Section: Orthopaedics

Original Research Article

TO STUDY THE CLINICAL EVALUATION ON THE EFFICACY AND OUTCOMES OF UTILIZING VACUUM-ASSISTED CLOSURE IN THE TREATMENT OF OPEN WOUNDS IN ORTHOPAEDICS

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Abstract

Background: The utilization of Vacuum Assisted Closure (VAC) in wound management has emerged as a contemporary approach that has demonstrated efficacy in promoting expedited and enhanced wound healing. The fundamental principle involves the utilization of negative pressure to extract blood and serous fluid from the wound site, thereby expediting the healing process through the modification of the local microcellular environment. The aim to study the clinical evaluation on the efficacy and outcomes of utilizing vacuum-assisted closure in the treatment of open wounds in orthopaedics. **Materials and Methods:** A total of 60 patients exhibiting non-healing open wounds and wounds exceeding an area of 50 cm2 were enrolled as participants in the present study. This study included patients who were above the age of 18years, of both genders (male and female), with wound sizes greater than 2cm, and with various types of open wounds in the upper and lower limbs, regardless of the cause. **Result:** The application of vacuum-assisted closure (VAC) involved the use of intermittent suction at regular intervals of one and a half hours. A vacuum pressure exceeding 150 mm of Hg was administered to the majority of patients, specifically 45 individuals (75%). In 5 patients (8.33%), the pressure ranged between 100 and 150 mm of Hg, while in 10 patients (16.67%), the pressure did not exceed 100 mm of Hg. The wound healing outcomes were deemed excellent in 40 patients, accounting for 66.67% of the total, while 20 patients, constituting 33.33%, exhibited good wound healing. **Conclusion:** Vacuum-assisted wound closure offers several advantages, including expedited healing, straightforward application, enhanced safety, and cost-effectiveness. The utilization of negative pressure wound treatment may potentially result in decreased rates of graft loss.

INTRODUCTION

Impairment in wound healing following surgical procedures and road traffic accidents is a prevalent issue within the realm of healthcare. Furthermore, the social and financial burdens resulting from the failure of wound healing and graft rejection are additional factors to consider, alongside the associated pain and suffering. Vacuum-assisted closure (VAC) is an innovative technique utilized in the complex realm of managing contaminated, acute, and chronic wounds.[1] Vacuum assisted closure, also known as vacuum therapy, vacuum sealing, or topical negative pressure therapy, is an advanced iteration of a conventional surgical technique. It entails the application of negative pressure through a vacuum to eliminate blood or serous fluid from a wound or surgical site. Negative pressure wound therapy (NPWT), also known as vacuum-assisted wound closure, pertains to the utilization of wound dressing systems that consistently or periodically administer sub-atmospheric pressure to the surface of a wound.[2] The utilization of regulated levels of negative pressure has demonstrated the ability to expedite the removal of dead tissue and facilitate the process of wound healing across various wound types.[3] The optimal negative pressure level seems to be approximately 120 mmHg below the ambient pressure. It is widely believed that negative pressure aids in the elimination of interstitial fluid, thereby reducing localized edema and promoting enhanced blood circulation. The decrease in tissue bacterial levels is a result of.[4,5] Despite the considerable expenses associated with it, the technique is purported to exhibit a favorable cost-effectiveness when compared to conventional treatments for the management of challenging wounds. Fundamentally, the technique is characterized by its simplicity. The procedure entails the utilization of a sterile, open-pore foam dressing that is applied directly onto the wound. Subsequently, an occlusive drape is employed to effectively seal the wound, thereby establishing a confined and regulated milieu. A vacuum tube with fenestrations is linked to a vacuum source, facilitating the extraction of fluid from the wound. The fluid is then drawn through the foam material and collected in a reservoir for subsequent disposal. A negative pressure of 125-150 mm/Hg is employed, leading to a reduction in the regional interstitial pressure and facilitating the extraction of wound effluent into the collection apparatus. The application of vacuum pressure is initially continuous. As the quantity of drainage diminishes, the application of vacuum may subsequently occur intermittently.[6,7] The vacuum dressing is typically replaced at an approximate interval of 48 hours.[8,9] Furthermore, it induces a hypoxic environment on the surface, thereby facilitating angiogenesis. Additionally, it maintains optimal wound temperature and moisture levels, effectively preventing desiccation.

