Efficacy of VAC Suction in Traumatic & Non-traumatic Wound Infection Management

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ABSTRACT

Objective: To asses the efficacy of VAC suction in traumatic and non-traumatic wound infection management

Methods: This retrospective study was conducted on patients received as primary traumatic wounds or patients with chronic wound infections from January 2014 to December 2016.

Results: A total of 67 patients underwent VAC suction with traumatic and non-traumatic wound infection management including 49 (73.1%) males and 18 (26.9%) females. Mean age of patient was 41.5 (SD ±19.5 years) with a range of 10 to 80 years. Mean hospital stay was overall 12.7days (SD± 5.3), with range from 5-27 days.

In 35 patients (52%) showed no growth on culture and sensitivity (C/S), while 20 (30%) patients C/S showed Staphylococcus aureus, and very few patients showed Escherichia coli (1.5%), Klebsiella (3%) and Pseudomonas (4.5%) and other organisms (8.5%).

In 64 (95.5%) patients Vac suction Treatment achieved full eradication, while there were very few cases of reinfection (3%) and fulminant infection (1.5%).

Conclusion: Vacuum suction therapy proved to be very effective method in traumatic and non-traumatic wound infection including acute and chronic infections.

Keywords: vacuum-assisted closure, topical negative pressure, traumatic and non-traumatic wounds.

INTRODUCTION

Wound is a type of injury in which the continuity of the skin is lost *(an open wound)* or where the blunt trauma causes contusion *(a closed wound).*

According to the level of contamination, a wound can be classified as;

Centre for Disease Control and Prevention (CDC) Surgical Wound Classification

Wound healing is a complex process that includes cell migration leading to repair and closure. This sequence takes place with the removal of debris, control of infection, tissue granulation, contraction, connective tissue remodelling and maturation. When this sequence fails, a chronic wound without anatomical or functional integrity results [1].

Fractures with open wounds require both skeletal stability and soft tissue coverage. In such type of injuries, necrotic and nonviable tissue requires debridement which can produce significant soft tissue defects precluding healing through primary closures, delayed primary closure or secondary closure [2]. Proper wound management is most important in orthopaedics if not treated properly leads to chronic infection and posttraumatic osteomyelitis [3]. Posttraumatic Osteomyelitis can cause delayed union and non-union and complicate the treatment [4].

Clean	A non-infective operative wound
Clean-contaminated	An operative wound
Contaminated	Open, fresh, accidental wounds.
Dirty-infected	Old traumatic wounds with retained devitalized tissue
Reference-:http://www.cdc.gov/hicpac/SSI/table7-8-9-10-SSI.html	

Vacuum Assisted Closure is in fact an active wound therapy first introduced by Morykwas and Argentain 1997 [5].

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A high bacterial load interferes with the healing process of a wound. Vacuum-assisted closure (VAC) is a wound healing therapy that utilizes a dressing system that continuously or intermittently applies a negative pressure to the wound surface [6]. This surgical technique has been widely used from the last few decades for the management of acute and chronic wounds**,** and studies have demonstrated to improve wound healing [6].

It is also known by pseudonyms - TNP (topical negative pressure) SPD (sub-atmospheric pressure), VST (Vacuum sealing technique) and SSS (sealed surface wound suction) [7]. Use of VAC suction has extended to multiple types of wounds, like surgical wounds from abdominal, chest and cardiac (heart) surgical procedures [8, 9].

Currently, vacuum-assisted closure can be used on all types of wounds: acute, subacute or chronic.

VAC (Vacuum Assisted Closure) assisted infection control is a widely acceptable method for chronic and traumatic wounds. Role of VAC suction was for the first time practised in 1990s [10] for the management of decubitus ulcers and chronic wounds [11].

The term vacuum means a space devoid of all gases including air, VAC is standard surgical procedure in which intermittent negative pressure of approximately -125 mmHg is applied causing debridement and leading to the formation of granulation tissue in chronic wounds and ulcers. It also assists to remove blood or serous fluids from a wound or surgical site.

