Original Research Article

A Clinical Study of Vacuum Assisted Closure of Open Wounds in Orthopaedics

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Abstract

Background: The management of difficult to heal wounds has always been a cause of concern for the treating orthopeadicians. There has been a tremendous increase in the number patients presenting with difficult to heal wounds. **Aims**: to study the functional outcome of open wounds in orthopaedics by VAC therapy. Infection rate, time taken for secondary closure or split skin grafting studied. **Materials and methods:** It is prospective study in Seventeen patients with open wounds collected over a period of two and a half years. Gustilo Anderson Compound Grade 2,3a,3b type fractures, Acute traumatic soft tissue injuries without bone involvement and Post operative infected wounds with implant in-situ were included in study.**Results**:. The age group 30-50 dominates the series accounting for 44% among the cases. Open compound fractures caused by road traffic accidents includes 14 cases (82.35%), train traffic accident 2 cases(11.76%) and accidental fall 1 case(5.88%). Mean wound size reduction at treatment completion 15mm (10-20mm) . 15 patients among the 17 achieved good wound healing and the tendons which were exposed were adequately covered by granulation tissue. The mean duration required for formation of healthy uniform granulation bed was 10.5 days(9-12 days) After VAC therapy, SSG was done to cover the healthy granulation tissue in 13 patients and flap cover was done for 4 patients. **Conclusions:** VAC therapy has wide range of benefits it can be applied to most of the wounds but all wounds cannot be treated by VAC therapy. VAC causes bone exposed wound to be covered by granulation tissue which requires a simple split skin graft to cover the granulation tissue where as the bone exposed area needs a more time consuming and more expertized flap cover for covering the wound.

Keywords: Vacuum Assisted Closure(VAC), split skin grafting, granulation tissue.

Introduction

Vacuum Assisted Closure (VAC) or micro-deformational wound therapy or negative pressure wound therapy (NPWT) has been emerging as a beneficial management of open wound in the field of orthopaedics. Open wounds include fractures with extensive soft-tissue damage, significant periosteal stripping, gross contamination & exposed fractured ends 1. Vacuum assisted closure of open wounds is one of several methods enabling the surgeon to obtain better treatment results in case of open and complicated wounds. Management of open fractures need good simultaneous management of both bones and soft tissue injury for good healing and to avoid infection. Large, complicated wounds pose a significant problem to both surgeon and patients.

In the earlier days, open and soft tissue injuries were managed by conventional methods like daily or alternate day wound debridement, wet dressing, dry dressing etc.According to a study by Caudle and Stern2the problem is that incidence of infection was 59%. Similarly studies by Cierny et al3 about incidence of wound infection in open bone fractures were 20.8% and 83.3% in early and delayed skin cover cases Debridement was required for more individuals , more duration of time was taken for healing, required more duration to make the wound adequate for soft tissue coverage & prolonged hospital stay.

The primary aim of this study is to find out the rate of wound healing, duration required for making the wound suitable for skin cover procedures, total number of days required for formation of uniform granulation tissue covering of the wound, hospital stay duration and healing of soft tissue injury fractures treated by Vacuum Assisted Closure & by stabilization of fracture

The process and mechanism of VAC therapy is not complicated. According to size and shape of the wound, foam is cut and then it is placed on the wound bed, a drain with suction and perforations at the end of the tube is laid on the foam. Then the whole circumference of the wound is sealed with an opsite or a transparent sheet which is adhesive then the other end of the suction tube is connected to a vacuum machine, once the wound is sealed and the machine is switched on, the exudate from the wound is collected through the foam into a disposable canister. Due to this, the edema from the wound is removed , new vasculature are formed (angiogenesis) & hence leads to healthy granulation bed & all this leads to earlier skin cover procedures of the wounds

Incidence of infection in a study by Mehbod et al4 and Mooney et al5. showed comparitive decrease when compared with saline

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dressing and thus the duration of hospital stay decreased, number of debridement required were also few.The indirect effects of VAC therapy are reduced morbidity & cost effectiveness and early mobilization.

Materials and Methods

Seventeen patients with open wounds are studied prospectively in department of orthopaedics in Gandhi hospital over a period of two and a half years. All patients were selected based on our inclusion and exclusion criteria.

All patients were studied and clinical findings were recorded as per the proforma case sheet.

All patients in the study underwent the all basic investigations like Complete blood picture, Random blood glucose levels, Renal function tests and CRP,ESR Imaging studies as X-RAY of the involved limb. Culture was sent from the wound.

