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Clinical study of outcome of vacuum assisted closure in open fractures of tibia at a tertiary hospital

Milind Nivrutti Kolhe[1], Sanjay Manohar Patil[2]

[1]Associate Professor, Department of Orthopedics, Dr. Ulhas Patil Medical College and Hospital, Jalgaon, India.
[2]Associate Professor, Department of Orthopedics, Dr. Ulhas Patil Medical College and Hospital, Jalgaon, India.

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Abstract

Background: Vacuum-assisted closure (VAC) in the management of the soft tissue component of open tibia fractures helps in healing of wound via a sealed sponge or foam dressing, removing fluid and exudate, and encouraging blood flow to the wound site. Present study was aimed to study outcome of vacuum assisted closure in open fractures of tibia at a tertiary hospital. **Material and Methods:** Present study was single-center, prospective, comparative, parallel-group, observational study, conducted in patients aged above 18 years of age, haemodynamically stable with open fractures of tibia {G.A.II, IIIA, and IIIB} undergone primary internal fixation and Vacuum assisted closure (VAC) application. **Results:** Among 30 patients in present study, majority were male (83.33 %), mean age was 41.34 ± 14.56 years. The frequency of VAC dressing application was every 4 day per dressing from the second day of post-operative period, 5 times VAC dressing done in 15 cases (50 %), 4 times VAC dressing done in 10 cases (33.33 %) & > 5 times VAC dressing done in 5 cases (16.67 %). Mean Hospital stay was 18.82 ± 9.46 days. Post-primary Procedure, majority had Split skin-graft (63.33 %), Repeat debridement and then secondary closure (16.67 %), Direct closure (10 %), Tissue transfer (6.67 %) & healing by secondary intension (3.33 %). Mean decrease in wound size was 10.23 ± 3.72 cm^2. Complications observed were implant related infection in 2 cases (6.67 %) & exposed implant in 1 case (3.33 %). Functional outcome at 1 year follow up was excellent in 3 cases (10 %), good in 17 cases (56.67 %), fair in 9 cases (30 %) & poor in 1 case (3.33 %). **Conclusion:** VAC application reduces wound infection rate, shortens the healing time and reduces the number of secondary soft tissue defect coverage procedure.

Keywords: open fractures, fracture tibia, VAC application, NPWT

Corresponding Author: Dr. Milind Nivrutti Kolhe, Associate Professor, Department of Orthopedics, Dr. Ulhas Patil Medical College and Hospital, Jalgaon, India.

Introduction

Complex musculoskeletal wounds occurring secondary to high energy trauma pose challenge to the treating surgeons in terms of wound healing, coverage and reconstruction. The superficial location of the tibia leaves it particularly susceptible to open fractures and potential loss of soft tissue and bone.[1,2] Compared to closed injuries, open fractures have a significantly higher risk of infection, non-union, and wound healing complications, and often require multiple surgeries for definitive care.[3]

Radical debridement of the wound outside the zone of injury, skeletal stabilisation and early soft tissue coverage with a vascularised muscle flap are regarded as ideal management.[4] Despite the introduction of new therapeutic strategies for improved wound care, such as

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dressings, local growth factors, hyperbaric oxygen, and local and systemic antiseptic agents, continuous wound management remains a clinical problem.[5]

Negative pressure wound therapy (NPWT) or vacuum-assisted closure (VAC) should be seen as an adjunctive modality in the management of the soft tissue component of open tibia fractures. It involves the application of subatmospheric pressure to a wound via a sealed sponge or foam dressing, removing fluid and exudate, and encouraging blood flow to the wound site.[6] Present study was aimed to study outcome of vacuum assisted closure in open fractures of tibia at a tertiary hospital.

Material And Methods

Present study was single-center, prospective, comparative, parallel-group, observational study, conducted in Department of Orthopedics, Dr. Ulhas Patil Medical College and Hospital, Jalgaon, India. Study duration was of 2 years (January 2020 to December 2021). Study approval was obtained from institutional ethical committee.

