Vacuum assisted closure [VAC] in management of diabetic foot

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Abstract: Introduction: Treatment of diabetic foot wound, especially hard to heal wound. Need more effort to develop a standardized protocol for management of diabetic foot. The purpose of this study was to evaluate the efficacy of the use of vacuum assisted closure (VAC) in management of diabetic foot. Patients and Methods: Fifteen cases of advanced diabetic foot that were treated with VAC, between October 2012 -May 2014. Age of patients between (44-65years). Ten patients had undergone local foot surgery, five patients had undergone Spinal foot surgery in all patients extensive debridement was performed that resulted in open minor amputation in three cases, ten cases with deep ulcer and below knee amputation of two cases. The median follow-up period of the patients was six months. Results: Wound healing of diabetic foot was achieved in all cases. Number of changes with VAC was 12 within median period of 6 weeks, most of them was performed as outpatient procedures. There was no major complication. Conclusion: The uses of VAC in management diabetic foot appears as gold standard and very helpful in closure of diabetic foot wound.
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1. Introduction:

Diabetis now affects more than 371 Million people world wide, with $ 471 billion spent in 2012 on diabetes – related health care.[1] In 2012, 4.9 million people worldwide died of diabetes, of which half were younger than 60 years.[2] Up to 25% of people with diabetes will developed a foot ulcer at some point during their life time,[2] with half developing infection and requiring hospitalization and 1 in 5 requiring amputation.[3]

The vacuum assisted closure system (VAC) was continuous or intermittent sub-atmospheric pressure over the surgical wound, applied with a polyurethane sponge sealed with adhesive transparent plastic. This system came into clinical use 15 years ago, it has been stated that treatment with negative pressure dressing can accelerate healing of diabetic foot lesions.[4-5]

The mechanism action for this system has multiple factor and consist and removal and excess fluid and reducing odema in tissues to therefore improve microvascular perfusion and decrease bacterial contamination.[6]

VAC therapy reduced complexity size-i.e. simplify the wound, in non infected, non ischaemic, deep complex diabetic foot ulcers, VAC therapy can be used to reduced the surface area of the wound by encouraging granulation tissue formation over exposed bone, tendon or tissue. This may help to avoid the need for skin grafting and/or flaps or to reduce the complexity of subsequent surgical closure procedure.[7,8]

The aim of this study is to describe our experience treating advanced, complicated diabetic foot using VAC.

2. Patients and Methods:

We performed this study on fifteen cases of advanced diabetic foot lesion that were treated with VAC, between October 2012-May 2014, age of patients between (44-65years).ten patients had undergone local foot surgery, five patients had undergone spinal foot surgery. In all patient extensive debridement was performed that resulted in open minor amputation in three cases, ten cases with deep ulcer and below knee amputation of two cases.

All patient presented diabetic foot lesion: seven patients grade 3 lesions, three patients grade 2, three patients grade 4 and two patients grade 5, according to Wagner classification system[9] (Table 1) :

Table 1: Wagner grading system for diabetic foot infection:

0- Intact skin
1-Superficial ulcer of skin or subcutaneous tissue
2- Ulcer extend into tendon, bone or capsule.
3- Deep ulcer with osteomylitis or abscess.
4-Gangrene of toes or forefoot.
5-Mid foot or hind foot gangrene.

All of the patients were informed about the technique to be performed.

Sequence of Procedure:

***1.* Wound preparation**:

We start by (surgical debridement). any necrotic tissues should be surgically removed. A culture swab for microbiology should be taken before using VAC.

Irrigation of wound with normal saline, apply antiseptic solution for wound and surrounding skin, then dry skin around wound.

***2.* Placement of foam**:

Sterile, open-cell foam dressing is gently placed into wound cavity. There are two different types of foam available. Black foam, polyurethane ether (PU), has been larger pores, is lighter, easily collapsible and with wide pores. White foam, polyvinylalcohal (PVA), it is denser with smaller pores, require higher negative pressure to collapse.

In our study we use dry white sponge instead of original foom to reduce the cost of procedures, which is locally manufactured and have the same characterize of white foam. Embedded in the sponge a fenestrated evacuation tube, which is connected to a vacuum pump that contains a fluid collection canister (Fig. 1).

Figure1-Dry sponge with connected tube.

3. **Sealing with drapes**:

The site is them sealed with adhesive drape, we used in this study thin sheet of plastic drape or opsite. Drapes should cover the foam and tubing and at least three to five centimeters of surrounding healthy tissue h ensure a seal as (Fig. 2).

Figure2-Plastic drape.

4. **Application of negative pressure**:

In this study we used a VAC apparatus model SX 300, with pump Can delivers intermittent pressure, ranging from 125 to 175 mmHg, and work for five minute on and 3 minute off (Fig. 3).

Figure3: Main unit of VAC.

The foam dressing should compress in response to the negative pressure.

For all case, a VAC system was used during the procedure, with intermittent mode. The VAC changes were performed using sterile technique every three to four days, or with shorter interval where indicated. The wound was inspected daily to identify inflammation sign in the tissue surrounding the lesion. VAC treatment continued until the lesion filled completely with granulation tissue and after that the decision was taken for do a partial thickness skin graft, or continue with conventional dressing. The mean length of patient follow up was six month, ranging from four to ten months.

3. Results

Wound healing of diabetic foot was achieved in all cases. We managed to save the extremity in all cases. Average number of change of VAC was 12 within median period of 6 wks, most of tham was performed as outpatient procedures. The hospital stay due to VAC treatment ranged from 4 day to 23 days. The median was 12 days. There was no major complication.