MATERIALS AND METHODS

This prospective study was conducted at the Department of Orthopedics. A total of 60 patients exhibiting non-healing open wounds and wounds exceeding an area of 50 cm2 were enrolled as participants in the present study. This study included patients who were above the age of 18, of both genders (male and female), with wound sizes greater than 2cm, and with various types of open wounds in the upper and lower limbs, regardless of the cause. Only patients who provided consent for topical negative pressure were included in the study. The study excluded patients who were under the age of 18, had Charcot disease, had ulcers caused by chemical or radiation burns, had malignant ulcers, had wounds with unstable fractures or loose bone fragments, or had wounds with exposed blood vessels or organs.

Methodology

Following a comprehensive debridement procedure to remove necrotic slough, the attainment of haemostasis is ensured. The measurement of the wound surface area is then conducted by utilizing a plastic sheet imprinted with a grid pattern, which is placed over graph paper. The resulting imprints are carefully observed and the corresponding measurements in square centimeters (cm2) are duly recorded. Autoclaved Sponge foams with a thickness of 8 mm are selected and subsequently shaped to match the dimensions of the wound, with a slightly larger size than the wound itself. A wound swab specimen is collected in order to perform a culture and sensitivity test. If there is clean granulation tissue present above the wound surface, it is advisable to apply bactigrass or Vaseline gauge. This will prevent the dressing from sticking to the wound surface and minimize bleeding when the dressing is removed. In order to address the wound size, a pressure tube or Ryle's tube with an appropriate number of fenestrations is inserted between the two layers of sponge. The entire wound site is enclosed using a tegaderm/sterilized polyethylene cover/cling drape/sterile surgical glove. The suction catheter is connected to a vacuum-generating device and is energized. The syringe, mucus suction device, romo-vac, and pedal suction machine are systematically cleared of drainage and recharged with vacuum following each clearance at regular intervals. This discussion pertains to the technique employed for the administration of dressings, as well as the potential generation of negative pressures through the utilization of suction devices such as romo-vac, syringe, and mucus sucker. The magnitude of negative pressure applied during vacuum creation can vary between 100 mm Hg and 250 mm Hg, depending on the modality employed. The observation of fluid exudation and its corresponding volume is recorded. During the dressing change, the area surrounding the wounds was examined for any signs of cellulitis or maceration. The dressings are periodically replaced every 48-72 hours, taking into consideration factors such as the volume of exudate, potential leakage resulting from fluid accumulation, and the overall condition of the wound. During these intervals, measurements are also recorded. If maceration is detected, the subsequent dressing should be applied within a period of 12-24 hours to facilitate the restoration of the skin to its normal condition. When utilizing a surgical glove for dressing purposes, the creation of small fenestrations in the distal end of the glove can effectively reduce air leakage to a minimum and subsequently decrease the occurrence of maceration. The wound swab and exudates collected using the vacuum device are periodically sent for culture analysis on a weekly basis. The dimensions of the wound are assessed during each dressing change, utilizing graph paper to ensure accurate measurement. Subsequent measurements are then documented for record-keeping purposes. The evaluation of wound progress is conducted using a modified photographic wound assessment tool, with the recorded scores serving as indicators of improvement. The dressing expenses for each patient are individually assessed and documented as part of the comprehensive cost analysis.[10] The VAC dressing is applied until the granulation tissue of the wound reaches the skin surface, at which point it is left to heal through secondary intention or alternative methods of wound closure, such as secondary suturing, split skin grafting, or flap repair. The data was subjected to statistical analysis using the SPSS-25.0 software.

