CASE SERIES

Vacuum-assisted closure: A weapon in the arsenal of orthopaedic surgeons in the treatment of Gustilo-Anderson III-B fractures

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Abstract

The study aimed to assess the benefit of negative pressure dressing in the management of Gustilo Anderson type III-B open fractures. This prospective case series was conducted between March 2023 and March 2024 in the Department of Orthopaedics, Dr Ruth K M Pfau Civil Hospital, Karachi, in which records of 32 patients with open fractures treated with vacuum-assisted closure (VAC) dressing, who were admitted to the orthopaedic department, were analysed. The study showed that VAC dressing plays a beneficial role in the treatment of open fractures and reduces the need for large grafts and flaps for coverage by decreasing the size of the wound through contraction and covering the exposed bone with granulation tissue, which can then be covered by a split skin graft. VAC has provided an alternative for the lack of expertise and time-consuming procedures required for the coverage of open fractures.

Keywords: Gustilo Anderson III-B, Vacuum Assisted Closure (VAC), Open fracture, Coverage.

DOI: https://doi.org/10.47391/JPMA.22419

Introduction

One out of every 120 people will sustain a fracture in their life, and three percent of all those fractures are open fractures; hence, open fractures are a major health risk.[1] Open fractures are injuries in which a part of the fractured bone or fracture haematoma communicates with the external environment.[2] It is a surgical emergency in which the aim is to restore the limb, decrease mortality, and prevent morbidity, such as infection, non-union, and amputation.[3] Gustilo Anderson (GA) type III-B fractures are associated with extensive soft tissue injury with periosteal stripping and bone exposure.[4] Lenarz et al. reported a rate of 10.6% after GA type III-B open fractures.[5] Caudle and Stern reported a non-union rate of about 43% with Gustilo Anderson type III-B fractures.[6] Gustilo Anderson type III-B open fractures are the direct result of high-velocity injuries, such as a fall from height or a crush injury, and result in high rates of infection and non-union, may cause limb loss in an otherwise fit and healthy individual.[7] These fractures are treated by initial wide wound debridement, stabilisation of the bone with external fixation, and delayed wound closure.[8]

The use of the vacuum-assisted closure device has provided a new pathway for the successful management of severe traumatic wounds with open fractures.[9] In his study on open tibia fractures, Dedmond et al. highlighted a 50% decrease in the need of free tissue transfers or rotational muscle flaps for coverage.[10] The rate of infection noted in wounds treated by VAC was 11.67% as reported by Chalimeda et al.[11] as compared to saline dressing, which had an infection rate of 27.4% as reported by Gopal et al.[12] VAC stimulates wound healing by contracting the wound, removing exudates and infectious material, decreasing oedema, increasing perfusion, and stimulating granulation tissue formation.[13]

The current study aims to demonstrate the effect of VAC in situations in which primary wound coverage is not possible and to highlight the benefit of negative pressure dressing in the management of Gustilo Anderson type III-B open fractures.

Case Series

The study was a prospective case series which included 32 patients presenting with Gustilo Anderson type III-B fractures in the emergency department, Dr Ruth K M Pfau Civil Hospital, Karachi, from March 2023 till March 2024.

Patients of any age, of both genders with GA type III-B fractures who were labelled as post-debridement, being treated by VAC were included in the study. All GA type I-IIIA and III-C, GA type III-B patients being treated by other methods were excluded.

At the time of admission in the emergency department of Dr Ruth K M Pfau Civil Hospital, Karachi, data regarding the socio-demographics of the patient, wound size, mechanism of injury, and time of presentation since injury was recorded. Number of VAC dressings, time since injury

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Submission completed: 14-01-2025 **1st Revision received:** 26-09-2025
Acceptance: 30-05-2026 **Last Revision received:** 29-05-2026

to coverage was noted during the stay, while admitted in the department of orthopaedics. The wound was assessed at the time of presentation and change of dressing using Wound Bed Score by Falanga.[14,15] All VACs were done by orthopaedics team members to minimise variation in assessment and method of application, and the steps were as follows:[16]

- The wound was washed with normal saline.
- Bedside or debridement in OT was done, if necrotic tissue was noted.
- The wound was covered with paraffin gauze and sterile foam cut to the size of the wound.
- An 18 fr suction catheter was placed over the foam through which negative pressure was created.
- The whole apparatus was covered with transparent adhesive dressing, making sure there was no leakage.
- The catheter was connected to a suction machine, which maintains a pressure of -x125mmHg
- Intermittent pressure was applied by keeping it, two hours on and one hour off.
- Dressings were changed every three days.
- Wound cultures were taken after each dressing.

