Vacuum-packing temporary abdominal closure in post laparotomy wound sepsis and wound dehiscence

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Abstract

Background/Aim: Post-laparotomy wound sepsis and dehiscence occur in 0.25% to 3% of patients. Frequently, definitive fascial and/or cutaneous reconstructions cannot be performed in an immediate setting due to the wound condition or the general condition of the patient. Commercial VAC (Kinetic Concepts, Inc, San Antonio, TX) have been predominantly used for treatment of the open abdomen and in abdominal sepsis. However, commercial devices are either not available or prohibitively expensive for most patients in resource-poor regions. The method described herein is a relatively crude and low cost one applying the principals of topical negative pressure and temporary abdominal wound closure and our aim is to check its feasibility, safety and efficacy as a temporary abdominal closure method in post laparotomy wound sepsis and wound dehiscence.

Patients and methods: This prospective study included 17 patients with significant post laparotomy wound dehiscence admitted to surgery department between June 2008 and May 2011. Vacuum packing closure therapy was administered for the whole 17 patients. Eleven patients (64 %) had complete fascial dehiscence with exposed bowel and six patients (36 %) had partial thickness fascial dehiscence. The evaluations included descriptive characteristics of the patients, rate of primary fascial closure and vacuum packing related morbidity and mortality.

Results: Of these 11 patients with full thickness wound dehiscence and bowel exposure, two patients died of vacuum packing unrelated problems, six patients underwent successful primary fascial closure. In those 6 patients with partial thickness wound dehiscence, vacuum packing therapy achieved satisfactory wound healing in all the patients, Problems related to vacuum packing therapy included necrosis of fascial edges (2 patients) and blister under the adhesive tape (2 patients). No variables had a significant influence on vacuum packing wound therapy specific morbidity or primary closure rate in the univariate analysis. Three variables showed a significant influence on mortality: age ($P<0.001$), adult respiratory distress syndrome ($P=0.01$), multiorgan failure ($P=0.01$) and MPI($P=0.01$).

Conclusion: Vacuum-packing therapy is safe and effective temporary abdominal closure in post laparotomy wound sepsis and dehiscence. Its effectiveness is similar to the known commercial device but the cost is much less which could be advisable in health care systems with limited funds in poor developing countries.

Key words: Vacuum wound therapy, open abdomen, temporary abdominal closure, post laparotomy wound dehiscence.

Introduction:

Post-laparotomy wound dehiscence occurs in 0.25% to 3% of patients, and multiple factors can contribute to its occurrence.[1] The most common local factors associated with wound breakdown are wound infection, hematoma, and seroma. Regional factors include bowel edema and abdominal distention,

which may be caused by intra-abdominal infections, hemorrhage, and trauma, while systemic factors commonly associated with abdominal wound dehiscence are advanced age, malnutrition, pulmonary disease, renal failure, obesity, diabetes mellitus, steroid use, administration of radiotherapy, and/or administration of chemotherapy. Imperfect surgical technique and emergency laparotomies are associated with an increased risk of wound dehiscence as well.[2]

Post-laparotomy wound dehiscence can range from a superficial, localized wound separation to complete fascial dehiscence. In the majority of cases with dehiscence of fascia, a polymicrobial infection is present.[3] Restoration of the abdominal wall integrity is the paramount goal of treatment for this condition and can be achieved only if the underlying problem causing the dehiscence is addressed in parallel with the establishment of a supportive environment for wound healing.[2,3]

Frequently, definitive fascial and/or cutaneous reconstructions cannot be performed in an immediate setting due to the wound condition or the general condition of the patient. In these cases the closure of the wound is done in a delayed setting.[4] This delay provides an opportunity for debridement of necrotic tissue if present, control of local infection, resolution of bowel edema, and treatment of any associated intra-abdominal pathologic conditions. The "dressings" during this interval should provide adequate coverage of the abdominal wound, particularly when associated with exposed abdominal viscera, and promote healing of the abdominal wall.[5]

A method of temporary closure of these abdominal wounds that would promote wound healing, contain the abdominal viscera if exposed, reduce dressing change frequency, and reduce pain would be invaluable to both the patient and surgeon. Saline-soaked gauze dressings, Bogota bag, towel packing with or without suction, absorbable or permanent mesh, and/or other prosthetic materials such as plastic, silastic or silicone sheets had been used to provide a temporary abdominal closure in cases of dehisced abdominal wounds.[6]

