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A Study of Effectiveness of Negative Pressure Wound Therapy in Wound Management

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Abstract: ***Background and objective: Wounds are a major source of morbidity, lead to considerable disability, and are associated with increased mortality; therefore, they have a significant impact on public health and the expenditure of healthcare resources. Vacuum-assisted closure (VAC) uses negative pressure to assist wound healing. Negative pressure drains fluid from the wound, thus removing the substrate for growth of microorganisms. Negative pressure may also accelerate granulation tissue formation and promote angiogenesis. The mechanical stimulation of cells by tensile forces may also play a role by increasing cellular proliferation and protein synthesis. Methodology: A total of 50 cases clinically presenting as ulcer between January 2018 and July 2018 were taken for study. Each case was examined clinically in systematic manner as per the proforma drafted, for study of all patients presenting with ulcer. VAC dressing was done and outcome was measured by recording wound scores on days 3, 7 and 10. Interpretation and conclusion: In our study VAC therapy enhanced granulation tissue formation leading to better wound healing, and faster recovery. VAC is thus a promising new technology in the field of wound healing with multiple applications in a variety of wounds and can be used in both acute and chronic wounds, salvage procedures or as an adjuvant therapy to improve the results of various surgical procedures.***

1. Introduction

Vacuum-assisted closure (VAC) is a new technique in the challenging field of management of contaminated, acute and chronic wounds. Vacuum assisted closure (also called vacuum therapy, vacuum sealing or topical negative pressure therapy) is a sophisticated development of a standard surgical procedure, and involves the use of vacuum to remove blood or serous fluid from a wound or operation site. Negative pressure wound therapy (NPWT) also called vacuum-assisted wound closure and refers to wound dressing systems that continuously or intermittently apply sub- atmospheric pressure to the surface of a wound. The application of controlled levels of negative pressure has been shown to accelerate debridement and promote healing in many different types of wounds. The optimum level of negative pressure appears to be around 125 mmHg below ambient and it is believed that negative pressure assists with removal of interstitial fluid, decreasing localised edema and increasing blood flow. This in turn decreases tissue bacterial levels. Despite the significant costs involved, the technique is said to compare favourably in financial terms with conventional treatments in the management of difficult wounds. [1]

In essence, the technique is very simple. It involves application of sterile, open-pore foam dressing directly on the wound. The wound is then sealed with an occlusive drape in order to create a closed, controlled environment. A fenestrated vacuum tube is connected to a vacuum source; fluid is drawn from the wound through the foam into a reservoir for subsequent disposal. Negative pressure is applied at 50-125 mm/Hg, resulting in a decrease in the local interstitial pressure, and effluent from the wound is drawn out into the collection device. Initially, the vacuum pressure is applied continuously. As the amount of drainage decreases, the vacuum may be subsequently being applied on an intermittent basis. The vacuum dressing is usually changed at approximately 48-hour interval. [2, 3]

2. Mechanisms of Action of VAC

Wounds generally heal by primary, where edges are brought into close apposition for example by suturing, or secondary intention, where the wound edges are not opposed and a matrix of small blood vessels and connective tissue must be formed in between in order for keratinocytes to migrate across the surface and reepithelialise the defect. It is a complex, intricate process. The aims of the process can be considered as minimization of blood loss, replacing any deficits with new tissue (granulation) and restoring an intact epithelial barrier as quickly as possible. In order to achieve healing debris must also be removed; any infection controlled and inflammation eventually cleared. The wound then heals with granulation, remodeling of the connective tissue matrix and finally maturation. The rate of healing may be limited by vascular supply and the capacity of the wound to form new capillaries/matrix. Any disruption in the various processes involved in proliferation, angiogenesis, chemotaxis, migration, gene expression, protein production can lead to a chronic wound. The VAC ensures a closed environment for wounds and, therefore, adheres to universal precautions.[3,4]

