Alginate dressings and diabetic foot lesions

Vanessa Jones

ARTICLE POINTS

1 Alginates are the calcium and sodium salts of alginic acid, a natural component of brown seaweed.

2 They may contain either 100% calcium alginate, or a combination of calcium and sodium alginate.

3 They are highly absorbent and thus suitable for moderate to highly exuding wounds.

4 Alginates are non-adherent, producing a hydrophilic gel that can be either rinsed off or lifted off, depending on the product used.

5 Their major advantage with regard to diabetic foot lesions is their ability to provide a non-adherent packing for small tortuous sinuses.

KEY WORDS
- **Alginates**
- **Wound healing**
- **Diabetic foot lesions**

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Introduction

Alginates are highly absorbent, non-adherent dressings which transmit oxygen and moisture vapour (Choucair and Phillips, 1998). Their use as a modern wound management product is extensive, particularly in heavily exuding wounds, cavities and sinuses. The major advantage in the treatment of diabetic foot lesions is their ability to provide a non-adherent packing material for small tortuous sinuses. However, their ability to form a hydrophilic gel on contact with the wound surface is diminished if they are used on a wound producing low levels of exudate. The wound type and stage of healing should be assessed carefully before applying an alginate dressing.

Alginate dressings are produced from calcium and sodium salts of the naturally occurring alginic acid found in a species of brown seaweed called Phaecophyceae (Morgan, 1996). Traditionally, alginates have been used in many industries, from food to textiles, since the 1930s. Alginic acid was first extracted by the British chemist Stanford in 1881 (Berry et al, 1996), although seaweed was reportedly used by sailors centuries ago to heal wounds and was known as 'mariner's cure'. However, it was not until 1947 that Blaine reported the use of alginates in the treatment of experimentally produced burns (Thomas, 1992).

Alginates were used as haemostatic agents in a variety of wounds throughout the 1950s and 1960s, but their popularity declined in the 1970s. However, as manufacturing techniques improved and our understanding of wound healing increased, alginate usage became widespread again during the 1980s (Morgan, 1996).

The manufacture of alginates is based on an ion-exhange reaction. Sodium alginate, produced following purification and extraction of the seaweed, is dissolved in water to produce a colloidal solution. This is then extruded through a fine orifice into a bath of calcium ions, where fibres of insoluble calcium or calcium sodium alginate are produced (Thomas, 1992; Morgan, 1996).

Until recently, alginate dressings were composed of either 100% calcium alginate or a combination of calcium and sodium alginate, usually in a 2:1 ratio. As with many other dressing groups, alginate dressings are available in different combinations, e.g. alginate/ hydrocolloid, alginate/hydrogel and alginate/collagen.

This may present problems for the practitioner as it is difficult to ascertain from the current literature whether any one of these newer formulations has any particular advantage over the traditional calcium or calcium/sodium alginate formulation. *Table 1* lists some of the variety of alginate dressings available in the UK.

Alginates have a complex chemical structure, being rich in either guluronic acid or mannuronic acid (Thomas, 1992). Alginates that are high in guluronic acid tend to be stronger but brittle, and retain their basic structure, whereas alginates that are high in mannuronic acid partially dissolve in the presence of sodium ions, and therefore form a hydrophilic gel on contact with wound fluid. Depending on the ratio of guluronic to mannuronic acid in the dressing formulation, alginates can absorb 15–20 times their own weight and can either be washed off with saline or be lifted from the wound bed in one piece.

Absorption of exudate

The capacity to absorb such large amounts of exudate is one of the major advantages of alginates (*Figure 1*). This property is particularly useful when the dressing is used on a diabetic foot ulcer, which is often prone to

Table 1. A selection of the different types of alginate dressings available and their formulation

