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Research Article

Efficacy of Modified Vaccum Assisted Dressing in Wound Healing Of Open Injuries

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Abstract

Aim: To assess the efficacy of modified vacuum assisted dressings as compared to conventional betadine wound dressings in improving the healing process in open injuries and to prove that modified vacuum assisted dressings can be used as a much better treatment option in the management of open injuries.

Material and Methods: This was prospective non-randomized comparative study where data from 60 patients with open injuries, of which 30 patients were included in each group. The results were compared based on average reduction of the wound size and average duration for formation of healthy granulation tissue. The variables were compared using Mann Whitney U test and independent t test**,** P value was <0.05 and was considered significant.

Results: Among 30 patients treated with modified vacuum assisted dressings the mean reduction in size of the wound overall is 15.06 mm and overall time for appearance of healthy granulation tissue is 7.7 days. 25 patients required flap as a definitive closure procedure whereas in 20 patients wound was closed by split skin grafting and 5 wounds was contracted with treatment on comparison with 30 patients treated with conventional betadine dressings the mean reduction in size of the wound overall is 7.7 mm and overall time for appearance of healthy granulation tissue is 18.8 days. 4 patients required flap as a definitive closure procedure whereas in 18 patients wound was closed by split skin grafting and 8 wounds was contracted with conventional betadine dressing's treatment without requiring a secondary procedure. There is significant decrease in reduction in size of wound and average duration.

Keywords: modified vacuum assisted dressings; healthy granulation tissue; t test**;** P value

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 localized edema and increasing blood flow. This in turn decreases tissue bacterial levels. Despite the significant costs involved, the technique is said to compare favorably in financial terms with conventional treatments in the management of difficult wounds [1].

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 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 48-hour interval [2, 3].

Wound progress is recorded using parameters in the wound scoring system. The objectivity of assessments used to generate the wound score make this scoring system ideal for evaluating treatment and outcome of wounds. To evaluate efficacy of the modified method of vacuum dressing in wound healing in low resource settings.

Materials and Methods

Study Design: Prospective non-randomized study.

Study Size: 60 Cases.

Study Period: July 2018 to July 2020.

Patients were part of the study as per the inclusion and exclusion criteria.

Inclusion criteria:

1. Patients with Open Injuries, where primary closure is not possible and requires surgical debridement.

Exclusion criteria:

1. Pathological fractures with untreated osteomyelitis.
2. Presence of a thick, necrotic eschar in wound.
3. Patients with hemophilia or haemoglobinopathies.
4. Open Injuries that could be closed in initial surgery
5. Wounds of large surface area (area more than 30% body surface area)
6. Malignancy in wound, Diabetic ulcer

Age and Sex Distribution:

Thirty patients who were treated with VAC therapy were between 8 years to 55 years. Among the thirty patients, twenty-five were male and five were female. Thirty patients who were treated with conventional betadine dressings were between 7 years to 66 years. Among the thirty patients, twenty-three were male and seven were female.

Assessment of Wound and Investigations done before starting VAC treatment:

Patients were evaluated with following investigations and wounds were assessed with following parameters-

1. Hemoglobin %
2. Total and differential WBC count
3. E.S.R.
4. Blood grouping and typing
5. Blood urea, Serum creatinine, Random blood sugar
6. Plain radiographs of fractures
7. Size of wound
8. Area of the bone exposed
9. Area of tendons exposed
10. CRP

Protocol before applying VAC:

Initially the wound is thoroughly debrided and all the devitalized tissue and foreign materials like mud etc. are removed and through wound wash is given. Antibiotics are given as soon as the patient is received in the emergency ward. Initially broad-spectrum antibiotics are given and later specific antibiotics are given according to sensitivity profile.

Protocol after each dressing:

1. Pus culture/sensitivity
2. Size of the wound
3. Area of bone exposed
4. Area of tendons exposed
5. Amount of drain collection
6. Duration taken to get healthy granulation bed
7. Skin covering procedures (needed or not)
8. ESR
9. CRP

Materials Used:

The application of topical negative pressure moist dressings needs the following materials. They include

1. Gel foam
2. Vacuum suction apparatus
3. Transparent semi permeable adhesive membrane sheet
4. Drain tube
5.

The materials used are shown below:

