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Original research article

Functional outcome of vacuum assisted closure (VAC) dressing therapy for the management of traumatic wounds and non-healing wounds

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Abstract

Wound healing is a complex and dynamic process that includes an intricate sequence of cell migration leading to repair and closure. When wound fails to undergo this sequence of events, a chronic open wound is formed without anatomical or functional integrity. Negative pressure wound therapy (NPWT) has had a major impact in the management in orthopedic injuries.

This is a Prospective study of 32 patients with Gustilo Anderson type 2, 3a, 3b open fractures. Inspection of wound site was done at the start of the therapy and then again at the end of NPWT and serial measurement of the VAC drain done. Out of 32 wounds taken in the study, 25 showed development of adequate granulation tissue with 20 wounds that reduced in area and were resurfaced with split thickness skin grafting and 5 wounds showed reduction in area and were subjected to secondary closure. The remaining 5 wounds were subjected to second round of NPWT. During start of vaccum assisted closure (VAC) dressing therapy, all wounds were infected confirmed with pus cultures. At the end of VAC dressing, all wounds became microbial swab negative. Our study shows that Vacuum assisted closure therapy has good functional outcome for patients with compound fractures and post-operative infective wounds.

Keywords: Vacuum assisted closure (Vac) dressing therapy, traumatic wounds, non healing wounds

Introduction

Open fractures need good coordinated management of both bones and soft tissue injury to achieve good healing and to avoid infection. Blood supply of bone is derived from the nutrient vessels to the bones and also from surrounding muscles and soft tissue structures.

A useful treatment option in all injuries where soft tissue cover is not immediately possible is Vacuum-Assisted Wound Closure (VAC) using Negative Pressure Wound Therapy (NPWT). NPWT has largely replaced wet dressing therapy in most centres that treat a large number of open injuries. It has been developed as an alternative to the standard forms of wound management and it incorporates the use of negative pressure to optimize conditions for wound healing.

It can be used for the early management of acute trauma or when other more conventional conservative methods have failed [1].

Earlier the soft tissue injuries were managed by conventional methods like regular wound debridement, saline dressing, dry dressing etc.

The aim of this prospective study is to know the rate of wound infection, number of days required for making the wound fit for skin cover procedures, number of days required for formation of uniform granulation tissue bed in the wound, number of days of hospital stay and healing of soft tissue injury.

In 1997, Morykwas *et al*. performed a series of animal experiments, to identify the optimal negative suction pressure needed to achieve the best wound healing. Negative pressure was applied in two forms; continuous and intermittent. The results revealed that there is four times increase in the blood flow when using VAC with a negative pressure of 125 mmHg compared to the baseline technique of simple wound closure [2].

The mechanism of VAC therapy is very simple. An open-cell structured foam is cut according to size

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and shape of the wound and then it is kept on the wound bed, a suction drain with perforations only in the end of the tube is laid on the foam. Then the entire wound is then sealed with an opsite or a transparent membrane which is adhesive then the other end of the suction tube is connected to a vacuum machine, once the wound is sealed and the machine is switched on the fluid from the wound is drawn through the foam into a canister which can be disposed subsequently. By this the edema from the wound is removed, new blood vessels are formed (Angiogenesis) & hence leads to formation of healthy granulation bed & all this leads to earlier skin cover procedures of the wounds [3, 4].

The negative pressure is created by commercially available vacuum pumps which allow regulation of the magnitude and duration of the negative pressure. In animal models, ithas been shown that a pressure of –125 mm Hg, applied for 5 minutes at intervals of 7 minutes, has the most beneficial effect on the formation of granulation tissue and it increases the blood flow in the surrounding tissues by almost fourfold [1].

