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Original Research Article

Negative pressure wound therapy in surgical wounds: a prospective comparative study

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ABSTRACT

Background: The goal of treating any type of wound is to promote healing in a timely fashion. Wound healing is most successful in moist, clean and warm environment. One of the most significant discoveries in wound management is the improvement of wounds with negative pressure wound therapy (NPWT). NPWT entails applying topical negative pressure to a wound. In this study, the efficacy of topical negative pressure dressing was assessed in comparison with a control group using conventional moist wound dressings in wound healing.
Methods: This is a prospective comparative study conducted on 50 patients with acute, sub-acute and chronic open wounds of various aetiologies. The patients were divided into two groups each group comprising of 25 patients. One group received negative pressure wound dressing while the other group received conventional saline moistened gauze dressing. Wounds were assessed depending on wound size, appearance of granulation tissue, wound bed score, reduction in wound size along with the time taken for wound closure. Statistical analysis was done using unpaired T-test and paired T-test. A p value of <0.05 was taken as significant.
Results: Present study showed that there was a statistically significant decrease in the wound size in study group, early appearance of granulation tissue, significant increase in the wound score and faster rate of wound closure compared to the control group.
Conclusions: Negative pressure wound therapy can be considered as a superior option in the management of open wounds.

Keywords: Negative pressure wound dressing, Wound healing, Wound bed score

INTRODUCTION

Wound dressings evolved very little for many years until 1867, when Lister introduced antiseptic dressings by soaking lint and gauze in carbolic acid. Since then, numerous more sophisticated products have become available. Wound healing is most successful in moist, clean and warm environment.

Studies have demonstrated that the rate of epithelialization under a moist occlusive dressing is twice that of a wound that is left uncovered and allowed to dry. An occlusive dressing provides a mildly acidic pH and low oxygen tension on the wound surface which is conducive for fibroblast proliferation and formation of granulation tissue.

However, wounds that produce significant amounts of exudate or have high bacterial counts require a dressing that is absorptive and prevents maceration of the surrounding skin.[1,2] These dressings also need to reduce the bacterial load while absorbing the exudate produced. One of the most significant discoveries in wound management in recent decades is the improvement in wounds with negative pressure wound therapy. This modality has many uses and has found its way into the

armamentarium of a wide array of surgical and non-surgical specialties. It should best be thought as an adjunct to assist in surgical closure of a problem wound.

In 1997, Dr. Louis Argentina and Dr. Michael Morykwas first described applying controlled suction through open cell foam to create an environment conduce to healing and granulation tissue formation.[3]

Negative pressure wound therapy entails applying topical negative pressure to a wound.

Pre-requisites

- Wound is free of necrotic tissue
- Wound is well vascularized.

To avoid the risk of a deeper infection the wound should be completely debrided before application of VAC device.

Common clinical scenarios amenable to NPWT include diabetic wounds, venous stasis wounds, pressure sores, traumatic wounds, abdominal wounds, sternal wounds, lymphatic leaks.

METHODS

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The study was conducted between November 2016 to April 2017. The source of data was patients admitted to the General Surgery Department for the management of wounds. The sample size was 50 cases. The study group consisted of 25 patients who received negative pressure dressing. The control group consisted of 25 patients who received conventional moist dressings.

Inclusion criteria

- Diabetic foot ulcers
- Post infective raw area
- Pressure sores
- Chronic open wounds
- Wound dehiscence
- Acute traumatic wounds
- Venous stasis ulcers.

Exclusion criteria

- Fistulae in organ or body cavity
- Necrotic tissue
- Osteomyelitis
- Malignant wounds
- Charcot's arthropathy
- Patients on medications like corticosteroids, immunosuppressant and chemotherapy agents.

Data was collected by recording details of the onset of the wound, progress of the wound and its characteristics with respect to appearance of granulation tissue and percentage of increase along with demographic details. Prior written and informed consent was taken.

Care was taken so that both the groups had a comparable distribution of patients with regards to age as well as aetiology of the ulcer. The wounds were thoroughly debrided and dimensions and the surface was assessed before the dressing was applied.

