Original Research

OUTCOME OF VAC THERAPY IN TYPE 3 TIBIAL FRACTURES AMONG DIABETIC PATIENTS AND SMOKERS

Dr. Prashanth Reddy P.[1], Dr. Arjun A.[2], Dr. Mahesh J. Nerkar[3], Dr. Nitin N. Sunku[4]
[1]Assistant Professor, Department of Orthopedic's, Farookh Academy of Medical Education Hospital and Research Institute, Mysore, Karnataka, India.
[2]Assistant Professor, Department of Orthopedic, Farookh Academy of Medical Education Hospital and Research Institute, Mysore, Karnataka, India.
[3]Assistant Professor, Department General Medicine, Farookh Academy of Medical Education Hospital and Research Institute, Mysore, Karnataka, India.
[4]Assistant Professor, Department of Orthopedics, The Oxford Medical College, Hospital & Research Centre, Bangalore, Karnataka, India.
Corresponding Author: Dr. Nitin N. Sunku
Assistant Professor, Department of Orthopedics, The Oxford Medical College, Hospital & Research Centre, Bangalore, Karnataka, India.

ABSTRACT

Background
Wound healing is one of the most challenging clinical problems in wound management, especially in high-energy open fractures. This study was conducted to assess the influence of smoking and diabetes on wound healing in open tibial fractures using VAC (Vacuum-Assisted Closure) dressing in comparison to conventional dressing.

Methods
Patients with open type IIIB tibial fractures were enrolled in the study following approval and clearance from the institutional ethical committee. Wound scores before and after application of VAC, as well as reduction in the size of the wounds, were recorded.

Results
The mean age of the conventional dressing group was 38.60 ± 15.41 years, with the majority, 60% belonging to 20-40 age range. The percentage of patients with scores of 1 and 2 increased significantly after application of VAC, while there were no patients with scores of 3 and 4. Reduction in size of wound among smokers was significantly less compared to non-smokers after VAC (Vacuum Assisted Closure). The reduction was greater among diabetics than in non-diabetics with VAC.

Conclusions
Utilization of VAC in the management of open tibial fractures was found to be beneficial in both smokers and diabetics, more so in the latter group of patients.

Keywords: Vacuum Assisted Closure, Type IIIB Open Tibia Fractures.

INTRODUCTION

NPWT, or negative pressure wound therapy, is a new non-invasive supplemental treatment. By removing liquid from the open wound, preparing the wound bed for closure, reducing swelling, and encouraging granulation and perfusion, the NPWT machine helps the wound heal by creating a vacuum in the area of the damage with the external environment.[1,2] Despite the widespread recognition of NPWT's effectiveness, reports from the clinical literature vary greatly, and the results are not adequately quantified.

www.ajmrhs.com
eISSN: 2583-7761

Date of Received: 04-02-2026
Date Acceptance: 23-03-2026
Date of Publication: 28-03-2026

The most frequent long bone fractures are tibial shaft fractures.[3] After a lengthy bone fracture, bone healing is a complicated process that is impacted by a number of variables. There is no callus production during primary bone healing. Callus development leads to secondary bone repair.

There are two types of elements that interfere with the previously mentioned process: systemic and local. Infection, reduced blood flow to the fracture site, and excessive movement at the fracture site are examples of local causes. Smoking, diabetes, obesity, and malnutrition are examples of systemic issues.[4] Smoking and diabetes mellitus both negatively impact wound healing and fracture union in open tibia fractures, including Gustilo type IIIB cases treated with VAC (Vacuum-Assisted Closure). While VAC promotes granulation and

prepares wounds for closure, these comorbidities increase risks of delayed healing, non-union, and complications. The present study was carried out to assess the effect of smoking and diabetes mellitus on the outcome of vacuum assisted closure for wound healing in type IIIB open tibia fractures.

