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STAGED ABDOMINAL RE-OPERATION FOR ABDOMINAL TRAUMA

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ABSTRACT
Background: *To review the current developments in staged abdominal re-operation for abdominal trauma.*
Methods: *To overview the steps of damage control laparotomy.*
Results: *The ever increasing importance of the resuscitation phase with current intensive care unit (ICU) support techniques should be emphasized.*
Conclusions: *General surgeons should be familiar to staged abdominal re-operation for abdominal trauma and collaborate with ICU teams, interventional radiologists and several other specialties to overcome this entity.*
Key words: *abdominal trauma, staged laparotomy, abdominal compartment syndrome, damage control surgery*

INTRODUCTION

During the past decade, a new surgical approach to patients with devastating trauma has emerged. Based on a modified operative sequence using rapid lifesaving techniques, definitive resection and reconstruction are delayed until the patient can be adequately resuscitated and stabilized in the surgical intensive care unit.[1-5]

Damage control is currently the most common term to describe staged surgery or staged abdominal re-operation for abdominal trauma (STAR). Although most experience with damage control surgery comes from STAR, it also has applicability to a wide range of other traumatic and nontraumatic problems, including thoracic, gynecologic, and orthopedic procedures. [6-8]

HISTORICAL BACKGROUND

The technique of abdominal packing with planned re-operation was first described in the beginning of 20th century as perihepatic packing.[9-10] At that time, liver lacerations were frequently packed with absorbable or nonabsorbable materials sutured in place. Removal of the packing often resulted in uncontrollable hemorrhage. Surgeons turned attention to the military model, in which a staged approach to complex injury was thought to be the most effective way to manage multiple patients during warfare.[11] A similar protocol is used for maintaining hemostasis, preventing enteric contamination, and planned reoperations. During World War II, perihepatic packing fell into disfavor due to reports of hemorrhage, sepsis, and necrosis.[1] In 1981 Feliciano et al.[12] reported the survival in nine of ten patients who underwent temporary laparotomy with pad tamponade for hepatic injuries. In the beginning of the 1980's, two studies reported abdominal packing followed by rapid abdominal closure that was used for treatment of coagulopathy of nonhepatic abdominal injuries.

WHAT IS STAR?

STAR is a technique of serial operations, planned either before or during the first index operation, and performed within 24 to 48 hours, with temporary closure of the abdomen, and culminating in a final aponeurosis-to-aponeurosis abdominal closure.[13,14] Myoaponeurotic margins can be gradually trimmed to bring aponeurotic borders progressively closer to one another. Wittman et al.[14] compared several devices used for temporary closure of the abdomen, including zippers, a slide fastener, and a Velcro (Velcro USA Inc, Manchester, NH) analog. They concluded that the Velcro analog was the most practical option.

DAMAGE CONTROL TECHNIQUE

Damage control surgery consists of three phases, initial laparotomy, resuscitation phase, and definitive operation.[15]

1. Initial laparotomy

The decision for damage control should ideally be made within the first 15 minutes of the operation. Operative situations that lead the surgeon to choose an abbreviated laparotomy include: the exsanguinating patient with hypothermia and coagulopathy who is

hemodynamically unstable, inability to control bleeding by direct hemostasis, and inability to close the abdomen formally without tension because of massive visceral edema or the so called entity "abdominal compartment syndrome)".[16]

The abdominal compartment syndrome (ACS) is a clinical entity that develops after sustained and uncontrolled intra-abdominal hypertension. ACS has been demonstrated to affect multiple organ systems including the cardiovascular, respiratory, gastrointestinal, genitourinary, and neurologic systems.[16-19] ACS is also defined following severe burn injuries, extra-abdominal trauma or non-trauma laparotomies.[18,20,21] To date most descriptions of ACS are found in the trauma literature, but the development of ACS in the general surgical population such as; surgery of aortic aneurysm or pancreatitis, is being increasingly observed.[18]

Currently, trauma patients who develop ACS but do not have abdominal injuries are defined as "secondary ACS". Secondary ACS is identified as an early but, if appropriately monitored, recognizable complication in patients with major extra-abdominal trauma who require aggressive resuscitation.[21,22] ACS not only concerns intra-abdominal organs, but also creates systemic life-threatening problems. It is demonstrated experimentally that ACS provokes the release of pro-inflammatory cytokines which may serve as a second insult for the induction of multiple organ failure.[23,24] Management of the open abdomen with the temporary abdominal closure does not prevent the development of ACS. Mortality is high when ACS occurs in this scenario. Severe physiologic derangement and high crystalloid requirements may predict which patients will develop ACS.[24]

Morris et al.[25] defined exclusion criteria for damage control surgery as: age 70 years or elder, fatal closed head injuries, and pre-hospital cardiac arrest after blunt injury. However; in daily practice it is experienced that elderly patients, benefit more from staged surgery because of increased sensitivity to physiologic instability.

