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Original Research Article

Effect of vacuum assisted therapy in wound healing

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ABSTRACT

Background: Vacuum assisted closure (VAC) is a new technique developed in the management of contaminated, acute, and chronic wounds. It refers to wound dressing system that continuously or intermittently apply sub-atmospheric pressure to the surface of a wound which accelerates debridement and promote healing. The optimum pressure for VAC is around 125 mmhg below ambient and this negative pressure helps in removing interstitial fluid, decreases localised edema and increases blood flow. This in turn decreases tissue bacterial levels and promotes wound healing.
Methods: Hospital based prospective study.
Results: Most common etiology for wounds is diabetes i.e., 50%, Most common organism cultured from wound is Staphylococcus aureus, and least is proteus. Surface area of wound is reduced to <40 cm^2 in 76% cases and 7% cases had >60 cm^2. After applying VAC dressing 91% of patients had bright red granulation tissue. Mean duration hospital stay was reduced to 10days in patients with VAC dressing.
Conclusions: VAC or NPWT therapy is an excellent alternative modality of treatment of acute or chronic large non-healing wounds. It reduces the number of changes of dressing and reduces the time of hospital stay before definitive surgery for covering wound can be planned. Based on the data from the present study and other studies available, VAC appear to result in better and rapid healing and thus a better option of wound management technique.

Keywords: Vacuum assisted dressing, Chronic wounds, Negative pressure wound therapy

INTRODUCTION

A wound is defined as an injury to living tissues caused by a cut, blow, or other impact, typically one in which the skin is cut or broken. Delayed wound healing particularly in difficult wounds and in elderly with co-morbidities is a major concern. it leads to the pain, morbidity, prolonged treatment, and require major reconstructive surgery which imposes enormous social as well as financial burden.[1]

Conventional moist gauze dressings are the most commonly used dressing for delayed wounds but however are not very effective treatment for delayed wounds/non healing ulcers.[2]

VAC [Also called vacuum therapy, vacuum sealing or topical negative pressure therapy] is a new technique in the challenging field of management of contaminated, acute and chronic wound. VAC was introduced by Argenta and Morykwas in 1993 using polyvinyl-alcohol (PVA) / and polyurethane (PU).[3] It is also called as negative pressure wound therapy [NPWT] or micro deformational wound therapy [MDWT].[4] It refers to wound dressing system systems that apply continuously or intermittently apply sub-atmospheric pressure to surface of wound. The application of controlled levels of negative pressure has been shown to accelerate the debridement and wound healing. The optimum level of negative pressure appears to be around 125mmhg below ambient and it is believed that it helps in removal of

interstitial fluid, decreasing localised edema.[5]It is used as an adjunct or alternate to surgery for wide range of wounds with an aim to decrease morbidity, cost, duration of hospitalization and increase the patient comfort.

Mechanism of action are as follows:

Macrodeformation

Macrodeformation describes the actions of the vacuum assisted therapy on a macroscopic level that cause the wound to contract and significantly reduce its overall size as a result of the dressing's centripetal forces on the wound foam interface. Different wounds exhibit varying degrees of contraction as a result of the varied tension in dermis and the connection of its underlying tissues.[6]

Microdeformation

Microdeformation is the term used to describe changes that occur on a millimetre to nano scale. The negative pressure applied to the wound is evenly distributed among each of the individual cells by the foam. Along with gravity, the cells are subjected to a variety of mechanical forces, such as shear, stretch, and compressional forces. When subjected to such mechanical stressors, healthy cells adapt and proliferate whereas unhealthy cells finally perish as a result of apoptosis.[7]

Reduction of edema

Edema and chronic wounds frequently coexist, and fluid accumulation is widely recognized as a barrier to wound healing. It slows the healing of wounds by having a compressive impact on the local tissue and microvasculature. vacuum therapy effectively drains excess fluid from the site by subjecting it to sub atmospheric pressure, which improves tissue perfusion and oxygenation and ultimately speeds up wound healing.[8]

Wound environment

In order to maintain the necessary negative pressures at the wound dressing interface, drape, which is semi occlusive, is essential. This dressing helps to provide a warm, moist wound environment that is excellent for healing by being impervious to microorganisms and semi-permeable to water vapour and gases.

Modulation of inflammation and cellular responses

It removes infiltrating leukocytes while simultaneously inducing inflammation. The cellular deformations lead to cellular proliferation, migration, and differentiation. There is granulation tissue formation, increased angiogenesis, enhanced perfusion and faster wound healing rates.[9]

Angiogenesis

The negative pressure results in local hypoxia with resultant vascular endothelial growth factor (VEGF) gradient that leads to angiogenesis.[10]

Stimulation of Granulation tissue formation

This induces fibrogenesis and endothelial cells with microvascular ingrowth, tissue proliferation and resultant robust granulation tissue formation.[11]

Peripheral nerve response

It also activates the neurocutaneous system, thereby stimulating neural growth and neuropeptide expression which act as homeostatic factors in the skin

Alterations in bioburden

Some studies have shown a decrease in bioburden with treatment while others have shown comparable levels between cases and controls.

