

The Feasibility of the Damage Control Surgery for Life Threatening Conditions

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Abstract

Background: Damage control surgery is a lifesaving technique used to control bleeding or contamination and to close temporary operative wounds in life threatening conditions. After the correction of physiologic abnormalities, patients will receive definitive management. The aim of this study is to evaluate the feasibility of the DCS for life threatening conditions.

Methods: This study was conducted on 13 patients who underwent DCS between March 2003 and May 2007. 10 patients were traumatic injury patients, and 3 were mesenteric infarction patients. We retrospectively evaluated the feasibility of DCS, and analyzed the risk factors after DCS.

Results: Overall mortality rates were 38.5% (five deaths among thirteen patients). The mortality rates of the patients with lethal triad; acidosis, hypothermia and coagulopathy are 83.3% (five deaths among six patients), 60.0% (three deaths among five patients), 50.0% (five deaths among ten patients), respectively. None survival patients were more frequent acute respiratory distress syndrome (60.0%), multi-organ dysfunction (100.0%) and abdominal compartment syndrome (60.0%).

Conclusions: DCS for the patients with life threatening conditions showed feasible results in our study. The mortality of patients with acidosis, coagulopathy and hypothermia were higher than the patients without.

Keywords Damage control surgery; Life threatening; Lethal triad

This study aims to evaluate the feasibility of abdominal DCS for patients with life threatening conditions in a single institution.

Introduction

Damage control surgery (DCS) had been initiated thirty years ago [1,2]. Traditional surgical principles dictated a series of standard steps that included access, exposure, hemostasis, resection, and reconstruction. Irrespective of the patient's physiologic condition, surgeons continued to perform the technically correct procedure however that the patients often died [3]. For this reason, managing patients with life threatening conditions can be a therapeutic challenge for surgeons. The concept of DCS and the improvement in the pathophysiology for abdominal compartment syndrome contributes significantly to the treatment for traumatic [4] or non-traumatic life threatening condition patients [5]. The practice of DCS includes three components: 1) rapid termination of the procedure after hemorrhage control; 2) continuation of aggressive intensive care unit (ICU) resuscitation; 3) return to the operating room for definitive care [4]. Moore et al. [6] described the six general indications for damage control surgery; 1) the inability to achieve hemostasis due to coagulopathy, 2) an inaccessible major venous injury, 3) the time-consuming procedure in a patient with suboptimal response to resuscitation 4) the management of extra-abdominal life-threatening injury, 5) the reassessment of intra-abdominal contents, 6) the inability to reapproximate abdominal fascia due to visceral edema.

Material and Methods

Thirteen patients who had undergone abdominal DCS between March 2003 and May 2007 were included in this study. We retrospectively analyzed the feasibility of DCS and the risk factors of mortality and morbidity after DCS. DCS was defined as a limited operation where there was control of hemorrhage and contamination. Initial status of patients was assessed with the ASA physical status classification system. Our indications for damage control surgery were an inability to achieve hemostasis due to coagulopathy, inaccessible major venous injury, time-consuming procedures in patients with suboptimal responses to resuscitation, management of extra-abdominal life threatening injuries, reassessment of intra-abdominal contents or the inability to re-approximate abdominal fascia due to visceral edema [6]. This included the management of solid organ injuries by packing, resection of gastrointestinal track injuries without re-anastomosis, the use of temporary closure techniques at a surgical exploration site [7]. Intra-abdominal abscess, intestinal necrosis, enteric fistula formation and pancreatic pseudocyst were defined as a local complication. Acute respiratory distress syndrome, multi-organ dysfunction syndrome and abdominal compartment syndrome were defined as a systemic complication.

Results

Among the thirteen participants, 10 patients had traumatic life threatening conditions and three patients had non-traumatic life threatening conditions. Two suffered from retroperitoneal bleeding (15.4%) 3 from pancreatic head injury (23.1%), 3 had superior mesenteric infarction (SMA) infarction (23.1%) and 2 had massive bowel and duodenal injuries (15.4%). The mean age was 49.7 ± 15.6 , and the mean age of survivors and non-survivors were 47.4 ± 16.8 and 52.3 ± 15.1 . The mortality of the complications were retroperitoneal bleeding 1 (50.0%), pancreatic head injury 1 (33.3%), SMA infarction 1 (33.3%), massive bowel injury 2 (66.6%) and duodenal injury 0 (0.0%) respectively, with an overall mortality at 38.5% (a total of five patients among thirteen patients). The mortality according to ASA II, III, and V were 33.3%, 65.5% and 0.0%, respectively (Table 1).

Variables	No. of patients	Mortality
Retroperitoneal bleeding	2	1 (50.0%)
Pancreatic head injury	3	1 (33.3%)
SMA infarction	3	1 (33.3%)
Massive bowel injury	3	2 (66.6%)
Duodenal injury	2	0 (0.0%)
ASA PS classifications		
II	3	1 (33.3%)
III	8	5 (62.5%)
V	2	0 (0.0%)
Total	13	5 (38.5%)
SMA: Superior mesenteric artery		

Table 1: Characteristics and mortality of the enrolled patients.

When the mortality was analyzed according to lethal triad (acidosis, hypothermia and coagulopathy), the mortality was 83.8% for severe acidosis with a pH under 7.2 and in the cases of hypothermia and coagulopathy were 60.0% and 50.0% respectively, and the patients who had more than two lethal triad category accompanied with hypothermia showed more poorer survival rate (Table 2).

