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Comparison of Vacuum Assisted Closure Vs Conventional Moist Dressing in the Management of Chronic Wounds

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Abstract:
Aim: *To assess the efficacy of vacuum assisted closure as compared to conventional moist wound dressings in improving the healing process in chronic wounds and to prove that vacuum assisted closure can be used as a much better treatment option in the management of chronic wounds.*
Study design: *Randomized control trial.*
Place and duration of study: *General Surgery Department, NRI Medical College & General Hospital, Chinakakani from October 2013 to September 2015.*
Methodology: *120 patients with chronic wounds, of varying etiology, admitted in NRI Medical College & General Hospital, Chinakakani from October 2013 to September 2015. They were randomized into 2 groups. One group was subjected to vacuum assisted closure and the other group is subjected to conventional moist dressing. Variables that are studied include rate of granulation tissue, graft uptake and duration of hospital stay.*
Results: *Rate of granulation tissue was more rapid in vacuum assisted closure group as compared to conventional moist dressing group i.e. mean 78.68%for VAC group and mean51.92% forconventional moist dressing. Hospital stay was reduced in vacuum assisted closure group compared to conventional moist dressing group i.e mean 32.48 days for VAC group and mean 59.43 days for conventional moist dressing group. Percentage of graft uptake is more in vacuum assisted closure group compared to conventional moist dressing group i.e. mean 80.78% for VAC group and mean 59.58% for conventional moist dressing group*
Conclusion: *To conclude, vacuum assisted closure helps in faster healing of chronic wounds and better graft take-up and reduce hospital stay of these patients.*
Key Words: *Vacuum assisted closure, conventional moist dressings, chronic wounds.*

I. Introduction

In past few centuries medicine is so much advanced, in spite of thatmanagement of chronic wounds remains a tough challenge. To solve thislot of modalities of dressings and local applicants have been developed and lot of studies are still going on. Wounds which are showingcharacters of delayed healing or non healing is a problem which gives rise to various complications. Regardless of etiology, wounds are difficult to treat if coexisting factors (e.g.- infection or diabetes mellitus) prevent regular wound healing. Wounds represent a significant risk factor for hospitalization, psychological burden,amputation, sepsis, and even death, and from the patient's perspective, wound therapy is often uncomfortable or painful. Chronic wounds result in significant functional impairment, reduction in quality of life, and large financial costs for patients and the health care system.

Chronic wounds affect at least 1% of the population[1].Chronic wounds generally take longer time to heal, and care is enormously variable, as is the time to heal. There are approximately 4.5 million pressure ulcers in the world that require treatment every year. Many chronic wounds around the world are treated sub-optimally with general wound care products designed to cover and absorb some exudates. The optimal treatment for these wounds is to receive advanced wound management products and appropriate care to address the underlying defect that has caused the chronic wound; in the case of pressure ulcers a number of advanced devices exist to reduce pressure for patients. There are approximately 9.7 million venous ulcers, and approximately 10.0 million diabetic ulcers in the world requiring treatment. Chronic wounds are growing in incidence due to the growing

age of the population, and the growth is also due to increasing awareness and improved diagnosis. Growth rates for pressure and venous ulcers are 6%–7% in the developed world as a result of these factors.Diabetic ulcers are growing more rapidly due mainly to increased incidence of both Type I and maturity-onset diabetes in the developed (high-GDP) countries around the world. The prevalence of diabetic ulcers is rising at 9% annually. At present, this pool of patients is growing faster than the new technologies are reducing the incidence of wounds by healing them.

Although wound dressing have been used for at least two millennia, there exists no ideal dressing. Surgical dressing of both open and closed wounds is based mainly on tradition, training and the surgeons own philosophy. Modern wound-healing concepts include different types of moist dressings and topical agents, although only a few of these treatments have convincingly been shown to give higher wound closure rates compared with traditional wet gauze dressings.[2-4].During the last two decades a wide variety of innovative dressing have been introduced.Negative pressure wound dressing is a new technology that has been shown to accelerate granulation tissue growth and promote faster healing, thereby decreasing the period between debridement and definite surgical closure in large wounds. In developing countries like India where the cost of dressing is a major concern, the locally constructednegative pressure dressing was an option.Clinical knowledge about the management of difficult-to-treat wounds is still limited owing to the lack of high-quality evidence.[5-8]. During the past few years, many clinical trials have been initiated, and first results have been reported in leading journals.

Recent studies have shown that application of a sub atmospheric pressure in a controlled manner to the wound site has got an important role in assisting wound healing. The present study was conducted to assess the efficacy of vacuum assisted closure dressings as compared to conventional moist wound dressings in improving the healing process in chronic wounds and to prove that negative pressure dressings can be used as a much better treatment option in the management of chronic wounds.

II. Aims And Objectives

To compare the efficacy of vacuum assisted closure with that of a control group using conventional moist wound dressings, in healing of chronic ulcers, in terms of:

1) Number of days required for healing
2) Number of ulcers unhealed in either group at the end of trial period.
3) Rate of granulation tissue formation as percentage of ulcer surfacearea.
4) Graft survival as percentage of ulcer surface area.
5) Period of hospital stay.

