



## Original Research Article

## To evaluate the outcome of vacuum assisted closure in open fractures of tibia

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## ABSTRACT

**Introduction:** Despite numerous advances, compound fractures of long bones continues to be a challenge for the treating surgeon. Standard wound dressing required prolonged period, repeated debridement, trauma to granulation tissue and had poor patient compliance. Vacuum-assisted closure provides an extremely efficacious method for treating difficult wounds. This research aimed to study whether VAC gives better outcome in open fractures after primary intervention, whether it leads to faster and more effective wound healing and whether it leads to shorter length of stay in hospital.

**Materials and Methods:** An interventional study was conducted, studying 30 cases of open tibia fractures who were fitting in the inclusion criteria. It followed Gustillo- Anderson classification to classify cases and then mapped out various conclusions on the aim of study whilst also charting the effect of the treatment in different circumstances, demographics and like.

**Result:** Amongst the 30 cases studied, all patients were evaluated clinically after the primary fixation and following VAC application, for an average period of follow up of 12 months. Majority of patients required 4-5 VAC dressings. The mean decrease in wound size was 9.97 cm<sup>2</sup> [21.22%]. Out of 30 patients, 4 patients had excellent, 16 patients had good, 8 patients had fair and 2 patients had poor result.

**Conclusion:** In this study, 30 patients were included with open fractures of tibia after primary internal fixation with VAC application. The greatest advantage of VAC was found to facilitate rapid formation of granulation tissue on wounds with exposed tissue and implants hence shorten healing time and minimize secondary soft tissue defect coverage procedures. This technique has indeed resulted in the effective decrease in wound size, and decrease in hospital stay and given a better functional outcome.

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## 1. Introduction

High energy open fractures have higher incidence of loss of soft tissue and infection and required urgent irrigation and debridement. Wound healing was considered as the primary and most clinically relevant management of these open injuries. Standard wound dressing required prolonged period, repeated debridement, more trauma to granulation tissue and had poor patient compliance. In the past fifteen years, we have been trying numerous methods including

self-made antibiotic cement, negative pressure assisted closure, external fixators, and new flap choices for the treatment. We find that these methods could be effectively combined and work together for implant related infection in the tibia. The concept of using negative pressure that creates a suction force, enabling the drainage of surgical wounds in order to enhance wound healing, is well documented in the literature.<sup>1-8</sup> VAC therapy provides a sterile, controlled environment that combines the benefit of both open and closed treatment and wound healing take place under moist, clean and sterile conditions.<sup>9-11</sup>

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This research aimed to study whether VAC gives better outcome in open fractures of tibia after primary intervention, whether it leads to faster and more effective wound healing and whether it leads to shorter length of stay in hospital.

**2. Materials and Methods**

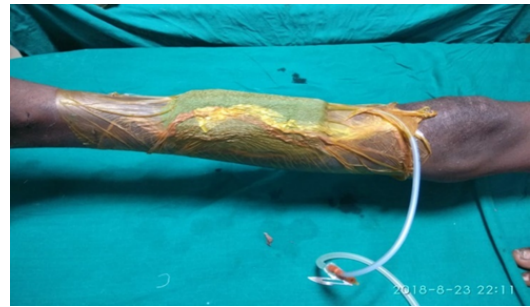
The study was prospectively conducted in the Department of Orthopaedics, S.N. Medical College, Agra. All cases presenting in OPD and emergency over a period of 18 months from January 2017 to July 2018 and fulfilling inclusion criteria were included. The inclusion criteria of study was those patients aged above 18 years of age, with open fractures of tibia {G.A.II, IIIA, and IIIB}, and patients who are haemodynamically stable. Those excluded were patients unfit for surgery, patients having Pre-existing osteomyelitis in the wounds, Neurovascular deficit in the injured limb, those having malignancy and those on anticoagulants, chemotherapy and corticosteroids.

**2.1. Initial management of patient**

Patients with open fractures were graded using the Gustilo-Anderson classification for open fractures. Antibiotics were started immediately for all patients. Injection Ceftriaxone 1-gram intravenous twice daily along with injection Amikacin 500mg intravenous twice daily were given and single dose of tetanus toxoid was given. After obtaining the necessary radiographs, Type 2 & 3A open fractures were treated by cleaning of the wound with copious amount of normal saline, and Hydrogen peroxide, followed by painting of the skin around the wound with povidone iodine. This was followed by primary wound closure if required. The limb was then immobilized till definite fixation was done. Primary internal Fixation of fracture was done as soon as possible followed by VAC application.

