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Review Article

Damage Control Strategy

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Abstract

Damage control surgery (DCS) includes principles of controlling bleeding; contain abdominal contamination, and completing definitive surgery on resuscitated patients. Evolved from DCS research, damage control resuscitation (DCR) incorporates early and massive blood product transfusion, restriction of crystalloid administration and permissive hypotension in selected patients. The development of DCS and DCR forms the current great achievement of modern trauma care. DCS combined with DCR has increasingly improved the survival in critically injured patients.

Keywords: Damage Control Surgery; Damage Control Resuscitation; Permissive Hypotension; Open Abdomen

Introduction

The bleeding is the major cause of death in trauma injury [1]. Performing repair surgery in severely injured patients with physiologic derangement is known to be detrimental to the outcome [2-4]. Therefore, rapid and effective control of bleeding associated with delayed definitive surgery and patient resuscitation was the best treatment strategy that led to improving outcome and survival in critically injured patients [2-4]. The continued research in trauma care has led to the development of new concepts in managing severely trauma patients [3]. These concepts include damage control surgery (DCS) and damage control resuscitation (DCR) and form the modern trauma care of critically injured patients [3]. The combined use of DCS and DCR has increasingly improved patient survival.

Damage control surgery

The damage control surgery concept (DCS) had been rapidly endorsed by the surgical emergency community as a treatment strategy for critically trauma injured patients [3]. The fundamental objective of the DCS strategy was to rapidly controlling bleeding, containing abdominal contamination, delaying repair surgery, restoring patient physiology, correcting coagulopathy and achieving a temporary abdominal wall closure. The definitive surgery will be completed with fascial closure if possible on optimized patients [4-7]. Historically, the concept of DCS strategy emerged from the clinical benefits of liver trauma management development [8,9]. In severely injured patients, the perihepatic packing has been firstly described in 1970 [8,9]. This treatment strategy aimed to control bleeding, delaying repair surgery, allowing patient resuscitation, correcting coagulopathy and performing definitive surgery on resuscitated patients. Over time, due to the important benefits of patient survival, the staged laparotomy with perihepatic packing has become a widespread practice and life-saving method in severe liver trauma [8-12].The benefits of the DCS strategy on survival has been clearly demonstrated in severely injured patients when applied in an appropriate setting [5,13,14,15,16]. However, this treatment approach is associated with increased health care resources utilization, high costs and prolonged length of ICU and hospital stays [16]. Also, the patients treated with DCS are subjected to multiple iterative surgeries. Therefore, it is so crucial to select the right patients within the appropriate scenarios .unfortunately, with lack of consensus, concerns remain regarding the appropriateness of the DCS indications. As a result, the rapid and widespread use of this approach has led to overutilization resulting in increased associated morbidity [17].In essence, the DCS approach should be considered in patients who continually suffer the tissue shock sequelae manifesting as persistent hypothermia and metabolic acidosis associated with non-surgical bleeding. Hence, opinion –based DCS triggers have been established including core temperature <35 8C, pH<7.2, base deficit >15, and/

or significant coagulopathies [18]. However, with the lack of coherent research, these indications have not been validated [18]. Consequently, the most indications for DCS strategy are based on intraoperative rather than preoperative data including injured patient characteristics such as physiology, injuries, amount or type of provided resuscitation [18]. So as a result of large volume experience, not all patients initially presenting with physiology derangements require DCS process, patients with multiple abdominal injuries do not always engage in metabolic failure and with rapid control of bleeding and intensive resuscitation, some patients improve dramatically their physiologic parameters allowing repair surgery.

Damage control resuscitation

The patient resuscitation is considered as a crucial step of the damage control surgery strategy. The continued research on trauma care resulted in the development of a new concept "damage control resuscitation "(DCR). This concept incorporates early blood product administration with massive transfusion and early correction of coagulopathy, restriction of fluid administration, permissive hypotension in selected patients, and rapid and immediate control of bleeding. This resuscitation strategy must be started in the emergency room and continued intraoperatively and postoperatively in the IUC [19]. Compared to traditional resuscitation, DCR allows rapid and early correction of physiological derangements and post-traumatic bloody vicious cycle as well as it increases the rate of repair surgery during the first operation [19-22]. Also, correctly implemented, DCR reduced the need for DCS strategy, decreased the stay length in the ICU, increased the rate of primary abdominal closure [22-25]. Currently, the DCR combined with DCS form the modern trauma care continuum [26,27].