Product (trade name)	Manufacturer	Formulation
Algisite M	Smith & Nephew	Calcium alginate
Algosteril	Beiersdorf	Calcium alginate
SeaSorb filler and flat sheet (FP10)	Coloplast	Calcium alginate 92%/sodium alginate 8%
Carboflex	ConvaTec	Calcium sodium alginate 70%/hydrofibre 30%
Kaltogel (FP10)	ConvaTec	Calcium alginate 80%/sodium alginate 20%
Kaltostat rope and flat sheet (FP10)	ConvaTec	Calcium alginate 80%/sodium alginate 20%
Melgisorb	Mölnlycke	Calcium alginate 96%/sodium alginate 4%
Nu-Gel (FP10)	Johnson & Johnson	Hydrogel 97%/sodium alginate 3%
Sorbsan ribbon, packing and flat sheet (FP10)	Maersk Medical	Calcium alginate
Sorbsan Plus (FP10)	Maersk Medical	Calcium alginate 100%/viscose padding
Tegagen (FP10)	3M Health Care	Calcium alginate

maceration owing to the pooling of exudate. The wound should always be observed closely as exudate decreases during the healing process, and the alginate may not gel. If this occurs, the alginate will remain hard, forming a focus for pressure or blocking drainage of the remaining exudate (*Figure* 2).

The fluid-handling properties of alginates were investigated by Thomas and Loveless (1992) who found that Kaltostat, Sorbsan and Tegagel (now called Tegagen) varied in this respect, depending on the ionic composition of the test solutions used.

Haemostasis

Although all alginates have the capacity to arrest bleeding, Kaltostat is the only alginate marketed as a haemostatic agent. Kaltostat causes haemostasis by activation of the clotting mechanisms initiated by the exchange of calcium for sodium ions in the blood (Jarvis et al, 1987). Animal studies carried out by Blair et al (1988) also demonstrated that Kaltostat was significantly better at arresting haemorrhage than collagen, oxidised cellulose or gauze.

Biodegradability

Concern that alginate particles left in the wound might cause an inflammatory reaction has been highlighted by several researchers. It is assumed that the molecules of retained fibres are broken down by

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Figure 1. A large wound that is producing a lot of exudate and requires daily dressing changes; it is therefore suitable for an alginate dressing.

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Figure 2. Alginate packing that has been left in the wound and allowed to dry out.

enzymes, giving rise to claims that these dressings are biodegradable. These claims have been questioned by Schmidt and Turner (1986) and Berry et al (1996) who demonstrated an inflammatory response in the form of a giant cell foreign body reaction when Kaltostat was used on clean surgical cavity wounds.

A similar type of reaction had previously been reported in a patient following tooth extraction (Mathew et al, 1993). Mathew et al noted that remnants of the alginate material could still be found in the tooth socket at 12 weeks. This could potentially have a long-term effect, as a case of a florid foreign body giant cell reaction after the use of Kaltostat had been reported in a patient following tooth extraction 7 months previously (Odell et al, 1994).

Obviously these are isolated cases and occurred in cavities that are particularly small and tortuous. However, diabetic foot ulcers often have small openings with sinuses that make dressing removal difficult, and this may be a potential problem. It is important to note that both Blair et al (1998) and Berry et al (1996) reported that retained fibres apparently disappeared as the wound matured.

It would therefore seem advisable for practitioners to ensure that alginate dressings are removed with the same meticulous care as any other dressing.

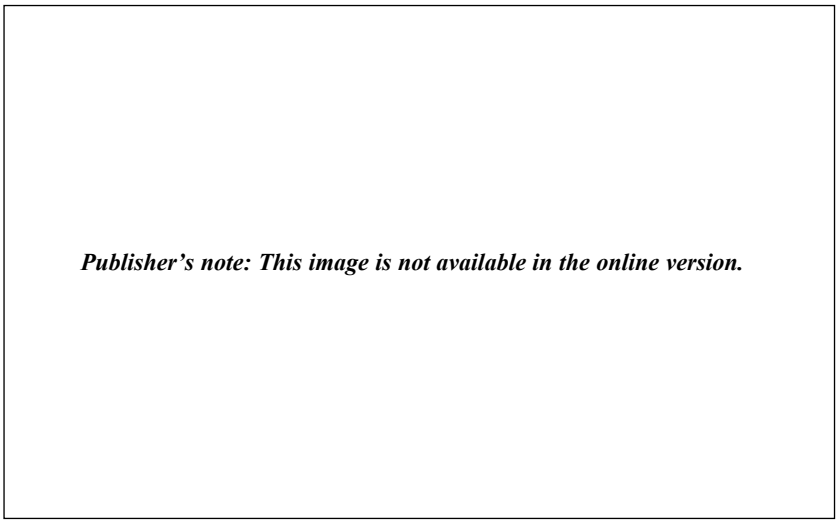

Figure 3. Discoloration: this may be caused by slough, infection or the normal reaction of wound fluid with an alginate. It is probably an indication to discontinue the use of alginates in this instance.

