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Original Research Article.

A Comparative Study on Wound Management by Vacuum Assisted Closure With Low Cost Negative Pressure Wound Therapy and Conventional Moist Wound Dressing

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ABSTRACT

Objective: Moist wound dressing (MWD) therapy, conventionally used for surgical closure after debridement, takes long time to heal and thus it creates considerable logistic and financial burden. In the present study locally developed relatively low cost negative pressure wound healing therapy (NPWT) equipment based on the Vaccum-assisted closure (VAC) with the MWD for clinical outcome.

Materials and Methods: Sixty patients with full thickness wounds were randomly divided into two groups to be treated with VAC and MWD therapies. Treatment efficacy was the primary outcome variable and it was assessed a semi-quantitative scoring of wound conditions and wound surface measurement. The secondary outcomes were complications during therapy and postoperative duration of hospital stay.

Results: Initially the proportion of the patients with different outcome variables (pain, pus, oedema, wound size, color, bleeding and slough) did not differ significantly between the two groups. At the first follow up visit after 3 days all the sign-symptom, except oedema and color, started to improve at proportions which were not significantly different between the groups. In contrast to the presence of oedema among 70% subjects in the MWD group, the sign was present only among 40% case in the VAC group (p= 0.02). Similarly, dark red color was present in 60% case of the MWD group in contrast to only 10% case of the VAC group. At the 2nd follow up visit after 6 days, except oedema and color again, all the parameter improved in the two groups in similar proportions oedema and dark red color were present among 50% and 53% subjects in the MWD group in contrast to 10% and <10% subjects in the VAC group (p<0.05). In parallel to the earlier improvement in oedema and color (along with other features) the patients in the VAC group could be released from the hospital earlier as compared to the MWD group (duration of hospital stay, M±SD, 6.86±1.63 in VAC vs 9.44±1.89 in MWD groups, p<0.05).

Conclusions: For the treatment of wounds by NPWT, the locally developed low cost VAC equipment is an acceptable tool with clinical effectiveness comparable to the conventional MWD therapy and it has an added advantage for quicker closure of the wounds.

Keywords: Moist Wound Dressing, Negative Pressure Wound Healing Therapy, Vaccum-Assisted Closure.

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INTRODUCTION

Injury to the soft tissue is now accepted by orthopedics and trauma surgeons as being the most important component of high-energy trauma, often dictating the initial and sometimes the definitive management of the injured extremity. Everyday many patients come with open facture and lacerated injury, and some of them need fasciotomy. With this technique there are lots of difficulties to treat the facture due to open wound. In this condition, there are several ways to treat the wound as well as to treat the fracture. In most of the cases the open wound is treated by the conventional moist wound dressing (MWD) technique. This conventional treatment method is used for open wounds skin grafting after the formation of healthy granulation tissue by wet

dressing.[1] The duration of the treatment, however, may be prolonged in this method due to infection or wound condition. Some alternate technologies are presently used for this purpose among which the negative pressure wound therapy (NPWT) is used as a form of vacuum dressing to promote healing of wounds. The therapy involves the controlled application of sub-atmospheric pressure to the local wound environment, using sealed wound dressing connected to a vacuum pump[2,3] which has been suggested as an important option for the advanced management of many wound types.[4-6] It is important that wounds affect quality of life of patients'.[7-10]

NPWT was first described by Argenta and Morykwas.[1] In this technique the wound is covered by sterile foam, a tube interposed, wound sealed by adhesive tapes and the tube is connected with a NPWT machine to create negative pressure. It plays a great role to control oedema, stimulation of angiogenesis and early tissue granulation through mechanical stimuli at cellular level. It has also been helpful for the limitation of destructive proteases within the wound, facilitation of bacterial clearance and continuous excursion of inflammatory proteolytic exudates from the wound and limitation of cross contamination in the hospital environment.[11-13]

Even with some shortcomings NPWT is rapidly becoming popular all over the world for open wound management. But, unfortunately, the NPWT equipment is still quite expensive; so many patients in low resource settings cannot afford it. Aim of our study, to find out the clinical outcome of relatively low cost locally developed negative pressure wound healing technique, which is based on a vacuum-assisted closure (VAC) principle, in comparison to the conventional MWD technique.

MATERIALS & METHODS

Study Design: It was non-blinded randomized clinical trial.

Sample Size and Sampling Technique: Sixty patients with full thickness open trauma wound were recruited from the National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Dhaka, Bangladesh and they were randomly divided into vacuum-assisted closure (VAC) and conventional moist wound dressing (MWD) groups for their treatment.

Inclusion Criteria

- Post-traumatic wound (up to G 111 A)
- Age 15-60 years.
- Patients who are mentally fit & physically alert (ASA group 1-3).

Exclusion Criteria

Patients with following condition were excluded:

- Diabetes
- Neurological deficit
- Tropic ulcer
- Known or suspected malignant wound.
- Exposed neurological bundle
- Wound caused by infection (cellulites, synergistic gangrene)
- Tubercular ulcer

The low cost locally developed VAC technique for NPWT

Wound Preparation

Any discharge or pus from the wound are removed and discarded. Dead tissues are surgically removed (surgical debridement), and after that adequate haemostasis is ensured. Before application, it is very important to prepare the periwound skin and ensure that it is dry.