Treatment for open IIIB tibia fractures is still very difficult and is linked to a high rate of complications, morbidity, and even amputations. Timing and the best kind of treatment are still up for dispute, especially when it comes to wound covering. The management of open tibial fractures has changed recently due to the introduction of negative-pressure wound therapy. Granulation tissue production is quickly accelerated by creating a closed environment by the use of a nonadherent sponge and intermittent suction using a VAC.[5] Furthermore, VAC has been demonstrated to be successful in lowering bacterial populations in wounds up until final bone covering.[6]

MATERIAL AND METHODS

Study Design

This study is a Randomized trial conducted for a period of 1.5 years in Hospitals attached to BMCRI, Victoria hospital and Bowring hospital, Bangalore

Sample Size

Sample size calculated and found to be 40.

Inclusion Criteria

1. The patient is prepared to consent to the operations.
2. Patients between the ages of 18 and 60, regardless of gender.
3. Individuals with type IIIB open tibia fractures, who necessitate surgical debridement because primary closure is not feasible.
4. Wounds that are polluted or not.

Exclusion Criteria

1. Untreated osteomyelitis accompanied by pathological fractures.
2. The wound has a thick, necrotic eschar.
3. Individuals with hemoglobinopathies or haemophilia.
4. When a flap is necessary.

40 patients who met the inclusion criteria and were hospitalised to the orthopaedics department were enrolled in the study after receiving approval and clearance from the institutional ethics committee. Patient information was documented using a case record form, and informed consent was obtained. The group was split equally between VAC and traditional dressing.

The topical negative pressure wound dressing combines vacuum-assisted wound closure methods with a composite synthetic hydrocolloid sheet dressing. The technique involves the following steps:

1. Devitalised tissue is removed and the wound is completely debrided. Assess the size of the wound after cleaning it with regular saline.
2. Apply the foam over the wound after cutting and shaping it to fit its dimensions.
3. A sticky, semipermeable, translucent membrane covers the foam and the surrounding normal skin. The area surrounding the wound has to have a good air seal.
4. A device that generates a negative pressure suction between –25 and –200 mm of Hg is now attached to the distal end of the drain tube. Simple suction drain devices and wall suction equipment can accomplish this. Depending on the volume of wound drainage, suction may be used constantly or sporadically. In our work, we adapt the traditional method by using an inexpensive wall suction apparatus or a basic suction drain device instead of the computerised VAC device used in normal VAC dressings.
5. The foam must be visibly deflated into the wound bed after the vacuum is applied.
6. The foam absorbs the fluid from the wound and uses suction to remove it from the wound bed. Studies have shown that for the most benefit, the negative pressure must be maintained for an average of 10–14 days. After sufficient granulation tissue has developed, the dressing should be taken off, and partial- or full-thickness grafts, flaps, or suturing should be used to accomplish final wound closure.

The topical negative pressure moist dressing application requires the following supplies. Among them are

1. Gell foam
2. Vacuum suction apparatus
3. Transparent semi permeable adhesive membrane sheet
4. Drain tube

The materials used are shown in the figure given below

Figure 1: Materials Used For VAC

STATA 11.2 (College Station, Texas, USA) was used to conduct the statistical analysis. The mean and standard deviation of the students' independent sample t-test were used to determine the significant difference between the groups (vacuum assisted closure and conventional dressing) in terms of age, duration of stay, and size reduction. The link between the age distribution, gender distribution, smoking history, diabetes, culture, therapy provided, wound grade, and appearance with groups was measured using the chi-square test for goodness of fit, and the results were expressed as frequency and percentage. P<0.05 is regarded as statistically significant.

RESULTS

The mean age of the conventional dressing group was 38.60 ± 15.41 years, with the majority, 60%, belonging to 20-40 years. The mean age of the vacuum-assisted group was 41.65 ± 12.21 years, with 50% belonging to the 20-40 years age group. There was no difference between the groups with respect to age, and hence they were comparable (p = 0.492). The majority were males in both the groups. There was no difference between the groups with respect to sex distribution, and hence they were comparable (p=0.212).

