INTRODUCTION

The open abdomen technique may be used to manage in critically ill patients of abdominal injury, to reduce the septic complication and to prevent the abdominal compartment syndrome. Many different techniques have been proposed and various studies have been conducted, but still there is no consensus for single best technique. Despite the numerous advances in recent years, severe abdominal sepsis remains a serious, life threatening condition with a high mortality rate. Currently mortality rates for intra-abdominal sepsis ranges between 30% and 40%[1].

Negative pressure wound therapy (NPWT) is one of variety of techniques used to manage the open abdomen. It was introduced in 1996 [2] to deal with chronic soft tissue wounds. Later it found its way into management of open abdomen. NPWT is considered as relatively new concept in wound management. It is also called as subatmospheric pressure therapy, vacuum sealing, vacuum pack therapy. In this retrospective study, we included 50 patients all with clear indication of open abdomen management in view of severe abdominal sepsis and intra-abdominal hypertension. Out of 50, 32 (64%) were male and 18 (36%) were female. Average age was 48 years for males and 42 years for females. Mortality (n=4) (8%) in these patients was attributed to Multi-Organ Dysfunction syndrome (n=2), Acute Respiratory Distress Syndrome (n=1), and pulmonary embolism (n=1). In cases of abdominal sepsis, most critical concern is about surgical source control of sepsis, it determines patients outcome in terms of survival and is especially important with the current increase in antibiotic resistance in surgical ICU patients [14], as well as suboptimal practices related to the use of antibiotics.

ABSTRACT

Negative pressure wound therapy (NPWT) is one of variety of techniques used to manage the open abdomen. It was introduced in 1996 [2] to deal with chronic soft tissue wounds. Later it found its way into management of open abdomen. NPWT is considered as relatively new concept in wound management. It is also called as subatmospheric pressure therapy, vacuum sealing, vacuum pack therapy. In this retrospective study, we included 50 patients all with clear indication of open abdomen management in view of severe abdominal sepsis and intra-abdominal hypertension. Out of 50, 32 (64%) were male and 18 (36%) were female. Average age was 48 years for males and 42 years for females. Mortality (n=4) (8%) in these patients was attributed to Multi-Organ Dysfunction syndrome (n=2), Acute Respiratory Distress Syndrome (n=1), and pulmonary embolism (n=1). In cases of abdominal sepsis, most critical concern is about surgical source control of sepsis, it determines patients outcome in terms of survival and is especially important with the current increase in antibiotic resistance in surgical ICU patients [14], as well as suboptimal practices related to the use of antibiotics.

INTRODUCTION

The open abdomen technique may be used to manage in critically ill patients of abdominal injury, to reduce the septic complication and to prevent the abdominal compartment syndrome. Many different techniques have been proposed and various studies have been conducted, but still there is no consensus for single best technique. Despite the numerous advances in recent years, severe abdominal sepsis remains a serious, life threatening condition with a high mortality rate. Currently mortality rates for intra-abdominal sepsis ranges between 30% and 40%[1].

Negative pressure wound therapy (NPWT) is one of variety of techniques used to manage the open abdomen. It was introduced in 1996 [2] to deal with chronic soft tissue wounds. Later it found its way into management of open abdomen.

NPWT is considered as relatively new concept in wound management. It is also called as subatmospheric pressure therapy, vacuum sealing, vacuum pack therapy. The purpose of therapy is to apply negative pressure over the wound to create suction, which drains the exudates and maintains hypoxic atmosphere in tissue that results immunoangiogenesis and granulation formation. In past open abdomen used to be managed by simpler approaches such as bagotta bag [3], wittmannpatch [4] and Barker vacuum pack [5], all have various complication like marked adhesion formation [6], development of enteric fistula, non-quantifiable loss of fluids, evisceration, haemorrhage, contamination of abdominal cavity and high rates of subsequent incisional hernia. Various method of temporary abdominal closer have been developed to protect the open abdomen and decrease the complication. The use of NPWT has come with lesser rates of hernia formation. The utility of this technique [7] is not limited to early post-operative period, but can be successful up to 3-4 weeks after initial surgery [7]. The recent large scale studies have reinforced the benefits of NPWT as compared to other temporary abdominal closer methods [8] and its early application has shown to be beneficial [9].

