

Reconstruction of large abdominal wall tissue defect using vacuum assisted wound closure

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Ethics Committee Approval

Ethical Clearance was obtained from institutional ethical committee, Faculty of Medicine, Jawaharlal Nehru Medical College, Aligarh Muslim University on 17.07.2017 (D. No. 642/FM).

All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest

No conflict of interest was declared by the authors.

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Abstract

Background/Aim: Abdominal wall defects may result from trauma, burn, necrotizing soft tissue infection or complications of abdominal surgeries. Reconstruction poses a great challenge for the surgeon in cases of large abdominal wall defects with lack of surrounding tissue. Abdominal wall defects lack a good functional and aesthetic impact and early reconstruction is prudent for better outcomes. This study evaluates the results of Vacuum assisted wound closure (VAC) therapy in patients with large anterior abdominal wall tissue defect which could not be closed primarily otherwise.

Methods: This case series included 20 patients with partial thickness, anterior abdominal wall tissue defects. All patients had suffered an acute trauma. Wound debridement was done and VAC therapy dressing was applied in systematic manner. Dressing was changed every 3 or 4 days and continued up to 9-14 days.

Results: Twenty patients underwent VAC therapy with an average age of 32 years (range, 25-52 years). Indications comprised tissue loss after acute trauma due to road traffic accident, burn and other trauma leading to anterior abdominal wall soft tissue defect. VAC was used for an average of 12 days, with an average negative pressure of 125 mm Hg. Healthy granulation tissue was formed in all patients. Subsequently split thickness skin grafts were applied in these patients. This results in early recovery as well as decreased morbidity in all patients.

Conclusions: All patients had good tolerance to Vacuum-assisted closure. It offers many benefits comprising fewer dressing changes and an earlier return to daily activities. Patients with large abdominal defects can benefit from this procedure.

Keywords: VAC therapy, Split skin grafting, Abdominal wall tissue defect

Introduction

Successful restoration of substantial large soft tissue defects, especially of abdominal wall, has always been considered challenging for reconstructive surgeons. The morbidity associated with delayed abdominal wall wound healing, imposes a significant psychological and financial burden both for patient and society. So achieving early success in initial stage of reconstruction of abdominal wall is very critical and warranted [1-3].

Methods adopted for reconstruction of abdominal wall depend on the location, extent (layers involved), size, etiology as well as types of wound. For better understanding and communication among reconstructive surgeons, abdominal soft tissue defect can be classified by anatomical zones and by extent or depth of tissue loss.

Abdominal wall defect has been assigned zones depending on the location of defect. Three anatomical zones have been designated (Figure 1(a) and 1(b)) [4].

Zone 1: Midline defects with extension across the midline

Zone 2: Upper quadrants defect of the abdomen

Zone 3: Lower quadrants defect of the abdomen

Depending upon depth, there are three types of abdominal wall defects [5]:

1. Involvement of only skin and subcutaneous tissue;
2. Involving of muscle and fascia only; and
3. Full thickness defects involving skin, subcutaneous tissue, muscle, and fascia.

Figure 1a: Anatomical Zones of Abdominal wall:- Zone 1



Figure 1b: Anatomical Zones of Abdominal wall:- Zone 2 and 3



There are various clinical conditions which can lead to abdominal wall defect requiring replacement including traumatic injury, radiation-associated wounds, oncologic resection, superficial soft tissue infection, and septic evisceration, burn or complications of various surgeries [1, 5].

Reconstruction can be done by primary closure when wound can be approximated easily and that too without tension, flap cover needed when appropriate tissue is available, bioprosthetic mesh can be used along with flap when there is full thickness loss, skin grafting can be done when there is partial thickness loss and also wound is clean [4].

Reconstruction of large abdominal wall defects with no surrounding tissue pose a great challenge for the reconstructive surgeon. It becomes more challenging in the cases when the wound is grossly contaminated. Such a large abdominal wound requires daily dressing till the wound becomes healthy for cover. This traditional method of wound management takes longer time

which adds to morbidity of patients and financial burden to family and society [1].

In this era of wound management, the use of vacuum assisted wound closure therapy for management of complicated wound has been well documented. Vacuum-assisted closure (VAC) therapy includes the use of negative pressure to augment conditions for wound healing. It can be effectively applied during early management of acute trauma patients. It not only stimulates granulation tissue formation due to application of micromechanical forces but also provides a closed moist environment with removal of excess fluid [6, 7]. Since ideal reconstruction can only be performed on a non-edematous, clean wound with no sign of active infection and with minimal comorbidity, vacuum assisted wound therapy methods can be good option in early stage of large partial soft tissue defect in abdominal region. Keeping this aspects of early wound management in consideration, we applied Vacuum assisted wound closure methods in large abdominal defects which otherwise could not be primarily closed and the depth of wound included only skin and subcutaneous tissue.

Ultimately, the main goal of such reconstruction is early recovery with improved patients' health related quality of life. Successful abdominal wall reconstruction with VAC has shown positive influence on patients' pain, physical as well as social functioning, and rejoining of work.