Variables	No. of patients	Mortality
Acidosis		
pH \leq 7.2	6	5 (83.3%)
pH $>$ 7.2, pH \leq 7.33	5	0 (0.0%)
pH $>$ 7.33	2	0 (0.0%)
Hypothermia		
35	5	3 (60.0%)
$>$ 35	8	2 (25.0%)

Coagulopathy			
	positive	10	5 (50.0%)
	negative	3	0 (0.0%)
Acidosis and coagulopathy and hypothermia		4	3 (75%)
Acidosis and coagulopathy		5	2 (40%)
Coagulopathy and hypothermia		4	3 (75%)

Table 2: Mortality of the enrolled patients according to lethal triad.

When complications were compared between survivors and non-survivors, in the survivors the local complication was 62.5%. As for the systemic complication, in the survivors Acute respiratory distress syndrome (ARDS), multi-organ dysfunction syndrome (MODS) and abdominal compartment syndrome (ACS) were 50.0%, 37.5% and 25.0% respectively; in the non-survivors, ARDS, MODS and ACS were 60.0%, 100.0% and 60.0% respectively. And the intensive care unit length of stay for survivors and non-survivors were 28.3 and 19.3 days, respectively (Table 3).

	Survivors (n=8)	Non-survivors (n=5)
Local complications	5 (62.5%)	1 (20.0%)
Systemic complications		
ARDS	4 (50.0%)	3 (60.0%)
MODS	3 (37.5%)	5 (100.0%)
ACS	2 (25.0%)	3 (60.0%)
ICU care (day)		
range	11 ~ 55	2 ~ 60
mean	28.3	19.6
ARDS: Acute respiratory distress syndrome; MODS: Multi-organ dysfunction syndrome; ACS: Abdominal compartment syndrome		

Table 3: Comparison of the complications and ICU care periods between survivor and non-survivor.

Discussion

The damage control surgery (DCS) had been undertaken thirty years ago as a method of salvaging critically ill patients with physiologic compromise [1,2]. Multiple trauma and abdominal catastrophes are associated with significant morbidity and mortality. Associated systemic inflammatory processes, combined with large-volume fluid resuscitation, may lead to the development of acidosis, coagulopathy, and hypothermia. This "lethal triad" synergistically contributes to further physiologic derangement and, if uncorrected, almost invariably results in mortality [8]. In 1983, Stone et al. [2] suggested that the development of coagulopathy contributed significantly to poor outcomes in these exsanguinating patients. They proposed a method rapidly to terminate the procedure, reverse the coagulopathy, and return the patient to the operating room at a later time for definitive care.

Acidosis results from hypoperfusion and subsequent oxygen debt to the tissues resulting in a shift from aerobic to anaerobic metabolism at the cellular level and subsequent lactic acidosis [3]. Acidosis is known to be related with early mortality [7,9] as was demonstrated in our study. When the pH was over 7, there was no mortality, however a pH below 7, had a very high mortality (83.3%).

Coagulopathy had occurred with the appearance of multiple factors such as the dilution of coagulation of factors and platelets by fluid resuscitation, decreased total and ionized calcium concentration, hypothermia, the severity of injury, shock, and metabolic acidosis [10,11]. Stone et al. [2] reported that when DCS was performed on patients with major bleeding diatheses, 82% of patients with coagulopathy were corrected.

Frischkencht et al. [7] reported that coagulopathy upon hospital admission was one of the strongest predictors of poor outcome among the lethal triad. In their study, early deaths presented with significantly deranged coagulation parameters including an elevated INR and lower platelet counts on hospital and ICU admission. In our study, 10 among the 13 patients (76.9%) showed coagulopathy and among them 10% of the patients with coagulopathy died. However, there were no cases of mortality in the patients without coagulopathy.

Thermal homeostasis depends on a balance between the factors governing heat loss and the body's ability to generate and maintain metabolic energy. Heat loss begins at the moment of traumatic insult, and is exacerbated by extenuating circumstances such as shock and low perfusion, prolonged exposure, immobility of acutely injured patients, and the extremes of age [11]. Clinically significant hypothermia is considered present when the core temperature is less than 35° [12]. Hypothermic patients have significantly greater fluid, transfusion, vasopressor and inotropic requirements, resulting in higher incidences of organ dysfunction, mortality, and markedly prolonged ICU stay [1,13,14]. Steinemann et al. [13] reported that hypothermic patients had a lower predicted probability of survival and a higher mortality rate than eutermic patients. However, when patients were stratified by physiologic and anatomic indicators of injury severity, mortality rates among the eutermic and hypothermic patients were not significantly different. Early post-traumatic hypothermia does not appear to exert an independent effect upon outcome. In our study, the mortality of hypothermic patients was 60.0%, higher than that of eutermic patients. This shows that the hypothermic state may reflect disease severity.

The morbidity of DCS was about 40% and abdominal abscess or fluid collection was known as the most frequent abdominal complications [15]. In the survival group, local complication including intra-abdominal abscess was frequent and in the non-survival group systemic complication was frequent, and the period of ICU stay was longer in the survival group. It may have resulted from the masking of local complications from systemic complications and early death in the non-survival group. Recently, Johnson et al. [16] reported that the continued application of damage control surgery has led to improved survival in patients with penetrating abdominal injury by comparing a historical cohort with a current study population. In their study, the overall survival improved from 58% to 90% with equivalent injury severity. They concluded that the early treatment of hypothermia and coagulopathy and the increasing experience with the open abdomen significantly contribute to improved survival. A review by Rotondo et

al. [15] identified 961 damage control patients in the literature, with 50% mortality and 40% morbidity overall [15]. In our study, the overall mortality was 38.5%. There is no comparative study with the patient group with equivalent injury severity, but when compared with the studies of Johnson et al. [16] and Rotondo et al. [15], the results are acceptable. Although our study had the limitation to the retrospective study and a low volume. However, our study showed acceptable results of the DCS, so we think that DCS may be a useful surgical treatment option for the life threatening condition patients.

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