The primary goal of temporary abdominal closer (TAC) is to create a tension free closure of the abdomen without increasing intraabdominal pressure. Attempting primary fascia closure under tension in patients with extensive abdominal wall and intra abdominal organ edema, is associated with high rates of mortality due to Multi Organ Dysfunction Syndrome (MODS) and necrotising abdominal wall infection. The optimal method of TAC should contain and protect the contents of the peritoneal cavity from external contamination and injury, preserve fascia, minimize desiccation and damage to viscera.
remove and quantify third space fluid, prevent loss of domain, lower bacterial count and inflammatory response, keep patients abdominal wall skin dry and intact, preserve the integrity of the abdominal wall, be simple to perform and maintain, provide ease of re-entry and have minimal adverse physiologic effects. Various TAC methods have been subjected to multiple studies, and their advantages and disadvantages are known, but are too numerous to cite. Although no prospective randomized studies are available to compare effectiveness of various TAC techniques as compared to NPWT, some evidence exists that shows a beneficial effect of this technique in the management of complex abdominal pathology.

In this study, we describe our use of NPWT in the management of abdomen.

**METHOD**

In this retrospective study, we included 50 patients all with clear indication of open abdomen management in view of severe abdominal sepsis and intra-abdominal hypertension. This study was performed upon the patients treated between January 2018 and June 2019 in a single unit, department of general surgery, Safdarjung Hospital, New Delhi.

**Inclusion Criteria**

A. Age > 12 years  
B. Bjorck open abdomen class 2B until 3B  
C. Patients showing signs of IAH (decrease in urine output, intraabdominal pressure ≥20 mm Hg with new onset organ dysfunction)  
D. Patients with APACHE score of 12 or greater at time of admission with abdominal sepsis.

**Exclusion Criteria**

1. Patients with age less than 12 years.  
2. Bjorck open abdomen class <2B and 4

**Demographic Data**

Data were collected from inpatient and outpatients clinical records of 50 patients, of which 32 were males and 18 were females between the age group of 22 and 76 years all of whom were subjected to NPWT

**Method of application of NPWT:** The procedure was performed by applying sterile abdominal dressing, which consist of

a. fenestrated soft plastic non-adherent layer with enclosed central foam, which is placed on the surface of visera.  
b. two layer of VAC dressings are applied over the plastic layer, the first layer in direct contact with the non-adherent plastic and located inside the abdominal cavity under the edges of the incision filling the exact space of the wound opening  
c. Finally a transparent adhesive is placed over the Foam and the wound to seal the abdominal cavity.

A 1-inch diameter orifice is cut off the plastic seal on the lower or caudal area of the wound to connect an adhesive pad, which will serve as an outflow tubing, that will be later connected from the dressing to the canister in the negative pressure device. During the final step, a continuous vacuum set at range of 100-125 mm Hg is used. All dressing changes were performed in a sterile fashion in the operating room. All patients were monitored with routine blood investigations, which consisted of a complete metabolic panel and complete blood count. Bladder pressure was monitored in search of intraabdominal hypertension.

**Criteria of Discontinuation of NPWT:** when the abdominal cavity was ready for fascia closure or covered with granulation tissue. Fascia closure was performed when the following criteria were met:

a. Patient was vitally stable with normal biochemical and blood parameters.  
b. No sign/symptoms of any systemic infection/inflammation  
c. The source of contamination was controlled and the abdominal cavity was macroscopically clean.  
d. Absence of intraabdominal hypertension.
RESULTS

In this study, 50 patients were included, who were having open abdomen following exploratory laparotomy and treated with NPWT.

