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Original Article

Orthopaedics Section

Negative Pressure Wound Therapy: A Pilot Study

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ABSTRACT

Introduction: Impaired wound healing has a significant socio-economic impact. The introduction of Vacuum Assisted Closure (VAC) has been one of the major breakthroughs in the management of nonhealing wounds owing to its property of granulation tissue formation via effects related to local sub atmospheric pressure and fluid drainage.

Aim: To study the efficacy of Negative Pressure Wound Therapy (NPWT) in wound healing.

Materials and Methods: A pilot study was performed on 50 patients out of which 41 were males 82% and 9 were females (18%) with chronic non healing wounds of different aetiologies between the age of 15-70 years. Eligible patients were treated with NPWT at two days interval for an average of two dressings. Patients were evaluated after two dressings for appearance of granulation tissue, reduction in wound size and decrease of bacterial load in the wound. Paired t-test and Chi-square tests were used. The $p<0.05$ was considered significant.

Results: The use of NPWT in different types of open wounds, pressure sores, postoperative wounds resulted in reduction of wound size (p-value=0.001), infection rate (p-value=0.001) within a week after two dressings to finally be closed with split skin grafting or secondary suturing.

Conclusion: NPWT dressing is a safe, reliable intervention for patients with chronic wounds associated with impaired wound healing, particularly with wounds larger in surface area which requires closure by split skin grafting or musculocutaneous flaps.

Keywords: Infected wound, Non healing wound, Vacuum assisted closure

INTRODUCTION

Impaired wound healing causes significant socio-economic impact to the healthcare sector and society at large. There is a plethora of wound care techniques (moist wound healing dressings, platelet rich plasma therapy etc.,) advocated for impaired healing [1-5]. However, none of these are universally reliable. Moist wound healing dressings require a long duration for the wound to heal. Similarly, platelet rich plasma therapy requires multiple injections of autologous plasma which is quite painful for the patients and quite a cumbersome procedure for the clinicians too [6]. Therefore, impaired healing or nonhealing wounds remain a challenging problem in current practice.

Currently, there is a focus on negative pressure therapy for the treatment of nonhealing ulcers [7,8]. The introduction of Vacuum Assisted Closure (VAC) has been one of the major breakthroughs in the management of nonhealing wound. It hastens granulation tissue formation by stimulating local angiogenesis [9]. The primary objective of present study was to assess the potential therapeutic effects of negative pressure therapy as VAC in the healing of wound.

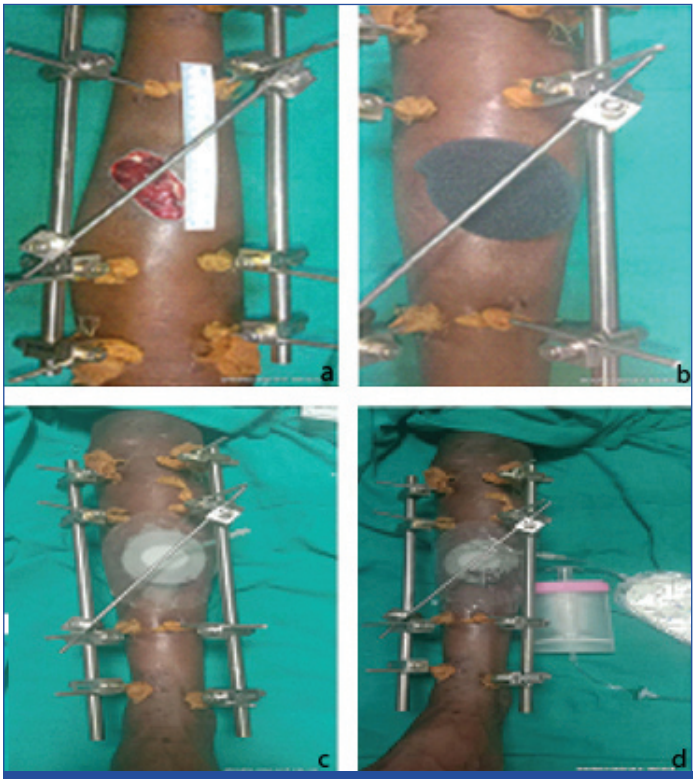
MATERIALS AND METHODS

A pilot study with prospective cohort design was performed in Department of Orthopaedic, Traumatology and Rehabilitation, Netaji Subhash Chandra Bose Medical College Jabalpur, Madhya Pradesh, India from December 2018 to October 2020. Informed consent was obtained from each subject. Institutional Ethical Comittee clearance for the study was obtained with number IEC/2021/2824.

