Vacuum with mesh is a feasible temporary closure device after fascial dehiscence

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ABSTRACT

INTRODUCTION: The open abdomen is a challenging condition and a temporary abdominal closure device is required in order to protect the intra-abdominal viscera. We aimed to evaluate the feasibility of a recent device: vacuum-assisted wound closure and mesh-mediated fascial traction (VAWCM) after fascial dehiscence focusing on fascial closure rate, mortality and procedure-related complications.

MATERIAL AND METHODS: We performed a retrospective study on 18 patients treated with VAWCM after fascial dehiscence who were consecutively admitted to the Department of Surgery, Slagelse Hospital, between October 2008 and October 2012.

RESULTS: The 18 patients had a median age of 64 (29-90) years. 80% (12/15) obtained delayed primary abdominal closure. The in-hospital mortality was 17% (3/18). The median treatment period with VAWCM and vacuum-assisted wound closure were 18 (7-34) and 21 (7-53) days, respectively, with a median of six (1-11) tightenings. One patient developed an intra-abdominal abscess. Three patients survived until discharge without having obtained delayed primary closure. In two of these patients, the fascial edges were adapted with a prosthetic mesh and one patient was left with a planned ventral hernia. We performed a retrospective follow-up with a median duration of 21 months 21% developed an incisional hernia. Two patients died within 60 days after closure of the abdomen.

CONCLUSION: We found that VAWCM is a safe and useful technique for delayed primary closure of the open abdomen after fascial dehiscence. We stress the need for more studies on temporary abdominal closure devices in selected groups of patients.

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TRIAL REGISTRATION: not relevant.

Open abdomen (OA) defined as a damage control laparostomy may be indicated in several clinical conditions [1-5]. A temporary abdominal closure device (TAC) is used to protect the intra-abdominal viscera which will otherwise be undesirably exposed. An ideal technique for this would include easy access to the peritoneal cavity, drainage of contaminated materials and prevention of desiccation of the bowel with low mortality and morbidity.

Several TACs have been used in order to facilitate delayed fascial closure, and the highest closure rates have been observed with the Wittmann patch (78%), dynamic retention sutures (DRS; 72%) and vacuum-assisted wound closure (VAWC; 58%) [6].

A recent technique for delayed primary closure of the OA – vacuum-assisted wound closure and mesh-mediated fascial traction (VAWCM) – has shown promising results in a mixed population of patients [7-9].

Fascial dehiscence is a serious complication after primary closure of the abdomen and has been associated with a mortality of 44% [10-13]. Its reported incidence ranges from 0.4% to 3.5% [14]. Fascial dehiscence can result in evisceration and acute surgery is needed. The complications to fascial dehiscence include reoperations, incisional hernias, prolonged hospital stay and increased mortality.

We aimed to assess the feasibility of VAWCM in patients after fascial dehiscence focusing on fascial closure rate, mortality and complications.

MATERIAL AND METHODS

We performed a single-centre retrospective cohort study from October 2008 to October 2012. Included in the study were patients who had undergone open abdomen treatment with VAWCM after fascial dehiscence. Using the procedure-code QBB10 *Change of wound dressing* (from the national hospital sector classification system), a search in the local database was made and 100 patients were obtained. Electronic medical records were reviewed and patients subjected to VAWCM during hospitalisation after fascial dehiscence were further analysed. We only included patients with midline-incision and who were older than 18 years. Eighteen patients fulfilled the criteria for inclusion and were enrolled.

Owing to the retrospective nature of the present study, there was no need for approval by the local Ethical Committee and for informed consent from the patients. Patients were not identifiable from the data registered. The study was performed in accordance with the Helsinki Declaration of 1975, as revised in 1983. No funding was required and none of the authors have any conflicts of interest.