Inclusion criteria

- patients aged above 18 years of age, haemodynamically stable with open fractures of tibia {G.A.II, IIIA, and IIIB}, willing to participate in present study

Exclusion criteria

- Patients unfit for surgery,
- Patients having pre-existing osteomyelitis in the wounds,
- Neurovascular deficit in the injured limb,
- Those having malignancy
- Those on anticoagulants, chemotherapy and corticosteroids.

Study was explained to patients in local language & written consent was taken for participation & study. On receiving patients in emergency, all patients received primary emergency care (thorough cleaning of the wound with copious irrigation of normal saline, hydrogen peroxide and povidone iodine paint following it), dressing, antibiotics, tetanus toxoid & immobilization. All patients were classified based on Gustilo-Anderson classification for open fractures.

30 patients with open fractures of tibia had undergone primary internal fixation and Vacuum assisted closure (VAC) application. Sterile, open-pore foam dressing with pore sizes 400-600 microns were gently placed onto the wound cavity. The foam, tubing and surrounding five centimetres 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. The pump was set to deliver an intermittent negative pressure of 125 mmHg. The cycle was scheduled for 7 minutes in which pump was on for 5 minutes and off for 2 minutes. The dressings were subjected to be changed on the fourth day. The presence of drainage, oedema, erythema, exposed bone or exposed tendon were fairly noted.

All patients were evaluated for an average period of follow up of 12 months. Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Statistical analysis was done using descriptive statistics.

Results

Among 30 patients in present study, majority were male (83.33 %), fracture on right side (63.33 %) & fracture due to road traffic accident (80 %). Majority were from 30-39 years age group (40 %) & 19-29 years age group (23.33 %), mean age was 41.34 ± 14.56 years.

Table 1: General characteristics

Characteristics	No. of patients	Percentage
Age groups (in years)		
19-29	7	23.33

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30-39	12	40
40-49	5	16.67
50-59	3	10
60-69	2	6.67
70-79	1	3.33
Mean age (mean±SD)c	41.34 ± 14.56	
Gender		
Male	25	83.33
Female	5	16.67
Laterality		
Right	19	63.33
Left	11	36.67
Mode of injury		
Road traffic accident (high energy trauma)	24	80
Fall from height (low energy trauma).	6	20

In present study, majority cases had G.A type 3A fracture (43.33 %) followed by G.A type 2 (30 %) & G.A type 3B (26.67 %). The frequency of VAC dressing application was every 4 day per dressing from the second day of post-operative period, 5 times VAC dressing done in 15 cases (50 %), 4 times VAC dressing done in 10 cases (33.33 %) & > 5 times VAC dressing done in 5 cases (16.67 %). Mean Hospital stay was 18.82 ± 9.46 days.

Table 2: Fracture characteristics

Characteristics	**No. of patients**	**Percentage**
Type of fracture (Gustilo-Anderson classification)		
Type 2	9	30
Type 3A	13	43.33
Type 3B	8	26.67
Frequency of VAC dressing application		
4	10	33.33
5	15	50
>5	5	16.67
Mean Hospital stay (days)	18.82 ± 9.46	

Post-primary Procedure, majority had Split skin-graft (63.33 %), Repeat debridement and then secondary closure (16.67 %), Direct closure (10 %), Tissue transfer (6.67 %) & healing by secondary intension (3.33 %). Mean decrease in wound size was 10.23 ± 3.72 cm^2. Complications observed were implant related infection in 2 cases (6.67 %) & exposed implant in 1 case (3.33 %). Functional outcome at 1 year follow up was excellent in 3 cases (10 %), good in 17 cases (56.67 %), fair in 9 cases (30 %) & poor in 1 case (3.33 %).