Objectives

Objectives of the study were to study the effect of vacuum assisted therapy on wound healing, to study the rate of healing of the wound, to assess efficacy of vacuum assisted therapy in infected wounds and to assess effect on duration of hospital stay due to the vacuum therapy.

METHODS

Study design

It was hospital based prospective study.

Study place

Study carried out at department of the general surgery, Malla Reddy institute of medical sciences, Suraram, Medchal.

Study population

Patients with ulcers were selected from the surgical wards of Malla Reddy hospital, Suraram for study of vacuum assisted therapy.

Study period

The 7 months study from the August 2021 to February 2022

Sample size

Total 70 patients were selected.

Ethical approval

The study was approved by the institutional ethics committee.

Inclusion criteria

Patients with age- >18 years, ulcer size >5 cm, ulcers not connected to any body cavity and patients giving consent for vacuum assisted therapy were selected in the study.

Exclusion criteria

Patients with ulcer with the underlying osteomyelitis, Charcot's joint peripheral vascular diseases, ulcer with Wagner Grades III and IV, fistula to organ or body cavity, malignancy in the wound and post burn ulcer were excluded from the study.

Statistical analysis

All the data is collected in approved proforma, and the data is entered in MS excel 2019 and subjected to statistical analysis.

Equipment

Equipment used were-Sterilized foam (Figure 1), Romovac suction tubes (Figure 2), IO drape (Figure 3) and suction apparatus (Figure 4).

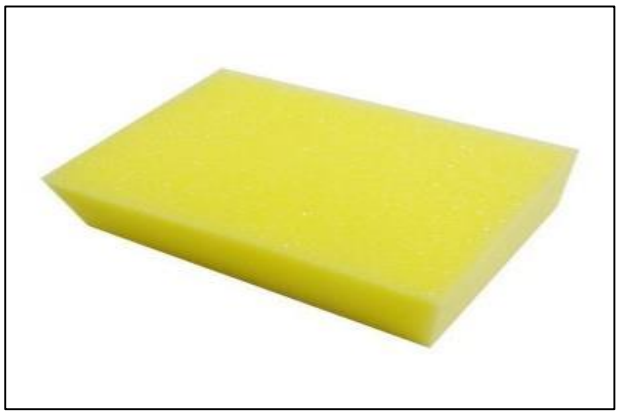

Figure 1: Sterile foam.

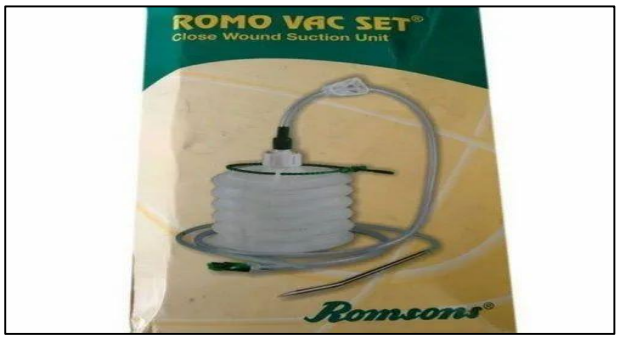

Figure 2: Romo vac tube.

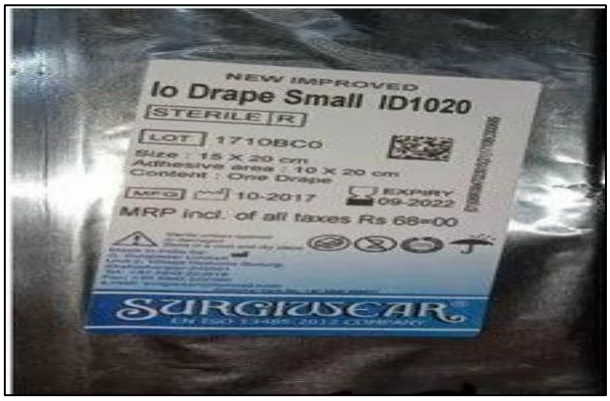

Figure 3: IO drape.

