

## ORIGINAL ARTICLE

### A VACUUM ASSISTED CLOSURE (VAC) THERAPY IN ORTHOPAEDIC TRAUMA: A PROSPECTIVE STUDY

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**ABSTRACT: BACKGROUND:** Management of open fractures and massive soft tissue injuries around leg ankle, foot and hand requires multi-disciplinary approach. VAC therapy is an innovative approach to the treatment of these wounds. VAC therapy facilitates granulation tissue formation, promotes healing, reduces infection and allows early skin grafting or flap closure.

**AIM:** To describe our experience with VAC therapy for orthopaedics trauma around leg ankle, foot and hand. **MATERIALS AND METHODS:** 41 patients were included in Prospective Study performed at Preethi hospital, Madurai in years 2011-12. Only patients having traumatic wound of leg, ankle, foot and hand were included. Patients with bleeding disorders were not included. VAC therapy was used as adjuvant to debridement in wound care. **RESULTS:** In 39 patients lower limb and in 2 patient hands was involved. The mean age was 39.3 years and 38 patients were male 3 were female. Mean wound grade after VAC therapy decrease by 1 grade. Average wound area reduction was 10%. The mean duration of VAC therapy was 5.2 days. Plastic surgery was done in mean 6 days after removal of VAC dressing. Local flap was required in only 39% of patients. After VAC therapy all 10 patients having heel injury showed good granulation tissue. Complications like infection, bleeding and skin irritation were not seen in our study.

**CONCLUSION:** VAC therapy is a viable adjuvant in the management of traumatic open wounds. It facilitates the rapid granulation tissue formation and wound healing. It reduces the duration of treatment, hospital stay and need of extensive plastic surgery.

**KEYWORDS:** Sub atmospheric pressure, Negative pressure wound therapy, Macrostrain.

**INTRODUCTION:** Patients with severe orthopaedic trauma with open fractures and massive soft tissue damage caused by motor vehicle accidents, industrial injuries, falls, and gunshot wounds pose a demanding clinical challenge. Management requires multi-disciplinary approach, orthopedic, vascular and plastic-reconstructive procedures. Amputation always remains possibility after exhaustive management. VAC therapy is an innovative approach to the treatment of serious, complex wounds through the use of sub-atmospheric or negative pressure. Known today as "negative pressure wound therapy" (NPWT). NPWT is being used to treat many of these wounds with the hope of reducing infection and promoting healing, sufficient to allow skin grafting or flap closure.<sup>1,2,3</sup> The most important benefits of this therapy include, a reduction in the wound area together with induction of new granulation tissue formation, effective wound cleansing (removal of small tissue by suction), and the continuous removal of wound exudates.

The aim of this study was to describe our experience with VAC therapy for orthopaedics trauma around leg ankle, foot and hand.

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**MATERIALS AND METHODS:** Prospective Study was performed at Preethi hospital, Madurai in years 2011-12. 41 patients were included in the study.

**Inclusion Criteria:** Traumatic wound of leg, ankle, foot and hand.

**Exclusion Criteria:**

1. Exposed blood vessels, anastomotic sites, organs, or nerves.
2. Chronic wounds, dehisced wounds, partial-thickness burns and ulcers (such as diabetic or pressure).
3. Patients with bleeding disorders or on anticoagulants.
4. Inadequately debrided wounds - granulation tissue will not form over necrotic tissue.

Patient after receiving in emergency department, ATLS protocol was followed. Vitals were stabilized and general evaluation was done. Primary H<sub>2</sub>O<sub>2</sub>, betadine and saline wash was given in emergency department. Patient was shifted to Operation Theater for debridement and fixation which was decided on table. A patient wound was evaluated after 48 hrs and decision was taken whether re-debridement or VAC therapy was required. Patients underwent serial operative irrigation and debridement until wounds appeared clean on gross inspection. Mainstay of wound care was debridement and VAC therapy was adjuvant for this. Patient's age, sex, mechanism of injury, site, associated injury, associated co-morbidities, wound grade<sup>4</sup> and size before and after VAC therapy was noted. Number of foams and duration of VAC was decided on wound status. All VAC dressings were applied in Operation Theater after debridement. Definitive procedure like SSG or/and flap was done once wound looked healthy.