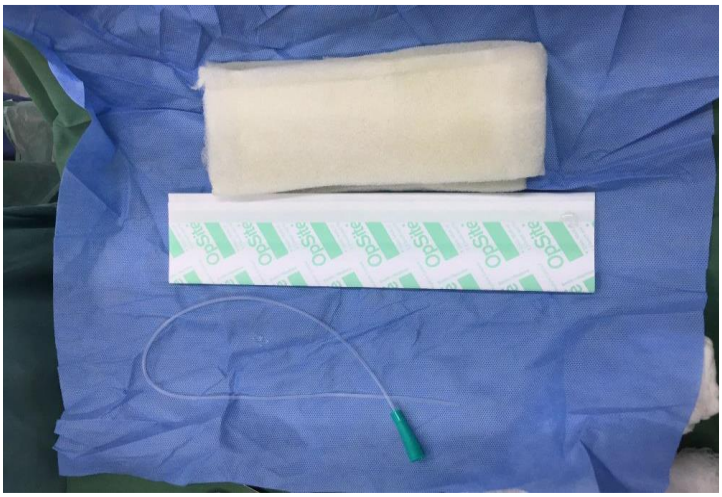

Figure 1: *Gel foam, sterile occlusive dressing, and Suction catheter.*

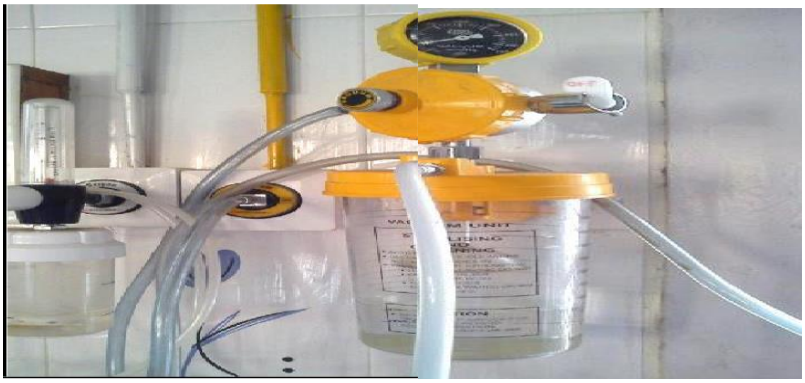

Figure 2: *Central suction unit*

Figure 3: *Vaccum suction drain*

Application of VAC

The topical negative pressure wound dressing is a combination of composite synthetic hydrocolloid sheet dressing with vacuum assisted wound closure systems. The technique involves six steps. These are

1. The wound is thoroughly debrided, and devitalized tissue removed. A perforated drain tube is placed on top of the wound bed and other end is brought out subcutaneously a little away from main wound [Figure 4].

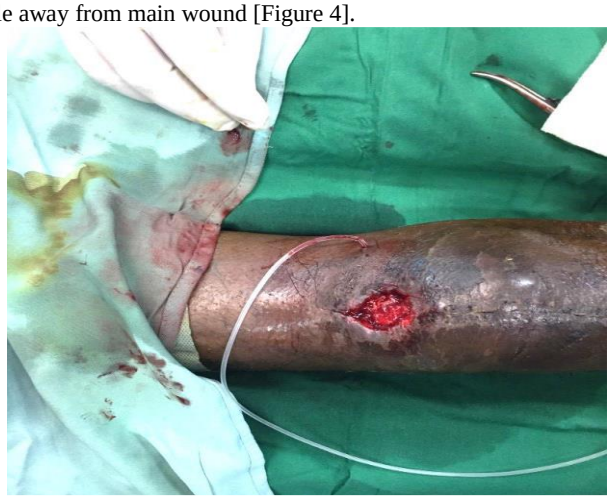

Figure 4: *Debridement and application of drain tube.*

2. The foam dressing is cut to size of the wound and applied over the drain tube [Figure 5].

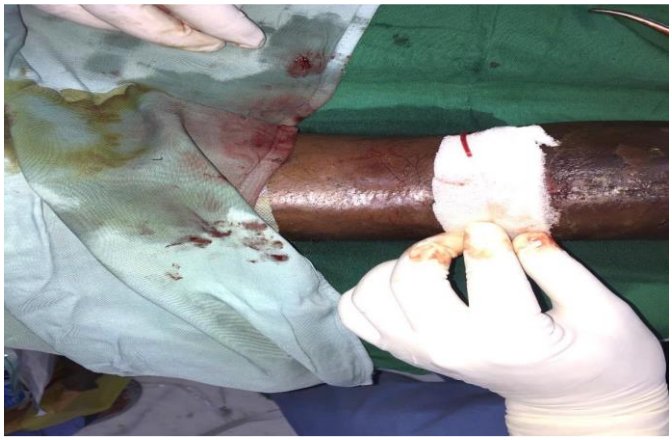

Figure 5: *Application of gel foam*

3. The foam with the surrounding normal skin is covered with adhesive, semipermeable, transparent membrane. A good air seal must be ensured around the wound [Figure 6].