Materials and methods

This case series was conducted in department of plastic and reconstructive surgery, at Jawaharlal Nehru Hospital, Aligarh Muslim University. Ethical Clearance was obtained from institutional ethical committee, Faculty of Medicine, Jawaharlal Nehru Medical College, Aligarh Muslim University on 17.07.2017 (D. No. 642/FM). After informed consents taken, vacuum assisted wound closure dressings were applied to 20 patients who fulfilled the following inclusion criteria:

- Acute wound either due to trauma or burn
- Partial thickness loss of anterior abdominal wall
- Age over 12 years.

Exclusion criteria of this study were patients with:

- Polytrauma
- Unstable condition
- Chronic wounds

Preliminary patients' data were noted in all patients who fulfilled above mentioned criteria and Vacuum assisted wound closure device were applied in systematic manner. Clinical examination of wound was done during dressing change at every 3rd / 4th day or when the canister was filled. This was continued for 10-14 days until healthy granulation tissue formed. And wound became fit for skin grafting.

Vacuum Assisted Wound Therapy technique:

1. **Wound Preparation:** After taking microbiological culture swab from wound, adequate surgical debridement of wound was done and hemostasis was achieved. Peri-wound area was cleaned and dry.
2. **Foam placement:** Specially designed sterile, open-cell foam placed in wound cavity, covering all areas of wound cavity.
3. **Sealing with drapes:** Wound cavity along with 3-5cm of peri-wound area was sealed with adhesive drapes.
4. **Negative pressure application:** After attachment of tubing to dressing and connecting it with machine, a controlled, uniform negative pressure of 125mm Hg was applied.

Results

Twenty patients received VAC therapy. Among these patients, 16 had suffered road traffic accident (RTA), 2 patients suffered heavy machine injury at work place and 2 patients had sustained thermal burn. Average length of VAC therapy was use was 12 days (10-14). In all the patients vacuum-assisted closure therapy was continued until wound becomes ready for skin grafting. After VAC therapy, skin grafting was performed to cover granulation tissue in all the 20 cases. The average age of patients was 32 years (range, 22–52 years). There were 15 male and 5 female (Table 1, 2). No complication occurred that could be directly attributed to VAC therapy, such as, a deep infection or bleeding. Two of the representative case of this study has been shown below with their details of study.

Table 1: Patients and VAC therapy details

Total cases	20	
Average age	32 years (range 22-52 years)	
Sex	Male	15 (75%)
	Female	5 (25%)
Etiology	Road traffic accident	16 (80%)
	Heavy machine injury	2 (10%)
	Thermal Burn	2 (10%)
Average duration of VAC therapy	12 days (10-14 days)	
Pressure used in VAC therapy	-125 mm Hg	
Average length of stay at hospital	20 days (17-24 days)	
Largest size of wound covered	21 x 20=420 cm ²	
Complications due to VAC dressing	Nil	

Table 2: Patients demographic details

Case	Age (years)	Sex	Mode of injury	Size of wound (cm ²)	Number of VAC dressing	Total Days of VAC therapy done	Total duration of hospital stay(Days)
1	26	M	Machine injury	420	5	14	24
2	17	M	RTA	240	3	9	20
3	40	M	RTA	330	5	14	23
4	25	F	RTA	99	3	10	18
5	52	M	RTA	180	3	9	18
6	34	F	Burn	330	4	12	21
7	32	M	RTA	380	4	13	21
8	28	M	Machine injury	361	3	10	20
9	42	M	Burn	285	3	9	19
10	38	F	RTA	273	4	11	20
11	24	M	RTA	252	4	10	22
12	33	M	RTA	204	3	9	17
13	25	F	RTA	352	4	12	21
14	23	M	RTA	336	5	14	24
15	27	M	RTA	168	4	11	20
16	31	M	RTA	414	4	12	18
17	24	M	RTA	224	3	9	17
18	34	M	RTA	360	3	10	20
19	33	F	RTA	400	4	13	23
20	48	M	RTA	288	3	10	20

M: Male, F: Female, RTA: Road traffic accident

Representative case 1

26 years old man suffered heavy machine injury while working in lock making factory. There was avulsion of skin and subcutaneous tissue from anterior abdominal wall leading to a defect of about 21 cm x 20 cm (420 cm²). Initially patient was admitted under emergency surgical team. Patient was transferred to plastic surgery side for reconstruction, once he was stabilized, on 6th day. VAC dressing which was applied, changed on every third day and continued for 14 days, followed by split-thickness skin grafting. Patient was discharged on day 24th in stable condition with good graft take (Figure 2).

Figure 2a: Condition of wound before VAC Figure 2b: VAC therapy being applied application in a case of post road traffic accident abdominal wall defect



Figure 2c: After VAC therapy, the contour has improved

Figure 2d: After split thickness skin grafting



Figure 2e: After 1 month follow up



Representative case 2

This patient was a 17 years boy who had road traffic accident. There was anterior abdominal wall defect with skin and subcutaneous tissue loss along with abrasion and friction burn present. The wound was debrided to remove gross contamination then VAC dressing was applied once infection was controlled and it was continued for 9 days. After VAC therapy, split-thickness skin grafting was done and then on day 20th, patient was discharged in satisfactory condition (Figure 3).