Before the procedure it is necessary to remove the necrotic tissue as it has a significant effect on the delayed wound healing and increasing the risk of infection. So it is highly recommended to do wound debridement before going to vacuum assisted closure.

VAC stimulates wound healing through two processes called macrostrain and microstrain. Macrostrain draws the edges of the wound together, equally distributes the negative pressure, and removes exudate and infectious materials. Microstrain reduces oedema, stimulates perfusion, and stimulates granulation tissue formation [12,13].

As a consequence it causes reduction in bacterial count and increases proliferation, providing a suitable ground for flap or graft cover.

Duration of treatment depends on certain parameters including, size of wound, and depth of wound and duration of wound.

The Complications of the Vac suction are rare, but may be associated with pain, reinfection, fluid depletion, and bleeding and persistent infection/discharge.

The procedure consists of foam cut according the size of the wound and the placement of a perforated drain. The wound is then firmly sealed with a transparent adhesive film or membrane (IOBAN®). Vacuum is applied to the drain. The exposed end of the drain is attached to a suction source or suction pump. Hence fluid is drawn from the wound site through the foam and is carried out to disposal.

Hence the negative pressure acts by removal of serous fluids (decreasing oedema) and increasing blood flow through vasodilatation.

METHODS

This retrospective study was conducted at Quaid-e-Azam International Hospital, Islamabad, Pakistan from January 2014 to December 2016. All patients who had traumatic or non-traumatic wound infections underwent Vacuum assisted closure were included. Additional procedure done other than VAC suction and those with lack of data / loss to follow-up were excluded.

All the patients with traumatic or non-traumatic wounds were prepared for debridement, Irrigation and VAC suction. Essential laboratory workup like blood complete count, CRP, ESR, serum electrolytes, PT/INR and APTT and radiological significant images were then ordered.

Preoperative anaesthesia workup was done in all the cases. RCCs were arranged according to their haemoglobin and type of injury.

Patients were kept NPO from midnight and plan for the surgery for the next day. Those patients have a reserved Operation Room where the same surgical team did all surgeries and additional measures were taken to attain germ free environment.

Patients were given suitable type of anaesthesia according to age, type of injuries and co-morbidities.

After anaesthesia the involved extremity was painted with Povidone Iodine Solution and proper draping of surgical site was done carefully. Wounds were thoroughly debrided and all necrotic tissue was excised completely. After thorough debridement of bone and soft tissues, area was irrigated with copious amount of normal saline using pulse lavage.

After extensive removal of necrotic tissue and irrigation a sterile sponge is taken and a drain was

placed according to the size of a sponge. The sponge with a drain was inserted in a wound and wound was primarily closed with loose stiches. Then the wound is sealed with transparent adhesive tape (Ioban). The end of the drain was attached to suction machine while applying 40-60mm Hg negative pressure to drain. Suction was continuous applied in all cases while monitoring its function total output in every 24 hours was noted. If less than 50 ml of output was observed, then the patient was scheduled for the wound relook debridement and closure. But if during surgical procedure condition of wound was found not satisfactory with evidence of dirty foul smelling discharge or necrotic tissue, Vac suction dressing was reapplied. If the condition of wound was found satisfactory, then secondary closure of wound was done after thorough irrigation of area. Patients were given empirical antibiotics therapy after initial debridement and if the C/S showed any growth, appropriate antibiotics were given intravenous. In cases where patient presented with Open fractures, after initial vac suction and closure, an appropriate external fixation either unilateral or circular external fixator was applied.

The patients were subjected to include were acute and traumatic wounds, subacute wounds (i.e. dehisced wounds), pressure ulcers or bedsores or decubitus ulcers and chronic open wounds like diabetic ulcers and those were excluded fistulas to organs or body cavities, malignancy in wound (Incomplete record or followup).

