Pelvic fractures

Faiz S Shivji

Conal Quah

Daren P Forward

Abstract

Fractures of the pelvic ring are significant injuries that affect diverse population groups. They range from low-energy, stable fractures to high-energy, unstable injuries with a substantial morbidity and mortality. The osseous and ligamentous relationships involved in maintaining the stability of the pelvis are complex, and knowledge of these is essential to appropriately manage pelvic fractures. The mechanism of injury and force vectors involved may be used to predict pelvic instability, likely additional injuries, and management strategies. Initially, temporary stabilization, blood-based resuscitation, and appropriate imaging are required. Further haemorrhage control, via embolization, may be required. Urogenital injuries should be identified and treated early. Definitive pelvic fixation should take place once haemodynamic compromise has been reversed and normal parameters maintained, and should aim to restore anatomic alignment and pelvic stability. In addition to the acute risk of major haemorrhage and death, pelvic fractures are associated with long-term morbidity due to gait disturbances, chronic pain, non-union, mal-union, and neurological and urogenital disruption. Therefore, the management of pelvic fractures provides a challenge for clinicians from their initial presentation through to their definitive treatment.

Keywords Haemorrhage control; pelvic fracture; pelvic fracture classification; pelvic fracture treatment; pelvis anatomy

Epidemiology and aetiology

Fractures of the pelvic ring are significant injuries, with a prevalence of 23–37/100,000 person-years in the general population.[1] They have a bimodal distribution, with peaks occurring in those aged 15–30 years, and those 50–70 years old. In the younger population, the majority of pelvic fractures occur in males, whereas females appear to suffer more injuries with increasing age. The mechanism of injury for pelvic fractures mirrors the diverse population groups, with the younger population more likely to sustain high-energy, unstable injuries due to blunt trauma such as road traffic accidents and falls from height. The osteoporotic, elderly population more commonly sustain stable fractures via low-energy falls from standing.

***Faiz S Shivji** BM BS MRCS is a Specialist Registrar in Trauma and Orthopaedics at the Queen's Medical Centre, Nottingham, UK. Conflicts of interest: none declared.*

***Conal Quah** BM BS FRCS (Tr & Orth) is a Specialist Registrar in Trauma and Orthopaedics at the Queen's Medical Centre, Nottingham, UK. Conflicts of interest: none declared.*

***Daren P Forward** MA FRCS DM is a Consultant Pelvic and Acetabular Surgeon at the Queen's Medical Centre, Nottingham, UK. Conflicts of interest: none declared.*

Due to the wide variation of aetiologic and patient factors, overall mortality is difficult to evaluate. Recent literature has shown overall mortality to be 7–23%; however, patients presenting with a pelvic fracture and haemodynamic instability have an in-hospital mortality of 7–34%.[1–3] Data from the Trauma Audit and Research Network highlights the common association of pelvic ring injuries with other injuries, such as chest trauma (21.2%), head injuries (16.9%), liver or spleen injuries (8.0%), and two or more long bone fractures (7.8%), increasing the patient's risk of death.[4]

Pelvic ring fractures are therefore complex injuries that often occur in the multiply injured patient, the effects of which can be devastating. The variation in presentation, associated injuries, and availability of temporizing and definitive treatments in secondary care increases the difficulty in developing management strategies. An understanding of the pathoanatomy, classification, and management of such injuries is important to avoid preventable complications.

Pathogenesis

Anatomy of the pelvis

The bony pelvis consists of the two innominate bones and the sacrum, joined at the pubic symphysis and sacroiliac joints. The pelvis is a true ring structure; hence if the ring is broken in one area, there must be an injury in another part of the ring. The stability of the pelvic ring depends upon the sacroiliac ligaments, symphysis and the pelvic floor – the bony structure has no intrinsic stability at all.

The posterior sacroiliac ligaments play a major role in maintaining the position of the sacrum in the pelvic ring. They are aided by the iliolumbar ligaments, which connect the transverse processes of L5 to the iliac crest, and the transverse fibres of the interosseous sacroiliac ligaments. The anterior sacroiliac ligaments, although weaker than their posterior counterparts, resist external rotation and shearing forces.

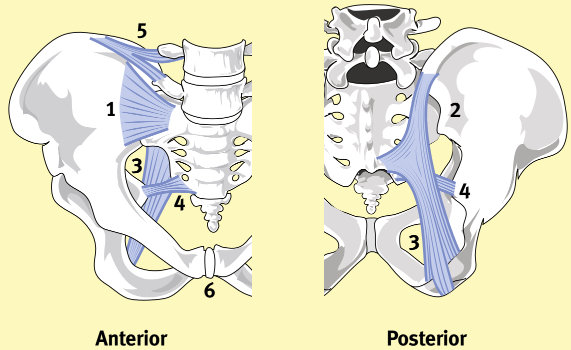
The pelvic floor adds to pelvic stability by its muscular layer and two major ligaments. The sacro-spinous ligament resists external rotation forces whilst the sacro-tuberous ligament resists vertical shear (Figure 1).

