Damage Control Surgery for Exsanguinating Abdominal Trauma Patients

Ahmed Kamal Gabr, *MD****; Hossam M. Saleh,*** *MD.*

Vascular Surgery Department, Ain Shams University, Cairo, Egypt.

Background/Aim: *Damage control surgery (DCS) has become a well-established in the past few decades as a surgical strategy to be applied in the unstable trauma patients. Damage control surgery, sometimes known as "damage limitation surgery" or "abbreviated laparotomy, is best defined as creating a stable anatomical environment to prevent the patient from progressing to an unsalvageable metabolic state. Patients are more likely to die from metabolic failure or the lethal triad (hypothermia, metabolic acidosis and coagulopathy) than from failure to complete organ repairs. The aim of this study was to analyze the role of damage control surgery in abdominal trauma patients in terms of morbidity and mortality.*

Patients and methods: *A retrospective review of all patients undergoing a laparotomy and damage control surgery in a level 1 trauma center over a 3-year period was performed. This study includes 42 severely injured patients who presented in the emergency room of a tertiary referral hospital in the eastern province in Saudi Arabia. These patients were hemodynamically unstable because of life-threatening hemorrhage following either blunt or penetrating abdominal trauma. After stat shifting to the operating theatre, both resuscitation and operative intervention were done simultaneously. Variable procedures of damage control surgery like abdominal packing for hepatic and pelvic trauma, major abdominal vessel ligation and temporary shunting using silastic tubes for vascular injury were done in phase I. In phase II patients were managed in the surgical intensive care unit (SICU) for hypothermia, acidosis, and coagulopathy. Phase III for definitive treatment was done after 24-72 hours once the patients got stable.*

Results: *Over the duration of this 3-year study, 42 patients underwent a damage control laparotomy following trauma. There were 93 organ injuries in these 42 patients. The mechanism of injury was blunt trauma in 31 patients (74%), stab wound in 7 patients (17%) and gunshot wounds in 4 patients (9.5%), 28 patients (66.7%) had been involved in motor vehicle accidents and 3 patients (7%) are involved in fall from height. Average time interval between presentation in emergency department and surgical intervention was 17 minutes, and average operating time was 50 minutes. Twenty patients died, giving an overall mortality rate of 47.6%. The mean age of the patients who survived was 24 years, compared with 36 years in the non-survivor group. Increasing age was found to be a statistically significant factor predicting mortality, with a p-value of 0.001. The development of DIC ($p<0.001$), the need for inotropes ($p<0.001$) and the presence of septic shock ($p=0.017$) were found to be significant predictors of mortality.*

Conclusion: *Damage control surgery still represents an important refuge to reduce morbidity and mortality in trauma resuscitation as it gives the patient a chance to survive in an otherwise hopeless situation. The results obtained from our study are in accordance with other studies published to-date i.e. Reducing mortality and morbidity in addition to an improved outcome. The management of this complex problem requires a multidisciplinary team approach with patient counseling and communication with the family.*

Key words: *Damage control surgery, abbreviated laparotomy, abdominal packing, open abdomen, hypothermia, coagulopathy.*

Introduction:

Damage control surgery, "abbreviated laparotomy", "staged laparotomy", "temporary abdominal closure" are synonymous. Over the past two decades, damage control surgery (hereafter, DCS) rather than definitive repair of all injuries has become established as the appropriate surgical strategy in the severely injured patient needing operative intervention.[1] The term "damage control surgery" was first described in trauma by Rotondo and Schwab, who in 1993 outlined a three-phase approach to patients with major abdominal injuries.[2] Damage control is defined as the rapid initial control of hemorrhage and contamination, temporary closure, resuscitation to normal physiology in the ICU, and subsequent re-exploration and definitive repair.[2,3] Damage control is applied when the initial laparotomy is ended and expeditious indirect methods are applied to control massive bleeding or soil or both.[4,5] This has increased the survival rate after major trauma to over 50%. These comprise the first stage, namely the decision as to when to perform DCS, and the final stage of abdominal wall closure.[6] However, little appears to have been documented on factors predicting mortality in this setting. In essence, damage control surgery equates with abbreviated surgery and restoration of near physiology, in a staged approach to a life-threatening injury.[7] This study reviews the experience of damage control surgery for exsanguating abdominal trauma patients in terms of care and complications.