The main indications for vacuum packing wound therapy are uncontrollable exudate necessitating frequent dressing changes, exposed bowel, significant abdominal wall defect with or without fascial dehiscence, and nonhealing wound many weeks after surgery.[5,6]

The abdominal wall integrity can be restored by secondary healing, surgical closure of all or some of the abdominal wall layers, placement of a split-thickness skin graft (STSG) over the granulated bowel, and utilization of local or regional tissue flaps. When the fascia is involved, its closure can be achieved by delayed primary closure, component separation, prosthetic mesh placement, and/or a local tissue flap.[7]

The vacuum-assisted closure system (VAC) was introduced in 1997 by Argenta and Morykwas for the management of difficult-to-treat wounds, and many applications of this negative pressure technique have been reported since then.[8]

Commercial VAC (Kinetic Concepts, Inc, San Antonio, TX) have been predominantly used for treatment of the open abdomen in trauma patients, especially in abdominal compartment syndrome as a damage control strategy and in abdominal sepsis. Simple and easy application, low system-related morbidity, and a high rate of primary fascial closure are the described main advantages. However, commercial devices are either not available or prohibitively expensive for most patients in resource-poor regions.[9,10]

Two broad mechanisms of action of negative pressure therapy were proposed: removal of fluids and mechanical deformation. Fluid removal encompasses two beneficial effects in the process of wound healing. The first is a decrease in edema, leading to a decrease in interstitial pressure and a reduction in diffusion distance. The second is the removal of soluble factors such as cytokines, collagenases and elastases, which are primary inhibitors of fibroblasts and endothelial cell proliferation - essential to proper wound healing. The relationship between mechanical deformation and increased growth is well known, as it is the basis of tissue expansion.[11]

An altered wound environment promotes increased blood flow, angiogenesis and oxygen tension, decreased bacterial counts and increased granulation tissue formation and the

induction of cell proliferation resulting in improved wound healing. It also induces a reduction in the wound surface area with a positive modulation of the inhibitory contents in the wound fluid.[12]

It is not yet clear whether the vacuum assisted wound dressing combined with gauzes as wound surface filler is as effective as the commercial VAC device using Polyurethane or Polyvinyl Alcohol sponges. To date, most studies were conducted using the commercial VAC device in combination with Polyurethane or Polyvinyl Alcohol sponges.

We applied a fenestrated nonadherent plastic liner composed of the inner surface of blood collection bag as compared to Bogotá bag in full thickness wound dehiscence with fascial defect and exposed bowels and omentum, and we filled the wounds with highly absorbant sterile gauze instead of Polyvinyl Alcohol sponges.

The method described herein is a relatively crude and low cost one applying the principals of topical negative pressure and temporary abdominal wound closure and our aim is to check its feasibility, safety and efficacy.

Patients and methods:

This prospective study was carried out at The Gastrointestinal and Laparoscopic Surgery Unit, General surgery Department, Tanta University Hospital and Tanta University Emergency Hospital from June 2008 to May 2011. All patients with significant post laparotomy wound dehiscence that could not be immediately resutured because of severe wound sepsis or bad general condition were included in this study. The decision to administer vacuum packing closure therapy was taken after considering the nature of the primary illness and coexisting local, intra-abdominal, and systemic factors that compromised wound healing.

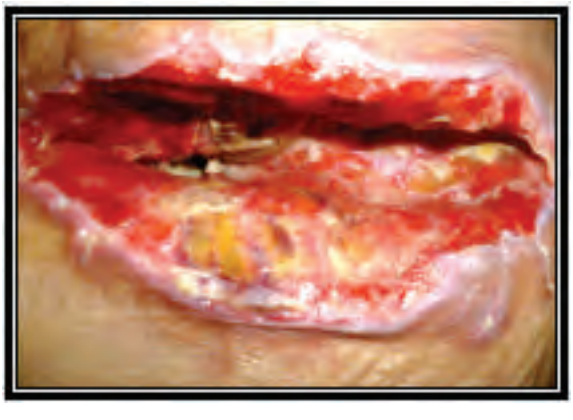


Figure (1): Full thickness wound dehiscence with fascial defect and exposed bowels and omentum.

Figure (2): Partial thickness wound dehiscence.

Vacuum packing wound therapy were applied by staff members of the Gastrointestinal and Laparoscopic Surgery Unit in a ward-based setting or in the operating theatre. In all infected laparotomy wounds, adequate wound debridement and wound swabbing were done with sending for culture and sensitivity tests.

