Original Research Article

A comparative study on outcome of vacuum assisted closure and conventional dressing of wound healing in type IIIB open tibia fractures: A randomized control study

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Abstract

Wound healing is one of the challenging clinical problems, need for correct and efficient wound management is essential. The management of high energy open fractures is one of the difficult problems confronting the orthopaedic surgeons. After obtaining approval and clearance from the institutional ethical committee, the patients with open type IIIB tibia fractures admitted in Department of Orthopaedics hospital attached to BMCRI, fulfilling the inclusion criteria were enrolled for the study after obtaining informed consent.

Demographic data, history, clinical examination and details of investigation and intervention were recorded in the study proforma after admission. After assessment, patients were randomly allocated into two groups i.e. Group A (patients treated with vacuum assisted closure) and Group B (patients treated with conventional dressing).

Among 20 patients treated with vacuum assisted dressings, the mean reduction in size of the wound overall is 13.05 mm and appearance of healthy granulation tissue is better compared to conventional dressing (P-0.018). 11 patients wound was closed by split skin grafting and 9 wounds were secondarily healed with Vacuum-assisted closure (VAC) treatment on comparison with 20 patients treated with conventional betadine dressings the mean reduction in size of the wound overall is 5.15 mm. 10 patients wound was closed by split skin grafting and 10 wounds were secondarily healed with conventional betadine dressings treatment without requiring a secondary procedure. There is significant decrease in reduction in size of wound and average duration with VAC.

Keywords: Vacuum assisted closure, conventional dressing of wound healing, type IIIB open tibia fractures

Introduction

Fractures of the lower limb are common injuries. The majority of these injuries are “closed”, that is, the skin around the fracture is intact. In such cases, the risk of infection is low; however, if the fracture is “open”, such that the barrier provided by the skin is breached, then the fractured bone is exposed to contamination from the environment. In open fractures, the risk of infection is greatly increased [2]. The greater the extent of the injury to the soft tissues around the fractured bone, the greater the risk of infection. In severe, high-energy fractures of the lower limb, infection rates of 27% have been reported [3], even in specialist trauma centres.

Now a days incidence of high velocity trauma is increasing day by day. As a consequence, open wound fractures are on an upswing. Despite of numerous evolvements in management techniques, management of open wound fractures still remains a challenge. Such wounds act as a hindrance in early definitive management of open fractures owing to its high infection and contamination rates. Thus, management of such open wound fractures becomes the primary mainstay [4].

Wound healing is one of the challenging clinical problem, the need for correct and efficient wound management is essential. The management of such high energy open fractures is one of the difficult problem confronting the orthopaedic surgeons [1].

Wound healing is an uncomfortable and painful process that may at times lead to infection, hospitalization and even death of the patient. Throughout the years many attempts have been made to make this process more manageable for patients, as well as clinicians. If the injury involves the exposure of bone, early coverage of the defect must be a goal of treatment to prevent secondary problems such as osteomyelitis [5].

Conventionally, the wound is covered by dressing to protect the open fracture from further contamination. The wound is covered in this way until a reassessment and further debridement is performed in the operating theatre, usually within 48-72 hours after the initial injury.

Vacuum-assisted closure (VAC) is a new technique in the challenging field of management of contaminated, acute and chronic wounds. Negative-pressure wound therapy (NPWT) is an alternative form of dressing that may be applied to open fractures.

In this treatment, an “open-cell” foam is cut to size of the wound and laid onto the wound, followed by a sealed dressing. A sealed tube is used to connect the dressing to a pump, which creates a partial vacuum over the wound. This NPWT removes blood and exudate from the area of the wound and may also remove any residual bacteria, encouraging “granulation” (healing) tissue [6]. Recent laboratory studies have also suggested that NPWT may stimulate the release of “cytokines” that encourage new blood vessel formation [7].