Inclusion criteria: Gustilo Anderson Compound Grade 2,3a,3b type fractures, Acute traumatic soft tissue injuries without bone involvement and Post operative infected wounds with implant in-situ

Exclusion criteria: Wounds associated with Chronic osteomyelitis, Pressure sores, Acute Fractures with vascular injuries (Gustilo-Anderson type 3c)

17 patients were treated with VAC therapy of age between 21yrs to 60 yrs Among the 17 patients 15 being male and 2 were female. Assessment of wound before applying VAC therapy Size of wound, Area of the bone exposed, area of tendons exposed and any implants exposed

Initially the wound is thoroughly debrided and broad spectrum antibiotics are given and later specific antibiotics are given according to sensitivity profile.

Protocol after each dressing as Pus culture/sensitivity, Size of the wound, area of bone exposed, area of tendons exposed, amount of drain collection, duration taken to get healthy granulation bed and skin covering procedures (needed or not) Among the 17 patients for 14 patients VAC dressing was applied early within 24 hrs of admission in our hospital and for 3 patients who developed superficial infection, the wound was thoroughly debrided and then VAC dressing was applied.

Spinal anesthesia was used in patients having injury in lower limbs and supraclavicular block was used in patients having injury in upper limbs only for debridement purpose and repeat dressings were applied without any anesthesia.

Technique for application of VAC dressing

1. Debride the wound thoroughly and remove the necrosed tissue and foreign materials
2. Thorough wound wash is given and then a swab is taken for microbiological study(pus culture and sensitivity)
3. The wound size is measured and then the foam is cut according to size and shape of the wound. And then it is kept over the wound.
4. Then wound is completely covered using a sterile transparent opsite and a small hole is made in the centre of the sponge for the connecting tube.
5. Insert the evacuation tube over the dressing and the other end of the tube is connected to a container which collects the edema fluid.
6. Connecting tube to the suction machine. Connect the draining tube from the edema collecting container to the suction machine.
7. Then start up the VAC machine and watch it compress, the sponge will start contracting as the suction pressure is started.
8. The dressing was removed after 3-5 days and dressing was done again if necessary.

Skin cover procedures

1. Split skin graft.
2. Flap cover.

Follow up of patients were done till definitive skin cover procedures.

Results

Table 1: Distribution of cases based on age and gender

Age in Years	Number of patients	%
21-30	6	35.29
31-50	8	47.05
51-60	3	17.64
Total	17	100
Gender		
Male	14	82.35
Female	3	17.64
Site		
Fore arm	4	23.52
Thigh	2	11.76
leg	8	47.05
foot	3	17.64

From the above table it is very clear that majority of cases occurred in 31-50 years age group correlating with common occurrence of RTA in that age. open compound grade II and III fractures occurred in leg in 47.05% of patients.

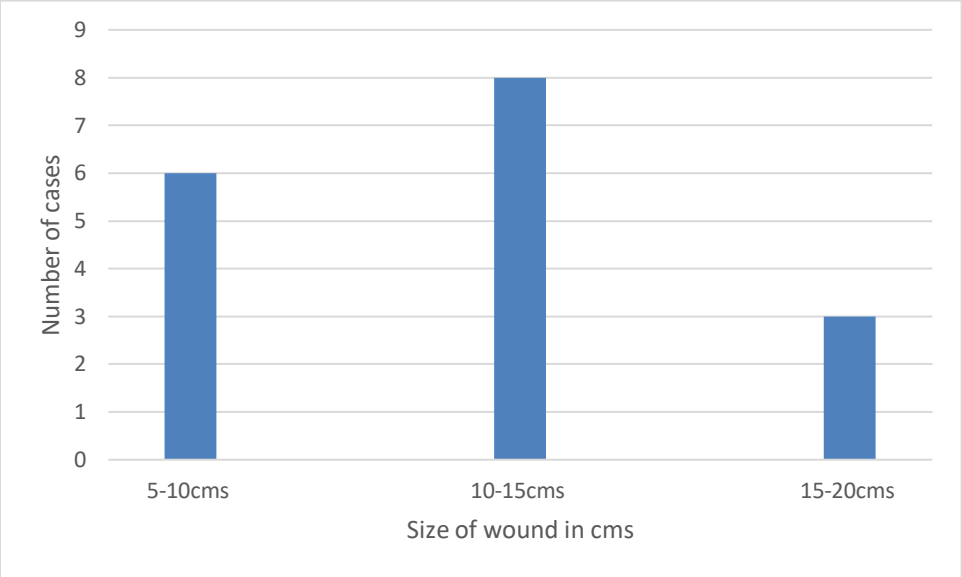


Fig. 1: Distribution based on size of the wound

Score 0 – skin and soft tissue intact
Score 1 – defect in the skin is present
Score 2 – one of the following is exposed in the wound bed a-Bone, b-tendon, or c- implant. Score 3 – a combination of any two of the above are exposed
Score 4 – presence of deep infection.