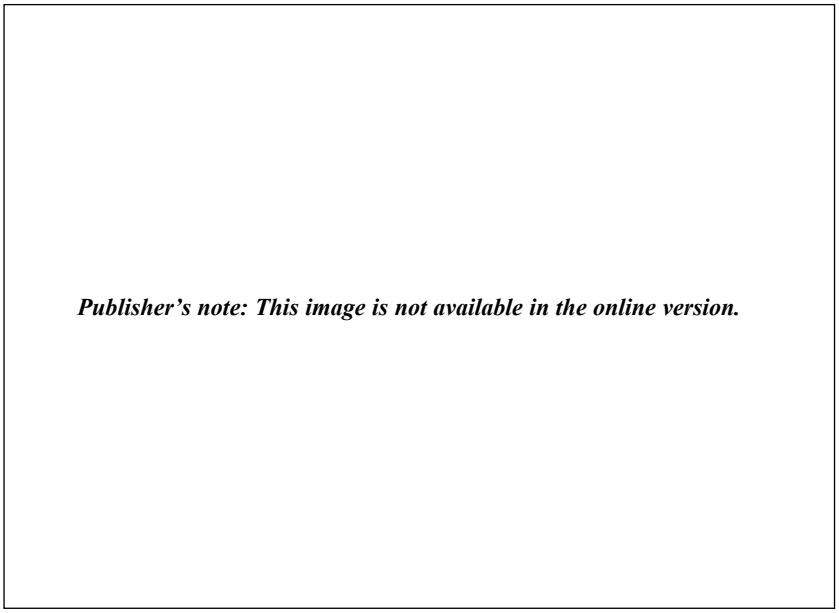

Figure 4. Alginate packing in a small cavity wound: note the loose packing of the wound.

Infection

Wound infection is of great concern in patients with diabetic ulcers that are being treated with alginate dressings, because of the decreased immunity of this patient group. Drainage of exudate to reduce the risk of infection is of prime importance in any wound, but may be particularly problematic in the typical plantar ulcer occurring in patients with peripheral neuropathy. Plantar ulcers often have small openings with a larger interior wound cavity, making dressing of the ulcer difficult. An alginate ribbon such as Sorbsan has the advantage that it can be irrigated from the cavity.

Infected plantar ulcers have been reported by Foster et al (1994) and Lawrence et al (1997). The infection was caused by blockage of exudate with hardened plugs of Kaltostat. However, the number of cases was small (four in total), and they should be viewed within the context of care.

To avoid such consequences, alginates should not be allowed to dry out or be left in the wound for a prolonged period. This is a potential hazard as alginate that has dried out can resemble diabetic callus and be inadvertently left in the wound bed, causing problems such as infection (Cazzaniga et al, 1992) (*Figure 3*).

The correct method of packing should also be observed: alginates should be laid into sinuses, not tightly packed, and the number of sheets/ropes should be recorded (*Figure 4*).