Local blood flow

Morykwas et al used needle probe laser Doppler flowometry to show that sub-atmospheric pressures of 125 mm Hg resulted in a fourfold increase in blood flow using an excisional wound model in pigs. This increase in blood flow has also been shown in human burns. Further higher increases in pressure (200 mm Hg) were shown to decrease blood flow. There remains confusion as to whether continued pressure leads to an eventual decline in blood flow[18] or a cyclical pattern of blood flow. These direct effects on dermal vasculature are thought to be mediated by

influencing vasomotor mediators.. However, the indirect effects of mechanical forces exerted on the extracellular matrix inevitably affect the microvasculature contained within it. Vacuum Assisted Closure (VAC) is widely used in wound therapies and has been shown to positively affect angiogenesis.[5,6,7]

Mechanical stress
The importance of physical forces in TNP therapy is still theoretical; however there is good evidence of the importance of mechanical stress on cellular reproduction and angiogenesis[20]. Increasing mechanical stress in vitro causes an increase in cellular activity, the nature of which varies with the cell type and methodology. Accelerated cell cycling and DNA synthesis have been seen. Experimental evidence from model systems also suggests that mechanical forces can result in increased fibrogenesis in cutaneous wound models.[8,9]

Granulation tissue formation
In Morykwas' studies using porcine dorsal midline excisional full thickness excisional wound models, alginate impressions were taken daily after treatment with TNP. Volume displacement of these casts demonstrated that TNP treated wounds showed increased granulation tissue formation compared with the controls by 63% and 103.4% (continuous and intermittent suction respectively), although it is not known what effect contraction played to change the size of these wounds.[10]

Bacterial colonization
Studies using swine wounds inoculated with a human isolate of Staphylococcus aureus and a swine isolate of Staphylococcus epidermidis that were treated with TNP or controlled moist saline dressing showed a more rapid decline in bacterial levels in the TNP treated wounds.[11,12]

Edema reduction and exudate management
Clinically VAC removes large amounts of fluid from wounds especially acute burns[28]. The resulting reduction in oedema is thought to aid in the enhancement of blood and nutrient flow into the wound. However, this removal of exudates (which will include metalloproteinases and other inflammatory mediators)[23] from the wound and oedema from the surrounding tissues encourages nutrient movement into the wound area even if blood flow is not increased. Removal of fluid prevents a buildup of inflammatory mediators and encourages diffusion of further nutrients into the wound. This is all beneficial to the healing process especially in the case of chronic wounds where it has been hypothesised that an imbalance of metalloproteinases can inhibit healing. Anecdotally the volume of wound exudate gathered from acute wounds decreases significantly over the first three to four days signifying a decrease in wound edema. However, currently there is no quantitative evidence to support an actual reduction in interstitial wound fluid although studies are underway to attempt to evaluate changes in wound fluid constituents under VAC.

3. Objectives of the Study

- To study the outcome of vacuum assisted closure of wounds.
- To evaluate the positive impact of vacuum assisted closure on wound healing in enhancing granulation tissue

4. Methodology

Source of Data
In-patients in all surgical units of LG General Hospital, Maninagar, Ahmedabad clinically presenting as ulcer between January 2018 and July 2018 were included in the study.

Sample Size
50 Cases

Inclusion Criteria
- Patient more than 12 years of age
- Patients presenting with ulcer.

Exclusion Criteria
- Patients less than 12 years of age
- Patients diagnosed as malignancies.

Sequence of Procedure:

Wound Preparation:
Any dressings from the wound was removed and discarded. A culture swab for
microbiology was taken before wound irrigation with normal saline. Surgical debridement was done and adequate haemostasis achieved.

Placement of foam:
Sterile, open-cell foam dressing was gently placed into the wound cavity.

Sealing with drapes:
The site was then sealed with an adhesive drape ensuring that the drapes covered the foam and tubing and atleast three to five centimetres of surrounding healthy tissue.

