Pelvic fractures and high energy traumas

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Pelvic fractures are associated with a high mortality and morbidity and their presence should be considered in all high energy traumas. Early management is directed towards basic advanced trauma life support (ATLS) principles but it is essential to be aware of the diagnosis and management of these complex injuries.

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The pelvis transmits weight bearing forces from the axial spine to the lower limbs, provides origin for muscles operating the hip, knee, spine, as well as abdominal and perineal muscles. It is formed by a bony ring consisting of the two innominate bones and the sacrum. The innominate bone is formed by the fusion of three ossification centres at the acetabulum: ilium, ischium and pubis. The innominate bones are joined anteriorly at the symphysis pubis and posteriorly to the sacrum at the sacroiliac joint.

TABLE 1.
Ligaments of the pelvic ring

Ligament	Position	Comments
Posterior sacroiliac (SI) ligaments	1) Short component run from posterior ridge of sacrum to posterosuperior and posteroinferior iliac spines 2) Long component run from lateral sacrum to posterosuperior iliac spines (and merges with sacrotuberous ligament)	Considered to be the strongest ligaments in the body
Anterior SI ligaments	From Ilium to sacrum	
Sacrotuberous ligaments	From posterolateral sacrum and dorsal aspect of posterior iliac spine to ischial tuberosity	Along with posterior SI ligament it maintains vertical stability of pelvis
Sacrospinous ligaments	From lateral edge of sacrum and coccyx to sacrotuberous ligament inserts on ischial spine	Separates the greater and lesser sciatic notches
Iliolumbar ligaments	From L4 & L5 transverse processes to posterior iliac crest	Stabilizes spine to pelvis
Lumbrosacral ligaments	From L5 transverse process to sacral ala	

The sacroiliac (SI) joint has two components, an articular portion, located anteriorly comprising articular cartilage on the sacral side and fibrous cartilage on the ilium, and a fibrous portion, located posteriorly. The pubic symphysis has hyaline cartilage on the medial (articular) aspect of the pubis. It is surrounded by fibrocartilage and a thick band of fibrous tissue. There are strong ligaments contributing to the stability of the pelvic ring and these are outlined in *Table 1*.

Neural structures of important note are the sciatic nerve (exiting the pelvis deep to piriformis, the lumbosacral trunk) crossing the anterior sacral ala and SI joint, and the L5 nerve root (exiting below the L5 transverse process crossing the sacral ala).

Important vascular structures to remember are the internal iliac artery and its branches as these are of major importance in pelvic trauma. The notable anterior division branches are; inferior gluteal artery (exits the pelvis via greater sciatic notch), internal pudendal artery (commonly injured in pelvis fractures), and obturator artery (may be disrupted in pubic rami fractures). The posterior division is more prone to damage as a result of posterior pelvic displacement and it is the superior gluteal artery (the largest branch of the internal iliac supplying predominantly the gluteal muscles) which is the most commonly injured vessel in posterior pelvic disruptions. However, it is the pelvic veins (or moreover the massive venous plexus that drains into the internal iliac vein) that is the major source of haemorrhage in most pelvic fractures.

The close proximity of the genitourinary system to the pelvis results in a high incidence of injuries, primarily to the bladder and urethra –

