Original Research Article

Customized vacuum assisted closure therapy of wounds as a simple and cost-effective technique of wound closure—a prospective observational study from underdeveloped world

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ABSTRACT

Background: Aim of the study was to study the efficacy and cost-effectiveness of indigenously designed customized vacuum assisted closure (VAC) of wounds in our patients. The management of difficult to heal wounds has been the main force that led to the development of advanced gadgets for their management. The technique of vacuum assisted closure has revolutionized the management of difficult to heal wounds and delivers better results as compared to conventional technique. Our aim was to assess the efficacy and cost effectiveness of customized VAC therapy.

Methods: This prospective study was conducted in the department of surgery and allied specialties, GMC Srinagar, from June 2018 and September 2020. During this period, 80 patients were subjected to VAC therapy and were included in this study.

Results: VAC dressing was used in 80 patients. 55 were males and 25 were females. Most of the wounds in our study were located over lower limbs (70%). RTA was the most common mode of injury followed by fall from height. After the VAC therapy, 78.8% patients were managed by STSG, 11.3% by flap cover, 6.3% by secondary suturing and 3.8% healed by secondary intention. Pain was experienced by 30% of the patients, 7.5% had hypoalbuminemia, 3.8% had surrounding skin maceration. The average total cost of the VAC therapy was 863.13 (±399.82) Indian rupees (11.76 USD). The mean duration of hospital stay for our patients was 22 days.

Conclusions: Customized VAC Therapy has revolutionary potential in the management of the difficult to treat wounds as far as its safety, speed and cost effectiveness is considered especially in a setup of poor income nations like ours.

Keywords: VAC, Negative pressure wound therapy, Wounds, Cost effectiveness, Customized

INTRODUCTION

The management of difficult to heal wounds has been the main force that led to development of advanced gadgets for their management. Wounds of patients in need of reconstructive surgery are frequently large with extensive soft tissue loss. There are a variety of pharmacological, cellular, biochemical, and mechanical methods that alter the normal wound healing sequence. In recent past, there has been surge in research for management of non-healing wounds by both surgical and non-surgical methods. Among the methods, negative pressure wound therapy (NPWT) which was described by Fleischman et al, in 1993, who first reported use of sub atmospheric pressure for an extended period to promote wound debridement and healing. NPWT or VAC therapy of the wounds have 4 primary effects on the wounds i.e., (1) contraction of the wound (macro-deformation); (2) stabilization of the wound environment; (3) removal of wound exudate and decrease in edema; and (4) micro-deformation of the foam-wound inter-face. Apart from
these primary effects, various secondary effects of the VAC therapy are: 1) It speeds up wound healing compared to normal saline dressings. 2) Increase in blood flow around the wounds by increased granulation tissue with small blood vessels observed on histological sections. 3) Causes changes in bacterial bio-burden. 4) Changes in wound biochemistry and systemic response through depressing the expression of MMP-1, 2, 13 and also depressing the degradation of collagen and gelatin. 5) Improvement in wound bed preparation by increase in granulation tissue formation by greater than 60%, when applied to porcine wounds in comparison to wounds treated with moist gauze dressing. Also, it has been seen that granulation tissue covered the wound more quickly in patients treated with VAC device, resulting in faster wound closure, than in patients receiving standard treatment.

Aim of the study was to study the efficacy and cost-effectiveness of indigenously designed customized vacuum assisted closure of wounds in our patients.

METHODS

The present prospective observational study was conducted in the post-graduate department of surgery and allied specialties, government medical college, Srinagar, Kashmir, India. This study was conducted from June 2018 to September 2020. Ethical clearance for the study was taken from the ethical committee of the hospital.

Patients admitted with wounds of different etiologies in the department of surgery and allied specialties, after initial debridement and management were subjected to indigenously devised vacuum assisted wound therapy using wall mounted suction apparatus. The patients/attendants were explained the procedure and informed written consent was taken. The patients were kept in a comfortable position and it was ensured that patient had received adequate analgesia before the procedure. All patients having different types of wounds were subjected to wound preparation in terms of debridement of any necrotic tissue, cleansing of wound with normal saline irrigation and appropriate hemostasis prior to application of vacuum device. The hair of the patient was shaved around the margins of the wound (where needed). An appropriate size of sterilized polyurethane foam was selected and contoured to fit on the wound surface without overlapping skin edges. It was ensured that the foam filled all areas of the wound including any tunnel or undermining. The tubing was placed onto the foam and then a sterile transparent adhesive dressing (Iodrape) was applied over the wound and foam allowing at least 3-5 cm of coverage onto healthy tissue to assure proper occlusive seal. By this, open system was converted into closed system which was open through tubing only. After that a wall mounted suction device unit was connected to the tubing and was set to the desired pressure (75-125 mmHg). The patients were subjected to VAC therapy in a continuous manner.

