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Outcome of Vacuum Assisted Closure Dressing Therapyin Management of Postoperative Infected Compound Wounds

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Abstract: *Vacuum-assisted closure (VAC) dressing therapy uses negative pressure to assist in wound healing. The Negative pressure drains fluid from the wound, thus removing the substrate for growth of microorganisms. The negative pressure also accelerates granulation tissue formation and promote angiogenesis. The mechanical stimulation of cells by tensile forces also play a role by increasing cellular proliferation and protein synthesis.*
Negative pressure wound therapy (NPWT) involves the use of a negative pressure therapy or suction device to aspirate and remove fluids, debris, and infectious materials from the wound bed to promote the formation of the granulation tissue.
Aim: *Our study aims to evaluate outcome of vacuum-assisted closure (VAC) dressing therapy in the management of postoperative infected compound wounds.*
Materials and methods: *Our study was conducted on 50 patients in the Department of Orthopaedics at Narayana Medical College and Hospital, Nellore, Andhra Pradesh from November 2017 to November 2018. Out of 50 patients, 38 male and 12 females, the mean age ranging from 20 to 58 for males and 22 to 65 for females. In our study,majority cases were reported Road traffic accident 34 (67%) patients, followed by machinery injury in 10 (20%) patients and 6 (13%) patients had a fall from height. Vacuum-Assisted Closure (VAC) dressing therapy applied for postoperative infected non-healing traumatic wounds.*
Results: *Out of 50 wounds taken in the study, 40 wounds reduced in the area & were resurfaced with split thickness skin-grafting and ten wounds showed a reduction in the area & were subjected to secondary closure. During the beginning of VAC dressing therapy, all postoperative wounds were infected. At the end of VAC dressing therapy, all included wounds became swab negative, no patient required surgical debridement, and there was a gradual decrease in the size of the wound.*
Discussion: *Our study showed that VAC dressing therapy after day 3, 50% of patients who had no bacterial growth, and on day seven, 90% of patients had no growth, whereas in patients with saline-wet-to-moist dressings only 8% of patients had no bacterial growth on the 7th day. Our study showed that VAC dressing therapy improves the vascularity and rate of granulation tissue formation compared to standard wound dressing therapy.*
Conclusion: *VAC dressing provides a sterile and controlled environment to large and infected wound surfaces. By controlled application of sub-atmospheric negative pressure, it prepares wounds for closure with split-skin grafting or by secondary closure in short time leading to less overall morbidity for patients witha decreased hospital stay.*

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I. Introduction

Wound healing is a complex process and delayed wound healing is a significant health problem in India. In addition to pain and suffering, failure of the wound to heal imposes Social & financial burdens.Open fractures still represent a significant challenge for treating surgeon, frequently demand complex of soft tissue and bone procedures to achieve healing with adequate limb function. Wound healing includes an immediate sequence of cell migration leading to repair and closure. This sequence begins with the removal of debris, angiogenesis, control of infection, deposition of granulation tissue, clearance of inflammation, remodeling of the connective tissue matrix, contraction, and maturation. Standard treatment of wound care includes debridement of necrotic tissue, application of hydrocolloid wound gels, dressings with enzymatic debridement compounds, local ulcer care, infection control, mechanical off-loading, management of blood glucose levels, hyperbaric oxygen therapy and education on wound care to the patient. When wound fails to undergo the above sequence of events, a chronic open wound without anatomical or functional integrity results. Open fractures need skeletal stability and adequate soft tissue coverage. In such compound injuries, debridement of all nonviable tissue produce significant soft-tissue defects precluding healing through primary closures, delayed primary closures, or secondary intention. The management of chronic, open wounds is variable and costly, demanding lengthy hospital stays or specialized home care requiring skilled nursing and expensive supplies. Various types of surgical methods has been established for wound healing such as skin grafts, local rotation flaps, Advanced Wound Care Therapies (AWCT)/Vacuum-Assisted Closure (VAC) and myo-cutaneous or fascio-cutaneous tissue transfers, Stander dressing therapy, etc. Topical Negative Pressure (TNP) therapy has dramatically improved the strenuous wound healing. Vacuum-Assisted Closure (VAC) System is a therapeutic device based on the administration of controlled TNP. It can be used on a variety of acute and chronic wounds to achieve woundclosure or prepare the wound for additional surgical interventions. It aids in healing by maintaining a moist wound environment, increase local blood flow, removing wound exudates, promoting granulation tissue, reducing infection, and exerting mechanical pressure.