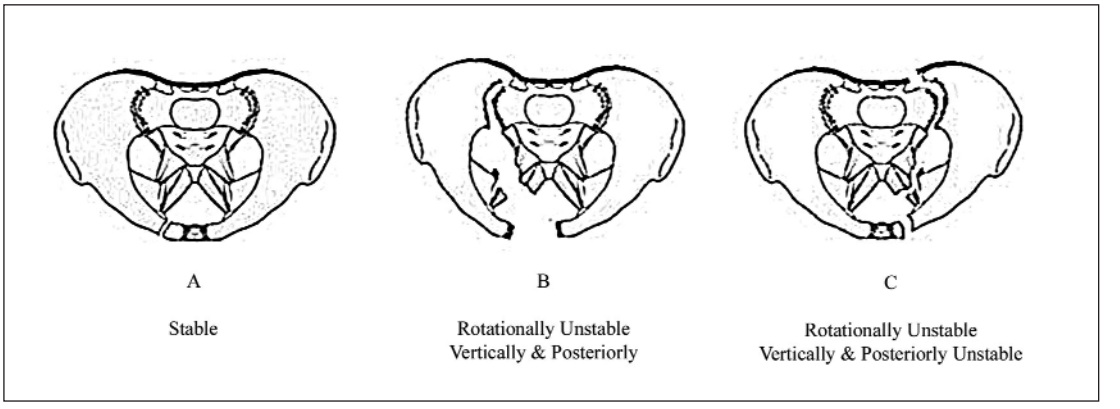

Figure 1. Tile Classification (simplified)

although vaginal injuries from bony spikes are not uncommon.

CLASSIFICATION

Pelvic fractures have been classified by Tile (1988) based on the mechanism of injury into antero-posterior compression, lateral compression, or vertical shear fractures (*Figure 1*). Further classification by Burgess et al (1990) indicates that the fracture patterns are likely to be associated with major haemorrhage. These classifications are useful in the early management of pelvic ring fractures.

MANAGEMENT

Pelvic fractures are an important group of injuries and account for 1–3% of fractures, and 60% of fractures occur in men (Dalal et al, 1989). High-energy fractures that cause disruption to the pelvic ring are commonly caused by motor vehicle accidents, crush injuries and falls from heights. High-energy pelvic ring fractures are often associated with severe or life-threatening soft tissue injuries. The mortality of pelvic ring fractures is in the region of 15–25% with open pelvic fracture carrying mortality in excess of 50%. Associated soft tissue injuries include vascular, genitourinary, abdominal, neurological and open fractures.

Early management of pelvic fractures is the management of the life-threatening associated injuries. This is a combination of assessment and treatment following advanced trauma life support (ATLS) (American College of Surgeons, 2004) guidelines. Trauma team treatment is aimed at rapidly ensuring a patent airway and that breathing, and circulation is established. Multiple large-bore intravenous lines are established allowing prompt restoration of circulation. Application of a pelvic belt may be required for early stabilization of the circulation in patients with unstable pelvic fractures. Early recognition and appropriate initial treatment of all the soft tissue complications of pelvic ring fractures is important for overall outcome as inappropriate initial management may well prejudice the definitive surgical treatment of the pelvic fracture and its associated injuries.

Physical Examination

When conducting a physical examination for suspected pelvic fracture, the following should be assessed:

- Bimanual compression and distraction of the iliac wings – assesses for rotational instability
- Manual leg traction – can aid in determining vertical instability
- Rectal examination – a high riding prostate may indicate a urethral tear in males, the sacrum is palpated for irregularity
- Vaginal examination – bleeding or lacerations indicate open fractures
- Perineal skin – lacerations may indicate an open fracture (hyperabduction of leg).

Radiographic Evaluation

An anteroposterior view of the pelvis is obtained as part of the trauma series, this can identify up to 90% of pelvis injuries. Further radiographic views may be required to improve diagnosis and these include the pelvic inlet view (~45 degree caudal tilt to show antero-posterior (AP) displacement), the pelvis outlet view (~45 degrees cephalad tilt to show superior-inferior displacement), lateral sacral view (identifies transverse sacral fractures) and computed tomography (CT) (best vizualization of SI joints).

Associated Injuries

Common associated major injuries involve the central nervous system, chest and abdomen. Haemorrhage occurs in 75% of patients with pelvic fractures; it is the leading cause of death and requires aggressive fluid resuscitation. There are three sources of bleeding: osseous, vascular and visceral. In up to 40% of patients

there is an intra-abdominal source of bleeding. Arterial bleeding only occurs in 10–15% of patients. Bleeding from the pelvic venous plexus can result in a retroperitoneal haematoma of up to 4 litres in volume. Stabilizing an unstable pelvic ring limits the pelvic volume and therefore the volume of haematoma that can form. The fastest method of achieving initial skeletal stability is by application of a pelvic belt that can stabilize both the anterior and posterior pelvic ring. Pelvic belts are only a temporary measure for controlling a pelvic fracture, and where application of a pelvic belt achieves haemodynamic control, a pelvic external fixator is often required (Tile, 1996).

