



## Vacuum Assisted Closure in Chronic Wound Management-A Study of 20 Cases

Authors

Irfan Andleeb Gul<sup>1</sup>, Tabish Tahir Kirmani<sup>2</sup>, Mohammad Shahid Bhat<sup>3</sup>,  
Zahid Andleeb Gull<sup>4</sup>

<sup>1,2</sup>Senior Resident, Orthopaedics at Hamdard Institute of Medical Sciences and Research, New Delhi

<sup>3</sup>Senior Resident, Orthopaedics at GS Medical College & Hospital, Uttar Pradesh

<sup>4</sup>MBBS Intern at Dhaka National Medical College, Bangladesh

### Abstract

**Purpose:** To evaluate the efficacy of VAC in wound healing.

**Materials and Methods:** This prospective study was done from September 2016 to August 2017 over 20 patients who presented in our hospital with severe wounds. These wounds were either traumatic, idiopathic or iatrogenic; either infective or non-infective. We had 13 males and 7 females in our study, with age ranging from 15 to 65 years. VAC was applied to all the wounds in continuous mode at pressure of 125 mmHg. The parameters assessed were nature of the wound, status of infection along with infecting organism, length of VAC application, number of dressings required and complications, if any, related to the use of this therapy. All patients were followed for a period of 3 months.

**Results:** Among 20 patients, we lost 1 patient in follow-up. Rest 19 patients (95%) were treated successfully. Cost of dressings was less. There was a significant reduction in wound infection in infected cases and a rapid rate of granulation tissue formation in all cases. Graft uptake in the form of PTSG was seen in all the grafted patients. There was no major complication.

**Conclusion:** VAC is a safe and reliable option in the treatment of wounds with better healing, graft uptake and reduced hospital stay. It appears as a promising alternative for the management of various wound types including infected wounds.

**Keywords:** Wound healing, Vacuum assisted closure.

### Introduction

Acute and chronic wounds affect 1% of the general population<sup>1</sup>. Millions of patients worldwide suffer from non-healing wounds at various anatomical sites. Regardless of the etiology, treatment becomes more complicated when the patient has wound infection or suffering from other comorbidities. In the past few centuries, medicine is so much advanced and in

spite of that, the management of wounds remains a tough challenge.

Several treatment methods have been utilized for improving the healing process of the wound until today, including various forms of medical dressings, topical applications, surgical debridement, and antiseptic medicines.<sup>2-4</sup> Great efforts were done to develop new products for improving wound healing. The vacuum-assisted wound

closure method, which was developed in the late 1980s, is the most recent method in this regard.<sup>5</sup>

Vacuum assisted closure (VAC) is a non-invasive, active wound management therapy exposing the wound bed to sub-atmospheric negative pressure through a closed system in order to facilitate wound healing. This technique was initially introduced in human medicine for the treatment of chronic wounds. VAC removes fluid from the extra-vascular spaces, improves circulation, enhances the proliferation of granulation tissues and controls bacterial colonization. Additionally, the mechanical effects of VAC appear to have an 'illizarovian' type effect resulting in a vigorous proliferation of healing granulation tissue.

The vacuum-assisted wound closure system consists of a sterilized polyurethane open-cell foam covering, which is covered with transparent, adhesive cover and its attached pump. The foam is placed within the wound so that the foam is in contact with the entire wound surface. A plastic sheet with adhesive on one side is placed over the sponge and around the tubing creating an airtight seal with the skin around the wound margins. The pump applies intermittent or continuous negative pressure on the foam cover by means of a discharge tube. Vacuum pressure is usually kept at 125 mmHg and applied in a continuous mode<sup>6</sup>.

### Materials and Methods

This study was carried out in patients who were admitted in Hamdard Institute of Medical Sciences and Research (HIMSR), New Delhi from September 2016 to August 2017. A total of 20 patients were included in the study. All the patients were discharged after successful treatment and followed up at monthly intervals till at least 3 months in OPD of the same institution. The inclusion criteria were based on the existence of primarily unclosed wounds and surgically untreated patients.

### Inclusion Criteria

- ✓ Age between 15 to 70 years
- ✓ All types of wounds irrespective of etiology

- ✓ Patients giving consent for VAC

### Exclusion Criteria

- ✓ Wounds with underlying osteomyelitis
- ✓ Malignancy within the wound
- ✓ Exposed vessels(Arteries or veins)
- ✓ Presence of necrotic tissue
- ✓ Dry gangrene
- ✓ Patients with fistulae to body organs or cavities
- ✓ Patients with collagen vascular diseases, peripheral vascular disease or history of coagulopathy.