RESULTS

In the present study, a total of 51 patients (85%) were identified as males, while 9 patients (15%) were classified as females. Most of the patients 28(46.67%) were belong to 40-50 years of age followed by 30-40 years 16(26.67%), below 30 years 8(13.33%), above 60 years 5(8.33%) and 3(5%). Mean age were 47.85±5.95years. All individuals in the study had experienced an acute traumatic event resulting in non-healing open wounds in their upper and lower extremities. The study revealed that road traffic accidents were the most prevalent cause of injury, accounting for 40 cases (66.67%) among the patients. Machinery injuries were the second most common cause, observed in 15 cases (25%), while falls from height were reported in 5 cases (8.33%). The most frequently observed co-morbid condition in relation to non-healing infected wounds was hypertension, which was present in 17 cases (28.33%). Additionally, diabetes mellitus was identified in 12 cases (20%), while heart disease was found in a smaller proportion of patients (3.33%).

The application of vacuum-assisted closure (VAC) involved the use of intermittent suction at regular intervals of one and a half hours. A vacuum pressure exceeding 150 mm of Hg was administered to the majority of patients, specifically 45 individuals (75%). In 5 patients (8.33%), the pressure ranged between 100 and 150 mm of Hg, while in 10 patients (16.67%), the pressure did not exceed 100 mm of Hg [Table 2].

The frequency of VAC changes was determined by the presence of infection or slough in the wound, as well as the initial response to VAC therapy. Changes were typically made every second or third day. On average, patients required approximately 15 days of Vacuum-Assisted Closure (VAC) therapy, with a range of 3 to 15 applications. The VAC therapy elicited a positive response from all of the wounds. The assessment of wound healing encompassed the examination of microbial eradication, the development of granulation tissue, and the decrease in wound dimensions, as indicated in [Table 3]. [Table 4] illustrates that wound healing outcomes were deemed excellent in 40 patients, accounting for 66.67% of the total, while 20 patients, constituting 33.33%, exhibited good wound healing.

Table 1: Basic parameter of the patients

Gender	Number of patients	Percentage
Male	51	85
Female	9	15
Age		
below 30	8	13.33
30-40	16	26.67
40-50	28	46.67
50-60	3	5
Above 60	5	8.33
Mean age	47.85±5.95	
Co morbidity		
Hypertension	17	28.33
Diabetic	12	20
heart problem	2	3.33
Others	2	3.33
Road traffic accident	40	66.67
Machinery injury	15	25
Fall from height	5	8.33

Table 2: VAC pressure applied

VAC pressure	Number of patients	Percentage
Upto 100 mm of Hg	10	16.67
100-150 mm of Hg	5	8.33
>150 mm of Hg	45	75

Table 3: VAC therapy

VAC therapy	Number of patients	Percentage
No. of VAC dressings used		
Below 4	25	41.67
5-6	35	58.33
No. of surgical debridement		
2	40	66.67
3	20	33.33
Time to complete microbial clearance (days)		
below 10 days	32	53.33
10-15 days	28	46.67
Surgical procedures		
Healing by secondary intention	31	51.67
Secondary suturing	29	48.33

Table 4: Wound healing

Wound healing	Number of patients	Percentage
Excellent	40	66.67
Good	20	33.33
Poor	0	0

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DISCUSSION

In the field of orthopaedics, the occurrence of surgical site infection following implant surgery is a significant concern that poses detrimental consequences for both the patient and the surgeon involved. Consequently, this phenomenon contributes to an extended duration of hospitalization, heightened reliance on antibiotics, repeated instances of debridement, protracted rehabilitation, and potentially leads to adverse health outcomes and fatalities. The utilization of negative pressure wound dressing was initially introduced as a means of managing sub-acute and chronic wounds. Due to the highly promising outcomes, the utilization of this approach in wound management experienced a rapid surge. Currently, Vacuum-Assisted Closure (VAC) therapy is widely employed for the treatment of various types of wounds.[10]