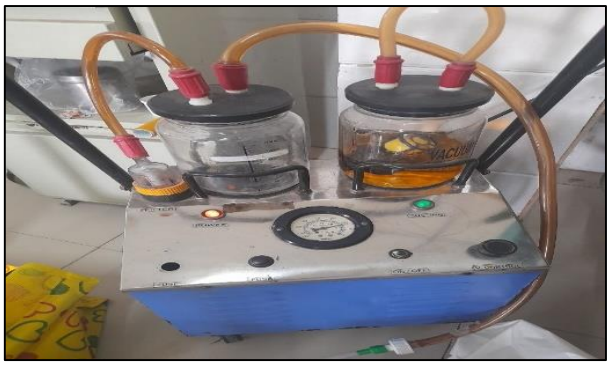

Figure 4: Suction apparatus.

Sequence of procedure

Preparation of the wound-a swab was taken from the wound and sent for culture and sensitivity. Surgical debridement is done to remove slough. Sterilized foam is approximated to the size of the ulcer and is placed over it. Romovac suction tube is placed between the two layers of foam. Site is then sealed with an adhesive drape extending 5 cm onto surrounding healthy area (Figure 5). Tubes are then connected to a mobile suction apparatus maintaining a pressure of -125mmHg. The pressure applied continuously for 48 h and changed as required thereafter. Outcome measured in terms of-reduction in wound surface area, appearance of granulation tissue and duration of hospital stay (Figure 6 to 10).

Figure 5: VAC dressing.

Figure 6: Before VAC.

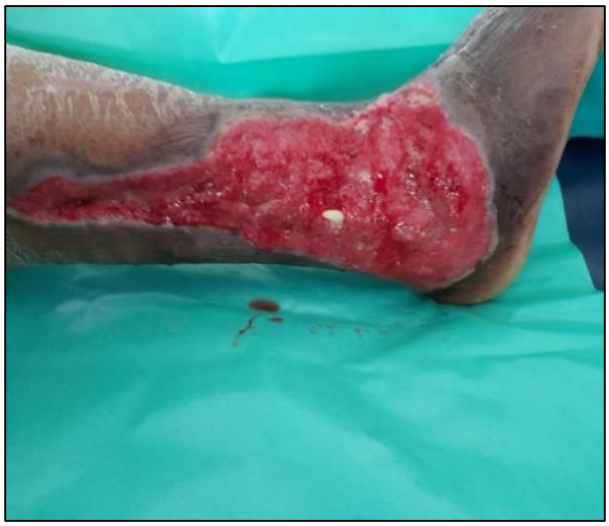

Figure 7: After VAC.

Figure 8: After skin grafting.

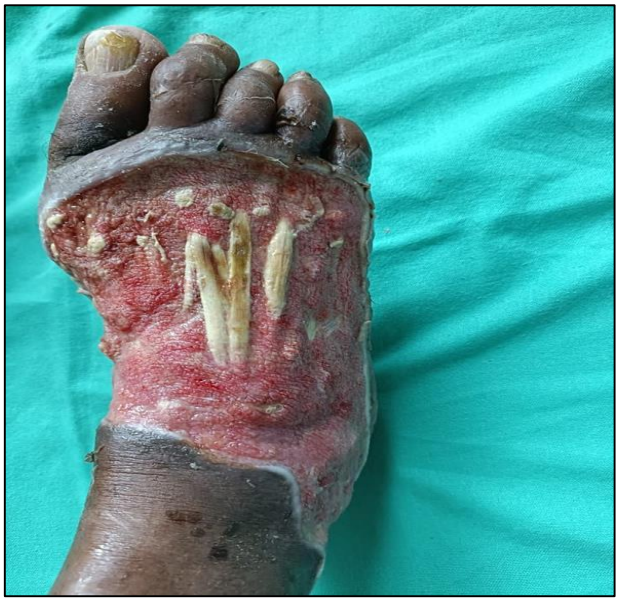

Figure 9: Before VAC.

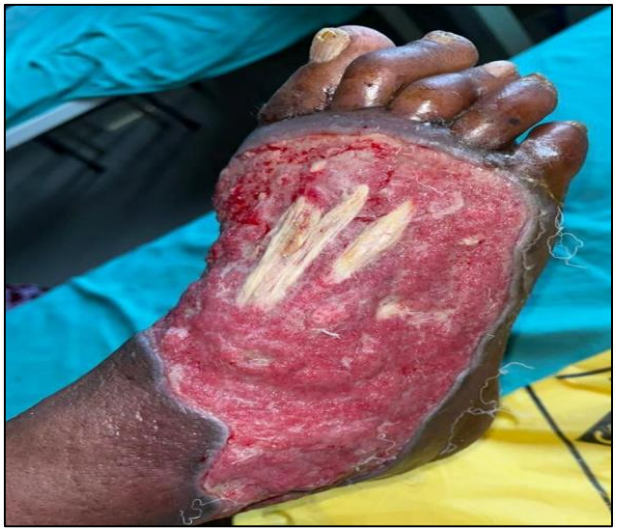

Figure 10: After VAC.