Of the 20 patients treated with conventional dressing, 10 patients were smokers (50%) and 10 were non-smokers (50%). Of the 20 patients treated with vacuum-assisted closure, 13 patients were smokers (65%) and 7 were non-smokers (35%). Of 20 patients treated with conventional dressing, 5 patients were diabetic (25%) and 15 were non-diabetic (75%); of 20 patients treated with vacuum-assisted closure, 7 patients were diabetic (35%) and 13 were non-diabetic (65%). 35% of the cases in

Conventional Dressing and 35% of the cases in Vacuum Assisted Closure were infected.

The wounds were scored as below:

Score 0 - Skin and soft tissue intact

Score 1 - Defect in the skin is present

Score 2 - One of the following in the wound bed

a) Bone
b) Tendon
c) Implant

Score 3- a combination of any two of the above are exposed

Score 4- presence of deep infection

Assessment of the wounds based on the above scoring system before and after application of VAC was carried out. The results are as shown in Table 1. The percentage of patients having scores of 1 and 2 increased significantly after application of VAC, while there were no patients with score 3 and 4.

		Vacuum Assisted Closure	**Total**
Before	Score 1	1 (5%)	2
	Score 2	7 (35%)	13
	Score 3	5 (25%)	11
	Score 4	7 (35%)	14
After	Score 1	12 (60%)	25
	Score 2	8 (40%)	15

Table 1: Wounds Score Before and After VAC Application

Reduction in size of wound was significantly lesser among those with conventional dressing compared to vacuum assisted closure among both smokers and non-smokers. Reduction in size of wound among smokers was significantly less compared to non-smokers after vacuum assisted closure

	Conventional Dressing	**Vacuum Assisted Closure**	**P-Value**
	Mean ± SD	**Mean ± SD**	
Smoker			
Size reduction (mm)	5.10 ± 1.37	12.38 ± 3.91	<0.001
Non Smoker			
Size reduction (mm)	5.20 ± 1.03	14.28 ± 2.81	<0.001

Table 2: Reduction in Size of Wound among Smokers Compared to Non-Smokers

Reduction in size of wound was significantly lesser among those with conventional dressing compared to VAC among both diabetics and non-diabetics. While the reduction in size of wound among diabetics was significantly lesser compared to non-diabetics after conventional dressing, with VAC the reduction was greater among diabetics.

	Conventional Dressing	**Vacuum Assisted Closure**	**P-Value**
Diabetes	Mean ± SD	Mean ± SD	
Size reduction (mm)	4.4 ± 1.14	13.28 ± 2.92	<0.001
Non-Diabetes			
Size reduction (mm	5.40 ± 1.12	12.92 ± 4.03	<0.001

Table 3: Reduction in Size of Wound among Diabetes and Non-Diabetes

The figure below depicts the effect of these two coexisting conditions on the reduction in size of the wound.

