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Review Article

Vacuum-Assisted Closure in Treatment of Post-operative Orthopedic Infections

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Abstract

Postoperative orthopedic wound infections causes serious health deteriorations, leading to delayed wound healing, prolonged hospitalization and a significant increase in Morbidity. Vacuum-Assisted Closure (VAC) has shown its efficacy in promoting healing in post-operative wound infections after different surgeries, a number of reviews and meta-analyses have been written on the use of VAC, however few closely investigate its results in postoperative orthopedic wound infections. Our aim is to analyze the current literature to assess the efficacy of VAC in postoperative orthopedic infections.

Keywords: *Vacuum-Assisted Closure (VAC); Postoperative Orthopedic Wound Infections*

Introduction

Postoperative wound infections continue to be a challenging problem that emerges after performing various surgeries. These infections account for about 25% of Nosocomial infections [1].

In orthopedic surgery, postoperative orthopedic wound infections causes serious health deteriorations. The severity of the infection can lead to delayed wound healing, prolonged hospitalization and thus a financial burden, and a significant increase in morbidity.

Different treatment protocols have been recommended for postoperative wound infections such as debridement, antibiotic, and soft-tissue management, but with mixed results. However, the risk of morbidity remains high with these treatment options [2].

Negative Pressure Wound Therapy (NPWT), using the Vacuum Assisted Closure system (VAC), has proven its efficacy in promoting healing in postoperative wound infections that occur after open colorectal, cardiothoracic surgery and diabetic foot amputation. Furthermore, the usage of the VAC has significantly decreased acute postoperative Infections and led to faster healing rates as well as a higher proportion of healed wounds with a decrease in hospital stay [3-5].

A number of reviews and meta-analyses have been written on the use of VAC, however few closely investigate its results in postoperative orthopedic wound infections.

Our study analyzes the current literature to assess the efficacy of VAC in postoperative orthopedic infections.

Historical overview

NPWT was introduced for the first time in the late 1980s and 1990s in Russia [6]. One of the variants of NPWT was the VAC. It was first popularized in the USA by Morykwas and Argetna and became the most widely used variant of NPWT by 1997 [7].

Principles and composition

Wound VAC promotes healing in a humid environment by locally applying and controlling sub-atmospheric pressure [8]. It is composed of an interface material, foam, through which removal of exudate and application of sub-atmospheric pressure is done. This foam fully covers the wound bed as well as its tunnels and cavities [9]. Moreover, there is an adhesive transparent film that covers the foam and isolates the wound entirely from the external medium in order to obtain a closed environment [10]. Furthermore, that system and exudate reservoir are linked to a suction tube and a computerized device which that controls the sub-atmospheric pressure in the wound bed. That device has an audible alarm which indicates possible air leakage from the dressing and may indicate the need to reservoir exchange [8]. However, the administration of sub-atmospheric pressure can either be continuous, intermittent, or associated with instillation of solutions. The aim of intermittent therapy, in particular, is the acceleration of granulation tissue formation. Thus, in infected wounds installation therapy is indicated [11].

However, a more advanced version of wound VAC has been introduced, the VAC therapy with instillation. In addition to the tube used for drainage in wound VAC, a second tube was introduced in VAC therapy with instillation to instill solutions into the wound intermittently. Moreover, fluid is instilled via gravity into the foam interface from an intravenous bottle or bag. The solution is held for a short period of time (dwell time) at the wound site followed by wound fluid removal under negative pressure. The sequence of these events was repeated in cycles [12].

Indications

Vacuum assisted closure is indicated as a first line measure in acute wounds and a second line measure after failure of the first line in chronic wounds [13].

It is also used prior to flap or graft treatments in cases of acute wounds, burns, diabetic ulcers, and osteomyelitis [14].

Contraindications

Although VAC therapy has many indications, a few contraindications exists such as osteomyelitis that has not been treated surgically, Marjolin ulcers, coagulopathies, active sepsis, allergies to one of the NPWT components required for treatment, unexplored fistulae, treatment with anticoagulants, nerves or vital organs, wounds with exposed blood vessels, and the presence of necrotic tissue within the wound. In addition to these contraindications, there are other situations where the usage of VAC therapy is highly dangerous, such as its usage in grossly infected wounds [15].

Mechanisms

Wound VAC's efficacy is centralized on two principles: first, it stimulates local blood circulation and promotes tissue granulation, second, it significantly reduces bacterial count in the tissue [15].