III. Materials And Methods

This prospective randomized comparative study included 120 patients with chronic wounds, of varying etiology, admitted in NRI Medical College & General Hospital, Chinakakani from October 2013 to September 2015 satisfying all the inclusion criteria mentioned below, after the clearance from the ethical committee was obtained. All chronic wounds where conventional dressings are indicated were included in the study.

3.1Inclusion criteria

- Patients with age between 12 - 75 years
- All types of chronic wounds irrespective of etiology
- Wound size <10% TBSA
- Patients giving consent for vacuum therapy

3.2 Exclusion criteria

- Wounds with necrotic tissue
- Untreated underlying osteomyelitis
- Exposed arteries or veins
- Malignancy within wounds
- Dry gangrene
- Wounds resulting from electrical,chemical, or radiation burns and those with collagen vascular disease

The whole sample population was divided into two equal and comparable groups of 60 patients, based on the willingness for undergoing vacuum therapy. Those who were not willing for vacuum therapy were subjected to conventional moist wound dressings and formed the control group. Selection of patientswasdone by purposive sampling method. Care was taken so that both the groups had a comparable distribution of patients

with regards to age as well as etiology of the ulcer.

All patients underwent detailed clinical examination and relevant investigations and the wounds were thoroughly debrided and the ulcer dimensions as well as the surface area assessed. Before the start of VAC therapy, after initial debridement,the wound was photographed with a ruler placed besidethe wound. A double layer of polyethylene sheets was held firmly in place over the wound, and an outline of the woundwas traced using a permanent marker. The layer in directcontact with the wound was discarded. The tracing madeon the top layer of polyethylene was fixed against a graphicgrid (2 x 2 mm), and its area was quantitated to measurethe area of the wound to the nearest 4 mm^2.At subsequent VAC dressing changes, the wound waslikewise photographed, and its area was quantitated using the double polyethylene sheet technique. Before surgicalintervention at the end of VAC therapy, the final appearanceof the wound was again noted and recorded. The patients were followed up on a daily basis in both test and control groups. The control group was subjected to twice-daily dressings by conventional methods whereas the test group was subjected to topical negative pressure dressings and was left undisturbed for 2 days and wound was inspected twice daily.

3.3 Materials used

The application of topical negative pressure moist dressings needs the following materials. They include

- Synthetic hydrocolloid sheet
- Vacuum suction apparatus
- Transparent semi permeable adhesive membrane sheet

3.4 Technique of application

The VAC dressing is a combination of composite synthetic hydrocolloid sheet dressing with vacuum assisted wound closure systems. The technique involves six steps. All the patients included in Group II were subjected to these six steps. These were as follows :

1. The wound was thoroughly debrided and devitalized tissue removed. A perforated drain tube was placed on top of the wound bed and other end was brought out a little away from main wound
2. The hydrocolloid foam dressing soaked in povidone iodine solution was cut to size of the wound and applied over the drain tube.
3. The foam with the surrounding normal skin was covered with adhesive, semi-permeable, transparent membrane. A good air seal was thus ensured around the wound.
4. Distal end of the drain tube was now connected to a device, which provided a negative pressure of -125 mmHg was applied to the wound, either continuously or intermittently (5 minutes "on", 2 minutes "off").
5. This was achieved by wall suction apparatus, computerized devices or mobile suction drain devices. Suction was applied continuously or intermittently based on amount of wound discharge.
6. Once vacuum is applied, the foam must be seen collapsed into the wound bed, thus giving the surface a concave appearance.
7. The fluid from the wound is absorbed by the foam and is removed from the wound bed by suction.

The negative pressure was maintained for an average of 2 days for Maximumbenefit as studies have proved. Once adequate granulation tissue was formed the dressing was removed and definitive wound closure achieved by skin grafting.At the end of two days the wounds in both the groups were inspected after removal of the dressings from the test group. The wounds were compared based on the following parameters. They are,

- Rate of granulation tissue formation as percentage of the ulcer surface area
- Quality of ulcer bed

Present dimensions and surface area of the ulcer

Once these parameters were assessed, both the groups were subjected to split thickness skin grafting. Both groups were given the same systemicantibiotics during the postoperative period. The wounds were reassessed at the end of the fifth postoperative day and the following parameters were accounted for. They were,

-Skin graft take up as a percentage of ulcer surface area

-Number of days of hospitalization

After discharge, patients were followed up in the out patient department after one month to assess post skin grafting complications like contractures, itching, pain and infection.

The results obtained were statistically evaluated and the main parameters, which were analyzed, were,

- Rate of granulation tissue formation
- Graft survival and take up
- Duration of hospital stay

The mean rate of granulation tissue formation, graft survival and hospital stay was calculated and compared for both groups. The variables were compared using the Unpaired Student's Z-test. A P value <0.05 was considered significant.

IV. Observation And Results

The 120 patients admitted in our hospital selected for study are divided into two equal and comparable groups. Those patients who were subjected vacuum pressure dressing were considered as group1, and who underwent conventional moist dressings were included in group2.

