

## Comparative Study of Negative Pressure Wound Therapy vs Moist Saline Dressing in management of Stage III/IV Sacral Pressure Sores

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### Abstract

**Introduction:** Pressure sores in sacral area are a common cause of prolonged morbidity & increased health expenditure. In this study, we compare two methods of treating pressure sore- the newer “Negative Pressure Wound Therapy”(NPWT) and the conventional moist saline dressing. **Materials & Methods:** 124 patients participated in the study with half (n=62) of the patients in NPWT group & the other half (n=62) in moist saline dressing group. Descriptive statistics of both the groups were laid out. The two management modalities were compared by Chi square test for granulation tissue formation, wound size reduction, absence of wound discharge and negative wound culture. Statistical calculations were done with Microsoft excel & [www.socscistatistics.com](http://www.socscistatistics.com). **Results:** The patients in the NPWT group had significantly higher formation of granulation tissue, higher contraction of wound size, lesser discharge from wound & lower culture positivity compared to moist saline dressing group (p<0.05). Stroke followed by spinal disorders & malignancy were found to be the commonest precipitating factors for development of pressure sores. **Conclusions:** NPWT fares significantly better compared to moist saline dressing in pressure sore management. Though expensive but a significantly faster rate of recovery & lower requirement of surgical procedures makes it overall cost effective as well.

**Keywords:** Pressure sores, NPWT, saline dressing

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### Introduction

Pressure sores around sacral area are a common health problem associated with great morbidity and cost [1]. Now, it has become clear that pressure is but one of many factors that contribute to the development of pressure sores. The pathogenesis involves not only pressure, but a multitude of additional factors including friction, shear, moisture, nutrition, neurological damage and infection. The most common conditions giving rise to pressure sores include stroke and spinal cord injury among paralytic causes & chronic debilitating conditions like malignancy or fractures or prolonged mechanical ventilation as non-paralytic causes [2, 3]. With the subject supine, the points of highest pressure were the sacrum, buttocks, heel, and occiput, all of which were subject to pressures of roughly 50–60 mmHg. When sitting, pressures up to 100 mmHg were recorded over the ischial tuberosities [4]. Much of the pressure applied to tissues is carried by the connective tissues surrounding the blood vessels. Furthermore, autoregulation of local blood flow will tend to increase blood pressure in response to applied pressure within a certain range [3]. Dinsdale found that pressure roughly double capillary closing pressure, applied for 2 hours, resulted in irreversible ischemic damage to tissue [5]. Pressures below this threshold were unlikely to cause tissue necrosis, while increased pressures were correlated with increased likelihood of ulceration. Furthermore, different tissues have different susceptibility to pressure. Nola and Vistnes noted that pressure on skin over a bone is more injurious than pressure on skin

over muscle [6]. In this study, we have tried to compare the 2 modalities of treatment of pressure sores: conventional moist saline dressing & by Negative Pressure Wound Therapy (NPWT). NPWT comprises of the following steps: 1) Wound preparation 2) Placement of foam. 3) Sealing with drapes. 4) Application of negative pressure [7].

### Materials & Methods

This was a non-randomized, prospective, interventional study carried out on patients admitted with Stage III or IV pressure sores in General Medicine, Plastic Surgery, General Surgery, Neuromedicine, Neurosurgery & Orthopaedics wards of a tertiary care hospital in West Bengal. The underlying disorder responsible for development of pressure sores was noted and the determination of grade of ulcer was done as per the National Pressure Ulcer Advisory Panel (NPUAP) staging system [8]. Table 1 shows the classification system. The study was cleared by the Institutional Ethics Committee. All patients <80 years of age presenting with pressure sores around the sacral area were included in the study. Patients with Stage I & II pressure sore and those with extensive generalized skin disease were excluded from the study. Informed consent was taken from patients who participated in the study. A total of 132 patients were recruited over a period of five years as a part of this study. 8 patients were lost to follow up & 124 patients completed the study. Baseline blood investigations were done for all the patients including complete blood count, fasting & post prandial blood sugar & renal & liver function tests and swab culture sensitivity from wound were done. Two groups were made- those who would undergo moist saline dressing & those who would undergo negative pressure wound therapy (NPWT). The consecutive patients who were selected on the basis of inclusion & exclusion criteria were put alternately into moist saline dressing group & NPWT therapy group.