The application of controlled levels of negative pressure has been shown to accelerate debridement and promote healing in many different types of wounds. The optimum level of negative pressure appears to be around 125 mmHg below ambient pressure and it is believed that negative pressure assists with removal of interstitial fluid, decreasing localised oedema and increasing blood flow. This in turn decreases tissue bacterial levels. Despite the significant costs involved, the technique is said to compare favourably in financial terms with conventional treatments in the management of difficult wounds [8].

Methodology

Study design: Randomized trial.

Study period: 1.5 years.

Sample size: Sample size calculated and found to be 40.

Place of study: Hospitals attached to BMCRI. Victoria hospital and Bowring hospital Bangalore

Inclusion criteria

1) Patient willing to give consent for the procedures.
2) Patient of either sex with age group: 18 to 60 years.
3) Patients with type IIIB open tibia fractures, where primary closure is not possible and requires surgical debridement.
4) Contaminated/non contaminated wounds.

Exclusion criteria

1) Pathological fractures with untreated osteomyelitis.
2) Presence of a thick, necrotic eschar in wound.
3) Patients with hemophilia or haemoglobinopathies.
4) Where flap is required.

After obtaining approval and clearance from the institutional ethical committee, the patients fulfilling the inclusion criteria admitted in department of orthopedics, were enrolled for the study after obtaining informed consent and patient details were recorded as per case record form.

The enrolled patients were divided into two groups of 20 patients each by computerized randomization. Initial thorough wound wash and local debridement done at casuality and wound assessment done. One group of patients were treated with vacuum assisted closure and other group was treated with conventional dressing. Progress of wound healing was assessed in terms of decrease in wound size, appearance of healthy granulation tissue.

Results

The distribution of the patients based on treatment offered in this study is as given below.

10 patients wound was closed by split skin grafting, 10 wounds were Secondarly Healed with Conventional Dressing.

11 patients wound was closed by split skin grafting, 9 wounds were Secondarly Healed with Vacuum Assisted Closure.

Table 1: Distribution of patients based on treatment offered

	Conventional Dressing	**Vacuum Assisted Closure**	**Total**	**P-Value**
Secondary Healing	10 (50%)	9 (45%)	19	0.752
SSG	10 (50%)	11 (55%)	21	
Total	20	20	40	

Our study shows for 35% among the cases in Conventional Dressing and for 35% the cases among Vacuum Assisted Closure were infected.

Table 2: Distribution of patients based on infection of wound

	Conventional Dressing	**Vacuum Assisted Closure**	**Total**	**P-Value**
Infected	7 (35%)	7 (35%)	14	1.000
No Growth	13 (65%)	13 (65%)	26	
Total	20	20	40	

Table 3: Wound score of patients treated

	Conventional Dressing	**Vacuum Assisted Closure**	**Total**	**P-Value**
Before				
Score 1	1 (5%)	1 (5%)	2	0.983
Score 2	6 (30%)	7 (35%)	13	
Score 3	6 (30%)	5 (25%)	11	
Score 4	7 (35%)	7 (35%)	14	
After				
Score 1	13 (65%)	12 (60%)	25	0.744
Score 2	7 (70%0	8 (40%)	15	

Our study includes 20 patients treated with conventional dressing of which the mean reduction of wound size is 5.15mm, 20 patients treated with vacuum assisted closure dressings of which the mean reduction of wound size is 13.05mm.

Table 4: Distribution of cases based on Reduction in size of wound

	Conventional Dressing	**Vacuum Assisted Closure**	**P-Value**
	Mean ± SD	Mean ± SD	
Size reduction (mm)	5.15 ± 1.18	13.05 ± 3.61	<0.001

Our study shows appearance of healthy granulation tissue is better with VAC dressing compared to conventional dressing with p value 0.018.