Table 1Comparison of Age Distribution between Study & Control Group

Age in Yrs	Vacuum Therapy	Regular Therapy
20-31	5	6
32-41	11	7
42-51	19	16
52-61	16	20
62-71	8	8
72-81	1	3
Total	60	60

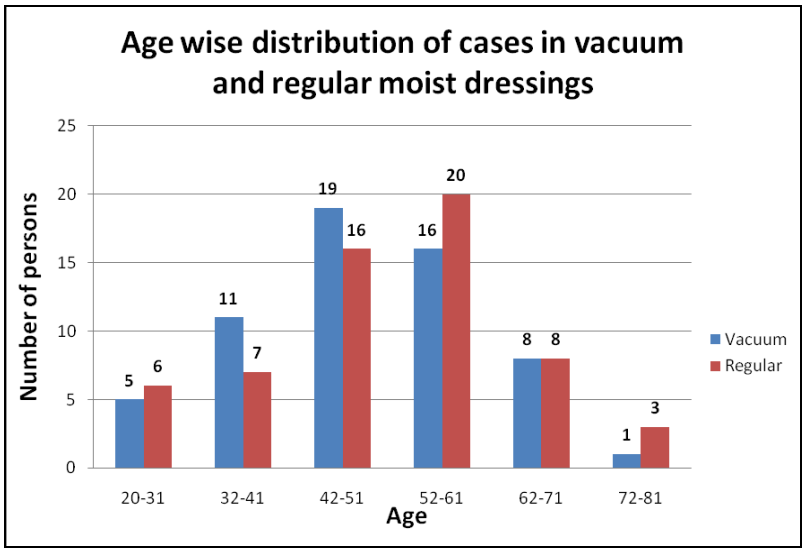

Table 2 : Comparison Of Sex Distribution Between Study And Control Group

Type of Dressing	**Female**	**Male**
Vacuum	26	34
Regular	24	36

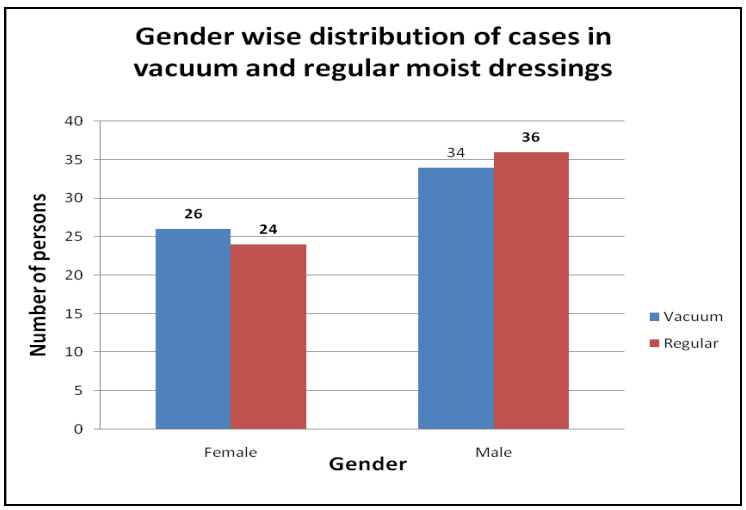

Table 3 :Comparison Of Duration Of Hospital Staybetween Study And Control Group

Duration of hospital stay	Vacuum	Regular
17-26	23	0
27-36	21	8
37-46	5	2
47-56	7	5
57-66	2	12
67-76	2	20
77-86	0	7
87-96	0	6
Total	**60**	**60**

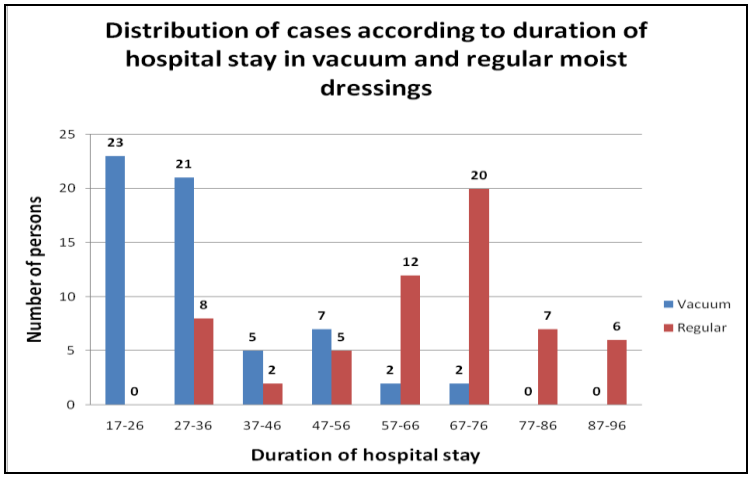

Table 4 : Comparison Of Duration Of Hospital Staybetween Study And Control Group

Granulation in % of ulcer area	Vacuum	Regular
20-29	0	3
30-39	0	23
40-49	8	12
50-59	6	3
60-69	8	6
70-79	8	3
80-89	12	5
90-99	18	5
Total	**60**	**60**