Moist saline dressing involved cleansing of wound by hydrogen peroxide, with or without surgical debridement followed by daily moist saline dressing. Wound was examined daily during dressing. In

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the NPWT group, wound bed was prepared by saline irrigation of the wound & surgical wound debridement. Sterile open pore foam dressing was placed in the wound cavity. The site was then sealed with an adhesive drape covering the foam and tubing and at least three to five centimeters of surrounding healthy tissue to ensure a seal. It was followed by application of negative pressure by NPWT pump apparatus. Controlled pressure was uniformly applied to all tissues on the inner surface of the wound. The pump delivered an intermittent negative pressure of -125mmHg. The dressings were

changed on every fourth day. Hence wound evaluation was done every 4<sup>th</sup> day in the NPWT group & everyday in the daily moist saline dressing group.

All the patients were followed up for 3 weeks. Primary endpoint of the study was covering of the wound by healthy granulation tissue. Secondary end point was decrease in the wound size.

Statistical analysis: Statistical analysis was done using Microsoft excel & www.socscistatistics.com.

**Table 1: The National Pressure Ulcer Advisory Panel (NPUAP) Staging System**

Stage I	Intact skin with non-blanchable redness of a localized area usually over a bony prominence
Stage II	Partial-thickness loss of dermis presenting as a shallow open ulcer with a red pink wound bed, without slough. May also present as an intact or open/ruptured serum-filled blister
Stage III	Full-thickness tissue loss. Subcutaneous fat may be visible but bone, tendon, or muscle is not exposed. Slough may be present but does not obscure the depth of tissue loss. May include undermining and tunnelling
Stage IV	Full-thickness tissue loss with exposed bone, tendon, or muscle.
Suspected deep tissue injury	Purple or maroon localized area of discoloured intact skin or blood-filled blister due to damage of underlying soft tissue from pressure and/or shear.
Unstageable	Full-thickness tissue loss in which the base of the ulcer is covered by slough (yellow, tan, gray, green, or brown) and/or eschar (tan, brown, or black) in the wound bed. Until the base of the wound is exposed, the true depth, and therefore stage, cannot be determined

## Results

**Table 2: Descriptive statistics of patients in NPWT & moist saline dressing groups**

Parameters	Npwt	Moist Saline		P-Value (Determined By Independent T-Test)	
Total Cases	62	62			
Male:Female	48:14	44:18			
Age Distribution (In Years)				0.2 Insignificant	
Mean Age	50	49.27			
S.D.	20.435	20.690			
Range	15-80	15-80			
Distribution Of The Stages Of Pressure Sores					
Stage (NPUAP)	Frequency	%	Frequency	%	
III	41	66.1	46	74.2	0.5 Insignificant
IV	21	33.9	16	25.8	

Table 2 shows the descriptive statistics of the patients involved in the study along with the stages of pressure sores in each of the groups. Both the NPWT group & saline dressing group had 62 patients each. Male: female ratio was 48:14 in NPWT group & 44:18 in the saline dressing group. The mean age in both the groups was about 50 years. The distribution of Stage III & IV pressure sores was 41 & 21 for the NPWT group & 46 & 16 for the saline dressing group respectively.

In the NPWT group, out of the 62 patients, 57 patients reached the primary endpoint i.e., they were fully covered with healthy granulation tissue. Little or no granulation tissue covering was seen in 5 patients. In the moist saline dressing group, 41 patients had their wounds covered by healthy granulation tissue and the rest 21 had little or no granulation tissue. Contraction in wound size was seen in 51 patients in the NPWT group & 32 patients in the saline dressing group. Persistent discharge at 3 weeks was seen in 9 patients of the NPWT group and 20 patients in the saline dressing group. Wound swab culture remained positive for 4 patients in the NPWT group in contrast to 13 in the saline dressing group. The findings have been described in Table 3. Figure 4, 5 & 6 shows the progress of the sacral wounds of a patient before during & after NPWT respectively. The different etiologies underlying the pressure sores and their frequencies have been shown. The highest number of patients had suffered stroke (39.5%) followed by spinal disorders (33.1%) & pelvic or lower limb fractures (16.9%).