In full thickness wound dehiscence with fascial defect and exposed bowels and omentum, a fenestrated nonadherent plastic liner composed of the inner surface of blood collection bag (JMS Singapore PTE limited LTD) was used. It was moistened with 0.9% saline solution and tucked under the fascial edges and over the omentum and exposed intestines and extended laterally under the anterior abdominal wall to prevent the intestine from adhering to the abdominal wall and thus allow safe placement of fascial sutures, if and when required. When negative pressure was applied to the dressing, this material became semirigid, providing additional protection and containment of the intraabdominal contents.

Figure (3): Blood collection bag.

Figure (4): A fenestrated nonadherent plastic liner composed of the inner surface of blood collection bag.

Figure (5): Tucking the fenestrated nonadherent plastic liner under the fascial edges and over the omentum and exposed intestines.

In partial thickness wound dehiscence, we did not use this non adherent plastic sheet as there were no exposed internal viscera. In both full thickness and partial thickness wound dehiscence, a drainage tube with multiple small-sized holes was inserted, with a metal trocar of a surgical vacuum composed of a single-use evacuation fluid suction canister (VACUGMS Sanicom, S;L Barcelona, Spain).

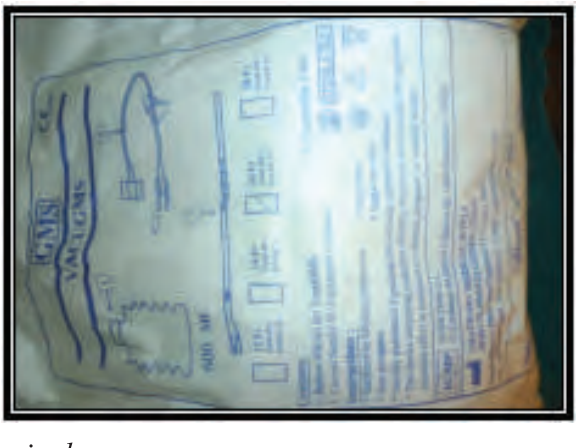


Figure (6 and 7):Surgical vacuum.

The drain could exit either through the adhesive film or through the surrounding healthy skin like a usual surgical drain with securing its cut end to the skin. The vacuum was provided from a single-use evacuation fluid suction canister. These evacuation fluid canisters are sold with a pre-existing vacuum inside. Continuous negative pressure was used usually between 100 and 200 mmHg below ambient pressure.

Then several highly absorbant sterile gauze (Dura-Med, Masco Mid Egypt) of appropriate size were applied over the tube drain to fill the wound. The number of gauzes used for each dressing was recorded and controlled at the next dressing change to avoid the retention of gauze pieces. The wound was examined twice daily to examine the presence of vacuum and to detect possible leaks.

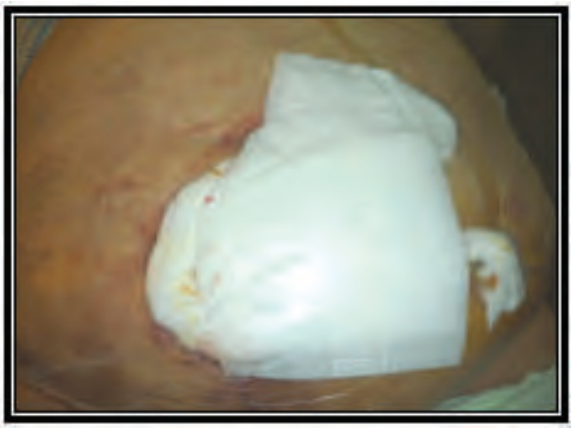
Figure (8): Sterile gauze.

Figure (9): Filling the wound with the sterile gauze.

The wound was covered with an adhesive drape (Incifim, theatre incise drape, Kafr Alzayat, Egypt), which extended at least 10 centimeters beyond the wound margins onto intact and dry skin. The drape was carefully wrapped around the suction tube to avoid pressure leakage. The wounds were washed with normal saline and assessment was made about the wound parameters and presence of granulation tissue.

Figure (10): The adhesive tape (the opsite sheet).

At that time, a decision was made regarding whether to reapply the dressing or to cover the wound with routine saline soaked gauze dressing. If an air leak, local signs of extending cellulitis, or generalized septicemia were evident, the dressing was removed earlier and the wound was reassessed. The patients who were sent home with the device were specially instructed and counseled regarding its use and monitoring protocol. The dressing was changed immediately if a leak was evident.