Procedure:

After surgical debridement, fracture fixation, and adequate hemostasis were achieved, sterile, open-pore foam dressing was gently placed into the wound cavity and sealed with adhesive drape. Negative pressure applied. Thepump delivered intermittent negative pressure of −125mmHg. The dressings were changed on the third or fourth day depending upon the amount of drain. Primary outcome variables were presence of infection, time interval between the initial injury and reconstructive soft tissue procedure, duration of hospital stay and complete healing of the wound. Infection assessed based on clinical signs and symptoms that included increasing drainage, increasing pain, purulent discharge and increasing erythema. Conclusion: VAC is a simple and low-cost method for treating soft tissue injury associated with severe open fractures. Adequate early debridement followed by application of primary VAC has reduced wound infection rate,and early wound healingcan be achieved.

Aim:

Our study aims to evaluate the outcome of Vacuum-Assisted Closure (VAC) dressing therapy in the management of infected compound wounds.

II. Materials And Methods

This prospective study was carried out on patients of the Department of Orthopaedics at Narayana Medical College and Hospital, Nellore, Andhra Pradesh from November 2017 to November 2018. A total 50 adult subjects (both male and females) aged ≥ 18, years were included in this study.

Study Design: Prospective observational study

Study Location: This wastertiary care teaching hospital-based study done in the Department of Orthopaedics at Narayana Medical College and Hospital, Nellore, Andhra Pradesh.

Study Duration: November 2017 to November 2018.

Sample size: 50 patients.

Method of collection of data:A total of 50 cases with infected compound injuries associated with fractures from November 2017 and November 2018 were included in thestudy.

Table 1: Distribution of patients according to Age, Sex, and Mode of injury.

Number of cases	50
Sex	Male-38
	Female-12
Average age of patients	Male 20-58
	Female 22-65
Mode of injury	RTA-34 (67%)
	Machinery injury-10 (20%)
	Fall from height-6 (13%)

Inclusion Criteria:

- Patient more than 18 years ofage.
- Patients operated withfractures associated with compound injuries.
- Infected wounds secondary to fracture fixation with implants in situ.

Exclusion Criteria:

- Patients less than 18 years of age.
- Wounds with exposed blood vessels and organs.
- Compound injuries without underlying fractures.
- Non traumatic ulcers.
- Wounds of very large surface area (an area more than 10% body surface area, areas like perineum, groin, axilla).
- Wounds due to untreated osteomyelitis, malignancies and peripheral vascular diseases.

- Patients with haematological disorders.
- Swab culture negative wounds.

Materials Required:
- Autoclaved sponge foam (double autoclaved at pressure of 20 PSI, 250°F for 30 min).
- Tegaderm /surgical glove of appropriate size/ Ioban.
- Disposable syringes (10 cc, 20 cc, 50 cc), Romovac suction drain, mucus suckers, pedal suction apparatus, portable electrical suction machine.
- Suction catheter/Ryle's tube/infant feeding tube.
- Transparent adhesive tape/micro pore.
- Plastic sheet.

TECHNIQUE:
STEPS:
- **Preparation of wound bed:**Any dressings from the wound were removed and discarded. A culture swab for microbiology taken before wound irrigation with normal saline. Surgical debridement was done by eliminating all the necrotic tissue and debris till fresh bleed is seen and adequate haemostasis achieved.
- **Foam placement:**Sterile, open-cell foam was connected to drain tubes and was then 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 dressing, tubing and at least four to sixcentimeters of adjacent healthy tissue.
- **Application of negative pressure:**Controlled pressure was applied uniformly to all tissues of the wound on the inner surface using acentralized vacuum pump, which is capable of delivering continuous andintermittent pressures, ranging from 50 to 125 mm Hg. The foam dressing shrinks in response to the negative pressure. The pressure was applied in cycles of 2 hours each for 48 hours, in which negative pressure was on for 1 hour and off for a subsequent hour.

The outcome was assessed using wound scoring system consisting of the area of granulation tissue covering and its colour and consistency.

The infection was assessed based on swab culture, clinical signs and symptoms that included increasing drainage and pain, purulent discharge and increasing erythema.

Pre VAC Wound

VAC Dressing applied

Day 3

Day 5

Day 7

Split Skin Grafting done

III. Results

Out of 50 wounds taken in the study, 40 wounds reduced in area & were resurfaced with split thickness skin grafting and five wounds showed a reduction in the area & were subjected to secondary closure. In our study, five patients were considered as a failure (2 patients developed a leak in vacuum, 2 patients not improved and changed to other modality of dressing, 1 patient underwent amputation) and these patients were excluded from this study population of vacuum dressing. During beginning of VAC dressing therapy, all wounds were infected. At the end of VAC dressing, all wounds became swab negative during course of VAC dressing therapy, no patient required surgical debridement and there was gradual decrease in size of wound.
According to Gustilo Anderson classification, out of 50 patients, 38 patients had grade IIIB injury, 10 had grade IIIC injury and 2 had IIIA injury.

