Original Article

Management of the Wound in Type IIIB Open Tibiofibular Fractures: The Role of Improvised Vacuum-assisted Closure Dressing

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Abstract

Background: The negative pressure used in vacuum-assisted closure (VAC) dressing helps to suck out fluid and bacteria from the wound and enhances granulation tissue formation and wound contraction, thus causing wound healing. **Aim:** The aim of the study is to demonstrate the effectiveness of VAC in extensive wound management when using local materials. **Methods:** This was a prospective study in which all consented patients who met the inclusion criteria within the study period were included in the study; suctioning machine, rubber tube, foam and cling film were adapted to make the local VAC which was used to manage the wound. The results were analysed by IBM SPSS Version 22. **Results:** Thirty-two wounds were managed with VAC, there were 28 males and four females, the mean age of patients was 33.7 ± 9.6 years, the mean length of wound managed was 10.6 ± 2.9 cm and the average number of dressing was five times. All wounds were culture positive at the beginning of the management, with *Staphylococcus aureus* being the most common organism. At the end of VAC treatment, 90.6% of the wound were negative for culture. Healing by secondary wound intension occurred in 50% of the wound, secondary suturing was done in 31.2% of the wound, while 18.8% of the wound had split-thickness skin grafting. The complications noted during the treatment are pain in 9.3% of the patients and skin excoriation in 3.1% of the patients. **Conclusion:** VAC method of wound management using local materials is effective in the treatment of extensive wound, and it is associated with less frequent dressing to achieve the desired result.

Keywords: Dressing, vacuum, wound

Introduction

Open tibiofibular fracture occurs when there is break in continuity of tibia and fibula with the fracture haematoma communicating with the exterior due to the disruption of skin and the underlying soft tissue, and this type of fracture is a difficult fracture to manage, especially the Gustilo–Anderson Type III fractures due to soft tissue loss and the high risk of infection involved. According to the Gustilo–Anderson classification, Type IIIB fracture is a high-energy injury in which the associated wound required tissue flap for its closure.[1,2]

Fracture healing depends largely on the integrity of the surrounding soft tissue; the nutrients and oxygen needed for fracture healing are delivered by the soft tissue. If wound in open fracture is not properly managed, it can lead to long-term complications such as chronic osteomyelitis, Marjolin ulcer or squamous cell carcinoma, which make the management complicated.[3,4]

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Wound management in open fracture gives good results when patients present early, and wound irrigation, wound debridement and closure are done immediately.[5,6] Wound closure in Type IIIB open fracture is often challenging, especially in those that require free flap cover, due to late presentation, the technicality and facilities (skills and equipment) required for raising a free flap, which are not available in most centres in Nigeria including this centre.

Vacuum-assisted closure (VAC) dressing is a non-operative means of wound closure using a negative pressure mechanism.

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It aids wound healing by sucking out pus in the wound, reduces oedema fluid, moisturises the wound, reduces bacterial load in the wound, increases tissue perfusion and encourages granulation tissue formation. With the aid of VAC, studies have shown that complex wound which might have required flap cover has been healed non-operatively with VAC or converted to a simple wound that required only skin grafting for the wound to heal.[7-11]

The aim of this study is to demonstrate the effectiveness of VAC in wound cover, especially when our local materials are being used.

Methods

This was a prospective study that spanned a period of 2 years, from June 2015 to May 2017, at Federal Medical Centre, Birnin Kebbi. All consented patients within the study period who had Type IIIB tibiofibular fracture with infected wound or patients with Type IIIB tibiofibular fracture who had had flap cover but had flap necrosis (failed flap) were recruited; sickle cell disease patients, patients with Marjolin ulcer and patients with previous history of bleeding disorders were excluded from the study. At presentation, wound debridement and irrigation with normal saline were done; VAC was subsequently applied for these patients.

The information from the study was recorded in a pro forma that contains the bio-data, site of the open fracture, length of the wound, time to wound healing after application of VAC and complications of VAC. The data from the pro forma were analysed using IBM SPSS version 22 (IBM Inc., Chicago, IL, USA). $P < 0.05$ was set as significant.

Vacuum-assisted closure dressing

Locally available materials were used for VAC dressing in this centre, and these consist of sterilised foam, cling film, rubber tube and suction machine. The foam was cut to the size of the wound, the rubber tube was fenestrated at the tip and inserted into the foam, the cling film was used to wrap the foam and the tube on the wound and was made airtight at both ends with the aid of adhesive tape. The tube was then connected to the suction machine; the foam collapses once the machine starts working [Figures 1 and 2]. The machine was left on continuously for the first 24 h and then intermittently 2 h on and 1 h off for another 24 h, and the wound was then inspected and dressing was changed. The subsequent change of dressing was every 4–5 days (with intermittent 4 h on and 2 h off of the machine) till the wound heal or converted to a simple wound that needed few days of dressing to heal by secondary intension, needed secondary wound closure or needed skin grafting to heal the wound.

