ORIGINAL ARTICLE

# Vacuum-Assisted Closure Therapy as A Pretreatment For Split Thickness Skin Grafts

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## ABSTRACT

**Objective**: To evaluate the effect of vacuum-assisted closure (VAC) therapy on wound management by measuring the graft take, wound healing time, need for any re-grafting and duration of hospitalization.

**Study Design**: Single blinded randomized controlled trial.

**Place and Duration of Study**: This study was carried out in the Department of Plastic and Reconstructive Surgery, Pakistan Institute of Medical Sciences (PIMS), Islamabad, from October 2007 to December 2009.

**Methodology:** A total of 100 adult patients of either gender with acute traumatic wounds were included. Patients who needed flap coverage as the primary intervention, and those with Diabetes, malignancy, bleeding diathesis were excluded. Half of the patients were randomly assigned to the intervention group and the rest to the control group with lottery method. All wounds were initially subjected to thorough excision. Wound bed preparation for STSG (split thickness skin graft) was achieved using 10 days pre-treatment with VAC dressings in the intervention group while employing normal saline gauzes in the control group. All patients were subsequently treated with STSG. The primary outcome measure was graft take while the secondary outcome measures included wound healing time, need for any re-grafting and duration of hospital stay. Results were compared in both groups using chi-square test.

**Results:** Marked differences were found in favour of the VAC therapy group with respect to the various wound management outcome measures studied. i.e. graft take (greater than 95% graft take in 90% of VAC therapy group vs. 18% of controls), wound healing time (2 weeks postgrafting in 90% of VAC therapy group vs. 18% of controls), need for re-grafting (none among VAC therapy group vs. 8% of controls) and duration of hospital stay (less than 3 weeks in 90% of VAC therapy group vs. 18% of controls).

**Conclusion**: VAC therapy should be employed in the pre-treatment of wounds planned to be reconstructed with STSG, since it has marked advantages in the wound bed preparation compared with the traditional normal saline gauze dressings.

**Key words:** *Open wound. Wound bed preparation. Vacuum assisted closure therapy. Vacuum-assisted closure dressing. Split thickness skin graft. Graft take.*

## INTRODUCTION

Wound has been a formidable foe for healers since antiquity. The general principles of wound management, entailing debridement and repeated dressings have been established since ancient times. The key objective of wound management is to achieve early complete healing. Delay in healing predisposes to infection and poses protracted morbidity. Direct closure of wound is the most efficient way of achieving healing, however, only clean wounds without much tissue loss are amenable to it e.g. clean surgical wounds. In complex wounds with tissue loss, healing can be promoted by secondary intention or reconstruction with grafts and flaps.[1-3]

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VAC therapy has been reported very useful in the treatment of both acute and chronic wounds. In 1993 Fleischmann *et al.* from Germany were the first to report successful use of this technique in 15 patients with open fractures.[4] Argenta *et al.* from the US in 1997 pioneered further clinical research that lead to popularity of VAC therapy across a range of specialties.[5]

Since VAC therapy is a relatively novel addition to the wound care armamentarium, its exact mechanism of action still continues to be researched. It has been shown to increase wound blood flow, granulation tissue formation, and decreases edema fluid and bacteria at the wounded site.[5,6]

The present study was undertaken to evaluate the effect of VAC therapy on wound management outcomes in patients undergoing reconstruction with STSG.

## METHODOLOGY

The study was carried out at the Department of Plastic Surgery, PIMS, Islamabad, from October 2007 to December 2009. It included a total of 100 adult patients of either gender aged over 13 years, having different acute traumatic wounds (of a duration of up to 06 weeks) measuring $\geq$ 9 cm$^2$ surface area. Patients who needed flap coverage as the primary intervention, and those with either Diabetes, malignancy or bleeding diathesis were excluded. Informed consent was taken from all the patients for participation in the study and be randomized to either intervention or control group without being aware of it. Initial assessment and diagnosis was made by history, physical examination and necessary investigations.

Half of the patients were randomized to the intervention group (those whose wounds were pre-treated with VAC therapy before STSG) and half to the control group (whose wounds were pre-treated with daily normal saline gauze dressings before STSG). Simple random sampling was done with lottery method. The two groups were matched for age, gender, and wound characteristics including size and site of the wound.

Initially all wounds were debrided with thorough surgical excision of devitalized tissues, and tissue sent for bacterial culture and sensitivity tests. Before proceeding to STSG reconstruction, the wounds were optimized with 10 days pre-treatment, using VAC dressings in the intervention group (two VAC dressings each maintained for 5 days) while employing daily normal saline gauze dressings in the control group. This pre-treatment was continued for 10 days when STSG reconstruction was undertaken in all culture-negative patients.