Table 3: Postoperative characteristics

Characteristics	**No. of patients**	**Percentage**
Post-primary Procedure		
Split skin-graft	19	63.33
Repeat debridement and then secondary closure	5	16.67
Direct closure	3	10
Tissue transfer	2	6.67
Healing by secondary intension	1	3.33
Mean decrease in wound size (cm^2) (mean ±	10.23 ± 3.72	

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SD)		
Complications		
Implant related infection	2	6.67
Exposed implant	1	3.33
Functional outcome (at 1 year follow up)		
Excellent	3	10
Good	17	56.67
Fair	9	30
Poor	1	3.33

Discussion

Open tibia fractures are associated with an increased risk of infection, delayed union, non-union and wound complications. Management is aimed at mitigating the risk of infection while optimising the biological and biomechanical environment to encourage soft tissue and bone healing.[7] Several determinants are always to be well-thought-out when assessing and treating compound fractures in the extremities, including the patient's condition, fracture type, antimicrobial therapy, wound debridement, site and size of the wound, neurovascular status, and the degree of muscle tear.[8,9]

The management of severe open fractures of the lower leg remains a major challenge in surgery, and adequate treatment of the concomitant soft tissue injury is of the highest priority. In such injuries, debridement of all non-viable tissue can produce significant soft tissue defects. Various surgical methods have been developed to obtain coverage in these difficult situations, including skin grafts, local rotation flaps, and myocutaneous or fasciocutaneous tissue transfers.

Vacuum assisted closure (also called vacuum therapy, vacuum sealing, or topical negative pressure therapy) is a sophisticated development of a standard surgical procedure and involves the use of vacuum to remove blood or serous fluid from a wound or operation site. It aids healing by maintaining a moist wound environment, increasing local blood flow, removing wound exudates, promoting granulation tissue, reducing infection. Before achievement of wound closure or plastic surgical coverage, further debridement of non-viable tissue may be required. In the periods between these operative interventions, use of NPWT shows advantages over the standard wet to dry (WTD) dressings. NPWT seals the wound from the hospital environment, acts as a temporary dermal substitute, and prevents bacterial access to the wound bed, thus offering protection from nosocomial contaminants and promotes local wound perfusion and drainage.[10]

Proper application of vacuum assisted closure results in near-complete debridement and adequate irrigation before wound closure, thus preventing bacterial access to the wound bed. This can remarkably reduce the risk of deep infection.[11,]

Saurabh S et al.,[12] studied 45 patients (29 male, 16 female). 25 patients had open fractures of right tibia and 15 patients had open fracture of left tibia. 27 cases sustained fracture following road traffic accident (high energy trauma), 7 cases sustained fracture following fall from height (low energy trauma). 5 patients had GA type-2, 20 patients had GA type 3A and 8 patients were observed with G.A type 3B open fractures of both bone leg in adults. The advantage of VAC was found to facilitate rapid formation of granulation tissue on wounds with exposed tendons, bones, raw area wounds and exposed implants and thereby shortening the healing time and reducing the number of secondary soft tissue defect coverage procedure.

In study by Clevio D et al.,[13] among 30 patients treated with modified vacuum assisted dressings the mean reduction in size of the wound overall is 15.06 mm and overall time for appearance of healthy granulation tissue is 7.7 days. 25 patients required flap as a definitive closure procedure whereas in 20 patients wound was closed by split skin grafting and 5

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wounds was contracted with treatment on comparison with 30 patients treated with conventional betadine dressings the mean reduction in size of the wound overall is 7.7 mm and overall time for appearance of healthy granulation tissue is 18.8 days. 4 patients required flap as a definitive closure procedure whereas in 18 patients wound was closed by split skin grafting and 8 wounds was contracted with conventional betadine dressing's treatment without requiring a secondary procedure. There is significant decrease in reduction in size of wound and average duration.

Mittal V et al.,[14] studied 30 cases, 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 cm2 [21.22%]. Out of 30 patients, 4 patients had excellent, 16 patients had good, 8 patients had fair and 2 patients had poor result. Kartik G[15] studied 50 patients treated with VAC, the prevalence of infection was 12%. The duration required for healthy granulation tissue and for making the wound fit for skin cover procedures was 9 days i.e. 45(90%) and12 days in only 5(10%) patients.

Advantages of VAC include, it completely isolates the wound that decreases the risk of secondary contamination from the environment and secondly, it reduces edema from the limb. Removal of edema improves capillary blood flow, which in turn increases the delivery of oxygen and nutrients to the wound.[16] VAC accelerates protein and collagen production, cell replication and reduces bacterial colonisation of the wound. It has been clinically and economically proven in the treatment of chronic wounds.[17,18]

Conclusion

Management of open fractures of tibia after primary internal fixation followed by VAC application is useful procedure. It reduces wound infection rate, shortens the healing time and reduces the number of secondary soft tissue defect coverage procedure. This method is easily available, uses inexpensive materials and is easily reproducible.