**2.2. Application of VAC**

Pictures of wound before VAC dressing were taken (Figure 4). Standard wound preparation was done. Sterile, open-pore foam dressing with pore sizes 400-600 microns were gently placed onto the wound cavity. The foam, tubing and surrounding five centimeters of healthy tissue was then sealed with an adhesive to ensure a seal. Controlled pressure was uniformly applied to all tissues on the inner surface of the wound (Figure 1). The pump delivered an intermittent negative pressure of -125 mmHg. The cycle was of seven minutes in which pump was on for five minutes and off for two minutes. The dressings were changed on the fourth day. The presence of drainage, edema, erythema, exposed bone, or exposed tendon were documented. Any complications associated with vacuum assisted closure therapy were also documented. Pictures of wound after serial VAC dressings were also taken (Figures 5, 6 and 7).



**Fig. 1:** Application of VAC

Wound Bed Score			
	Scores of 0	Scores of 1	Scores of 2
<b>Black Eschar</b>	0	1	2
<b>Eczema/Dermatitis</b>	0	1	2
<b>Depth</b>	0	1	2
<b>Scarring (fibrosis/callus)</b>	0	1	2
<b>Color of wound bed</b>	0	1	2
<b>Oedema/Swelling</b>	0	1	2
<b>Resurfacing epithelium</b>	0	1	2
<b>Exudate Amount</b>	0	1	2
<b>Add scores for each column</b> →			
<b>TOTAL SCORE</b>			

**Fig. 2:** Wound bed score

Criteria	Excellent (%)	Good (%)	Fair (%)	Poor (%)
Nonunion/infection	None	None	None	Yes
Neurovascularinjury	None	Minimal	Moderate	Severe
Deformity				
Varus/valgus	None	2-5	6-10	>10
Pro/recurvatum	0-5	6-10	11-20	>20
Rotation	0-5	6-10	11-20	>20
Shortening	0-5mm	6-10mm	11-20mm	>20mm
Mobility				
Knee	Full	>80	>75	<75
Ankle	Full	>75	>50	<50
Subtalar	>75%	>50	<50	
Pain	None	Occasional	Moderate	Severe
Gait	Normal	Normal	Mild limp	Significant
Activities				
Strenous	Possible	Limited	Severely limited	Impossible

**Fig. 3:** Johner and Wruh's (1983) criteria with modification



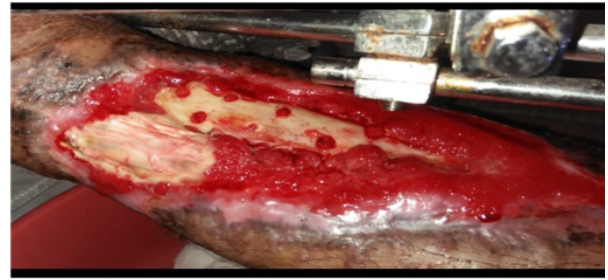
**Fig. 4:** Picture of wound before VAC



**Fig. 5:** Picture of wound after 2<sup>nd</sup> VAC dressing



**Fig. 6:** Wound after 1<sup>st</sup> VAC dressing



**Fig. 7:** Wound after 2<sup>nd</sup> VAC dressing

After satisfactory results with VAC, patient was managed by skin graft or flap rotation grafting according to condition of wound needed for wound closure.

Wound was assessed using wound bed score (Figure 2) and functional outcome of limb was assessed using Johner and Wruh's (1983) criteria with modification (Figure 3)

### 3. Results

In the present study, 30 patients with open fractures of tibia had undergone primary internal fixation and VAC application. All patients were evaluated clinically after the primary fixation and following VAC application, for an average period of follow up of 12 months. The age of the patient in this study, ranged from 18 years to 65 years, average being 36.15 years. There were 24 male patients as compared to 6 female patients in this study. 20 patients had open fractures of right tibia and 10 patients had open fracture of left tibia. 23 cases sustained fracture following road traffic accident (high energy trauma), 7 cases sustained fracture following fall from height. (low energy trauma).

In this study of 30 cases, 5 patient had G.A type 2, 17 patient had G.A type 3A and 8 patient had G.A type 3B open fractures of both bone leg in adults. The frequency of VAC dressing application were 4-5 day per dressing from the second day of post-operative period in which 12 patient had 4 times, 12 patient had 5 times and 6 patient had >5 times application and the range in hospital stay was 12 to 38 day.

There was no need of repeated surgical debridement in 26 patient during the course of VAC therapy. However, in 4 patients, repeated surgical debridement were done due to presence of infection. The mean decrease in wound size was 9.97cm<sup>2</sup>. Out of 30 patients 4 patient had excellent, 16 patient had good, 8 patient had fair and 2 patient had poor result.