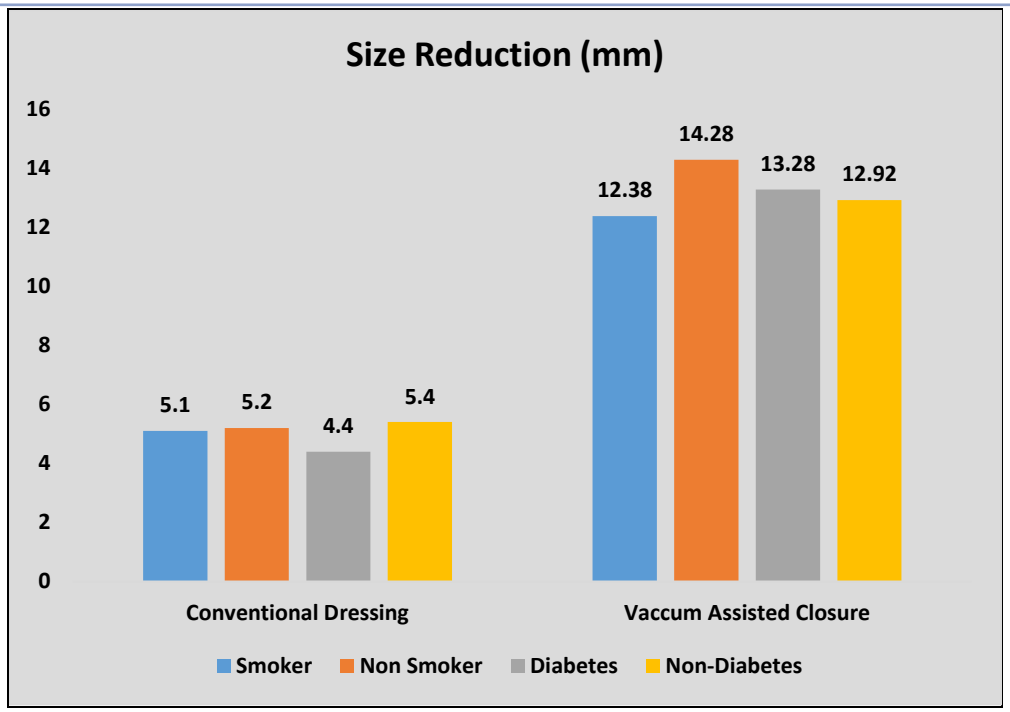

Figure 2: Reduction in Size of Wound among the Two Groups

DISCUSSION

Although there are a number of studies published on the utilization of VAC in the treatment of wounds, the utility of this modality in tibial fractures is very sparse, as is the influence of diabetes and smoking, two important determinants of healing. This was a novel attempt to fill-in this gap in the literature and pave the way for further research. The following discussion is based on the limited literary evidence available on the subject. In a prospective, randomised, interventional study, Sinha et al.[7] used VAC for musculoskeletal ailments. They found that whereas wound size decreased by less than 5 mm with standard wound care, soft-tissue deficits diminished by more than 5 mm to 25 mm (a drop of 26.66%) after VAC. They came to the conclusion that VAC care shortened the time needed for healing and secondary soft-tissue defect-covering procedures by promoting the rapid formation of granulation tissue. Comparable studies by Joseph et al.[8] Morykwas and Argenta[9] revealed that VAC was superior to conventional wound dressings in reducing wound widths over time. 95% of the cases in conventional dressing and 90% of the cases in VAC were caused by automobile accidents. The conventional dressing group's mean age was 38.60 ± 15.41 years, with the majority of males (60%) falling within the 20–40 age range. Open tibial fractures were more common in younger, economically active males in the Singh A et al.[10] series as well. In contrast to comparable studies conducted in other affluent countries that found that 66% of these fractures occurred in the male population, about 93.2% of the population was male.[11]

The application of a VAC facilitates the growth of granulation tissue, readying the wound bed for more flap covering. This might lessen the requirement for complex surgical approaches to achieve sufficient coverage, but it might not completely eliminate the necessity for soft tissue coverage treatments. In contrast to 65% of patients receiving conventional dressing, 95% of patients in our study showed the formation of healthy granulation tissue following VAC. In line with our findings, DeFranzo et al.[12] examined 75 patients who received VAC therapy and discovered a nearly 80% increase in the rate of granulation tissue formation when compared to traditional dressings, which may reduce the wound's surface area and the requirement for flap coverage. A study conducted in 2024 on Gustilo IIIA/IIIB fractures (11.8% diabetics) revealed before and after VAC therapy, the average wound size was 66.05 cm2 and 27.97 cm2, respectively.[13] The mean difference before and after the intervention was statistically significant ($p = 0.001$), according to the paired t-test. Consequently, it was statistically demonstrated that VAC dressing aids in the reduction of wound size. The authors concluded that VAC is an effective strategy for reducing the rate of infection and accelerating wound closure. We noticed similar things with smokers and diabetes.