For VAC dressing, two synthetic foam sheets were fashioned to the size and shape of the wound and applied to cover the wound with a Redivac suction drain (with multiple side ports) sandwiched between the two layers. A transparent sealing plastic membrane sheet (Opsite™ in small wounds and plastic food wrap for large wounds) was then applied to the foam layers, making the system water tight and air tight. Thus the open wound was converted into a close controlled one. The suction drain was connected to suction machine or wall vacuum suction maintained at 50-120 mmHg intermittently. At the end of 5 days, VAC dressing was removed and a fresh VAC dressing applied after washing the wound with normal saline and undertaking wound debridement if needed. After 10 days of VAC therapy, STSG reconstruction was undertaken in all culture-negative patients.

All patients underwent reconstruction with intermediate thickness STSG (0.012–0.015 inch). All skin grafts were meshed 1.5:1 ratio. The skin grafts were applied on the granulating wound bed and secured in place with staples. Non adherent sofratulle gauzes were placed onto the skin graft prior to the application of tie over and absorbent dressings. The dressings were left in place until 5th postoperative. During this time, the patients were kept on bed rest to avoid any shearing forces on the grafted wounds. On the 5th postoperative day, the dressings were removed and wounds assessed by gross inspection for graft take which was measured as the percentage of the grafted surface area where graft was taken by wound bed. The patients were stratified into three groups with regard to graft take: good take where $\geq$ 95% graft was taken, fair take where 80-95% wound surface had taken graft and poor take where less than < 80% wound surface had taken graft.

Following discharge, the wound dressings were changed every 3rd day for 10 days. Wounds were examined on 14th postoperative day of grafting for evidence of healing with stable skin coverage and/or need for re-grafting. Figures 1 through 4 are representative pictures of one of the VAC treated patients.

The data were analysed through SPSS version 10 and various descriptive statistics were used to calculate frequencies, percentages, means and standard deviation. The numerical data such as age, wound size and duration of hospital stay were expressed as mean ± standard deviation while the categorical data such as the site of wounds, causes of wounds, and organisms cultured were expressed as frequency and percentages. The percentages of various outcome variables were compared by employing chi-square test and a p-value of less than 0.05 was regarded as statistically significant.

## RESULTS

Out of a total of 100 patients, 86% (n=86) were males. The age ranged from 13-65 years, with a mean of 33.07 ± 13.60 years. Majority of the patients were in their 3rd and 4th decades of life.

Most frequent location of the wounds was lower limb (n=56), followed by upper limb (n=24), trunk (n= 14), and scalp (n=6). The causes of wounds included road traffic accidents in 72%, machine injuries in 12%, falls in 6%,

**Figure 1:** Road traffic accident victim with degloving injury right thigh.

**Figure 2:** VAC dressing in place after radical debridement.

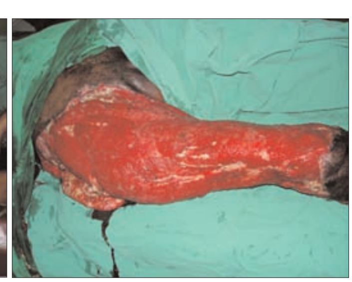

**Figure 3:** Wound rendered graftable by two VAC dressings.

**Figure 4:** Good graft take on 5th postoperative day.

firearm injuries in 4%, blast injuries in 4% and fire crackers in 2%. Wound surface area ranged from 9 $cm^2$ to 500 $cm^2$. The overall mean wound surface area was 64. 58± 90.88 $cm^2$.

The initial culture of the wounds sent at the first wound debridement showed growth of organisms in 17 patients. The most commonly found organisms were *Staphylococcus aureus* (n = 11), followed by coagulase negative *Staphylococcus* (n = 2), *Enterococcus faecalis* (n = 2), *Pseudomonas aeruginosa* (n = 1), and *Escherichia coli* (n = 1). The repeat culture of these patients after 5 days treatment with intravenous antibiotics were negative for growth of organisms. The most frequently instituted antibiotic was co-amoxiclave.

Greater than 95% graft take was seen in 45 (90%) patients of the VAC group compared to only 9 (18 %) of the control group. Table I shows the graft take as percentage of the grafted surface area.

None of the patients in VAC group needed re-grafting, however, 4 (8%) patients among the control group were re-grafted for residual areas of graft failure. The remaining patients with partial skin graft failure healed successfully with repeated dressings, alginate dressings and healing by secondary intention.

Duration of hospital stay was significantly shorter among the VAC group patients (Table II). Table III depicts the healing time observed among the patients of the two groups.

The hospital stay was 18-35 days with a mean of 21.58 ± 3.58 days. There was no in-hospital mortality.

**Table I**: The take of split thichness skin graft among the patients (n=50 each group).

| S. No. | Graft take % | Number of patients (VAC group) | Nnumber of patients (control group) | p-value (%) |
|---|---|---|---|---|
| 1 | ≥ 95% | 45 (90%) | 9 (18%) | p < 0.001* |
| 2 | 80-94% | 4 (8%) | 32 (64%) | p < 0.001* |
| 3 | < 80% | 1 (2 %) | 9 (18%) | 0.03* |

* p-value significant = < 0.05.