Alginates have been used in other wound types, including diabetic foot ulcers, without

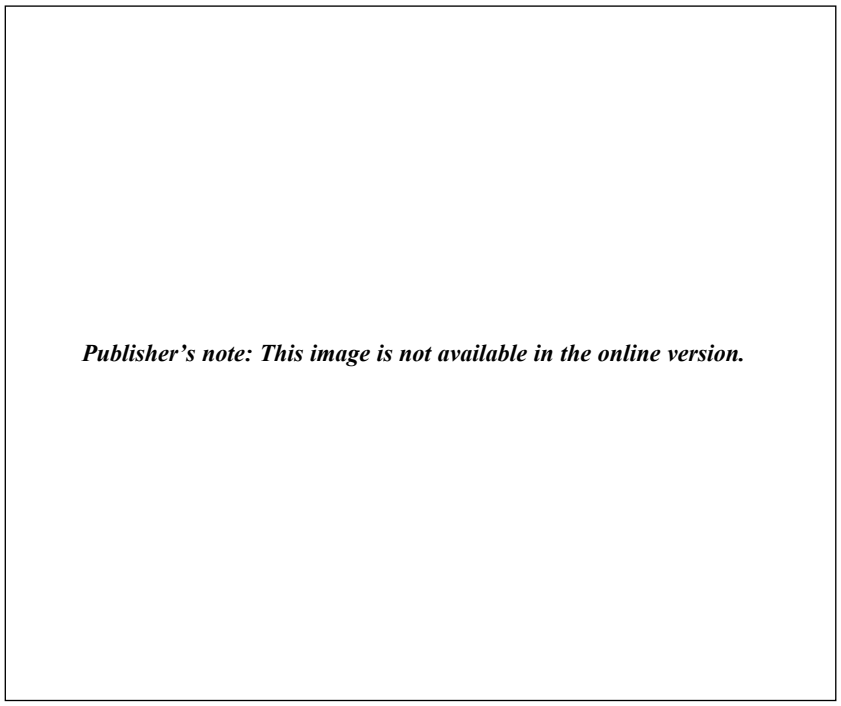

Figure 5. Clean wound (previously debrided). An alginate dressing could be used and changed less frequently (every 2–3 days).

ill effect. Pecoraro and Ahroni (1992) compared the use of Sorbsan and gauze and found no incidence of serious infection in the Sorbsan group, with no apparent risk of exacerbating infection.

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, Streptococcus pyogenes* or *Bacteroides fragilis* (Cazzaninga et al, 1992).

It would appear that alginate dressings can be used safely on infected diabetic foot ulcers, provided that they are removed thoroughly at dressing changes and changed daily. This may cause problems in terms of time and availability of dressings, but these should be outweighed by the advantages of ease of removal and patient comfort.

PAGE POINTS

1 Alginates are cost-effective, decreasing the number of dressing changes required, compared with other dressings, and allowing earlier patient discharge.

2 Alginates should not require moistening with saline before application if the wound is producing sufficient exudate for the gelling process to take place.

Dressing attributes

Alginates will generally not adhere to the wound surface, and one of their major advantages is the ease with which they can be removed. Alginates high in mannuronic acid, e.g. Sorbsan, can be removed easily following irrigation with normal saline. Those high in guluronic acid will not wash off with saline but can be removed intact with a gloved hand or forceps. It would, however, be incorrect to assume that all alginates are non-adherent, as some studies have reported problems with removal.

Foster et al (1994) found that the dressing adhered to the wound in 10 out of 52 dressing changes. Alginates are sometimes moistened with saline before application, as in this study, but should not require moistening if the wound is producing sufficient exudate to allow the gelling process to occur naturally.

Compared with other dressings, alginates are cost-effective as they decrease both the number of dressing changes required and nursing time, and enable the patient to be discharged earlier (Thomas and Tucker, 1989; Fanucci and Seese, 1991) (*Figure 5*).

In some circumstances, the reduction in dressing changes can be correlated with a reduction in the time to healing (Donaghue et al, 1998). Statistically, however, it may not always be possible to show a significant reduction in healing time owing to the small sample size (Foster et al, 1994) or the introduction of other dressing materials towards the end of healing (Berry et al, 1996).

Many studies that have been carried out on alginates report favourably on the dressing's performance in terms of ease of use and acceptability by the patient (Chaloner and Fletcher, 1992; Berry et al, 1996; Donaghue et al, 1998).

For the future, the introduction of other interactive substances within the alginate material may prove beneficial for patients with diabetes, e.g. Fibracol (Johnson & Johnson, USA) is a collagen/alginate dressing which gels immediately on contact with the wound. The gel is supplemented by the gradual breakdown of the collagen which reportedly contributes to wound healing.