Associated musculoskeletal injuries occur in 60–80% of patients, urogenital injuries being seen in 12%, and lumbosacral plexus injuries in 8%. The mortality rate is 15–25%.

Open pelvic fractures

Open pelvic fractures carry mortality in excess of 50% (Raffa and Christiensen, 1976). There is potential for major vascular injury with haemorrhage and a high incidence of gastrointestinal and genitourinary injuries. A high proportion of these patients die at the scene of the accident or fail to respond to resuscitation. Overwhelming pelvic sepsis is the most common cause of death in those surviving the initial resuscitation. Those that survive the initial phase require emergency surgery to stabilize the pelvis, debride and washout the open wounds, and a diverting colostomy with a distal washout to protect the pelvis from further contamination. Open pelvic fractures require an aggressive multidisciplinary approach to treatment.

Beyond the 'trauma room'

Following the initial phase of emergency treatment and patient stabilization, the definitive plan for fracture management is made. Stable type lateral compression fractures that do not cause significant disruption to one side of the pelvis allow patients to mobilize non-weight bearing until the fracture unites. Unstable fractures are those that are likely to go on to a mal- or non-union, cause pain, neurological or other soft tissue complications if the patient mobilizes. These unstable fractures may require operative stabilization in order to allow effective nursing, to avoid prolonged bed rest and allow the patient to mobilize early.

Deep vein thrombosis is very common following major pelvic fractures and may complicate operative treatment. The other main risks of operative treatment are infection, heterotopic ossification, delayed and non-union. Operative treatment, if indicated, should be carried out by surgeons trained in pelvic reconstructive surgery and preferably in a tertiary referral pelvic unit.

KEY POINTS

- Pelvic fractures are caused by high energy injuries and are associated with other life-threatening injuries.
- There remains a significant mortality rate in patients presenting with pelvic fractures of up to 25%.
- Correction of hypovolaemia is essential and may require definitive surgical stabilization.
- A simple 'pelvic belt' may prove life saving in a haemodynamically compromised patient.
- An experienced orthopaedic trauma surgeon should be involved in the case from the outset.
- Long term morbidity from the pelvic fracture and associated injuries are a common problem.

CONCLUSION

A patient with a high energy injury should be carefully examined for the presence of a pelvic injury and emergency resuscitation commenced as soon as possible. Despite great effort there is still a high mortality rate from these injuries and subsequent morbidity may be long lasting.

Treatment of the pelvic fracture requires an understanding of local anatomy. Repeated examination of an unstable pelvis disrupts early haemostasis and should be avoided. An experienced orthopaedic trauma surgeon should be examining the pelvis as part of the trauma team management at an early stage, minimizing secondary trauma from repeated examination before stabilizing the fracture.

A multi-disciplinary team approach is required for the rehabilitation of these patients who often present complex rehabilitation problems including chronic pain, neurological deficit, urological impairment, impotence, psychological disturbance, as well as reduced mobility.

Conflict of interest: none

American College of Surgeons (2004) Advanced trauma life support for doctors. *Student Course Manual*, 7th edn.
Burgess AR, Eastridge BJ, Young JWR et al (1990) Pelvic Ring Disruptions: Effective Classification System and Treatment Protocols. *J Trauma* **30**(7): 848–56
Dalal SA, Burgess AR, Siegel JH et al (1989) Pelvic fractures in multiple trauma: Classification by mechanism is key to pattern of injury, resuscitative requirements and outcome. *J Trauma* **29**(7): 981–1000
Raffa J, Christiensen NM (1976) Compound fractures of the pelvis. *Am J Surg* **132**(2): 282
Tile M (1988) Pelvic ring fractures: Should they be fixed? *J Bone Joint Surg Br* **70**(1): 1–12
Tile M (1996) Acute pelvic fractures. II. Principles of management. *J Am Acad Orthop Surg* **4**(3):152–61