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VACUUM ASSISTED CLOSURE IN GRADE III OPEN TIBIAL FRACTURES

KEYWORDS: open fracture tibia, soft tissue cover, Vacuum Assisted Closure

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ABSTRACT Open fracture of tibia is a surgical emergency. This study aims to find out the efficacy of negative pressure wound therapy in these fractures. 30 patients with type III open Tibia fractures, treated with wound debridement and external fixation were divided in two groups of 15 each; A and B. Vacuum Assisted Closure was used in Group A and sterile dressings were used in Group B. The frequency of wound infection was less and wound coverage was better in Group A (p value of 0.028) when compared to Group B. Wound healed earlier and hospital stay was less in Group A (p value 0.010). Early debridement followed by V.A.C therapy has reduced wound infection rate and time for soft tissue coverage in patients with open fracture tibia. The method uses easily available and inexpensive materials and is easily reproducible.

INTRODUCTION

Open fracture is a surgical emergency. The annual incidence of open fractures of long bone has been estimated to be 11.5 per 1,00,000 persons with 40 % occurring in the lower limb of which Tibia is the most commonly fractured long bone with frequency of approximately 11–26 fractures per 100,000 populations per year.

Even in low energy mechanisms of injury, fractures of the tibia are often open due to the poor antero medial soft tissue coverage. Infection rates of open tibial fractures have historically been noted as 10–20 times that of other open skeletal fractures and deep infection rates range between 8-12%.

The primary surgical treatment of an open.[1] fracture always starts with thorough debridement and stabilization of the fracture before addressing the soft tissue defects. It has been accepted that open fractures require early (within 72 hours) bony stabilization and soft tissue reconstruction [2]. Unfortunately, primary soft tissue coverage is not always possible in an acute setting for numerous reasons.

Vacuum Assisted Closure (V.A.C) or negative pressure wound therapy (NPWT) [3] is a method to achieve wound closure or prepare the wound bed for further surgical interventions. 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.

Regardless of when a flap is placed, NPWT is preferred over traditional gauze dressings in the interim period. NPWT decreases tissue edema, enhances local blood flow, limits or prevents infection, improves flap rates, and possibly reduces the overall need for flaps.

The V.A.C system is made up of 4 major components; a filler material or sponge placed into the wound, a semipermeable dressing to isolate the wound environment and transmit sub atmospheric pressures to the wound surface, a connecting tube and a vacuum system with fluid collection canister.

This prospective randomized study compares the rate of wound infection, primary wound coverage, and hospital stay and healing of soft tissue injury associated with open fractures treated with two different standard techniques V.A.C and sterile dressing.

MATERIALS AND METHODS

The present study is a prospective study of 30 patients aged more than 18 years, who sustained type 111 open tibia fractures, treated by external fixation in the Department of Orthopaedics, Government Medical College Hospital, Thrissur, from January 1st 2015 to July 31st 2015.

Patients who had fracture site directly in contact with exposed blood vessels, anastomotic sites or nerve; those with associated neurovascular injuries (Gustilo Type IIIc) were excluded from the study.

They were divided in two groups of 15 each, Group A (V.A.C group) and Group B (sterile dressing group). All these patients were treated with wound debridement and external fixation. This was followed by application of Vacuum Assisted Closure in Group A and sterile dressings for group B patients.

The character of the wound and infection rates of these two groups were analysed by clinical signs and symptoms that included increasing drainage, increasing pain, purulent discharge and increasing erythema. Infected wounds were treated with wound care and parenteral antibiotics based on pus culture and sensitivity report.

To obtain vacuum assisted closure of the wound, a polyurethane open celled sponge (having pore size approximately between 400-600 micrometer) obtained from upholstery shop, which was cut to match the shape of the wound and autoclaved was used. The suction tube of a standard negative suction apparatus of 16 mm ending in a round pad with holes was placed on the sponge and allowed to exit the dressing parallel to the surface of the sponge. The entire dressing was covered by an adherent clear plastic film to make it air tight. The suction tube is now connected to the suction apparatus which was made to operate cyclically 20 minutes every 2 hours to get cyclical negative pressure at the wound site.

Continuous measurements are presented as Mean ± SD and results of categorical measurements are presented in Number (%). Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between the two groups. SPSS 22.0, R environment ver. 3.2.2, Epi-Data were used for the analysis of the data.

Statistical significance was assumed as follows:
Suggestive significance (Value: 0.05<P<0.10)
Moderately significant (P value: 0.01<P< 0.05)
Strongly significant (P value: P<0.01)

RESULTS

The participants included 26 (86.7%) males and 4 (13.3%) females. The mean age was 46.73 ± 14.67 years (range 21 to 68 years). Road traffic accident was found to be most common cause with 18 (66.0%) patients, followed by fall from height in 8 (26.7%) and by machinery injury in 4 (13.3%) patients. 9 (30%) patients had type III A tibia fracture and 21 (70%) patients had type III B tibia fracture.

