

THE FACTORS AFFECTING SURVIVAL IN OPEN ABDOMEN DUE TO SURGICAL ABDOMINAL SEPSIS

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ABSTRACT

Introduction: In the literature, there are studies comparing open abdomen technique and primary closure technique in terms of survival and other results in patients with surgical abdominal sepsis. There are no studies investigating the factors affecting survival in patients treated with open abdominal technique alone. These factors should be investigated retrospectively in open abdomen patients. We aimed to investigate the factors affecting survival in patients with severe intraabdominal sepsis treated with vacuum-assisted closure systems for open abdomen. We hypothesized that use of open abdomen with vacuum-assisted closure systems was reduced mortality in patients with severe intraabdominal sepsis.

Materials and methods: We retrospectively reviewed 40 open abdomen patients performed vacuum-assisted closure for severe intraabdominal sepsis. Alive and mortal groups were evaluated in terms of age, gender, body mass index, etiology of surgical abdominal sepsis, Apache II score, Mannheim peritonitis index score, Bjourck classification, fascia score, abdominal defect size, stoma and fistula presence, and vacuum-assisted closure treatment duration. It was evaluated whether any of these parameters was effective on survival.

Results: Mean age and body mass index were significantly elevated in the mortal group compared with the alive group. A significant difference with regard to Bjourck classification was detected between the alive and mortal groups. In Bjourck 1 and 2, mortality rates were 36.8% and 31.3%, respectively, while in Bjourck 4, mortality was 100%. The presence and type of fistula were statistically significant for mortality. None of the other parameters were statistically significant for mortality.

Discussion: The studies of the last twelve years showed that the open abdomen technique with the temporary abdominal wall closure using negative pressure dressing methods gave positive results. The 42.5% mortality rate in our study is much lower than the mortality rate for abdominal sepsis patients in the literature. Our study indicated that the management of open abdomen and negative pressure therapy was possible to increase the survival in patients with surgical abdominal sepsis.

Keywords: Abdominal sepsis, Open abdomen, Vacuum-assisted closure, Negative pressure therapy.

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Introduction

Sepsis, the first cause of noncardiac deaths in intensive care units (ICU), has mortality rates varying from 25% to 50%⁽¹⁻³⁾. The literature data about the ideal surgical technique for the treatment of abdominal sepsis is not sufficient⁽⁴⁾. The damage control approach can be performed to improve the physiologic derangements observed in septic shock, especially in situations where primer source control

cannot be satisfactorily carried out at first operation. There is an increasing tendency in the world in this regard. This type of management can be successfully applied to surgical abdominal sepsis including open abdomen (OA) technique. Patients with severe abdominal sepsis may be in septic shock having progressive organ dysfunction, hypotension, myocardial depression and then coagulopathy. These patients are not optimal candidates for immediate complex operative interventions

because of hemodynamically unstable. Early treatment with aggressive hemodynamic support can limit the damage of sepsis-induced tissue hypoxia and may limit the over stimulation of endothelial activity⁽⁵⁾.

Present studies have pointed out that mortality rates of abdominal sepsis dramatically increase in the event of severe sepsis and septic shock. Severe sepsis may be a reasonable approximation of the “tipping point” between stable and critical clinical conditions in the management of intraabdominal infections. Severe sepsis is described as sepsis associated with at least one acute organ dysfunction, hypoperfusion, or hypotension⁽⁶⁾. OA is a significant advantage to perform subsequent laparotomies more efficiently and prevent the onset of abdominal compartment syndrome which may worsen the systemic disease. In patients with severe sepsis and septic shock, OA allows easy second-look to control the source of infection and evacuate inflamed and toxic content, reducing the load of peritoneal cytokines and other inflammatory substances and preventing their production by removing the source itself⁽⁷⁾. In patients with OA, vacuum-assisted closure (VAC) techniques have been extensively used for temporary abdominal wall closure. If an early fascial closure is impossible, commercially prepared negative pressure dressings are available and can be changed under general anesthesia with interval 2-4 days for subsequent dressings. Negative pressure therapy (NPT) actively discharges toxins and bacteria-rich intraperitoneal fluid. Moreover, it has a high rate of fascial and abdominal wall closure⁽⁸⁾.

In the literature, there are studies comparing OA technique and primary closure technique in terms of survival and other results in patients with surgical abdominal sepsis. There are no studies investigating the factors affecting survival in patients treated with open abdominal technique alone. In particular, the presence of enteroatmospheric fistula increases mortality very much. OA technique may produce enteroatmospheric fistula if appropriate temporary closure techniques are not applied. In patients applied OA technique for surgical abdominal sepsis, it is not clear what other factors affect survival. These factors should be investigated retrospectively in OA patients.