Inclusion criteria: All participants aged 15-70 years of either sex having chronic ulcers or nonhealing wounds; ulcers of various aetiologies (lacerated wounds associated with open fractures, amputation wounds, diabetic foot ulcer, post operative wounds and bed sores) were included.

Exclusion criteria: Patients with vascular injury, severe head injury, uncontrolled blood sugar in patients with diabetes mellitus and patients with coagulopathies, were excluded from the study.

Eligible patients were treated with NPWT with an average of two dressings at an interval of 48 hours. Thorough debridement of the wound was done. An open cell structured sponge was cut to fit the size of the wound adequately and placed inside wound cavity. This foam was next covered by a transparent adhesive layer which extended and adhered, to the skin surrounding the wound. This seal was broken at a single point where a drain was placed to allow direct contact to the underlying foam. The other end of the drain was connected to a vacuum machine for the drainage of the fluid away from the wound [Table/Fig-1a-d].



[Table/Fig-1]: a) Thorough debridement of the wound is done; b) An open cell structured sponge is cut to fit the size of the wound adequately and placed inside wound cavity; c) NPWT dressing, prior to application of negative pressure; d) The distal end of the drain is connected to a vacuum source (NPWT), which allows the drainage of the fluid away from the wound.

STATISTICAL ANALYSIS

Data was analysed by descriptive statistics such as mean, standard deviation Paired t-test and Chi-square tests were used. The p-value <0.05 was considered statistically significant. Data was entered in Microsoft (MS) Excel and analyzed by SPSS Version 24.0.

RESULTS

Among the included patients 41 (82%) were males and 9 (18%)were females with a mean age of 39.14±13.38 years. In this study, different types of wounds were treated with VAC. Of these, the majority of cases were bed sores (44%, n=22). Open wounds comprised 40% of the total cases (n=20), post operative infected wounds were in 14% (n=7) and a single case had diabetic foot [Table/Fig-2]. Before dressing, culture of the 40% (n=20) of the wounds showed no growth of organism. After two VAC dressings, most of the wounds 92% (n=46) did not show any growth [Table/Fig-3]. Thus, NPWT decreased the infection rate by almost 82%. The mean predressing wound size was 18.08±17.70 cm^2. After application of VAC dressing the mean wound size was observed to be 16.07±16.55 cm^2 (p-value 0.001), after four days [Table/Fig-4]. The area of the wound size reduced at an average of 0.5 cm^2 per day. Of the 50 patients included in this study, 50% (25) wounds required closure by split skin grafting, 42% (21) wounds healed by secondary closure and rest of the 8% (4) healed by flap closure [Table/Fig-5]. Few images of the cases are illustrated in [Table/Fig-6,7].

Type of wound	Frequency	Percentage (%)
Bedsore	22	44
Diabetic foot	1	2
Open wound	20	40
Post operational wound	7	14
Total	50	100

[Table/Fig-2]: Four different types of wounds included in the study.

Culture	Predressing (%)	Postdressing (%)	Total	p-value
Positive	30 (60)	4 (8)	34	0.001
Negative	20 (40)	46 (92)	66	
Total	50 (100)	50 (100)	100	

[Table/Fig-3]: Culture findings before and after dressing.
Chi-square was used

Size (cm^2)	Mean±SD	Paired t-value	p-value
Predressing size (50)	18.08±17.70	9.44	0.001
Postdressing size (50)	16.07±16.55		

[Table/Fig-4]: Change in pre and post dressing wound size.

Method	Frequency	Percentage
Secondary closure	21	42
Split skin grafting	25	50
Flap coverage	4	8
Total	50	100

[Table/Fig-5]: Final method of wound closure.

DISCUSSION

This study aimed to evaluate the response of chronic non healing wounds toward NPWT. The overall findings showed that NPWT is a viable option for such chronic wounds. It helps in granulation tissue formation and also reduces the microbial burden on the wound [9].

