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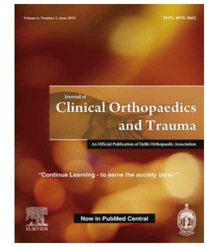

Review Article

Pelvic ring injuries: Emergency assessment and management

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ABSTRACT

Pelvic ring injuries are associated with significant morbidity and mortality. Understanding the anatomy of the pelvic ring is essential for accurate diagnosis and treatment. A systematic approach taking into account the mechanism of injury, physical examination, and radiographic assessment is important to quickly identify unstable pelvic disruptions and associated injuries. Because the pelvis is a ring structure, isolated pubic rami fractures on plain radiographs are unusual and should warrant careful evaluation for posterior pelvic disruption with computed tomography. Hemorrhagic shock can occur in about 10% of pelvic ring injuries. Immediate recognition and treatment of this life-threatening condition is critical in emergency management. In addition to fluid resuscitation and blood transfusion, circumferential wrapping, angiographic embolization, laparotomy with pelvic packing, and external fixation can be important life-saving adjuncts in the setting of hemodynamic instability.

1. Introduction

Pelvic ring disruptions make up 3% of all skeletal fractures.[1] Traffic accidents are the most common mechanism of injury, accounting for the 60% of pelvic fractures followed by falls (30%) and crush injuries (10%).[2] Disruption of the pelvic ring can also result from low energy mechanisms, such as falls from standing height in elderly persons with osteoporosis.[3] The morbidity and mortality associated with pelvic ring injuries are significant. Mortality rate is estimated at 28% from multiple pooled studies,[1] but can be as high as 50% in open fractures.[4] In a multicenter retrospective review of 2551 patients with pelvic ring injures, Gansslen et al. found mortality to be closely associated with the presence of concomitant soft tissue injury.[5]

2. Anatomy

The pelvis is a ring structure consisting of the sacrum and the two innominate bones. It encases important visceral structures and serves as a link between the axial skeleton and the lower extremities. While the pelvic ring lacks inherent bony stability,[6] it is held together by a network of interosseous ligaments. Anteriorly, there are the public symphysis and the anterior sacroiliac (SI) ligaments, which collectively contribute about 40% to the stability of the pelvis.[4] Posteriorly, there are the much stronger posterior SI, sacrospinous, and sacrotuberous ligaments. These posterior ligaments form a suspension bridge that maintains the position of the sacrum within the pelvic ring.[6] Additional stability is provided by the iliolumbar and lumbosacral ligaments.[7] Collectively, the aforementioned

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ligaments stabilize the pelvic ring by resisting rotationally and vertically applied deforming forces. The transversely oriented anterior SI and sacrospinous ligaments more effectively resist rotation, whereas the vertically oriented sacrotuberous ligaments help prevent vertical displacement.[8] The posterior SI ligaments, on the other hand, consist of short transverse and long vertical fibers, and therefore resist both rotational and vertical deforming forces.[9]

3. Classification

The two most commonly used classification systems for pelvic ring injuries are those described by Tile[6] and Young-Burgess.[7] The Tile system, which is the basis of the AO/OTA classification of pelvic ring fractures, is divided into three categories based on stability of the posterior SI complex (Table 1): type A injuries that can withstand physiologic forces without deformation, type B injuries that are rotationally unstable, and type C injuries that are rotationally and vertically unstable.[6] The Young-Burgess system, on the other hand, is based on the vector of force applied to the pelvic ring.[8] Three injury patterns are described: lateral compression (LC), anteroposterior compression (APC), and vertical shear (VS; Table 2).

LC injuries, the most common pattern, are caused by a laterally applied force to the pelvis leading to compression of the SI joint and internal rotation of the hemipelvis on the side of injury.[9] In LCII pattern, there is a characteristic avulsion fracture of the iliac wing (crescent fracture), which remains attached to the sacrum by the strong posterior SI ligaments. Alternatively, there may be disruption of the posterior SI ligaments without a crescent fracture, especially in young patients.[9] In LCIII pattern, also known as windswept pelvis, there is concomitant opening (external rotation) of the contralateral hemipelvis caused by a secondary crush injury.

APC injuries, also referred to as open book injuries, occur from an anteriorly or posteriorly applied force resulting in opening or external rotation of hemipelvices. Depending on the magnitude of the force applied, the spectrum of injury can range from pubic symphysis diastasis (APCI), to disruption of the anterior SI ligaments (APCII), to complete hemipelvis separation (APCIII). APCIII can be differentiated from VS injury by the absence of vertical displacement of the hemipelvis.

Koo et al. examined the interobserver reliability of the Tile and Young-Burgess classification systems among surgeons with variable levels of expertise: two senior orthopedic trainees, two orthopedic traumatologists, and two pelvic and acetabular specialists.[10] Thirty patients, each with three radiographs (AP, inlet, and outlet) and a pelvic CT scan were reviewed. The authors found substantially higher interobserver reliability using the Young-Burgess system among trainees and orthopedic traumatologists, but not pelvic and acetabular specialists. The addition of CT scan did not improve the overall reliability of either system although it significantly improved the determination of pelvic stability.[10]

Osterhoff et al. compared the Tile and Young-Burgess classification systems with regard to their predictive value on mortality, resuscitation requirements, and associated injuries.[11] 285 consecutive patients with pelvic ring fractures were retrospectively reviewed. The authors found no relationship between mortality and fracture pattern for both systems. However, a subgroup analysis showed unstable Young-Burgess fractures (LC II/III, APC II/III, VS, and combined patterns) to carry a significant risk of mortality. In both classification systems, the severity of the fracture pattern significantly correlated with blood transfusion and total fluid resuscitation requirements.[11] Furthermore, while there was no significant relationship between fracture pattern and concomitant head and chest injuries, open book fractures were associated with more severe injuries of the abdomen, spine, and extremities in both classification systems.

Table 2 – Young-Burgess classification of pelvic ring injuries.[8]

Pattern	Characteristics	Incidence
LC	I. Rami fracture and ipsilateral sacral compression.	48.7%
	II. Rami fracture and ipsilateral crescent fracture.	7.4%
	III. Rami fracture and contralateral APC injury.	9.3%
APC	I. Symphysis diastasis < 2 cm; SI joints intact.	0%
	II. Symphysis diastasis with disruption of the anterior SI ligaments.	11.1%
	III. Symphysis diastasis with disruption of the anterior and posterior SI ligaments.	4.3%
VS	Vertical displacement of one or both hemipelvices.	5.6%
Combined	A combination of the above injuries.	6.8%

Table 1 – Simplified Tile classification of pelvic ring injuries.[6]

Type	Stability	Examples
A	Stable	Isolated iliac wing fractures, avulsion fractures of the iliac spines or ischial tuberosity, nondisplaced pelvic ring fractures.
B	Rotationally unstable; vertically stable	Open book fractures, LC fractures, and bucket-handle fractures.
C	Rotationally and vertically unstable	VS injuries.