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REVIEW

Vacuum Assisted Closure: A Review of Development and Current Applications

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Vacuum assisted closure is being increasingly used for wound management. This review examines the history of its development and appraises the current evidence on its use so far.

Keywords: Vacuum assisted closure; Topical negative pressure; Vacuum sealing technique; Sub-atmospheric pressure; Dressings; Wound management; Acute wounds; Chronic wounds.

Introduction

Vacuum assisted closure (VAC) is a relatively new technology with applications in a variety of difficult to manage acute and chronic wounds. It is known by many pseudonyms—TNP (topical negative pressure) SPD (sub-atmospheric pressure) VST (vacuum sealing technique) and SSS (sealed surface wound suction).[1]

It involves the application of open cell foam to a suitable wound, adding a seal of adhesive drape and then the application of sub atmospheric pressure to the wound in a controlled way.[2] Encouraging results in terms of rates of healing have been reported in the literature but there is a relative paucity of randomised controlled trials with significant numbers to substantiate the findings. This article reviews some of the work published so far and explains the postulated mechanisms of action of the VAC as well as some of its reported clinical applications to date.

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The VAC Technique

VAC uses medical grade open cell polyurethane ether foam (which is FDA approved for open wounds) as a dressing.[2] The pore size is generally 400–600 μm (thought optimal for tissue growth).[2] This foam is cut to fit and closely applied to the selected wounds. An evacuation tube with side ports, which communicate with the reticulated foam, is embedded in it. The aim of the reticulation being that the negative pressure will be applied equally to the entire wound bed. An adhesive drape is then applied over the area with an additional 3–5 cm border of intact skin to provide an intact seal.

The evacuation tube is connected to an adjustable vacuum pump and a canister for collection of effluent. The pump can be adjusted in terms of both the timing (intermittent vs. continuous) and magnitude of the vacuum effect. In general an intermittent cycle (5 min on, 2 min off) is employed as this has been shown to be most beneficial.[2]

Guidelines have been produced to aid in administration of this technique (Table 1). Effectively the technique converts an open wound into a controlled and temporarily closed environment.

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Table 1. Clinical management: negative pressure therapy

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Guidelines for use of the VAC

1. Gently remove previous dressing and discard as per local institutional protocol
2. Aggressively cleanse wound and peri-wound area
3. Debride necrotic tissue if applicable
4. Achieve haemostasis
5. Shave bordering hair if necessary
6. Dry and prepare the peri-wound skin
7. Select appropriate foam dressing
8. Select appropriate sponge kit to fill the cavity
9. Size and trim the drape to cover an area around the wound large enough to secure the foam and to maintain an air tight seal
10. Gently place the foam into the cavity covering the entire wound base including sides, tunneling and undermining
11. Apply tubing to the foam
12. Cover the foam and an area of healthy surrounding tissue with the drape in order to accomplish an airtight seal
13. Attach tubing from the wound to tubing in the canister placed in the VAC unit. Ensure clamps are unclamped
14. Program the appropriate pressure and cycle in the computerized unit and begin treatment

Research and Experimental Work

The VAC was first investigated by Morykwas and Argenta *et al.* in 1997.[2] Their work followed on from studies of negative pressure years previously that had suggested it might improve wound healing. Early work suggested that negative pressure increased blood flows as evidenced by hyperaemia.[3] Morykwas and Argenta[2] used a swine model to investigate the effect of negative pressure applied via the VAC on wound healing. They postulated that it might have application in chronic wounds but had no animal model available on which to mimic this state (Table 2). They, therefore, produced acute wounds on pigs and attempted to extrapolate their findings to what might reasonably be expected in chronic wounds. They compared the VAC with the standard treatment for wound dressings—saline soaked wet to moist dressings. Each subject had two wounds, one treated with the VAC and one a control treated with standard dressings. Four parameters were measured. The effect of the VAC on Doppler measured flows in the wound and adjacent tissues (five subjects), the amount of granulation tissue formation (10 subjects, five continuous VAC vs. control, five intermittent VAC vs. control), bacterial clearance (five subjects) and nutrient flow/random pattern flap survival (five subjects).

They found that the peak blood flows as measured by Doppler ultrasonography were recorded with a 125 mmHg vacuum setting. Flows gradually decreased after this, falling below the baseline observed at room pressure at 400 mmHg. Interestingly the flows also declined after 5–7 min of pressure returning also eventually to baseline (Fig. 1). The flows were seen to increase again with re-establishment of flow with an optimum off time of 2 min and an optimum cycle of 5 min on, 2 min off—the current regimen favoured by clinicians. However, from the authors' later reported clinical experience of 300 chronic wounds[4] they now recommend an initial 48 h continuous administration followed by the standard intermittent regime. This is from anecdotal rather than rigorous clinical evidence. Certainly from the early animal study[2] intermittent pressures did produce significantly improved healing rates (63.3 vs. 103.4%).

Other authors recommend various regimes for certain clinical situations, again mostly from their anecdotal experience. In general reduced pressures (50–75 mmHg) are employed for chronic ulcers and other cases where pain may be of concern or for example to encourage skin grafts to take.[4] Higher pressures may be used for larger cavities or some acute traumatic injuries,[4] however, these recommendations, as we have said, all stem from anecdotal evidence.

Banwell *et al.*[1] have found immediate application of the VAC following injury/debridement to produce good results (from their experience with acute and traumatic wounds). They recommend changes of dressing every 4–5 days (but every 48 h if any evidence of infection) from anecdotal evidence.

Many groups have attempted to corroborate Argenta and Morykwas' findings of increased local blood flows with a vacuum in a human model. Skagen and Henrikson[5] looked at negatively applied pressure in a specially designed circumferential chamber applied to human forearms. They surprisingly showed decreased flows at only 40 mmHg (as evidenced by Xenon wash out studies) increased vascular resistance and vasoconstriction (later shown to be abolished by nervous blockade). This was corroborated in further work by the same author.

His work contrasted with a study by Fentem and Matthews[6] which looked at negative pressure applied to the fore arms of healthy volunteers and this time showed the expected increased flows with application of negative pressure. However, neither of these groups were directly comparable to the original animal model