal in the 6-week study period.

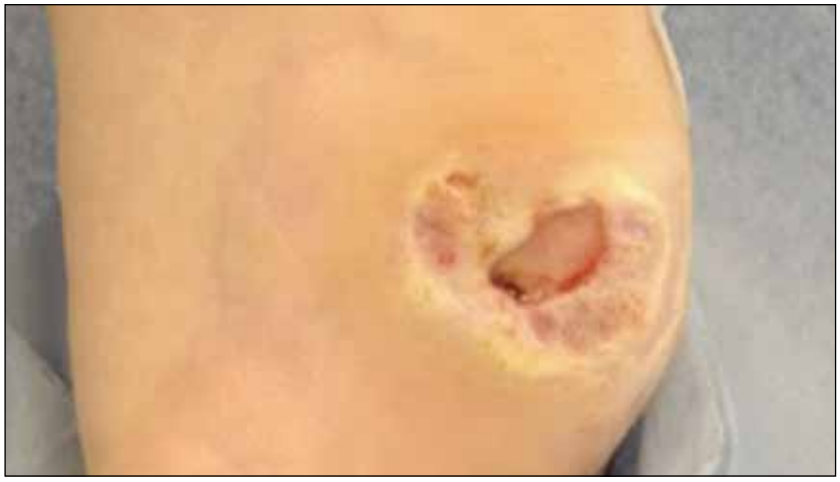

Figure 1. A neuropathic ulcer (of 3 months' duration) on the left foot of a 55-year-old male, post-debridement.

It must be remembered that dressing choice should always be guided by the characteristics of the individual ulcer, the requirements of the patient and cost.

The range of alginate dressings available

As *Table 1* illustrates, there are many different alginate dressings available. Two of these (Sorbsan and Kaltostat) are discussed in more detail below.

Sorbsan

The first clinical report of Sorbsan was published in 1983 (Gilchrist and Martin, 1983). The dressing is presented in the form of a creamy non-woven fleece that has been sterilised by ethylene oxide (Thomas and Loveless, 1992).

Sorbsan is a highly absorbent biodegradable alginate dressing that can be used in a wide variety of moderate to highly secreting lesions (Gilchrist and Martin, 1983). It is made up of 100% calcium alginate (Williams, 1994). The high absorption of exudate is achieved via the formation of a strongly hydrophilic gel, which also serves to control wound secretion levels and to minimise bacterial contamination (Gilchrist and Martin, 1983).

Fibres from the dressing can become trapped in the healing wound; this does not pose a problem as the fibres are biodegradable and do not have to be removed, thus avoiding disturbance of granulation tissue formation (Gilchrist

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1 It is important to remember that the wound must not be packed too tightly with any alginate dressings as there is a danger that a 'plug' will form which can trap exudates and, therefore, stop exudate drainage from the ulcer, thus increasing the risk of any infection spreading and also increasing the chances of the wound not healing as rapidly as possible.

2 Alginate dressings vary in absorbency, but typically absorb up to 15–20 times their own weight in exudate.

3 A non-woven alginate dressings has been shown to be an effective haemostat and to be generally well tolerated by body tissues.

4 Alginate dressings have been shown to be effective in infection control in exuding wounds.

and Martin, 1983). Additional features of Sorbsan include odour remission, conformability and ready-removal of tissue-adherent material (Gilchrist and Martin, 1983).

Kaltostat

This dressing consists of numerous thinner (as compared with Sorbsan) layers of alginate fibres woven together and gamma-irradiated. Unlike Sorbsan, Kaltostat contains 20% sodium alginate (and 80% calcium alginate), which is included to enhance the initial gelling properties of the dressing (Thomas and Loveless, 1992).

Table 2 describes some guidelines on the application of some of the alginate dressings. *Figure 1* shows a neuropathic ulcer post-debridement, prior to the application of an alginate dressing.