RESULTS

Age

Incidence of ulcers was more in the age group >60 years (26 cases) followed by 50-60 years (18 cases) (Table 1).

Table 1: Age distribution of patients.

Age (years)	N
18-30	2
30-40	8
40-50	16
50-60	18
>60	26

Gender

Incidence of ulcers was more in males (64%) when compared to females (36%) (Table 2).

Table 2: Gender distribution of patients.

Sex	N
Male	45
Female	25

Etiology

The 35 (50%) of the cases fell into diabetic group, 25 (36%) cases into post debridement group and 10 (14%) cases into trauma group (Table 3).

Table 3: Etiology of the ulcer.

Etiology	N
Diabetes	35
Post debridement	25
Trauma	10

Organism cultured from the wound

Most common organism cultured from wound is *Staphylococcus*. Least common organism is proteus. In 20 cases there was no growth of any organisms (Table 4).

Table 4: Micro-organism cultured from the ulcer.

Organism	N
No	20
Staphylococcus	32
P. aeruginosa	10
E. coli	5
Proteus	3

Surface area of the ulcer

Before applying VAC dressing 19 (27%) cases had surface area of <40 cm^2 and 14 (20%) cases had surface area >60 cm^2. After 3 rounds of dressing i.e., on 13th day, 53 (76%) cases had surface area <40 cm^2 and 5 (7%) cases had >60 cm^2 (Table 5).

Table 5: Surface area of the ulcer before and after VAC dressing.

Days after VAC application	<40 cm^2	40-60 cm^2	>60 cm^2
Before VAC application	19	37	14
Day 3	22	35	13
Day 7	28	31	11
Day 10	41	22	7
Day 13	53	12	5

Colour of granulation tissue

Initially 55 (79%) patients had wounds with pale granulation tissue. After application of VAC dressing for 3 times, on 13th day 64 (91%) patients had bright red granulation tissue, whereas none had pale granulation tissue (Table 6).

Table 6: Colour of granulation tissue.

Days of vac application	Pale	Pink	Bright red
Before vac	55	8	7
Day 3	42	16	12
Day 7	15	18	37
Day 10	0	23	47
Day 13	0	6	64

Duration of hospital stay

the mean duration of hospital stay was 10days before any definitive surgical management like skin grafting for patients in whom VAC dressing was applied. Whereas it was around 25 days for patients in whom conventional dressings were applied (Table 7).

Table 7: Duration of hospital stay.

Dressing method	Duration of hospital stay (days)
Conventional dressings	25
VAC dressing	10

DISCUSSION

Vacuum assisted therapy is a non-invasive system that uses controlled negative pressure (-125 mmHg) continuous/intermittently using vacuum device to promote wound healing by removing fluid from open wounds through-sealed dressing/foam dressing connected to collection container using sub-atmospheric pressure.

Thomas first postulated that application of mechanical stress would result in angiogenesis and tissue growth. Unlike sutures or tension devices, the VAC dressing therapy can exert a uniform force at each individual point on the edge of the wound drawing it toward the centre of the defect by mechanically stretching the cells when negative pressure is applied

The most common etiological factor of ulcers in our study is diabetes. Similar study was done by Francis et al in which the most common etiological presentation was diabetic ulcer.

The most common organism grown on culture from wound in this study is *Staphylococcus*.

The findings on the clinical outcome in this study is in line with the findings of Sarkar et al who demonstrated that VAC is more effective than conventional therapy in

reducing wound surface area and in generating healthy granulation tissue.[11]

The surface area of ulcer in our study decreased gradually after 2 cycles of vac dressing. The findings are in line with the study done by Mukadam et al.[5]

Our study showed that VAC dressing therapy increases the vascularity and rate of granulation tissue formation in line with the findings of Charles et al.[12]

In our study the mean duration of hospital stay is 10 days before any definitive surgical management like grafting is done. Study done by Charles et al the mean hospital stay was 19 days and it was 12 days in a study done by Mukadam et al.[5,12]

Limitations

The sample size of the study is less. Large sample size studies should be conducted. Single institution centered study. Few confounding factors which can affect wound healing could exist and have not been considered in this study.

CONCLUSION

VAC or NPWT therapy is an excellent alternative modality of treatment of acute or chronic large non-healing wounds. It reduces the number of changes of dressing and reduces the time of hospital stay before definitive surgery for covering wound can be planned. Based on the data from the present study and other studies available, VAC appear to result in better and rapid healing and thus a better option of wound management technique.

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