Figure 1: Materials adapted for local vacuum-assisted closure in our centre. (1) Cling film, (2) foam and rubber tube and (3) suctioning machine

Results

There were 32 patients during the study period of which 28 males and four females, with a male-to-female ratio of 7:1. The mean age of the patients studied was 33.7 ± 9.6 years (17–55 years). The mean length of the wound of patients studied was 10.6 ± 2.9 cm (6–18 cm). The average number of dressing was 5.0 times (4–7 times). The mean duration of VAC was 24.1 ± 4.2 days.

The mean time to wound healing was 5.1 ± 2.7 weeks (4–9 weeks). The statistical relationship between the length of wound and time to wound healing was significant ($P = 0.007$). The statistical relationship between the site of wound on the leg and time to wound healing was not significant ($P = 0.506$). Furthermore, the relationship between the age of the patients and time to wound healing was not statistically significant ($P = 0.532$).

Discussion

Wound management is an important aspect of managing open fractures because fracture healing depends on the integrity of the surrounding soft tissue. During the study period, VAC treatment of 32 wounds in 32 patients with Gustilo–Anderson Type IIIB fractures was reviewed. The mean age of patients was 33.7 ± 9.6 years, which shows that young patients are mostly affected by this type of injury.

The average number of times of change of VAC dressing during the treatment was five times, after which the wound was allowed to heal by secondary intension or had secondary wound closure, or split-thickness skin grafting (STSG) was used to

Figure 2: Patient on the local vacuum-assisted closure

cover the residual wound, which demonstrates the effectiveness of VAC in managing extensive wounds.

The average duration that the patient stayed on VAC was 24.1 ± 4.2 days; during this period, the patients were strictly on the bed, and the electricity supply was constant while the patient was on VAC. This average duration of time that patients stayed on VAC in this study was a bit longer than that of the study by Raj *et al*.;[10] this may be because they used the convectional materials of VAC for their own study. Furthermore, Jiburum *et al*. reported much shorter duration of stay on VAC by their patients; this may be due to the fact that the type of wound they treated in their own study was not trauma related, mainly chronic leg ulcers.[12]

Table 1: Sites of the wound on the leg

Sites	*n* (%)
Proximal third	6 (18.8)
Middle third	9 (28.1)
Lower third	17 (53.1)
Total	32 (100.0)

Majority of the wound (53.1%) were located in the distal third of the leg; [Table 1] this is the part of the leg with the least muscle bulk, and wound healing around this region is usually difficult. All the wounds were culture positive for organisms at the beginning of treatment, [Table 2] with *Staphylococcus aureus* being the most common (37.5%); this was followed by mixed growth (28.1%), others were *Pseudomonas* (15.6%), *Klebsiella* (9.4%) and *Escherichia coli* (9.4%). By the end of VAC treatment, 90.6% of the wounds were culture negative for organisms. Jones *et al*. also reported a rapid decline in bacterial colonisation of wounds in their study.[13]

After the removal of VAC, six patients (18.8%) had STSG, 10 patients (31.2%) had secondary wound suturing, while 16 patients (50%) had their wound healed by secondary intension. This shows that VAC is effective in converting

Table 2: Outcome of managing thirty-two wounds with improvised VAC

Age (years)	Sex	Number of VAC dressing	Duration on VAC (days)	Initial wound culture	Culture at end of VAC dressing	Fate of the wound after VAC
28	Male	5	26	*S. aureus*	Negative	HC
34	Male	7	33	*S. aureus*	Negative	STSG
19	Male	5	26	*S. aureus*	Negative	HC
32	Male	4	21	*Klebsiella*	Negative	HS
26	Male	5	23	Mixed growth	Negative	STSG
29	Male	5	24	*Pseudomonas*	Negative	HC
41	Male	5	22	*S. aureus*	Negative	HS
28	Male	7	35	Mixed growth	*Pseudomonas*	HC
34	Female	4	20	*E. coli*	Negative	HS
33	Male	6	29	Mixed growth	*S. aureus*	HS
22	Male	6	30	*Pseudomonas*	Negative	HC
17	Male	6	30	*S. aureus*	Negative	HC
43	Male	6	27	*Klebsiella*	Negative	STSG
25	Male	6	27	*S. aureus*	Negative	HS
23	Male	5	20	*S. aureus*	Negative	HC
38	Male	5	27	*Pseudomonas*	Negative	HS
45	Female	5	25	*S. aureus*	Negative	STSG
30	Male	5	23	*Pseudomonas*	Negative	HC
34	Male	4	19	Mixed growth	Negative	HS
55	Male	4	21	*S. aureus*	Negative	HC
23	Male	6	29	*Klebsiella*	Negative	HS
36	Male	5	24	Mixed growth	Negative	HC
39	Male	5	26	Mixed growth	*S. aureus*	HS
41	Male	5	23	*E. coli*	Negative	STSG
50	Female	5	22	*Pseudomonas*	Negative	HS
47	Male	4	19	*S. aureus*	Negative	HS
33	Male	4	21	*S. aureus*	Negative	HS
41	Female	4	18	*E. coli*	Negative	HS
20	Male	4	18	Mixed growth	Negative	HS
46	Male	4	20	Mixed growth	Negative	HS
40	Male	4	21	*S. aureus*	Negative	HS
25	Male	6	31	Mixed growth	Negative	STSG

