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Fluid volume overload negatively influences delayed primary facial closure in open abdomen management

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ABSTRACT

Background and aim: The open abdomen (OA) is associated with significant morbidity and mortality, and its management poses a formidable challenge. Inability to achieve primary closure of the abdominal wall is one of the most severe complications of this technique. Factors influencing primary fascial closure, however, are unknown. This study aims to explore the influence of fluid volume overload on the application of vacuum-assisted and mesh-mediated fascial traction (VAWCM) in OA treatment.

Methods: A review of patients undergoing OA management using VAWCM technique from January 2006 to November 2011 was performed. Patients with aged <18 y OA treatment for fewer than 5 d and abdominal wall hernia before OA treatment were excluded.

Results: Average age was 45 ± 10.1 y and average OA treatment time was 31 ± 6.8 d. The complete fascial closure rate was 60%. The overall mean bodyweight-based fluid overload was 7.2 kg (range: −8.0 to +21.6 kg), representing a mean percent weight gain of 11.5% (range: −9.5% to +27%). Patients with fluid-related weight gain ≥10% had a lower primary facial closure rate than those with <10% (39% *versus* 77%). And primary facial closure rate seems to further decrease with fluid-related weight gain ≥20%, suggesting a dose-response effect of progressive fluid accumulation.

Conclusions: The VAWCM method provided a high primary fascial closure rate after long-term treatment of OA. Fluid volume overload negatively influences delayed primary facial closure. Judicious intravenous fluid resuscitation should be advocated in the therapy of critically ill patients.

1. Introduction

The open abdomen (OA) is now a common clinical challenge in surgical intensive care units (ICUs). Several clinical conditions and situations are favorably treated with OA. In patients with intra-abdominal infections, abscesses or severe pancreatitis sometimes precludes closure of the abdominal wall after surgery or leads to abdominal compartment syndrome (ACS) with its profound and life-threatening effects on cardiovascular, respiratory, and renal functions [1]. Leaving the abdomen open enables repeated access to the peritoneal cavity and facilitates repeated debridement of nonviable tissue, peritoneal toilet, and effective drainage.

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Management of the OA has become an obligatory conundrum for general and trauma surgeons performing damage-control surgery. In view of the OA complications such as damage of organs, fistula, loss of water-electrolyte and protein, abdominal closure should be performed as soon as possible without compromising the patient's physiological condition. Temporary abdominal closure (TAC) is performed with Bogota bags, towel clips, skin only, or any of the various negative pressure dressings [2]. Early fascial closure of the OA seems feasible within 7–8 d in the majority of light trauma victims [3], whereas a longer time may be required in critically ill patients undergoing OA treatment owing to serious abdominal infection. If TAC techniques do not facilitate primary definitive closure of the abdominal wall, skin-only closure or split-thickness skin grafting may be used for covering the bowels and omentum. The major drawback with these techniques is the formation of extensive ventral hernias that have to be dealt with later.

According to the most recent literature, the most promising TAC method is vacuum-assisted wound closure and mesh-mediated fascial traction (VAWCM). Acosta *et al.* [4] reported that VAWCM method provided a high fascial closure rate after long-term treatment of OA and demonstrated the safety of this technique, with few complications, in a prospective nonrandomized descriptive trial containing 151 patients. In the retrospective analysis of Rasilainen *et al.* [5], VAWCM method improved the delayed primary fascial closure rate by 78%, and planned hernia rate is lower than nontraction methods. And in those OA patients who did not achieve primary fascial closure, deep wound infections and intra-abdominal abscesses have been shown to prevent delayed primary fascial closure.

The intensive care management of the OA is important to the surgical success of primary fascial closure. Historically, the surgical community has advocated aggressive and liberal crystalloid infusion to correct hemodynamic and metabolic derangements. However, this can lead to volume overload and increased risks of ACS, pulmonary edema, and acute respiratory distress syndrome. Judicious intravenous fluid resuscitation targeting dynamic hemodynamic parameters (stroke volume variance or pulse pressure differential) *versus* static parameters (central venous pressure or left atrial pressure) may decrease the incidence of ACS and OA [6]. As far as we know, no clinical trials of fluid overload and primary facial closure have been attempted. We addressed this by analyzing demographic, clinical, and primary facial closure data from an observational, single-center registry of OA patients treated with VAWCM at our institution.

2. Materials and methods

2.1. Study design and population

The study was approved by the Institutional Review Board of the Jinling Hospital. Adult OA patients (>18 y) who were treated with VAWCM in our medical and surgical ICUs between January 2006 and November 2011 were retrospectively included. Patients were excluded if they had age <18 y, preexistent abdominal wall hernia before OA treatment, and anticipated OA treatment lasting fewer than 5 d. Data from patients who underwent a primary fascial closure were compared with those in whom primary fascial closure could not be achieved (i.e., planned ventral hernia or partial fascial closure).

2.2. Definitions

Intra-abdominal hypertension (IAH) and ACS were defined according to the World Society of the Abdominal Compartment Syndrome consensus definitions [7]. ACS was defined as an intra-abdominal pressure exceeding 20 mmHg and organ dysfunction. Fluid overload was calculated as bodyweight before initiation of OA treatment minus habitual bodyweight. It is a standard of care at our institution to weigh patients on OA treatment daily. Fluid intake included blood products, intravenous fluids and flushes, medications, and all forms of nutritional support. Fluid output included urine output, drain output, blood loss, nasogastric tube output, stool volume, and wound drainage. For each patient, the daily flow charts were reviewed and 24 h totals of fluid intake and output were recorded for each patient for every day during OA treatment.

2.3. Vacuum and mesh-mediated fascial traction

The principle of VAWCM as a temporary abdominal closure technique after laparostomy has been described previously [8]. In brief, in each patient where the abdomen was left open, a sterile perforated plastic sheet was placed intra-abdominally to cover the viscera and then an oval-shaped polypropylene mesh (Prolene; Ethicon, Johnson & Johnson, Somerville, NJ) was sutured to the fascial edges with a running 0 monofilament suture. Moist laparotomy pads covered the plastic sheet and protected the fascia and subcutaneous tissue. A sterile gauze was placed over the pads and two silicone drain tubes were brought in caudally through the skin over the gauze. The drains were covered with a layer of dry laparotomy pads and the wound was sealed with adhesive plastic dressings. The drains were linked to a suction device with continuous topical negative pressure (100–150 mmHg) (Figs. 1 and 2). After 2–3 d, the possibility to close the abdomen was evaluated. If possible, the abdominal wall was closed. Otherwise, the mesh was cut in the midline, the inner plastic sheet and gauze were changed, and the mesh was tightened by suturing it in the midline with a running 0 monofilament suture, keeping the viscera from protruding and putting some tension on the abdominal wall. This temporary abdominal closure system was changed every 2–3 d. Abdominal closure was considered when 3–5 cm of separation of the fascial edges remained with week tension assessed by pulling the fascial edges toward the midline. The mesh was then removed, and the fascial were closed, followed by skin closure. Delayed primary fascial closure referred to the ability to achieve fascial closure during the initial hospital stay.

2.4. Statistical analysis

Continuous variables are presented as medians and interquartile range, and categorical variables are presented as percentages. The χ^2 test or the Fisher exact test was used for qualitative variables. Differences between groups were tested