Placement of Foam

Sterile and open-pore foam (35 ppi density and 33 mm thick-approximately) dressing was placed in the wound area. Open-pore foams were used generally with polyurethane with 400–600 microns (approximately) size which had hydrophobic that is usually open cell structured network. These sizes of pores are mostly effective on transmitting forces mainly mechanical across the wound area and provide mostly equal distribution of negative pressure on the entire wound area for healing (figures 1 to 3).

Sealing with Drapes

Site was covered with an adhesive drape that encircling the foam and tubing with minimum three to five centimeters that surrounding healthy tissue for ensuring the seal.

Application of Negative Pressure

Uniformly controlled pressure was given in the inner surface area of the wound. The pump delivers an intermittent negative pressure of −90 mmHg to −100 mmHg. The machine pumps the wound continuously for 12 hours and then at 15 minute interval for cleaning the channel of the VAC machine with normal saline. This cycle is continued for 3 days. After that the dressing is removed and findings are recorded (figures 4 to 7). Using the VAC technique a second time NPWT is again applied for another 72 hours. Dressings are then removed, wound checked and findings are recorded. At last, the wound was closed either by secondary closure or split thickness skin graft.

Fig 1: Measure the Foam

Fig 2: Foam dressing is cut

Fig 3: Perforated drain tube placed into foam

Fig 4: Covered with the adhesive

Fig 5: Distal end of the drain is connected to NPWT machine

Fig 6: Collapse inwards and check.

Fig 7: Output is connected to disposable container.

Study Procedure: Wound debridement of each patient in both the groups was done following standardized procedure followed in NITOR. Then the locally developed VAC technique was applied for NPWT and the conventional wound dressing was applied for the MWD group. After 3 days, the wound was inspected and second time debridement was done followed by the application of NPWT technique for the VAC and conventional wound dressing for the MWD groups during next 3 consecutive days. All patients were followed up until secondary suture or skin grafting. The amount of pus, pain parameters, oedema size, wound size, granulation tissue, and total hospital stay were compared between the two groups.

Data Collection: A semi-structured interviewer-administered questionnaire was used to collect information on the history, clinical examination, investigation, and post-treatment follow-up.

Statistical Analysis: Statistical analysis was performed using the computer software Statistical Package for Social Science (SPSS) for windows version 22.0 (SPSS Inc, Chicago, USA). The data were analyzed by unpaired t-test and Chi-square test as appropriate.

Table 1: Comparison between two groups before application of VAC and MWD in first visit at first day (0 day) of injury (n=60)

Follow up findings		VAC (n=30) Number (%)	MWD (n=30) Number (%)	p value
Infections	**Pus**	27(90.0)	26(86.7)	0.68
	No pus	3(10.0)	4(13.3)	
Pain	**Mild**	1(3.3)	1(3.3)	0.85
	Moderate	11(36.7)	9(30.0)	
	Severe	18(60.0)	20(66.7)	
Oedema	**Present**	27(90.0)	25(83.3)	0.74
	Skin shrink	1(3.3)	2(6.7)	
	Absent	2(6.7)	3(10.0)	
Wound size (cm)		5.16±2.02	5.21±2.41	0.93
AMOUNT OF GRANULATION				
Colour	**Bright red**	2(6.7)	2(6.7)	0.60
	Dark red	27(90.0)	28(93.3)	
	Black	1(3.3)	0.0	
Bleeding on touch	**present**	2(6.7)	1(3.3)	0.55
	absent	28(93.3)	29(96.7)	
Slough	**present**	28(93.3)	27(90.0)	0.64
	absent	2(6.7)	3(10.0)	

Results are expressed as Mean ±SD and frequency, percentage. Unpaired t-test and Chi-square was performed to compare between groups. The test of significance was calculated and p values < 0.05 was accepted as level of significance.

Table 2: Comparison between two groups after removal of VAC and MWD in the first follow-up after three days (n=60)

Follow up findings		VAC (n=30) Number (%)	MWD (n=30) Number (%)	p value
Infections	**Pus**	18(60.0)	24(80.0)	0.09
	No pus	12(40.0)	6(20.0)	
Pain	**Mild**	16(53.3)	11(36.7)	0.16
	Moderate	4(13.3)	10(33.3)	
	Severe	10(33.3)	9(30.0)	
Oedema	**Present**	12(40.0)	21(70.0)	**0.02**
	Skin shrink	16(53.3)	6(20.0)	
	Absent	2(6.7)	3(10.0)	
Wound size		4.75±1.62	5.01±1.05	0.46
AMOUNT OF GRANULATION				
Colour	**Bright red**	27(90.0)	8(26.7)	**0.001**
	Dark red	2(6.7)	18(60.0)	
	Black	1(3.3)	4(13.3)	
Bleeding on touch	**present**	28(93.3)	23(76.7)	0.07
	absent	2(6.7)	7(23.3)	
Slough	**present**	20(66.7)	21(70.0)	0.78
	absent	10(33.3)	9(30.0)	

Results are expressed as Mean ±SD and frequency, percentage. Unpaired t-test and Chi-square was performed to compare between groups. The test of significance was calculated and p values < 0.05 was accepted as level of significance.

