Control of haemorrhage and damage control surgery

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Abstract

Major haemorrhage is associated with significant morbidity and mortality. Prompt recognition and resuscitation is key to improving short- and long-term outcomes and survival. Knowledge of mechanism of injury and potential trauma sustained assists identification of life-threatening bleeding. Management of the patient goes beyond the 'ABCDE' approach with a series of clinical interventions known as damage control resuscitation addressing complications of major haemorrhage (coagulopathy, hypothermia and acidosis).

Investigations are reserved mostly for the haemodynamically stable patient. For unstable patients the operating theatre is the place to achieve haemostasis by endovascular approaches or damage control surgery (DCS). Damage control surgery sacrifices the completeness of the immediate surgical repair and restoration of anatomy in order to adequately address the combined physiological insult of trauma and subsequent surgery. Surgical strategy in a severely traumatised patient should be considered by the multidisciplinary team prior to operating.

Regular discussion between the anaesthetist and surgeon allows progress to be reviewed and realistic goals set for initial surgery. Definitive surgery should be delayed until abnormal physiology is corrected.

Keywords Damage control resuscitation 5–10; damage control surgery; major haemorrhage

Introduction

'Major haemorrhage' is defined[1] as:

- loss of more than total blood volume within 24 hours (around 70 ml/kg, >5 litres in a 70-kg adult)
- 50% of total blood volume lost in less than 3 hours
- bleeding in excess of 150 ml/minute
- bleeding which leads to a systolic blood pressure of less than 90 mmHg or a heart rate of more than 110 beats per minute.

Haemorrhage to this extent has a significant impact on morbidity and mortality, making robust knowledge of the principles of rapid haemostasis and damage control surgery (DCS) essential for improving patient survival rates. The immediate priorities are to control haemorrhage promptly and ensure adequate perfusion to vital organs, which can be achieved by expeditious decision-making and clinical intervention in a multidisciplinary team approach by team members with sufficient seniority and experience.

Causes of major haemorrhage

Trauma

Trauma is the leading cause for major haemorrhage with road traffic collisions (RTC) accounting for the vast majority of trauma in the UK.[1] Trauma can either be blunt, penetrating or a combination of the two. An understanding of these aetiologies helps to guide management of the bleeding. Advanced trauma life support (ATLS) teaches to look for signs of major life-threatening haemorrhage 'on the floor or four more', referring to bleeding into thoracic cavity, peritoneum, pelvis and long bones, which can result in death if unrecognized.

Blunt trauma: blunt trauma is a direct result of shearing and crush forces acting on tissue planes. Typically, at transition points between fixed and mobile structures, in particular vascular pedicles of viscera and the junction between the ascending and arch of aorta. Likewise crush injuries resulting in the compression of viscera or vascular structures between external forces and bone can result in significant haemorrhage. Most frequent injuries are spleen (45%), liver (40%), and retroperitoneal structures (15%).[2]

Penetrating trauma: penetrating trauma refers to injuries that result from foreign material penetrating tissues. It is less common in the UK than blunt trauma, but the incidence is rising with increasingly sophisticated and coordinated acts of terrorism and civil disorder. The weapons used can be classified based on the amount of energy their projectiles produce:

- low energy – knife or hand-energized missiles
- medium energy – handguns
- high energy – military or hunting rifles.

Stabbings result in a low level of energy transfer along a tract and damage only local tissues. Surrounding tissues are not injured; however major bleeding can still result if solid organs or major vessels are disrupted.

Gunshot wounds (GSW) deliver kinetic energy to the tissues they pass through and surrounding organs. The degree of this spread varies depending on the energy dissipated by the missile prior to exiting the body. The passage through solid organs and vascular structures provides a significant deceleration force on the bullet and thus significant trauma to tissues involved and structures distant to the missile tract. The velocity of the round sucks in surrounding debris making debridement of the wound more challenging.

Blast injuries

Once rare, blast injuries are becoming increasingly common with the use of improvised explosive devices (IEDs) rather than commercially available munitions although they still remain a minor proportion of major haemorrhage cases. Terrorist incidents frequently involve coordinated multiple explosions detonated simultaneously to create maximum disruption to

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emergency services. All surgeons should be familiar with their hospital role in a major incident to maximize survival of the injured. Triage, or sorting of casualties according to clinical need, is vital to ensure the maximum number of patients survive. The surgeon plays a key role in deciding resource allocation in terms of which patient needs theatre first and who can safely wait or requires further investigation. Explosions cause a combination of blunt and penetrating trauma.