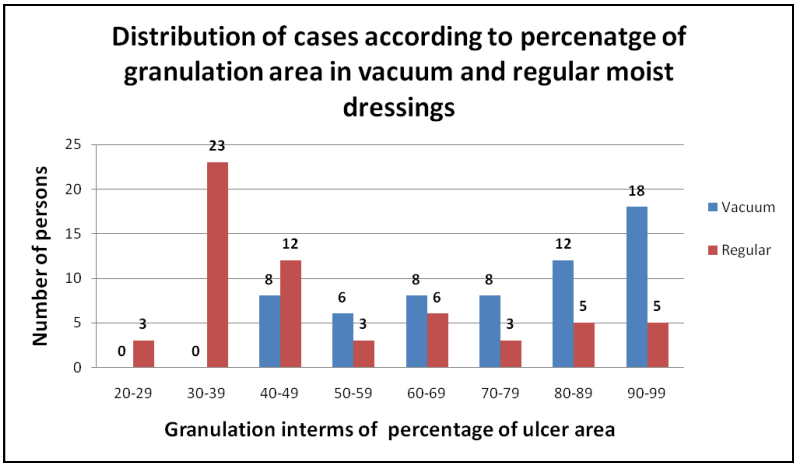

Table 5 : Comparison Of Type Of Ulcer Between Study And Control Group

Type of ulcer	Vacuum	Regular
Diabetic ulcer	20	21
Ischemic ulcer	8	3
Bedsore	11	16
Venous ulcers	3	3
PIRA	11	8
Traumatic	7	9
Total	60	60

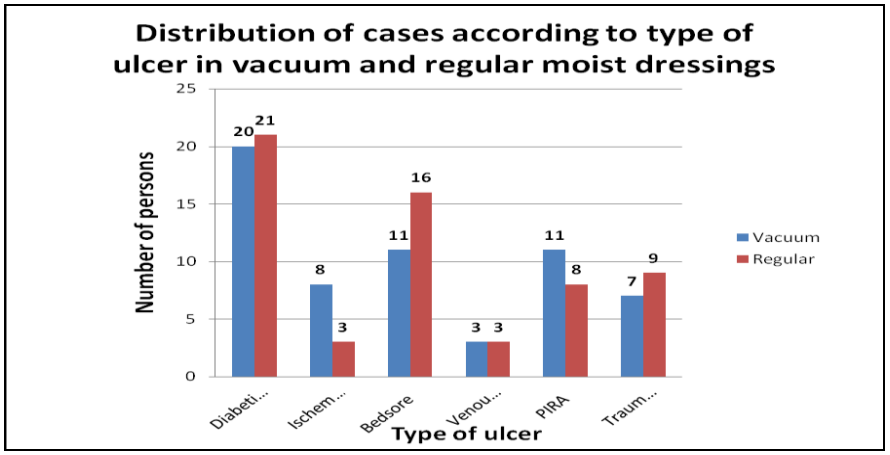

Table 6 : Comparison Of Type Of Ulcerbetween Study And Control Group

Graft take up %	Vacuum	Regular
20-29	1	2
30-39	1	7
40-49	0	10
50-59	8	1
60-69	1	19
70-79	18	6
80-89	4	12
90-99	27	3
Total	**60**	**60**

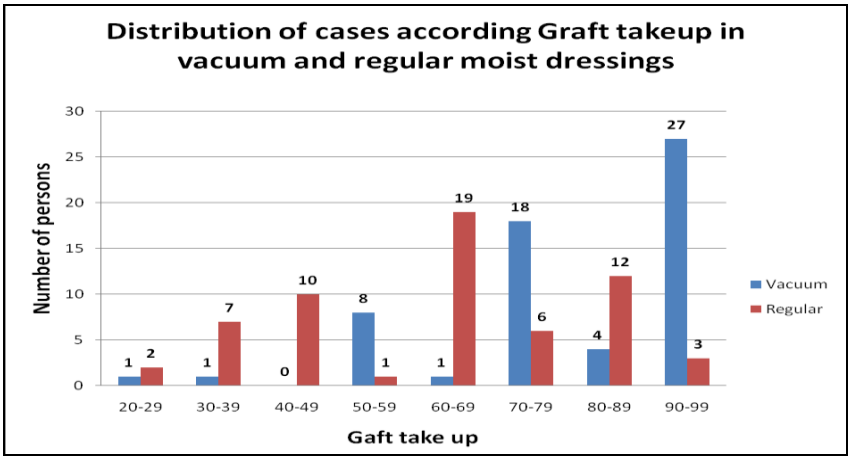

Table 7 : Comparison Of Different Parameters Between Study And Control Group

	Vacuum		Regular	
Parameter	**Mean**	**SD**	**Mean**	**SD**
Age	48.53	11.68	48.78	12.56
Duration of hospital stay	32.48	13.12	59.43	17.26
Granulation as % of ulcer area	78.68	18.12	51.92	21.03
Average graft take-up	80.78	14.54	59.58	19.25