After wound closure patient was monitored clinically and with laboratory investigations for control of infection. In 64 (95.5%) showed full eradication, 2(3.0 %) patients underwent reinfection, 1 (1.5%) patient developed fulminant infection**.** Patient were kept in hospital for few days until wound healing was found satisfactory and then were discharged on appropriate IV antibiotics and were followed in OPD regularly and were assessed clinically and All data was collected from the file of the patients from department of medical records and was evaluated using SPSS 19. Analysis of the results was done and P value less than 0.05 were considered not significant.

RESULTS

From January 2014 to December 2016 a total of 67 patients underwent vac suction management for various types of their infection and included 73 %(49) male and 27 %(18) female patients. Mean age of the sample was 41.5 years (SD ±19.5 years) with a range of 10 to 80 years. Mean hospital stay was 12.7 days (± 5.33), with range from 5 to 27 days.

41 patients (61.2 %) presented with open wounds including open fractures while 21 (31.3%) have complicated deep infection, and 3 (4.5%) were having osteomyelitis while 02 (3.0%) were having other types of infection (Table 1).

Table 1: Diagnosis

	Frequency	Percent
Open wound infection	41	61.2
Complicate/Deep infection	21	31.3
Osteomyelitis	3	4.5
Others	2	3.0
Total	67	100.0

In 2 (3.0%) patients had forearm as site of wound infection, 36 (53.7%) had wounds on their hips and thigh, while 23 (34.3%) had wounds on their legs, 1 (1.5%) patient had wounds on their foot while 5(7.5%) had multiple wounds.

Table 2: Site of Infection

	Frequency	Percent
Forearm	2	3.0
Hip and thigh	36	53.7
Leg	23	34.3
Foot	1	1.5
Multiples	5	7.5
Total	67	100.0

In 35(52.2%) patients had no comorbid, 13 (19.4%) patients had 1 comorbid, 10(14.9%) patients had 2 comorbid and 9 (13.4 %) patients had multiple comorbid.

In this study, in 15 (22.4%) patients where infection was present with internal fixation implant and was removed during debridement while in 52 (77.6%) patients infection was present in the bone or soft tissues without implant. In 56 (83.6%) patients the previous culture and sensitivity report showed no growth while in 11 (16.4%) patients study showed growth of organism on culture and sensitivity.

In 30(44.8%) were had no previous surgeries, 22(32.8%) had one previous surgery 13(19.4%) had previous Surgeries, while 2(3.0%) had multiples previous surgeries.

The mean duration of vac therapy is 3.33 SD±0.97 with range from 1-4 days.

In 35 (52.2%) showed no growth while in 20(29.9%) Culture and sensitivity revealed Staph aureus, 1 (1.5%) patient showed Escherichia coli, and 2 (3.0 %) patients showed Klebsiella on their CS. While 3 (4.5%) patients revealed Pseudomonas on their CS. 1 (1.5%) patient revealed Acinetobacter johnsonii on their CS. 5 (7.05%) patients showed other organisms on their CS.

In 64 (95.5%) showed full eradication, 2(3.0 %) patients underwent reinfection, 1 (1.5%) patient developed fulminant infection.

Table 3: Outcome

	Frequency	Percent
Eradicated	64	95.5
Reinfection	2	3.0
Fulminant infection	1	1.5
Total	67	100.0

In 54 (80.6 %) had 1 surgery before closure, while 10(14.9%) patients had 2 surgeries before closure and 1(1.5%) patient underwent 3 surgeries. While 2(3.0%) patients underwent more than 3 surgeries.

In cross tabulation, outcome vs comorbidity, a total of 64 patients had complete eradication of infection. While 01 patient with multiple comorbid and 01 with no comorbid developed reinfection and 01 had one comorbid developed fulminant infections .The P value is 0.32, which is statistically not significant (p <0.05) (Cross tabulation t-test)

In 33 patient with eradicated infection had no growth on their CS, 19 patients had Staphylococcus aureus on their CS, 1 had Escherichia coli, 2 had Klebsiella, 3 had Pseudomonas on their CS, and 01 had Acinetobacter johnsonii while 5 had other microorganisms on their CS.2 patients with reinfection had no growth on their CS while 1 patient with fulminant infection had Staphylococcus aureus on their CS. The 'P' value is 0.97 the result is statistically not significant at p <0.05 (Cross tabulation t-test).