**Fig.1** Patient with VAC machine applied in leg

### Results

All patients had a minimum follow-up of 3 months (3 to 6 months). Mean age was 43 yrs (Range 15-65). There were 13 female and 7 male patients. Infection was the main cause of hospitalization (9 cases) followed by trauma (5 cases). Table 1 describes the baseline characteristics of the patients in our study. The data suggests age, sex, site, comorbidity etc. of the patients. Among the 9 infected cases, 2 were infected cases of bed sores and 1 case each of operated TKR, posterior instrumentation spine, DHS, PFNA II, fasciotomy leg, diabetic foot and post debridement cellulitis leg. Infection status of

the wound was revealed by culture characteristics. Most common organism causing infection in our study was Staphylococcus aureus in 56% patients (Table 2). In the trauma group, there were 3 cases of degloving injury in forearm, knee and leg due to RTA and 1 case each of compound fracture in the ankle and tibia, both of which were fixed using external fixator. Rest of the patients were the cases of non-infected diabetic foot(2 cases), 2 cases of bed sores over sacrum and 1 case each of burns and post debridement cellulitis.

In our study, we have done additional procedures in the form of partial thickness skin grafting (PTSG) in two patients. Among these two patients, one had degloving injury in forearm and other one had a non-infected bed sore in the back. Initially VAC was applied to both the patients and subsequently grafting was done. Graft uptake was seen nicely in both the patients without any complication.

There was no major complication in any of our patients. There was mild pain and bleeding in one of our patient during dressing and superficial dermatitis in other patient. Both these complications were dealt with easily without any effect on our VAC therapy.

Our study consisted of total 9 patients of infected wounds in whom VAC was applied. Initial culture and sensitivity was done in all the infected cases. The most common organism which was isolated in our study was Staphylococcus aureus. Other organisms in our study were Pseudomonas, E. Coli and Klebsiella species (Table 2).In all the patients, dressing was done after every 48 to 72 hours depending on wound or when the canister was full and then VAC was re-applied. Sponges obtained after 2<sup>nd</sup> VAC application were send for culture and sensitivity testing. All the samples were then negative for any organism. In none of our infected operated cases, there was any need of implant removal.

**Table 1** showing base line characteristics of all the patients in our study

S. No.	Age(Yrs)/ Sex	Site	Organism isolated	Comor-bidity	Length of VAC(Days)	No. of dressings	Major Compli-cation
1	24/M	Forearm	—		10	2	Nil
2	45/F	Foot	—	DM	14	3	Nil
3	15/M	Ankle	—		13	3	Nil
4	65/F	Hip	Pseudomonas	HTN	14	5	Nil
5	58/M	Foot	Staph aureus	DM+HTN	21	6	Nil
6	56/F	Back	Staph aureus	COPD	11	3	Nil
7	18/M	Leg	—		9	2	Nil
8	46/F	Back	Staph aureus	Obesity	19	4	Nil
9	51/F	Back	—	CRF	17	3	Nil
10	32/F	Foot	—		16	3	Nil
11	40/F	Hip	E. coli	HPT	7	2	Nil
12	32/M	Leg	Staph aureus		24	6	Nil
13	39/F	Leg	Klebsiella		23	6	Nil
14	34/F	Foot	—	DM	18	3	Nil
15	54/F	Leg	—		13	3	Nil
16	64/F	Knee	Staph aureus	DM	16	4	Nil
17	53/F	Knee	—		28	5	Nil
18	62/M	Spine	Pseudomonas	DM	18	5	Nil
19	48/F	Back	—		12	3	Nil
20	20/M	Leg	—		8	1	Nil

HTN (Hypertension), DM (Diabetes mellitus), HPT (Hypothyroidism), COPD (Chronic Obstructive Pulmonary Disease), CRF (Chronic renal failure)





**Fig.2** Before & after the application of VAC in degloving injury leg



**Fig.3** Before & after the application of VAC in knee due to RTA



**Fig.4** Crush injury forearm before & after the VAC and subsequent PTSG

**Table 2** showing causal organisms in our infected study cases

ORGANISM	NO. OF PATIENTS	PERCENTAGE
Staphylococcus aureus	5	56
Pseudomonas aeruginosa	2	22
Escherichia coli	1	11
Klebsiella species	1	11

## Discussion

Acute and chronic wounds affect 1% of the general population.<sup>1</sup> Wounds complicated with skin loss, implant exposure, bone/ tendon exposure are associated with difficult closure. Granulation tissue and blood vessel formation are important for wound healing. VAC is better indicated for the management of difficult/chronic wounds due to many reasons as has been suggested by many studies:

- The concept of applying sub-atmospheric environment on wounds to accelerate the healing process came into practice in 1993 and was first described by Fleischmann *et al*<sup>7</sup>. The science behind topical negative pressure dressings is to apply a sub-atmospheric pressure over a wound bed and maintain the negative pressure environment by means of a semi-permeable occlusive coverage.
- Traditional frequent wet dressing changes (3-4 times daily) are protracted and painful<sup>8</sup>.
- Interstitial fluid from local wound reduces local blood supply and disturbs wound healing due to collagenase and metalloproteinase enzyme constituents<sup>9</sup>. VAC by the action of suction keeps the wound free from this collection. Edema elimination decompresses the surrounding tissue and local microcirculation is re-established<sup>10</sup>. Transportation of toxins and inhibitors is facilitated also which in turn induces wound healing<sup>11</sup>. Local antibiotic concentration within the wound is also increased due to increased angiogenesis<sup>12</sup>.
- It has been reported that VAC provides continuous physical stimulus that enhances new blood vessel and granulation tissue formation<sup>13</sup>.