Beneficial effects of Negative pressure wound therapy (NPWT) include promotion of wound contraction and increases the chance of delayed primary closure. NPWT removes excess edematous fluid, proteins and electrolytes that are harmful for wound healing. Causes reactive increase in blood flow and decreases bacterial burden, cellular micro deformation and favorable electrical fields to promote wound healing.[1]

The advantages of negative pressure wound therapy are that it is relatively easy to use, has minimal side effects and is associated with relatively short therapy and decreased length of hospital stay.

The aim of present study is to evaluate efficacy of NPWT therapy in all compound fractures and post-surgical infected wounds. The indirect effects of VAC therapy are reduced morbidity, earlier return to work & cost effectiveness

Methodology

Source of data: All Patients are of above 18 years of age of both sexes include in this study and classified according to the grade of ulcer/wound (Wagner classification) all grades will be included except 0, and according to gustilo and Anderson type 2 and type 3a, 3b, Tscherne classification for soft tissue injuries for closed/open fractures at department of Orthopaedics.

Method of collection of data (including sampling procedures if any): This was a hospital based observational study, where patients meeting the research criteria will be recruited for the study and followed up.

Inclusion criteria

1. Age more than 18years
2. Wounds with exposed bone and tendons
3. Traumatic wounds
4. Wound with crust and debris
5. Non healing ulcers
6. Patient giving consent for NPWT (negative pressure wound therapy).

Exclusion criteria

1. Age less than 18 years
2. Ulcers over the extremities with peripheral vascular disease.
3. Fistula to organs or body cavities
4. Untreated osteomyelitis
5. Wound with exposed blood vessels or organs
6. Malignancy in wound
7. Patients with hemorrhagic disorders
8. Allergies to adhesive drape
9. Patients on anti-coagulants or platelet aggregation inhibitors

Sample size: 32

The Application of Negative Pressure: Controlled pressure is uniformly applied to all tissues on the inner surface of the wound. The foam dressing should compress in response to the negative pressure. The pump can deliver either continuous or intermittent pressures, ranging from 50 to 125 mmHg (adjustable up to 200 mmHg). Intermittent delivery consists of a seven-minute cycle of two minutes off and five minutes on, while the negative pressure is maintained. The ideal pressure setting is 125mmHg, but particularly painful chronic wounds such as chronic leg ulcers are usually managed with lower therapeutic pressures of 50 to 75 mmHg. Higher pressures of 150 mmHg plus are used for large cavity wounds such as acute traumatic wounds, as they produce copious amounts of exudate. The pressure is set to continuous for the first 48 hours and the pressure is changed as required thereafter.

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Results

Table 1: Site of injury

Site of injury	Right	Left	No. of cases	Percentage
Forearm	1	1	2	6.3
Around hip	0	1	1	3.1
Thigh	1	5	6	18.8
Knee	1	0	1	3.1
Leg	4	9	13	40.6
Ankle	1	0	1	3.1
Foot	4	4	8	25.0
Total	12	20	32	100

Mean = 10.84 DAYS
Standard deviation = 4.57 days
Median = 10 days
Range = 1 – 21 days

Table 2: Duration of NPWT

Duration of NPWT dressing	No. Of cases	Percentage
1-5	2	6.25
6-10	18	56.25
11-15	9	28.125
16-20	0	0
21-25	3	9.375
Total	32	100

Table 3: Number of NPWT dressings

Number of NPWT dressings	No. Of cases	Percentage
1	6	18.75
2-3	25	78.125
≥4	1	3.125
Total	32	100

Table 4: Size of wound- before and after NPWT

Size of the wound	Before NPWT (no. Of cases)	After NPWT (no. of cases)
1-5	0 (0%)	11 (34.3%)
6-10	8 (25%)	17 (53.12%)
11-15	18 (56.2%)	4 (12.5%)
16-20	4 (12.5%)	0
21-25	2 (6.25%)	0
Total	32	32

Table 5: Statistical analysis of wound size- before and after NPWT

Size of the wound	Mean (cm)	STD. Deviation (cm)	Median (cm)	Range (cm)	Student T Test (p value)
Before NPWT	13.18	4.14	13.5	7-25	<0.0001 (Highly significant)
After NPWT	7.31	2.86	7	3-15	