The choice of temporary closure techniques is left to institutional preference. The towel-clip closure can be performed quickly and is easily reversible in the SICU if necessary, but they have the disadvantage in the requirement of X-rays. Often, the increased capillary permeability of traumatic shock and concurrent fluid resuscitation produce massive visceral edema. If extensive edema is present, a temporary 3-L sterile irrigation bag, also known as the Bogota bag is used. We favor to use the Bogota bag, since it's practical, transparent which is suitable for direct vision of intra-abdominal organs for hemorrhage, leakage, and necrosis, and with low cost (Picture 1). This concept was first used in Bogota, Columbia, where no prosthetic materials existed, and surgeons used creative means to cover edematous abdominal wounds.[6,26] Abdominal packing may be used before closure of the abdomen, with laparotomy pads or rolled mesh gauze. It is advantageous to cover these pads and gauze with sterile drapes, in order to prevent pealing of solid organs during the de-packing process. The hemorrhage is best controlled with placement of packing both above and below the injury, achieving compression from both sides.[27]

Picture 1. Application of the Bogota bag with the transparency availability of the bowel

Difficulties of this technique are that packing may fail to stop the bleeding because of incomplete tamponade or arterial bleeding, and over packing may cause increased intra-abdominal pressure. Balloon catheter tamponade with a Foley catheter or Sengstaken-Blakemore tube or closed Penrose drain filled with saline.[1-4]

2. Resuscitation phase

The primary goals of the resuscitation in the intensive care unit (ICU) are immediate resuscitation and prevention of the onset of the trauma triad of death: hypothermia, coagulopathy,

and acidosis. To abandon this triad several cautions have to be taken.[3,15,16,28]

a. Rewarming

Heat loss during major trauma surgery may be as high as 4.6°C per hour despite aggressive attempts to limit heat loss.[16] Hypothermia, results with platelet dysfunction and disruption of the coagulation cascade. Room temperatures may be increased, and any unnecessary skin exposure avoided. Blood and intravenous fluids may be administered through a rapid infusion fluid warmer. We favor the microwave to heat the crystalloids. In temperatures below 33°C, continuous arteriovenous rewarming should be considered.[28]

b. Reversing coagulopathy

Thrombocytopenia is the leading cause of coagulopathic bleeding in the trauma patient after massive transfusion. Large volumes of crystalloids and packed red blood cells contribute to coagulopathy by diluting coagulation proteins. Re-warming the patient is also required in reversing coagulopathy.[29]

c. Reversing acidosis

Persistent metabolic acidosis is generally a sign of hypoperfusion and the need for ongoing volume resuscitation. Packed red blood cells, platelets, fresh-frozen plasma, inotropic agents, and sodium bicarbonate are administered in addition to crystalloids.[13,30]

d. Optimizing pulmonary function and oxygen delivery

Following damage control surgery, patients are intubated and maintained on mechanical ventilation. Goals are to achieve oxygen saturation or more than 92% with Fio_2 of less than 0.60, with the least adverse effects on cardiac function. These patients usually require sedation and pain medication.[13]

Screening modalities

Upon completion of the resuscitation phase and prior to definitive operation all screening methods should be planned. Angiography, helical computerized tomography (CT) are the most widely used modalities. A very tight coordination between teams of Surgery, Anesthesia, ICU, interventional radiology, and other required departments is a must.[1,2,6,13,27]

3. Definitive operation

Following the resuscitation phase, a careful planning with multidisciplinary coordination is required. The indications for planned return to the OR include removal of packs, closure of the abdomen, assessment of viability of and debridement of ischemic or necrotic tissue, and treatment of other injuries previously left untreated. A re-operation is recommended within 18 to 48 hours.[25,31,32] Early closure of the wound also

Picture 2a, 2b. Delayed skin closure of an intra-abdominal abscess with evisceration following blunt abdominal trauma

allows early mobilization, which is essential for decreasing pulmonary complications and pressure ulcers and for facilitating rehabilitation efforts. When skin closure is still not possible, an absorbable mesh may be sutured to the fascia if sufficient omentum exists to protect the underlying viscera. Some groups favor the skin only closure technique.[33,34] In the late period, it is sometimes safer not to approximate the fascia but just close the skin, in order to prevent from iatrogenic hollow viscera injuries (Pictures 2a and 2b).

CONCLUSION

STAR operation is a cornerstone in the evolution of trauma surgery. Damage control procedures require a high standard ICU care and well-coordinated multidisciplinary approach. Experienced teams on this field should carry out the definitive operation. Patient and the family should be well informed on the risks of mortality and morbidity. If the patient recovers from the acute phase, long recovery period following a major trauma should be explained.

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