The Negative pressure wound therapy is also known as vacuum assisted closure (VAC) therapy. The VAC system is made up of four major components:[4]

- A filler material or a sponge which is placed over the wound
- An adhesive drape to isolate the wound environment and allow the vacuum system to transmit sub atmospheric pressures to the wound surfaces
- A connecting tube
- Fluid connection canister.

Figure 1: Negative pressure therapy applied to wound.

Figure 2: The VAC system.

The most common settings are 50 to 125 mm Hg negative pressure either continuous or intermittent frequency.

All fluid secreted in the wound is aspirated into a waste canister. The canister is changed when it is full. The sponge is changed every 48 to 72 hours

Follow up of the wound was done in all cases and wound assessed depending on wound size, wound bed score, bacterial load and the time of wound closure.

Wound bed score

Wound bed score is a classification system that scores the following parameters

- Healing edges
- Presence of eschar
- Greatest wound depth
- Amount of wound exudate
- Edema
- Peri wound dermatitis
- Peri wound callus and/or fibrosis
- Pink/red wound bed.

Each parameter receives a score from 0 (worst) to 2 (best) and all the parameter scores are added for a total score. Each wound can have a maximum of 16 (best possible score) and a minimum of 0 (the worst possible score).

Dressings were done 1 to 4 days depending on the amount of wound discharge for both groups. Wound characteristics were observed every week. Patients were treated until closure by either direct closure or by secondary closure/ SSG/Flap. Sub atmospheric pressure was applied within a range of -50 mmHg to -125 mmHg. Dressings were changed as and when required.

Control group received twice daily saline moistened gauze dressings. Cultures were taken from the floor of the ulcers to asses for the bacterial flora. Standard antibiotic regimens were administered to all the patients which consisted broad spectrum antibiotics initially and later according to the culture sensitivity report.

Unpaired student's T test and paired T test were used to find out the statistical significance.

RESULTS

The patient's characteristics of the two groups were comparable as elaborated in Table 1

In this study age of the patients ranged between 30 and 75 years. The mean age of the patients in study group was 61.33±7.63years and in control group was 55.40±11.54years. The age distribution was comparable and statistically insignificant in both groups

In study group, 80% were males and 20% were females. In control group 86.67% were males and 13.33% were females.

Table 1: Comparative analysis of demographic details.

Characteristics	Study group	Control group
No. of patients	25	25
Mean age in years	61.33±7.63	55.40±11.54
Sex ratio (male:female)	20:05	21:04
Wound size	30-260 cm^2	24-220 cm^2

The wound size in the study group was 30 -260 cm^2 and in control group was 24-220 cm^2

Table 2: Etiological distribution of ulcers in two groups.

Type of ulcer	Study group	Percentage	Control group	Percentage
Diabetic ulcer	9	36%	8	32%
Post infective raw area	5	20%	5	20%
Posttraumatic raw area	3	12%	2	8%
Venous ulcer	2	8%	3	12%
Surgical site infection	1	4%	2	8%
Pressure sore	2	8%	3	12%
Chronic non-healing ulcer	3	12%	2	8%

Aetiology of the ulcer wise distribution of the two groups were as depicted in Table 2.

In present study, the most common aetiology of the ulcer was found to be Diabetic ulcer which was noted in 36%, followed by post infective raw area noted in 20% of the patients.

Granulation tissue

In the study 48% (12/25) of the patients had developed granulation tissue in the study group during the first week of observation compared to 24% (6/25) of the patients in the control group.

The appearance of granulation tissue was 68%, 88% and 100% in the study group in 2nd, 3rd and 4th week of observation and in the control group it was 40%, 50% and 72% respectively. Two patients ended up in below knee amputation. This was found to be statistically significant.

Figure 3: Wound before application of NPWT.

Figure 4: Wound after application of NPWT.