Blast injuries can be further sub-categorized into primary, secondary, tertiary and quaternary. Primary blast injuries result from the direct effects of the pressure wave and typically result in damage to gas containing organs. Secondary blast injuries result from flying objects hitting the patient and typically cause penetrating trauma. Tertiary blast injuries result when the individual is thrown against a solid structure or the floor resulting in blunt trauma. Quaternary blast injuries include burns, inhalation of dust or toxic fumes or crush injuries.[3]

For patients who have sustained traumatic amputation as a result of exposure to a high-energy explosion, rapid application of a tourniquet in the field is vital to preserve life.

Surgical

Primary haemorrhage intraoperatively could be due to inadequate control of vessels, for example, misplaced vessel clamps or clips, loose surgical ties, inappropriate use of stapling devices or inadequate proximal and distal control of vessels. Reactionary bleeding occurs within 24 hours of surgery and is due to technical faults or the coagulopathic status of the patient. Secondary bleeding is delayed and typically occurs between 5 and 10 days following surgery, usually due to infection or coagulation defects.

Iatrogenic

Laparoscopic surgery has revolutionized surgery by reducing pain, wound size and improving recovery. It is rare but not unheard of for major haemorrhage to occur during laparoscopic surgery which can significantly compromise the patient. This may be due to loss of control of major vessels manipulated and encountered during the procedure or when initially establishing a pneumoperitoneum. Confirmation of entry to abdominal cavity prior to commencing gas insufflation reduces the risk of gas embolism and should be considered a standard element of establishing a pneumoperitoneum via an open technique. All other ports should be placed under direct vision to ensure the cutting blades of sharp trocars are visible at all stages of insertion, taking care to avoid visible vessels. Likewise observing instrument and port removal and confirmation of haemostasis is essential to identify any bleeding that may have been masked whilst the trocar was in-situ providing a tamponade effect.

Pathological

This category of major haemorrhage occurs due to a pathological disease process occurring in the patient, for example, ruptured abdominal aortic aneurysm (AAA), peptic ulcer disease, angiodysplasia or colonic diverticulitis.

Clinical assessment and diagnosis of major haemorrhage

In any trauma patient the sequential ATLS approach of ABCDE is employed in the initial assessment and management of abnormal physiology as it is identified. Knowledge of the mechanism of injury helps to predict injury patterns that may be encountered, which can be corroborated with physical signs on examination. Visible marks on the chest or abdomen from seat belts suggest the potential for significant abdominal or thoracic trauma to be present. In the obtunded patient a confirmatory history from friends or family including anticoagulant use and previous medical history is invaluable and essential to be sought as part of an AMPLE History (Allergies, Medications, Past Medical History, Last ate, Events leading up to the injury).[3]

Rapid assessment of potential blood loss is key in guiding fluid resuscitation during the primary survey. Physiological parameters such as pulse, blood pressure, respiratory rate, conscious level can be used to estimate blood loss and degree of shock being experienced by the patient (Table 1[3]).

Ultrasound is useful to diagnose cavity bleeding − FAST (focused abdominal sonography in trauma) and eFAST (enhanced FAST with examination of the pleura[3]) are rapid bedside investigations with up to a 95% sensitivity that can rule in the presence of free fluid in the abdomen or chest. Stabilization of the pelvis with a pelvic binder or long bones with a Thomas splint can reduce blood loss considerably helping to stabilize the patient.

Grades of shock

The definition of shock is hypoxia due to inadequate tissue perfusion. In trauma patients this is due to hypovolaemia, secondary to haemorrhage until proven otherwise. The grade of shock refers to the volume of blood loss and resulting abnormalities identified in physiological parameters (i.e. pulse, blood pressure, respiratory rate and conscious level).

Resuscitation

Haemodynamically unstable patients should be simultaneously assessed and resuscitated. High-flow oxygen should be administered via a non-rebreathe mask (Hudson mask). Intravenous access should be achieved with two large-bore cannulae in the antecubital fossae. Bloods should be taken for full blood count, coagulation studies, urea and electrolytes, liver function, amylase, lactate, venous gas and cross-matching, initiating the hospital's major haemorrhage protocol if required. Where venous access cannot be established intraosseous access should be considered to allow fluid resuscitation to commence.[4]

On some occasions the most appropriate place for resuscitation to occur is the operating theatre, with resuscitative or DCS. A resuscitative thoracotomy or laparotomy is indicated in a patient with unresponsive hypotension despite adequate fluid administration when no other cause for bleeding has been identified.

The degree of response to fluid resuscitation is divided into three groups, responders, transient responders and non-responders. Responders have a physiological improvement with fluid resuscitation that persists over time. Transient responders have an improvement in physiological parameters with fluid resuscitation however the effect is then lost, requiring further resuscitation. Non-responders have no physiological improvement with fluid resuscitation and will need urgent resuscitative surgery to control haemorrhage (Table 2).

Patients with major haemorrhage should be given O Rh−ve blood and fresh frozen plasma (FFP) if there is insufficient time to cross-match type-specific blood. Blood has a high oncotic

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