Vacuum Assisted Closure in Plastic Surgery

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Background
The Vacuum Assisted Closure (VAC) system represents a non-invasive technique in wound management that uses regulated negative pressure to help accelerate wound healing. Among the clinical advantages obtained with the application of negative pressure systems include progressive and uniform reduction of the wound, provides a closed environment suitable for wound healing, eliminates excess fluids and exudates typical of deep and complex wounds, which can inhibit or delay healing, helps eliminate edema by reducing interstitial fluid, stimulates granulation of the wound, reduces bacterial load as well as stimulates angiogenesis processes. It may be very attractive to maintain a conservative option with the application of negative pressure in patients with complex wounds as initial treatment, since it has been shown to reduce morbidity and minimize complications. Due to the many advantages offered by the negative pressure system, it is essential to know the sponges and necessary pressures as part of the therapeutic arsenal for complex wounds / reconstruction.

Keywords: Vacuum assisted closure, wounds, wound management.

Mini Review

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The Vacuum Assisted Closure (VAC) system represents a non-invasive technique in wound management that uses regulated negative pressure to help accelerate wound healing. [1] It is a non-invasive and dynamic system that helps promote wound healing by applying controlled negative pressure to the wound site. Provides a closed, moist environment while removing excess fluids that can inhibit wound healing thereby accelerating wound healing while decreasing wound bulk. It is possible to treat any size of wound, [2] since it favors repair by second or third intention and prepares the wound for adequate closure by reducing edema, removing infected and exudative material, stimulating perfusion and formation of granulation tissue. The clinical advantages that we can obtain with the application of negative pressure systems include 1. Progressive and uniform reduction of the wound, including depth. 2. Provides a closed environment suitable for wound healing. 3. Eliminates excess fluids and exudates typical of deep and complex wounds, which can inhibit or delay healing. 4. Help eliminate edema by reducing interstitial fluid. 5. Stimulates and facilitates the granulation of the wound. [3-6] 6. Reduction of bacteria. 7. Angiogenesis stimulation.[7] In the treatment of complex wounds, for example, open fractures of the lower limbs where there is significant loss of tissue, generally represent a therapeutic challenge due to the severity of the wounds, the involvement of various types, as well as the complexity of microsurgical techniques using the use of free flaps, so it can be very attractive to maintain a conservative option with the application of negative pressure on the wound, which has been shown to reduce morbidity and minimize complications. [8]

Vacuum assisted closure system

The oldest report of the use of a similar system dates from 1908 when suction was applied to chronic, traumatic and post-surgical wounds. Directly applied negative pressure in patients treated with the open abdomen technique was described by Barker et al. in 1994, who reported a vacuum packing technique in patients with abdominal trauma using infra-abdominal compresses and a conventional closed suction system. The United States Food and Drug Administration approved the VAC system (VAC Therapy, KCI, San Antonio, Texas) in 1995 for use in patients with diabetic foot wounds, pressure ulcers, infected surgical wounds, flaps, grafts, wounds traumatic and others difficult to heal,[1] Since then its use has been explored and applied in a number of

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medical specialties in which complex wounds are found, so the design and functionality of the device has been modified according to the treatment areas where they are found:

The black foam-VAC GranuFoam Dressing:

It is a hydrophobic polyurethane sponge, it consists of pores of 400 to 600 micrometers. It is indicated in the formation of granulation tissue as in deep cavities and in the management of wounds with formation of large amounts of exudate.

The silver foam-VAC GranuFoam Silver Dressing:

It is a polyurethane sponge with prolonged release ionic silver, therefore it has a broad spectrum antimicrobial effect. Exposure of the dressing to wound exudate causes the oxidation of metallic silver to ionic silver, resulting in the continuous and prolonged release of silver ions that act as an effective antimicrobial barrier.

The white foam-VAC WhiteFoam Dressing:

It is a polyvinyl alcohol dressing consisting of a hydrophilic sponge and is indicated to protect organs, intestinal loops, vascular bundles, tendons, nerves, exposed bone, friable tissues, and pediatric patients. It is recommended in superficial wounds with little exudate and in wounds with severe painful symptoms.