References

1. Dickson DR, Moulder E, Hadland Y, Giannoudis PV, Sharma HK. Grade 3 open tibial shaft fractures treated with a circular frame, functional outcome and systematic review of literature. Injury. 2015;46(4):751-58.
2. Hutchinson AJ, Frampton AE, Bhattacharya R. Operative fixation for complex tibial fractures. Ann R Coll Surg Engl. 2012;94(1):34-38.
3. Ryan SP, Pugliano V. Controversies in initial management of open fractures. Scand J Surg. 2014;103(2):132-37.
4. Hutson J, Dayicioglu D, Oeltjen J, Panthaki Z, Armstrong M. The treatment of Gustilo grade IIIB tibia fractures with application of antibiotic spacer, flap, and sequential distraction osteogenesis. Ann Plast Surg 2010;64:541–52.
5. Arti H, Khorami M, Ebrahimi-Nejad V: Comparison of negative pressure wound therapy (NPWT) & conventional wound dressings in the open fracture wounds. Pak J Med Sci. 2016, 32:65-9.
6. Mauffrey C, Bailey JR, Bowles RJ, Price C, Hasson D, Hak DJ, et al. Acute management of open fractures: proposal of a new multidisciplinary algorithm. Orthopedics. 2012;35(10):877-81.
7. Basson T, Du Preez G, Du Toit J, Ferreira N. Current concepts in the management of open tibia fractures. SA Orthop J 2019;18(4):52-62.
8. Suman H, Krishna J, Sharma Y, Jain P, Parmar S: Role of VAC dressing in the large open fracture: a single center prospective study from Indore. Int J Res Rev. 2021, 8:22-5. 10.52403/ijrr.20210404

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9. Cross WW 3rd, Swiontkowski MF: Treatment principles in the management of open fractures . Indian J Orthop. 2008, 42:377-86.
10. Shin SJ, Han D, Song H, Jang YJ, Park DH, Park MC. Continuous high-pressure negative suction drain: new powerful tool for closed wound management: clinical experience. J Craniofac Surg. 2014; 25:1427-31.
11. Kumaar A, Shanthappa A H, Ethiraj P (April 01, 2022) A Comparative Study on Efficacy of Negative Pressure Wound Therapy Versus Standard Wound Therapy for Patients With Compound Fractures in a Tertiary Care Hospital. Cureus 14(4): e23727.
12. Saurabh Sahu, Shaiwal Saxena, Anurag Tiwari, Harshit Paliwal, Outcome Analysis of Vacuum Assisted Closure in Open Fractures of Tibia at a Tertiary Care Hospital, European Journal of Molecular & Clinical Medicine, 9 (6), Summer 2022, 1386
13. Clevio Desouza, Yogesh Khandalkar, Maulik Langaliya, Shail Shah. (2022). Efficacy Of Modified Vaccum Assisted Dressing In Wound Healing Of Open Injuries. Journal of Orthopedics and Surgical Sports Medicine. 5(2);
14. Mittal V, Uppal A, Kappor R, Pal CP, Patel J, Saini SK, Yadav R. To evaluate the outcome of vacuum assisted closure in open fractures of tibia. Indian J Orthop Surg 2022;8(1):49-52.
15. Kartik Ghate, Nishad Situt. Prospective study of vacuum assisted closure in treatment of soft tissue injuries associated with compound fractures. MedPulse International Journal of Orthopedics. July 2021; 19(1): 01-05.
16. Suman H, Krishna J, Sharma Y et.al. Role of VAC dressing in the large open fracture: a single center prospective study from Indore. International Journal of Research and Review. 2021; 8(4): 22-25.
17. Kaufman WSM, Pahl DW. Vaccum-assisted closure therapy: wound care and nursing implications. Dermatol Nurs 2003;15:317–25.
18. Stannard J. Complex orthopaedic wounds: prevention and treatment with negative pressure wound therapy. Orthop Nurs 2004;23:1–6.