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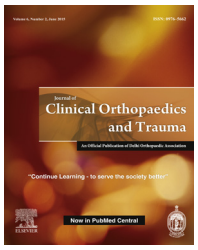

Review Article

Pelvic ring injuries: Surgical management and long-term outcomes

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ABSTRACT

Pelvic ring injuries present a therapeutic challenge to the orthopedic surgeon. Management is based on the patient's physiological status, fracture classification, and associated injuries. Surgical stabilization is indicated in unstable injury patterns and those that fail nonsurgical management. The optimal timing for definitive fixation is not clearly defined, but early stabilization is recommended. Surgical techniques include external fixation, open reduction and internal fixation, and minimally invasive percutaneous osteosynthesis. Special considerations are required for concomitant acetabular fractures, sacral fractures, and those occurring in skeletally immature patients. Long-term outcomes are limited by lack of pelvis-specific outcome measures and burden of associated injuries.

1. Introduction

Pelvic ring disruptions make up 3% of all skeletal fractures[1] and are associated with significant morbidity and mortality. Fractures of the ischiopubic bones, SI joint, and sacrum are the most common bony injuries[2] while lacerations to the urinary tract, retroperitoneal hematoma, and injuries to the lumbosacral plexus are the most common associated soft tissue injuries.[3] The two most commonly used classification systems for pelvic ring injuries are those described by Tile[4] and Young–Burgess[5] (Tables 1 and 2). Careful examination of the fracture pattern is essential for surgical decision-making.

1.1. *Indications*

Type I anteroposterior compression (APC) and lateral compression (LC) injuries are generally stable patterns (i.e., able to withstand physiologic stress) and therefore are managed nonoperatively. Four relative indications for surgical stabilization in this group have been reported: (1) substantial displacement, (2) associated abdominal injury requiring laparotomy, (3) tilt fracture protruding into the perineum, and (4) refractory pain.[6] Olson and Pollack defined significant displacement as presence of a leg length discrepancy greater than 1.5 cm or a rotational deformity resulting in loss of all internal or external rotation in the lower extremity.[6] APC and LC types II and III, on the other hand, are rotationally unstable patterns often associated with substantial displacement and are generally indications for surgical stabilization. Treatment of associated pubic rami fractures is often not necessary, as the risks of surgical dissection to fix these fractures outweigh the benefits.[4] Similarly, the vertical shear (VS) pattern is both rotationally and vertically unstable, and requires fixation. However, due to often associated massive hemorrhage, VS pattern is usually treated with external fixation with or

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Table 1 – Simplified Tile classification of pelvic ring injuries.[4]

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, lateral compression fractures, and bucket-handle fractures.
C	Rotationally and vertically unstable	Vertical shear injuries.

Table 2 – Young–Burgess classification of pelvic ring injuries.[5]

Pattern	Characteristics	Incidence
Lateral compression (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%
Anterior-posterior compression (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%
Vertical shear (VS)	Vertical displacement of one or both hemipelvices.	5.6%
Combined	A combination of the above injuries.	6.8%

without skeletal traction as a temporizing measure until definitive fixation can be safely performed. Traction can prevent shortening of the hemipelvis, thus facilitating staged open reduction and internal fixation.

1.2. *Timing*

The optimal timing for definitive surgical stabilization is not clearly defined. While there is an emerging trend toward early fixation, the term "early" has been variably used in the literature and ranged from less than 8 h[7] to less than 1 week.[8] Advantages of early fixation include pain relief, improved fracture reduction, early mobilization, easier nursing care, better positioning for respiratory care, and bleeding control.[9–11] Disadvantages of early definitive fixation, on the other hand, are increased risk of bleeding and the potential of introducing a second hit in patients who are not fully resuscitated.

Vallier et al. retrospectively reviewed 645 patients with unstable pelvic and acetabular fractures treated surgically and found early fixation (≤24 h) to be associated with lower morbidity (pulmonary complications and multi-organ failure) and length of ICU stay.[9] However, the mean ISS for the early treatment group was statistically lower than the late treatment group. Similarly, Enninghorst et al. retrospectively reviewed 286 consecutive patients with unstable pelvic ring injuries who had either early (<24 h) or late (>24 h) fixation. Complex fractures requiring extensive open surgery were excluded. The authors found a trend toward less transfusion requirements, less complications (pneumonia and deep vein thrombosis), and shorter LOS in the early fixation group despite significantly worse preoperative resuscitation parameters in this group.[10] Recently, Katsoulis and Giannoudis performed a systematic review on the timing of definitive pelvic fixation and found that late fixation was associated with increased risk of nosocomial infections, thromboembolism, and pressure ulcers, and inability to achieve anatomic reduction leading to more extensile approaches.[12] The authors pointed that the most important factors to influence the timing of surgery were hemodynamic status and response to resuscitation, fracture pattern, associated injuries, and inflammatory status of the patient. Fluids and blood products should be immediately administered to hemodynamically unstable patients and the source of bleeding should be identified as soon as possible. Definitive fixation in the emergency phase is primarily indicated for hemodynamic instability associated with open fractures. Otherwise, unstable fractures can be temporarily stabilized by external techniques until systemic inflammation has decreased, especially in patients with high injury severity scores who are prone to multi-organ failure or patients with brain, thoracic, abdominal, or perineal injuries that should be addressed first.[13]

1.3. *Surgical options*

1.3.1. *External fixation*

External fixation with either a pelvic clamp or traditional frames can provide provisional stabilization (1) in hemodynamically unstable patients, (2) in cases of symphyseal widening with fecal or urinary contamination that may be prone to infection with internal fixation, or (3) as a definitive treatment.[4] External fixation permits upright position, which may improve ventilation, especially in patients with chest injuries. The pelvic clamp and external fixators have equivalent effectiveness against displacement in rotationally unstable injuries, but none are sufficient to stabilize combined rotationally and vertically unstable injuries to allow the patient to get out of bed.[11]

Several external fixator configurations have been described. While more sophisticated configurations may offer slightly better biomechanical stability over a simple rectangular configuration, they are not rigid enough to allow ambulation and hence the additional time needed to apply these frames is not justified.[4] When used as a definitive treatment for APC II pattern, the external fixator is generally applied for