Table 2: Distribution based on scoring of the wound prior to VAC therapy

Score of the wound	No. of cases	%
Score-0	0	0%
Score-1	0	0%
Score-2 Bone exposed Tendon exposed Implant exposed	 8 4 0	 47.05% 23.52 0%
Score-3 Bone+tendon exposed	3	17.64%
Score-4	2	11.76%
Total	17	100%

Gustilo Anderson compound grade II and III fractures are associated with bone exposure and tendons are also exposed in few cases depending on the site of the defect. Tendons are more commonly exposed in forearm.

Table 3: Distribution based on number of dressings applied

Score of the wound	No.of cases	No.of dressings
Score-0	0	0
Score-1	0	0
Score-2 Bone exposed Tendon exposed	 5+3 4	 3+4 3
Score-3 Bone+tendon	3	4
Score-4	2	4

Five cases of bone exposed wounds required 3 dressing changes, three cases of bone exposed wounds required 4 dressing changes, four cases of tendon exposed wounds required 3 dressing changes, three cases of bone & tendon exposed wounds required 4 dressing changes, two cases with bone exposed and with superficial infection cases required 4 dressing changes.

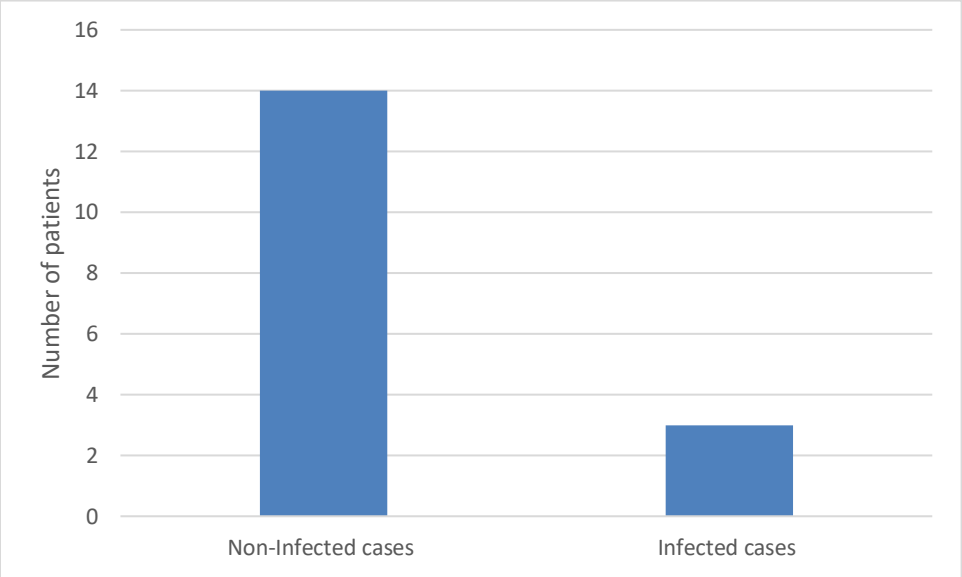
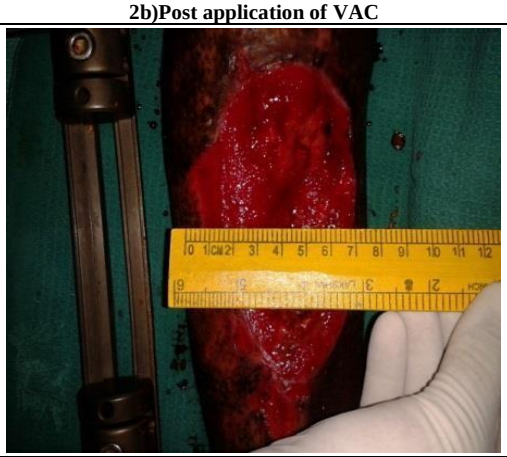