Result

The patients' ages ranged from seven to 68 years, with the mean age being 28.69±15.25 years. The time of presentation in the hospital since the injury ranged from eight to 56 hours, with the mean time of presentation being 31 ± 6 hours. The most common bone fractures were in the tibia and fibula, 17(53.1%) in total, as shown in Table 1.

The most common mode of injury was bike vs car collision in 14(43.8%) patients, followed by bike slip in 8(25%) patients being the second most common and machine crush injury being the least common of the mechanisms as shown in Table 2.

The wound bed score on presentation ranged from 2–8 cm, with the mean wound bed score being 6.06 ± 0.8 cm out of an aggregate of 16. The area of wound size after first debridement ranged from 72-560 cm^2, with the mean wound area being 172.8±61 cm; similarly, the wound depth after first debridement ranged from 1–5cm, with the mean depth being 2.75±1 cm. The number of VAC dressings required ranged from 1–7 with the majority requiring 4 dressings in 8(25%) patients, after which the wound condition was adequate for coverage. About 18(56.3%) patients did not need any re-debridement, with 12(37.5%) requiring only a single re-debridement. The time needed for coverage from the time of presentation ranged from 7–30 days, with the mean time being 16.94±5.75 days. Coverage was done using SSG in 28(87.5%) cases, with 4(12.5%) needing SSG+Flap for coverage, as shown in Table 3.

The mean decrease in area of wound after each VAC was noted to be 12.87±3cm^2, whereas the decrease in depth was 0.3±0.1cm and improvement of wound bed score was noted to be 1.87±0.4 with each VAC dressing. The descriptive statistics are summarised in Table 4. It was noted that with the increase in the time of presentation since injury the wound bed score at presentation was decreased in those patients showing a negative relation (r=-0.567, p=0.02). It was also noted that patients presenting late needed more VACs for improvement, (r=0.477, p = 0.031) showed a direct relation. With decrease in size of wound the wound bed score also increased

Table-1: Bones fractured.

	n (%)
Tibia/fibula	17 (53.1)
Femur	3 (9.4)
Medial malleolus	4 (12.5)
Radius	4 (12.5)
Lateral malleolus	4 (12.5)
Total	32 (100)

Table-2: Mode of injury.

	n (%)
Bike va car	14 (43.8)
Bike slip	8 (25.0)
Machine crush	4 (12.5)
Bike vs paeds	6 (18.8)
Total	32 (100)

Table-3: Coverage done using.

	n (%)
SSG	28 (87.5)
SSG+Flap	4 (12.5)
Total	32 (100)

Table-4: Descriptive Statistics.

Value	Minimum	Maximum	Mean±SD
Age of patient (years)	7	68	28.69±15.25
Time of presentation since injury (h)	8	56	31±6
Wound bed Score on presentation	2	8	6.06±0.80
Area of wound after initial debridement (cm^2)	72	560	172.8±61
Depth of wound after initial debridement (cm)	1	5	2.75±1
No. of VACs required	1	7	4±0.64
No. of Redebridements needed	0	2	0.56±0.62
Time till coverage (days)	7	30	16.94±5.75

SD: Standard Deviation

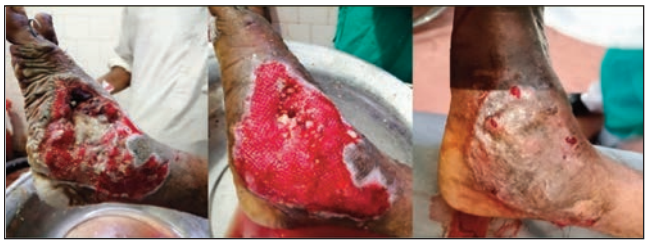

Figure-1: An elderly male with open ankle fracture treated with debridement, VAC dressing and later on SSG.

Figure-2: Open femur fracture in young male treated with debridement, application of external fixator and VAC.

(r=0.705, p=0.001). It was also noted that more the number of VACs needed, lesser was the change in wound bed score with each VAC change (r=-0.525, p=0.018). The mean decrease in the area of wound after each VAC also decreased with the increase in numbers of VACs (r=-0.638, p=0.004). The effect of VAC therapy on open fractures can be seen in Figure 1 and Figure 2.

