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Negative Pressure Wound Therapy: A Promising Weapon in the Therapeutic Wound Management Armamentarium

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Abstract:

Management of infected non healing wounds or the classically described hard to heal ulcers continue to pose a challenge to attending surgeon. Newer methods are being evolved to meet the challenge. The concept of negative pressure wound treatment or vacuum assisted closure is an innovative method. The mechanism of action, methodology and clinical applications are presented in this paper.

Key words: *negative pressure vacuum assisted wound treatment.*

INTRODUCTION

Despite advances in surgical techniques, antibiotics and development of newer agents to enhance wound healing yet wound management still continues to pose a challenge to the wound

management specialist. The morbidity and cost due to wound infection puts an added load on the health care system. The problem posed by hard to heal ulcers therefore still continues. Negative

pressure wound treatment is an innovative concept aimed at achieving wound healing. The mechanism of action of this method, methodology and applications are discussed in this paper.

PATHOPHYSIOLOGY OF NON-HEALING WOUNDS

Non-healing wounds or hard to heal ulcers as classically described lack the intensity and vigour of the normal healing process. Various factors contribute to this negative phenomenon. Infection leads to prolongation of the acute phase of inflammation. This leads to persistence of tissue oedema which in turn results in reduced vascularity of the wound. This causes reduction in the local immunity or immune response thereby allowing the infecting organisms to proliferate and release toxins causing more tissue damage leading to failure of the inflammatory mechanism. The weakened local inflammatory mechanism leads to chronicity of the wound. Use of higher antibiotics as well as newer topical agents to stimulate wound healing fail to achieve a positive response.

In order to rekindle the local inflammatory response, a number of steps need to be taken. Removal of slough is of utmost importance. This can be achieved surgically or chemically. This also aids in reducing bacterial counts in the wound. This serves as an impetus to improve the blood supply which indirectly leads to the formation of granulation tissue. Reduction of

infection, prevention of slough formation and improvisation of vascularity are the corner stones for stimulating the growth of healthy granulation tissue. Application of negative pressure to such wounds leads to improvisation in the healing potential of the wound by way of the aforementioned mechanisms.

DEVELOPMENT OF VACUUM ASSISTED WOUND MANAGEMENT

The technique of exposing a wound to negative pressure in order to promote healing was first described by Fleischmann. [1] It was found that efficient debridement and healing took place in the wounds. Subsequently many more workers adopted this technique and achieved excellent results ranging from diabetic ulcers to chronic radiation ulcers. [2, 3, 4] Promising results led to the development of a commercial system for promoting vacuum assisted closure. This was described as VAC.[5,6] The system comprised of a microprocessor controlled vacuum unit that is capable of providing controlled level of continuous or intermittent sub atmospheric pressure ranging from 25-200mm of mercury. Subsequently various versions of the system were developed to enhance the portability of the machine. This aided the wide spread use of vacuum assisted treatment for wounds thus expanding the spectrum of application.

MECHANISM OF ACTION OF VACUUM ASSISTED MANAGEMENT OF WOUNDS:

In the initial phase of applying this methodology, no attempt was made to understand the underlying basis of this technique. As a result the method lacked standardisation. [7] Subsequently with improving results, researchers investigated the exact mechanism of action in various animal models.

Laser Doppler was used to measure blood flow in the subcutaneous tissues and muscle surrounding the wounds which were exposed to increasing levels of negative pressure. Results revealed that there was an increase in the blood flow in tissues exposed to negative pressure value of 125mm Hg. [8] However increasing the pressure to 400mm Hg or more led to a decrease in the blood flow. [9, 10, 11]

Rate of granulation tissue production under the influence of negative pressure was determined in the same model by measuring the reduction in wound volume overtime. It was observed that wounds exposed to negative pressure reduced in size with good amount of granulation tissue as compared to wounds which were treated just by saline or antiseptic dressings. [10, 11]

Intermittent treatment was found to be more effective than continuous therapy. The exact mechanism underlying this phenomenon could not be determined. Various explanations were

advanced. [3, 4] Intermittent treatment results in rhythmic perfusion of the tissue which is maintained because the process of auto regulation of capillaries was not activated. Another effect of intermittent therapy was on the cells undergoing mitosis. These cells need to undergo the cycle of rest, cellular component production and division. Continuous stimulation of such cells may lead to a blunted response to the stimulus thereby rendering it ineffective. Intermittent stimulation gives the cells adequate time to rest and prepare for the next cycle of proliferation.

Microbiological analysis of punch biopsy samples from the wounds treated by negative pressure therapy revealed significant reduction in the bacterial counts as compared to control values. [4]

Multiple mechanisms may be responsible for these beneficial effects. Removal of interstitial fluid reduces the local oedema thereby increasing the local blood flow. This in turn may be helpful in reducing local bacterial counts. Application of sub atmospheric pressure also removes suspended cellular debris, osmotically active molecules and various toxic biochemical mediators which otherwise are detrimental to the process of smooth wound healing. It also produces mechanical deformation or stress within the tissue resulting in protein and matrix molecular synthesis accompanied by enhanced angiogenesis. [9, 11]

METHODOLOGY

Proper steps with respect to methodology need to be followed in order to achieve beneficial effects. [4, 5] A foam dressing is cut exactly to the size of the wound with scissors and is placed gently over the cleaned wound.

The perforated drain tube is then placed on the foam and a second piece of foam placed over the top. This is applicable for larger wounds. For smaller wounds, a single piece of foam will suffice. The ideal material is polyurethane foam which may not be available at all times. In such circumstances, a sterile piece of sponge may suffice. The use of simple gauze pieces may also suffice.

An occlusive, adhesive, transparent membrane is applied which covers not only the wound covered with foam but also the surrounding area of healthy skin. Utmost care needs to be ensured that a good seal is formed between the membrane and both the skin and the drainage tube in order to prevent leakage of pressure. The distal part of the drain is then connected to the VAC unit which is programmed to provide the required pressure. [5]

The fluid including cellular debris is taken up by the foam and transported via the drain tube into a disposable container within the main vacuum unit. The pressure may either be intermittent or even continuous as determined by the merits of the case. Usually intermittent therapy is more

beneficial and easy to manage. A close watch on the VAC system is necessary in order to ensure complete exposure of the wound to the required sub atmospheric pressure for the stipulated time. This may require training of the relatives or the patient himself in case of home treatment by specialist nurses while in hospital. [11]

CLINICAL APPLICATIONS:

Negative pressure wound therapy or vacuum assisted closure can be used for a variety of wound types. These include diabetic foot ulcers, chronic non healing wounds, pressure sores, infected sternotomy wounds and extensive de glancing injuries.[12,13,14] This method is of great help in treating diabetic ulcers. [15] These ulcers are usually resistant to all standard methods of treatment including hyperbaric oxygen therapy. Pressure sores in chronically bed ridden patients are a great challenge to the attending surgeon. Vacuum assisted closure can safely be used with good results even in such patients. [16]

CONCLUSION

Vacuum assisted closure technique or negative pressure wound therapy is indeed a new and useful weapon in the therapeutic armamentarium of wound care specialist. It can help in achieving wound healing in a wide range of hard to heal wounds.

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