Score (grade)	Status of wound
0	Closed wound
1	Skin or soft tissue defect
2	Bone, tendon, implant exposure(any 1)
3	Bone, tendon, implant exposure(any combination of 2 or more)
4	Associated or Residual infection

Table 1

**Mechanism of Action:** Willy<sup>(5)</sup> in his book on vacuum therapy enumerated five mechanisms by which negative pressure aid in the healing process:

- Wound retraction,
- Stimulation of granulation tissue formation,
- Continuous wound cleansing after adequate primary surgical debridement,
- Continuous removal of exudate, and
- Reduction of interstitial edema.

Under negative pressure, V.A.C. Therapy applies mechanical forces to the wound. These forces are known as macrostrain and microstrain.<sup>6,7,8</sup>

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Macrostrain is the visible stretch that draws wound edges together, evenly distributes negative pressure, and removes exudate and infectious materials. Micro strain is the micro deformation at the cellular level that reduces edema, promotes perfusion, and promotes granulation tissue formation by facilitating cell migration and proliferation. Continuous wound cleansing may reduce the bacterial burden <sup>6</sup> and remove substances that inhibit wound healing. Removal of exudate from a wound may reduce tissue oedema and promote blood flow back into the wound area.<sup>6,9,10</sup>

V.A.C. Therapy systems include a vacuum pump, tubing, Sensa T.R.A.C and a dressing set. Dressing set contain open-celled reticulated foam and transparent film (Drape). Foam evenly distributes the negative pressure across the wound bed. Transparent film covers foam to prevent bacteria from reaching the wound and also seals the wounds to maintain the vacuum. Foams may contain silver or other antibiotics. Drainage tube draws excess exudates away from the wound and into a canister attached at the other end. The canister is attached to a vacuum pump that provides either continuous or intermittent negative pressure, adjusted for the type of wound.<sup>11</sup> Sensa T. R. A. C. (Therapeutic Regulated Accurate Care Technology) monitors and maintains target pressure. It helps in reducing tubing blocks and false alarms. Provides alarms for enhanced patient safety

**RESULTS:** In year 2011- 12 total 41 patients were included in the study. In 39 patients lower limb and in 2 patient hands was involved. The mean age of the patients was 39.3 years (range 21 to 70 years), and 38 patients were male 3 were female. 35 patients mechanism of injury was RTA, 3patient had work spot injury and 3patient had fall from tree. Right side was involved in 30 patients and left in 11 Patients. All except 1 patient had associate fractures which were managed accordingly. No patients had systemic involvement like head injury, chest injury, abdo-pelvis injury which will alter the treatment coarse. Associated co-morbidities like diabetics and/or anemia present in 15 patients.

Mean wound grade before VAC therapy was 2.9, which decrease by 1 grade. This signifies improved wound status. Exposed tendon or bone was covered with healthy granulation tissue. Average wound area reduction was 10%. The mean duration of VAC therapy was 5.2 days (range 4 to 9 days).

Mean duration of inpatient care was 27.69 days. Average 2.5 debridements were done before VAC dressing was applied. Foam was changed in 25 patients after 4 days, of these 10 patients had heel injury. Plastic surgery was done in mean 6 days after removal of VAC dressing. Local flap was required in 8 patients and skin graft in 25 patients skin grafting with local flap required in 8 patients.