Discussion

Open fractures are one of the most difficult to treat injuries compared to closed fractures, as they have a significant risk of infection, non-union, and other complications requiring multiple procedures to treat, which may result in loss of limb or disability.[17]

The study included 32 patients presenting in the emergency department of the hospital with GA 3-B fractures. The mean age of the patients was 28.69±15.25 years, and all 32 patients were males. The mean time of presentation was about 31±6 hours after the event of injury, which shows a significant delay in presentation in such patients, which may have an adverse effect on the outcome. Ashford et al. in their study, reported that despite delayed presentation, satisfactory outcomes can be obtained by adhering to the established principles of management of open fractures.[18] However, steps should be taken to decrease the interval between the injury and presentation to the hospital. The commonest mechanism of injury was noted to be a bike-versus-car collision, with bike slips being the second most common mechanism. The most commonly fractured bones were noted to be the tibia and fibula, which is the same in this region as it occurs internationally.[19] The mean wound bed score on presentation was 6.06 and an increase of 1.87 was noted after each VAC application. Falanga et al., in their study regarding the healing of chronic wounds, reported that a single unit increase in the wound bed score increased the chance of wound healing by 22.8%.[14] However, its implications for acute open injuries need to be further studied. The majority of the patients required about four dressings until the wound was healthy enough for coverage, and a total decrease in wound area of about 23% was noted in the patients in the current study as compared to the disease of 26.66% reported by Sinha et al. in their study regarding the management of musculoskeletal studies with VAC.[20] About 56.3% did not need any re-debridement, with 37.5% needing only a single re-debridement. The average duration of VAC therapy required in the patients making the wound coverable was 16.94 days, in contrast to 8.04 days reported by Khurram et al. who also had a total decrease in wound area of 26.66%.[21] The mean decrease in wound area after each VAC was noted to be 12.87 cm^2, whereas the decrease in depth was 0.3 cm.

With delayed presentation, the wound bed score on presentation also decreased, showing that patients presenting late had unhealthier wounds. Hull et al., in their study, also reported a linear relationship between delayed presentation and deep infection, showing a 3% increase with each hour of delay.[22] The number of VAC dressings needed also increased with delay in presentation, as the patient needed more therapy time for his wound to improve. With multiple changes in VACs, it was noted that with each change in VAC, the decrease in wound area and increase in wound bed score lessened, showing that VAC also has some limitations in wound healing. However, VAC has still developed its ability to improve wound healing, as reported by Sagy M et al., who noted that compared to standard therapy, the wound surface area reduced twice as quickly with VAC dressings.[23]

The limitations of this study are that a diverse age group of patients was included in it, which may have variable physiological conditions that may have affected the patient's ability to heal wounds. Secondly, patients presenting in the hospital almost always belonged to a deprived socioeconomic class, and VAC dressings in these patients were done using makeshift equipment that was free or available at a cheap price. Proper equipment and material designed specifically for this purpose may have different results.

A multi-centre study should be done to assess the effectiveness of VAC with a larger sample size and variable conditions. Until then, VAC can be used as an effective tool for wound management in places where plastic surgeons are not readily available.

Conclusion

Road traffic accidents are a major cause of open fractures, with open tibia and fibula fractures being one of the most common bones that are fractured. VAC dressing has a salutary part in the treatment of open fractures and reduces the need for large grafts and flaps for coverage by decreasing the size of the wound through contraction and covering the exposed bone with granulation tissue, which can then be covered by a split skin graft. In majority of cases 4 VAC dresses provided enough granulation tissue so that the wound could e covered with skin grafts. VAC also decreased the need for redebridments of the wound. Hence, VAC has provided an alternative for the lack of expertise and time-consuming procedures needed for coverage of open fractures.

Ethics approval: Approval for Institutional review board was obtained.

Data access statement: Only the principal investigator had access to the patients' personal data. Patients confidentiality was maintained using hospital MR instead of names, no pictures were taken or shared without permission.

Conflicts of interests: The person who signed the departmental approval letter i.e. Dr Badar uddin Sahito is also a co-author in this study.

Funding Sources: None.

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Author Contribution:

MMAK: Concept, methodology, project supervision, data collection and writing.
BS: Concept, administration, supervision, reviewing and editing.
TAB, HA, WA & SMMA: Data collection and writing.