Study done by Fleishmann W et al., showed no infection in patients except one which was due to insufficient sealing of the wound [10]. When the correct technique was applied the infection cleared up. In our study, we also found that out of 50 patients granulation tissue appeared in all of the patients and space reduced by almost 82% after two VAC dressings. Contrary to our findings Costa ML et al., found no difference in the number of surgical site infections or other complications at any point in the 12 months after surgery [11]. Probably, it was due to their faulty sealing technique of the wound.

[Table/Fig-6]: a) Predressing photo of wound; b) Photo after debridement; c) Photo after VAC application; d) Photo after 2nd dressing; e) Photo after skin grafting; f) Photo after one and a half month.

[Table/Fig-7]: a) Predressing photo of wound; b) Photo after debridement; c) Photo after VAC application; d) Photo after 2nd dressing; e) Photo after skin grafting; f) Photo after one and half month.

Several studies [12,13] also showed that a definitive closure technique like secondary suturing, split skin grafting or musculocutaneous flap was required after VAC dressing in which adequate granulation tissue has appeared. These findings is in concordance with the present study findings. Philbeck TE Jr et al., showed that the healing can be enhanced with NPWT that accelerated granulation tissue formation and decreased wound size at an average of 0.23 cm^2 per day in pressure ulcers [14]. Mullner T et al., treated 45 patients with bed sores, open and infected compound wounds after rigid stabilisation of lower extremity fractures using vacuum sealing technique [15]. Total 84% of the patients treated with the VAC showed decrease in the size of the initial wound, and quicker healing and the removal of any associated infection. Wound closure by granulation, secondary closure, or split thickness skin grafting was achieved in 35 wounds. Thus, they concluded that VAC is an effective option in the management of infected wounds. In this study, wound closure was achieved in 100% of the patients, of which 50% (25) wounds healed by secondary closure, 42% (21) wounds healed by SSG and rest of the 8% (4) healed by flap closure.

Hou Z et al., studied 32 patients in his study with Gustilo type IIIB open tibia fractures which were applied VAC therapy [16]. All wounds closed after being treated with the primary VAC closure. The average time required for definitive intervention was 10.9 days. Eleven patients out of 32 developed infections. The infection rate increased significantly in patients who underwent flap coverage after more than 7 days of injury. In our study, flap closure was required in only 8%(4) of the wounds. It was probably due to lesser area of the wounds and lesser soft tissue loss in the wounds included in our study. Stannard JP et al., treated 62 severe high-energy open fractures which were all treated with initial irrigation and debridement every 48-72 hours until wound closure [17].

Interval NPWT was used in 37 fractures and 25 were subjected to standard fine mesh gauze dressing. The NPWT group had significantly less infections than the control group. These findings were in concordance with the present study findings. Sinha K et al., studied 30 open musculoskeletal injuries to NPWT dressings that was changed every 3-4 days versus standard daily dressings [18]. Measurements were taken at day 4 and day 8 after initial debridement. In the NPWT group, a significant reduction in wound size was observed over the eight days (mean 13.24 mm versus 3.02 mm, p=0.0001). Reduced bacterial load by day 8 (60% no growth versus 20%), as well as a significant increase in angiogenesis, granulation tissue and fibrosis was also noted. These findings were in agreement with the present study findings. Lee HJ et al., in his study included 16 patients with open wounds in the foot and ankle region with exposed tendon or bone [19]. After debriding the wound properly NPWT was applied. The dressing was changed every 3-4 days for 11-29 days. He observed that 15 of the 16 patients healed by secondary intention (production of granulation tissue), and a single case required free flap. Infection was not seen in any of the case. A pilot study in 2015 was done at a paediatric burns Outpatient Department (OPD). Twenty children were included in the study with acute burns half were given a combination of NPWT and silver-impregnated dressings whilst the other half received silver dressings alone. It was found that the NPWT group exhibited moderately faster healing and reported lower pain scores [20].

Thus, it was observed that the outcome of this study was comparable to other similar studies done to assess the utility of negative pressure therapy in management of various wounds. Wounds treated with this therapy showed lower infection rates, significant decrease in wound size, and an overall lesser time for appearance of healthy granulation tissue, ultimately leading to quicker final closure of the wound.

Limitation(s)

The limtations of the present study included a small cohort and absence of any control group. Age was a confounding factor in this study.

CONCLUSION(S)

In conclusion, NPWT remains a reliable, intervention for patients with chronic wounds associated with impaired healing, particularly with wounds larger in surface area which requires closure by split skin grafting or musculocutaneous flaps.

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