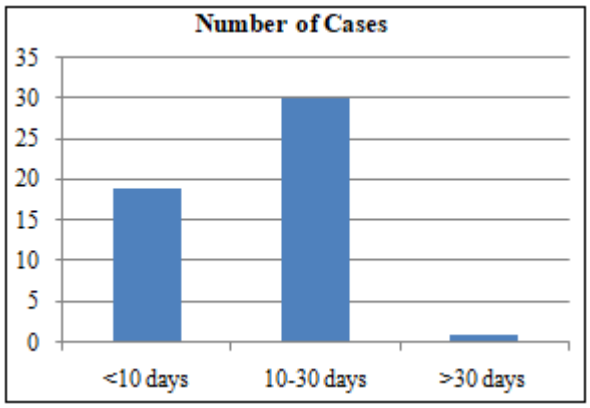
Application of negative pressure:
Controlled pressure was uniformly applied to all tissues on the inner surface of the wound using centralised vacuum pump, which could deliver either continuous or intermittent pressures, ranging from 50 to 125 mm Hg. The foam dressing compressed in response to the negative pressure. The pressure was applied continuously for the first 48 hours and changed as required thereafter.

The outcome was measured using area of wound covered with granulation tissue, and its color and consistency.

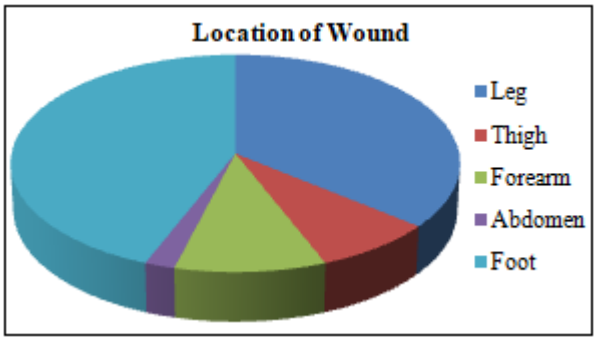
5. Result

- Most of the patients presenting with wounds were in the 5th decade of life 18(36%), followed by the 6th decade 17(34%).

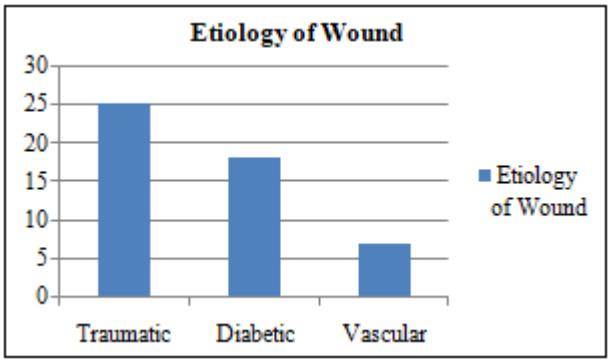
- Wounds were more common in males 38 cases (76%) than in females 12 cases(24%) Male to female ratio 3.2: 1.
- Based on the duration of wounds, cases were grouped into 3 categories: <10 days, 10-30 days and >30 days. Most cases fall in the group 10-30 days 30(60%), 19 cases(38%) in the group <10 days and 1 case (2%) in the group > 30 days.



- Wounds were most commonly located in the foot 22(44%) followed by the leg 18(36%), forearm 5(10%) , Thigh 4(8%) . One case of wound in the abdomen was included.



- Based on etiology of wounds, which were determined by history and clinical examination, wounds were divided into Traumatic, Diabetic and Vascular. A major portion 25(50%) of cases fell into traumatic group and 18(36%) into diabetic and 7 (14%) into vascular group.