**Table II**: The duration of hospital stay (n=50 each group).

| S. No. | Duration of hospital stay | Number of patients (VAC group) | Number of patients (control group) | p-value (%) |
|---|---|---|---|---|
| 1 | Upto 20 days | 45 (90%) | 9 (18%) | p < 0.001* |
| 2 | 21-28 days | 5 (10%) | 37 (74%) | p < 0.001* |
| 3 | > 28 days | - | 4 (8%) | 0.349 ** |

* p-value significant = < 0.05; ** = not significant.

**Table III**: Time to complete healing observed among the patients (n=50 each group).

| S. No | Time to complete healing | No. of patients (VAC group) | No. of patients (control group) | p-value (%) |
|---|---|---|---|---|
| 1 | 2 weeks postgrafting | 45 (90%) | 9 (18%) | p < 0.001* |
| 2 | 3-4 weeks postgrafting | 3 (6%) | 36 (72%) | p < 0.001* |
| 3 | > 4 weeks postgrafting | 2 (4 %) | 5 (10%) | 0.111 ** |

* p-value significant = < 0.05; ** = not significant.

## DISCUSSION

In this study, as the inclusion criteria was open wounds of traumatic origin, majority of the patients were young males. Males are more frequently involved in outdoor activities and hence more prone to sustain different traumatic insults because of road traffic accidents, falls, firearm injuries and blasts etc. Predominant involvement of young males further amplifies the grave implications of such disabling injuries. Male predominance and more frequent involvement of younger population is well documented in the context of trauma in general.[7] With increasing civil violence, there is an increasing number of patients with blast injuries as well.

In this study the use of VAC therapy as pre-treatment for skin grafts, favourably influenced the management of open wounds. In the past, a number of adjuvant therapies such as use of skin substitutes, growth factors and hyperbaric oxygen etc. have been employed to expedite wound healing. VAC therapy was found a better alternative in this regard as it is more economical and safer. The present findings are in conformity with those of other published studies.[8-10]

In this study, VAC therapy was employed only in the preparatory phase before skin grafting of the wounds. Several published studies have successfully used VAC dressings for securing skin grafts postoperatively, especially in wounds with exudative, irregular, or mobile recipient beds and in difficult anatomic locations. It has been reported to stabilize the skin graft and conform it well to the shape of recipient bed, remove edema fluid, decrease bacterial counts, and provide a secured dressing. All these factors further improve the graft survival and reduce the need for repeat skin grafting.[11-14]

In this study healing time and hospital stay were significantly reduced in the patients treated with VAC therapy. Other published studies have also shown fast healing with VAC therapy.[15-17] A variety of factors have been described to account for the accelerated healing. VAC therapy continually decontaminates the wound and drains the wound surface of exudates, which contain large amounts of proteases. Those would normally inhibit fibroblastic division, collagen production, and cell growth. Fluid removal helps with localized edema that otherwise causes an increase in interstitial pressure with consequent occlusion of microvasculature and lymphatics, decreased nutrient, and oxygen delivery. Protein degradation enzyme is released with metabolic waste accumulation and increased bacterial colonization, which causes capillary damage and hypoxia. VAC therapy also provides a moist environment to promote granulation tissue formation and prevents eschar formation, which allows for a smoother pathway to re-epithelialize the wound surface. Angiogenesis is stimulated, which improves tissue oxygenation and tissue reconstruction. This enhanced angiogenesis occurs even in patients with diabetic microangiopathy, and promotes healing of distal lesions.[18,19] Micro-mechanical forces exerted on wound surface by low pressure suction are also important. This mechanism mimics the stretch-induced cell proliferation typically operative in tissue expansion phenomenon seen elsewhere in the body. [20,21]

Owing to its low cost, VAC therapy can provide an economical alternative to the other available costly local wound management measures. Such economic implications of wound management are particularly important in the context of our poor patients. Cost effectiveness has also been reported in terms of shortened hospital stays, and decreased overall medical cost in the published literature. [22,23]

In this study VAC therapy was additionally found to be more comfortable for patients as well as the surgical staff. It obviated the need for daily dressing changes. Similar findings have been reported by other studies as well.[22,23]

This study has some limitations. It is a single centred study. Blinding of the treating doctors was not possible and so observer bias could not be eliminated completely.

This study should prompt other local studies and hence allow more meaningful comparison of results in our own population. We recommend the conduct of a multicentre local study to confirm and improve upon our results. Additionally a local study may be conducted to compare the cost of VAC therapy versus other wound preparatory methods such as use of skin substitutes or growth factors, and hence evolve an evidence base to confirm VAC therapy as an economical alternative to the other costly local wound management measures.

## CONCLUSION

VAC therapy should be employed in the pre-treatment of wounds planned to be reconstructed with STSG, given its significant advantages in the wound bed preparation compared with traditional normal saline gauze dressings.

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