Table 2: Bacterial growth on various days. Number of Patients- 50 (n=50)

Bacterial growth	Day 0	Day 3	Day 7
Present	50 (100%)	25 (50%)	5 (10%)
Absent	0 (0%)	25 (50%)	45 (90%)

IV. Discussion

Wound healing is independent process involving complex interactions between cells, cellular microenvironment and extracellular matrix molecules usually resulting in functional restoration of the injured tissue. Locally acting growth factors influence healing in the events of migration of neutrophils, proliferation, angiogenesis, the formation of extracellular matrix, macrophages, fibroblasts, increasing collagen and protein production thereby enhancing the healing of wound. Disruption of any of the above factors may adversely affect the healing process, resulting in a chronic or non-healing wound.

Application of sub atmospheric pressure decreases the bacterial colonization over the wound and increases the blood flow. Increase in oxygenated blood flow to the damaged tissues increases the wound resistance to the infection. Increased oxygenated blood flow to the wound healing promotes oxidative bursts in neutrophils, thereby promoting the killing of microbes and preventing infection. Successful, spontaneous healing and healing followed by surgical intervention are correlated with bacterial tissue counts of less than 106 organisms per gram of tissue.

Our study showed that in course of VAC dressing therapy after Day 3, 50% of patients had no bacterial growth and on Day 7, 90% of patients had no bacterial growth. In contrast, in saline-wet-to-moist patients only 10% of patients had no bacterial growth on Day 8. There have been similar studies by Michael J Morykwas and Argenta, Banwell*et al*, and Morykwas *et al*. showed clearance of bacteria from infected wounds using VAC dressing therapy. Weed *et al*. while quantified bacterial bio burden during negative pressure wound therapy concluded with serial quantitative cultures that there is no consistent bacterial clearance with the VAC dressing therapy, and the bacterial growth remained in the range of 104–106.

Thomas first postulated that application of mechanical stress would result in angiogenesis and tissue growth. Unlike sutures or tension devices, the VAC dressing therapy can exerts a uniform force at each individual point on the inner edge of the wound drawing it towards centre of the defect by stretching the cells mechanically when negative pressure is applied. This allows the VAC dressings to move distensible soft tissue, similar to expanders, towards the centre of the wound, thereby decreasing the actual size of the wound.

Our study showed that VAC dressing therapy increases the vascularity and rate of granulation tissue formation compared to standard wound dressing therapy. Histological, VAC dressing patients showed angiogenesis and healthy tissue growth. Those who were treated with standard wound therapy, the inflammation had increased and decreased in those patients treated with VAC dressing therapy. The greatly significant increase in rate of granulation tissue formation the sub atmospheric pressure-treated wound was postulated to be due to transmission of the uniformly applied force to the tissues on the periphery of the wound. These forces both recruit tissues through visco-elastic flow and promote granulation tissue formation. Standard wound dressings adhere to debilitated tissue and the gauze can be removed within four to six hours, along with thedevitalized tissue, as a method of mechanical debridement and this method of wound care has been criticized for eliminating both viable and nonviable tissue as well and being traumatic to the granulation tissue and to new epithelial cells.

For the treatment with VAC dressing therapy, many factors to be considered in view of the goal of treatment, type of dressing, suction pressure application. For different types of wounds, there is different amount pressure protocols and the duration of treatment changes. In acute wounds, it is beneficial to start VAC dressings within 48 h initially with continuous suction followed by intermittent suction therapy. For chronic wounds, they benefit more by continuous VAC dressing therapy. Short and intermittent VAC dressing therapy shows improved tissue response than compared to the continuous effect, but it may not be applicable for all types of cases. Intermittent VAC dressing pressure may not be tolerated by some patients due to discomfort. The optimal pressure to be applied for improvement of the wound is not yet currently known, there are different studies with application from −75 mm Hg to −150 mm Hg pressure and achieved good healing. Frequent change of vacuum dressings may be required for wounds with increased risk of infection.

V. Conclusion

VAC dressing therapy provides sterile and controlled environment to large, wound surfaces by controlled application of sub-atmospheric pressure. Application of sub-atmospheric pressure after the initial debridement to the wounds results an accelerated rate of granulation tissue formation, an increase in local functional blood perfusion, and a decrease in levels of bacteria in tissues. VAC dressing prepares wounds for closure through split skin grafting and secondary closure in short time leading to less overall morbidity with decreased hospital stay. In our study Vacuum assisted closure (VAC) dressing therapy appears to be beneficial for the treatment of compound and non-healing wounds.

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