Vacuum-assisted wound closure and mesh-mediated fascial traction

Treatment with VAWCM (**Figure 1**) was performed at

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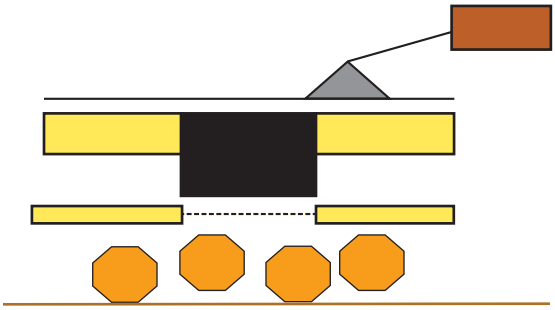
the Department of Gastrointestinal Surgery, Slagelse Hospital. Patients were initially treated with VAWC (V.A.C. Abdominal Dressing System; KCI, San Antonio, Texas, USA) alone. At the first redressing after 2-3 days, a polyprolene mesh (Prolene; Ethicon, Johnson & Johnson, Somerville, New Jersey, USA) was applied. The mesh, measuring 30 × 30 cm, was adapted to the wound and sutured to the fascial edges on each side with a running monofilament non-absorbable suture (Prolene 2-0; Ethicon, Johnson & Johnson, Somerville, New Jersey, USA). A polyethylene sheet was placed intra-abdominally adjacent to the viscera, extending laterally beneath the abdominal wall. Two thick polyurethane sponges were placed on top of the fascia and the wound was covered with occlusive thin polyethylene sheets. A negative pressure was applied with VAWC and the function of the system was controlled (**Figure 2**). A continuous topical negative pressure of 75-150 mmHg was applied according to the surgeon's preference.

During the following dressing changes, the meshes were divided into two halves, with some exceptions, and the mesh halves were approximated in the midline with a running monofilament suture (Prolene 2-0) applying traction to the fascial edges.

Under general anaesthesia in the operating room, the mesh was tightened if fascia tension allowed this without tearing, optimally every 2-3 days during dressing changes. On a few occasions, dressing changes were performed without mesh tightening. When the operating surgeon found conditions in favour of delayed primary closure, the mesh was removed and the fascia closed with the recommended suturing technique [15].

FIGURE 1

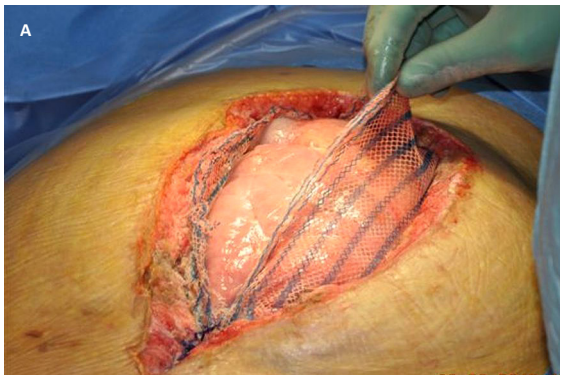
Illustration of vacuum-assisted wound closure with mesh-mediated fascial traction.

