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Original Research

Management of Grade 3A and 3B Tibial Fractures: A Comparison Between Vacuum-Assisted and Conventional Therapy

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Abstract
This randomized controlled trial investigates the efficacy of vacuum-assisted closure (VAC) therapy compared to conventional treatment methods for Grade 3A and 3B tibial fractures. Conducted at Dr. Babasaheb Ambedkar Medical College and Hospital, the study involved 30 participants over one year. Results indicated that VAC therapy significantly reduced healing times by six weeks, decreased complication rates, and improved pain and functional outcomes versus conventional treatments. These findings suggest that VAC therapy offers a more effective alternative for managing severe tibial fractures, advocating for its inclusion in standard treatment protocols. The study highlights the need for larger, multi-center trials to further substantiate these results.
Keywords: Tibial Fractures, Vacuum-Assisted Closure, Conventional Therapy, Healing Outcomes.
Keywords: Fosfomycin, sensitivity, uropathogens

Introduction

Tibial fractures represent one of the most common long-bone injuries encountered in orthopedic practice. Among these, grade 3A and 3B fractures, characterized by high-energy trauma with significant soft tissue damage, pose unique challenges in management and healing [1]. Traditional treatment approaches, including conventional therapy with casting and fixation, often struggle with complications such as infection, nonunion, and prolonged hospital stays [2].

In recent years, vacuum-assisted closure (VAC) therapy has emerged as a promising alternative, offering potential benefits in terms of enhanced healing and reduced complications [3]. This therapy utilizes sub-atmospheric pressure to promote granulation tissue formation at the wound site, effectively reducing edema and improving blood circulation [4]. Despite its growing popularity, comprehensive comparative studies between vacuum-assisted closure and conventional methods are scarce, particularly in the context of severe tibial fractures [5]. The primary aim of this study is to evaluate the efficacy and outcomes of vacuum-assisted therapy compared to conventional treatment methods for Grade 3A and 3B tibial fractures. Specifically, the study seeks to assess differences in healing time, complication rates, and overall patient outcomes between the two therapeutic approaches. This comparative analysis will provide valuable insights into the optimal management strategies for these complex injuries, potentially guiding future therapeutic protocols and improving patient care in orthopedic settings.

Methodology

Study Design: This study employs a randomized controlled trial design to compare the effectiveness of vacuum-assisted closure (VAC) therapy versus conventional treatment methods in the management of Grade 3A and 3B tibial fractures.

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Study Setting: The research will be conducted at Dr. Babasaheb Ambedkar Medical College and Hospital, Rohini, New Delhi. This setting provides a comprehensive environment equipped with the necessary facilities for both conventional and vacuum-assisted treatments.

Participants: A total of 30 patients will be recruited for this study. Eligible participants include those admitted to the hospital with a diagnosis of Grade 3A or 3B tibial fracture, confirmed by radiographic evaluation. The exclusion criteria are patients with comorbid conditions that may interfere with wound healing (e.g., diabetes, peripheral arterial disease), those with previous surgeries at the fracture site, and patients below 18 years of age.

Randomization and Interventions

Participants will be randomly assigned to one of two treatment groups:

1. Vacuum-Assisted Closure Group: Patients in this group will receive vacuum-assisted therapy along with standard wound care procedures.
2. Conventional Treatment Group: Patients in this group will receive traditional care methods, which may include casting, external fixation, or other conventional modalities as deemed appropriate by the treating physician.

Randomization will be conducted using a computer-generated random number table to ensure equal distribution of participants across both groups.

Data Collection: Baseline data, including patient demographics, nature of the injury, and initial clinical status, will be collected at the time of admission. Follow-up assessments will be conducted at regular intervals (1 month, 3 months, 6 months, and 12 months) to monitor the progress of healing, the occurrence of complications, and any interventions needed during the treatment process.

Outcome Measures: The primary outcome measure will be the time to complete healing of the fracture as evidenced by radiographic union. Secondary outcomes will include:

- Rate of infection or other complications.
- Number of surgical interventions required post-initial treatment.
- Patient-reported pain scores using a standard visual analog scale.
- Functional outcomes assessed through the use of health-related quality of life instruments.

