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Management of Complex Pelvic Fractures



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Abstract

This paper discusses the management of complex pelvic ring fractures, including prevalence of mortality, risk factors, most common causes of pelvic fractures among different age-groups, the treatment options and advances that result on more fixable options for the anterior and posterior pelvic ring, and finally the goals of successful orthopaedic interventions. Optimal management of complex pelvic ring fractures requires multidisciplinary involvement. The anatomy of the lesion, the pshysiologic status of the patient and associated injuries will continue to guide treatment. Advances in orthopaedic and non- orthopaedic management have and will continue to yield more favorable short and long-term results.

Keywords: Complex pelvic ring fractures, management, multidisciplinary involvement.

Optimal management of complex pelvic ring fractures requires multidisciplinary involvement. Treatment decisions are based upon the anatomic lesion, physiologic status of the patient, and associated injuries.

Pelvic ring fractures in young patients are generally the result of a high-energy mechanism of injury. Common mechanisms include falls from heights and motor-vehicle related events. Pelvic ring fractures in geriatric patients may occur as a consequence of a low-energy mechanism. Patients injured via either mechanism are at risk for associated morbidity. The elderly patient is at an increased risk for bleeding from osteopenic bone and from intracranial bleeding, particularly, when receiving anticoagulants. In addition, the elderly patient is at risk for rib fractures and osteoporosis related fractures of the axial and appendicular skeleton.

Patients sustaining a pelvic ring fracture as a result of high-energy mechanisms are at an increased risk of death, particularly, if presenting

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with hemodynamic instability. Most early mortality cases are hemorrhage related. Overall, mortality is more commonly the result of head injury or thoracic injury. The German Multicentre Study Group identified 2551 patients with pelvic ring injuries, of which 61.7% were multiply injured.[1] Overall mortality was 13.4%. However, pelvic ring injury was causal in only 1.4%. Increased mortality correlated closely with an increase in mechanical instability of the pelvic ring. Pennal and Sutherland in 1961 described a classification based upon the mechanism of injury[2]. The classification was based upon the direction of applied force with resulting variants including lateral compression, anterior-posterior compression, and vertical shear. Anterior-posterior compression and lateral compression injuries occurred across a spectrum of severity such that stability varied within group. By definition, all vertical shear injuries were mechanically unstable. The Tile classification divides pelvic ring fractures into type A (stable), type B (rotationally unstable), and type C (vertically and rotationally unstable) variants.[3] A majority of pelvic ring injuries (54.8%) in the German Multicentre cohort were stable type A injuries. Approximately 25% were rotationally unstable and 20% vertically and rotationally unstable. Young et. al. incorporated mechanism and stability into the system we use today.[4] Lateral compression and anterior posterior compression injuries were divided into stable, rotationally unstable, and vertically and rotationally unstable variants. A combined mechanism of injury category was added. Burgess et. al. attempted to correlate associated injuries, hemorrhage, and mortality with injury mechanism.[5] A 7% mortality and an association with head and abdominal injuries was identified in patients with lateral compression mechanism. Anterior and posterior compression mechanism resulted in a 20% mortality, with pelvic and visceral injuries common, and a high incidence of thoracic aortic injury. Vertical shear mechanism was associated with head, chest, and abdominal injury. Both vertical shear and combined mechanism of injury resulted in no mortality in the Burgess study. Presumed mechanism of pelvic fracture has also been utilized to predict hemorrhage and transfusion requirements with the highest blood loss seen in association with anterior and posterior compression mechanism and the lowest with lateral compression mechanism.