Several studies investigated mechanisms of VAC in the contribution of wound healing. Borgquist reported that any increase in the negative pressure gradually changes the microvascular blood flow of the wound edge, which in turn accelerates wound healing [16].

Chen found that VAC promoted the velocity of capillary blood flow, increased blood volume, stimulated angiogenesis and endothelial proliferation, narrowed endothelial spaces, and restored the integrity of capillary basement membrane [17].

Moues reported that VAC influences the wounds' microenvironment. which increases cell growth and wound healing [18].

Technical pearls

The VAC Dressing should be designed to fit the typography of the wound but cutting over the wound should be avoided in order to avoid entrapment of small pieces. Instead, before insertion loose pieces should be removed by gently rubbing the freshly cut foam edges. The foam should be packed loosely in order to fill the wound borders while stuffing it into the wound or packing it tightly should be avoided. With coverage of the wound with the drape.

Dressing changing should be conducted at least three times a week unless cultures are sterile when a wound is closed, in this situation more changes might be required. Despite the efficacy of debridement, it does not always reduce wound planktonic bioburden.

Review of Literature

The first large investigation of NPWT was conducted in the 1980s by Argenta and Morykwas (N = 300) using the vacuum-assisted closure system. This investigation demonstrated that NPWT could improve granulation in acute subacute and chronic wounds [12].

Zhou conducted a series of 101 patients, this study showed the efficacy of VAC in acute postoperative infection after ankle surgery. The patients were divided into 2 groups a VAC group and a standard moist wound care group (SMWC). Both groups received wound debridement and irrigation before dress cover. Follow up for 3 months showed that the complete wound closure rate was 90.2% (55 of 61) in the VAC group, and 72.7% (24 of 33) in the SMWC group. There was a significant difference between the two groups; the complete wound closure for VAC was 31 days, and for SMWC it was 63 days [19].

Kale conducted a series of 12 patients who were treated for Acute postoperative infections after spinal surgery using VAC. Although the standard treatment of postoperative wound infections after spinal surgery is flap coverage, kale's study showed that using wound VAC or wound conditioning of high complex back wounds after spinal surgery is effective and there was no need for antibiotics [2].

Izadpanah conducted a series of 106 patients, all of which had undergone surgery. Staged lavage (every 4 to 5 days), VAC and local debridement were performed with no exception, in 73% of all cases, infection healing was achieved. 16% of all cases had locally controlled persisted osteomyelitis and 4% underwent an amputation. Among all implants, 44% survived at least until bony consolidation and in 78% of patients only mesh grafting or secondary suturing had to be done for wound closure [20].

Lehner conducted a series of 32 patients, 10 had an infected knee implant, 20 had an infected hip implant, and 2 with infected osteosynthesis material. Moreover 10 patients had chronic and 22 patients had acute infection. They were treated by wound surgical debridement combined with lavage with polyhexamethylene biguanide (PHMB), systemic antibiotic therapy and NPWTi. The study suggested that NPWTi with PHMB maybe an effective adjunctive therapy in managing infected orthopedic implants as it removes infectious materials and helps retaining the implant [21].

Kelm conducted a series of 28 patients of acute hip Periprosthetic joint infection they were treated with irrigation and debridement followed VAC. Mean follow-up was 36 months, infection was eradicated in 26 out of the 28 cases [22].

Dyck conducted a series of 64 patients who underwent open posterior spinal fusion who and had a high risk of infection, they were divide into 2 groups; 21 patients received VAC (VAC group), versus 43 patients whom received standard wound care (Control group) all patients had 1 year follow up, VAC application resulted in a 50% reduction in postoperative wound infections [23].

In Wang's study he performed a metanalysis with the total of 6 studies; 4 cohort studies and 2 Randomized control controlled trials to determine the efficacy of VAC therapy versus conventional wound dressings in terms of surgical site infections, it showed that VAC is an effective method to help prevent surgical site infections on closed incisions in orthopedic trauma surgery [24].

Future Directions

Although the mechanisms of VAC has been cleared [25] further research should be conducted to determine if they are similar to VAC with instillation or should we consider additional mechanisms.

Data suggests that VAC with instillation is more effective than VAC in promoting the rate of wound granulation in animal models [26]. These results, however, are influenced to some degree by using different types of dressing foams, mechanical properties and hydrophobicity. Accordingly, further research should be conducted on human patients. Moreover, more studies should be carried in order to determine the solutions that can be used use with VAC with instillation, and the appropriate clinical applications for each solution.

Conclusion

Vacuum assisted closure is effective in postoperative orthopedic wound infections.

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