We aimed to investigate the factors affecting survival in patients with severe intraabdominal sepsis treated with VAC systems for OA. We hypothesized that use of OA with VAC systems was

reduced mortality in patients with severe intraabdominal sepsis.

Materials and methods

Ethics approval was obtained from Okmeydanı Education and Research Hospital Ethics Board. All patients gave their informed consent prior to their inclusion in this study. We retrospectively reviewed 40 OA patients performed VAC for severe intraabdominal sepsis between January 2013 and September 2017 in our clinic. Alive and mortal groups were evaluated in terms of age, gender, body mass index (BMI), etiology of surgical abdominal sepsis, Apache II score, Mannheim peritonitis index (MPI) score, Bjorck classification, fascia score, abdominal defect size, stoma and fistula presence, and VAC treatment duration. It was evaluated whether any of these parameters was effective on survival.

A total of 40 OA patients over twelve old years were included in this study. Patients underwent temporary abdominal closure with VAC systems in the management of preoperative severe intraabdominal sepsis or septic shock was included in the study. Severe sepsis was defined as at least one clinical finding of systemic inflammatory response syndrome criteria along with evidence of organ dysfunction. Systemic inflammatory response syndrome criteria are white blood cell $4 < \text{or} > 12 \times 10^3/\mu\text{L}$, body temperature $36 < \text{or} > 38.2^\circ\text{C}$, heart rate > 90 beats per minute, respiratory rate $> 20/\text{minute}$.

Evidences of organ dysfunction are altered mental status, arterial hypoxemia ($\text{PaO}_2/\text{FiO}_2 < 300$), urine output less than 0.5 mL/kg/hour, creatinine increase greater than 0.5 mg/dL, ileus, platelets less than 100,000, hypoperfusion (lactate > 1 mmol/L, “mottling”), or hypotension (systolic blood pressure < 90 mm Hg) responsive to fluid resuscitation. Septic shock was defined as hypotension nonresponsive to the fluid challenge of 30 mL/kg bolus, mean arterial pressure less than 60 mmHg or use of vasopressors^(3,5). All patients were taken to the ICU either secondary to intraabdominal sepsis or developed new onset intraabdominal sepsis while in the ICU.

Patients treated with planned relaparotomy in the 36-48 hour postoperative period (when relaparotomy is planned after the first operation) or with relaparotomy on demand (when required by the patient's clinical condition) in the management

of severe intraabdominal sepsis or septic shock were excluded.

Disease severity was measured using the acute physiology and chronic health evaluation-II (APACHE- II) score and Mannheim peritonitis index (MPI) score. The APACHE-II scoring system is widely used for stratifying disease severity and predicting patient mortality in the ICU. The APACHE-II score integrates the patient's age, physiological parameters, laboratory data, Glasgow coma scale within the first 24 hours of ICU admission and also chronic health evaluation. MPI is a simple but highly predictive scoring system for patient mortality, based on demographic data and disease etiology.

The front wall of the abdomen was not closed after primer source control. The domain of abdomen was temporarily closed with a negative pressure dressing. Common indications for VAC application during the initial operation were hemodynamic instability, gross peritoneal contamination, bowel edema, ongoing volume resuscitation, abdominal loss of domain and anticipated abdominal compartment syndrome. Patients with VAC returned to the operating room for a reassessment of the peritoneal cavity, washing with 6-12 liters warm serum saline and replacement of VAC, within 48 to 72 hours of the index operation. This process was repeated every 2-5 days. It went on until the abdomen was suitable for definitive closure after macroscopic resolution of peritonitis and clinical assessment by the attending surgeon.

The front wall of the abdomen was closed in some of our patients by the attending surgeon with only the skin or Bogota bag after the source control in the initial operation. These patients also returned to the operating room within 48 to 72 hours of index operation for VAC application.

All the cases were carried out with Abthera Open Abdomen Management System which is produced by KCI Licensing Inc. (Acelity) in Athlone, Dublin. An Abthera system has one central sponge and six additional sponge extensions. All the sponges are covered with visceral organ protective layers. Six additional sponge extensions are embedded completely of the intra-abdominal cavity after washing with 6-12 liters warm serum saline. An elliptical uncovered sponge is applied above six additional sponge extensions. The back face of the elliptical uncovered sponge is at the fascia level and its front face is at the level of the skin. The elliptical uncovered sponge and skin of abdomen are covered

by the physicians with sterile and adhesive drape. It is connected with 125 mmHg negative pressure to vacuum devices via a collecting system and then NPT is started smoothly by physicians. All the patients in our study were treated by applying temporary abdominal closure with described VAC technique.