During the treatment 4 patients had debridement and then secondary closure, 2 had tissue transfer, 20 had split skin-graft, 3 patients were directly closed and 1 patient was healed by secondary intension. During the follow up 3 patient developed implant related infection, 2 had exposed implant and rest of all had no complication.

#### 4. Discussion

Open fractures of tibia are among the most difficult fractures to treat effectively. The status of the soft tissues, the degree of comminution sustained at the time of injury affect the long-term clinical results. VAC has been advocated as a novel method in the healing of wound by stimulating the wound environment in such a way that it reduces bacterial burden and interstitial wound fluid, increases circulation and to an extent mechanically enhances the viscoelasticity of peri-wound area. VAC is a well-tolerated procedure and, with few contraindications or complications, is fast becoming a mainstay of current wound care. Hence, we planned to use VAC for the treatment and fast healing of wound in open fracture tibia.

The number of dressing change varied based on the extent of the wound, wound healing duration, presence of infection and the number of hospitalization days.

There was no need of repeat surgical debridement in 26 patients during the course of VAC therapy. However, in 4 patients, repeat surgical debridement was done due to presence of infection.

In our study No. of VAC dressings were 4 in 12 patients, 5 in 12 patients and more than 5 in 6 patients. The number of days of stay in hospital are in range of 12 to 38 day.

The most important issue dealing with open fracture is to restore the outline and healing of the soft tissue as soon as possible. In the present study there was decrease in wound size attained by VAC therapy which ranged from 2.8 to 25cm<sup>2</sup>, with an average reduction of 9.97cm<sup>2</sup> (p=0.0481).

In our study, 2 patients were in 1<sup>st</sup> quartile, 10 patients were in 2<sup>nd</sup> quartile, 14 patients were in 3<sup>rd</sup> quartile, and 4 patients were in 4<sup>th</sup> quartile, according to wound bed score.

In our study, 4 patient had excellent, 16 patients had good, 8 patients had fair and 2 patients had poor result out of 30 patients according to johner and wruh criteria.

Although, a larger sample of patients and longer follow up are required, we strongly encourage its consideration in the treatment of such complex fractures.

#### 5. Conclusion

According to this study, 30 patients were included with open fractures of tibia after primary internal fixation with VAC application. This technique has resulted in the effective decrease in wound size, decrease in infection, and decrease in hospital stay and given a better functional outcome. The other advantage of VAC was found to facilitate rapid formation of granulation tissue on wounds with exposed tendons, bones, raw area wounds and exposed implants hence shorten healing time and minimize the number of secondary soft tissue defect coverage procedures.

#### 6. Source of Funding

None.

#### 7. Conflict of Interest

None.

#### References

1. Morykwas MJ, Argenta C, 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(6):553–62.
2. Mouës CM, van den Bermd G, Heule F, Hovius SER. Comparing conventional gauze therapy to vacuum-assisted closure wound therapy: a prospective randomised trial. *J Plast Reconstr Aesthet Surg.* 2007;60(6):672–81.
3. European Wound Management Association (EWMA). Position Document: Topical negative pressure in wound management in wound management; 2007. Available from: <http://www.ewma.org>.
4. Mendonca DA, Papini R, Price PE. Negative-pressure wound therapy: a snapshot of evidence. *Int Wound J.* 2006;3(4):261–71.
5. Pham CT, Middleton PF, Maddern GJ. The safety and efficacy of topical negative pressure in non-healing wounds: a systematic review. *J Wound Care.* 2006;15(6):240–50.
6. Plikaitis CM, Molnar JA. Subatmospheric pressure wound therapy and the vacuum-assisted closure device: basic science and current clinical successes. *Expert Rev Med Devices.* 2006;3(2):175–84.
7. Ubbink DT, Westerbos SJ, Nelson EA, Vermeulen H. A systematic review of topical negative pressure therapy for acute and chronic wounds. *Br J Surg.* 2008;95(6):685–92.
8. Fleischmann W, Strecker W, Bombelli M, Kinzl L. Vacuum Sealing as Treatment of Soft Tissue Damage in Open Fractures. *Unfallchirurg.* 1993;96(9):488–92.
9. Joseph E, Hamori CA, Bergman S, Roaf E, Swann NF, Anastasi GW. A prospective randomized trial of vacuum assisted closure versus standard therapy of chronic non-healing wounds. *Wounds.* 2000;12(3):60–7.
10. Philbeck TE, Whittington KT, Millsap MH, Briones RB, Wight DG, Schroeder WJ. The clinical and cost effectiveness of externally applied negative pressure wound therapy in the treatment of wounds in home healthcare medicare patients. *Ostomy Wound Manag.* 1999;45(11):41–50.
11. Smith N. The benefits of VAC therapy in the management of pressureulcers. *Br J Nurs.* 2004;13(22):1359–65.

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