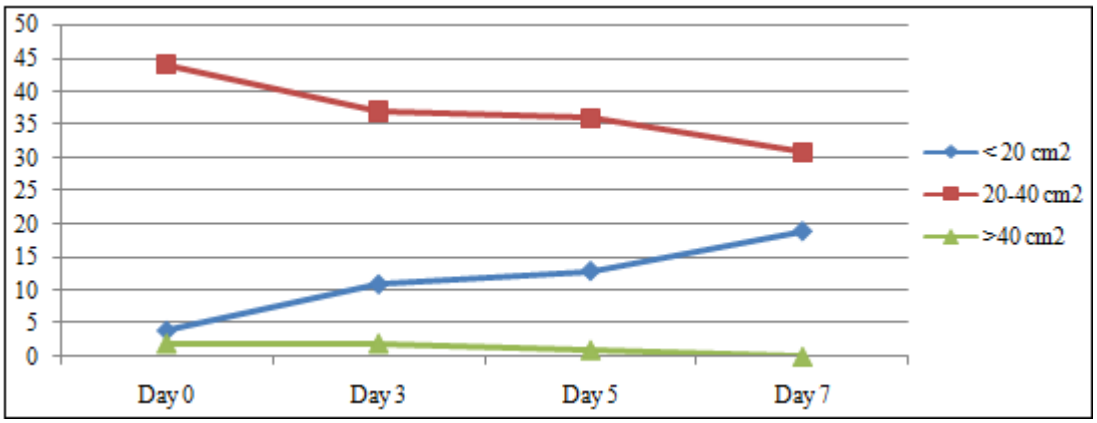


- Most common organism cultured from the wounds was Staphylococcus aureus 21(42%).

Organism Cultured	No. of Cases
No Growth	**13 (26%)**
Staphylococcus	**21 (42%)**
Pseudomonas	**7 (14%)**
E. Coli	**3 (6%)**
Klebsiella	**4 (8%)**
Proteus	**2 (4%)**

- Following V.A.C. Dressing for 3-7 days, most of the wound shows improvement in terms of decreased wound surface area, layer of granulation tissue covering wound and quantity of exudate.

Number of Cases	Wound Surface Area		
	< 20 cm^2	20-40 cm^2	>40 cm^2
Day 0	4	44	2
Day 3	11	37	2
Day 5	13	36	1
Day 7	19	31	0



6. Discussion

Delayed wound healing is a significant health problem and a challenge in the community setting particularly in older adults, often requires daily or more frequent hospital visits. With conventional wound-healing methods, it may take several months to heal the wound. In addition to the pain and suffering, failure of the wound to heal also imposes social and financial burdens. Vacuum-assisted closure (VAC) therapy has been developed as an alternative to the standard forms of wound management, which incorporates the use of

negative pressure to optimise conditions for wound healing and requires fewer painful dressing changes.[14,15]

Negative pressure therapy is an expensive treatment modality, and, because the costs are high, a recent consensus report suggests that use as a first-line therapy is inappropriate. However, others suggest that negative pressure therapy has the potential for saving money if it is used on the "right patient, the right wound, at the right time." The use of negative pressure therapy has been proposed as a novel method of manipulating the chronic wound environment to assist and accelerate wound healing. Although initial clinical results are promising, the gap between available scientific evidence and everyday clinical practice does not give a balanced view of the appropriate use of negative pressure therapy.[16]

Although most studies were probably too small to detect significant differences between wounds managed by conservative dressings and by VAC, some did show VAC to result in better healing than standard methods, with few serious complications. VAC appears to be a promising alternative for management of wounds. VAC was also more effective at treating various chronic and complex wounds, with a significantly greater reduction in wound volume, depth and treatment duration for VAC. It has the potential to reduce health care costs, for both hospital and patient, and enhance patient satisfaction and quality of life.[17,18,19]

In our study, following VAC therapy, wound scoring was done with scores from 1-7 given for area of granulation tissue, color and consistency of granulation tissue. The wounds following VAC therapy can be considered for skin graft. In the present study, >70% cases showed considerable improvement following a week of VAC therapy. The use of sub-atmospheric pressure dressings, available commercially as the VAC device, has been shown to be an effective way to accelerate healing of various wounds. The optimal sub-atmospheric pressure for wound healing appears to be approximately 125 mm Hg. VAC has significantly increased the skin graft success rate when used as a bolster over the freshly skin-grafted wound. VAC is generally well tolerated and, with few contraindications or complications, is fast becoming a mainstay of current wound care.