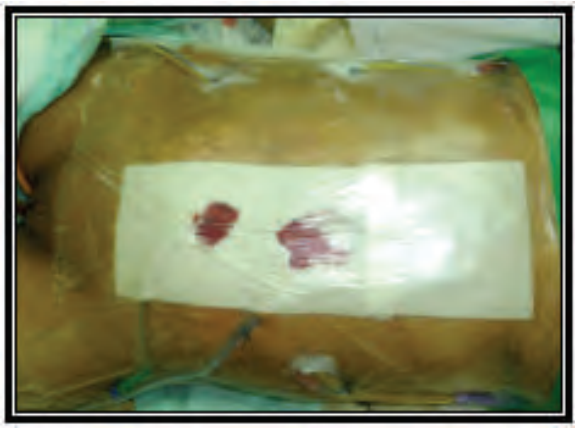


Figure (11 and 12): Final appearance after packing of the wound , inserting the surgical drain and connecting it to the surgical vacuum and applying the adhesive tape.

With few modifications in technique we were able to overcome the problem of leaks through sandwiching the tube drain between two gauzes to avoid drain sitting directly under the opsite and tunneling it through normal tissue rather than taking it out directly under opsite border.

Indications for open abdomen treatment with vacuum packing were high tension on the fascia, persistent bacterial contamination of the abdominal cavity, and massive bowel edema. As a standard, an interval of 48 hours was determined for revisional surgery with change of the abdominal vacuum packing. If granulation tissue reaction was very slow and abdominal sepsis under control, abdominal vacuum packing change intervals up to 96 hours were possible. The treating surgeon made the decision.

The details of treatment were entered prospectively into a database and patients were followed up until successful completion or stoppage of vacuum packing. Factors such as appearance and size of the wound, nature and extent of granulation tissue, the quality of surrounding fascial tissues, the general condition of the patient, and patient preference were taken into account before any surgical intervention was attempted on the wound to achieve definitive closure. Following discharge from the hospital, further follow-up was based on the underlying initial pathology.

In this prospective study, endpoints were flat complete healthy granulation tissue with or without incisional hernia, secondary sutures of the skin and closure of the fascial defect, loss of follow up or death. The following variables were analyzed: age, sex, American Society of Anesthesiology (ASA) score, body mass index (BMI), origin of abdominal sepsis (colorectal, small bowel, stomach, unknown), maximal Mannheim Peritonitis Index (MPI), time and numbers of vacuum packing changes, time after initial operation when abdominal sepsis was under control, and comorbidities (pneumonia, respiratory, cardiac, renal and hepatic insufficiencies, insufficiency and impairment), emergency or planned laparotomy, number of laparotomies, type of skin incisions, partial or full thickness wound dehiscence, hospital stay and rate of primary fascial closure and detection of factors predicting nonclosure.

Statistical analysis:

Results are expressed as mean ± standard deviation (SD) or median with range. The influence of the following variables on primary

closure, vacuum packing-specific morbidity, and mortality was conducted: age, sex, ASA score, BMI, origin of abdominal sepsis (colorectal, small bowel, stomach, unknown), MPI index, number of vacuum packing changes, time after initial operation when abdominal sepsis was under control, and medical comorbidities. Univariate regression using Fisher's exact test and v2 test for dichotomous data and Mann-Whitney U test for continuous data were performed. Results are shown as odds ratio (OR) with 95% confidence interval (CI). Statistical analysis was performed by using SPSS® version 13 (SPSS Inc., Chicago, IL). Regardless of the statistical tests selected, the level of significance was defined as $P \leq 0.05$.

Results:

During the 36-month study period 17 (11 male, 7 female) patients with a median age of 46 (12-67) years underwent vacuum packing wound therapy for the management of abdominal wounds sepsis and dehiscence. All the patients had wound dehiscence of varying depth and extent following laparotomy. Eleven patients (64%) had complete fascial dehiscence with exposed bowel and six patients (36%) had partial thickness wound dehiscence.

The initial laparotomy was performed as an emergency procedure in 13(76%) patients, while the rest underwent a planned laparotomy. A midline incision was performed in 13 patients, lower right paramedian in two patients and 2 patients had transverse incisions. A single laparotomy was performed in 13 patients, 3 underwent two operations and 1 underwent 3 operations. The median duration of hospital stay was 32 (19-63) days and 6 patients (35%) spent a median of 27 (15-27) days in the intensive care unit. The laparotomy wound was present for a median of 7 (6-19) days prior to instituting vacuum packing therapy.