For 2 cases below knee amputation was done due to extensive tissue necrosis and poor blood supply. That patient presented by infected stump, debridement was done start VAC therapy, for 6 wks and complete closure of wound was achieved (Fig4 a,b).

Other 3 cases presented by partial necrosis of forefoot, extensive debridement was done and start VAC treatment at the time, for 4 wks, one of them after that undergo skin graft to close but 2 other close spontaneous.

10 cases presented by deep ulcer vary 7 at leg and 3 at foot. All presented by infection and tissue gangrene, after debridement start VAC treatment period about 8 wks (fig5 a,b,c,d).

2 of deep ulcer undergo skin graft to close but other cases the wound close spontinous.

2 cases presented by slow granulation tissue growth and required long time of VAC treatment more than 8 wks until complete closure of wound.

The most microorganisms were identified in bacterial cultures were staphylococcus aureus, staphylococcus epidermidis, klebsiella pneumonia and bactericides fragilis.

Figure4a-Wound after below knee amputation.

Figure4b-The same patient after VAC treatment for two months.

Figure5a-Deep infection in leg ulcer in diabetic patient. note the suppuration in the wound and the sign of infection.

Figure 5b-The same patient, the vacuum-assisted closure system in place.

Figure5c-The same patient after use the VAC for two weeks. Note the wound is clear and skin around show no sign of infection. the pt for skin graft or traditional dressing.

Figure5d-The same pt after six weeks with the traditional dressing.

No serious complication was noticed no odema, pain, erythema or suppuration. None of patient refused treatment of VAC or wish to discontinue of treatment.

There is some complication occurred related to technique included blockage of tube by blood clot or loss of dressing seal.

After all effort we do to decrease the cost but still high for most of the patient.

Table 2: Efficacy finding with VAC

Hospital stay	**4 days -28 days**	**Mean 12 days**
Number of dressing changes	4 -20 times	Mean changes 12
Costing of VAC	750LE - 3750LE	Mean 2250LE
Complete closure wound	3/15 (20%) for skin grafting	12/15 (80%) Spontaneous closure
Follow up period	4 months -10 months	Mean 6 months
Treatment failure with VAC	0/15(0%)	

Complication with VAC.(Tab3).

Complication	**Percentage**	**Comments**
Pain	3/15(20%)	Some patients suffer from minor discomfort at wound site, usually with large wound or high pressure.
Haematoma	1/15(6.6%)	Pt on anti-coagulant drug.
Slow granulation tissue growth	2/15(13.3%)	Need uses of VAC more than 8 weeks.
Reinfection	1/15(6.6%)	
Blockage of tube	2/15(13.3%)	By blood clots.
Cost	2250LE	Still high.

4. Discussion:

Our study has shown that using VAC system in management of diabetic foot lesion, is safe and effective, even in patient with co-morbidity. It showed that the treatment can be given on an out patient basis without causing complication.

Most of published studies on VAC therapy in treating diabetic foot lesion done on minor ulcer than those in our patient study.[9] Most recreantly study published multi-center study only selected patient with grade 2 and 3 ulcer (according to Wagner classification), meaning our patient lesion are more advanced.[10]

Before starting VAC therapy it is important to define treatment aims, objective and clinical endpoint.[11] In some circumstances the objective will be to avoid further complication and to control symptoms, rather than to influence time to healing. Example of clinical endpoints for VAC therapy include 50% volume reduction 80% granulation tissue formation or complete closure.[12] In general, the key aim are to:

- Remove exudates and reduced periwound edema.
- Increase local micro vascular blood flow.
- Promote formation of granulation tissue.
- Reduced complexity/size of the wound.

-Optimize the wound bed prior to and following surgery.

Reduce complexity of surgical wound closure procedures.[13] In addition, the application of VAC dressing system creates a closed, moist wound environment, which may act as a barrier to bacteria. [13] Clinicians may sometimes wrongly consider all diabetic foot ulcers to be the same for treatment purposes. Infact, there is considerable variation and the decision to use VAC therapy will depend on the wound subtype.VAC therapy can be considered for deep complex wound, for post-surgery wounds and occasionally, for superficial wounds in addition to standard treatment. For patient with ischaemic wounds, referral to vascular surgeon should be considered.[14]

Many factors may increase success of therapy shown in Table (4):

Table (4):

Wound factors	*Patient Factors*
• Wound has good blood supply • Wound has healthy, granular bed • Wound as been freshly debrided • Wound grater than 2 cm wide	• Patient has been maximally medically stabilized (e.g. nutrition, Bl pressures, Bl glucose, fluid balance, infection) • Patient has few or well-controlled co morbidities • Patient is comfortable (e.g. not in pain) • Patient is adherent with therapy

There may be benefits to starting VAC therapy as early as possible. Delaying may allow the wound to deteriorate before being treated effectively.[15]

Haemostasis must be done before applying the VAC dressing because its not a haemostatic dressing. If this not done, blood clots can occur leading to blocking of sponge or drainage tube.

If the skin surface surrounding the wound not dry, the adhesive plastic will not stick well to skin surface, which can cause a loss of seal in the dressing and expose healthy skin around the wound to negative pressure, which can cause maceration.

One of the important facts is that VAC treatment, decreases dressing change frequency in our patients dressing were changed every three or four days, while conventional treatment they are changed 2 or 3times daily.

VAC therapy should be stopped after the clinical endpoint is achieved (e.g. an appropriate reduction in volume or adequate wound bed preparation for subsequent skin grafting).

Conclusion:

VAC system in management of diabetic foot lesion appears to be very useful as an adjuvant treatment after radical debridement.

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