10 patients had heel injury; all showed delayed granulation tissue formation. After VAC therapy good granulation tissue was seen, plastic surgery was done in 2 to 5 weeks duration. Of these 8 required flap and 2 skin graft. 2 patients had mangled extremity MESS-7 which ultimately required below knee amputation. This outcome was not directly related to VAC therapy. 3 patients had flap necrosis and 2 patients had skin graft necrosis for which VAC therapy was given and then skin grafting was done. Complications like infection, bleeding and skin irritation were not seen in our study.

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**DISCUSSION:** Injuries around leg, ankle and foot commonly associated with exposure of tendon, bones and implants. Conventional treatment method is plastic surgery after the formation of granulation tissue by wet dressing.<sup>12</sup> Frequent wet dressing is required which will be painful and protracted. It is difficult to form healthy granulation tissue over tendon, bone or implants which often require surgical exercise like free flap surgeries. Free flap surgeries have their own drawbacks and morbidities.<sup>13</sup>

Webb et al<sup>14</sup> reported that mechanical effect of the vacuum on the tissue at the wound surface appears to have a "lizarovian" effect resulting in healthy healing granulation tissue. VAC therapy removes excess extravascular tissue fluid, which lowers capillary after load and thereby improves microcirculation. Labler, Ludwig et al<sup>15</sup> suggests that VAC therapy of traumatic wounds leads to increased local IL-8 and VEGF concentrations, which may trigger accumulation of neutrophils and angiogenesis and thus, accelerate neovascularization. DeFranzio<sup>16</sup> also reported that 80% of patients treated with NPWT as compared with a simple wet dressing showed rapid granulation formation. In the present study, Plastic surgery was done in mean 6 days after removal of VAC dressing, which signifies early covering of wound.

Soft tissue defects in foot, ankle and hand are difficult to treat with skin grafting only due to limited granulation tissue. They usually require local or free flap procedure. Shilt et al<sup>17</sup> in their study to compare the results of traditional dressings and NPWT for lawnmower injuries of the lower leg found that the need for free flap surgery was decreased by 30%. In a study on open tibia fractures IIIB and IIIC with massive soft tissue loss, VAC System not only helps the patient to recover faster but replaced microsurgical soft-tissue transfer and thus allows salvage of the leg, in orthopaedic teams lacking advanced reconstructive experience.<sup>18</sup> VAC dressing when applied on split-thickness skin graft act as anchor.<sup>14</sup> Dedmond et al<sup>19</sup> and Hyun-joo Lee et al in their study reported that severities of open wounds were noticeably reduced after NPWT; only one patient needed a free flap to cover exposed bone and tendon. In the present study, grade of wound reduced by 1 grade. No patient required free flap, local flap was required in 16 patients and skin grafting in 25 patients. Only 39% patients required local flap surgery. In patients those who required flap, healing was better.

Webb et al<sup>14</sup> in their study noticed superficial skin irritation in 2.5% of patients. In present study, no case of superficial skin irritation during the treatment period occurred. This is the avoidable complication, by carefully confining the sponge to the wound tissue and avoiding the overlap of normal tissue. In patients with large wound and drainage, careful monitoring of electrolytes and hematocrit, should be done.

VAC therapy is effective in treating deep infections. Vacuum evacuates haematoma, exudates and even pathogens from the wound defect. VAC dressing seals wound and prevent exposure to the atmosphere. In present study, no case of infection was seen.

10 patients had heel pad avulsion. All patients showed delayed granulation as compared to wounds over foot, ankle leg and hand. Plastic surgery was done within 2 wks to 5 wks, which would have been many months without VAC therapy. VAC therapy not only reduces requirement of extensive plastic surgery but also reduces hospital stay, pain, humiliation and depression associated with wound.

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**CONCLUSION:** VAC therapy is a viable adjuvant in the management of traumatic open wounds especially around foot, ankle leg and hand. It facilitates the rapid granulation tissue formation and wound healing. It reduces the duration of treatment and hospital stay which indirectly reduce the expenses of treatment. It also remarkably reduces the need of extensive plastic surgery.

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