Properties and application of alginate dressings

It is important to remember that the wound must not be packed too tightly with any alginate dressings as there is a danger that a 'plug' will form which can trap exudates and, therefore, stop exudate drainage from the ulcer, thus increasing the risk of any infection spreading and also increasing the chances of the wound not healing as rapidly as possible (Thomas, 1992).

A secondary dressing (such as Melolin, a dry non-adherent dressing) is required over the top of the selected alginate dressings.

Absorbency

Alginate dressings vary in absorbency, but typically absorb up to 15–20 times their own weight in exudate (Thomas, 1992). This capacity to absorb large amounts of exudate is one of the major advantages of these dressings – *Figure 2* illustrates a heavily exuding diabetic foot ulcer that is to have an alginate dressing applied. It is very important to regularly check the wound for amount of exudate as the wound may become drier, meaning that the use of the alginate dressing should be stopped.

Thomas and Loveless (1992) found that Kaltostat appeared to be more absorbent than Sorbsan which in turn is more absorbent than Tegagen (3M Health Care Ltd, Loughborough).

Removal of alginate dressings

Sorbsan and Tegagen, both of which are rich in D-mannuronic acid residues, form soft amorphous gels that will dissolve fairly readily in 0.9% w/v sodium chloride solution and may be washed off the wound surface or irrigated out of a cavity or sinus (Thomas, 1992). Therefore, removal of the dressing does not interfere with any granulation tissue – a factor that makes dressing changes virtually painless (Motta, 1989).

Kaltostat is not soluble in sodium chloride solution and therefore is best removed from the wound surface with a pair of forceps (Thomas and Loveless, 1992).

Haemostasis

Barnett and Varley (1987) and Gupta and colleagues (1991) showed that a non-woven alginate dressing is an effective haemostat and is generally well tolerated by body tissues.

Groves and Lawrence (1986) reported on the use of Sorbsan as a haemostat at skin graft donor sites. They noted significant haemostasis in the immediate post-surgical phase and observed no adverse reactions.

Kaltostat has been shown to have haemostatic activity, which is the result of platelet activation and whole-blood coagulation initiated by the exchange of calcium ions within the alginate dressing

Table 2. Applications of alginate-based dressings.

Dressing	Application guidance
Sorbsan sheets	Can be allowed to overlap onto the surrounding skin
Kaltostat	Should be trimmed to size and shape of the wound

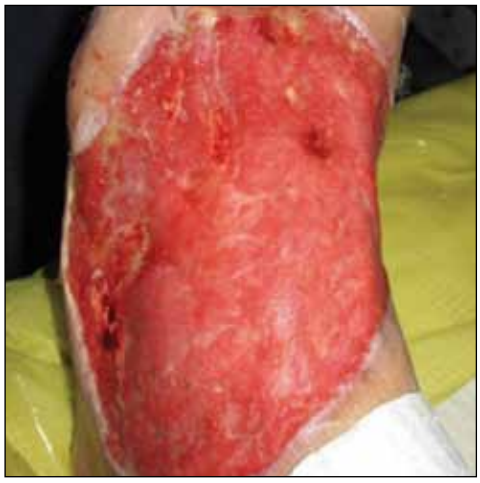

Figure 2. A heavily exuding diabetic foot ulcer that is to have an alginate dressing applied.

for sodium ions from the blood (Jarvis et al, 1987). Kaltostat has a product license for use as haemostatic dressings and a loose 'ball' for packing cavities (Thomas, 1992).

Treatment of infection

Alginate dressings have been shown to be effective in infection control in exuding wounds, as the following examples show. Cazzaniga and colleagues (1992), in in vitro studies of the effect of Sorbsan on the growth of bacterial pathogens, demonstrated a significant inhibition of *Staphylococcus aureus* ($P<0.001$), with no increase in the growth of *Pseudomonas* species, *Streptococcus pyogenes* or *Bacteroides fragilis*.

Gupta and colleagues (1991) found a lower bacterial count using alginate dressings in post-operative surgical wounds when compared with proflavin-soaked swabs.