**Table 3: Comparison for outcome of NPWT vs Moist saline dressing**

Parameters	NPWT	Moist Saline	P-Value (Determined By Chi Square Test)	Significance Of P-Value
(I) Granulation				
Complete Granulation	57	41		
No Or Minimal Granulation	5	21	=0.0004	Significant
(II) Discharge				
Absent	53	42		
Present	9	20	=0.02	Significant
(III) Wound Size				
Decreased	51	32	=0.003	Significant

Increased Or Same	11	30	=0.02	Significant
(Iv) Wound Culture				
Negative	58	49		
Positive	4	13		

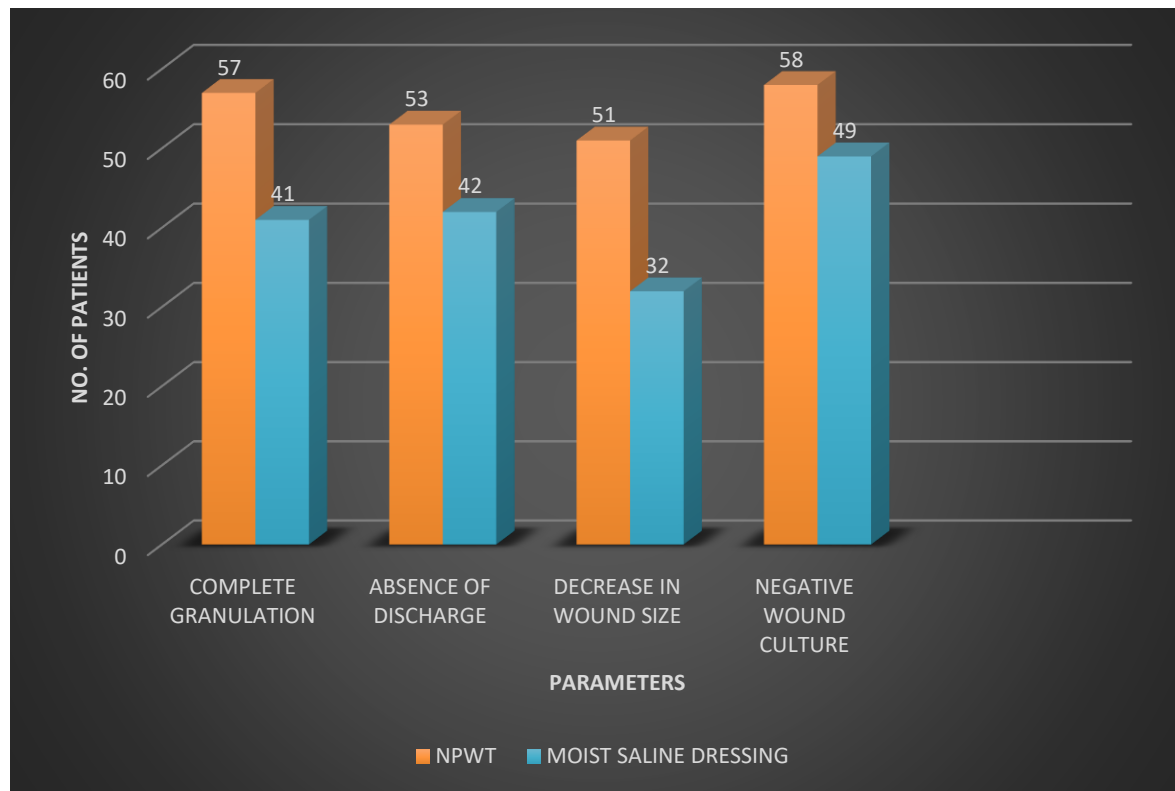


Fig 1: Clustered Columns for NPWT Vs Moist Saline Dressing

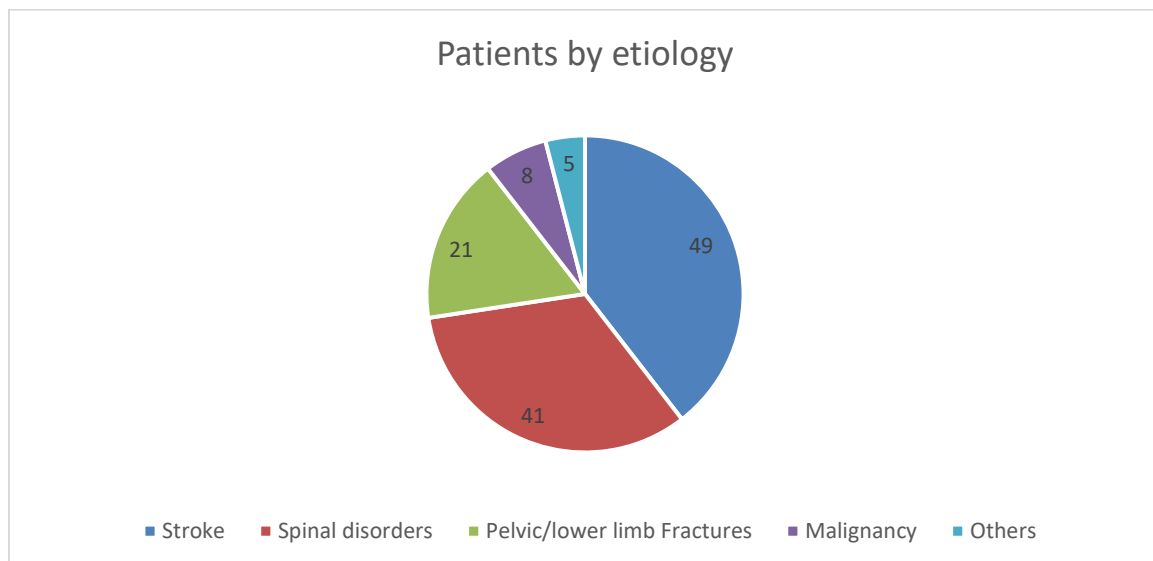


Fig 2: Distribution of patients by etiology of pressure sores



Fig 3: Sacral pressure sores before NPWT



Fig 4: Patient receiving NPWT



Fig 5: Patient after receiving NPWT

### Discussion

Conventionally, moist normal saline dressing of wounds were done since a long time. But this gave neither a full satisfactory outcome with respect to appearance of granulation nor a rapid wound healing [9,10]. Therefore, other methods of dressing were sought for. 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 [10]. The rate of wound healing is limited by the available vascular supply and the rate of formation of new capillaries and matrix molecules. NPWT has been advocated as a novel method in the healing stimulating the chronic wound environment in such a way that it reduces bacterial burden and chronic interstitial wound fluid, increases vascularity and cytokine expression and to an extent mechanically exploiting the

viscoelasticity of peri-wound tissues [11]. Negative pressure wound therapy help the tissues to heal by the following means:

1. Increasing the growth of granulation tissue,
2. Stimulating proliferation of capillaries (angiogenesis),
3. Suctioning matrix metalloproteinase in the wound exudates, which have detrimental effects on wound healing, and
4. Contracting the wound

In our study, the outcomes of NPWT & moist saline dressing were compared by Chi square test. Stage III & stage IV pressure sores treated with NPWT had significantly higher granulation tissue covering, absent wound discharge, decrease in wound size & negative wound culture in comparison to moist saline dressing. Thus, NPWT is an effective modality of management for sacral pressure sores which aids in much better wound healing than conventional moist saline dressing. Blood flow increases and bacterial colonization of