Table 6: Requirement of secondary procedures

Secondary procedures	No. Of cases	Percentage
Split skin grafting	26	81.25
Flap cover	6	18.75
Total	32	100

Mean = 24.5 days
Standard deviation = 9.32 days
Median = 23 days
Range = 7-46 days

Discussion

In this study 32 cases were analyzed for average no. of dressing change which is 2.15 with least of 1 dressing needed and maximum of 4 dressing. In another series by Hyun Joo Lee *et al.* [5] mean dressings was 4.5 which is comparable to our study. In a study by Piyushi *et al.* (2018) [6] there were 25 patients mean no. of dressing were 8.In study conducted by N Shaheed *et al.* (2012) [7] there were 16 patients, mean no. of dressings were 5.5.In studies done by Burkhard *et al.* [8] there were 32 cases and their mean no. of dressing were 3.5.

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In this study intermittent pressure of 100-125 mm Hg was applied different for each case. In a study by Piyushi *et al*. (2018) [6] intermittent pressure around 100-125mmhg was applied differing with each case. In study conducted by N Shaheed *et al*. (2012) [7] intermittent pressure between 100-125 mmhg was applied. In a series by Burkhard *et al*. (2010) [8], intermittent pressure of 125-200mm Hg with a mean of 138.3mm Hg was applied.

In our study the mean duration of stay in the hospital was 24.5 days with a minimum of 7 days and maximum of 46 days which is comparable to the study by Nandakishore *et al*. (2015) [9] where mean hospital stay was 26 days with maximum of 38 days and minimum of 18 days. In study by Burkhard *et al*. (2010) [8] where mean hospital stay was 39.5 days ranging from 12-97 days. In study by Piyush *et al*. (2018) [6] mean hospital stay was 24 days.

This series mean duration of treatment with NPWT dressings was 10.84 days with a minimum of 5 days and maximum of 21 days. This study is comparable to series by Jens Klem *et al*. (2009) [10] where the mean duration of treatment was 9 days ranging from 4-12 days. In a study by Burkhard *et al*. (2010) [8] mean duration of treatment with VAC dressing was 16.3 days ranging from 9-46 days. In a study by N Shaheed *et al*. [7] mean duration of therapy was 15.62 days ranging from 7 to 28 days.

This study, mean wound size was 13.18 cm2 before the application of NPWT dressing which reduced to a mean of 7.31 cm^2 at the completion of NPWT with average reduction in wound size by 44.5% which is comparable to a study by N Shaheed *et al*. [7] where average wound size reduction of 26.69% and mean wound size was 43.3cm2 reduced to 31.75 cm2. In series by Hyun Joo Lee *et al*. (2009) [5] were the mean wound size prior to NPWT was 56.4cm2 which was reduced to 42.9 cm^2 at the completion of treatment.

In my study, 26 cases out of 22 cases underwent SSG and 6 cases needed flap cover. All the cases (100%) needed split skin grafting or flap coverage. In study by Piyushi, *et al*. (2018) [6] 12 cases required secondary suturing and 10 cases required split skin grafting and 3 cases required flap cover. In study by N Shaheed *et al*. (2012) cases were closed by secondary suturing and 4 cases by split skin grafting. In study by Nandakishore *et al*. (2015) [9] 19 cases were closed by secondary suturing and 8 cases by split skin grafting and 5 cases by flap cover and 2 cases required none [7].

Conclusion

Our study shows that Vacuum assisted closure therapy has good functional outcome for patients with compound fractures and post-operative infective wounds.

VAC has been proven to be cost-effective in the setting of an Indian tertiary care hospital.

It requires less number of dressing changes improving patient comfort and compliance.

VAC resulted in better and faster healing after secondary procedures, such as skin grafting and flap coverage, thus promoting early rehabilitation and improving patient quality of life.

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