Damage control in orthopaedic injuries

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The principles of 'damage control surgery', first described by Rotondo et al (1993) in relation to severe penetrating abdominal injury, can also be applied to patients with orthopaedic injuries. The basic principles are the same:

1. An early recognition of the injured patient for which damage control surgery is appropriate
2. An initial 'salvage operation' based on control of blood loss and reduction of contamination
3. Transfer to the intensive care unit for care aimed at normalizing physiological parameters
4. Further operation(s) for definitive repair and reconstruction
5. Rehabilitation.

PHYSIOLOGY

In the polytraumatized patient it is recognized that even extremity injuries have a systemic impact. Injury creates a local inflammatory response leading to the release of cytokines into the systemic circulation. Systemically these mediators cause microvascular damage, being responsible for neutrophil adhesion, extravasation and the release of oxygen free radicals and proteases. This process contributes to the development of multiorgan failure. Blood concentrations of these inflammatory mediators are being evaluated as a potential measure of trauma severity (Hildebrand et al, 2004) and might provide an indicator of whether damage control techniques are appropriate.

ORTHOPAEDIC INJURY

Until the 1980s it was widely believed that polytraumatized patients with orthopaedic injury did not have the physiological reserve for early definitive fixation of all their fractures. Then the concept of 'early total care' was developed, the intention being for all fractures to be fixed within hours of injury. Despite some success with this approach it was recognized that not all patients benefited. In particular, those patients with any associated severe abdominal, thoracic, head injury or very raised injury severity score (ISS) appeared to do worse with such an approach (Boulanger et al, 1997). It was this recognition which has led to the development of damage control orthopaedics.

The 'index' fracture when considering damage control orthopaedic strategies is the femoral shaft fracture, because it is the most frequent fracture in the polytraumatized patient and is representative of a high energy injury. 'Gold standard' definitive care of isolated femoral shaft fractures is locked intramedullary nailing. However, it has been seen that patients with a high ISS did not necessarily benefit from this procedure because a high complication rate was observed. Potentially this group, once identified, might benefit from the less invasive external fixation of the fracture as a damage-control strategy.

OPEN WOUNDS

The extent of the associated soft-tissue injury is an important determinant in the indications for damage-control strategies in the injured extremity. An open wound containing necrotic, contaminated or infected tissue, is a potent source of the inflammatory mediators contributing to multiorgan failure. Furthermore the presence of such a wound limits the repertoire of fracture fixation methods which might be used.

Early operative debridement of such wounds is a damage-control strategy – excising from the wound any dead, contaminated or infected tissue. Following this, the wound can be left open, aiming at delayed primary closure, skin grafting or other reconstruction after an interval of typi-

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cally, 2–5 days. At initial surgery there should be no attempt at repair of divided nerve or tendon; such procedures should be deferred until the reconstructive phase of treatment.

AMPUTATIVE SURGERY

In the polytraumatized patient, attempts to save a severely injured limb of dubious viability or with limited potential for reconstruction may predispose to multiorgan failure. Early amputation in such cases is thus a damage control strategy. The most important step is to determine that amputation is appropriate. In this the concept of a 'limb inventory' is useful; assessing distal perfusion, sensation, soft tissue loss/damage and the severity of bony injury. Absence of distal sensation is a poor prognostic sign for reconstruction as are 'IIIC' tibial fractures, i.e. compound fractures with loss of distal perfusion.

Although scoring systems have been proposed to assist in the decision to amputate (Rotondo et al, 1993; McNamara et al, 1994), these systems are poorly applicable and often not validated outside the originating institution (Bonnani et al, 1993). Obtaining consensus among surgical colleagues in the decision to amputate is valuable.

If primary amputation is indicated, it is preferable to fashion flaps at initial surgery rather than perform 'guillotine'-type amputations (Coupland, 1993). The amputation stump should be left open and a dry, bulky sterile dressing applied. The dressing should remain in place until the patient is returned to theatre after an interval period (typically 2–5 days) for wound inspection and consideration of delayed primary closure.

PELVIC FRACTURES

Pelvic fractures represent 3–8% of skeletal injuries and are usually indicative of high energy transfer. Associated injury to other organ systems is common, with severe haemorrhage in 75%, urogenital injury in 12% and injury to the lumbosacral plexus in 8%. The Young–Burgess method of classification (Burgess et al, 1990) is useful because it is based on the mechanism of injury, is predictive of associated injury patterns and can be used to guide acute treatment. It divides the fractures into four categories: lateral compression, anterior-posterior compression, vertical shear and those of combined mechanism.

Emergent stabilization of an unstable pelvic fracture in a critically injured patient reduces the potential space within the pelvis, thereby assisting in obtaining tamponade and stabilizing clots before patient movement. Several methods exist, ranging from a simple circumferential sheet 'sling' through Velcro-fastened 'pelvic bands' to external fixator devices. If external fixator devices are used, pin placement is critical to obtaining stability, and frame construction should allow access to the abdomen for laparotomy. For ongoing bleeding not controlled by stabilization, pelvic angiography and embolization is becoming more frequently used than the alternatives of pelvic packing or direct surgical haemostasis. Internal fixation of pelvic fractures, where indicated, is typically delayed several days.

CONCLUSIONS

Just as in the critical patient with a penetrating abdominal wound the principles of damage control surgery can be applied to the orthopaedic injuries of a polytraumatized casualty. Critical to this is early recognition of the patient in which damage control is appropriate. At surgery both the bony and soft tissue aspects of the injury should be addressed. Early amputation of a non-viable or unreconstructable limb may prevent secondary complications. Emergent stabilization with slings, bands or external fixators can help prevent ongoing blood loss into an unstable fractured pelvis. HM

KEY POINTS

- Orthopaedic patients with associated raised injury severity score may not benefit from early definitive fracture fixation.
- External fixation is a less invasive fracture fixation technique for patients with severe abdominal, thoracic, or head injury.
- The extent of associated soft-tissue injury is an important determinant for orthopaedic damage control, including early debridement.
- Early amputation of extremities is a damage-control strategy to minimize multiorgan failure and other secondary complications.
- Emergent stabilization of an unstable pelvic fracture during resuscitation using circumferential sheets, pressure from pelvic bands or external fixation can tamponade exsanguinating pelvic hemorrhage. Angiographic embolization may allow pelvic haemorrhage control.

Conflict of intersest: none

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