Treatment options have increased considerably in the last 35 years. In 1986, treatment of pelvic ring fractures was generally confined to the use of skeletal traction and/or anterior pelvic external fixation. External fixation was typically performed utilizing an open technique and placing multiple Schanz pins within the anterior iliac crest. Open treatment was uncommon and generally confined to plate fixation of the pubis, or placement of relatively short screws across the sacroiliac joint engaging the lateral sacrum. Our ability to treat traumatically injured patients, including patients with pelvic ring injuries, has improved considerably. We now have a significantly more advanced understanding of the systemic response to trauma and of the second hit phenomenon. Physiologic monitoring is available via laboratory assessment including lactic acid and base deficit. Diagnostic capabilities have improved considerably, including the availability of ultrasound imaging and rapid CT scan. Treatment advances include the common use of pelvic binders, both pre-facility and upon arrival at treating facilities. Massive transfusion protocols have been developed to address hemorrhage and avoid coagulopathy. Preperitoneal packing has been shown to limit pelvic hemorrhage. Angiography with embolization is now commonly available in many facilities. Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) has, in many cases, replaced the need for open thoracotomy and aortic cross clamping. Direct fracture management aids in the restoration of physiologic homeostasis, protects the pelvic viscera, and provides for optimal functional outcome.

The goals of orthopaedic intervention include safely and reliably restoring pelvic ring anatomy, providing stable fixation to allow for early mobilization, and limiting additional damage to

soft tissues. Numerous advances now allow orthopaedic surgeons to meet more reliably these goals. External fixation performed with the use of supra-acetabular Schanz pins allows for greater control of the posterior pelvic ring. Both iliac and supra-acetabular pins are now placed in a predominant percutaneous manner utilizing fluoroscopic imaging. Direct reduction of the posterior pelvic ring is now feasible with use of a pelvic resuscitation clamp. Improved reduction of the posterior pelvic ring results in greater stability and better hemorrhage control. Use of a pelvic resuscitation clamp requires precise placement. The procedure may be performed in an emergency department setting, but it is more reliably performed when fluoroscopic imaging is available in the operative suite. Indirect, fluoroscopically guided percutaneous, and limited open approaches to stabilizing the pelvic ring and, in particular, the posterior pelvic ring and sacrum, have resulted in decreased soft tissue injury at the time of surgery. Less invasive approaches have necessitated a greater understanding of normal and variant pelvic ring anatomy particularly when placing hardware in the sacrum or pubic rami given the relatively narrow corridors for screw placement and the proximity of neurovascular structures.

Numerous advances have resulted in more stable fixation options for the anterior and posterior pelvic ring. The posterior pelvic ring is subject to greater physiologic forces particularly with weight bearing; however, restoration and stabilization of the anterior ring can aid in reduction and supplement posterior ring fixation. Amongst the techniques for stabilization of the anterior pelvic ring are plate and screw fixation, antegrade or retrograde intramedullary screw fixation of the pubic rami, and anterior pelvic external fixation. A variation of anterior pelvic external fixation, useful in the morbidly obese, involves placement of an external fixation type device beneath the skin: a so-called INFIX. The predominant difficulties encountered in providing posterior ring fixation occur when a sacral fracture is present. Sacral fractures are often comminuted and occur through relatively soft metaphyseal bone with limited surface area, especially, when the sacral foramina are involved. There are significant physiologic forces acting across these fractures. Prior to the routine use of fluoroscopy, sacroiliac screws could not safely and reliably engage the vertebral bodies. A significant improvement in strength was achieved once sacral bodies could be safely engaged. Iliac transsacral screw fixation, engaging both the vertebral body and contralateral iliac wing, has further improved fixation. Tension band plating and spinopelvic fixation with or without sacroiliac fixation, have resulted in far fewer mechanical failures.

Evolving techniques and current areas of research include computer-aided navigation for hardware placement and the use of robotic techniques. These techniques will not replace the need for multidisciplinary patient management. The anatomy of the lesion, the physiologic status of the patient, and associated injuries will continue to guide treatment. Advances in orthopaedic and non- orthopaedic management have and will continue to yield more favorable short and long-term results.

Conflict of Interest Disclosure Statement

The author has no conflict of interest to disclose.

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