Permissive hypotension

The dogma of restoring the physiologic blood pressure of patient has been challenged by describing the concept of permissive hypotension in 1994 [27]. This concept criticized initially, has been recently supported by the published report [28]. Therefore, Permissive hypotension is a major topic of recent trauma research [29]. The hypotensive resuscitation aims to decrease bleeding from injured tissue or the operative site. The Short-term hypotension with a mean arterial pressure of 50mmHg or systolic blood pressure of 80–100mmHg is well tolerated in non-severe bleeding; however, aggressive resuscitation should be undertaken in patients whose conditions continue to deteriorate [28,29]. The conservative hypotensive strategy is more efficacious resuscitation method to facilitate the complete control of bleeding with less administration of blood components and crystalloids, decrease postoperative coagulopathy and reduce early mortality [28,30-33]. Moreover, hypertensive resuscitation has been revealed to be a more effective strategy than traditional resuscitation in terms of multi-organ failure and acute respiratory distress syndrome [33]. Therefore, permissive hypotension can be applied in critically injured patients who respond to resuscitation or need transfer to the trauma centre, and in the preoperative setting. Moreover, permissive hypotension can be used preoperatively and perioperatively; however, once bleeding controlled, the blood pressure should be maintained to a normal level with sufficient urine output. Additionally, if the time to control bleeding is short, the indication of permissive hypotension becomes obvious resulting in reduced blood transfusion. Unfortunately, there is no current consensual strategy regarding when and how to apply permissive hypotension during the resuscitation phase, and its duration and tolerability, Hence, further studies investigating these issues are highly needed.

Abdominal Compartment Syndrome

Abdominal compartment syndrome is characterized by an abdominal pressure superior to 20 mmHg with organ dysfunction/ failure [34-38]. Oppositely, the intra-abdominal hypertension is defined as a pression elevation greater than 12 mmHg and it is graded from I –V. The ACS syndrome has been first, described after abdominal closure in 1993[35]. A tightly packed and closed abdomen associated with intestinal oedema led to significantly increasing the intra-abdominal pressure and the development of ACS) [39]. The ACS impacts the major system including cardiovascular (hypotension), renal (acute kidney injury) and respiratory (failure). Fascinatingly, the risk factors for developing ACS as the same as those proposed as physiologic triggers for indicating DCS/DCR. Indeed, these indicators (pH, base deficit, and core temperature) clearly represent the extremely physiologic derangements of most critically injured patients. Initially, the reported ACS incidence was superior to 30% and associated mortality was greater than 60% in major trauma patients [15]. However, over time, open abdomen surgery combined to DCR technique has increasingly reduced the incidence of ACS syndrome [35,36,38]. Therefore, temporary abdomen closure and planned delayed fascial closure is a vital component of DCS strategy and a clear method to prevent ACS. Currently, the prevention of ACS constitutes the greatest documented achievement of modern post injury critical care.

Open Abdominal or temporary abdominal closure

Open abdomen (OA) or temporary abdominal closure (TAC) is a planned management strategy applied in critically injured patients who need relaparotomy to complete definitive surgery [41,42]. So, the abdominal organs are covered with skin or prosthetic materials to protect them and avoid abdominal pollution [41,42]. Historically, delaying primary abdominal wall closure in the context of DCS approach has been described firstly in 1981 [43]. Compared to delayed fascial closure, the mortality was higher in patients whose primary abdominal wall was closed under tension resulting in intra-abdominal pression elevation and abdominal compartment syndrome (ACS) [43]. Multiple techniques are available for covering the open abdomen including the skin closure techniques include skin suture, towel clips, silo technique and silicone diaphragm placement. The skin closure technique is rapid, economical and easy to implement. However, it is associated with increased risk of skin necrosis, abdominal contamination, evisceration and abdominal wall retraction. Hence, this technique is rarely used nowadays. Fascial closure techniques (FCTs) consist of suturing prosthetic materials (absorbable and nonabsorbable meshes) to the edges of the abdominal fascia in order to cover and protect the abdominal organs [44]. The materials sutured to fascia edges should be redundant to keep abdominal wall relax and prevent ACS, and progressively tightened in the postoperative stage [44,45]. The great achievement of FCTs is to obtain a tension-free temporary abdominal closure (TAC), facilitate repeated operations especially for patients who have limited opportunity to perform definitive abdominal closure within 1 week [44,45]. The disadvantages of the FCTs are the inability of wound drainage and peritoneal fluid evacuation that can lead to recurrent ACS. Another major inconvenient with the use of nonabsorbable mesh is the risk of intestinal fistula formation [44-46]. Vacuum-assisted closure technique consists of covering the exposed intestine with omentum majus and suturing tailored gelatin sponge composite material to the abdominal wall in order to provide a moist environment and avoid intestinal desiccation. A biological membrane is used to seal foam and wounds with 3-4 cm over the incision edge. The applied negative pressure varies from 45–60 mmHg. Besides, vacuum-assisted closure system prevents mechanical damage of viscera, facilitates peritoneal fluid evacuation, avoids contamination of abdominal cavity, reduces inta-abdominal pression (IAP), decreases dressing change number, and favours wound healing [44,46,47]. Among previously described techniques for covering OA, The vacuum-assisted closure system is the most used technique with multiple choices [44,46,47]. However, a trauma centre should use a single technique that is more familiar with the health care team including surgeons and nurses working in the ICU. The OA approach has increasingly contributed to preventing ACS following DCS strategy. Unfortunately, the OA is associated with significant early morbidities such as protein and fluid loss, sepsis, entero-atmospheric fistula, overuse of care health resources and high economic costs [48,49]. As long-term morbidity, OA is a source of chronic physical discomfort, delayed return to work and poor quality of life [48,49]. Over time, as a result of continued research on trauma care, the OA approach has become a component of DCS strategies for trauma management.

Conflict of Interest

None declared.

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