Promising results after vacuum-assisted wound closure and mesh-mediated fascial traction

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ABSTRACT

INTRODUCTION: Patients with an open abdomen (OA) present a major challenge to the surgeon. High mortality and associated complication rates have been reported depending on the specific method of temporary abdominal closure, the primary disorder and any co-morbidity. Vacuum-assisted wound closure and mesh-mediated fascial traction (VAWCM) is a novel technique recently introduced for late fascial closure of the OA. In previous studies, the disease aetiologies were mainly vascular and visceral surgical disease and trauma. We report our results using VAWCM in a non-trauma patient population treated with an OA due to visceral surgical disease.

MATERIAL AND METHODS: Medical records of all patients in our department treated with VAWCM during the period from 1 August 2009 to 31 May 2011 were reviewed. All sixteen patients were non-trauma patients. The initial treatment was vacuum-assisted closure (VAC) (Abdominal Dressing System KCI, San Antonio, Texas, USA). VAWCM treatment was initiated if complete fascial closure could not be obtained with VAC.

RESULTS: Two patients died of multiple organ failure that was not associated with the VAWCM treatment. In one patient, treatment was terminated due to a very short life expectancy. We achieved a complete fascial closure rate in seven out of 16 patients. One patient had a pancreatic fistula at discharge that was not associated with the VAWCM treatment. No enteric fistulas occurred.

CONCLUSION: It seems that VAWCM can improve the rate of complete fascial closure after treatment with OA without increasing the mortality or the occurrence of enteric fistula compared with other kinds of temporary abdominal closure.

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Inability to close the fascia during a laparotomy results in a laparostomy or an open abdomen (OA). This can be due to severe abdominal sepsis with faecal contamination or bowel oedema, the need for a second-look operation based on compromised circulation of the abdominal organs, damage control surgery in relation to trauma surgery or abdominal sepsis, or a decompressing laparotomy in patients with abdominal compartment syndrome. Another frequent condition causing OA is post-operative fascial dehisence with fascial necrosis. Patients with OA present a major challenge to the surgeon. Depending on the specific method of temporary abdominal closure (TAC) and on the primary disorder and any co-morbidity, high mortality rates have been reported, averaging between 17% and 41% [1]. The associated complications are also frequent with reported incidences of enteric fistulae of up to 28% [1].

When the patient's physiological condition allows for permanent abdominal closure, this should be achieved. In order to reduce the frequency of planned ventral hernias, delayed primary fascial closure is warranted in these patients. Depending on the technique, the reported mean rate of delayed primary fascial closure is between 11% and 90% after TAC [1]. With the use of commercial abdominal vacuum-assisted closure (VAC) kits, a mean closure rate of 60% has been reported with mortality and fistula rates of 18% and 3%, respectively [1]. However, studies on VAC differ with regard to study population as well as methods used. The reported mortality rates, fascial closure rates and fistula rates range between 0-65%, 22-92% and 0-22%, respectively [2-11].

Recently, vacuum-assisted wound closure and mesh-mediated fascial traction (VAWCM) was introduced as a novel technique for late fascial closure of the OA [12]. In a multicentre prospective study of the VAWCM, a delayed primary fascial closure rate of 89%, an intestinal fistula rate of 7% and an in-hospital mortality of 30% were reported [13]. In both studies, the disease aetiologies were mainly vascular, visceral surgical disease and trauma.

In this study, we report our results with VAWCM in a non-trauma patient population treated with an OA as a consequence of visceral surgical disease.

MATERIAL AND METHODS

Medical records of all patients treated at our department with VAWCM during the period from 1 August 2009 to 31 May 2011 were reviewed. Data recorded were: age, body mass index (BMI), American Association of Anesthesiologists (ASA) score, cardiovascular disease, hypertension, pulmonary disease, diabetes, neurological disease, hepatic disease, existing or previous abdominal hernias, type of incision, indication for treatment with