- VAC, by the action of negative traction force reduces wound surface area, which increases mitosis of tissues around the wound<sup>12,14</sup>.
- Morykwas<sup>15</sup>, in his study in pigs using needle probe laser Doppler flowmetry showed that sub-atmospheric pressure of 125mmHg resulted in four fold increase in blood flow. This increase in blood flow has also been found in human burns<sup>16</sup>. But pressure >200 mmHg were found to decrease that flow.

## Conclusion

In our study, it was found that the rate of granulation tissue formation was good in all of our patients. VAC reduced workload in our hospital by reducing the number of dressings required. There were no major post-operative complications in our patients and overall patient satisfaction was better. We in our study also treated many cases of infection, which all showed good results. Thus, VAC can be considered as a better option in the management of all types of wounds.

**Conflict of interest:** None

**Source of funding:** None

**Consent:** Proper informed consent taken from patients for publication

## References

1. Gregor S, Maegele M, Sauerland S, Krahn JF, Peinemann F, Lange S (2008) Negative pressure wound therapy: A vacuum of evidence? *Arch Surg* 143(2):189-196
2. Bradley M, Cullum N, Nelson EA, Petticrew M, Sheldon T, Torgerson D. Systematic reviews of wound care management: Dressings and topical agents

- used in the healing of chronic wounds. *Health Technol Assess.* 1999;3(17):1–35. [PubMed]
3. Dryburgh NSH, Donaldson J, Mitchell M, Smith FC (2006) Debridement for surgical wounds. *Cochrane Database of Systematic Reviews* 2006, Issue 4. [Art. No.: CD006214. doi:10.1002/14651858.CD006214] [PubMed]
  4. Vermeulen H, Ubbink DT, Goossens A, de Vos R, Legemate DA. Systematic review of dressings and topical agents for surgical wounds healing by secondary intention. *Br J Surg.* 2005;92(6):665–672. doi: 10.1002/bjs.5055. [PubMed] [Cross Ref]
  5. Argenta LC, Morykwas MJ. Vacuum-assisted closure: a new method for wound control and treatment: clinical experience. *Ann Plast Surg.* 1997;38(6):563–576. doi: 10.1097/00000637-199706000-00002. [PubMed] [Cross Ref]
  6. DeFranzo AJ, Argenta LC, Marks MW. The use of vacuum-assisted closure therapy for the treatment of lower-extremity wounds with exposed bone. *Plast Reconstr Surg.* 2001;108:1184–1191. doi: 10.1097/00006534-200110000-00013. [PubMed] [Cross Ref]
  7. Fleischmann W, Strecker W, Bombelli M, Kinzl L. Vacuum sealing as treatment of soft tissue damage in open fractures. *Unfallchirurg* 1993;96:488-92.
  8. Lionelli GT, Lawrence WT. Wound dressings. *SurgClin North Am.* 2003;83:617-638.
  9. Bucalo B, Eaglstein WH, Falanga V. Inhibition of cell proliferation by chronic wound fluid. *Wound Repair Regen* 1993;1:181-186.
  10. Webb LX, Schmidt U. Wound management with vacuum therapy. *Unfallchirurg* 2001; 104: 918-926.
  11. Bouree M, Koziarka J, Die V.A.C. Therapie in der Allgemeinchirurgie. *European Society ACA* 2003;191(Suppl 35):45-38
  12. Loree S, dompmartin A, Penven K, Harel D, Leroy D. Is Vacuum Assisted Closure a valid technique for debriding chronic leg ulcers? *J Wound care* 2004; 13: 249-252
  13. Morykwas MJ, Argenta LC, Shelton-Brown EI, McGuirt W. Vacuum-assisted closure: a new method for wound control and treatment: animal studies and basic foundation. *Ann Plast Surg.*1997;38:553-562.
  14. Chen SZ, Li J, Li XY, Xu LS. Effects of vacuum-assisted closure on wound microcirculation: an experimental study. *Asian J Surg,* 2005; 28:211
  15. Morykwas MJ, Argenta LC, Shelton-Brown EI, et al. Vacuum-assisted closure: a new method for wound control and treatment: animal studies and basic foundation. *Ann Plast Surg* 1997;38:553-62
  16. Banxell PE, Teot L. Topical negative pressure (TPN): the evolution of a novel wound therapy. *J Wound care* 2003;12:22-8.