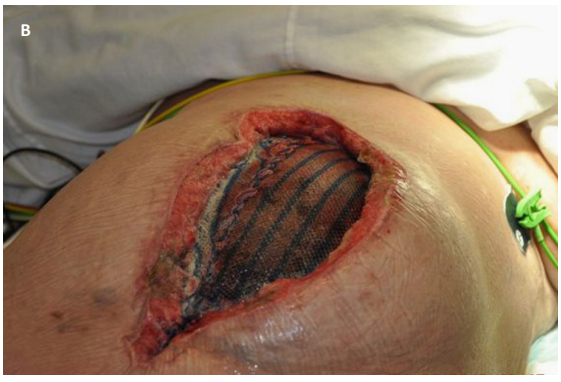


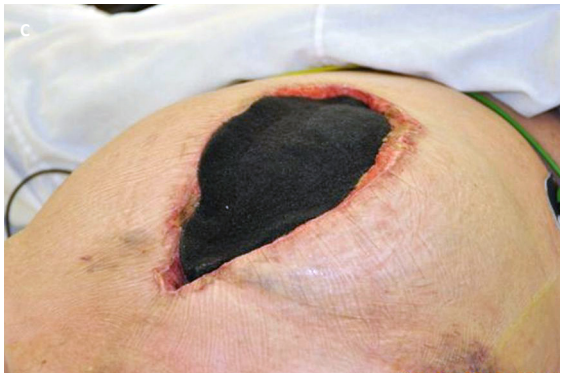
At the bottom, the bowel is shown (light brown) covered by a polyethylene sheet protecting the viscera (dark line). Above the protective sheet on the viscera the fascial edges (light yellow) are connected by a polyprolene mesh (dotted line). A pair of subcutaneous (yellow) polyurethane sponges (dark) are placed on top of the ployprolene mesh and covered by thin occlusive polyethylene sheets (uppe dark line). The grey triangle represents a pad applying negative pressure through a vacuum source (brown rectangle).

FIGURE 2

Photographs of layers in vacuum-assisted wound closure with mesh-mediated fascial traction. **A.** A polyprolene mesh is adapted to the fascial edges and divided in the middle, exposed bowel is seen below. **B.** Polyprolene mesh adapted to wound and fixed to the fascial edges with a running monofilament suture on both sides and tightened in the middle. **C.** On top of the polyprolene mesh, two black sponges are placed after having been adapted to the edges of the wound. **D.** Thin occlusive polyethylene sheets placed above sponges and negative pressure applied.







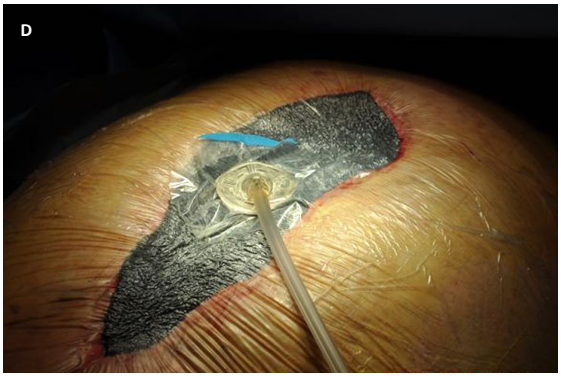


TABLE 1

Patient characteristics (N = 18).

Age, years, median (range)	64 (29-90)
Female, n (%)	8 (44)
BMI, kg/m², median (range)	27 (18-40)
Tobacco consumption, n (%)	9 (50)
Cardiovascular disease, n (%)	9 (50)
COPD, n (%)	3 (17)
Diabetes mellitus, n (%)	1 (6)
Malignancy, n (%)	7 (39)
ASA score ≥ 3, n (%)	5 (28)
Acute primary operation, n (%)	15 (83)

ASA = American Society of Anesthesiologists; COPD = chronic obstructive pulmonary disease.

TABLE 2

Data on open abdomen treatment (N = 18).

Closure of fascia, n (%)	12 (67)
Closure of fascia, alive at discharge[a], n (%)	12 (80)
In-hospital mortality, n (%)	3 (17)
Treatment with VAWCM, days, median (range)	18 (7-34)
Treatment with VAWC, days, median (range)	21 (7-53)
Tightenings, median (range)	6 (1-11)
Stay at Department of Surgery, days, median (range)	42 (14-162)
Stay at ICU > 21 days, n (%)	3 (17)
Organ failure, n (%)	
Inotropic support	5 (28)
Respirator therapy	3 (17)
Renal replacement	1 (6)

ICU = intensive care unit; VAWC = vacuum-assisted wound closure; VAWCM = vacuum-assisted wound closure with mesh-mediated fascial traction.
a) N = 15.

The whole length of the incised fascia had to be completely closed before delayed primary fascia closure was obtained.

Classification of the open abdomen

In order to make comparison possible between our study and other studies with heterogeneous patient populations and to describe the patients' clinical course, we classified the patients upon initiation of OA treatment and at the last dressing change before the end of the OA treatment. We used the classification system proposed by Björck and colleagues [16].