Donaghue et al (1998) evaluated the use of a collagen/alginate dressing in 50 patients with diabetic foot ulcers, and found that wound size was significantly reduced over an 8-week period and complete healing was achieved in 24 (48%) patients. Given the difficulties that diabetic patients have with collagen formation, this dressing may prove to be a useful alternative for ulcers that are hard to heal. The comparator dressing in this study was saline gauze; bearing in mind the high cost of this type of alginate dressing, further justification of its efficacy over a conventional alginate would need to be proven.

PAGE POINTS

1 Alginates are a comfortable and cost-effective treatment option for moderate to heavily exuding wounds.

2 Their ability to fill irregularly shaped cavities makes them particularly suitable for diabetic foot ulcers.

3 They should be used with caution on infected wounds or wounds with a low level of exudate.

Conclusion

Alginate dressings should certainly be considered a comfortable and cost-effective alternative to other dressings for moderate to heavily exuding wounds. Their ability to absorb large amounts of exudate and fill irregularly shaped cavities is particularly useful in the treatment of diabetic foot ulcers. Caution should be observed with wounds that are infected or have only a low level of exudate production as inappropriate dressing management may result in further unwanted complications. ■

Berry DP, Bale S, Harding KG (1996) Dressings for cavity wounds. *Journal of Wound Care* **5**(1): 10-13

Blair SD, Backhouse CM, Harper R et al (1988) Comparison of absorbable materials for surgical haemostasis. *British Journal of Surgery* **75**: 969-71

Cazzaniga AL, Marshall DA, Mertz PM (1992) The effect of calcium alginate dressing on the multiplication of bacterial pathogens in vitro. Presentation at the 5th Annual Symposium on Advanced Wound Care, New Orleans

Chaloner D, Fletcher M (1992) Clinical trials: comparing dressings. *Nursing Standard* **7**(7): 9-11

Choucair M, Phillips T (1998) A review of wound healing and dressings material. *Skin and Ageing* **6**(6): 37-43 Suppl

Donaghue VM, Chrzan JS, Rosenblum BI (1998) Evaluation of a collagen-alginate wound dressing in the management of diabetic foot ulcers. *Advances in Wound Care* **11**(3): 114-19

Fanucci D, Seese J (1991) Multifaceted use of calcium alginates: a painless, cost-effective alternative for wound care management. *Ostomy Wound Management* **37**: 16-22

Foster AVM, Greenhill MT, Edmonds ME (1994) Comparing two dressings in the treatment of diabetic foot ulcers. *Journal of Wound Care* **3**(5): 224-8

Jarvis PM, Galvin DAJ, Blair SD et al (1987) How does calcium alginate achieve haemostasis in surgery? *Proceedings of the 11th International Congress on Thrombosis and Haemostasis* **58**: 50

Lawrence IG, Lear JT, Burden AC (1997) Alginate dressings and the diabetic foot ulcer. *Practical Diabetes International* **14**(2): 61-2

Matthew LR, Browne JW et al (1993) Tissue response to a haemostatic alginate wound dressing in tooth extraction sockets. *British Journal of Oral and Maxillofacial Surgery* **31**: 163-69

Morgan D (1996) Alginate dressings. *Journal of Tissue Viability* **7**(1): 4-14

Odell EW, Oades P, Lombardi T (1994) Symptomatic foreign body alginate. *British Journal of Oral and Maxillofacial Surgery* **32**(3): 178-9

Pecoraro RE, Ahroni JH (1992) Evaluation of Sorbsan in the treatment of diabetic foot and lower extremity ulcers. Presentation at the 5th Annual Symposium on Advanced Wound Care, New Orleans

Schmidt RJ, Turner TD (1986) Calcium alginate dressings (letter). *Pharmaceutical Journal* **236**: 578

Thomas S (1992) Alginates: a guide to the properties and uses of the different alginate dressings available today. *Journal of Wound Care* **1**(1): 29-32

Thomas S, Tucker CA (1989) Sorbsan in the management of leg ulcers. *The Pharmaceutical Journal* **243**: 706-9