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Fractures of the pelvic ring

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ABSTRACT

Traumatic disruptions of the pelvic ring are high energy life threatening injuries. Management represents a significant challenge, particularly in the acute setting in the presence of severe haemorrhage.

Initial management is focused on preserving life by controlling haemorrhage and associated injuries. Advances in prehospital care, surgery, interventional radiology and the introduction of treatment algorithms to streamline decision making have improved patient survival.

As more patients with unstable pelvic injuries survive, the poor results associated with nonoperative management and increasing patient expectations of outcome are making surgical management of these fractures increasingly common. The aim of operative fracture fixation is to correct deformity and restore function. The advent of percutaneous fixation techniques has reduced the morbidity previously associated with large operative exposures and internal fixation.

Introduction

Pelvic ring fracture management has seen a gradual evolution since the initial work of the Judet brothers and Letournel in the 1960s [1]. Continued advances in prehospital care, management of haemorrhage and operative intervention have seen a reduction in subsequent mortality and morbidity.

There is an estimated incidence of 23 per 100,000 people per year [2], with roughly half of this figure representing low energy, stable fractures and the other half high energy injuries with the potential for catastrophic haemorrhage and death. These high energy injuries are typically caused by motor vehicle accidents and falls from height [3]. The mortality rate associated with pelvic ring fractures is 19% although this is higher in the elderly and in the presence of a severe chest injury or haemodynamic instability [3,4]. Mortality rates as high as 37% have been reported in the presence of haemodynamic instability [5].

Anatomy

The pelvis is a bony and ligamentous ring comprising the sacrum posteriorly and the two innominate bones, composed of the ilium, ischium and pubis. It serves to connect and transfer loads between the axial skeleton and the lower extremities. The anatomical geometry of the bony pelvis is inherently unstable, and hence the integrity of the pelvic ring is reliant on stabilising ligamentous structures. The posterior ring is stabilised by the anterior, intra-articular and posterior sacroiliac ligaments across the sacroiliac joint, as well as the sacrospinous and sacrotuberous ligaments connecting the sacrum to the ischium. Anteriorly, the ring is supported by the symphyseal ligaments.

These structures also provide support for the vascular, visceral and neural structures contained within and traversing the pelvis, which are consequently at risk during fracture. The major branches of the iliac arterial system pass immediately anterior to the sacroiliac joints. The symphysis pubis is just anterior to the bladder and urethra, whereas the rectum is immediately anterior to the sacrum. When the significant force required to fracture the pelvis is released, these adjacent structures are at risk.

Classifications

Classification systems can help guide management as well as predicting associated injuries and prognosis. The Tile and Young–Burgess systems are the most commonly used. Both were developed for use with plain radiographs.

In Tile's classification, the pelvis is divided into posterior (posterior to the acetabulum) and anterior arches (anterior to the acetabulum). Fractures are classified based on the stability of the sacroiliac complex (posterior arch). This classification can therefore be used to guide management. The pelvic ring is stable in Tile type A fractures. Type B injuries are partially stable, representing an incomplete disruption of the sacroiliac complex with an intact pelvic floor. In these fractures the pelvis is rotationally unstable, but vertically stable. In Tile type C fractures, a complete disruption

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Table 1
Tile classification.

Type A: stable (posterior arch intact)	
A1	Avulsion injury
A2	Iliac wing or anterior arch fracture
A3	Transverse sacrococcygeal fracture
Type B: rotationally unstable (incomplete disruption of posterior arch)	
B1	External rotation open-book type fracture. Rotation hinges on an intact posterior SI complex. Disruption of the anterior pelvic arch through the symphysis pubis or rami.
B2	Internal rotation lateral compression injuries with a combination of anterior and posterior arch fractures.
B3	Bilaterally rotationally unstable
Type C: rotationally and vertically unstable (complete disruption of posterior arch)	
C1	Unilateral
C2	Bilateral, with one side type B, one side type C
C3	Bilateral

Table 2
Young-Burgess classification.

Anteroposterior compression fractures (APC)	
APC I	Diastasis of the pubic symphysis < 2.5 cm. No posterior instability
APC II	Diastasis of the pubic symphysis > 2.5 cm and anterior sacroiliac widening. Posterior instability secondary to the anterior sacroiliac complex damage but with intact posterior SI ligaments
APC III	Complete disruption of the SI joint
Lateral compression fractures (LC)	
LC I	Sacral compression on side of impact
LC II	Crescent (iliac wing) fracture on side of impact
LC III	LC I or LC II injury on side of impact; contralateral open-book (APC) injury
Vertical shear fractures (VS)	
VS	Vertical displacement anteriorly through the pubic symphysis and posteriorly, through the SI joint, iliac wing or sacrum
Combined mechanical injury (CMI)	
CMI	Combination of injury patterns. Usually LC/VS

of the posterior arch causes both rotational and vertical instability. Fractures can be further subdivided based on fracture pattern and whether or not the instability is bilateral (see Table 1).

