INTRODUCTION

Foot ulceration is one of the most common complications associated with diabetes and is notorious for its complexity and healing difficulties. Even in the case of the most superficial wounds, treatment is frequently challenged by a poor healing response and high level of complication.

Vacuum assisted closure (V.A.C.®) has been advocated as a safe and effective adjunctive therapy in the surgical treatment of diabetic foot ulcers. It can be used to promote granulation, accelerate the preparation advocated as a safe and effective adjunctive therapy in the treatment of chronic wounds, including lower-limb (minor/distal) amputations and wounds with exposed tendons.

This section focuses on the role of V.A.C. therapy in the surgical management of diabetic foot ulcers.

PREPARING FOR SURGICAL TREATMENT

All patients with diabetic foot ulcers should be evaluated by an experienced vascular surgeon and be considered for debridement, revisional surgery to correct bony deformities, vascular reconstruction and definitive reconstructive surgery. Bone and joint surgery in the diabetic foot may be classified, depending on indications, according to the following recently proposed four-level system:

- Class 1 – Surgery to promote granulation, accelerate the ulcer surface area to increase closure in deep wounds with bone, joint and tendon exposure.

- Class 2 – Surgery to reduce deformity, and thus reduce risk, in patients with loss of protective sensation.

- Class 3 – Surgery to heal a wound and reduce the risk of recurrence.

- Class 4 – Surgery to limit the spread of acute infection.

Recent data suggest that the higher the class of surgery, the higher the risk of (re)ulceration, infection and high-level amputation.

Excellent preparation of the patient and wound prior to commencing V.A.C. therapy and reconstructive surgery is crucial to maximise the chance of a successful outcome. Age, diabetes control, co-morbidities, prognosis, mental status, patient mobility, adequate wound care and appropriate pressure relief are all essential considerations. The following should also be addressed prior to surgery:

- Vascular assessment – Essential for wound healing. Doppler ultrasound and ankle-brachial blood pressure indices (or in the case of patients with calcified vessels, toe pressure measurements) are required, as well as other non-invasive vascular studies, such as segmental pressures, pulse volume recordings and transcutaneous oxygen tension. A vascular surgical opinion and possible intervention, such as angioplasty, stenting or femoral arterio-femoral bypass to improve perfusion may be indicated.

- Infection control – Since infection in the diabetic foot can be complex, underlying micro-organisms, diagnosis and resolution of infection remain a challenge to the clinician. Cultures, laboratory results and clinical indicators are helpful in making treatment decisions. Tissue specimens are better than wound swabs for identifying cultures. While the diagnostic criteria for infection are imprecise, there is little doubt that it is a major cause of lower extremity morbidity, potentially leading to wet gangrene and subsequent amputation. Antimicrobial therapy should be guided by culture results, focused on curing the infection rather than healing the wound.

- Debridement – Appropriate debridement is required prior to surgical reconstruction and/or V.A.C. therapy to remove hyperkeratotic (eg callus) and devitalised tissue, foreign materials and particulate matter from a wound. It can help to reduce the rate of infection and provide an improved healing environment.

Adequate debridement prior to the application of V.A.C. therapy is essential. It is important to ensure haemostasis has been achieved prior to commencing therapy.

PRE-SURGICAL OPTIMISATION

To debride the wound, the skin may be incised using a sterile and/or a tissue nippers may be used to introduct the fullest extent of the undermining between epidermis and dermis. Removal of undermined tissue should be performed until the edge of the epidermis and dermis may be visualised. Any devitalised tissue should be removed centrally from the wound, as required, through sharp excision or curettage. Finger pressure may be applied to the wound to help control bleeding. The wound may then be probed to check the involvement of underlying structures and for the presence of infection.

In addition to the wound bed, it is also important to debride the margins, which can become thick and calloused due to higher planter pressures at the leading edge of the wound. This concept is known as the ‘edge effect’. It can lead to tissue damage from shear stresses and vertical stresses on the edges of the wound. The vertical force progressively deepens the wound, while shear forces from the underlying epithelium undermine the edges, causing the wound area to increase. Debridement of the margins has been shown to assist offloading and to mitigate the edge effect.