The Kolmogorov-Smirnov test was used for normal distributions. Mann-Whitney U and chi-square tests were performed to compare the results. Differences were considered statistically significant at a value of $p \leq 0.05$. Statistical analyses were performed by using SPSS software (version 23.0, IBM Corporation, Armonk, NY, USA).

Results

A total of 40 patients were included in the study with 23 alive and 17 mortal open abdomen cases. Overall mean age was 57.3 years. Mean age was significantly elevated in the mortal group compared with the alive group (66.4 vs 50.6, $p: 0.001$) (Table 1) although there was no gender-related statistically significant difference between the alive and the mortal groups. Mean BMI was significantly elevated in the mortal group compared with the alive group (30.08 vs 27.33, $p: 0.048$) (Table 1). However, there was no significant difference with regard to Apache II score, MPI score, abdominal defect size and VAC treatment duration among these groups (Table 1). In addition, there was no stoma presence and fascia score related statistically significant difference between the groups. Median APACHE-II score was 20, 64 in the mortal group while it was 18, 82 in the alive group (Table 1). 50% of the patients had scores greater than 20 (predicted mortality rate $\geq 30\%$). 45 % of the patients ($n: 9$) having scores greater than 20 were in the mortal group.

	Mortal	Alive	<i>p</i>
Age	66,35± 11,73	50,60± 16,67	0,001
Body mass index	30,08± 5,75	27,33± 5,46	0,048
Apache II score	20,64± 4,30	18,82± 3,92	0,165
Mannheim peritonitis index score	30,00± 5,74	26,43± 7,31	0,101
Abdominal defect size (cm ²)	437,29± 194,15	489,65± 122,61	0,498
VAC treatment duration (day)	18,70± 15,01	20,86± 15,32	0,416

Table 1: The mean results of patients about age, body mass index, Apache II score, Mannheim peritonitis index score, abdominal defect size, VAC treatment duration. Mean± Standard Deviation

Primary etiologies of surgical abdominal sepsis are summarized in Table 2. The most common etiologies were an anastomotic failure, small bowel perforations, and large bowel perforations, accounting for 67.5 % of our patients. There was no significant difference with regard to primary etiologies of abdominal sepsis between the alive and mortal groups.

	Mortal	Alive	Total
Delayed perforated appendicitis	0 (0 %)	2 (8,7 %)	2 (5 %)
Anastomotic failure	7 (41,2 %)	6 (26,1 %)	13 (32,5 %)
Small bowel perforation	5 (29,4 %)	4 (17,4 %)	9 (22,5 %)
Large bowel perforation	1 (5,9 %)	4 (17,4 %)	5 (12,5 %)
Gastric and duodenal ulcer perforation	1 (5,9 %)	3 (13 %)	4 (10 %)
Ischemia / Infarct	2 (11,8 %)	1 (4,3 %)	3 (7,5 %)
Intraabdominal abscess	0 (0 %)	2 (8,7 %)	2 (5 %)
Biliary complication	1 (5,9 %)	1 (4,3 %)	2 (5 %)
Total	17 (100 %)	23 (100 %)	40 (100 %)

Table 2: Primary etiology of surgical abdominal sepsis ($p>0,05$).

Bjorck classification is the scheme for the complexity of the open abdomen. It was updated by the World Society of the Abdominal Compartment Syndrome in 2013^(9,10). A significant difference with regard to Bjorck classification was detected between the alive and mortal groups ($p: 0,02$). In Bjorck 1 and 2, mortality rates were 36.8% and 31.3%, respectively, while in Bjorck 4, mortality was 100% (Table 3).

Bjorck Classification Score	Mortal (n)	Alive (n)	Total (n)
1	7	12	19
2	5	11	16
3	0	0	0
4	5	0	5
Total	17	23	40

Table 3: Primary etiology of surgical abdominal sepsis ($p>0,05$).

The presence of fistula was statistically significant for mortality ($p: 0,021$). In addition, the type of fistula was statistically significant for mortality ($p: 0,04$) (Table 4).

Fistula type	Mortal	Alive	Total
No fistula	8 (47,1 %)	19 (82,6 %)	27 (67,5 %)
Enteroatmospheric fistula	5 (29,4 %)	0 (0 %)	5 (12,5 %)
Colonic fistula	3 (17,6 %)	2 (8,7 %)	5 (12,5 %)
Gastric fistula	0 (0 %)	1 (4,3 %)	1 (2,5 %)
Duodenal fistula	1 (5,9 %)	1 (4,3 %)	2 (5 %)
Total	17 (100 %)	23 (100 %)	40 (100 %)

Table 4: PDistribution of patients according to types of fistula ($p=0,04$).