One of the most common risk factors for problems following orthopaedic surgery is smoking; as of 2021, 11.5% of persons over the age of 18 reported using cigarettes, and 2.1% reported using smokeless tobacco.[14,15] By interfering with bone

turnover pathways, smoking is known to negatively impact bone fusion during healing.[8,10] In particular, it was discovered that smoking history was linked to a higher incidence of osteomyelitis and a longer time to union for open tibia fractures.[16] In our study, of the 20 patients treated with conventional dressing, 10 patients were smokers (50%) and 10 were non-smokers patients (50%); of the 20 patients treated with VAC, 13 patients were smokers (65%) and 7 were non-smokers patients (35%). Reduction in size of wound was significantly lesser among those with conventional dressing compared to VAC among both smokers and non-smokers .Reduction in size of wound among smokers was significantly lesser compared to non-smokers after Vacuum Assisted Closure.

Although their risk was not as high as that of present smokers, Castillo et al.[16] found that former smokers had a higher chance of delayed union following tibia fractures. Additionally, the study found that smokers were 37% and 32% less likely than non-smokers to attain union. Current smokers were 3.7 times more likely to get osteomyelitis and more than twice as likely to get an infection. Osteomyelitis was 2.8 times more common in former smokers, but there was no increased risk for other infection types. After a year, 20 smokers (36.4%) were found to have contracted an infection, but none of the nonsmokers had any symptoms. Both current and former smokers had much worse functional outcomes, needed more time to recover, and missed more work. A 2018 retrospective study[10] of 120 Gustilo IIIB tibia fractures (all requiring flaps, many using VAC adjunctively) reported a 30% infection rate and a 41% delayed union needing revision. Smokers had 65% infection (vs. 25% nonsmokers, $p<0.05$) and 62% revision for union (vs. 36%).

Diabetes, particularly with poor glycemic control (HbA1c ≥6.5%), leads to poor bone healing in over 60% of lower extremity fracture cases. It causes impaired angiogenesis and higher infection risks, though VAC/NPWT improves healing rates and reduces amputations in diabetic foot ulcers. For type IIIB tibia fractures, diabetics achieve bone union with VAC plus flaps, but delayed healing is common. Glycemic control (HbA1c <7%) is key, as poor control exacerbates vascular issues and inflammation. Of the 20 patients treated with conventional dressings, 5 had diabetes (25%) and 15 did not (75%). Of the 20 patients treated with vacuum-assisted closure, 7 had diabetes (35%) and 13 did not (65%). 35% of the cases with vacuum-assisted closure and 35% of the cases with conventional dressing were infected. The most prevalent comorbidity in the Kumaar A et al.[13] study was diabetes mellitus (11.8%), whereas around 73.5% of the patients had no comorbidities. In contrast, a 2013 study conducted in Singapore by Joethy et al.[17] indicated that 11–12% of people had pre-existing comorbidities.

We observed that a reduction in the size of the wound was significantly lesser among those with conventional dressing compared to vacuum-assisted closure among both diabetics and non-diabetics. While the reduction in size of the wound among diabetics was significantly less compared to non-diabetics after conventional dressing, with vacuum-assisted closure the reduction was greater among diabetics. There are no similar studies for comparison of these parameters of healing.

Thus, smoking and diabetes synergistically exacerbate hypoxia and impair VAC efficacy via vasoconstriction and poor tissue oxygenation. No direct studies isolate both on VAC for type IIIB tibia fractures, but general evidence shows prolonged VAC use (>7 days) raises infection/amputation risks in high-risk patients. Smoking cessation and glycemic control are critical to optimize VAC outcomes. Early VAC (within days) shortens treatment and boosts granulation, but smokers/diabetics need optimized control (e.g., cessation, HbA1c<7%) for best results. Larger RCTs isolating comorbidities are lacking. This study had some limitations. This study included a rather limited number of patients. Given the prevalence of open injuries, a larger patient population should be included in the study. There is no research on the impact of VAC-treated wounds on fracture union. The current study did not include the quantitative evaluation of postoperative parameters such as wound contraction, pain, and residual raw ulcer area, which may have provided a much better analysis of the effectiveness of VAC dressings in comparison to traditional dressings.

