Journal of Visceral Surgery (2016) 153, 13—24

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Elsevier Masson France EM|consulte www.em-consulte.com/en

REVIEW

Abbreviated laparotomy or damage control laparotomy: Why, when and how to do it?☆

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Available online 16 August 2016

KEYWORDS
Trauma;
Abbreviated laparotomy;
Damage control

Summary The goal of abbreviated laparotomy is to treat severely injured patients whose condition requires an immediate surgical operation but for whom a prolonged procedure would worsen physiological impairment and metabolic failure. Indeed, in severely injured patients, blood loss and tissue injuries enhance the onset of the ''bloody vicious circle'', triggered by the triad of acidosis-hypothermia-coagulopathy. Abbreviated laparotomy is a surgical strategy that forgoes the completeness of operation in favor of a physiological approach, the overriding preference going to rapidity and limiting the procedure to control the injuries. Management is based on sequential association of the shortest possible preoperative resuscitation with surgery limited to essential steps to control injury (stop the bleeding and contamination), without definitive repair. The latter will be ensured during a scheduled re-operation after a period of resuscitation aiming to correct physiological abnormalities induced by the trauma and its treatment. This strategy necessitates a pre-defined plan and involvement of the entire medical and nursing staff to reduce time loss to a strict minimum.

☆ Study accomplished under the aegis of the French Society of Emergency Surgery (Société française de chirurgie d'urgence), member of the European Society for Trauma and Emergency Surgery.

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http://dx.doi.org/10.1016/j.jviscsurg.2016.07.002
1878-7886/

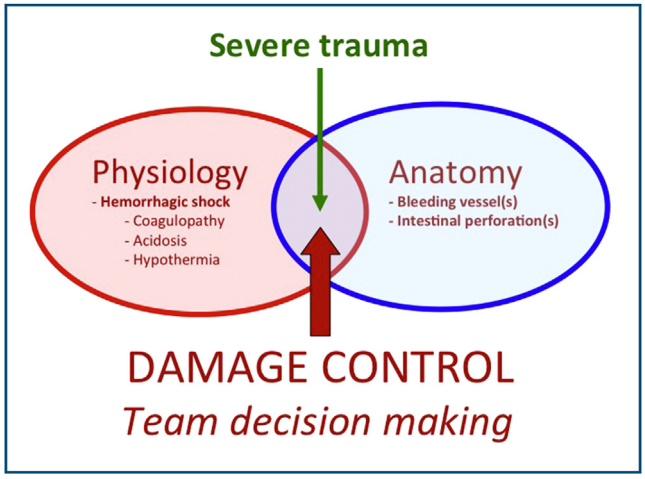

Figure 1. Damage control strategy. Damage control for a severe trauma victim requires simultaneous correction of physiological disorders and temporary restoration of anatomy to obtain hemostasis and stop the contamination. Success depends on pluri-disciplinary team decision-making.

Abbreviated laparotomy [1,2], or damage control laparotomy (DCL) [3], is an integral part of salvage therapy for severe abdominal trauma patients. Implementation requires a well-drilled multi-disciplinary and multi-professional team, working with pre-established protocols. Ideally, patients who require DCL should be identified as early as the pre-hospital phase of management [4]. In France, because pre-hospital care is medicalized, the rule is that triage should direct the most severe trauma patients straight to the operating room; this implies that a complete surgical team (general or emergency surgeon, one or two assistant surgeons, scrub and floor nurses, one or two anesthesiologist/intensivists, one or two anesthesiology nurses and care staff persons) should be physically present upon arrival of the patient in the receiving structure, ready to go. The term ''damage control'' comes from the US Navy and groups all the techniques that allow keeping a vessel afloat, by essentially sealing off all water leaks, but also combating fires, restoring the essential electric circuits and propelling the ship to safe port [5]. The Navy underscores the necessity of personnel preparation and situation training, and pre-positioning of the necessary material [5] in order to boost the chances of successful damage control. This same concept can be completely transposed to the DCL setting: structured simulation courses such as the Advanced Trauma Life Support (ATLS®) [6] and the Definitive Surgical Trauma Care (DSTC™) [7] courses, packed into a minimal working framework, provide the surgeon with the essential basic, practical and decision-making steps necessary for this salvage surgery. Both of these courses are based more on restoration of physiology than on the specific injuries of the trauma victim [7], thus representing a whole new paradigm for the surgeon (Fig. 1).

Physiological hemorrhage control

When bleeding occurs, the aortic arch and carotid sinus baroreceptors detect the drop in arterial pressure. This information is then transmitted to the central nervous system, which in turn increases the sympathetic vascular tone [8]. Increased sympathetic vascular tone triggers tachycardia (because of decreased blood volume, oxygen transportation is ensured by more rapid circulation of red blood cells) and vasoconstriction that privileges the vascular beds of the heart and brain to the detriment of all other organs and tissues (digestive tract, kidneys, muscle and skin). Vasoconstriction at the site of injury decreases the bleeding rate and allows platelets and activated coagulation factors to seal off the vascular breach by clot formation [9] (Fig. 2). Fibrinolysis regulates coagulation [10]. In the most favorable scenario, bleeding stops or decreases substantially. In unfavorable settings, either because the vascular breach is too large or there are too many, the trauma victim's coagulation factors are consumed and fibrinolysis ensues [11], leading to increased volume of blood loss. At some point, tachycardia and vasoconstriction no longer suffice to compensate for the loss of blood, and as the oxygen delivery capacity is reduced, bleeding continues.

The lethal triad: hypothermia, acidosis coagulopathy

Blood loss leads to hypothermia, since blood flow plays, among other roles, that of a fluid purveyor. As a result of acute hypoxemia, cell glycolysis stops at the level of pyruvates, which, instead of entering the Kreb's cycle, lead to increased lactate production [12]. Thus the trauma victim with ongoing bleeding develops lactic acidosis. In humans, coagulation proteins function best at 37°C and with a pH above 7.2. When hypothermia and acidosis set in, the activity of the unconsumed coagulation factors decreases [13]. As blood becomes hypo-coagulable, ongoing hemorrhage ultimately intensifies hypothermia and acidosis, which in turn exacerbate the coagulopathy: this is known as the bloody vicious circle [14], which can lead to death by exsanguination (Fig. 3).

It is very difficult to break out of the vicious circle; conversely, it is very easy to fall into it: delay in obtaining hemostasis due to efforts to assemble non-essential material and performance of useless imaging investigations (while bleeding continues), hemodilution by intravenous fluids (hypothermia, dilution acidosis, anemia, dilution of coagulation factors), hypocoagulability induced by hetastarch [15], and reliance on factitious ''hemodynamic stability'' maintained by vasoactive pressor agents (lactic acidosis enhanced by visceral and peripheral ischemia) are all contributing factors. For a patient with isolated severe abdominal trauma who is hypotensive upon arrival in the emergency department, the probability of death increases every three minutes by approximately 1% [16]. Medico-surgical procrastination greatly enhances the bloody vicious circle.

Damage control resuscitation

''The treatment of bleeding is to stop the bleeding'' [17]. The goal of the damage control resuscitation management strategy is to ensure survival of the trauma victim until hemostasis can be obtained, while keeping iatrogenic risks to a minimum.

Damage control resuscitation is an integral part of the ABCDE protocol of ATLS [18]:

- A = airway: the victim's airway must be clear and protected, most often by orotracheal intubation. The C-spine is protected by placement of a cervical collar;