7. Conclusion

VAC therapy is a recent modality of treatment of wounds. Its introduction has changed the course of management of wounds. Based on the data from the present study and other studies available, VAC does appear to result in better healing, with few serious complications, and thus looks to be a promising alternative for the management of various wounds. The application of VAC is simple, but requires training to ensure appropriate and competent use. The cost of VAC will vary and depend on the length of hospital stay and cost of supplies. There is a paucity of high quality RCTs on VAC therapy for wound management with sufficient sample size and adequate power to detect differences, if any, between VAC and standard dressings. More rigorous studies with larger sample sizes assessing the use and cost- effectiveness of VAC therapy on different wound types are required. Awareness about VAC and training on application of VAC dressings will allow its utilization more often.

References

[1] Eginton MT, Brown KR, Seabrook GR, et al. A prospective randomized evaluation of negative-pressure wound dressings for diabetic foot wounds. Ann Vasc Surg 2003;17(6):645-
[2] Banwell PE, Teotl L. Topical negative pressure (TNP): the evolution of a novel wound therapy. J Wound Care 2003;12(1):28–30.
[3] Morykwas MJ, Argenta LC, Shelton-Brown EI, et al. Vacuum-assisted closure: a new method for wound control and treatment: animal studies and basic foundation. Ann Plast Surg 1997;38:553–62.
[4] Leong M, Phillips LG.Wound Healing. Townsend CM, Beauchamp RD, Evers BM, Mattox KL. Sabiston Textbook of Surgery.19th ed. Philadelpia;Elsevier;2012:151-77.
[5] Barbul A,Efron DT. Wound healing.Brunicardi FC.Schwartz Principles of surgery. 9th ed.New York.McGraw Hill;2010:209-33.
[6] Galiano RD, Mustoe TA. Wound Healing.. Mulholland, Michael W, Lillemoe, Keith D, Doherty, Gerard M, Maier, Ronald V, Upchurch, Gilbert R. In Greenfield's Surgery: Scientific principles and practice.4th ed .Philadelpihia; Lippincott Williams & Wilkins;2006
[7] Armstrong DG, Lavery LA, Frykberg RG, et al. VAC therapy appears to heal complex DFU. Abstract presented at the 2nd World Union of Wound Healing Societies' Meeting, July 8-13, 2004; Paris, France
[8] Lazarus GS, Cooper DM, Knighton DR, et al. Definitions and Guidelines for Assessment of Wounds and Evaluation of Healing Arch Dermatol. 1994;130(4):489-493
[9] Joseph E, Hamori CA, Bergman S, Roaf E, Swann NF, Anastasi GW. A prospective randomized trial of vacuum-assisted closure versus standard therapy of chronic non - healing wounds. Wounds. 2000;12(3):60-67.
[10] Lionelli GT, Lawrence WT. Wound dressings. Surg Clin N Am 2003; 83(3):192-195.
[11] . Bowler PG. Wound pathophysiology, infection and therapeutic options. Annals of Medicine. 2002;34(6):419-427.
[12] Earley J. Wounds, tissue repair and scars. Williams NS. Bailey and love's short textbook of surgery 25th ed. 2010:3:29
[13] Vacuum therapy in wound management. Vacuum Therapy. Last updated 2001.
[14] Lee HJ et al. Negative pressure wound therapy for soft tissue injuries around the foot and ankle. Journal of Orthopaedic Surgery and Research 2009,
[15] Argenta LC, Morykwas MJ. Vacuum-assisted closure: A new method for wound control and treatment: Clinical experience. *Ann Plast Surg* 1997;38(6):563-76.
[16] Pories WJ, Schear EW, Jordan DR, et al. The measurement of human wound healing. *Surgery* 1966;59(5):821-4.

[17] Lazarus GS, Cooper DM, Knighton DR, et al. Definitions and guidelines for assessment of wounds and evaluation of healing. *Arch Dermatol* 1994;130(4):489-93
[18] Levin LS. The reconstructive ladder. An orthoplastic approach. Orthop Clin North Am 1993; 24:393–409.
[19] Erba P et al. Angiogenesis in wounds treated by microdeformational wound therapy. nn Surg. 2011 February ; 253(2): 402–409.