STSG: Split-thickness skin grafting, HS: Healed with secondary intension after few dressings, HC: Healed after secondary wound closure, *E. coli*: *Escherichia coli*, VAC: Vacuum-assisted closure, *S. aureus*: *Staphylococcus aureus*

Table 3: Complications

Complications	*n* (%)
Pain	3 (9.4)
Skin excoriation	1 (3.1)
Total	4 (12.5)

complex wound such as the type seen in Gustilo-Anderson Type IIIB to a simple wound that can heal by secondary intension or requires a simple procedure such as STSG or secondary suturing for the final healing of the wound.

The mean time from commencement of the treatment to final wound healing in this study was 5.1 ± 2.7 weeks, the relationship between the length of wound and time to wound healing was statistically significant (0.007) and this means that the smaller the length of wound, the earlier the healing. The relationship between the ages of the patients and the sites of the wound with time to wound healing was not statistically significant.

The most common complication noticed while patient was on VAC was pain in three patients, which usually resolved when the pressure on the suction machine was reduced. One patient (3.1%) had skin excoriation around the wound; [Table 3] this resolved few days after stopping the VAC dressing.

The advantages of VAC noted in this study include simple method of extensive wound management to get the desired result, less frequent wound dressing and good alternative to raising the flap. The disadvantages noted include restriction of patient on bed while on VAC, dependent on electrical supply.

The limitation of the method used in this study is that the suctioning machine used is not calibrated for their negative pressure; hence, the exact pressure used is not known and the pressure is usually regulated to the level that gives no pain to the patient.

Conclusion

VAC dressing using local materials is an effective way of managing the complex wound, and it reduces the bacterial loads in the wound and creates a favourable environment to enhance the healing. With VAC, complex wound can be healed successfully or get converted to a simple wound that will require further minor procedure to heal the wound.

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Conflicts of interest

There are no conflicts of interest.

References

1. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: Retrospective and prospective analyses. J Bone Joint Surg Am 1976;58:453-8.
2. Gustilo RB, Mendoza RM, Williams DN. Problems in the management of type III (severe) open fractures: A new classification of type III open fractures. J Trauma 1984;24:742-6.
3. Davis KM, Griffin KS, Chu TG, Wenke JC, Corona BT, McKinley TO, *et al*. Muscle-bone interactions during fracture healing. J Musculoskelet Neuronal Interact 2015;15:1-9.
4. Laroche M. Intraosseous circulation from physiology to disease. Joint Bone Spine 2002;69:262-9.
5. Okike K, Bhattacharyya T. Trends in the management of open fractures. A critical analysis. J Bone Joint Surg Am 2006;88:2739-48.
6. Hertel R, Lambert SM, Müller S, Ballmer FT, Ganz R. On the timing of soft-tissue reconstruction for open fractures of the lower leg. Arch Orthop Trauma Surg 1999;119:7-12.
7. Gupta S, Shaikh TP, Wani JB, Gujar A, Bagul A, Gautam R, *et al*. Role of vacuum assisted closure therapy in chronic wound: For some cases in Navi Mumbai. Int J Res Med Sci 2016;4:95-9.
8. 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;38:553-62.
9. Argenta LC, Morykwas MJ. Vacuum-assisted closure: A new method for wound control and treatment: Clinical experience. Ann Plast Surg 1997;38:563-76.
10. Raj M, Gill SP, Sheopaltan SK, Singh P, Dinesh, Sigh J, *et al*. Evaluation of vacuum assisted closure therapy for soft tissue injury in open musculoskeletal trauma. J Clin Diagn Res 2016;10:RC05-8.
11. Venu MH, Balu CB. Prospective study on vacuum assisted closure therapy in treatment of soft tissue injuries associated with Gustilo Anderson compound grade IIIB fractures. Intern J Orthop Sci 2016;2:101-4.
12. Jiburum B, Opara K, Nwagbara I. Experience with vacuum-assisted closure device in the management of benign chronic leg ulcers. J West Afr Coll Surg 2011;1:89-100.
13. Jones SM, Banwell PE, Shakespeare PG. Advances in wound healing: Topical negative pressure therapy. Postgrad Med J 2005;81:353-7.