Early Treatment and Damage Control in Orthopaedics

Written by Brian Hoyle

Early total care (ETC) treats as many fractures as possible in patients with polytrauma and offers a different strategy than damage control. Steven A. Olson, MD, Duke University School of Medicine, Durham, North Carolina, USA, discussed the early developments and trials in ETC and orthopaedic damage control.

ETC AND ORTHOPAEDIC DAMAGE CONTROL

ETC became popular in the 1980s, with refinements in orthopaedic care, including early fixation of open fractures and intramedullary nailing of femoral shaft fractures. Improved outcomes following the early fixation of long-bone fractures were reported. Early fixation was associated with a decrease in prevalence of acute respiratory distress syndrome (ARDS). Early treatment of femur fractures led to fewer days in the intensive care unit and reduced femur venting. In 1989, a prospective, randomized trial with early treatment of femur fracture was halted due to death in the delayed-treatment group. A 1994 multicenter study in which 676 patients whose femur or bilateral tibia fracture was stabilized within 48 hours of the injury were compared with 906 patients from the Major Trauma Outcome Study determined that ETC reduced mortality.

In 1993, the Hannover group reported that ETC in patients with severe pulmonary injuries had worse outcomes than in patients who had delayed definitive fracture fixation. Immediate care of all fractures is not always beneficial when a patient's condition is unstable. In such cases, damage control is practiced. In damage control, acute stabilization is limited to major fractures to control blood loss and improve mobilization. It may be better to delay definitive fixation for some patients, such as those who may be predisposed to an adverse pulmonary outcome. The presence of severe thoracic injury in the absence or presence of fracture is a risk factor for ARDS. However, delaying surgery after major trauma may worsen systematic inflammatory response syndrome (SIRS), which can prelude ARDS and multiple organ failure.

Patients can be assessed for physiologic markers of trauma, such as elevated lactate, to determine whether to use ETC or damage control. One option is to provide external support of fracture injuries, such as lower-extremity long-bone fractures and pelvic injuries, while more pressing life-threatening injuries are addressed [Scalea TM et al. *J Trauma*. 2000].

MITOCHONDRIAL DAMPs AND INFLAMMATION AFTER TRAUMA

Carl J. Hauser, MD, Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA, discussed post-trauma damage-associated molecular patterns (DAMPs) and SIRS. SIRS is a response to trauma and to any insult to the body (eg, infection, burns, and surgery).

In the setting of infection, part of the response involves the recognition of pathogen-associated molecular patterns (PAMPs). In the absence of infection that occurs in mechanical damage, toxin-mediated damage, and shock, DAMPs are operative. Both patterns activate proteins called pattern recognition receptors or Toll-like receptors, which start the innate immune responses in a complex system of communication involving multiple cell proteins. Key proteins are tumor necrosis factor and interleukin (IL)-1.

Mitochondrial DNA have been implicated as DAMPs. Mitochondria once were free-living bacteria that evolved a symbiotic relationship with eukaryotic cells precluding the process of becoming cell organelles. Cell damage that involves mitochondria causes the release of mitochondrial DNA, which triggers injury-related inflammatory responses [Zhang Q et al. *Nature*. 2010]. Mitochondrial formyl peptides have also been implicated as DAMPs [Raoof M et al. *J Trauma*. 2010].

SYSTEMIC RESPONSE TO INJURY IN PATIENTS WITH POLYTRAUMA

Hans-Christoph Pape, MD, RWTH Aachen University Medical Center, Aachen, Germany, discussed the systemic response to injury in patients with multiple injuries. If a patient is stable and

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responsive to resuscitation, treatment of polytrauma can be considered. If not, the bleeding should be addressed and the patient should be sent to the intensive care unit for treatment and stabilization prior to other surgeries.

The severity of injuries can be scored, with the most severe injury being addressed first to have the greatest influence on mortality [Kilgo PD et al. *J Trauma*. 2003]. The presence of IL-6–mediated inflammation can be a sign of organ failure and may involve an exacerbated host response [Cuscheri J et al. *Shock*. 2010].

TRANSLATING BASIC SCIENCE OF POLYTRAUMA DAMAGE CONTROL ORTHOPAEDICS TO CLINICAL SCIENCE

Todd O. McKinley, MD, Indiana University School of Medicine, Indianapolis, Indiana, USA, discussed damage control of patients with multiple injuries, including orthopaedics. Polytrauma can prelude multiple organ failure. A key influence is inflammation, which is subject to the interplay of pro- and anti-inflammatory signals. This interplay can increase inflammation when needed and subsequently suppress it. In SIRS, this interplay can drive the continuation of inflammation.

The influence of surgery on inflammatory responses in patients with multiple injuries is unclear. However, DAMPs from injured tissue cause inflammation. Prolonged inflammation can cause organ malfunction. It is possible that, in a patient with multiple injuries, the severity and type of injury are correlated with the severity and length of systemic inflammation and organ dysfunction.

The relation between the magnitude of tissue injury and damage control needs further study. Specifically, better ways of stratifying patient treatment are needed. Patients with higher levels of DAMP production may need closer attention.

FUTURE OUTLOOKS IN DAMAGE CONTROL

Robert V. O'Toole, MD, University of Maryland School of Medicine, Baltimore, Maryland, USA, offered a look at the future of damage control. Damage control is affected by a number of variables, including those related to the patient, injury, and treatment. Patient variables include age, medical comorbidities, the bone that is fractured, and the nature of the treatment. Damage control is subject to serious, even life-threatening consequences of inflammation. The type and timing of an orthopaedic procedure can influence patient outcome [Morshed S et al. *J Bone Joint Surg Am*. 2009], with a subsequent exacerbated immune response causing organ failure distant from the affected body site.

Whether the risk of ARDS can be modified remains an open question, as is the optimal timing of some treatments and the validation and application of valuable risk markers in the operating room. Airway pressure release ventilation, which allows the lungs to remain inflated with reduced tissue damage, may reduce mortality in high-risk patients.