The median duration of vacuum packing therapy was 19 (8-29) days. In those 6 patients with partial thickness wound dehiscence, vacuum packing therapy achieved satisfactory wound healing in all the patients, with healthy granulation tissue covering a flat contracted wound. Secondary skin sutures were performed in 4 patients and the other two patients there were no need to take further sutures as the wound was cosmetically satisfactory.

Of these 11 patients with full thickness wound dehiscence and bowel exposure , two patients died of vacuum packing unrelated problems , six patients underwent successful primary fascial closure with secondary suturing of the skin prior to discharge. In the remaining three patients with full thickness wound dehiscence and bowel exposure, fascial reconstruction was not undertaken mainly because of the patients not being fit for further surgery at this stage and the wound was allowed to heal by second intention culminating with planned incisional hernia accepted with stoppage of vacuum packing wound therapy.

The median duration of vacuum packing therapy was 23 (13-29) days with a frequency of change of 3 (2-5) days. A subsequent wound breakdown was not reported in any of these patients during follow-up. In 3 patients (17%) vacuum packing therapy was stopped due to poor patient compliance (1 patient), and death not related to vacuum packing therapy (2 patients). Problems related to vacuum packing therapy included necrosis of fascial edges (2 patients) and blister under the adhesive tape (2 patients).

Three patients were discharged home on vacuum packing therapy and were followed up in the outpatient clinic periodically until cessation of therapy. The median duration of follow-up after hospital discharge was 14 (13-35) months with loss of follow up of one patient. The eventual outcome after follow-up is outlined in **Table(2)**. Two patients died during their hospital stay due to adult respiratory distress syndrome (1 patient) and multiorgan failure (2 patients).

Table (1): Descriptive characteristics of the patients (n = 17).

Age (yr).	63 (27-86)
Male.	11
Female.	6
Emergency procedure .	13(76%)
Planned laparotomy.	4 (34 %)
Midline incision.	13 (76 %)
Lower right paramedian.	2 (12 %)
Transverse incisions.	2 (12 %)
ASA.	3 (2-4)
BMI.	25 (19-38)
Malignancy.	4 (23)
Origin of sepsis:	
Perforated appendix.	3
Neglected perforated Colon.	4
Perforated DU.	4
Neglected perforated Small bowel.	2
Unclear.	4
MPI	28 (12-43)
Length of hospitalization (days)	32 (19-63)
Length of ICU stay (days)	27 (15-27)
Number of wound debridement	2 (1-5)
Duration of vacuum packing wound therapy	23 (13-29)
Duration before application of vacuum packing wound therapy	7 (6-19)
Stoppage of vacuum therapy	3
Vacuum packing related wound complications	4
Necrosis of fascial edges	2
Blistering under adhesive tape	2
Frequency of vacuum packing wound therapy	3

Table (2): Final outcome.

Secondary skin sutures.	12
Primary fascial closure.	6
Incisional hernia not repaired	3
Loss of follow up.	1
Death	2

No variables had a significant influence on vacuum packing wound therapy specific morbidity or primary closure rate in the univariate analysis. Three variables showed a significant influence on mortality: age (P<0.001), adult respiratory distress syndrome (P = 0.01), multiorgan failure (P = 0.01) and MPI (P = 0.01).

Discussion:

The vacuum assisted wound dressing is an established method of wound management. Recent studies and publications have been limited to the highly sophisticated equipment marketed by the KCI.[13] Unfortunately the cost of equipment is a great hurdle to its use in the developing world where the cost of treatment has to be borne by the patient and relatives and there is limited healthcare funding or poor financial status. We describe a new method of wound topical negative pressure dressing application without using the standard VAC equipment, from material readily available to any surgeon applying the same principle with much lower costs.

The vacuum assisted wound dressing has been used in a wide variety of cases of acute and chronic wounds, open fractures, infected wounds, radiation ulcers, sternotomy wounds, degloving injury, open abdomen, severe abdominal sepsis, abdominal compartmental syndrome, enterocutaneous fistula, congenital abdominal wall defects, diabetic foot, post operative chest wall dehiscence and pressure sores.[14]

We describe a simple, low-cost and effective method of vacuum assisted wound dressing for treatment of abdominal wound sepsis and dehiscence which should benefit the larger population where the standard equipment is not available.

In this study, two patients died due to problems not related to vacuum packing wound dressing and the primary fascial closure rate was 6 out of nine patients (66%). In a retrospective study by Wild et al., (2006)[20] in patients with open abdominal wounds after surgery for peritonitis, a reduced mortality rate was found compared with conventional open wound packing.

