Vacuum assisted closure of diabetic ulcers

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Abstract
Diabetes affects more than a 100 million people worldwide. Around 10.5% of Americans and 10.9-14.2% of Indians are diabetics, and therefore susceptible to its complications of microangiopathy, neuropathy and poor wound healing, all of which contribute to high incidence of ulcers, particularly of the distal extremities, even after trivial trauma. Management of these ulcers require systemic management of diabetes and its complications in these patients. Vacuum assisted closure of Diabetic Ulcers, by application of its principle of Negative Pressure to the wound has gained popularity due to early appearance of granulation tissue, facilitation of secondary wound closure and decreased duration of hospital stay. We studied 80 patients with diabetic ulcers from December 2017 to November 2019, randomly assigning them to two groups, Vacuum Assisted Closure versus conventional moist wound dressing to ascertain any possible benefit of Negative Pressure wound therapy with respect to appearance of granulation tissue, secondary closure after the therapy, interval for skin grafting, duration of hospital stay.

Keywords: Diabetic ulcers, NPWT, Vacuum assisted closure

Introduction
Argenta and Morykwas were the first to report Vacuum Assisted Closure of wounds in 1997, wherein removal of oedema, production of granulation tissue and softening of surrounding tissue facilitating early wound healing and skin grafting were observed. Vacuum dressing involved thorough debridement, adequate hemostasis and application of sterile foam dressing with the machine delivering negative pressure at 50 to 125 mmHg. The advantage of NPWT is decrease in wound volume, depth, treatment duration and cost. NPWT also enables earlier secondary closure of wound and skin grafting as compared to conventional saline dressing.

Material and Methods
Patients presenting with non-healing ulcers with a past history of diabetes mellitus or diagnosed with the same after admission, localised abscesses in diabetics resulting in large wounds post drainage, post amputation stumps were all included in the study. Out of the 80 patients, 40 were randomly assigned to vacuum therapy and 40 to conventional saline dressing. Proper consent was taken from patients before including them in the study.

Inclusion criteria: Any non-healing wound in a diabetic patient, including post traumatic ulcers, post incision and drainage of abscess, post debridement or amputation of a diabetic foot.

Exclusion criteria: Wounds with critical limb ischemia and non-diabetic wounds weren’t included in the study. All patients underwent baseline Hemogram, Fasting and Post prandial blood sugar levels, HbA1C levels, X rays of relevant bones and joints, Arterial doppler of limb involved. Co morbidities and glycemic control were addressed during the admission. Patients underwent complete neurological examination and ophthalmological evaluation. All wounds were surgically debrided before subjecting them to either group. Patients subjected to Vaccum Dressing were given NPWT for 6 continuous days, whereas the control group was given daily saline moistened gauze dressing. Antibiotics were initially broad spectrum and later given according to culture sensitivity reports.

Vaccum device consisted of the following parts, 1.Sponge, 2.Semipermeable dressing, 3.Tubing, 4.Vaccum machine. The pressure applied was 50 to 125mmHg, intermittently.
The vacuum machine had a cannister attached to it that collected the effluent from the wound. Cannisters were changed once filled with effluent, with deeper wounds requiring more frequent changing than comparatively superficial ones. NPWT dressing was done under aseptic precautions. Patients and relatives were educated about the basic working of the setup, and to report if the machine stopped working or if the effluent was excessive. They were also taught to disconnect the tubing temporarily when they mobilised and to keep the dressing dry externally.

**Result and Discussion**

At the end of 6 days, patients subjected to Vacuum dressing had decreased depth of the wound, decrease in total surface area of the wound, decreased surface area of wound, decreased discharge from the wound, earlier skin grafting or secondary closure, decreased duration of hospital stay. Mean age of Case group was 56 years, 55.5 years in control group. 97.5% of patients in case group were males, while 100 % were males in control group. There was more than 50% decrease in depth of the wound in case group in 87.5% of patients while only 65% of patients in control group had such a significant decrease in depth of the wound. Average number of days needed for skin grafting or secondary closure was 12 in NPWT group compared to 20 in the control group with saline dressing.

Various theories have been postulated about the mechanism of action of vacuum therapy. *In vitro* studies have revealed that cells allowed to stretch, tend to divide and proliferate, in the presence of mitogens, whereas retracted cells remain quiescent [4]. NPWT provides a moist environment which is favourable for reepithelisation, angiogenesis, promotion of formation of granulation tissue and protects the local nerves [5]. There is a decrease in oedema which decreases interstitial pressure and positively affects microvascular occlusion and lymphatic drainage, increasing availability of oxygen nutrients and antibiotics reaching the wound [6]. Wound exudate is high in metalloproteinases, which are unsuitable for healing as they degrade proteins that are not normally their substrate, growth factors, receptors and extracellular matrix proteins. NPWT promotes an improvement in the balance between proteases and their inhibitors [7]. There is an increase in blood flow due to increase in vascular diameter, blood flow velocity and diameter [8]. NPWT promotes early angiogenesis and appearance of granulation tissue. There is a mobilisation of endothelial progenitor cells (EPC), higher beta fibroblast growth factors (bFGF), thus promoting healing [9]. The foam in Vacuum therapy transmits a negative force to surrounding tissues, thus deforming extracellular matrix and activating tyrosine kinase and growth and transport genes [10].

NPWT can be used in post-traumatic, diabetic, pressure, postsurgical dehiscent wounds. However it cannot be used in infected wounds and wounds with critical limb ischemia. Lower pressures are used in case of decreased perfusion of affected limbs. Debridement prior to application of Vacuum dressing with proper antibiotic coverage is imperative, as without debridement, infection will worsen with vacuum application. Hemostasis should be achieved post debridement and prior to application of vacuum therapy. Also, diabetics due to other associated complications associated with the disease tend to be on antiplatelets or anticoagulants or both and are at a risk of bleeding, therefore monitoring of output from vacuum device is essential. NPWT gives a significant decrease in wound size, earlier appearance of granulation tissue, earlier closure of wound or grafting is possible. It also decreases hospital stay and morbidity. However it has its cons, particularly cost of the device (70-130 USD, per application), mild pain or discomfort and irritation of surrounding skin due to barrier layer and abrasions associated with improper application of foam. Alternatively a combination of NPWT with topical wound oxygen therapy has also been tried.
These can be named as ‘post Vacuum application’

**Conclusion:** Vacuum Dressing yields better results compared to conventional dressing for diabetic ulcers in terms of earlier appearance of granulation tissue, decrease in depth of wound and from wound, decrease local oedema, facilitation of earlier secondary closure or skin grafting, decreased hospital stay and overall morbidity.

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