Patients and methods:

Forty-two patients who presented in the emergency room of a Almoosa Specialized Hospital, Al-Ahsa, Saudi Arabia, who underwent DCS for abdominal injury were retrospectively reviewed using the trauma registry of our level I trauma center to review all patients from 1st September 2010, through 31st August 2013. This included management of solid organ injuries by packing, resection of gastrointestinal tract injuries without re-anastomosis, major vessel temporary shunting using silastic tubes for arterial injuries to restore distal lower limb perfusion during the patient's stay in SICU or ligation of the venous injury, and use of temporary abdominal closure techniques. All patients admitted were resuscitated in accordance with treatment protocols outlined in the Advanced Trauma Life Support course (ATLS)[8] of the American College of Surgeons. Damage control surgery was defined as an abbreviated laparotomy performed either because of poor physiological status or the extent of the injury caused by the trauma, with definitive surgery to be performed 24-72 hours later after resuscitation in the ICU.

Inclusion criteria:

- Exsanguating abdominal trauma patients.
- Haemodynamically unstable patients.
- Early blood loss of 4 – 5 litres.
- Arterial pH of 7.25 or less.
- A core body temperature of 34° C.
- Evidence of disseminated intravascular coagulation (DIC).

Nevertheless, these inclusion criteria were somewhat arbitrary because they may involve borderline physiological conditions in which the patient's survival may be unlikely even with damage control. A decision to proceed should be made as soon as the extent of the visceral damage has been assessed. Nevertheless, the surgeon should not feel reluctant to use damage control at any time when needed. Early abbreviated laparotomy is done for the patient who can be only partly resuscitated to curtail life–threatening haemorrhage and minimize further major peritoneal soiling.

Exclusion criteria:

- Age 70 years and more.
- Fatal head injury patients.
- Pre-hospital cardiac arrest.

As soon as the patient met the inclusion criteria for abbreviated laparotomy as above mentioned reached the emergency room of our trauma 1 center, immediate regulations for shifting to operating room and surgical interventions were made. Simultaneous resuscitation and surgical intervention were started on the operation table. Abdominal

packing for hepatic trauma and pelvic injury, major vessel shunting using silastic tubes or major vessel ligations were utilized whenever required in these exsanguating abdominal trauma victims. We utilized different techniques of temporary abdominal closure, e.g. Towel clips, one layer continuous suture, or Bogota's technique using sterile uribag **Figure (1)**. After phase I of damage control is accomplished, the patient is to be shifted to the surgical ICU to be enrolled in phase II for prevention or correction of the trauma triad of death i.e. Hypothermia, coagulopathy and acidosis.

In the surgical ICU, re-warming, correction of coagulopathy, acidosis and optimization of the pulmonary functions were performed. Once the patient got stable in the phase II of damage control approach, planned return to the operating room was made for review of injuries, removal of packs, removal of temporary vascular shunts and definitive vascular repair, debridement of ischaemic necrotic tissues, assessment of viability of tissues, definitive treatment of other injuries previously left untreated and proper abdominal closure if feasible.

Medical records were maintained and later on reviewed for degree and pattern of injury, transfusion requirements for preoperative and postoperative phases, resuscitation and operative time, pH and bicarbonates, complications and definitive treatment and mortality.

Results:

Over the duration of this 3-year study, 42 patients underwent a damage control laparotomy following trauma. The mean age of these patients was 29 years (range 16 - 58 years). There were 34 males (81%) and 8 females (19%). There were 93 organ injuries in these 42 patients, distributed as set out in **Table (1)**. The mechanism of injury was blunt trauma in 31 patients (74%), stab wound in 7 patients (17%) and gunshot wounds in 4 patients (9.5%), 28 patients (66.7%) had been involved in motor vehicle accidents and 3 patients (7%) are involved in fall from height. Average time interval between presentation in emergency department and surgical intervention was 17 minutes, and average operating time was 50 minutes. Twenty patients died, giving an overall mortality rate of 47.6%. The mortality rates for gunshot wounds, blunt trauma and stab wounds were 35%, 32.5% and 5%, respectively. Seven patients (16.7%) died in the surgical ICU within 24 hours after the initial damage control laparotomy. An emergency re-look was necessary in 13 patients (31%) after a mean of 12 hours because of bleeding in 7 patients, abdominal compartment syndrome in 5 patients and bowel leakage in 1 patient. Of these patients, 5 died within the next 2 weeks. Twenty seven patients (64.3%) underwent a planned re-look after a mean of 41.6 hours, and 5 (18.5%) of these patients died. Three patients (7.1%) died within 1 week during phase II DCS during their stay in SICU, 1 from cardiac failure, 1 from pulmonary embolism, and 1 from the associated head injuries. The total number of deaths during the entire period of study was 20 patients (47.6%). The mean age of the patients who survived was 24 years, compared with 36 years in the non-survivor group. Increasing age was found to be a statistically significant factor predicting mortality, with a p-value of 0.001. Twenty three (54.76%) patients developed DIC, twenty patients (47.6%) required inotropes, 15 patients (35.7%) were diagnosed with systemic inflammatory response syndrome (SIRS), 10 patients (23.8%) developed abdominal compartment syndrome, 7 patients (16.7%) were treated for nosocomial pneumonia, and 3 patients (7.1%) were treated for septic shock. The development of DIC ($p<0.001$), the need for inotropes ($p<0.001$) and the presence of septic shock ($p=0.017$) were found to be significant predictors of mortality.

Discussion:

The premise of damage control laparotomy is that the metabolic derangement of ongoing bleeding supersedes the need for definitive operation. As such, the main thrust of damage control laparotomy is the rapid surgical control of bleeding. Damage control

laparotomy has led to better outcomes than expected in these grievously injured patients. Experience with high volume of severely injured casualties expedites the process. Historically these conditions have converged during times of conflict, improving the care of combat casualties and subsequently that of civilian trauma patients.[9]

The conventional sequence of the management of trauma surgery was to bring the patient to the operating room after initial resuscitation and then to operate for complete repair of the injuries. Even patients with multiple complex injuries were operated more aggressively over a prolonged period of time for definitive primary repair10. Subsequently, these patients were sent to the intensive care unit where a good number of the patients succumbed due to metabolic derangement of the body.[11,12,13]

In the most severely injured casualties, it is well-established that when the lethal triad of hypothermia, acidosis, and coagulopathy is present, death is imminent. Current practice is to avoid reaching these conditions by using damage control surgery. However conventional resuscitation practice for damage control focuses on rapid reversal of acidosis and prevention of hypothermia, and surgical techniques focus on controlling hemorrhage and contamination.[14] Direct treatment of coagulopathy has been relatively neglected, viewed as a byproduct of resuscitation, hemodilution, and hypothermia, and delayed by banking logistics.[15] Damage control resuscitation addresses the entire lethal triad immediately upon admission in hospital and as a structured intervention begins immediately after rapid initial assessment in the emergency department and progresses through or into ICU.[16,17]

At the first phase of damage control strategy, only abbreviated laparotomy was done for lifesaving measures, and then the patient was sent to the surgical intensive care unit (SICU) for the correction of the metabolic disorders. Following satisfactory correction the patient was once again taken to the operation room for definitive repair and sent back to SICU for further convalescence, which had been done in our study.

Staged surgical procedures including staged laparotomy represent an important development in the historical spectrum of trauma resuscitation.[17,18] Successful damage control operations are currently best to save life in experienced hands. Management of these complex patients requires an effort from all members of a multidisciplinary trauma team. Rontodo MF along with his team proved twice in his studies the role of damage control surgery and its logic and concluded that damage control is a safe approach for increased survival in exsanguinating patients with major vascular and multiple visceral penetrating abdominal injuries.[14,19] Optimal management involves rapid homeostasis and reversal of metabolic derangements utilizing damage control principles. The traditional concept of damage control surgery favors a life over limb approach and discourages elaborate, prolonged vascular reconstruction. However limb preservation could be successful when the control approach is combined with advanced resuscitative strategies and vascular techniques. Gillespie DL and his team suggested that aggressive damage control resuscitation maneuvers in critically injured casualties successfully permitted prolonged, complex extremity revascularization with excellent limb salvage and graft patency. Recombinant VIIa, fresh frozen plasma, fresh whole blood, platelets and cryoprecipitate, while minimizing crystalloids allowed limb salvage and did not result in early graft failures.[20] We also have seen in our study that this approach has made us able to save even the severely injured patients of polytrauma. A comparison of our patient population with previous report on damage control from Rotondo et al. The overall survival rate 58% in Rotondo et al. While in our study was 52.4%.