Cost-effectiveness

Fanucci and Seese (1991) reported that alginate dressings are cost-effective as they reduce the number of dressing changes and the amount of nursing time required, therefore enabling the patient to be discharged earlier.

Restrictions of alginate dressings

Thomas (1992) reported that when an alginate dressing is applied to a relatively dry wound, the patient may experience a transient burning sensation. This is thought to be caused by the partial dehydration of the wound bed caused by the hydrophilic nature of the dressing. Alginate dressings should not be used in very dry wounds or those covered with a dry black eschar as they can dry out and traumatise adjoining tissues (Foster et al, 1994; Pudner, 1998). If excessive amounts of alginate dressing are introduced into a wound, residues of non-dissolved fibre may induce a foreign body reaction (Barnett and Varley, 1987).

Jones and Milton (2000) reported that moistening an alginate dressing, prior to its use, affects the gelling process and limits absorbency. Therefore, this practice is not recommended.

A dried-out alginate dressing can increase pressure on the wound bed and, therefore, compromise healing (Hampton, 2004). One could challenge the suitability of alginate dressings in the treatment of neuroischaemic diabetic foot ulcers because not only is there arterial insufficiency, but the wounds can also be low-exuding and necrotic tissue may also be present.

Infected plantar ulcers have been reported by Foster and colleagues (1994) and Lawrence and colleagues (1997). The infection was caused by the blockage of exudates with hardened plugs of an alginate dressing although there were only four cases in total. However, Foster and colleagues (1994) found the same in 10 out of 52 dressing changes.

Therefore, when considering the use of an alginate dressing the healthcare professional should be observant as to the type of wound and the level of exudate.

Further work

There are very few well-controlled clinical studies which have specifically looked at the use and validity of alginate dressings in the management of diabetic foot ulcers. It may be possible to perform a randomised, double-blind, controlled study investigating whether there is less pain or trauma upon the removal of alginate dressings compared with other dressings. This work, if done, would provide an evidence base in terms of helping in selecting a dressing which would be less painful and least traumatise the wound when removed.

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1 Wound dressings play an important part in the management of diabetic foot ulcers yet there is very little research in their usage to provide healthcare professionals with the much-needed evidence upon which current practice is based.

2 Alginate dressings are highly absorbent for moderately to highly exuding wounds and have excellent haemostatic qualities. However, one cannot emphasise enough the need to lift any dressing, on a diabetic foot ulcer, on a daily basis for inspection of the wound for, as an example, any signs of infection.

This would help in guiding dressing choices for malodorous diabetic foot ulcers. If proven, reducing bacterial burden would be a very attractive property, especially with the argument against over-prescribing antibiotics in the treatment of diabetic foot ulcers.

A randomised and double-blinded study investigating and comparing healing times of diabetic foot ulcers is just as necessary. In their conclusion, Sayag and colleagues (1996) considered whether the healing efficacy of an alginate dressing suggests it possesses pharmacological properties which could be further investigated.

Conclusion

Wound dressings play an important part in the management of diabetic foot ulcers yet there is very little research in their usage to provide healthcare professionals with the much-needed evidence upon which current practice is based.

Alginate dressings are highly absorbent for moderately to highly exuding wounds (Hilton et al, 2004) and have excellent haemostatic qualities (Barnett and Varley, 1987; Gupta et al, 1991). However, one cannot emphasise enough the need to lift any dressing, on a diabetic foot ulcer, on a daily basis for inspection of the wound for, as an example, any signs of infection. Currently, the characteristics of the ulcer, patient requirements and cost all guide or dictate our dressing choice (Hilton et al, 2004); there is a paucity of high-quality scientific evidence, especially in reference to cost, to support one dressing over another.

It should not, however, be forgotten that dressings will not heal diabetic foot ulcers all on their own: callus has to be reduced; pressure must be off-loaded, especially in the indolent neuropathic ulcer; limbs should be revascularised in the neuroischaemic foot; and infection must be controlled. This cannot be achieved by one healthcare professional; it requires a multidisciplinary team approach. ■

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