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From Collapse to Control: A Case Report on Damage Control Resuscitation in Crush Injury

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ABSTRACT

Damage-control resuscitation is a method used to care for seriously injured trauma patients. It helps reduce blood loss and manage or treat problems with blood clotting. This approach uses early steps to stop bleeding, gives fluids carefully to keep blood pressure low, and uses blood products in a balanced way. This protocol is based on strong evidence and is meant to guide the best care for trauma patients who are losing a lot of blood (1). A serious problem that can happen is called the lethal triad, which includes acidosis, hypothermia, and coagulopathy. This triad can make it hard to fix all injuries in one surgery. In these cases, damage control surgery is recommended to delay full treatment and focus first on helping the patient's body recover instead of fixing all injuries at once. This approach has been shown to greatly improve the chances of survival for patients who are very badly injured (2).

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INTRODUCTION

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Here, we report case about patient with serious crush injury treated with damage control resuscitation management.

CASE REPORT

A 39-year-old male construction worker was brought to the emergency department after sustaining a severe crush injury to his right upper arm when a concrete beam collapsed during demolition work, trapping the limb for approximately 12 minutes. On arrival he was pale, confused, and in clear distress. His vital signs indicated significant hemodynamic instability with a blood pressure of 74/48 mmHg, heart rate of 142 beats per minute, respiratory rate of 28 breaths per minute, oxygen saturation of 94% on a non-rebreather mask, and a temperature of 35.1°C. A large, deep crush laceration extended across the mid-humerus, with active arterial bleeding, extensive soft-tissue destruction, and marked swelling. The arm was pale and cool distal to the injury, and both radial and ulnar pulses were absent. A rapid trauma assessment revealed no associated chest or abdominal injuries. Preliminary X-rays demonstrated a comminuted mid-shaft humeral fracture, while laboratory results showed a hemoglobin of 7.2 g/dL, lactate of 6.8 mmol/L, potassium of 5.7 mmol/L, INR of 1.9, creatine kinase of 12,600 U/L, and metabolic acidosis, consistent with hemorrhagic shock compounded by crush syndrome.

Given his deteriorating circulation and ongoing blood loss, the trauma team immediately initiated damage control resuscitation. Permissive hypotension was maintained with careful targeting of a systolic blood pressure between 80 and 90 mmHg, and crystalloid administration was minimized. Blood products alongside calcium replacement and early administration of tranexamic acid was given. Worsening shock prompted rapid transfer to the operating room within 22 minutes of arrival. Intraoperatively, near-circumferential soft-tissue destruction was found with multiple areas of devitalized muscle, a complete laceration of the brachial artery and major venous structures, and significant intermuscular hematoma. To rapidly restore limb perfusion, a temporary intraluminal vascular shunt was inserted into the brachial artery, while multiple bleeding venous branches were ligated. Devitalized muscle was sharply debrided, fasciotomies were performed to prevent worsening compartment syndrome, and a temporary external fixator was applied to stabilize the humeral fracture. The wounds were temporarily dressed, and the patient was transferred to the intensive care unit for continued DCR.

In the ICU, the patient received active warming to correct hypothermia. Aggressive fluid management, including bicarbonate infusion, was used to limit kidney damage from rhabdomyolysis, and urine output was maintained above 1 mL/kg/hr. Electrolytes were closely monitored, particularly potassium, due to muscle breakdown. Broad-spectrum antibiotics were initiated because of

the high risk of contamination. Over the next 12 hours, the patient's hemodynamics improved significantly; lactate fell to 2.4 mmol/L, blood pressure stabilized at 102/60 mmHg, and heart rate decreased to 96 beats per minute, allowing consideration of definitive surgery.

The patient's recovery was steady. He experienced no renal failure despite initial severe rhabdomyolysis. The skin graft healed completely, and he was discharged with a structured outpatient rehabilitation plan. By the three-month follow-up, he had regained functional elbow motion from 15 to 110 degrees and good hand function with mild residual weakness, ultimately returning to light administrative duties at work.

DISCUSSION

Damage control resuscitation (DCR) is a strategy used to resuscitate patients in hemorrhagic shock to restore homeostasis. Efforts focus on blood product transfusion with whole blood or component therapy that closely approximates whole blood, limited use of crystalloids to prevent dilutional coagulopathy, hypotensive resuscitation until bleeding is controlled, use of tranexamic acid, prevention of acidosis and hypothermia, and rapid definitive surgical control of bleeding (3).

The concept has been integrated into clinical practice to describe a management approach for patients with severe injuries. It is closely related to the widely accepted two hit model of the systemic inflammatory response to trauma, which suggests that severe trauma may trigger an excessive activation of the immune and inflammatory system (the first hit). During this acute phase, which is time-sensitive, a subsequent injury (the second hit), such as surgical intervention, can lead to uncontrolled physiological imbalance (known as the systemic inflammatory response syndrome). The initial pathophysiological response to serious injury typically leads to the classical "lethal triad" of hypothermia, coagulopathy, and acidosis (2,4).

The strategy we implemented in this case started with identifying the need for damage control resuscitation in the patient. First, in order for patients to benefit from a damage control sequence, our decision to abort operative intervention in this case must be made early such as hypotension in the trauma resuscitation area; early indicator that the patient is in decompensated state and elevated lactate and base deficit are also early warning signs of physiologic derangement. The decision made because of presence of acidosis in the first place. In DCS, choosing the right patients is essential. In patients with substantial physiological compromise, attempts at primary definitive surgical therapy will almost always result in a bad outcome or unanticipated operation shortening. On the other hand, overuse of DCS may deprive patients with sufficient physiological reserve of the advantages of successful early treatment and sentence them to needless additional treatments that carry a risk of morbidity and death (5,6).

In trauma patients, hemorrhage can result in a period of ischemia that results in tissue hypoxia. The restoration of adequate volume and tissue perfusion after control of hemorrhage and resuscitation improves blood flow and causes reperfusion injury to injured cells. If tissue ischemia is prolonged or ischemia-reperfusion injury severe enough, cells may undergo apoptosis or necrosis and further drive inflammation (7). Acute bleeding triggers cellular hypoxia resulting in metabolic acidosis (lactic acid) and hypothermia (decreased metabolism, loss of heat transport by hypovolaemia). Hypothermia and acidosis lead to coagulopathy because the coagulation factors are enzymes that do not work efficiently below 34°C and or pH <7.25. Coagulopathy exacerbates bleeding. Crystalloid volume resuscitation results in dilution of the coagulation factors, cooling and induction of acidosis by dilution and hyperchloraemia. Transfusions add to the deleterious effect of perfusions via the citrate anticoagulants added to PRBC (acidosis and hypocalcaemia); conversely, transfusions can decrease cell hypoxia by improving oxygen transportation (8). DCR have been associated with improvements in survival for the severely injured trauma patient. An abbreviated operation to attain control of haemorrhage and and also aggressive resuscitation allows one to improve the patients' physiology. DCR used during the initial phases of damage control has further been associated with improved mortality rates and reduced incidence of complications in major trauma patients. It may reduce the requirement for (DCS) as patients' better physiological condition after DCR allow them to better withstand early definitive surgery.

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