Table 3: Comparison between two groups after removal of VAC and MWD in the second follow-up after six days. (n=60)

Follow up findings		VAC (n=30) Number (%)	MWD (n=30) Number (%)	p value
Infections	**Pus**	6(20.0)	9(30.0)	0.80
	No pus	24(80.0)	21(70.0)	
Pain	**Mild**	25(83.3)	20(66.7)	0.31
	Moderate	4(13.3)	7(23.3)	
	Severe	1(3.3)	3(10.0)	
Oedema	**Present**	3(10.0)	15(50.0)	**0.001**
	Skin shrink	2(6.7)	9(30.0)	
	Absent	25(83.3)	6(20.0)	
Wound size		4.25±1.02	4.51±0.92	0.30
AMOUNT OF GRANULATION				
Colour	**Bright red**	27(90.0)	16(53.3)	**0.006**
	Dark red	2(6.7)	10(33.3)	
	Black	1(3.3)	4(13.3)	
Bleeding on touch	**present**	28(93.3)	25(83.3)	0.23
	absent	2(6.7)	5(16.7)	
Slough	**present**	10(33.3)	12(40.0)	0.59
	absent	20(66.7)	18(60.0)	

Results are expressed as Mean ±SD and frequency, percentage. Unpaired t-test and Chi-square was performed to compare between groups. The test of significance was calculated and p values < 0.05 was accepted as level of significance.

Table 4: Hospital stays of the study subjects

Hospital stay	VAC (n=30) Number (%)	MWD (n=30) Number (%)	p value
3-5 days	1(3.3)	1(3.3)	**0.001**
6-7 days	15(50.0)	2(6.7)	
8-9 days	11(36.7)	3(10.0)	
10-11 days	2(6.7)	6(20.0)	
12-13 days	1(3.3)	18(60.0)	
Total	30(100.0)	30(100.0)	
Mean	6.86±1.63	9.44±1.89	

Results are expressed as Mean ±SD and frequency, percentage. Unpaired t-test and Chi-square was performed to compare between groups. The test of significance was calculated and p values < 0.05 was accepted as level of significance.

ETHICAL CONSIDERATIONS

Each participant was informed about the research objectives, methods and techniques in detailed and informed written consent were taken.

The study protocol was approved by the Ethical Review Committee of the National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Dhaka, Bangladesh.

RESULTS

Initially the proportion of the patients with different outcome variables (pain, pus, oedema, wound size, color, bleeding and slough) did not differ significantly between the two groups (Table 1).

At the first follow up visit after 3 days all the sign-symptoms, except oedema and color, started to improve at proportions which were not significantly different between the groups. In contrast to the presence of oedema among 70% subjects in the MWD group, the sign was present only among 40% case in the VAC group (p= 0.02). Similarly, dark red color was present in 60% case of the MWD group in contrast to only 10% case of the VAC group (Table 2).

At the 2nd follow up visit after 6 days, except oedema and color again, all the parameter improved in the two groups in similar proportions oedema and dark red color were present among 50% and 53% subjects in the MWD group in contrast to 10% and <10% subjects in the VAC group ($p<0.05$) (Table 3).

In parallel to the earlier improvement in oedema and color (along with other features) the patients in the VAC group could be released from the hospital earlier as compared to the MWD group (duration of hospital stay, M±SD, 6.86±1.63 in VAC vs 9.44±1.89 in MWD groups, $p<0.05$) (Table 4).

DISCUSSION AND CONCLUSION

Data from the present study demonstrate that the locally developed NPWT tool, based on the VAC principle, is effective for the management of full-thickness wounds. The data also show that it may even be little better than the conventional MWD technique in terms of the faster resolution of oedema and dark red color. Two signs creates much higher degree of psychological distress to the subjects and by this the speed of the recovery from these two signs may help in the overall relief of the patients for a large extent.

The findings on the clinical outcome in this study is in line with the findings of Lange et al[14] who claimed that vacuum sealing is a new therapeutic concept in surgical wound closure may be sometimes replace by this. Moues et al also demonstrated that VAC is more effective than conventional therapy in reducing wound surface area and in generating a healthier wound resulting in taking less time for 'ready for surgical therapy'.[15]

Along with the faster recovery from the sign-symptoms, the mean hospital stay of the subject was shortened by about 3 days. This is of utmost importance in resource poor settings where the patients as well as public sector health care facilities have substantial economic difficulties.

Moues et al[16] has shown that the material cost in VAC therapy is little higher than the conventional moist gauze therapy; however, the overall cost goes down due to the reduced hospital stay. There was no cost assessment in the present study, but the findings on the hospital stay is in line with their findings.

The mechanism underlying faster wound healing on using NPWT by VAC is still not fully clear. Further large scale research is needed to explore the mechanism of faster healing as well as on the limitations of this technique in deep wound therapy.

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