Nine different techniques were compared in a systemic review comparing all literature until December 2007 (57 case series)[15] on delayed primary fascial closure in patients with an open abdomen. The vacuum assisted wound dressing together with the artificial burr technique (biocompatible material sewn to midline fascia for stepwise approximation) were associated with the lowest mortality rate and the highest facial closure rate. It was stated in the consensus document released by the World Union of Wound Healing Societies that extra care has to be taken in patients with bowel anastomoses or enterotomy repairs.[16]

In a systematic review by Hensbroek et al., (2009)[17] on the treatment of the open abdomen, the highest weighted delayed primary fascial closure rates were seen in the series with the artificial burr, the commercial VAC device and dynamic retention sutures. These techniques might simply have been superior to the other techniques. However, little information was available on the severity of the underlying condition. Therefore, the higher closure rates might have been due to less severe disease (inclusion bias). An indication for this could be the low mortality rates in these series; however, this remains speculation.[18]

A consensus document for the management of the open abdomen was launched in 2005 by an expert advisory panel.[19] In this document, 7 retrospective studies were analyzed on the

performance of the commercial VAC device versus other temporal abdominal closure techniques (static [e.g., absorbable mesh, Wittmann patch, and running suture] or dynamic [eg, Bogot bag and vacuum pack]). These other techniques all use some kind of biologically inert material (eg, 3 L intravenous bag [Bogotà bag], Marlex with zipper [Wittmann patch], fenestrated polyethylene sheet, and moist towels, and some combined with wall suction [Bogotà bag and vacuum pack]). Primary fascial Closure rates between 78% and 93% were achieved with VAC therapy, and the incidence of fistulas was measured (2.6% for VAC vs. 7% for vacuum pack and 13% for Bogotà).[20]

In this study, V.A.C.-specific morbidity was rather low. No patients developed fistulas, which is comparable to the rate in the literature of 0-20%. Rao et al.,[21] described an enterocutaneous fistula rate of 20% in a group of patients with predominantly abdominal sepsis and concluded that V.A.C. dressings should be used with caution in patients with abdominal sepsis. Other authors[22] supported this conclusion. However, the fistulas might not have been caused by the V.A.C. system or the negative pressure itself but rather by manipulation of the surgeon during dressing changes. V.A.C. system changes in patients with abdominal sepsis and associated fragile bowel should be performed by an experienced surgeon.[23]

Other vacuum packing wound therapy-related complications in this study were necrosis at the fascial edges and blister under the adhesive tape. Necrosis needing debridement might not be related to the vacuum packing wound therapy itself but rather caused by ischemia or ongoing infection of the fascial edges. Blisters occurred in one patient and might be related to tension between the skin and the adhesive tape. In our view, the majority of the mentioned vacuum packing wound therapy-related complications may be avoided by correct surgical technique.

There is a discussion on the intensity of negative pressure (ranging from 40 mm Hg to 150 mm Hg), the use of intermittent or continuous pressure, and the filler material covering the wound. The general recommendation is to adjust the negative pressure settings according to the location and depth of the wound.[24] Microvascular blood flow measurements using laser Doppler in humans showed that the superficial/ subcutaneous wounds may be best treated with pressures of around 75 mm Hg and muscle tissue around 100 mm Hg.[25]

Generally, lower pressure settings than the standard 125 mm Hg negative pressure are recommended to minimize possible ischemic effects.[26] There is a great need for basic research in human subjects and confirmed with histological findings to enable a definite recommendation on the pressure settings. However, patients often experience more discomfort, which reduces compliance.[27,28]

Like in every study, several limitations have to be considered when interpreting its results. The qualitative value of the current trial is without doubt; however, the limited number of patients involved limits its potential to generalization. Another parameter that we should potentially keep in mind is the exact calculation of the costs.

In this study, the end results were gratifying. We in no way claim that the method described here is better or worse than the system provided by KCI the method obviously lacks standardization or pressure regulation but it works pretty well and we recommend its use in situations where standard equipment is awaited or is simply not available.

Conclusion:

Vacuum-packing therapy is safe and effective method of temporary abdominal closure in post laparotomy wound sepsis and dehiscence. Its effectiveness is similar to the known commercial device but the cost is much less. Therefore vacuum wound packing could be an useful adjunct in treating post laparotomy wound sepsis and dehiscence when definitive fascial and/or cutaneous reconstructions cannot be performed in an immediate setting due to the wound condition or the general condition of the patient. The benefits of negative pressure dressing could be advisable in health care systems with limited funds in poor developing countries.

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