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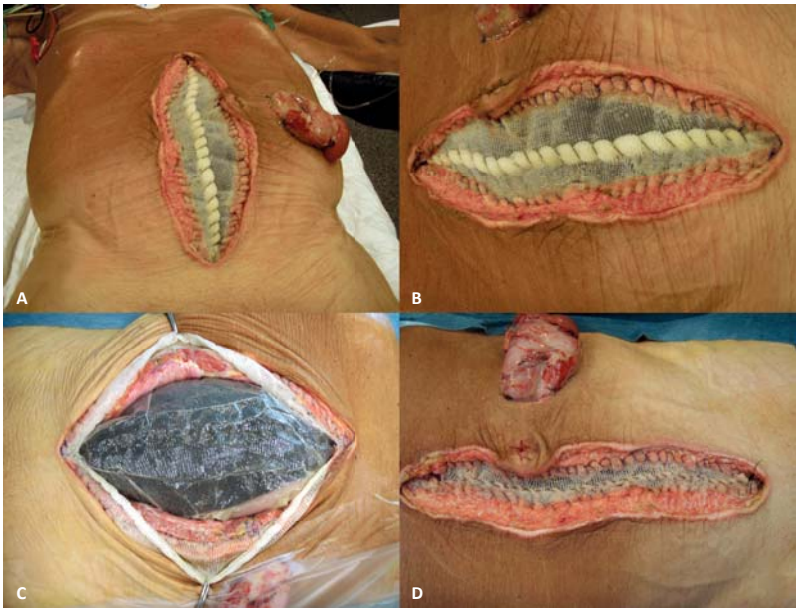
FIGURE 1

A and **B**. A polypropylene mesh sutured to the fascial edges of the laparostomy for continued traction of the fascia. The polypropylene mesh was opened in the midline when applied and closed with a running polypropylene suture. **C**. The midline suture is removed, the peritoneal cavity is exposed and vacuum-assisted closure abdominal dressing changed as usual. **D**. At the end of the procedure, the mesh is closed in the midline again tightened approximately 2 cm on each side.



OA, duration of VAC, duration of mesh-mediated fascial traction, number of intra-abdominal VAC changes, number of mesh tightening procedures and occurrence of enteric fistulas. The primary outcomes were fascial closure, planned ventral hernia, fascial dehiscence after VAWCM or death during treatment with an OA.

This study required no funding, and none of the authors have any conflicts of interest. Because of the retrospective study design, there was no need for approval from the local ethics committee.

Vacuum-assisted wound closure and mesh-mediated fascial traction

The VAWCM technique has been described in previously published studies [12, 13] and is shown in **Figure 1**. In our patients, the initial treatment was VAC (Abdominal Dressing System KCI, San Antonio, Texas, USA). VAWCM treatment was initiated if complete fascial closure could not be obtained with VAC alone. The decision to start VAWCM or to continue with VAC was made by the treating surgeon. A polypropylene mesh was sutured to the fascial edges of the laparostomy for continuous traction of the fascia. The polypropylene mesh was opened in the midline, an abdominal VAC dressing was inserted and the mesh was closed with a running prolene 2-0 suture. At the end of every procedure, the mesh was closed and, if possible, tightened (approximately 2 cm on each side) in the midline, as shown in Figure 1. This procedure was repeated every second to third day. VAWCM changes were performed under general anaesthesia. The procedures were performed by several surgeons.

Patients were considered as discharged with a planned ventral hernia if complete fascial closure was not possible at the end of VAWCM treatment. Use of biological mesh was not considered a complete fascial closure even if the long-term result may be no clinical hernia. None of the patients included in this study had been included in previously published studies.

Trial registration: not relevant.

RESULTS

A total of 16 non-trauma patients (12 men) were treated with VAWCM (**Table 1**). Their median age was 66 (48-83) years. Four patients had diabetes, four had a history of cardiovascular disease, one had a brain tumour, one had a history of stroke, eight had hypertension, and one had chronic obstructive pulmonary disease. At admission, two patients had ventral hernias and one had a parastomal hernia. The median BMI was 31 (18-52) kg/m^2. All patients had midline incisions except one who had a subcostal incision.

Complete fascial closure was obtained in seven (44%; 95% confidence interval (CI): 23-67%) out of the 16 patients treated with VAWCM. Seven patients were discharged with planned ventral hernias (**Table 2**).

The indication for treatment is shown in Table 1. Patients were managed according to "damage control" surgery principles [14]. The median times with intra-abdominal VAC and VAWCM were nine (3-76) and six (1-49) days, respectively. Patients were treated with VAC for a median of two (0-27) days before initiating VAWCM. A median of four (1-34) intra-abdominal VAC changes were made and three (1-21) mesh-tightening procedures performed.

Four of the patients discharged with a planned ventral hernia continued VAC treatment after the VAWCM was terminated while waiting for the creation of a planned ventral hernia. Two of the seven patients discharged with planned ventral hernias had fascial dehiscence after VAWCM. One of these two patients was discharged for terminal care at home with an expected survival of less than one month and no further surgical treatment options. The other patient with fascial dehiscence after VAWCM was only treated with VAWCM for two days.

