Management of Pelvic Ring Injuries in Unstable Patients

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KEYWORDS

- Unstable pelvic ring injuries • Hemodynamic instability • Polytrauma • Pelvic angiography
- Pelvic packing

KEY POINTS

- Pelvic ring injuries vary in severity and are frequent in the polytrauma patient population.
- A subset of patients presenting with complex pelvic ring injuries and hemodynamic instability require special attention secondary to significant risk of mortality.
- Mortality is bimodal: acutely, from lethal hemorrhage, and late from complications of multiorgan system failure.
- A multidisciplinary approach, and prompt intervention through an algorithmic approach, are necessary to promote survival.
- An understanding of the roles of resuscitation, mechanical pelvic stabilization, angiography, and pelvic packing aid in caring for this subset of extremely injured patients.

ANATOMY

Knowledge of pelvic anatomy is critical to the understanding of pelvic ring injury and treatment. This knowledge allows the surgeon to interpret the readily available bony imaging obtained during the initial trauma assessment, make inferences on pelvic ring stability, temporize life-threatening injuries, anticipate associated injuries, and ultimately definitively stabilize the pelvis to improve long-term functional outcomes.

The function of the pelvis is to transmit weight bearing from the proximal femur to the spine, primarily through the posterior pelvic ring, and to protect the pelvic soft tissue contents. The anterior pelvis, whose injuries are often more easily apparent, plays a secondary role in pelvic stability by functioning primarily as strut. In fact, isolated injuries of the rami or pubic symphysis have little effect on pelvic stability.[1] Because pelvic ring stability is dictated primarily by the posterior ring structures of the sacrum, ilium, and sacroiliac joint, or a combination of these structures, determining stability first requires an understanding of the sacral osteology and the sacroiliac ligamentous complex that connects these entities.

Pelvic osteology is best conceptualized on the inlet and outlet views. On the inlet view, the sacrum is shaped like a reverse keystone (Fig. 1A) to resist the internal rotation vector during weight bearing in conjunction with the transverse oriented fibers of the posterior ligamentous complex and the anterior ring strut. On the outlet view, the sacrum is shaped like a true keystone (Fig. 1B) to resist the medially

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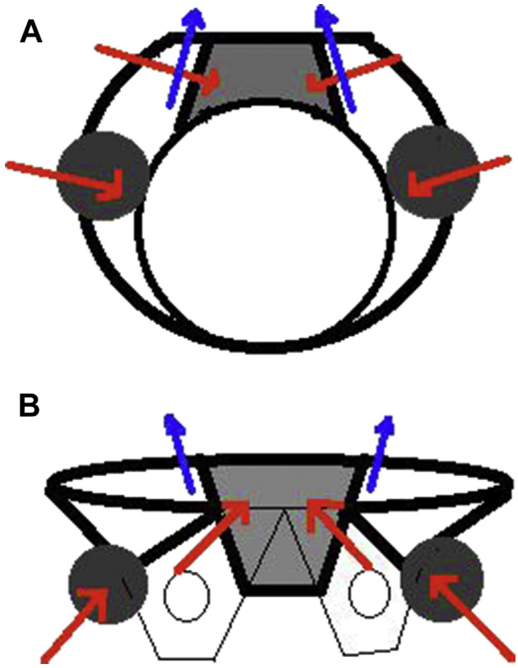

Fig. 1. (*A*) Pelvic inlet schematic demonstrating the medial force vector during weight bearing, denoted by the *red arrows*. The shape of the sacrum stabilizes the pelvis from internal rotation deformity. *Blue arrows* indicate the vector of posterior displacement of the hemipelvis in the setting of ligamentous, sacral, or iliac disruption (posterior ring disruption). (*B*) Pelvic outlet schematic demonstrating cephalomedial force vector during weight bearing, denoted by the *red arrows*. *Blue arrows* denote the vector of cephalad displacement in the setting of posterior ring disruption. The combined vector in the setting of instability is, therefore, posterocephalad displacement.

directed vector during weight bearing in conjunction with the longitudinally oriented fibers of the posterior ligamentous complex. It is easy to see that complete injuries of the sacrum, ligamentous complex, or ilium will result in posterior and cephalad displacement of the hemipelvis.

The posterior sacroiliac ligamentous complex is a collective term inclusive of the multiple ligaments that confer stability to the sacroiliac joints, connecting the ilium to the sacrum. Of these, the interosseous sacroiliac ligaments are the strongest and run transversely from the posterior superior and inferior spine of the ilium to the posterior sacrum. Posteriorly, the short and long posterior sacroiliac ligaments, collectively the posterior sacroiliac ligaments, run obliquely and longitudinally. The anterior sacroiliac ligaments pass transversely from the anterior sacrum to the anterior edge of the ilium (Fig. 2). The sacrotuberous ligament is confluent with the posterior sacroiliac ligament and runs longitudinally to the ischial tuberosity (Fig. 3) and forms the border of the greater sciatic notch along with the weight-bearing arch of the ilium. Another longitudinally oriented ligament is the sacrospinous ligament (see Fig. 3), which, as its name suggests, connects the sacrum to the iliac spine and forms the border of the lesser sciatic notch along with the ilium and sacrotuberous ligament. Finally, the iliolumbar ligament connects the L5 transverse process to the iliac crest (see Fig. 3).

The posterior ligaments contribute most to resisting forces across the sacroiliac joint and are known collectively as the posterior tension band. The transversely oriented fibers primarily resist rotational forces, whereas the longitudinally oriented ligaments are the primary restraint against vertical shear forces. The combination and degree of injuries to these ligaments, along with disruption to the sacrum or ilium, explains the wide spectrum of stability seen in pelvic ring injuries.

Knowledge of structures at risk for injury after a pelvic ring injury is essential because it directs the physical examination for life-threatening injuries and provides clues to pelvic stability for selecting provisional or definitive fixation.

Peripheral nerve deficit may occur with wide displacement of the hemipelvis and indicate

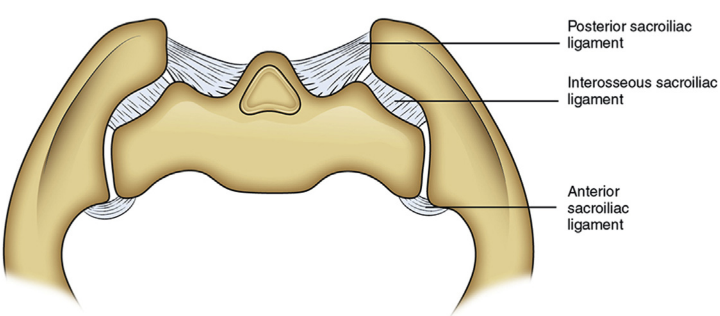

Fig. 2. The primary sacroiliac ligaments as demonstrated on a schematic pelvic inlet diagram. The posterior ligaments function similarly to a suspension bridge, resisting internal rotation deformity, whereas the anterior sacroiliac ligaments primarily restrain against external rotation forces. The interosseous sacroiliac ligaments, centered between them, are the strongest in the pelvis.