The VAC dressing was changed at serial intervals (after 48-72 hours) depending upon the nature and output of the wound and the efficacy of the VAC therapy in the management of wounds was assessed. The wound of the patient was serially photographed and the wounds were serially examined by one of the senior members of the attending team to determine the wound contraction and development of granulation tissue at each dressing change. End point of the therapy was selected when the wound was completely covered by granulation tissue.

RESULTS

In our study the age ranged from 10 to 80 years with majority i.e., 20 patients (25%) being 31-40 years of age. (Table 1). There were 55 males (68.7%) and 25 females (31.3%), with Male: Female ratio of 2.2:1 respectively.

The most common site of wounds in our study was legs, presents in 20 patients (25%) followed by thigh in 14 patients (17.5%) and foot in 10 patients (12.5%) making the lower limb the most common area of the body involved (Table 2). In our study road traffic accidents (RTA) comprised the most common mode of injury present in 24 patients (30%) followed by necrotizing fasciitis in 21 patients (26.3%) and fall from height in 15 patients (18.8%) (Table 2).

Table 1: Age and gender distribution of study patients.

| Parameters          | N   | %   |
|---------------------|-----|-----|
| **<10**             | 1   | 1.25|
| **11-20**           | 7   | 8.75|
| **21-30**           | 10  | 12.5|
| **31-40**           | 20  | 25  |
| **41-50**           | 17  | 21.25|
| **51-60**           | 14  | 17.5|
| **61-70**           | 10  | 12.5|
| **71-80**           | 1   | 1.25|
| **Mean±SD (range)** |41.8±12.17|
| **Gender**          |     |     |
| Male                | 55  | 68.7|
| Female              | 25  | 31.3|

In our study number of VAC dressing changes ranged from 1 to 6 with majority of the patients i.e., 37 (46.3%) required two VAC dressing changes before definitive wound coverage (Table 3). The most common post VAC procedure in our study was STSG done in 63 patients (78.8%) followed by various local, regional or distant flap covers in 9 patients (11.3%). Most common complication in study patients while being on VAC therapy was feeling of pain, which was present in 24 patients (30%). In study, maximum number of patients i.e., 37 (46.2%) had to spend between 500 to 1000 INR (mean 11.76 USD), with only 6/80 patients (7.5%) requiring to spend >1500 INR (Table 3). Maximum no. of patients 56/80 (70%) in study had a hospital stay of between 10-19 days followed 16 patients (20%) with 20-29 days.

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Table 2: Distribution of patients as per site and etiology of wound.

| Distribution of patients | No. of patients | Percentage (%) |
|--------------------------|-----------------|----------------|
| **Site of wound**        |                 |                |
| Leg                      | 20              | 25.0           |
| Thigh                    | 14              | 17.5           |
| Foot                     | 10              | 12.5           |
| Back                     | 6               | 7.5            |
| Knee                     | 5               | 6.3            |
| Buttock                  | 4               | 5.0            |
| Ankle                    | 3               | 3.8            |
| Forearm                  | 3               | 3.8            |
| Forearm with hand        | 2               | 2.5            |
| Sacral region            | 2               | 2.5            |
| Scrotum                  | 2               | 2.5            |
| Heel                     | 2               | 2.5            |
| Thigh with leg           | 2               | 2.5            |
| Hand                     | 1               | 1.3            |
| Hip                      | 1               | 1.3            |
| Perineum                 | 1               | 1.3            |
| Scalp                    | 1               | 1.3            |
| Breast                   | 1               | 1.3            |
| **Etiology of wound**    |                 |                |
| Road traffic accident    | 24              | 30.0           |
| Necrotizing fasciitis    | 21              | 26.3           |
| Fall from height         | 15              | 18.8           |
| Decubitus ulcer          | 8               | 10.0           |
| Burn                     | 4               | 5.0            |
| Diabetic foot ulcer      | 4               | 5.0            |
| Post incision drainage abscess wounds | 1 | 1.3 |
| Animal attack            | 1               | 1.3            |
| Paraplegic pressure ulcer| 1               | 1.3            |
| Trophic ulcer            | 1               | 1.3            |

Table 3: Distribution of patients as per number of VAC dressings, post VAC procedure, complications, cost of dressing and hospital stay.

| Distribution of patients | No. of patients | Percentage (%) |
|--------------------------|-----------------|----------------|
| **No. of VAC dressing changes** |                 |                |
| 1                        | 9               | 11.3           |
| 2                        | 37              | 46.3           |
| 3                        | 20              | 25.0           |
| 4                        | 7               | 8.8            |
| 5                        | 4               | 5.0            |
| 6                        | 3               | 3.8            |
| **Post VAC procedure**   |                 |                |
| STSG                     | 63              | 78.8           |
| Flap cover               | 9               | 11.3           |
| Secondary suturing       | 5               | 6.3            |
| Secondary healing        | 3               | 3.8            |
| Pain                     | 24              | 30             |
| Hypoalbuminemia          | 6               | 7.5            |
| Surrounding skin maceration | 3             | 3.8            |
| Flap site infection      | 1               | 1.3            |
| Nil                      | 46              | 57.5           |
| **Complications**        |                 |                |
| <500                     | 23              | 28.75          |
| 501-1000                 | 37              | 46.25          |
| 1001-1500                | 14              | 17.5           |
| >1500                    | 6               | 7.5            |
| **Hospital stays in days** |                 |                |
| 0-9                      | 2               | 2.5            |
| 10-19                    | 56              | 70             |