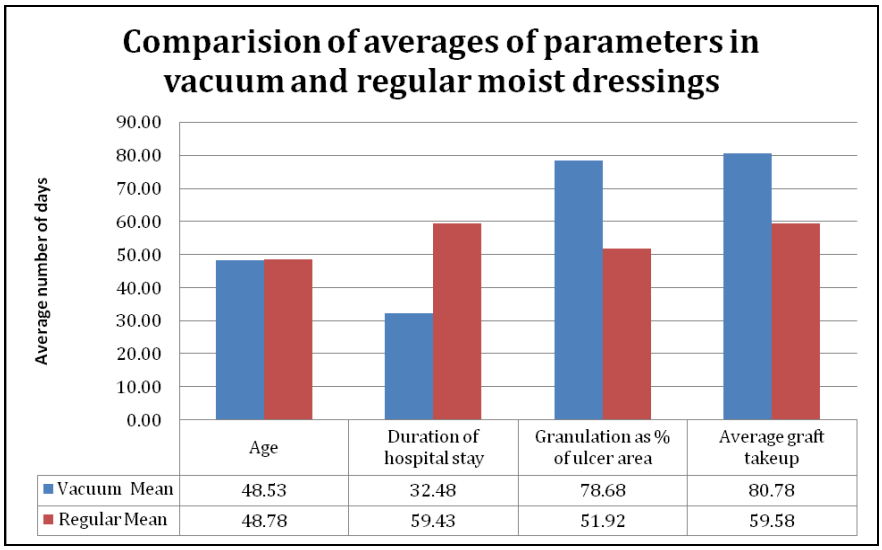

Table 8 : Comparison Of Different Parameters Mean±Sd Between Study And Control Group

					Z test of difference between two independent means		
	Vacuum		Regular				
Parameter	**Mean**	**SD**	**Mean**	**SD**	**Z-value**	**P-value**	**Conclusion**
Age	48.53	11.68	48.78	12.56	-0.1129	0.9101	There is no significant difference between average ages of the cases in vacuum and regular dressing
Duration of hospital stay	32.48	13.12	59.43	17.26	-9.6287	0.0001	There is a highly statistically significant difference between average duration of hospital stay and it is reduced significantly in vacuum dressing.
Granulation as % of ulcer area	78.68	18.12	51.92	21.03	7.467	0.0001	There is a highly statistically significant difference between average granulation in % of ulcer area and it is significantlyhigh in vacuum dressing.
Average graft take-up	80.78	14.54	59.58	19.25	6.8071	0.0001	There is a highly statistically significant difference between average graft take-upand it is significantly high in vacuum dressing.