Classification of pelvic fractures

The two most common classification systems used for pelvic ring fractures are the Tile classification and the Young and Burgess classification.[5,6] The Tile classification divides injuries into three categories of increasing severity: types A, B, and C. It classifies injuries by the pelvic ring's ability to withstand vertical or rotational physiological forces as a result of the fracture; its 'stability'. In this classification, the posterior pelvis is located posterior to the acetabulum, and the anterior arch anterior to it. Type A fractures, of which there is not an equivalent in the Young and Burgess classification, are stable; hence the pelvic ring cannot be displaced by a physiological force. Type B fractures are rotationally unstable but vertically stable, whereas type C fractures are vertically and rotationally unstable. Table 1 summarizes the Tile classification.

The basis of the Young and Burgess system is an understanding of the direction of force causing the subsequent injury. Once the direction of causative force vectors is deciphered, the

Anterior and posterior ligamentous structures of the pelvis



1. Anterior sacroiliac
2. Posterior sacroiliac
3. Sacrotuberous
4. Sacrospinous
5. Illiolumbar
6. Symphyseal

Figure 1

relevant bony and soft tissue anatomy disruption can be predicted. The three main causative vectors are lateral compression (LC), anterior-posterior compression (APC), and vertical shear (VS) (Table 2).

The key to understanding the classification is that the LC category represents anatomically different areas. As one works through the classification: 1 = sacrum, 2 = wing and 3 = bilateral posterior injuries. Each category has a wide spectrum of injury from benign to devastating. The AP category is the same injury, but sequentially worse in severity through the three types. The classification has the advantage over the Tile classification of being useful in the emergency department (ED). In general, a patient who appears to be bleeding out with an AP injury will most likely be bleeding from the pelvis. A patient with an LC injury that is sick will most likely be dying from their associated head, chest or abdominal injuries. Understanding this allows early appropriate focus.

A patient suffering impact from the side can be predicted to have an LC injury where the force compresses the sacrum and pubic rami resulting in a compressive sacral fracture and pubic rami fractures (LC1). With higher force, the sacrum acts as a pivot around which the hemipelvis rotates inward, resulting in a fracture of the iliac wing (LC2). With even greater force, the compressive force becomes a distracting force on the contralateral hemipelvis, externally rotating that side resulting in an opening of the contra-lateral SI joint and symphyseal disruption (LC3).

AP compression of the pelvis results in external rotatory forces being applied, disrupting the pubic symphysis. A low force will diastase the symphysis but leave the sacroiliac ligaments in tact (APC1). A continued force will open the pelvis to such an extent that the anterior sacroiliac ligaments rupture (AP2) (Figure 2), followed by complete rupture of the posterior sacroiliac ligaments (AP3). APC3 injuries are usually considered to be both vertically and rotationally unstable.

A significant vertically directed force will result in rupture of all the ligamentous structures of the sacroiliac complex, pelvic floor, and pubic symphysis resulting in a vertical shear injury. The hemipelvis will be displaced vertically, with dislocation of the sacroiliac joint or a vertical sacral fracture, combined with pubic symphysis disruptions or fractures to the pubic rami. A final category, combined mechanism of injury (CM), represents patients that have received more than one vector — a pedestrian stuck by a car, and then receiving a second force when landing, for example. The category is not intended for ring injuries that are initially difficult to classify.

Both of these classification systems have been found to predict the severity of associated injuries (such as head, chest or abdominal injuries), and mortality in patients with pelvic fractures, but only if divided into stable (type A and LC1) and unstable (all others) injuries. With regards to blood transfusion requirements, LC3, APC2, and APC3 fractures have higher transfusion requirements than LC1, APC1, and VS fractures.[7]

Diagnosis

Initial assessment

Injuries to the pelvic ring should always be expected in those suffering high-energy trauma. The initial assessment and resuscitation of such patients should follow Advanced Trauma and Life Support (ATLS) guidelines,[8] with a primary survey identifying any life threatening airway and breathing issues, followed

Tile classification

Injury type	Grade 1	Grade 2	Grade 3
Type A: Stable	Avulsion fracture on innominate bone (e.g. iliac spine/ischial tuberosity)	Iliac wing fracture or isolated and stable fracture of a pubic ramus (rare)	Transverse fracture of sacrum/coccyx
Type B: Vertically stable, rotationally unstable	Open book injury (disruption of pubic symphysis with intact posterior sacroiliac ligaments)	Lateral compression injury (ipsilateral anterior and posterior arch fractures)	Bilateral injuries: e.g. B1 on one side and B2 on the other.
Type C: Vertically and rotationally unstable	Unilateral: disruption of anterior and posterior sacroiliac ligaments and pelvic floor on one side	Bilateral: one side type B, one side type C1	Bilateral: both sides type C

Table 1