wound tissues decreases following the application of sub-atmospheric pressure to wounds [11]. Increase in circulation and oxygenation to compromised or damaged tissue enhances the resistance to infection. NPWT increases the vascularity and the increase in rate of granulation tissue formation compared to standard wound dressing. Histologically, NPWT patients showed angiogenesis and healthy tissue growth as compared to the inflammation and fibrosis seen in standard wound dressing. Inflammation had increased in those treated with standard wound therapy and decreased in those patients treated with NPWT [12, 13]. The highly significant increase in the rate of granulation tissue formation of sub-atmospheric pressure-treated wound is postulated to be due to transmission of the uniformly applied force to the tissues on the periphery of the wound. These forces both recruit tissues through viscoelastic flow and promote granulation tissue formation. Application of negative pressure over the wound bed allows the arterioles to dilate, increasing the effectiveness of local circulation, promoting angiogenesis, which assists in the proliferation of granulation tissue [12-15].

Standard wound dressings adhere to devitalized tissue and within four to six hours the gauze can be removed, along with the tissue, as a form of mechanical debridement. This method of wound care has been criticized for removing viable tissue as well as nonviable tissue and being traumatic to granulation tissue and to new epithelial cells. Only disadvantage comes with the cost of the therapy which is quite high as compared to that of conventional moist saline dressing [11, 13, 14]. But considering the cost-effectiveness of the therapy, NPWT appears to be the most appropriate non-surgical management of dressing pressure sores of higher stages. Although traditional soft tissue reconstruction may still be required to obtain adequate coverage, the use of this device appears to decrease their need overall [14, 15].

#### Conclusion

NPWT fares significantly better than moist saline dressing in pressure sore management. Though expensive but a significantly faster rate of recovery & lower requirement of surgical procedures makes it overall cost effective as well.

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