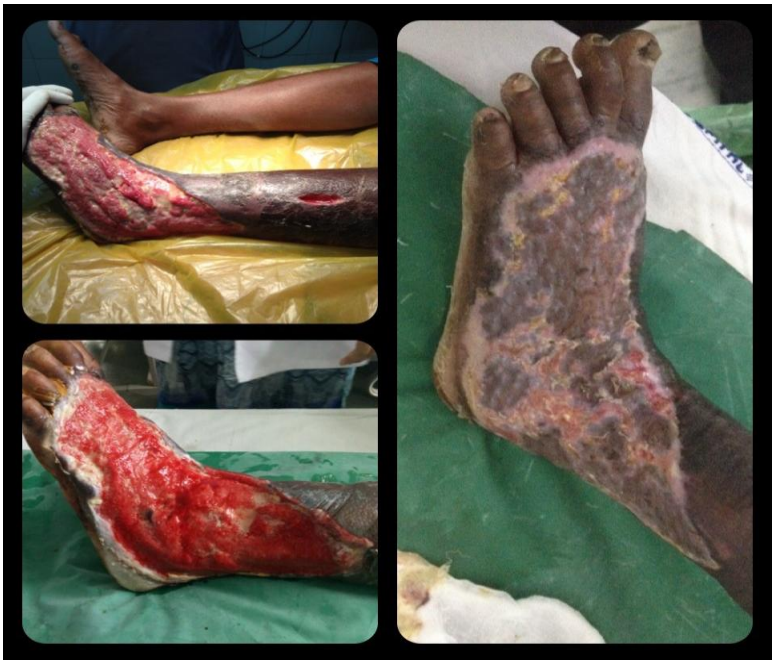

Fig-1 :Vacuum dressing in traumatic wound

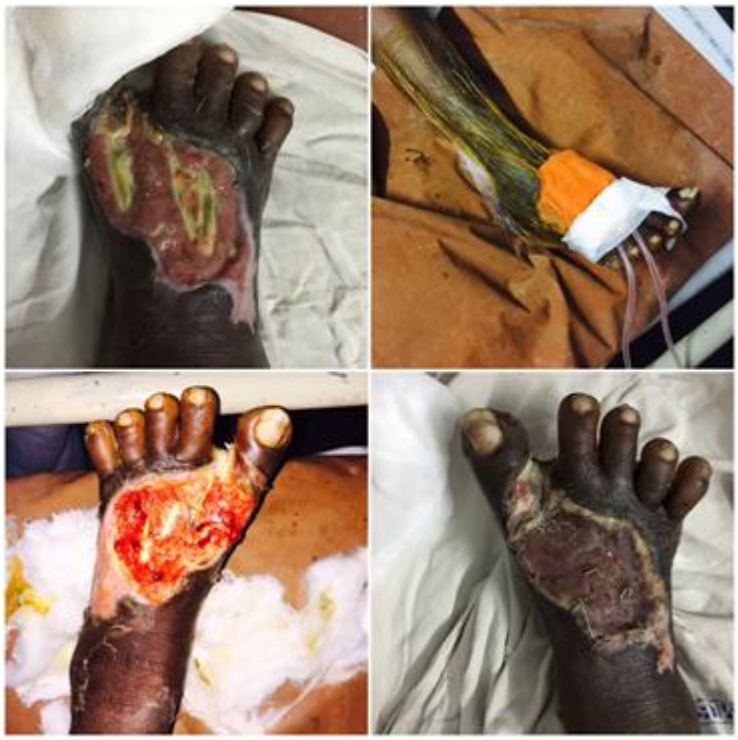

Fig-2: Vacuum dressing in diabetic wound

Analysis of the data

- Increased rate of granulation tissue formation was seen in to vacuum dressing group when compared to conventional dressing group.
- Increased wound contracture in vacuum dressing group compared to conventional dressing group.
- Better graft take up was seen in vacuum dressing group as compared to the conventional dressing group.
- Shorter duration of hospital stay was observed in the vacuum dressing group.

V. Discussion

Wound dressings have evolved from the status of providing physical protection to the raw surface, absorbing exudates and controlling local infections by local medications to the level of providing adequate environment promoting wound healing. This has been achieved by modern wound dressing techniques by promoting granulation tissue formation.Dressingsare applications for wounds to provide the idea environment for wound healing. Many studies have been conducted comparing various dressing modalities for different types of wounds. In developing countries like India where the cost of dressing is a major concern, the locally constructednegative pressure dressing was an option.

The concept of moist wound dressings which came into vogue in the 1960's which revolutionized wound care.[23] This led to further research in this direction leading to influx of many products like semi permeable plastic film dressings, hydrocolloids, hydrogels, collagen dressings into the wound care scenario, each claiming a better wound healing rate than the others. As the concept of 'outcome based medicine' evolved, the need for a better wound dressing modality became more acute. Now wound dressing systems were compared not only on the basis of the rate of granulation tissue formed or the rate of wound healing but also on the cost and duration of hospital stay of the patient which was considered as a measure of the morbidity of the patient.

Healing is an intricate, interdependent process that involves complex interactions between cells, the cellular microenvironment biochemical mediators, and extracellular matrix molecules that usually results in a functional restoration of the injured tissue[46,47]. The goals of wound healing are to minimize blood loss, replace any defect with new tissue (granulation tissue followed by scar tissue), and restore an intact epithelial barrier as rapidly as possible. The rate of wound healing is limited by the available vascular supply and the rate of formation of new capillaries and matrix molecules[48]. These events are heavily influenced by locally acting growth factors that affect various processes including proliferation, angiogenesis, chemotaxis and migration, gene expression, proteinases, and protein production[46,49-51]. Disruption of any of these factors may adversely affect the healing process, resulting in a chronic or nonhealing wound

The management of chronic wounds remains a challenge. In the early 1990s, the concept of topical negative pressure moist wound dressing was introduced into the field of chronic wound care. This type of dressing involved a combination of hydrocolloid dressings with topical negative pressure dressings.[53] The concept of applying a sub-atmospheric environment on wounds to accelerate the healing process came into practice in 1993 and was first described by Fleischmann *et al* .[54] The science behind topical negative pressure dressings is to apply a sub-atmospheric pressure over a wound bed and maintain the negative pressure environment by means of a semi-permeable occlusive coverage. Since the wound is occluded from the surrounding environment it is also called "Limited Access Dressing (LAD)"[54,55]. In 1994 Lazarus stated Wounds are regarded as chronic when they fail to heal or do not respond to treatment[56]. In an attempt to influence this wound healing process many kinds of treatment have been developed, for example surgical debridement[57], various types of dressings[58], topical applications[59], and antiseptic agents[60]. One of the recent developments is the application of topical negative pressure (TNP), a concept which emerged in the late 1980s since when several devices have been developed and marketed[61]

5.1 Mechanism Of Action

Despite the early clinical success and widespread empirical introduction of TNP into clinical practice, it is not known exactly how TNP therapy may exert effects on the wound. Several mechanisms have been proposed. TNP is said to increase local blood flow and reduce oedema and bacterial colonisation rates. It is thought to promote closure of the wound by promoting the rapid formation of granulation tissue as well as by mechanical effects on the wound. It concurrently provides a moist wound environment and removes excess wound exudates thus aiding in the creation of the "ideal wound healing environment".[63]

5.1.1 Local blood flow

Morykwas[64] used needle probe laser Doppler flowometry to show that sub-atmospheric pressures of 125 mm Hg resulted in a fourfold increase in blood flow using an excisional wound model in pigs. This increase in blood flow has also been shown in human burns.[65] Further higher increases in pressure (>200 mm Hg) were shown to decrease blood flow. There remains confusion as to whether continued pressure leads to an eventual decline in blood flow[9] or a cyclical pattern of blood flow.These direct effects on dermal vasculature are thought to be mediated by influencing vasomotor mediators. However, the indirect effects of mechanical forces exerted on the extracellular matrix inevitably affect the microvasculature contained within it.