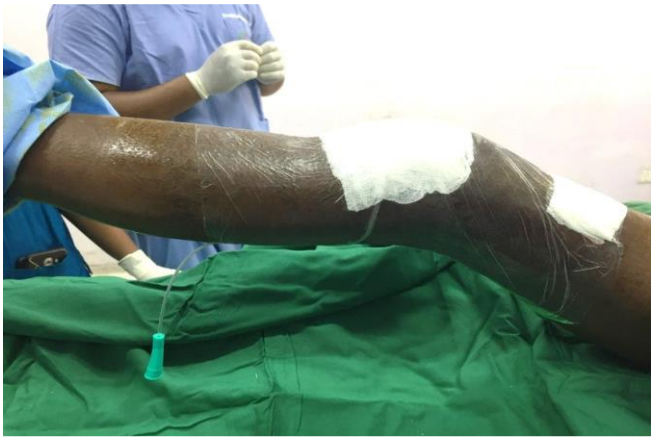

Figure 6: *Application of sterile semipermeable transparent adhesive membrane dressing.*

4. Distal end of the drain tube is now connected to a device which provides a negative pressure suction in the range of –25 to –200 mm of Hg. This can be achieved by wall suction apparatus, simple suction drain devices. Suction may be applied continuously or intermittently based on amount of wound discharge. Conventional VAC dressings use a computerized VAC device but, in our study, we modify the conventional technique by using cost - effective wall suction apparatus or a simple suction drain device [Figure 7].

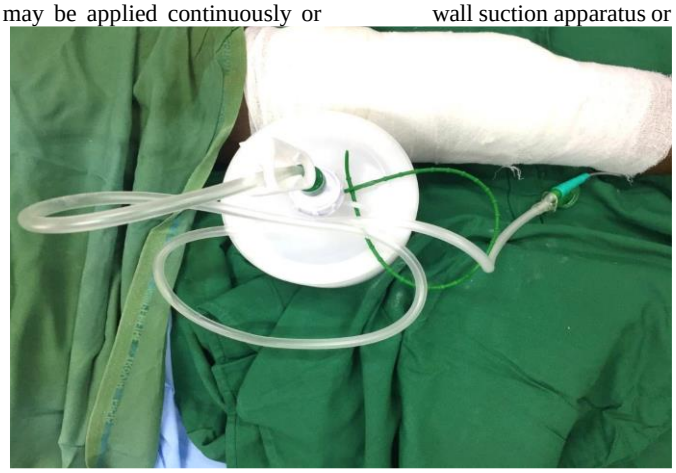

Figure 7: *Connection to simple vacuum suction drain device.*

5. Once vacuum is applied, the foam must be seen collapsed into the wound bed.
6. The fluid from the wound is absorbed by the foam and is removed from the wound bed by suction. The negative pressure must be maintained for an average of 10-14 days for maximum benefit as studies have proved. Once adequate granulation tissue is formed the dressing should be removed and definitive

wound closure is achieved by partial or full thickness grafts, flaps, or suturing.

Statistical Analysis:

Data was analyzed using SPSS 22 version software. Mann Whitney U test was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation. Independent t test was used as test of significance to identify the mean difference between two quantitative variables, respectively. p value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

Results

The 60 patients admitted for the study were divided into two equal and comparable groups. Patients subjected to topical vacuum assisted dressings were classified under Group I and those who underwent conventional betadine dressings were classified as Group II. The patient's characteristics of the two groups were well matched as given in the tables below.

The age wise distribution of the patients in this study was that the mean age of the group I was 31.37 years, the age group 20- 40 dominated the series accounting for 73% among the cases. Mean age of the group II was 34.20 years, the age group 20-40 dominated the series accounting for 67% among the cases.

Our study includes 30 patients treated with modified VAC therapy of which 25 patients were males (83%) and 5 female patients (17%), 30 patients were treated with conventional betadine dressings of which 23 patients were males (77%) and 7 female patients (23%).