Follow-up

We performed a retrospective follow-up. The follow-up period was defined as the period from closure of the abdomen to the last final examination of the abdomen or computed tomography (CT) of the abdomen. Patients with a planned ventral hernia after concluded treatment with VAWCM were excluded. No regular follow-up after closure of abdomen was planned. We reviewed electronic medical records for contact to domestic hospitals and performed imaging in all patients.

Trial registration: not relevant.

Statistical analysis

Statistical analyses were performed in an Excel (Microsoft 2011, Mac) spreadsheet using formulas. Medians and ranges were used on continuous data. Dichotomous data are presented as percentages.

Trial registration: not relevant.

RESULTS

Patient characteristics

Five patients had malignant disease in the gastrointestinal tract: three had localised rectal cancer, one metastatic rectal cancer and one localised caecum cancer (**Table 1**). Three patients had a localised colonic cancer removed prior to VAWCM during the same hospitalisation.

One patient had the uterus removed before being transferred with a fascial dehiscence to the Department of Surgery.

Causes of fascial dehiscence and indications for vacuum-assisted wound closure and mesh-mediated fascial traction

Five patients had fascial dehiscence with tearing of sutures through the fascia without any pathological findings in the peritoneal cavity or related to the wound. Six patients had an obviously impaired quality of the fascia and three had intra-abdominal contamination from perforated bowel. Two patients had subcutaneous infection and two subcutaneous haematoma.

The indications for VAWCM were inability to close the abdomen due to severe bowel oedema (n = 7), poor quality of the fascia making the patient unsuitable for primary closure (n = 6) and contamination (n = 5).

Data on open abdomen treatment

One patient had received abdominal VAWC at an earlier stay at hospital and later (prior to VAWCM) underwent abdominal skin grafting and ventral herniotomy with a prosthetic mesh. Six patients did not receive primary delayed closure of the OA with VAWCM of whom three died during OA treatment (**Table 2**).

In two patients, the fascial edges were impossible to adapt and a prosthetic mesh was adapted to the fascial edges. These two patients were treated with

VAWCM for ten and 27 days with three and ten tightenings, respectively. One of the patients was discharged with a planned ventral hernia.

At the initiation of OA treatment, 13 patients (72%) were classified as grade 2A, three as 2B, one as 2A and one as four with a frozen abdomen.

Before delayed primary closure of the abdomen or discontinuation of OA treatment, 11 (61%) patients were classified as grade 1A, four as 2A, one as 1B, one as 2B and one as 4.

Complications during vacuum-assisted wound closure and mesh-mediated fascial traction

An overall procedure-related complication count of 12 was seen. Half of the patients had complications during treatment. Three patients had more than one complication. Nine complications were related to the wound. Four of these complications were necrosis, three were infections and two were bleedings. The remaining three complications were located intra-abdominally and consisted of abscess in one patient, bowel perforation in one and necrosis of the greater omentum in one.

Follow-up

Three patients 21% (3/14) alive after completion of the VAWCM without a planned ventral hernia were diagnosed with an incisional hernia. Two of these were asymptomatic and incisional hernias were diagnosed by CT, and abdominal examination revealed an incisional hernia in one patient which was then confirmed by CT. The incisional hernias were identified after one month, 12 months and 19 months, respectively.

The median follow-up was 21 months (1-36 months). Two patients died during follow-up after one and two months, respectively. The latter patient was diagnosed with incisional hernia by CT after one month. Twelve patients were examined by CT for different causes. In one patient, two CT were performed after one and three years. Four CTs were used as controls after removal of a malignant tumour, and CT was used to investigate the effect of treatment with chemotherapy in one patient. One patient had an CT performed to evaluate dissemination of an unresectable leiomyosarcoma. One patient had an cicatrice defect, but CT showed no incisional hernia. Ileus was suspected in three patients. In one patient a gastrointestinal perforation was suspected, and in one patient a CT was performed to confirm an incisional hernia.

In five of the 13 performed CTs, intravenous contrast media was used.