At follow-up, the absence of undermining of the wound edges and/or odour are good indicators of successful debridement. If necessary, further debridement should be performed as required. For wounds with poor perfusion, it is important to ensure an adequate blood supply prior to debridement, with the exception of more urgent cases (eg gas gangrene, necrotising fasciitis and ascending cellulitis).

In most patients with diabetes, V.A.C. therapy can be used following surgical debridement to facilitate granulation tissue formation prior to surgical reconstruction or delayed primary closure.

Application of V.A.C. therapy

The recommended target pressure for optimal granulation tissue formation is 125mmHg, although recent data would support the use of higher pressures. A continuous rather than intermittent setting is generally recommended, this being easier for patients to tolerate. Intermittent therapy may also contribute to loss of an airtight seal during ambulation as well as problems with maceration (see section: Diabetic Foot Ulcers 2).

SURGICAL OPTIONS

Split-thickness skin grafts

Once the wound has been optimised using V.A.C. therapy, a split-thickness graft may be used to facilitate closure. Not all wounds will be suitable however; for example, healing by secondary intention may be more suitable for planter surface wounds. Skin grafts should not be applied immediately following debridement. It is also important for clinicians to ensure that the wound is relatively uncontaminated by bacteria prior to attempting skin grafting.

Flaps and alternative tissue cover

In diabetic foot ulcers where bone and tendon are exposed, skin, muscle, or pedicle flaps may be used to cover osseous or tendonous structures in patients considered suitable for flap surgery. Bioengineered tissue replacements, such as regenerative tissue matrix and bilayer matrix wound dressing, have been used in combination with V.A.C. therapy as a primary alternative to achieve closure in deep wounds with bone, joint and tendon exposure.

KEY POINTS FOR PRACTICE

Optimisation of the patient and wound prior to commencing V.A.C. therapy and/ or reconstructive surgery is vital for best results.

Appropriate debridement should be performed prior to the application of V.A.C. therapy and is often the key first step in effective wound care.

When applying V.A.C. therapy, special care is required in complex plantar foot wounds to prevent further pressure damage.
The application of V.A.C. therapy may act as a bolster dressing, helping to secure the bioengineered tissue replacement or skin grafts in place. This has been shown to improve the take-rate and time to vascularisation, expediting wound healing and enabling split-thickness skin grafting after 7–10 days.

The black polyurethane foam dressing (V.A.C.® GranuFoam®) is the standard dressing used for diabetic foot ulcers after appropriate debridement. However, the white polyvinyl alcohol foam dressing (V.A.C.® WhiteFoam®) can also be considered, especially in sinus tracks and over areas of exposed bone and tendon.

V.A.C. therapy should be continued until the wound bed has good coverage of granulation tissue and there is no exposed tendon, joint capsule, or bone. Duration of V.A.C. therapy ranges from 4–12 weeks depending on the size of the wound.

Complex postoperative wounds
Wounds that occur following amputation present a major challenge. They are often large and deep, with exposed bone and tendon, and occur in patients with compromised healing1. V.A.C. therapy has been shown to be effective in closing such wounds in a recent multicentre, randomised trial involving 162 patients. V.A.C. therapy healed more wounds after partial foot amputation in patients with diabetes compared with standard moist wound care alone (56% vs. 39%). All patients received appropriate pressure offloading therapy. Patients who received V.A.C. therapy had a less than 25% risk of requiring a second amputation compared with patients receiving standard care alone. This difference in re-amputation rate is most likely to be secondary to more rapid healing and better wound coverage with granulation tissue in the group receiving V.A.C. therapy. The duration of overall therapy showed a similar trend. Based on the results of this study, V.A.C. therapy appears to be a safe and effective alternative to standard care in patients with partial foot amputation1.