Our study includes 30 patients treated with modified VAC therapy of which 13 patients were smokers (43%) and 17 nonsmoker's patients (57%), 30 patients treated with conventional betadine dressings of which 11 patients were smokers (63%) and 19 nonsmokers patients (37%).

Our study includes 30 patients treated with modified VAC therapy of which 10 patients were diabetic (33%) and 20 nondiabetic patients (67%), 30 patients treated with conventional betadine dressings of which 7 patients were diabetic (23%) and 23 non diabetic patients (77%).

The mode of injury wise distribution of the patients in our study was that RTA (Road traffic accidents) dominated the series accounting for 90% among the cases in Group I and for 87% the cases among Group II. In 30 patients, location of open injuries was 56% in leg, 27 % in foot and 17% of wounds were with forearm treated with VAC dressings. In 30 patients, location of open injuries was 64% in leg, 23% in foot and 13% of wounds were with forearm treated with conventional betadine dressings.

5 patients required flap as a definitive closure procedure whereas in 21 patients wound was closed by split skin grafting. 4 wounds were contracted with VAC treatment without requiring a secondary procedure. 4 patients required flap as a definitive closure procedure whereas in 18 patients wound was closed by split skin grafting. 8 wounds were contracted with conventional betadine dressing's treatment without requiring a secondary procedure.

Our study shows for 50% among the cases in Group I and for 53 % the cases among Group II were infected.

Distribution of cases based on Initial wound score:

Open wound score (Journal of Orthopedic surgery and research 2009 4:14)
Score 0: Skin and soft tissue intact
Score 1: Defect in the skin is present
Score 2: One of the following in the wound bed, a-Bone, b- Tendon, or c-implant
Score 3: A combination of any two of the above are exposed.
Score 4: Presence of deep infection

Distribution of cases based on Reduction in size of wound

Our study shows Patients with initial wound score 2 showed average reduction of 15.25 mm with and patients with initial wound score 3 showed average reduction of 15.66 mm and patients with initial wound score 4 showed average reduction of 13.25 mm at the end of VAC treatment. The mean reduction in size of the wound overall is 15.06mm on comparison with patients with initial wound score 2 showed average reduction of 7.95 mm with and patients with initial wound score 3 showed average reduction of 7.2 mm and patients with initial wound score 4 showed average reduction of 6.66 mm at the end of conventional betadine dressings treatment. The mean reduction in size of the wound overall is 7.7mm.

Distribution of cases based on average time for formation of healthy granulation tissue:

Our study shows Patients with initial wound score 2 showed time taken for appearance of healthy granulation tissue by average of 9.5 days and patients with initial wound score 3 showed time taken for appearance of healthy granulation tissue by average of 10.83 days and patients with initial wound score 4 showed time taken for appearance of healthy granulation tissue by average of 10 days and at the end of VAC treatment with appearance of healthy granulation tissue by mean 9.83 days on comparison with Patients with initial wound score 2 showed time taken for appearance of healthy granulation tissue by average of 18.6 days and patients with initial wound score 3 showed time taken for appearance of healthy granulation tissue by average of 19.4 days and patients with initial wound score 4 showed time taken for appearance of healthy granulation tissue by average of 19.6 days and at the end of conventional betadine dressings treatment with appearance of healthy granulation tissue by mean days.

Discussion

The use of negative pressure wound therapy in the form of vacuum-assisted closure has been established as a promising method in the field of wound healing in a variety of wounds including those that are difficult to heal [4,5]. There are two main factors considered to be responsible for the dramatic response seen in these wounds: removal of fluid and mechanical deformation [6]. Removal of fluid decreases edema which decreases the interstitial pressure resulting in increased blood flow. Mechanical deformation causes a wide variety of molecular responses, including changes in ion concentration, permeability of cell membrane, release of second messengers, and stimulation of molecular pathways increasing the mitotic rate of stretched cells.

Recently, Scherer et al. have concluded that vascular response is related to the polyurethane foam, whereas tissue strain induced by vacuum assisted closure device stimulated cell proliferation [7].

Duration for change of Dressing:

DeFranzo et al. advocated the changing at 2 days interval, while Banwell et al. recommend 4-5 days [8,9]. Singh SH et al. advocated change at 3-5 days interval. In our study, VAC dressing was changed every 3 days.