DISCUSSION

In our study, the primary closure rate was 80% (12/15). This is equal to the 89% primary closure rate found by Acosta and colleagues in patients who were alive at the time of closure [8]. Populations between studies differ remarkably, and we only included patients with primary gastrointestinal diseases and fascial dehiscence, except for one patient. Acosta and colleagues had a mixed population of gastrointestinal, vascular and trauma-induced aetiologies.

Rasilainen and co-workers [17] conducted a retrospective study on delayed closure of the open abdomen comparing mesh-mediated fascial traction and non-traction techniques. They found a significantly higher closure rate with mesh-mediated fascial traction, 78% versus 44%. Few patients suffered from wound dehiscence. The median duration of OA treatment was nine (3-70) days in the VAWCM group, and the fascial closure rate was found to be stable until the end of the third week after laparostomy. In our setting, the median duration of OA treatment was 21 days. The damage to fascial edges after wound dehiscence from tearing of suturing material and local wound disturbances expose the fascial edges to further damage, and it requires great caution at each tightening of the fascia to avoid prolonging OA treatment unnecessarily. This may explain the longer duration of OA treatment observed in our study.

A minor Danish study [18] on VAWCM in a non-trauma setting found a complete fascial closure in 50% of the patients who were alive at discharge. Only 31% had wound dehiscence. The median time with VAWCM was six days with three tightenings. We had a considerably longer treatment with VAWCM and more tightenings. An explanation for the fascial closure rate of 80% in our setting could be less traction on fascial edges at each tightening.

In-hospital mortality was 17% as opposed to the 30% found by Acosta and colleagues [8]. Age and failure of fascial closure were independently associated with in-hospital mortality in their setting. Age and fascial closure rate are similar in the two studies. The observed difference in mortality may partly be explained by differences in the main disease aetiologies contributing to OA treatment. Van't Riet and colleagues found a mortality rate of 25% within 60 days after wound dehiscence and immediate suturing [19]. The comparable mortality rate in our study was 28% (5/18). In 83% of the patients in our setting, emergency surgery preceded wound dehiscence, whereas this was only the case in 48% after immediate suturing in the study by Van't Riet.

Formation of intestinocutaneous fistula is an important complication. Acosta and colleagues found it to be an independent factor associated with failure of fascial closure [8]. In our population, no patients developed intestinocutaneous fistula, which may be attributed to a type 2 error. Acosta and co-workers had 42 complications, but they had approximately six times as many pa-

tients. Part of the difference could be due to differences in the registration of complications, and we expect to reduce the number of complications as we gain more experience with VAWCM.

Incisional hernia may be a late complication after repair of wound dehiscence and a serious condition. The incidence of incisional hernia was 21% in our setting. Incisional hernia was detected in 44% of patients after wound dehiscence and repair with immediate suturing [19]. Incisional hernia was detected without the use of CT. The mean follow-up was 37 months. In our setting, the comparable incidence was 17% (2/12). A lower incidence may be expected in our setting due to a shorter follow-up period. On the other hand, the incidence of incisional hernia would probably have been higher in the population presented by Van´t Riet and colleagues if a CT of the abdomen had been added to physical examination.

Nevertheless, VAWCM seems to be a feasible temporary closure device in a selection of patients with wound dehiscence where immediate suturing is not possible. Obesity has been implicated as a risk factor for both wound dehiscence and incisional hernia [20]. Obesity increases intra-abdominal pressure and impairs healing. Our population had a median BMI of 27 kg/m^2. By applying an negative intra-abdominal pressure with VAWCM and less traction-forces on fascial edges compared with immediate suturing, we believe that VAWCM may be advantageous. In comparison, Van't Riet and colleagues had a population with a mean BMI of 25 kg/m^2.

Our study is limited by its retrospective design, the relatively few patients and lack of prospective patient follow-up. Nonetheless, we think that our study contributes to existing knowledge on OA treatment. We believe VAWCM is a safe and feasible device for temporary closure of the OA after fascial dehiscence when conditions do not favour immediate suturing. More studies are needed to evaluate the usage of VAWCM in different populations and conditions.

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CONFLICTS OF INTEREST: Disclosure forms provided by the authors are available with the full text of this article at www.danmedj.dk.

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