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POSTOPERATIVE OPTIMISATION USING V.A.C. THERAPY

Movement of tissue around the wound is one of the reasons for failure in skin graft and flap surgery. In poorly perfused lower limbs where the tendon is exposed, an external fixator may be used temporarily to prevent movement and stabilise the tendon. Knowledge of anatomy is important to help prevent movement.

The following illustrates the role of V.A.C. therapy in a complex posterior ankle wound with exposed tendon.

1. Immerse the exposed Achilles tendon (Figure 2.1) using a temporary external fixator, positioned over the lateral aspect of the foot (Figure 2.2).
2. Once the tendon is immobilised, surgically debride and irrigate the wound. Apply a bioengineered tissue replacement and suture in place (Figure 2.3).
3. Place the foam dressing (V.A.C.® GranuFoam®) over the wound and apply a film drape (V.A.C.® Drape) over the entire foam dressing (Figure 2.4). Cut a 1–2cm round hole in the drape and apply the dressing pad (T.R.A.C.® Pad) and tubing. Connect to the V.A.C. therapy unit and apply a lower pressure setting of 75mmHg unit and apply a lower pressure setting of 75mmHg.
4. When the wound bed approaches 100% coverage with granulation tissue and no exposed bone or tendon, new V.A.C. therapy can be applied. (Figure 2.5), remove the external fixator. (The fixator may be left in situ to reduce movement following skin grafting.)
5. Close the wound using a split-thickness skin graft (Figure 2.6). Apply a non-adherent, interposed dressing prior to the application of the foam dressing. Commence V.A.C. therapy for a further 4–5 days using a target pressure of 75mmHg on the continuous setting for 4–5 days to help secure the tissue replacement in place and prevent seroma/haematoma formation.
6. Apply a non-adherent, interposed dressing prior to the application of the foam dressing. Commence V.A.C. therapy for a further 4–5 days using a target pressure of 75mmHg on the continuous setting for 4–5 days to help secure the tissue replacement in place and prevent seroma/haematoma formation.

V.A.C. THERAPY APPLICATION

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Figure 2.1

Figure 2.2

Figure 2.3

Figure 2.4

Figure 2.5

Figure 2.6

Figure 2.7

2. Condition the periwound skin using a suitable skin preparation (eg skin barrier cream). Apply film drape (V.A.C.® Drape), overlapping the wound by 1–3cm to protect the periwound skin from maceration (Figure 3.2). Where the patient has a second ulcer in close proximity (eg heel), protect the periwound skin using additional drape in areas of bridging (Figure 3.3).

3. Commence V.A.C. therapy using a target pressure of 125mmHg. To aid mobility, place the tubing beneath the patient’s trousers, from the ankle to the waist, and connect to a portable device (V.A.C. Freedom®). Ensure appropriate offloading.

REFERENCES


POSTOPERATIVE MANAGEMENT

Adequate pressure relief must be provided in the postoperative period. The V.A.C. therapy, special care is required in complex planter foot wounds to prevent further pressure damage to weight-bearing surfaces of the foot. By modifying the dressing using a novel negative pressure wound therapy technique involving 162 dressings from the plantar foot to the dorsal foot, V.A.C. therapy using a portable device can be combined with a removable cast-walker and secured with a layer of silicone. A further 120 patients (120 patients with foot ulcers) were treated with a V.A.C. dressing (Figure 2.6). This approach has been shown to help patients tolerate treatment whilst also performing many daily activities. Common complications include periwound skin maceration and tube necrosis. This can be avoided by correctly placing the tubing to prevent direct contact with the patient’s skin. No additional complications have been seen to date when V.A.C. therapy is used in combination with a removable cast-walker.

Monitoring treatment
Most dressing changes should be performed every 4 hours or more frequently (12–24 hours) for infected wounds. Therapy should be active for 22 hours in any 24 hour period and dressing should not be left on a wound for more than two hours without the therapy being active. Once V.A.C. therapy has commenced, the wound should be monitored for increased bleeding, periwound bruising, the presence of fresh blood in the cannister. If excessive bleeding occurs, V.A.C. therapy should be discontinued until haemostasis is achieved.