The Young-Burgess classification divides pelvic injuries by the fracture patterns caused by three main force vectors: anteroposterior compression, lateral compression and vertical shear (see Table 2). In anteroposterior compression fractures (APC), the anterior structures are injured, usually in the form of pubic symphysis separation or vertically oriented pubic rami fractures, with varying degrees of posterior injury and instability. Lateral compression (LC) forces produce fractures with horizontally oriented pubic rami fractures anteriorly and variable injuries posteriorly. Vertical shear forces (VS) produce fractures with vertical displacement through anterior and posterior pelvic injuries, and represent the most unstable injury pattern. A fourth category, combined mechanical injury (CMI) represents a combination of injury patterns, usually lateral compression and vertical shear.

Although both classification systems are widely used, studies investigating inter- and intraobserver reliability have shown great variability. A recent paper found only slight agreement between three senior pelvic trauma surgeon when reviewing the X-rays and CT scans of 100 patients [6].

Initial management

Complete evaluation of a patient with a high energy pelvic fracture is vital as this is rarely an isolated injury [7]. The magnitude of forces required to disrupt the pelvic ring can also produce significant abdominal, thoracic and head injuries. Between 60 and 80% of patients will also have another musculoskeletal injury, 12% will have urogenital injuries and 8% lumbosacral plexus injuries [8].

The initial management of patients with pelvic fractures should always adhere to Advanced Trauma Life Support (ATLS®) principles [9]. The primary survey includes an assessment of the patient's airway, breathing and circulation whilst intravenous access is obtained with large bore intravenous access, allowing for resuscitation to occur during diagnostic evaluation.

In particular, signs of hypovolaemic shock should be looked for and stabilised in the initial management phases of suspected pelvic fractures. ATLS® classifies haemorrhage into four classes based on clinical signs, allowing blood loss to be estimated (see Table 3). Class I haemorrhage represents up to 15% blood volume loss and clinical signs are minimal. In healthy patients this amount of blood loss does not require replacement. Class II haemorrhage presents with tachycardia. Catecholamines increase peripheral vascular tone and a decreased pulse pressure and anxiety is seen. Class II haemorrhage occurs after 15–30% blood volume loss, or 750–1500 ml in a 70 kg male, and can be stabilised initially with crystalloid. Class III haemorrhage presents with tachycardia and a fall in systolic blood pressure, and represents 30–40% blood volume loss. Class IV haemorrhage is seen when blood volume loss exceeds 40% and patients present with severe tachycardia and a markedly decreased systolic blood pressure with a very narrow pulse pressure.

Management of haemorrhage is governed by the patients response to initial fluid resuscitation with warmed intravenous crystalloid. A transient response to an initial 1–2 L fluid bolus suggests either inadequate resuscitation or ongoing blood loss, and requires continued crystalloid infusion as well as blood transfusion. Minimal response to initial fluid resuscitation, or a transient response to blood transfusion, requires urgent intervention to control haemorrhage.

Management of haemorrhage

Management of haemorrhage should be case dependent and must take into account the patient's condition and locally available resources and expertise. Treatment options for achieving haemostasis in unstable patients with pelvic fractures include pelvic slings, external fixation, internal fixation, direct surgical haemostasis, pelvic packing, pelvic angiography and embolisation [10].

Life threatening blood loss from pelvic fractures is possible due to the major arterial and venous systems within the pelvis, the rich blood supply of the pelvic bones themselves, and the low tissue

Table 3
Estimated blood loss and initial presentation in haemorrhage.

	Class I	Class II	Class III	Class IV
% Blood volume loss	up to 15%	15–30%	30–40%	>40%
Pulse rate (bpm)	<100	100–120	120–140	>140
Systolic blood pressure (mmHg)	Normal	Normal	Decreased	Decreased
Pulse pressure (mmHg)	Normal	Decreased	Decreased	Decreased
Respiratory rate	14–20	20–30	30–40	>35
Urine output (ml/h)	>30	20–30	5–15	Negligible
Fluid replacement requirement	Crystalloid	Crystalloid	Crystalloid and blood	Crystalloid and blood