The Antiseptic Effect of VACWM Therapy: A Case Report

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Abstract
This case report illustrates that the continuous removal of inflammatory exudates from the abdomen might be a key factor in the treatment of septic shock in patients with an open abdomen. The vacuum assisted wound closure with mesh mediated traction technique has clearly proven his feasibility when it comes to closing rate of the abdomen. However, up to this moment, there is little evidence about the effect of continuous removal of inflammatory exudates on the septic status of the patient.

Introduction
Management of the open abdomen (OA) has rapidly evolved in the last decade. Leaving the abdomen open is the mainstay of surgical therapy in patients with intra-abdominal hypertension (IAH) leading to abdominal compartment syndrome (ACS), in patients with severe peritonitis and bowel edema, in patients with a planned second look or in any other case in which the fascia cannot be closed due to the acute setting of the patient [1]. Numerous methods of temporary abdominal closure (TAC) have been proposed and researched, focusing on the number of complications and fascial closure rate. Vacuum-Assisted Wound Closure with Mesh mediated fascial traction (VACWM) combines the benefit of vacuum therapy and mesh traction, leading to a high fascial closure rate with low morbidity [2-6]. However, the anti-septic effect by removing proinflammatory asites from the abdomen with negative pressure therapy has been conceptualized, however never proven in research [7-9]. We report a case that illustrates the anti-septic properties of the VACWM therapy.

Case Presentation
A 65 year old woman was admitted in the emergency department because of acute abdominal pain. Her medical history showed an epigastric hernia repair with gore tex mesh in 2003, with removal of this mesh four months later because of infection with a giant incisional hernia reoccurring. Due to high BMI, this hernia was treated conservatively. CT scan at the emergency department (Figure 1) showed herniation of the omentum, small bowel, caecum, ascending and transverse colon into the incisional hernia. The patient was referred to our hospital due to incarceration and perforation of small bowel with incipient septic shock. Laparotomy was performed with primary closure of one solitary small bowel perforation and a protective double-loop ileostomy was created. The hernia sac was excised and the herniation content reduced into the abdomen. Fascial closure was impossible due to bowel edema and VACWM (Abthera, KCI®) was installed. In a first step, the polyethylene sheet serves as a protective layer for the bowel and is placed into the paracolic gutters in such a way that all intestines are completely covered. A heavy weight polypropylene mesh is then sutured to the fascial edges and sutured together in the middle. All around subcutaneous foam is placed on top of the mesh and negative pressure of 100-150 mmHg is applied.

During surgery the patient went into deep septic shock with high levels of norepinephrine. Over a period of four days, the patient needed high levels of epinephrine, norepinephrine and dobutamin to keep her hemodynamically stable. She needed NO ventilation, had a lactate-acidosis under continuous dialysis and high inflammatory markers (Figure 2). A bedside revision in the intensive care unit was performed at day 4. It became clear that the VACWM therapy was wrongly placed: the visceral protective layer was placed subcutaneous on top of the closed mesh (Figure 1). The perforated foam was then placed on top of this layer. The improper position of the Abthera® was documented and the VACWM therapy was applied with correct placement of the visceral protective layer into the paracolic gutters.

Within 24 hours after correction of this surgical error, we saw a remarkable reduction in septic parameters. The patient became more stable and the norepinephrine could be reduced at a rapid
pace (Figure 2). Biochemical inflammatory markers decreased rapidly after this moment.