Figure 3a: Condition of wound at presentation in emergency department in a patient with history of RTA



Figure 3b: Condition of wound after debridement



Figure 3d: After split thickness skin grafting



Figure 3c: After VAC therapy



Figure 3e: After 20 days in follow up



Discussion

Trauma surgeons often come across abdominal wall soft tissue defect in emergency department. The management of this defect depends on site, size, depth, contamination, availability and conditions of surrounding tissue. In cases where the thickness of wound consists only of skin and subcutaneous tissue, early coverage of wound is warranted otherwise persistent infections in wound may lead to involvement of deeper tissue. This will lead to delay in reconstruction which will cause ill health to patients and monetary burden to family as well as society. It has been found in literature that infection in local tissue prolong the inflammatory phase, decreases oxygenation, causes collagenolysis and thus retard the progress of wound healing [8].

The biggest problem in large tissue defect in abdominal region is the availability of local tissue for coverage. At the time of presentation in emergency, usually the wound is grossly contaminated which preclude early coverage with skin grafting. Even if wound is clean and early skin grafting is done, it will lead to contour deformity because of cavity defect in wound at the time of presentation. So successful reconstruction requires optimal wound condition, which is the goal to reach as soon as possible. The main aim of reconstruction in trauma patient is early recovery with minimal complication and better aesthetic appearance with optimal functionality of reconstructed area. Conventional treatment methods such as frequent wet dressing will be painful and protracted [9].

Vacuum assisted wound closure (VAC) therapy has been considered an effective method in wound preparation for early coverage. As has been seen in this study that VAC therapy not only reduces duration for granulation tissue formation but also removes hematoma, exudate and pathogens. Sealing of wound with VAC dressing provides evenly moist environment and avoids contact to the atmosphere & thus intrusion of pathogens. VAC therapy also reduces size of wound with early obliteration of cavity defect.

Webb et al. [10] in their study reported a “Ilizarovian” effect of VAC on wound leading to healthy healing granulation tissue formation. In our study also we can clearly appreciate the early and healthy granulation tissue formation due to mechanical deformation effect of VAC therapy. de Alcântara Jones et al. [11] used vacuum assisted closure system in infected wounds where in 19 patients they observed that healthy granulation tissue which was free from any infection was obtained with a significantly reduced size of lesion.

Labler et al. [12] in his study found that VAC therapy may trigger accumulation of neutrophils and angiogenesis due to raised IL-2 and VEGF levels. We also found that there was augmentation in wound healing phase with early cavity coverage with healthy tissue with decreased infective foci. DeFranzo [13] also reported that patients treated with Negative Pressure Wound Therapy showed faster granulation formation than simple wet dressing. Z. Ali et al. [14] observed earlier appearance of granulation tissue in patients treated with VAC as compared to the conventional dressing group. They also found that complete (100%) granulation was achieved earlier and in higher proportions in VAC group as compared to the conventional group. Morykwas et al. [15] found a significant increased rate of

granulation tissue formation in both continuous and intermittent VAC application.

On comparison with previous experiences of conventional wound management at our center, we found that VAC therapy has significantly reduced the wound closure time by 30-50%. Average period of VAC treatment was 12 days and that of total hospitalization was 20 days. The longest duration of vacuum assisted closure therapy was 14 days. In DeFranzo et al. [2] study of VAC application on abdominal wound, the average time of VAC application was of 13 days. The longest duration of VAC therapy in their study was 96 days.

Although this treatment method is more expensive when we consider the cost of each dressing especially in developing countries like India but it reduces the costs of hospital stay for a longer time, in comparison with conventional dressing and multiple surgical debridement sessions. Flack et al demonstrated an overall lower cost of care (US\$52,830 versus US\$61,757 per person) for patients treated with VAC therapy compared with advanced dressings [16].

After removal of VAC therapy, early wound coverage was done with split thickness skin grafting in all our patients. In DeFranzo et al. [2] study 28 out of 63 patients; split thickness skin grafting was done.

Patients returned to their daily life as early as possible with minimum morbidity. Early return to family and society decreases their financial and psychological burden.

This study showed that early and aggressive wound management with VAC therapy creates aesthetically pleasing functional abdominal wall where patient can swiftly merge in the society and his profession with better chance for early recovery in one hospital stay.

However, smaller sample size and lack of control group are the limitations of this study which needs to be considered.

Limitations

Sample size is small due to the cost of the dressings. The study with large sample size will establish the definitive role of NPWT therapy in managing large abdominal wounds.

Conclusion

VAC therapy is a worthwhile adjuvant therapy in the treatment of partial thickness, large abdominal wall soft tissue defect which cannot be primarily closed or covered with flap. It not only facilitates the rapid granulation tissue formation but also controls of infection. Eventually, it reduces the expenses of treatment by decreasing the duration of treatment and hospital stay.

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