

## Damage control surgery

Damage control surgery (DCS) has been one of the major advances in trauma surgery over the past two decades and is now a well-established surgical strategy in the management of the severely injured and shocked patient. DCS refers to a conscious decision by the surgeon to minimise operative time in a seriously injured patient when the combined effects of the magnitude of the injury and the markedly altered physiological state of the patient preclude an immediate and safe definitive operative procedure. DCS encompasses a change in the surgical mindset with realisation of the need in the severely injured and shocked patient to halt and reverse the lethal cascade of events that include hypothermia, acidosis and coagulopathy, a sequence which has been termed the 'triad of death'. During the initial abbreviated surgical intervention, bleeding is stopped, contamination is controlled and the patient is transferred to the intensive care unit for 'physiological resuscitation and stabilisation'.<sup>1-3</sup> Once this has been achieved, the patient is returned to theatre for definitive treatment. The surgical decision to apply DCS is not a bail-out operation but the realisation that successful trauma surgery not only requires attention to the injuries sustained but also appreciation of the physiological status of the patient.

The term damage control is derived from the United States Navy, with reference to a strategy that allows the rapid inspection and urgent temporary repair of a damaged hull during conflict to enable the ship to return to port and undergo definitive repair under optimal conditions.<sup>4,5</sup> The success of the naval strategy led to use of the term to describe a similar approach in trauma surgery where the emphasis is on rapid assessment and often temporary repair to enable the survival of a patient. Rotondo *et al.* from the University of Pennsylvania used this term in 1993 to describe an abbreviated surgical strategy in the setting of a 'damage control laparotomy'.<sup>6</sup> The concept was not new, as there had been surgical reports of packing wounds dating back to the American Civil War, and Pringle and Halsted in the early 20th century described the technique of packing to control haemorrhage.<sup>7-8</sup> In the 1970s and later further reports demonstrated the effectiveness of liver packing after trauma,<sup>9,10</sup> and in 1983 Harlan Stone<sup>11</sup> successfully applied a new approach of the 'abbreviated laparotomy with intra-abdominal packing' in patients with apparent intra-operative coagulopathy. This surgical strategy has since evolved beyond the abdomen to include injuries involving the neck, chest, pelvis and extremities.

Modern damage control surgery comprises five stages. Stage 1 is the decision to perform DCS, stage 2 is the operation, stage 3 is the restoration of normal physiology, stage 4 is the relook laparotomy, and stage 5 is abdominal wall closure. The decision to perform DCS (stage 1) may range from an intuitive and obvious situation such as a high-velocity gunshot wound to the abdomen to more difficult operative decisions for implementation of DCS such as may be encountered in complex liver and pancreatic injuries. It is vital that the decision is made early in the operative course and not delayed until the patient is hypothermic and coagulo-

pathic with a firmly established 'vicious cycle'. Timmermans *et al.* in this edition of *SAJS* have evaluated the factors predicting mortality in DCS and have proposed specific criteria for DCS.<sup>12</sup> They advise that DCS should be initiated when the pH is <7.20, the base excess worse than minus 10.5 and the core temperature less than 35°C. When a major injury is recognised, however, the surgeon should not wait for these criteria to be reached. These data provide uniformity and specific criteria as to when DCS should be undertaken.

The second stage of DCS is the initial operation. The surgeon should do the minimum required to rapidly control exsanguination (suture, ligation, temporary vascular shunt or packing) and to prevent spillage of gastro-intestinal content and urine in the abdomen (suture, ligation, stapling or ureterostomy).<sup>13</sup> Long and complex surgical procedures that include resection and anastomosis should be avoided.<sup>1</sup> Chinnery *et al.* from King Edward VIII Hospital achieved a 77% survival rate by utilising primary repair of the duodenum with external drainage of the pancreatic injury in unstable patients with major pancreaticoduodenal injuries.<sup>14</sup> These authors advise that the pancreatic duct can be evaluated once the patient is haemodynamically stable and a definitive reconstructive procedure planned for a later stage, which represents a simple, quick and pragmatic approach to major pancreaticoduodenal trauma.

The determinants for splenectomy in blunt trauma are analysed in a paper from Wesley Guild Hospital in Nigeria.<sup>15</sup> A splenectomy was required in 60% of patients, with operative salvage achievable in 18%. While splenic preservation is the ideal, it does not have a place in the DCS scenario. When DCS is being undertaken, a splenectomy should be done for splenic injuries as the patient will not tolerate further haemorrhage from a splenic laceration that has been treated conservatively at the initial laparotomy.

Where primary abdominal fascial closure is not possible and abdominal compartment syndrome is a concern, a modified sandwich technique should be used.<sup>16</sup> Restoration of normal physiology is undertaken in the ICU with aggressive resuscitation, warming and correction of the acidosis and coagulopathy. The relook laparotomy is undertaken at 24 - 48 hours depending on the indication for the original DCS. Liver packs should only be removed at 48 hours after the initial operation, as the risk of rebleeding from the liver during an early relook at 24 hours significantly increases.<sup>17,18</sup> It is important to conduct a thorough examination for any missed injuries at the relook laparotomy. Bowel and vascular structures are reconstructed, but high-risk anastomoses should be avoided if possible. Final closure (stage 5) is usually performed after the definitive surgery has been completed, but in the case of the open abdomen, skin grafting on granulated bowel may be required with later closure of the ventral hernia.

DCS has dramatically improved the management of the severely injured patient. This strategy also allows surgeons with limited experience to deal simply but effectively with complex injuries and then transfer the patient to a regional

trauma centre with the necessary resources. However, DCS should not be over-used and it is important that specific criteria are used to implement this surgical strategy. When resources are overwhelmed by mass casualties, it will be necessary to triage patients and identify those patients who are not salvageable even with the use of DCS.<sup>19</sup>

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