5.1.2 Mechanical stress

The importance of physical forces in TNP therapy is still theoretical, however there is good evidence of the importance of mechanical stress on cellular reproduction and angiogenesis.[66] Increasing mechanical stress in vitro causes an increase in cellular activity, the nature of which varies with the cell type and methodology. Accelerated cell cycling[67] and DNA synthesis[68] have been seen. Experimental evidence from model systems also suggests that mechanical forces can result in increased fibrogenesis in cutaneous wound models.[68]

5.1.3 Granulation tissue formation

In Morykwas' studies[65] using porcine dorsal midline excisional full thickness excisional wound models, alginate impressions were taken daily after treatment with TNP. Volume displacement of these casts demonstrated that TNP treated wounds showed increased granulation tissue formation compared with the controls by 63% and 93.4% (continuous and intermittent suction respectively), although it is not known what effect contraction played to change the size of these wounds. This increase in granulation tissue formation has been confirmed by Joseph *et al* and Fabian *et al* using rabbit ear studies.[69,70]

5.1.4 Bacterial colonisation

Microbial colonisation of the wound bed is considered as one of the important factors responsible for delay in healing process in chronic wounds. The accumulated oedema fluid acts as a good medium for the proliferation of bacteria at the wound site. The impaired circulation and the resultant reduced local immunity also contribute to this. The microbial infection delays the healing process by a number of mechanisms. The microbes consume oxygen and nutrients from the healing wound environment. Moreover they express certain proteases and enzymes that breakdown cytokines which are necessary the proper progress of healing. Studies have shown that a reduction of bacterial load of a wound improves granulation tissue formation and thus faster

healing. Topical negative pressure application is believed to achieve this by removal of accumulated interstitial fluid, improved local circulation and oxygenation and improved local immunity. The increased flow should make greater amounts of oxygenavailable to neutrophils for the oxidative bursts that killbacteria.

5.1.5Oedema reduction and exudate management

Clinically TNP removes large amounts of fluid from wounds especially acute burns[71]The resulting reduction in oedema is thought to aid in the enhancement of blood and nutrient flow into the wound. However, this removal of exudate (which will include metallo-proteinases and other inflammatory mediators[72,73]) from the wound and oedema from the surrounding tissues encourages nutrient movement into the wound area even if blood flow is not increased. Removal of fluid prevents a build up of inflammatory mediators and encourages diffusion of further nutrients into the wound. This is all beneficial to the healing process especially in the case of chronic wounds where it has been hypothesised that an imbalance of metallo-proteinases can inhibit healing. Anecdotally the volume of wound exudate gathered from acute wounds decreases significantly over the first three to four days signifying a decrease in wound oedema. However, currently there is no quantitative evidence to support an actual reduction in interstitial wound fluid although studies are underway to attempt to evaluate changes in wound fluid constituents under TNP.

5.2 Comparisons of present study

In this study it is demonstrated that the use of vacuum therapy in chronic wounds results in improved wound healing compared to conventional moist gauze therapy.This is reflected by on average healthier wound conditions i.e. faster healing, increased graft uptake, and decreased hospital stay. One of the important advantages of vacuum therapy is the fact that healthier wound conditions were achieved without intermediate debridement. In most of the conventionally treated patients, debridement was necessary to remove slough. Mechanism of action that has attributed to TNP therapy are increase in blood flow promotion of angiogenesis,reduction of wound surface area in certain types of wounds, modulation of the inhibitory contents in wound fluid, induction of cell proliferation[82].

Another major advantage of vacuum therapy is the reduction of the number of dressing changes to once every 48 hours instead of daily dressings as in conventional therapy. The reduction of dressing changes leads to an improvedpatientcompliance as the patient suffers less often pain and inconvenience. In this study we have used a locally constructed VAC dressing.

Table -11 : Comparison Of Present Study With Similar Published Studies

Variables	Joseph et al[28]		L.F.Tauro et al[86]		Abidali et al[108]		PresentStudy	
Groups	Vacuum	Control	Vacuum	Control	Vacuum	Control	Vacuum	Control
Sample Size	18	18	56	56	60	60	60	60
Mean Age (Yrs)	52.41	53.2	47.59	47.42	56.13	55.73	48.53	48.78
RateofGranulation	81.56%	54.3%	80.6%	60.45%	79.40%	55.38%	78.68%	51.92%
Graft uptake	85.3%	56.43%	80.6%	60.45%	82.48%	57.55%	80.78%	59.58%
HospitalStay(Days)	36.25	70.4	32.64	60.32	32.22	39.07	32.48	59.43

5.3 Limitations of the study

The most important limitation of the present study is its sample size. Although a sample size of 120 patients is sufficient for statistical analysis, a randomized controlled comparative study with a much larger population may help to further substantiate the findings or reveal variations which were not observed in the present study.