Fig. 2: Distribution of cases based superficial infection

2a)Compound graded 3b wound | **2b)Post application of VAC**



2c and 2d) Granulation tissue ten days post VAC application

2e)Immediate post op after flap cover

2f) 4 weeks post flap

2g)Post-ex removal wound condition

In figure 2 we have shown a case of compound grade 3b fracture where external fixation was done (2a) for which vac was applied(2b) and within ten days a nice granulation tissue was seen covering the wound (2c and 2d).Later a flap cover was done (2e) which healed well within 4 weeks (2f) and after 6 weeks external fixative was removed and the wound was completely healed(2g)

Discussion

A very important role in open compound fractures management is soft tissue management. Numerous factors play an important role in wound healing like the composition of the wound, wound environment, which includes physical characteristics of the wound, chemical composition of wound, biological structure of the wound etc. all play important role in the healing.

The goals of soft tissue management are new granulation tissue should cover the soft tissue defects. The soft tissue defects should be covered by SSG or flap cover as soon as possible. Many factors affect the wound healing like Defect in vascular supply, angiogenesis, laying matrix proteins, locally acting growth factors, clearing dead and necrotic cells and migration of macrophages and their composition. [6]

Defect in enzymes which lyse the defective cells. Defect in production of new proteins for the wound. Any of these factors or a combination of these factors affect the wound healing and the wound goes into a stage of chronic non healing. After applying VAC therapy the negative force causes more blood circulation to the wound, reduces the burden of bacterial infection and supplies more oxygen to the affected soft tissue.

Rate of infection In our study rate of infection was 11.76% and we compared our result with the following literature study where the soft tissue injuries were managed by saline dressings[7]- Henley et al, JOT 1998- 34.7%[8]., Charalambous et al, Injury 2005- 27%[9]., Gopal et al JBJS-B 2004-27.4%[10] Duration required for forming new healthy granulation bed.

In our study an average of 10.5 days was taken for formation of a uniform healthy granulation bed of the wound. Similar studies were conducted by Argenta et al., Morykwas et al[11]., & Joseph et al[12],.& these studies also showed that VAC proved effective in shrinking of the diameter of the wound size and formation of healthy granulation tissue when compared to normal saline dressing methods.

Microscopically application of VAC therapy also showed increase in formation of new blood vessels and formation matrix tissue but the wounds treated by saline dressing showed inflammatory tissue & fibrous tissues as compared by above studies. The uniform negative pressure delivered by the VAC therapy to the wound bed plays a significant role in formation of new healthy granulation tissue.

In normal saline dressings the gauze pad sticks to the dead tissue and while changing the dressings the dead tissue along with the new and delicate tissue formed underneath is also removed along with the gauze pad and this causes mechanical damage to the formation of new granulation tissue in the wound bed. Duration of hospital stay- As the patient load was very high and availability of OT is limited in our institution the definitive management like split skin grafting, flap cover and fixation of the fractures was delayed and hence the duration of hospital stay was prolonged in our study.

Studies on application of VAC therapy on compound fractures is very less. And these compound fractures have high chances of going in for non union and secondary infection if they are not adequately treated. These wounds should be thoroughly debrided and skin cover should be given as soon as possible as the exposed bones, tendons & neurovascular structures should be covered as soon as possible to save these structures from infection.

The high cost of vacuum system and the cost of vacuum dressing has discouraged many doctors from its application but when compared with saline dressings which take longer duration for wound healing, more number of debridement & more number of days of absence from work when all these factors are compared with expense of VAC ,the treatment expense of VAC is lesser with also lesser morbidity to the patient. And lesser hospital stay and the hospital beds can be used for other patients. [13]

VAC therapy has wide range of benefits it can be applied to most of the wounds but all wounds cannot be treated by VAC therapy. VAC causes bone exposed wound to be covered by granulation tissue which requires a simple split skin graft to cover the granulation tissue where as the bone exposed area needs a more time consuming and more expertized flap cover for covering the wound.

Limitations

- The study is non randomized.
- Our sample size is small and the mean follow up period is short.
- Definitive management of the wound like SSG and flap cover is done by different surgeons.

Conclusion

The rate of wound infection was significantly reduced. The time duration taken for formation of healthy granulation tissue was less. The wound was fit for definitive skin cover procedures like SSG & flap cover at a faster rate. The number of debridement of the wound were reduced. The granulation tissue formed was healthy and uniform. Soft tissue defects which lead to ugly and irregular surface was avoided by forming uniform granulation tissue and the defects were covered. Technical difficulties are present in applying vac dressing in presence of external fixator but it was overcome by realignment of fixator.

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