Wound bed score

The wound bed score in the study group before treatment was 5.52±2.42 and in the control group it was 5.08±1.44 which was statistically insignificant (p value = 0.4382) indicating the comparability of wound bed score.

The wound bed score after the completion of the treatment in study group was 15.12±1.54 and in the control group was 10.20±2.69 (p value<0.05) which was statistically significant.

The difference in the wound bed score was 9.60±2.16 in study group and 5.12±1.99 in the control group. The difference is statistically significant (p value<0.05).

Wound size

The percentage decrease in the wound size was 16±13.04cm² in the study group and 5.98±14.41cm² in the control group.

Bacterial load

There was a steady decline in the bacterial load in the study group compared to the control group.40% of the cultures had no growth by 3rd week compared to 20% in in the control group. The most common organism was found to be *Staphylococcus aureus* in study group and mixed growth in control group.

Wound closure

The study group showed a faster healing rate compared to the control group. 60% of wounds in the study group had wound closure by 4th week and 34% in control group. Two patients underwent below knee amputation in control group. The most common mode of closure was done by STSG.

DISCUSSION

NPWT works through multiple important mechanisms which include:

- Wound shrinking[5]
- Removal of wound fluid rich in deleterious enzymes that inhibit local wound healing (proteases, matrix metalloproteinase 8 and elastases) and inflammatory cytokines.
- Mechanotransduction pathways that result in increased growth factor release, matrix production, and cellular proliferation.[6]

Applying intermittent negative pressure of approximately 125mmHg appears to hasten debridement and formation of granulation tissue.[7]

VAC is generally well tolerated with few contraindications or complications.

The demographic profile in the study was found to be comparable between the two groups. The mean age of patients in study group was 61.33±7.63 years and in control group was 55.40±11.34 years which was comparable to study done by Bluma et al that had a mean age of 58 years. The sex distribution was also similar to the study with 79% males.

Application of NPWT had earlier appearance of granulation tissue. Of all the patients who initially did not have granulation tissue, 68% of those in study group had granulation tissue appeared by the end of 2nd week compared to only 40% in the control group. This was found to be statistically significant (p value< 0.05).

Shreshta et al, in their prospective study of nine patients of renal transplantation who developed wound infection following radiotherapy observed progressive reduction in size of the wound and development of granulation tissue in all cases.

There was a significant increase in the wound bed score in the study group (mean difference was 9.60±2.16) whereas in the control group there was not much increase in wound bed score (mean difference was 5.12±1.99) which was statistically significant (p value-0.00001)

There was a statistically significant difference in percentage change in the wound between two groups. The mean decrease in the wound size was more in the study group (-16.14±13.04cm²) as compared to the control group (-5.98±14.41cm²). Present study was consistent with McCallon et al, who had observed an average decrease of 28.4% (±24.3) in wound size in VAC group as compared to 9.5% (±16.9) average increase in wound size in control group.

We observed that there was a rapid clearance of bacterial load in study group compared to the control group. 40% of the cultures had no growth by 3rd week compared to 20% in control group. *S. aureus* was found to be the most prominent in study group whereas culture group showed mixed growth. This correlates with the study by Moues et al, who observed that non-fermentative gram-negative bacilli showed a significant decrease in VAC treated wounds and significant increase in *S. aureus* in VAC treated wounds.

There was a faster rate of wound closure noted in study group compared to control group. This correlated with McCallon et al, who observed satisfactory healing in VAC group in 22.8±17.4 days compared to 42.8±32.5 days in control group.

The end point was a granulated wound or a wound ready for skin grafting or healing by secondary intention spontaneously whichever was earlier. The most common mode of closure was STSG.

In a study conducted by Weed et al, concluded that NPWT has become an accepted treatment modality for acute and chronic wounds.

CONCLUSION

Analyzing the results, we opine that NPWT has a definitive role in proliferation of granulation tissue, improved wound bed score, reduction in wound size, rapid clearance of bacterial load.

NPWT is cost effective, easy to use, patient friendly method of treating open wounds. Thus, VAC dressing can be considered as a superior option in the management of open wounds.[9]

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