There was a significant difference between the two groups in the rate of wound infection, p value being 0.028.

TABLE 1 WOUND INFECTION IN THE STUDY POPULATION

Wound Infection	Group A	Group B
Present	4 (26.7%)	10 (66.7%)
Absent	11 (73.3%)	5 (33.3%)

Wound coverage was attained within 3 weeks in 10 (66.7%) patients of group A and 4 (26.7%) patients in group B. Significant difference was observed in wound coverage between Group A and Group B with p value less than 0.05 (p=0.028).

Wound completely healed within 6 weeks in 12(80%) patients of group A and 5 (33.3%) patients of group B. Hospital stay of less than one month was required in 10 (66.7%) patients of group A and 3 (20%) patients in group B.

TABLE 2 WOUND COVERAGE

Wound Coverage	Group A	Group B
< 3 weeks	10 (66.7%)	5 (33.3%)
> 3 weeks	5 (33.3%)	10 (66.7%)

DISCUSSION

The events underlying the improvement in wound healing observed with V.A.C can be broadly classified as primary mechanisms and their associated secondary effects. Overall, 4 primary mechanisms of action proposed include: (i) Wound shrinkage or macro deformation (ii) Micro deformation at the foam-wound surface interface (iii) Fluid removal (iv) Stabilization of the wound environment. There are also several secondary effects including angiogenesis, neurogenesis, granulation tissue formation, cellular proliferation, differentiation, and migration.

Previously primary wound closure was avoided in open tibia fractures [4]. This was followed by studies showing that primary internal fixation and wound closure gives good results [5]. Recent studies show that towards radical debridement, immediate fracture stabilisation and immediate definitive coverage offers good results [2,5,6]. Various surgical methods have been developed to obtain soft tissue coverage including closure devices [7], skin grafts, local rotation flaps and myocutaneous or fasciocutaneous transfers.

A number of studies have compared NPWT with WTD dressings in this setting [8,9]. Stannard *et al* [10] randomised 37 severe high-energy open fractures to interval NPWT and 25 to standard fine mesh gauze dressing. The NPWT group showed significantly less infections than the control. Of the entire study group, 21 had either a rotational, free flap or skin graft; but the infection rate in this group was not separately analysed.

A further study by Sinha *et al.* [11] randomised 30 open musculoskeletal injuries to NPWT dressings changed every 3-4 days or standard dressings daily. Each time the dressings were changed, measurements were taken and at day 4 and 8post-initial debridement, tissue biopsies were taken for histopathological analysis. They found a significantly reduced wound size and a reduction in bacterial growth in the NPWT group and significantly increased angiogenesis, granulation tissue and fibrosis.

Lee *et al.* [9] prospectively treated 16 patients with open wounds in the foot and ankle region demonstrating exposed tendon or bone. After initial debridement NPWT was applied and changed every 3-4 days for 11-29 days, 15 of the 16 patients healed by secondary intention (production of granulation tissue), a free flap was required in a single case. There were no reports of infection.

Blum *et al.* [12] retrospectively reviewed 229 open tibia fractures with 72% receiving NPWT and 28% conventional dressings and found a significantly reduced deep infection rate in the NPWT group by almost 80%.

The randomised clinical trials of Stannard *et al.* [10] showed NPWT patients being less likely to develop infection, and of Sinha *et al.* [11] showed reduction in positive bacterial cultures after 8 days of NPWT.

Early NPWT animal model studies by Morykwas et al. and Lalliss *et al.* [13] showed reduced bacterial loads of *Staphylococcus aureus* and *Pseudomonas aeruginosa* respectively. The application of NPWT to a newly laid down skin graft shows an improvement in graft incorporation using a pressure range between -50 to -80 mm Hg.

A major limitation was that these studies reported limited information regarding methods of bony stabilization. No study provided information regarding time of external fixation, or internal fixation performed. No study provided detailed information regarding other factors, including hardware used (stainless steel versus titanium, locking constructs, plate length), or dimensions of a bony defect if it existed.

The success or failure of NPWT versus gauze dressings could be influenced by the fixation method. Infection rates reported was not detailed whether it was secondary to bony stabilization or not. It was not ascertained if the method and sequence of bony stabilization had any association with the overall infection rates. Therefore, only limited data is available to make conclusive statements regarding the influence of bony stabilization methods on infection rates and final outcome.

The results of the present study are comparable with that of the previous studies in terms of delay in wound coverage, final healing and hospital stay. The limitation of this study is that patients with primary internal fixation of open fractures have not been included in the study population.

CONCLUSIONS

Adequate early debridement followed by application of primary V.A.C has reduced wound infection rate, time interval between soft tissue cover and initial injury and duration of hospital stay in patients with severe soft tissue injury associated with open tibia fractures. Early wound healing is achieved. It provides psychological, social and financial benefits to the patient by reducing the hospital stay and allowing early return to normal life. The method uses easily available and inexpensive materials and is easily reproducible in any hospital setting.

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