Discussion

In the management of severe intraabdominal sepsis; the temporary closure of OA with conventional passive methods is ineffective when compared with closed abdomen and relaparotomy on demand technique and is associated with increased mortality and a higher incidence of enteroatmospheric fistula. There are serious clinical findings in this regard⁽¹¹⁻¹³⁾. The studies of the last twelve years showed that the OA technique with the temporary abdominal wall closure using negative pressure dressing methods gave positive results⁽¹⁴⁻¹⁶⁾.

A temporary abdominal closure should contain protecting the abdominal contents, preventing evisceration and the formation of fistulas, preserving abdominal wall domain, avoiding damage to the fascia, allowing the output of infected or toxic fluid from the abdominal cavity and making easy and safe reoperation. In addition, it should facilitate definitive closure at last. Commercially prepared negative pressure systems are available and advantage for temporary abdominal wall closure. The advantages of VAC system are to prevent abdominal compartment syndrome and loss of abdominal domain, collect and monitor fluid loss, no damage to skin or abdominal fascia. General anesthesia requirement to change VAC system, expensive commercial equipment are disadvantages.

Animal studies showed that OA techniques using constant negative pressure to the peritoneal cavity may remove inflammatory ascites, reduce the systemic inflammatory response and improve organ injury⁽¹⁷⁾. Even though NPT is a highly promising method of temporary abdominal closure in the management of critically ill patients with abdominal sepsis, it is still associated with high morbidity and high incidence of ventral hernia formation in surviving patients^(18,19). Since the treatment and management with OA and NPT of surgical abdominal sepsis

patients are especially prominent in the last decade, we have used commercially available VAC systems in these patients after the beginning of 2013. We have preferred to perform OA and VAC regardless of intraabdominal pressure levels before the initial operation in patients with abdominal sepsis. Thus, we obtained a patient cohort in which we could investigate the factors affecting survival by performing the same treatment strategies in patients with surgical abdominal sepsis.

Statistically significant differences in age, BMI, Bjorck classification, fistula presence and fistula type among alive and mortal groups were the most remarkable pieces of evidence affecting survival in our study (Table 1, 3, 4). These pieces of evidence suggested that survival decreased in surgical abdominal sepsis patients treated with OA and NPT as age and BMI increase. Although the mean APACHE II score in the mortal group was larger than the alive group, this difference did not reflect the statistic. Similarly, the mean MPI score in the mortal group was larger than the alive group but this difference did not reflect the statistic. These results, which are statistically insignificant, may be due to low patient numbers. We hope that these results will be statistically significant as the number of patients with surgical abdominal sepsis increases.

The occurrence of enteroatmospheric fistulas is one of the most devastating and frightening complications of OA procedure and NPT. The occurrence of fistulas has been established a connection with duration of NPT and frequency of changing the dressing⁽²⁰⁾. Lately published articles suggest that NPT can be used for the successful treatment of enteroatmospheric fistulas if an adequate isolation and external drainage of the enteroatmospheric fistula is maintained⁽²¹⁾. The mortality and morbidity of OA patients increase. Indeed, the mortality in infected OA patients is more than 50%. Furthermore, adding enteroatmospheric fistula to the clinical situation increases the mortality and morbidity further^(22,23).

According to the Bjorck classification, the distribution of our patients between the two groups was statistically significant as expected. Five patients belong to Bjorck 4 consisting of enteroatmospheric fistula were also in the mortal group (Table 3). This result corresponded with evidence in the literature. Furthermore, significant differences with regard to presence and types of fistula indicated that survival was directly dependent on the low Bjorck classification and absence of fistula.

The limitations of this study are associated with retrospective study designs. Besides, the number of our patients is also low. These are the weaknesses directions of our study. However, we used strict inclusion criteria to optimize uniformity of the patient population. The factors affecting survival were investigated in patients having been performed the same treatment strategies for surgical abdominal sepsis. The uniformity of the patient population with the same treatment strategies is a strong direction of our study.

Age and BMI are irreversible results, but the stage of Bjorck classification, the presence, and the type of fistula is commutable results. It is possible that the survival may be increased considering commutable results affecting the mortality. These results of our study group expressed that fistula formation should be prevented and NPT should be started without intraabdominal adhesions for better survival.

In conclusion, the 42.5% mortality rate in our study is much lower than the mortality rate for abdominal sepsis patients in the literature. Our study indicated that the management with OA and NPT was possible to increase the survival in patients with surgical abdominal sepsis.

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