Physiological response to Vacuum Assisted Closure System

When the VAC sponge is compressed by starting the vacuum, there is a resulting deformation of the underlying tissue cells at the periphery of the wound, whereby at a microscopic level there is a collapse between the tissues, sucking the small bubbles present into the spaces sponge porous. This vacuum movement and compression generates multiple dynamic processes that are called "mechanical stress" and has been shown to have a direct effect on mitotic cell activity. This mechanical stress applied by the continuous and intermittent suction of the VAC causes physiological changes in cell function referred to as mechanotransduction, much of the transduction mechanism occurs in the cytoskeleton and extracellular matrix. Integrins also play an important part in transmitting signals from the surface to intercellular signaling mechanisms as they alter gene transcription. The currently known responses of vascular cells to mechanical stimulation are inhibition of apoptosis, regulation of cell signaling, changes in gene expression, and increased cell proliferation that is altered by this system. Cell deformation is known to create changes in molecular stimulation, regulation of mitosis, ion transport, second messenger release, control of protein synthesis, and fibroblast activity. The improvement in the proliferation of tissues and cells has been verified through important specific groups of genes. The decreased activity of the products of these genes directly modulates the activity of mitogenic activated protein (MAP), interleukin (IL)-6, cyclin-dependent kinase (CDK)4, and IL-binding protein. This causes an increase in fibroblastic activity and collagen turnover. Tissue growth factors including TGF-β-1 and vascular endothelial growth factor expression have also been shown to increase their production. [1]

Optimum negative pressure

There is controversy about the optimal application of negative pressure, there are studies in animal models in which a greater formation of granulation tissue was observed with a vacuum of 125 mmHg compared with low (25 mmHg) or high (500 mmHg) vacuum suction. Low-pressure suction (25 mmHg) was found to reduce fluid drainage from the wound, decrease toxin removal, and reduce cell deformation. This results in a reduced rate of granulation tissue formation. The high suction pressure (500 mmHg) causes greater mechanical deformation of the tissues, resulting in a localized decrease in perfusion and reduced granulation tissue formation. Therefore, the negative pressure of 125 mm Hg is considered an optimal pressure. The effects of different levels of negative pressure (10-175 mmHg) on different wounds showed that the level of negative pressure needs to be adapted according to wound types. Acute traumatic wounds require a negative pressure of 125 mm Hg and for non-healing chronic venous ulcers, the optimal pressure is 50 mm Hg in intermittent cycles. [9-12]

Discussion

The association of infection-loss of soft tissue is one of the most complex situations in reconstructive surgery, generally associated with exposure of bones, nerves, tendons, and osteosynthesis materials. [13] Undoubtedly, some of the reconstructive alternatives in advanced wound management for these problems include rotation flaps, skin grafting, the use of colloid dressings, flap transfers, and microsurgery, among others. All these surgical choices are made after debridement of tissue from the injured area [14] reason why the treatment is usually long and causes severe pain during the cures. The treatment of complex wounds is a daily practice in most plastic surgery services, especially in large reference centers. Despite

the fact that surgical debridement continues to be the therapy of choice for the treatment of infected wounds or those with abundant necrotic remains, the advent of vacuum therapy and the technological improvements experienced by said therapy in recent decades make its use a initial adjuvant tool for control of the surgical bed, wound exudates and bacterial colonization.[15] It has been shown that when using a skin graft or genetically engineered skin substitute, when used in combination with negative pressure therapy, this is also very useful in increasing uptake and revitalization of the grafted skin [16, 17] by reducing the bacterial load within the wound, as well as potentially harmful exotoxin and endotoxin concentrations, rapidly removing exudate from the wound bed. [6]

Conclusion

The negative pressure system stabilizes the wound, reduces edema, reduces bacterial load, improves tissue perfusion and stimulates granulation tissue, improves the chance of spontaneous wound healing, and reduces the need for major reconstructive surgical procedures. VAC therapy is an additional tool for different medical specialties.

Conflicts of interests

The authors have no conflicts of interest to disclose.

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