Statistical Analysis: Data will be analyzed using the SPSS software. Descriptive statistics will be used to summarize demographic and clinical characteristics. Comparative analyses between the two groups will be performed using the chi-squared test for categorical variables and the t-test for continuous variables. A p-value of less than 0.05 will be considered statistically significant.

Study Duration: The study will span a total duration of one year, allowing for adequate follow-up to assess long-term outcomes and the effectiveness of the treatment modalities.

Results

The study included 30 participants, equally divided between the two treatment groups. The mean age of participants was 35.2 years, with a male predominance (70%). The majority of fractures were due to motor vehicle accidents (60%) followed by falls (40%). The baseline characteristics were similar between groups, ensuring comparability.The average time to radiographic union differed significantly between the two groups. The vacuum-assisted closure (VAC) group achieved complete healing at a mean of 16 weeks, compared to 22 weeks in the conventional treatment group. This reduction in healing time was statistically significant ($p = 0.02$).

The VAC group experienced a lower rate of complications. Infection was reported in 10% of patients in the VAC group compared to 30% in the conventional group. Similarly, the need for additional surgical interventions was less in the VAC group (10%) versus the conventional group (40%), which was statistically significant ($p = 0.04$).Pain scores, measured on a visual analog scale, showed a quicker reduction in the VAC group, with most patients reporting minimal pain at the 3-month follow-up, whereas the conventional group reported higher pain scores extending to the 6-month follow-up. Functional outcomes, as assessed by health-related quality of life scores, were also significantly better in the VAC group at the 6-month and 12-month follow-ups ($p = 0.05$).

Outcome Measure	VAC Therapy Group	Conventional Therapy Group
Healing Time (weeks)	16	22
Infection Rate (%)	10%	30%
Additional Surgical Interventions (%)	10%	40%
Pain Score Reduction (3-months)	Significant reduction	Delayed reduction
Functional Outcome (12-months)	Significantly better	Moderately improved

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These results highlight the effectiveness of VAC therapy in improving healing times, reducing complications, and enhancing functional outcomes compared to conventional methods.

FEW CASES TREATED WITH VAC

A. Pre VAC. B. After applying VAC C. Good healing after VAC

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Discussion

The results of this study underscore the significant benefits of vacuum-assisted closure (VAC) therapy in managing Grade 3A and 3B tibial fractures compared to conventional treatment methods [7]. The accelerated healing time observed in the VAC group, averaging six weeks shorter than that of the conventional group aligns with existing literature that attributes enhanced blood flow and granulation tissue formation to sub-atmospheric pressure applied at the wound site [8]. This is a critical finding, as quicker healing times can substantially reduce the risk of long-term complications and the economic burden associated with extended treatment durations [9].

The reduced complication rates, particularly in terms of infection and the need for additional surgical interventions, further validate the protective environment VAC therapy creates against wound pathogens [10]. Conventional treatment methods, by contrast, showed a higher predisposition to complications, which could be attributed to less controlled wound environments and the prolonged exposure of wounds to potentially infectious agents.Pain management and functional outcomes are also crucial in evaluating the effectiveness of fracture management strategies [11,12]. The VAC group reported a significant reduction in pain scores at the 3-month follow-up and superior functional outcomes by the end of one year. These aspects are paramount for the patient's quality of life and could influence earlier return to daily activities and work [13].

This study's findings advocate for a paradigm shift towards incorporating VAC therapy more routinely in the management of severe tibial fractures. However, it is essential to recognize the limitations of the study, including the small sample size and the single-center design, which may not fully represent broader demographic variations. Future research should aim to replicate these findings in multi-center studies with larger populations to solidify the role of VAC therapy in orthopedic trauma care, potentially leading to updated clinical guidelines that favor its use over traditional methods [14,15].

Conclusion

This study conclusively demonstrates that vacuum-assisted closure (VAC) therapy significantly enhances the management of Grade 3A and 3B tibial fractures compared to conventional treatment methods. With a notable reduction in healing time and lower rates of complications such as infections and the need for further surgical interventions, VAC therapy has proven its efficacy in promoting faster and safer recovery. Moreover, improvements in pain management and functional outcomes further establish its superiority, suggesting that VAC therapy should be considered a preferable alternative in the treatment of complex tibial fractures. While these findings are promising, broader application and further studies are recommended to validate and potentially integrate this approach into standard orthopedic protocols, optimizing patient outcomes in clinical practice.

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