The duration of vacuum assisted closure in 5 patients had duration of 2-3 days, 8 had duration of 3-4 days, 12 had duration of 4-5 days and 39 had duration of more than 5 days. While 1 patient with reinfection had duration of 3-4 days and 01 patient had duration of more than 5 days. The P value is 0.97, which is statistically not significant (p <0.5) (Cross tabulation t-test).

The mean hospital stay of 67 patients is 12.69 SD ± 5.33, with range from 5-27 days. The P value is 0.83 which is statistically not significant (p <0.5) Cross tabulation t-test)

DISCUSSION

Every trauma is associated with wound infections while there are other several infections associated with bones and soft tissues. Several techniques were used to close the wounds aiming for primary or delayed wound closure [14,15,16,17]. The role of VAC suction is not only useful efficient in the eradication of infection but also have a cost effectiveness. It reduces the longer hospital stay and the foci of the infections are eradicated which have an ultimate effect on the reduction of mortality and morbidity.

Our study has a proven role in the acute and chronic traumatic and non-traumatic wounds; it has a promising alternative for the management of wounds. It promotes wound healing by increasing blood flow and formation of granulation tissue. It should be done after thorough irrigation with normal saline approximately 6-9 litres after wound debridement. Necrotic tissue and serous fluid has an inverse effect on wound healing.

Our study confirmed that Staphylococcus aureus is the most common organism in causing wound infection. If not treated early, leads to osteomyelitis and it can only be prevented by vacuum suction therapy along with appropriate antibiotics. As in conventional treatment, wound dressing have to be changed twice daily where as in vacuum suction therapy the wound relook and debridement needs every 5-10 days.it is therefore less discomfort and time consuming for the patients and doctors. The duration of conventional treatment is longer than the vacuum suction therapy. This therapy helps to resolve some infections that have resisted more conventional methods of treatment.

The mean duration of vacuum therapy in the treatment of 67 patients was 3.33 days, with range from 1-4 days. Infection is known to stop in the progression of the wound healing. The wounds, which were treated with vacuum therapy, showed reduced levels of bacteria. [18]. It also showed that wound treated with vacuum therapy requires fewer courses of antibiotics as compared to other wounds which treated conventionally [19].

Although VAC is simple to use, inappropriate and incorrect use will lead to non-healing wound and pain

and discomfort to the patient. Banwell 2003 found that early application of vacuum following injury/debridement to produce best results (experimented from their wound with acute and traumatic wounds) [7].

Illizarov et al.showed that when mechanical stress to the tissue is applied leads to the stimulation of formation of new blood vessels and mitosis [20].

To function correctly, the adhesive tape, which was applied to the sponge, must form airtight seal with the skin. Such an airtight seal is difficult to obtained the wound near to perineal region where the surrounding skin is moist, so these problems can be overcome by applying Duoderm [1] first around the wound area, which provide a base for the adhesive tape.

Analysing the results of our study, we suggests that Vacuum suction therapy has a definitive role in the reduction of bacterial infections, angiogenesis and proliferation of granulation tissue. Our data demonstrates that the wound treated with vacuum therapy requires fewer courses of antibiotics as compared to other wounds, which are treated conventionally. It is suggested that vacuum suction therapy is cost effective and easy to use(but requires training to ensure appropriate and competent use) to control the traumatic and non-traumatic wound infections, which helps in early closure of wounds, preventing complications(osteomyelitis) and promising better outcomes.

CONCLUSION

Vacuum suction therapy proved to be very effective method in traumatic and non-traumatic wound infection as well acute and chronic infections. It is suggested that vacuum suction therapy treatment is worthy of trial in cases of chronic osteomyelitis and that have failed to respond to other methods.

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