Table 5: Distribution of patients based on appearance of healthy granulation tissue

	Conventional Dressing	Vacuum Assisted Closure	Total	P-Value
Yes	13 (65%)	19 (95%)	32	0.018
No	7 (35%)	1 (5%)	8	
Total	20	20	40	

Discussion

The use of negative pressure wound therapy in the form of vacuum-assisted closure has been established as a promising method in the field of wound healing in a variety of wounds including those that are difficult to heal.

There are two main factors considered to be responsible for the dramatic response seen in these wounds: removal of fluid and mechanical deformation. Removal of fluid decreases edema which decreases the interstitial pressure resulting in increased blood flow. Mechanical deformation causes a wide variety of molecular responses, including changes in ion concentration, permeability of cell membrane, release of second messengers, and stimulation of molecular pathways increasing the mitotic rate of stretched cells. Recently, Scherer *et al*. have concluded that vascular response is related to the polyurethane foam, whereas tissue strain induced by vacuum assisted closure device stimulated cell proliferation.

DeFranzo *et al*. advocated the changing of VAC dressing at 2 days interval, while Banwell *et al*. recommend 4-5 days [9, 10]. Singh SH *et al*. advocated change at 3-5 days interval.

In our study, VAC dressing was changed every 3 days.

Stannard *et al*. [11], studied the impact of NPWT on severely contaminated open fractures and observed significant difference between the 16 groups for infections, with regular saline dressing, our study showed a mean reduction in size of the wound by 15.06 mm after VAC therapy. Study by Kushagra Sinha *et al*. 77 showed a decrease in size of 1 to 4.9 mm in 26.66% of patients in VAC group whereas 93.33% in control group from day 0 to day 8. A decrease in size of 10 to 19.9 mm was seen in 46.66% of patients of VAC group and only 6.66% in control group. A decrease in size of more than 25 mm was seen in 13.33% in VAC group. Similar studies were conducted by Argenta *et al*., Morykwas *et al*. & Joseph *et al*., & these studies showed that VAC proved effective in shrinking of the diameter of the wound size and formation of healthy granulation tissue when compared to normal saline dressing methods.

Russel *et al*. [12] advocates that primary wound closure should be avoided in treatment of open Tibia fractures, whereas Veliskakis [13] described primary internal fixation and primary wound closure gives good results. Presently there is a tendency towards radical debridement, immediate fracture stabilization and immediate definitive coverage.

There are several advantages of applying a Primary VAC to an open injury and these include,

Protects the wound from external environment and further bacterial contamination. Absorbs the exudate from the wound and decreases local edema. Prevents loss of fluid from the wound and thus provides a moist environment at the wound which favors collagen synthesis and epithelial proliferation. Increases the local blood flow to the wound.

It considerably decreases the bacterial load of the wound and thus wound infection. Maintains an acidic pH and low oxygen tension on the wound which promotes granulation tissue formation and angiogenesis. Induces mechanical stretch on the cell cytoskeleton leading to the release of cytokines associated with wound healing. VAC also reduce wound size, accelerates granulation tissue formation and lower the coverage complexity down the "reconstructive ladder" when applied as a temporary dressing to acute open fractures.

Hence, VAC can be applied after each debridement and irrigation until the wound is fit for a reconstructive procedure such as SSG or flap cover. VAC can be applied in a continuous or cyclical manner. The observation that intermittent cyclical treatment appears more effective than continuous therapy is interesting although the reasons for this are not fully understood. Two possible explanations were proposed by Philbeck *et al*. [14]. They suggested that intermittent cycling results in rhythmic perfusion of the tissue which is maintained because

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the process of capillary auto regulation is not activated. They also suggested that as cells which are undergoing mitosis must go through a cycle of rest, cellular component production and division, constant stimulation may cause the cells to ignore the stimulus and thus become ineffective. Intermittent stimulation allows the cells time to rest and prepare for the next cycle. For this reason, it is suggested that cyclical negative pressure should be used clinically.
The daily rental charges for a conventional VAC machine and consumables are significant. This has discouraged many from using the system. However, there have been some reports showing that the increased healing time and downgrading of required operations correlate to decreased overall cost of care. The dressing should also enable larger wounds to be treated in the community with minimal nursing care impact. This would free up hospital beds permitting faster healing of operative patients and preventing waiting list buildup [44]. VAC therapy is not the answer for all wounds; however, it can make a significant difference in many cases.