Two patients died during VAWCM because of multi organ failure due to sepsis; one of whom developed sepsis on the basis of a nosocomial pneumonia and the second was septic at admission. These two deaths were be-

TABLE 1

Characteristics of patients and indication for open abdomen in 16 patients treated with vacuum-assisted wound closure and mesh-mediated fascial traction.

Patient no.	Gender	Age, years	BMI, kg/m²	ASA score	Indications for open abdomen
1	Male	74	35	4	Colonic obstruction with perforated caecum with faecal peritonitis
2	Male	83	22	2	Complete fascial dehiscence after small-bowel obstruction
3	Male	64	18	2	Perforated tumour of the sigmoid colon
4	Female	57	27	3	Necrotising pancreatitis with perforation of the transverse colon
5	Male	75	28	2	Anastomotic leakage after left hemi-colectomy
6	Male	48	32	4	Postoperative bleeding from the spleen (acute resection for perforated sigmoid cancer)
7	Male	55	25	3	Second-look and necrosectomy (acute pancreatitis)
8	Male	57	50	3	Anastomotic leakage after small-bowel resection
9	Female	77	29	3	Postoperative bleeding after left hemi-colectomy
10	Female	76	33	2	Intra-abdominal abscess after low anterior resection with loop-ileostomy
11	Male	59	33	3	Complete fascial dehiscence after Hartmann resection for diverticulitis, Hinchy stage 4
12	Male	75	52	1	Anastomotic leakage after left hemi-colectomy
13	Female	71	33	3	Intra-abdominal abscess after left hemi-colectomy
14	Male	54	39	2	Complete fascial dehiscence after Hartmann resection for diverticulitis, Hinchy stage 4
15	Male	67	24	3	Complete fascial dehiscence after colectomy for large-bowel ischaemia
16	Male	60	29	3	Complete fascial dehiscence after colonic obstruction with perforated caecum

ASA = American Society of Anesthesiologists; BMI = body mass index.

TABLE 2

Duration of treatment and final result of treatment of abdominal sepsis or complications of prior surgery with open abdomen and vacuum-assisted wound closure and mesh-mediated fascial traction.

Patient no.	Days with VAC[a]	VAC changes,[b] n	Delay of VAWCM, days	Days with VAWCM	Mesh-tightening procedures, n	Status at discharge
1	18	7	9	9	3	Complete fascial closure
2	8	4	7	1	1	Dead
3	4	2	2	2	1	Complete fascial closure
4	15	7	1	14	6	Complete fascial closure
5	15	8	2	13	7	Complete fascial closure
6	14	7	8	6	4	Dead
7	76	34	27	49	21	Planned ventral hernia
8	19	9	0	19	9	Planned ventral hernia
9	4	2	2	2	1	Planned ventral hernia[c]
10	8	4	4	4	2	Planned ventral hernia
11	10	4	1	9	3	Planned ventral hernia[c, d]
12	7	4	1	6	3	Complete fascial closure
13	8	4	2	6	3	Complete fascial closure
14	3	1	0	3	1	Planned ventral hernia
15	8	3	2	6	2	Planned ventral hernia
16	10	4	0	10	4	Complete fascial closure

VAC = V.A.C. Abdominal Dressing System; VAWCM = vacuum-assisted wound closure and mesh-mediated fascial traction.
a) Including days with VAWCM; b) Including mesh tightening procedures; c) Fascial dehiscence after VAWCM;
d) Had terminal cancer and was discharged after 20 days with an open abdomen for terminal care at home.

lieved to be unassociated with VAWCM treatment or laparostomy. One patient developed a pancreatic fistula due to necrotising pancreatitis (primary disorder). No patients developed enteric fistulas.

DISCUSSION

We achieved a complete fascial closure rate in seven (44%; 95% CI: 2-88%) out of 16 patients treated with VAWCM. A systematic review [1] reported a complete fascial closure rate of 60% (95% CI: 54-66%) with VAC as the TAC technique. Only two of the studies [6, 11] in the systematic review included only non-trauma patients, and our patient population is not comparable to the overall patient population of the review. The two studies [6, 11] with non-trauma patients reported a complete fascial closure rate of 35% and 72%, and a mortality rate of 38% and 22%, with 37 and 36 patients enrolled, respectively. Three later studies [4, 5, 10] in non-trauma patients reported complete fascial closure rates of 30%, 22% and 52%, and mortalities of 30%, 41% and 10% for