The cost burden on the patient is also not analyzed in this study as this can be influenced by various factors other than the cost of dressings.

The quantitative assessment of the post operative parameters like wound contraction, pain and residual raw ulcer area was also not included in the present study, which if included, might have given a much better analysis of the efficacy of topical negative pressure moist dressings as compared to conventional moist dressings.

Another problem with the study is the potential for performance bias. Because the VAC device setup is a large device set up and markedly different from moistened gauze and often has a rapid effect on wound appearance, it is difficult to adequately mask the direct caregivers and patients to group allocation and bedside wound assessment.

Another limitation with this study was that the standard for VAC therapy is vacuum assisted device

from Kinetic Concepts Inc. (KCI, San Antonio, Texas). It is quiet expensive and running cost is also very high which patients in our set up could not afford. So we used a modified form with suction apparatus / wall mounted suction as vacuum device. So that is why results might not be standardized in comparison to KCI device.

This study has not done any study on the optimal negative pressure and not maintained a record of specific pressures used in individual cases.

5.4Future trends

Vacuum therapy can be regarded as a method that combines the benefit of both open and closed treatment and adheres to DeBakey's principles of being short, safe, and simple. It has been shown to work and be beneficial to wound healing, but protocols for use have to date been clinician dependent and sometimes idiosyncratic. The Cochrane report (2001)[29] stated that there is a paucity of high quality trials, and most studies currently consist of small sample sizes or methodological limitations so that any results should be interpreted with caution. Further random controlled trials are required to investigate these issues although this may be a challenging problem for researchers in wound healing because of difficulties in the assessment and measurement of healing in wounds.

Vacuum therapy is not the answer for all wounds; however it can make a significant difference in many cases. In much of the current literature on TNP comparing it with more traditional dressings wound healing has been measured in "time to complete healing" or epithelialization. This may be an inappropriate measure of effectiveness as TNP is most useful in difficult cavity or highly exudative wounds. TNP is a useful tool in moving a wound to a point where more traditional dressings or more simple surgical reconstructive methods can be used. As such it is a well deserved, although at present pragmatic addition to the wound healing armamentarium and the reconstructive ladder.

Further research is needed to increase understanding of the therapeutic effects of VACtherapy to give clinicians stronger arguments to support its use[78,103]. In particular, futuretrials should focus on the generation of level-1 evidence and further comparative data forspecific indications. This will help to clarify the potential for VAC therapy in different woundtypes and to enhance clinical decision-making in various population groups.For example:

- There is a small but emerging use of VAC therapy in the pediatric population. Clarificationis needed on the type of foam dressing and pressure settings to be used in thesepatients
- Further research is needed to establish the relationship between negative pressure andblood flow and the optimal pressure for wound healing[104]
- The economic impact of VAC therapy requires further evaluation to justify the increasedcost of treatment against the overall benefit of shorter healing times
- As new negative pressure devices are developed, there will be a need to compare theeffectiveness of these emerging systems
- Prospective, multicentre studies with a common protocol should be performed and areneeded.
- Foam pore size has been shown to be directly related to the amount of granulation tissue formation. Largerporesstimulatemoregranulationtissueformationinadiabeticmouse model.[105]
  Other interfacematerialssuchaspolyvinylalcoholspongeswithsmallporesare non-adherent, with little tissue in growth. Several authors have instilled a variety of solutions into these devices, which may be effective, particularly when treating wounds with high bioburden of bacteria.
- Further research on optimal cycling.Most biological systems have a more robust response when subjected to variable rather than continuous mechanical forces. In a preclinical model, it is found that applying NPWT for 4 hours every 2 days gave a similar granulation tissue response as continuous therapy. Surprisingly, when faster cycle times were used, there was less granulation tissue formed, suggesting that too fast of a cycle time may damage nascent granulation tissue.
- Current devices are often limited to obtaining a good seal at the edges of the device, making it difficult to maintain suction. Advances in adhesive science to allow better adhesion around curved and moist surfaces would make the device more easily applied to difficult wounds.

The important areas where significant advances has occurred in chronic wound care are the development of wound dressing systems, which stimulate wound healing process by improved granulation tissue formation and the development of permanent composite skin replacement in the form of genetically engineered keratinocyte culture techniques and growth factors with artificially formed dermal analogues, namely Integra, AlloDerm, polygalactin mesh, human allogenic dermis etc., which has immense potential. The main problem of the latter technique is that it is still in the experimental phase and will not be available to common man in the near future[106]. Extensive research is going on in the development of artificial skin substitutes by combining cultured keratinocytes.[107]. It is only a matter of time before a successful approach to

the management of chronic wounds is devised.

VI. Conclusion

In our present study it was concluded that the rate of granulation tissue formation, overall graft survival and patient compliance was better in vacuum assisted closure dressing group as compared to conventional dressing group. It was also seen that the overall hospital stay and post-operative complications were less in the vacuum assisted closure dressing group. Thus, vacuum assisted closure dressing can be considered as a superior option in the management of chronic wounds. But further studies with larger population will be needed in the future before vacuum assisted closure dressing can be added to the wide spectrum of treatment modalities available in the management of chronic wounds.

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