

CUSTOM MADE VACUUM-ASSISTED CLOSURE SYSTEM IN ORTHOPAEDICSVenkat R¹, Suresh Babu G²¹Assistant Professor, Department of Orthopaedics, Sri Venkateswara Medical College, Tirupati.²Senior Resident, Department of Orthopaedics, Sri Venkateswara Medical College, Tirupati.**ABSTRACT****BACKGROUND**

VAC AKA-negative pressure wound therapy "the VAC acts as a new step in the 'reconstruction ladder'. The VAC enhances the tissue granulation, which makes it possible to use less complex reconstruction options, e.g., converting the wounds acceptable for the skin grafting, which otherwise would have required flap coverage."

MATERIALS AND METHODS

The present study was conducted in the Department of Orthopaedics, S. V. R. R. G. G. Hospital, Sri Venkateswara Medical College, Tirupati, from January 2014 to September 2015. 34 patients were treated for various fractures with significant soft tissue loss during this period with the proposed method and were included in the present study. This is a prospective study with longitudinal follow up of patients throughout the study period.

RESULTS

In our study, a total of 35 patients were treated with custom made vacuum-assisted closure system. All of them were initially opined to be requiring flap cover surgery by plastic surgeon to fill for the soft tissue defect, however, with our method, out of 35, only 2 required flap cover and rest of them could be managed with a lesser invasive method of split skin grafting. Out of 35 patients, 33 were lower limb injuries and 2 have sustained upper limb injuries. Average number of dressing required were 2.69 and average duration for wound healing was 5.3 days. There were no significant complications in the present study.

CONCLUSION

Homemade VAC is a cost effective, equally efficacious and a valuable alternative modality of treatment in traumatic soft tissue defects with decreased morbidity, improved compliance and fruitful outcomes.

KEYWORDS

VAC, Vacuum-Assisted Closure System, Negative Pressure Wound Therapy, Soft Tissue Injury, Custom Made.

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BACKGROUND

Management of complex wounds of different areas of the body has been the cornerstone of reconstructive surgery since its inception. Most of such wounds have exposed bones, tendons or vital structures in the presence of limited reconstructive options, which present a significant challenge to plastic surgeons. Salvaging severely traumatised limbs with exposed vital structures can be quite difficult when the options are limited. Regarding lower limb reconstruction, soft tissue defects of the heel, ankle and lower leg are difficult to cover most of the time and it remains a challenge to seek safer options with less morbidity. There are many possible reconstructive options including skin grafts, local flaps, distant flaps and free tissue transfer, but their usage is limited and problems

exist in these regions.¹ Soft tissue coverage is often difficult to obtain with mutilated hand trauma when multiple tissues like bone, tendons or nerves are involved.² Free tissue transfer has been established as a good tool for coverage of large, complicated wounds of the extremities, but when free flaps are contraindicated or they fail, management of such wounds presents a formidable task.³ Moreover, they require a microvascular team and equipment and the procedure is lengthy. Fleischmann et al introduced a new technique in 1993 describing the use of subatmospheric pressure to promote healing of wounds with open fractures resulting in efficient cleaning and conditioning of wound and marked granulation tissue.

Since its introduction, it has rapidly evolved into a widely accepted treatment for acute and chronic wounds.⁴ Authors have been using a simple alternative to provide controlled negative pressure environment for the wounds and have found it to be effective. By implementing this therapy, the authors have been able to convert complex soft tissue defects to healthy granulating wounds that easily accept skin grafts or local flaps. Vacuum-assisted closure has reformed the plastic surgery practice and wound management in the last decade and has become an established method of wound management.

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Currently, NPWT has become an established method of wound management. Most of reports used the foam-based NPWT system using commercially available devices (e.g., KCI's VAC).

These are affordable and easily available in developed nations. But, in developing countries, where the proportion of poor patients is very high, it is still beyond the reach of the needy patients. We describe a new method of wound VAC dressing application without using the standard VAC equipment from material readily available to any surgeon.

Aims and Objectives

1. To develop an alternative, safe, effective, user friendly and economical model with easily available utilities in the hospital, which can be used instead of costly VAC apparatus.
2. To demonstrate the effectiveness of such a model in various compound soft tissue injuries.
3. To prove the efficacy of custom made VAC apparatus in reducing the number of complex plastic surgery procedures required in the management of complex trauma cases.

MATERIALS AND METHODS

The present study was conducted in the Department of Orthopaedics, S. V. R. R. G. G. Hospital, Sri Venkateswara Medical College, Tirupati, from January 2014 to September 2015. 34 patients were treated for various fractures with significant soft tissue loss during this period with the proposed method and were included in the present study. This is a prospective study with longitudinal follow up of patients throughout the study period.