**Discussion**

In recent years, laparotomy management has gone through various evolutions with the introduction of a wide variety of technical modifications [6]. Vacuum therapy is the most used TAC. Various studies have shown that VAC therapy is an excellent answer for IAH and ACS, drains the abdomen of exudate, reduces the rate of abscess formation and has a low incidence of intestinal fistula formation [2,5,10-12]. VAC systems alone, however, cannot prevent fascial retraction [6]. For this reason, it must be combined with another technique that facilitates approximation of the fascia. The combination of fascial traction and vacuum therapy has first been described in 2003 by Nasvaria et al. [13]. He combined retention sutures with a vacuum pack. Fantus et al. [14] described the use of the Wittmann patch in combination with vacuum pack. Pettersson et al. [4] was the first to combine a polypropylene mesh and vacuum-assisted closure system in a series of seven patients. Since this first pilot study, more studies have focused on the use of this novel VAWCM therapy. Acosta et al. [2] reported primary fascia closure of 76.6% in the intention-to-treat analyses. Intestinal fistulae occurred in 7.2% of the population. In a multivariate analysis, they found that age and failure of fascial closure were independently associated with in-hospital mortality. In a follow-up study by Bjarnason 66% of patients had an incisional hernia one year after OA treatment. No patients were documented with a giant ventral hernia [3]. A study by Kleif et al. [5] reports fascial closure only in 44% of patient. However, this was a small sample study and a mesh was only inserted when fascia closure deemed impossible to the surgeon with vacuum-assisted therapy alone.

The ability of inflammatory as cites to propagate systemic inflammation has recently been the subject of many studies. Although there is no consensus about the specific pathway that causes severe

Figure 1: CT scan at the emergency department showed herniation of the omentum, small bowel, caecum, ascending and transverse colon into the incisional hernia.

Figure 2: Correction of VAWCM Placement.
sepsis and multiple organ dysfunction syndrome (MODS), secondary to abdominal sepsis, it is well documented that injury in one organ system can cause microvascular dysfunction and damage in another organ [15].

Abdominal injury and/or sepsis leads to microvascular dysfunction in the gut which results in tissue hypoxia. Loss of barrier function, due to alterations in endothelial and epithelial function and increased permeability result in intestinal edema and ascites [9,16]. A series of proinflammatory (e.g., IL-1, -6, -8, -10, -12, TNF-α) cytokines are then released in the abdominal cavity (ascites) and taken up into mesenteric lymph and plasma. Consequently, these inflammatory cytokines can cause inflammation and dysfunction in any other organ, most commonly the lung [17-21].

Prohibiting inflammatory cytokines to disseminate to other organs with negative pressure therapy might prevent severe sepsis and MODS.

The reduction in morbidity and mortality in open abdomen caused by intraperitoneal negative pressure therapy has been documented multiple times [22], but a study in pigs by Kubiaz et al. [9] was the first to prove a decrease in inflammatory response. Two groups of pigs were monitored after clamping the mesenteric artery for 30 minutes and placing a faecal clot in the abdomen. One group was treated with negative pressure therapy (NPT), the other group with passive drainage system. The group with NPT removed a larger amount of inflammatory exudate, was easier to ventilate, needed less fluid resuscitation had a lower inflammatory biochemistry and a reduction of histologic damage in major organs.

Another study by Batacchi et al. [8] reports the difference between patients treated with bogota bag versus VAC therapy. They report a shorter period of mechanical ventilation, faster closing rates of the abdomen and faster recovery from ICU in the VAC group [8].

When we look into studies reporting about the relationship between severe sepsis and levels of interleukins (IL), the proinflammatory cytokine IL-6, is associated with increased risk of organ failure, complications and mortality [7,23-26]. That’s why a study by Kirkpatrick et al. specifically focused on this cytokine to compare active NPT (Abthera temporary closure device) with less active NPT (Barker’s vacuum pack) [17]. There were no significant differences between the two groups in peritoneal fluid drainage or markers of systemic inflammation, although there was a big difference in survival in the two groups in favor of the Abthera. According to the author, this could be explained by the fact that the Abthera has little influence on a single inflammatory cytokine, but affects a whole inflammatory pathway leading to less mortality [17]. A new prospective study from Roberts et al. will also focus on the antiseptic effect of VAC therapy [7].

All these studies make it very clear that the pathway leading abdominal sepsis to a generalized inflammatory response is not fully understood. However, it seems that negative pressure therapy offers the most beneficial impact on morbidity and mortality when open abdomen is indicated. This could be the result of the continuous removal of inflammatory exudate from the abdomen. Further investigations about inflammatory pathways and the influence of VAC therapy are mandatory.

References