Rate of Infection:

Stannard et al, studied the impact of NPWT on severely contaminated open fractures and observed significant difference between the 16 groups for total infections [10]. With regular saline dressing, Henley et al, [11] reported 34.7% of infection. Charalambous et al, [12] reported 27% and, Gopal et al [13] reported 27.4% of infection. Comparatively our study showed overall 12.5% of infection.

Time for healthy granulation tissue formation and final reduction in wound size:

Our study showed a mean reduction in size of the wound by 15.06 mm after VAC therapy. Study by Kushagra Sinha et al. [14] showed a decrease in size of 1 to 4.9mm in 26.66% of patients in VAC group whereas 93.33% in control group from day 0 to day 8. A decrease in size of 10 to 19.9mm was seen in 46.66%of patients of VAC group and only 6.66% in control group. A decrease in size of more than 25mm was seen in 13.33% in VAC group. Similar studies were conducted by Argenta et al., Morykwas et al & Joseph et al [15] & these studies showed that VAC proved effective in shrinking of the diameter of the wound size and formation of healthy granulation tissue when compared to normal saline dressing methods. Russel et al [16] advocates that primary wound closure should be avoided in treatment of open Tibia fractures, whereas Veliskakis [17] described primary internal fixation and primary wound closure gives good results. Presently there is a tendency towards radical debridement immediate fracture stabilization and immediate definitive coverage [18-21].

There are several advantages of applying a Primary VAC to an open injury and these include,

1. Protects the wound from external environment and further bacterial contamination.
2. Absorbs the exudate from the wound and decreases local edema.
3. Prevents loss of fluid from the wound and thus provides a moist environment at the wound which favors collagen synthesis and epithelial proliferation.
4. Increases the local blood flow to the wound.
5. It decreases the bacterial load of the wound and thus wound infection.
6. Maintains an acidic pH and low oxygen tension on the wound which promotes granulation tissue formation and angiogenesis.
7. Induces mechanical stretch on the cell cytoskeleton leading to the release of cytokines associated with wound healing.
8. VAC also reduce wound size, accelerates granulation tissue formation, and lower the coverage complexity down the „reconstructive ladder" when applied as a temporary dressing to acute open fractures.

Hence VAC can be applied after each debridement and irrigation until the wound is fit for a reconstructive procedure such as SSG or flap cover. VAC can be applied in a continuous or cyclical manner. The observation that intermittent cyclical treatment appears more effective than continuous therapy is interesting although the reasons for this are not fully understood. Two explanations were proposed by Philbeck et al. They suggested that intermittent cycling results in rhythmic perfusion of the tissue which is maintained because the process of capillary auto regulation is not activated. They also suggested that as cells which are undergoing mitosis must go through a cycle of rest, cellular component production and division, constant stimulation may cause the cells to „ignore" the stimulus and thus become ineffective. Intermittent stimulation allows the cells time to rest and prepare for the next cycle. For this reason, it is suggested that cyclical negative pressure should be used clinically.

The daily rental charges for a conventional VAC machine and consumables are significant. This has discouraged many from using the system. However, there have been some reports showing that the increased healing times and downgrading of required operations correlate to decreased overall costs of care. The dressing should also enable larger wounds to be treated in the community with minimal nursing care impact. Our study uses modified VAC dressing and decreases the overall cost on comparison with conventional VAC dressing. This would free up hospital beds permitting faster healing of operative patients and preventing waiting list buildup. VAC therapy is not the answer for all wounds; however, it can make a significant difference in many cases.

Limitations of the study:

1. The number of patients in this study was relatively small. Considering that open injuries is a common injury, a study with larger number of patients should be undertaken.
2. The study is not randomized.
3. Effect of VAC treated wounds in fracture union is not studied.
4. The quantitative assessment of the postoperative parameters like wound contraction, pain and residual raw ulcer area was also not included in the present study, which if included, might have given a much better analysis of the efficacy of VAC dressings as compared to conventional dressings.

Conclusion

Modified Vacuum assisted closure therapy appears to be a viable adjunct for the treatment of open musculoskeletal injuries. Application of sub atmospheric pressure after the initial debridement to the wounds results in an increase in local functional blood perfusion, an accelerated rate of granulation tissue formation, and decrease in tissue bacterial levels. Although traditional soft tissue reconstruction may still be required to obtain adequate coverage, the use of this device decreases their need overall.

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