Vacuum-assisted closure (VAC) therapy, a treatment modality historically employed for addressing superficial tissue loss such as burns and pressure injuries, has recently demonstrated expanded applications in cases of significant soft tissue loss. These include instances associated with orthopedic infections, diabetic foot conditions, and tumor surgeries. The management of injuries necessitating prolonged antibiotic therapy and specialized procedures like free tissue transplantation is a complex undertaking. The utilization of Vacuum-Assisted Closure (VAC) therapy creates a hermetic environment that accelerates the process of granulation, diminishes edema, mitigates bacterial colonization, and alleviates wound-related pain.[11-14]

There exists a suggestion that the achievement of successful healing is associated with a quantity of organisms per gram of tissue that is below the threshold of 10. Typically, the numerical outcome associated with wound VAC therapy tends to be below ten.[15]

The present study involved a cohort of 60 individuals with open wounds who received treatment using Negative Pressure Wound Therapy (NPWT). All participants were monitored until their discharge from the healthcare facility. The findings in the present study were compared to those reported by Burkhard Lehner et al,[16] Jens Klen et al,[17] and Hyun Joo Lee et al.[18] The study conducted by Burkhard Lehnar et al,[16] reported that the average number of dressings used was 3.5, with a range of 1 to 8 dressings. Additionally, the average duration of treatment with VAC dressing was found to be 16.3 days, ranging from 9 to 46 days. The mean length of hospital stay was 39.5 days, with a range of 12 to 97 days. The size of the wound in this study exhibits a close resemblance to the study conducted by Hyun Joo Lee et al.[18] In their study, the initial wound size before the application of VAC therapy was measured to be 56.4 cm2. However, after the completion of the treatment, the wound size was reduced to 42.9 cm2.

The functional outcomes observed in this study were found to be similar to those reported in the aforementioned studies. Specifically, 64% of patients achieved excellent results, 36% achieved good results, and no poor results were observed in 5% of patients. Chronic wounds are a significant contributing factor to the hospitalization of patients in surgical departments, leading to substantial costs associated with their management, resource utilization, and workforce allocation. The utilization of Vacuum Assisted Closure (VAC) therapy has demonstrated a significant reduction in both the duration and financial burden associated with hospital stays, nearly halving these metrics. Empirical evidence demonstrates that it exhibits superiority in terms of both healing time and wound bed preparation duration when compared to traditional wound care methods.[19] The utilization of this intervention effectively mitigates the occurrence of frequent pain experienced by patients during the frequent alteration of dressings for large wounds.[20]

The VAC technique is associated with various complications, including localized infection, malodor, toxic shock syndrome, and anasarca.[21]

Several contemporary therapeutic approaches have been proposed for the treatment of chronic wounds, encompassing ultrasound, laser therapy, electrical stimulation, and electromagnetic waves. Electrotherapy is a therapeutic approach that involves the electrical stimulation of wound cells using electrodes or pulsed magnetic fields in order to promote healing. However, it has been observed that electromagnetic waves do not effectively reduce wound size, and the treatment cost associated with this method is high. Additionally, there is insufficient evidence to support the use of low level laser therapy for wound healing. Consequently, vacuum-assisted closure (VAC) therapy has emerged as the most cost-effective and efficient treatment option for non-healing wounds that do not respond to conventional wound care methods.[22]

CONCLUSION

Vacuum-assisted wound closure offers several advantages, including expedited healing, straightforward application, enhanced safety, and cost-effectiveness. The utilization of negative pressure wound treatment may potentially result in decreased rates of graft loss. The implementation of frequent changes in VAC (vacuum-assisted closure) and the adoption of a brief treatment regimen have been found to positively influence patient compliance.

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