Out of 50, 32(64%) were male and 18(36%) were female. Average age was 48 years for males and 42 years for females. (Table 2)

Table 2

<table>
<thead>
<tr>
<th>No. of Patients</th>
<th>Youngest</th>
<th>Oldest</th>
<th>Average Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male(32)</td>
<td>24</td>
<td>76</td>
<td>48 Years</td>
</tr>
<tr>
<td>Female(18)</td>
<td>22</td>
<td>65</td>
<td>42 Years</td>
</tr>
</tbody>
</table>

Causes of Exploratory Laparotomy Includes

1. Abdominal sepsis with peritonitis (nontraumatic) (n=30)(Table 3)
2. Damage control surgery with contaminated abdominal cavity (traumatic) (n=9)
3. Abdominal compartment syndrome (Post surgery) (n=11)

Table 3 Abdominal Sepsis: Causes

<table>
<thead>
<tr>
<th>Cause</th>
<th>No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peptic ulcer perforation</td>
<td>6</td>
</tr>
<tr>
<td>Enteric perforation</td>
<td>11</td>
</tr>
<tr>
<td>Tubercular perforation</td>
<td>8</td>
</tr>
<tr>
<td>Segmental bowel ischemia</td>
<td>3</td>
</tr>
<tr>
<td>and perforation</td>
<td></td>
</tr>
<tr>
<td>Ruptured Liver Abscess</td>
<td>2</td>
</tr>
<tr>
<td>and colonic perforation</td>
<td></td>
</tr>
<tr>
<td>Total no. of Patients</td>
<td>30</td>
</tr>
</tbody>
</table>

Mortality (n=4)(8%) in these patients was attributed to Multi-Organ Dysfunction syndrome (n=2), Acute Respiratory Distress Syndrome (n=1), and pulmonary embolism (n=1).

ICU stay: A total of 22 patients were admitted in ICU in post operative period, rest 28 patients were managed in High Dependency Unit of surgical ward. Average total hospital stay was 18 days and stay in ICU for patients requiring constant and meticulous monitoring and intensive care (n=22) averaged 7.5 days. During treatment there were no acute complication related to the NPWT. Enteric fistulae were detected in 2 patients that developed during home care with NPWT. All patients presenting with abdominal compartment syndrome (n=11) resolved after initiation of NPWT. A total of 36(72%) patients achieved fascial closure with NPWT, After an average 28 days. Four patients (8%) died during the course of treatment of causes unrelated to NPWT. A six months follow up of all the patients revealed no further complication related to their initial episodes except for 4 patients (8%) who presented with ventral hernia which was managed by surgery. (Table 4)

Table 4 Characteristics and Outcomes of Our Study Population

<table>
<thead>
<tr>
<th>Average Age</th>
<th>Gender (male/female)</th>
<th>Average SICU</th>
<th>LOS</th>
<th>Fascia closure rate</th>
<th>Mortality rate</th>
<th>Ventral hernia rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>32/18</td>
<td>7.5 days</td>
<td>18 days</td>
<td>36(72%)</td>
<td>2(4%)</td>
<td>2(4%)</td>
<td>4(8%)</td>
</tr>
</tbody>
</table>

SICU: Surgical Intensive Care Unit. LOS: Length of Stay.

Surgical source control in patients with severe abdominal sepsis is critical to patient survival[15], and is especially important with the current increase in antibiotic resistance in surgical ICU patients[16], as well as suboptimal practices related to the use of antibiotics[17]. Novel therapeutic approaches, such asNPWT, that allow for rapid source control without the use of drugs, appear to be valuable addition to traditional therapeutic strategies for management of contaminated abdominal cavities. The instillation and fluid retrieval, using NPWT-I device appeared to be a key element for obtaining safe and satisfactory results in the management of abdominal sepsis in our patient group. The use of normal saline appears to be sufficient in the management of complex wounds[18], while other substances seem to be ineffective[19,20] and exposes patients to added risks, therefore there is no clear benefit for their use in abdominal instillation[21].