Overall results obtained from this study are broadly consistent with the other studies published to-date, i.e. Reducing morbidity and mortality, and improving outcome.

Conclusion:

Damage control surgery still represents

Figure (1): Operative photograph of temporary abdominal closure.

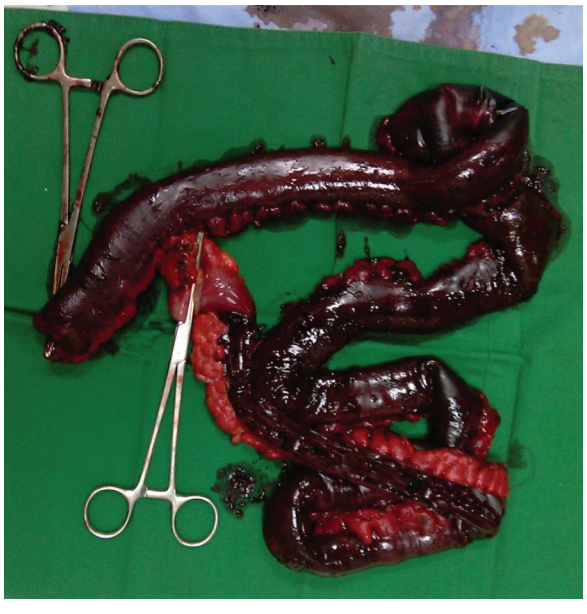

Figure (2): Operative photograph showing resected gangrenous jujenal loops after supersior mesenteric vein thrombosis following blunt abdominal trauma.

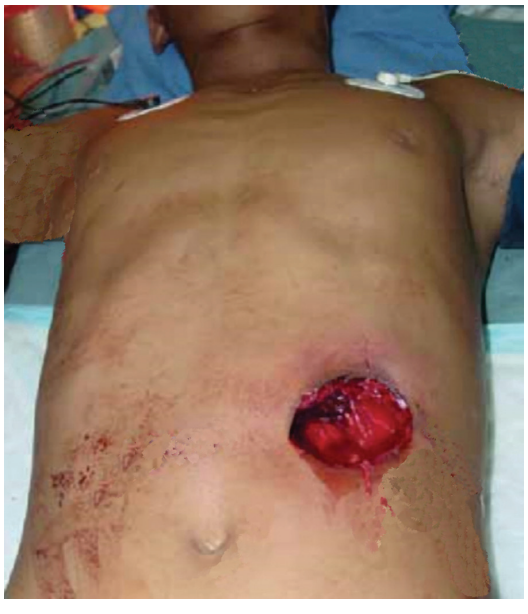

Figure (3): Abdominal automatic gunshot wound with resultant multiuple intra-abdominal injuries nesscitated damage control approach laparotomy.

an important refuge to reduce morbidity and mortality in trauma resuscitation as it gives the patient a chance to survive in an otherwise hopeless situation. It is difficult to learn when to stop and can be learned only from experience. The results obtained from our study are consistent with other studies published to-date i.e. Reducing mortality and morbidity in addition to an improved outcome. The management of this complex problem requires a multidisciplinary team approach with patient counseling and communication with the family.

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Table 1: Detected abdominal organ injuries in 42 patients:

Organ injury	Percentage in the treated patients	Intervention
Liver	45% (19 patients)	Perihepatic packing
Small intestine and avulsed mesentery	40% (17 patients)	Gut resection and temporary stapling
Large intestine	35.7% (15 patients)	Colon resection and temporary stapling
Duodenum	9.5% (4 patients)	Temporary external tube drainage
Spleen	16.7% (7 patients)	Splenectomy
Kidney	19% (8 patients)	Perinephric packing
Inferior vena cava	4.8% (2 patients)	Ligation
Iliac vessels	12% (5 patients)	Temporary shunting or ligation.
Diaphragm	9.5% (4 patients)	Packing
Bladder and ureter	12% (5 patients)	Packing and tie-off
Stomach	9.5% (4 patients)	Primary suturing
Pancreas	7% (3 patients)	Packing

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