Inclusion Criteria

1. All patients with type 3 compound fracture with significant soft tissue loss.
2. Patient willing for proposed treatment plan.

Exclusion Criteria

1. Patients on antiplatelets.
2. Patients with other life-threatening injuries/conditions.
3. Patients not willing for the proposed treatment plan.

Technique Requirements

1. Sterile polyurethane pad.
2. Uro Bag.
3. Romo Vac.
4. Sterile plastic drape.
5. Broad surgical plaster (paper).
6. Suction apparatus.

Steps of Application



Figure 1. Identify and Document the Wound Status



Figure 2. Map the Wound on to the Polyurethane Pad



Figure 3. Cut the Pad as Mapped



Figure 4. Check the Cut Pad onto the Wound



Figure 5. Cut another Pad of Same Shape and Size



Figure 6. Pass Through the Suction Drain across the Pad



Figure 7. Apply the Pad onto the Wound Site and a Second Pad Over it



Figure 10. Connect the Drain Tube in the Pad to Suction System



Figure 8. Cut Open the Uro Bag and Wrap it Around the Wound Site Circumferentially



Figure 11. Switch on the Suction, Check for Fluid being Sucked into the Tube



Figure 9. Now Apply Surgical Paper Plaster Circumferentially from Skin to Skin along the Length of the Dressing to get an Airtight Sealing

Mechanism^{1,2}

Subatmospheric pressures of about 120-300 mm of Hg bring about certain changes in the tissue, which include-

1. Removal of extracellular fluid- decrease oedema- increase blood flow.
2. Mechanical deformation- wide variety of molecular response.
 - a) Change in ion concentration.
 - b) Permeability of cell membrane.
 - c) Release of second messenger.
 - d) Stimulation of molecular pathway.
3. Removal of exudate.
 - a) Decrease in bacterial load.
 - b) Wash away proteases.

Indications

1. Acute injuries with significant soft tissue damage.
2. Chronic non-healing ulcer.
3. Osteomyelitis.
4. Preparatory phase of SSG.
5. Post SSG.

Contraindications^{5,6,4}

1. Wounds a/w malignancy.
2. Wounds nearby arteries or veins.
3. Coagulopathies.

Advantages^{7,8,9,10,11}

1. Better patient compliance.
2. Decreased morbidity.
3. Reduction in frequency of dressing.
4. Rapid wound granulation, epithelisation and contracture.
5. Decreased hospital stay.
6. Major soft tissue reconstruction procedures can be averted.
7. Reduced infection risk.
8. Control of exudate.
9. Concurrent rehabilitation.
10. Decreased financial burden.

Complications^{12,13}

1. Bleeding from wound site.
2. Skin irritation due to foam.
3. Wound desiccation.
4. Other mentioned in literature.
 - Localised infection.
 - Increased pain.
 - Bad odour.
 - Toxic shock syndrome.
 - Anasarca.

Economics	
1. Conventional Vac	
VAC apparatus	INR. 46,000
Per dressing change	INR. 4,500
2. Homemade Vac	
Polyurethane pad	INR. 0/-
Uro Bag	INR. 35/-
Romo Vac kit	INR. 160/-
Sterile drape plastic	INR. 80/-
Surgical plaster	INR. 12/-
Suction apparatus	Current bill
Total cost	INR. 287/- + current bill

OBSERVATIONS AND RESULTS

The present study consisted of 35 cases of type 3 compound fractures with significant soft tissue injury treated by appropriate fixation for bony element and soft tissue deficit treated with the proposed VAC method at S. V. R. R. G. G. Hospital, S. V. Medical College, Tirupati, during period of the following observations were made.

Age Distribution- The youngest patient is 19 years and oldest 67 years with a mean age of 40.49 years.

Gender- In the present study, female were 10 and male patients were 25 with a male-to-female ratio of 2.5:1.

Limb Involvement- In the present study, a total of 32 patients were affected with lower limb injuries, while only 3 were with upper limb injuries. Since, most of the

compound fractures were the result of high velocity road traffic injuries, all the three with upper limb injuries were aetiologically industrial injuries due to crushing in the work place machinery.

Comorbidities- There were no significant reported comorbidities in the study group, however, 10 of them were reportedly known diabetics with 8 of them with good glycaemic control and 2 with high glycaemic scale, which was controlled during the course of treatment.

Eight patients from study group had hypertension, of which, 5 were known hypertensive on treatment, while 2 were newly diagnosed and put on treatment.

Frequency of Dressing- As a protocol, all dressings were changed regularly after 48 hours of application.

Number of Dressings- Number of dressings varied with least number required being 2 to max dressings required being 5, average number of dressings required was 2.69. Maximum number of dressings of 5 was in case of elderly patient who was a known hypertensive and diabetic. The elderly age and associated comorbidities, poor nutritional status together with large wound size could be the factors for such long time for healing.