Conclusion

Vacuum assisted closure therapy for wounds associated with open fractures, results in significantly better outcomes, expressed in terms of reduction in hospital stay and lower hospital cost while improving culture sterility while promoting uniform healthy granulation tissue formation and significant reduction in wound surface area as compared to the control group.
It also promotes early rehabilitation, less post-operative complications and alleviates the need for a second procedure, thus improving patient satisfaction with minimal discomfort or inconvenience. The application of Vacuum assisted closure is simple, but requires training to ensure appropriate and competent use. More multicenter trials need to be undertaken with larger sample sizes, so that vacuum assisted closure therapy can be used universally in management of wide spectrum of wounds, especially in the patients with open fractures in orthopedic ward.

References

1. Yadav S, Raval G, Baxi M. vacuum assisted closure technique: a short review. Pan Afr Med J. 2017;28:246.
2. Louie KW. Management of open fractures of the lower limb. BMJ. 2009;339:b50-92. https://doi.org/ 10.1136/bmj.b5092
3. Pollak AN, Jones AL, Castillo RC, Bosse MJ, MacKenzie EJ. LEAP Study Group. The relationship between time to surgical debridement and incidence of infection after open high-energy lower extremity trauma. J Bone Joint Surg Am. 2010;92:7-15.
4. Charles NR, Gupta A, Datey S, Lohiya R. Negative pressure wound therapy by indigenous method: a decisive and cost-effective approach in management of open wounds. Int Surg J. 2016;3:1399-1406.
5. Mafi R, Malahias M, Jordan DJ, Hindocha S. The evidence-based principles of negative pressure wound therapy (NPWT) dressing applications; A review of the literature. Int J Infect Control. 2014;v10:i2.
6. Pollak AN, Powell ET, Fang R, Cooper EO, Ficke JR, Flaherty SF. Use of negative pressure wound therapy during aeromedical evacuation of patients with combat-related blast injuries. J Surg Orthop Adv. 2010;19:44-8.
7. Labler L, Rancan M, Mica L, Harter L, Mihic-Probst D, Keel M. Vacuum-assisted closure therapy increases local interleukin-8 and vascular endothelial growth factor levels in traumatic wounds. J Trauma. 2009;66:749-57.
8. Eginton MT, Brown KR, Seabrook GR, *et al*. A prospective randomized evaluation of negative-pressure wound dressings for diabetic foot wounds. Ann Vasc Surg. 2003;17(6):645-9.
9. Gosselin RA, Roberts I, Gillespie WJ. Antibiotics for preventing infection in open limb fractures. Cochrane database Syst Rev. 2004;(1):CD00-3764.
10. Mohammad SH, Jabeen A, Siddiqui MA. Al-Hijamah (Cupping Therapy): A Brief

Introduction with Modern Perspective. Research & Reviews: A Journal of Pharmacognosy. 2014 Apr;1(1):8-12.

11. Stannard JP, Volgas DA, Stewart R, McGwin Jr. G, Alonso JE. Negative pressure wound therapy after severe open fractures: a prospective randomized study. Journal of orthopaedic trauma. 2009 Sep;23(8):552-7.
12. Russell GG, Henderson R, Arnett G. Primary or delayed closure for open tibial fractures. The Journal of bone and joint surgery. British volume. 1990 Jan;72(1):125-8.
13. Veliskakis KP. Primary internal fixation in open fractures of the tibial shaft: The problem of wound healing. The Journal of bone and joint surgery. British volume. 1959 May;41(2):342-54.
14. 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. Osteomy wound management. 1999;45(11):41-50.