DISCUSSION

In this study, the rate of fascial closure was 72% on an intent-to-treat basis which compares well with comparable published studies (63.7%) of patients. Concurrent application of fascial tension: for example through the use of ‘dynamic suturing’, along with NPWT may further improve the frequency of fascial closure[22,23] although, to date, no comparative studies have been carried out to support this. Achievement of fascial closure not only has significant implications for the recovery of the patients but also leads to shorter ICU and hospital length of stay, reduced need for surgical reconstruction of the abdominal wall, and shorter recovery time. These factors all have considerable cost element so early but safe abdominal closure is the best outcome.

The most commonly cited objection to the use of NPWT TAC is a perceived increase in fistula formation. The rate of fistula formation in the current study of 4% was similar to that derived from the published studies of 3%. It is possible that these relatively low levels of fistula formation are observed in this specific population of open abdomen patients[24,25] and that higher incidence of de novo fistula formation may occur in ‘high risk’ subsets of patients i.e. those with more advanced grade of open abdomen (grade 3 or 4), sepsis, or in wounds where a bowel anastomosis following bowel surgery is present or where there is a delay or failure to achieve fascial closure. More evidence is needed to determine whether use of NPWT on grade 3 or 4 open abdomen is effective and whether an increased risk of fistulisation is indeed observed as a result of therapy in this sub-population. With regard to the current study, one drawback is the relatively low sample size, which may not accurately reflect the true incidence of fistula formation in these wounds.
CONCLUSION

In cases of abdominal sepsis, most critical concern is about surgical source control of sepsis, it determines patients outcome in terms of survival and is especially important with the current increase in antibiotic resistance in surgical ICU patients [14], as well as suboptimal practices related to the use of antibiotics. Novel therapeutic approaches such as NPWT, that allow for rapid source control without the use of drugs appears to be valuable addition to traditional therapeutic strategies for management of contaminated abdominal cavities.

In patients who required management with open abdomen therapy under our care, the use of NPWT showed encouraging results. Our patients had low morbidity and mortality, as well as shorter duration of stay both for the ICU unit and in hospital. When comparing our group, to similar case studies, both in our country and abroad, we see that NPWT had an almost four fold reduction in mortality [31], lower morbidity in terms of better respiratory efforts, good tolerance to enteral feeding, less skin excoriation and tissue loss, an increase in facial closure rates, a reduction in ICU stay, and hospital stay reduction too. We were unable to document any complication associated with this therapy in our patients group but definitely larger prospective comparative trials are required to propose any definitive superiority and recommendation.

References

10. Open Abdomen Abdominalvisary panel , campbell a., chang m., fabian t., francz m., Kaplan m. Management of the open abdomen: from initial operation to definitive closure. Am. Surg. 2019;75(November suppl.11)):s1-s22.

Table 5 Compasion with literature

<table>
<thead>
<tr>
<th>Reference</th>
<th>Number</th>
<th>Fascial closure</th>
<th>Mortality</th>
<th>Fistula</th>
</tr>
</thead>
<tbody>
<tr>
<td>This study</td>
<td>50</td>
<td>36(72%)</td>
<td>4(8%)</td>
<td>2(4%)</td>
</tr>
<tr>
<td>Miller et al. 2004</td>
<td>53</td>
<td>38(72%)</td>
<td>8(15%)</td>
<td>1(2%)</td>
</tr>
<tr>
<td>Garner et al. 2003</td>
<td>14</td>
<td>13(93%)</td>
<td>NR</td>
<td>0</td>
</tr>
<tr>
<td>Salibek et al. 2003</td>
<td>29</td>
<td>25(86%)</td>
<td>6(21%)</td>
<td>2(7%)</td>
</tr>
<tr>
<td>Stone et al. 2004</td>
<td>48</td>
<td>23(48%)</td>
<td>16(33%)</td>
<td>2(4%)</td>
</tr>
<tr>
<td>Labler et al. 2005</td>
<td>18</td>
<td>12(66.7%)</td>
<td>5(33%)</td>
<td>0</td>
</tr>
</tbody>
</table>


23. Matthias RK-r, Nina Z. Open Abdomen Treatment with Dynamic Sutures and Topical Negative Pressure Resulting in a High Primary Fascia Closure Rate. 2012.


How to cite this article:

*******