Measurement of Wound- All measurements were made using medium size mop measuring about 15 x 15 cm with the smallest one being 5 x 8 cm and the largest being 20 x 15 cm.

Duration of Wound Healing- Shortest duration of wound healing with healthy granulation tissue was 4 days with longest duration being 10 days. Average duration of wound healing was 5.3 days.

Shrinkage of Wound Size- Though the shrinkage of wound size could not be calculated exactly due to variable shapes of the wound and irregularity, however, there was a noticeable decrease in size of wound as was noticed on every subsequent dressing change, which was noted by mapping the wound on standard dressing gauze piece.

Follow up Procedure- In our study, out of 35 patients, 33 required split skin grafting, while only 2 required flap cover. All the study cases were initially opined to be requiring flap covers by the consulting plastic surgeon.

Complications and Difficulties- While we had no significant complication during the treatment, we experience following difficulties-

- a. Profuse bleeding from granulation tissue at the time of removal of dressing foam.
- b. Excruciating pain for the patient during removal of dressings.
- c. Intense foul smell during dressing change.

We could however manage to find solution for our first two problems to make this a comfortable procedure in patients. As a protocol before removal of the dressing pad, we used to disconnect the suction catheter from the connecting hub and infuse a solution of lignocaine with epinephrine diluted with distilled water in 1:1 ratio about 10 minutes before the removal. This essentially anaesthetised the wound area, decreasing significantly the pain experienced by patient and reduced the bleeding as well due to vasoconstriction action of epinephrine.

DISCUSSION

The VAC acts as a new step in the 'reconstruction ladder.' The VAC enhances the tissue granulation, which makes it possible to use less complex reconstruction options, e.g. converting the wounds acceptable for skin grafting, which otherwise would have required flap coverage.³

CONCLUSION

Homemade VAC is a cost effective, equally efficacious and a valuable alternative modality of treatment in traumatic soft tissue defects with decreased morbidity, improved compliance and fruitful outcomes provided the treating doctor is also aware of adverse effects it can cause and they are attended to as and when need arises though rare.

REFERENCES

- [1] Kolios L, Kolios G, Beyersdorff M, et al. Cost analysis of topical negative pressure therapy for traumatic acquired wounds. *Ger Med Sci* 2010;8:Doc13.
- [2] Jones SM, Banwell PE, Shakespeare PG. Advances in wound healing: topical negative pressure therapy. *Postgrad Med J* 2005;81(956):353-357.
- [3] Shalom A, Eran H, Westreich M, et al. Our experience with a homemade vacuum-assisted closure therapy. *IMAJ* 2008;10(8-9):613-616.
- [4] Bickles J, Kollender Y, Witing JC, et al. Vacuum-assisted wound closure after resection of musculoskeletal tumors. *Clin Orthopaed Rel Res* 2005;441:346-350.
- [5] Webb LX. New techniques in wound management: vacuum-assisted wound closure. *J Am Acad Orthop Surg* 2002;10(5):303-311.
- [6] Argenta LC, Morykwas MJ, Marks MW, et al. Vacuum-assisted closure: state of clinic art. *Plast Reconstr Surg* 2006;117(7 Suppl):127S-142S.
- [7] Armstrong DG, Lavery LA. Negative pressure wound therapy after partial diabetic foot amputation: a multicentre, randomised controlled trial. *The Lancet* 2005;366(9498):1704-1710.
- [8] Mouës CM, van den Bemd GJ, Meerding WJ, et al. An economic evaluation of the use of TNP on full-thickness wounds. *J Wound Care* 2005;14(5):224-227.
- [9] Leininger BE, Rasmussen TE, Smith DL, et al. Experience with wound VAC and delayed primary closure of contaminated soft tissue injuries in Iraq. *Journal of Trauma* 2006;61(5):1207-1211.
- [10] Apelqvist J, Armstrong DG, Lavery LA, et al. Resource utilization and economic costs of care based on a randomized trial of vacuum-assisted closure therapy in the treatment of diabetic foot wounds. *The American Journal of Surgery* 2008;195(6):782-788.
- [11] Braakenburg A, Obdeijn MC, Feitz R, et al. The clinical efficacy and cost effectiveness of the vacuum-assisted closure technique in the management of acute and chronic wounds: a randomized controlled trial. *Plastic and Reconstr Surg* 2006;118(2):390-397.
- [12] Friedman T, Westreich M, Shalom A. Vacuum-assisted closure treatment complicated by anasarca. *Ann Plast Surg* 2005;55(4):420-421.
- [13] Price RD, Nagarajan M, Srinivasan JR. Local anaesthetic for change of vacuum-assisted closure dressing. *Plast Reconstr Surg* 2006;117(7):2537-2538.