Continued.
DISCUSSION

VAC is a novel technique that has revolutionized the management of the wounds in the past 15 to 20 years. There is significant amount of literature regarding the efficacy, its safety, speed of action and cost effectiveness in management of complex wounds.5,13

In our study maximum numbers of patients were in the age group of 31-40 years (25%). Our finding was in concordance with those noted in their study by Zargar et al.14 The likely reason for this could be because of the fact that patients in this peak and productive age of life are most active and outdoors and are more at risk of sustaining accidental injuries and trauma. In our study 55 patients were males (68.75%) and 25 were females (31.25%) with a male to female ratio of 2.2:1. The general agreement in the literature regarding male predominance has been reported in majority of previous studies which is consistent with our study.15,16 This again is related to the tendency of males choosing more active and vigorous outdoor activities and hence more chance of injuries. Most of the wounds in our study patients were located over lower limbs (70%). Leg was the most common site followed by thigh and foot. Our observations are at par with those observed in their study by Mullner et al and DeFranzo et al where the wounds on the extremities was the most common site, managed by VAC therapy.17,18 Our study presented with complex soft tissue wounds that were sustained by a variety of modes; with road traffic accidents (RTA) being the commonest mode present in 24/80 patients (30%). Similar observations were noted by Dedmond et al and DeFranzo in their studies where they found RTA was the commonest mode present in 24/80 patients (30%).

Injuries. Most of the wounds in our study patients were located over lower limbs (70%). Leg was the most common site followed by thigh and foot. Our observations are at par with those observed in their study by Mullner et al and DeFranzo et al where the wounds on the extremities was the most common site, managed by VAC therapy.17,18 Our study presented with complex soft tissue wounds that were sustained by a variety of modes; with road traffic accidents (RTA) being the commonest mode present in 24/80 patients (30%). Similar observations were noted by Dedmond et al and DeFranzo in their studies where they found RTA was the commonest mode present in 24/80 patients (30%).

Our studies by Shilt et al and Madhav et al were where the wounds on the extremities was the most common site, managed by VAC therapy.17,18 Our study presented with complex soft tissue wounds that were sustained by a variety of modes; with road traffic accidents (RTA) being the commonest mode present in 24/80 patients (30%). Similar observations were noted by Dedmond et al and DeFranzo in their studies where they found RTA was the commonest mode present in 24/80 patients (30%).

Similarly, in another study reported by Chaput et al average cost of VAC therapy was 15 USD per day.23 A European study on the cost of treatment of VAC therapy of wounds reported an average cost of VAC therapy to be 24 Euros per day.24 The disparity in the average cost in our study as compared to other studies is explained by the fact that the classical commercially available VAC machine (Kinnester) and accessories cost about 3-4 lacs. While as we used indigenously devised VAC which comprised of wall mounted suction apparatus, sterilized foam, chest tube drains and simple connecting tubing and sterile adhesive drape which significantly reduced the cost of the VAC therapy.

| Distribution of patients | No. of patients | Percentage (%) |
|--------------------------|-----------------|----------------|
| 20-29                    | 16              | 20             |
| 30-39                    | 6               | 7.5            |
| 40-49                    | 0               | 0              |
Besides there were no costs of application and maintenance as all manpower and most of the material is free in government hospitals like ours. The patient had to buy only the adhesive drape used in the VAC therapy. Rest of the things including the foam, drainage tubing and manpower was provided by the hospital free of cost to the patient. We used a wall mounted vacuum creating apparatus for study, which is also property of hospital. Hence in our setup, VAC therapy was very much cost effective as compared to other mentioned studies.

The mean duration of hospital stay for a patient was 17 (±6.5) days, with an average of 22 days. Our results were consistent with those of Kilios et al however they are at variance with those of Chupat et al where mean hospital stay of 16 days duration was reported.22,23

CONCLUSION

To summarize, VAC therapy seems to have revolutionary potential in the management of the difficult to treat wounds as far as its safety, speed and cost effectiveness is considered, especially when supervised by professional wound care specialists.

Average time taken for the wounds to become fit for definitive wound closure methods is much less than the average time taken for similar wounds managed by conventional ways.

The cost of customized VAC therapy using wall mounted suction apparatus available in hospital wards is much lower and affordable to patients in a setup like ours. Thus, we conclude that this study supports the efficacy and cost effectiveness of the customized indigenous VAC therapy as a novel technique in management of complex wounds, suited for poor income countries like ours.

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