patients with an OA treated with VAC. Acosta et al [13] reported a complete fascial closure rate of 89% using VAWCM. Seternes et al reported a successfully delayed fascial closure in eight out of nine patients treated with VAWCM after vascular surgery [15], but all of their patients had a clean OA without any adhesions, and their population is therefore not comparable to ours. It seems that VAWCM has a higher rate of complete fascial closure than VAC without mesh-mediated fascial traction when comparing the study by Acosta et al [13] with the review by Van Hensbroek et al [1]. The Wittmann Patch, another type of TAC that usually combines fascial traction and negative pressure treatment, has a reported complete fascial closure rate of 90% (95% CI: 86-95%) [1]. This supports the idea that fascial traction increases the rate of delayed complete fascial closure. The Wittmann Patch is a Velcro-like closure system that can be used with or without negative abdominal pressure therapy. The advantage of a mesh-mediated fascial traction in comparison to the Wittmann Patch is that a polypropylene mesh can be found in any surgical department and is less expensive that the Wittmann Patch.

We believe that we achieved acceptable complete fascial closure and mortality rates during the implementation of VAWCM at our institution. Nevertheless, our closure rate was lower than that of Acosta et al [13]. One of the two patients who had fascial dehiscence after the VAWCM treatment had terminal cancer and it could be argued that simple skin closure would have been preferable to VAWCM. The other patient who experienced fascial dehiscence after the VAWCM treatment was treated only briefly with VAWCM and the fascial closure might have been performed prematurely and therefore under tension. In some of the patients discharged with planned ventral hernias, the fascial traction failed due to dehiscence of the mesh at its fixation at the fascial edges, and VAWCM treatment was then terminated; and some of the patients with planned ventral hernias had been treated with VAC for a long period prior to VAWCM treatment. An earlier application of VAWCM, when the fascia could be identified more easily, may be associated with a higher success rate for this technique. Our limited experience with VAWCM may, in part, explain why we reported a lower fascial closure rate than Acosta et al.

Thus, even though the procedure is a simple technique, it is very important to have proper fascial exposure of the edges to ensure a good lateral fixation of the mesh. In this study, VAWCM was used in patients in whom the surgeon believed that VAC alone would not have yielded complete fascial closure. We believe that a higher rate of complete fascial closure can be achieved by optimizing our technique, and that earlier use of VAWCM might have improved the closure rate. Acosta et al applied the polypropylene mesh at the first redressing after 2-3 days, and this partly explained why they had a higher rate of complete fascial closure [13]. At our institution, we now apply the polypropylene mesh at the second redressing after 4-5 days. VAWCM treatment was only used for a short period of time in a few of the patients discharged with a planned ventral hernia. A prolonged treatment with VAWCM might have resulted in a higher complete fascial closure rate in these patients. However, the morbidity of abdominal closure with a planned ventral hernia must be weighed against the morbidity associated with prolonged OA treatment. When it is not possible to close the fascia completely, component separation or biological mesh repair is an option. At our institution, we have good experience with the use of biological mesh repair [16]. Biological mesh repair is usually less invasive than component separation in this group of patients. It should be noted that closure of the abdominal wall and discharge of the patient alive is the primary goal in these complex patients.

Later repair of a planned ventral hernia is also an option. Whether this should be done with an open mesh procedure or as a component separation technique remains unclear [17, 18].

Concerns regarding increased fistula occurrence during VAC treatment seem unwarranted. The reported incidence of enteric fistulas during VAC treatment was not higher than that of other types of TAC [1]. A review from 2009 concluded that there was evidence supporting the hypothesis that VAC therapy increases the rate of successful fascial closure and no evidence supporting the hypothesis that fistulas are a result of VAC use [19].

The reported incidence of enteric fistulas after OA in non-trauma patients ranges from 3-22% [4, 6, 10, 11]. Acosta et al reported a 7% incidence of enteric fistulas during VACWM treatment [13], while Seternes et al experienced no fistula formation [15]. In our study, there were no enteric fistulas. The reported pancreatic fistula was due to the primary disorder of necrotising pancreatitis and not a consequence of VAWCM treatment. It does not seem that VAWCM presents an increased risk of enteric fistulas compared with other OA modalities.

We believe that we have been successful in implementing VAWCM at our institution. It seems that as a TAC technique, VAWCM may improve the rate of complete fascial closure after treatment with an OA without an increase in mortality or occurrence of enteric fistula compared with other types of TAC. However, there is a need for prospective randomized clinical trials to compare VAC alone, mesh closure without VAC and VAWCM in regard to fascial closure rates, complications, mortality and long-term follow-up regarding the development of ventral hernias.

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