CONCLUSION

Utilization of VAC in the management of open tibial fractures was found to be beneficial in both smokers and diabetics, more so in the latter group of patients. Further research involving a larger number of patients would pave the way for routine use of this modality in the management.

REFERENCES

1. Uğurlar M, Sönmez MM, Armağan R, et al. Comparison of two different vacuum-assisted closure (VAC) treatments of multiple chronic diabetic foot wounds in the same extremity. Foot Ankle Surg 2017;23(3):173-8.
2. Soylemez MS, Ozkan K, Kilic B, et al. Intermittent negative pressure wound therapy with instillation for the treatment of persistent periprosthetic hip infections: a report of two cases. Ther Clin Risk Manag 2016;12:161-6.

3. Egol KA, Koval KJ, Zuckermann J. Handbook of fractures. 6th edn. Alphen aan den Rijn, Netherlands: Wolters Kluwer 2020.
4. Sheen JR, Garla VV. Fracture healing overview. Treasure Island, FL: StatPearls; 2026.
5. [Stannard JP, Volgas DA, Stewart R, et al. Negative pressure wound therapy after severe open fractures: a prospective randomized study. J Orthop Trauma 2009;23:552-7.
6. Dedmond BT, Kortesis B, Punger K, et al. The use of negative-pressure wound therapy (NPWT) in the temporary treatment of soft-tissue injuries associated with high-energy open tibial shaft fractures. J Orthop Trauma 2007;21:11-7.
7. Sinha K, Chauhan VD, Maheshwari R, et al. Vacuum assisted closure therapy versus standard wound therapy for open musculoskeletal injuries. Adv Orthop 2013;2013:245940.
8. Joseph E. A prospective randomized trial of vacuum-assisted closure versus standard therapy of chronic non-healing wounds. Wounds 2000;12(3):60-7.
9. 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.
10. Singh A, Jiong Hao JT, Wei DT, et al. Gustilo IIIB Open Tibial Fractures: An analysis of infection and nonunion rates. Indian J Orthop 2018;52(4):406-10.
11. Court-Brown CM, Rimmer S, Prakash U, et al. The epidemiology of open long bone fractures. Injury 1998;29:529-34.
12. DeFranzo AJ, Argenta LC, Marks MW, et al. The use of vacuum-assisted closure therapy for the treatment of lower-extremity wounds with exposed bone. Plast Reconstr Surg 2001;108(5):1184-91.
13. Kumaar A, Shanthappa AH, Hongaiah D, et al. Evaluation of clinical outcomes of negative-pressure wound therapy in gustilo-anderson type IIIA/IIIB open fractures of extremities. Cureus 2024;16(2):e53801.
14. Centers for Disease Control and Prevention. Smokeless Tobacco Use in the United States. May 1, 2023. https://www.cdc.gov/tobacco/data_statistics/fact_sheets/smokeless/use_us/index.htm
15. Al-Bashaireh AM, Haddad LG, Weaver M, et al. The effect of tobacco smoking on bone mass: an overview of pathophysiologic mechanisms. J Osteoporos 2018;2018:1206235.
16. Castillo RC, Bosse MJ, MacKenzie EJ, et al. Impact of smoking on fracture healing and risk of complications in limb-threatening open tibia fractures. J Orthop Trauma 2005;19(3):151-7.
17. Joethy J, Sebastin SJ, Chong AK, et al. Effect of negative-pressure wound therapy on open fractures of the lower limb. Singapore Med J 2013;54:620-3.

How to cite this article: Dr. Prashanth Reddy P., Dr. Arjun A., Dr. Mahesh J. Nerkar, Dr. Nitin N. Sunku, OUTCOME OF VAC THERAPY IN TYPE 3 TIBIAL FRACTURES AMONG DIABETIC PATIENTS AND SMOKERS, Asian J. Med. Res. Health Sci., 2026; 4 (1):-15-21.
Source of Support: Nil, Conflicts of Interest: None declared.