Displaced Inferior Ramus Fractures as a Marker for Pelvic Instability

P. Maxwell Courtney, MD
Ryan M. Taylor, MD
John Scolaro, MD
Derek J. Donegan, MD
Samir Mehta, MD

Department of Orthopaedic Surgery,
University of Pennsylvania,
Philadelphia, PA

Background

Isolated anterior or posterior pelvic ring injuries rarely occur due to the ring structure of the bony pelvis. While much attention is focused on disruption of the sacrum or sacroiliac joint, the anterior ring is often neglected. Fractures of the pubic rami are not benign injuries, causing functional impairment, disability, and the utilization of substantial healthcare resources.[1] The purpose of this retrospective study was to determine whether displaced inferior pubic ramus fractures are a marker of posterior ring instability. Scheyerer *et al* described a case series of patients with a pubic ramus fracture and found that 96.8% of patients had a posterior ring injury on computed tomography (CT) scan.[2] The prevalence of posterior ring disruption and pelvic instability in the presence of a displaced inferior pubic ramus fracture has yet to be addressed in the literature.

While inferior ramus fractures in isolation are treated nonoperatively in the majority of cases, much controversy surrounds the need for fixation for Young and Burgess lateral compression type I (AO/OTA type 61-B) injuries. Lefaivre *et al* looked at these fractures, which have a high incidence of posterior ring injury but are considered stable, and found that with CT evaluation the severity of posterior ring injury represented a higher degree of instability than initially thought[3]. Previous studies have evaluated the disruption of the posterior pelvic ring with injury of the public symphysis,[4] but the correlation with displaced inferior ramus injuries has not been fully evaluated. The authors hypothesize that patients with displaced inferior ramus fractures on plain radiograph have a high incidence of unstable posterior ring injuries which warrants further careful clinical and radiographic evaluation.

Methods

Using International Classification of Diseases, 9th edition (ICD-9) codes, the authors identified 493 patients with any fracture of the pelvis at a single Level I trauma center from 2007 to 2011. Institutional review board approval was obtained for this study. Of this group, 155

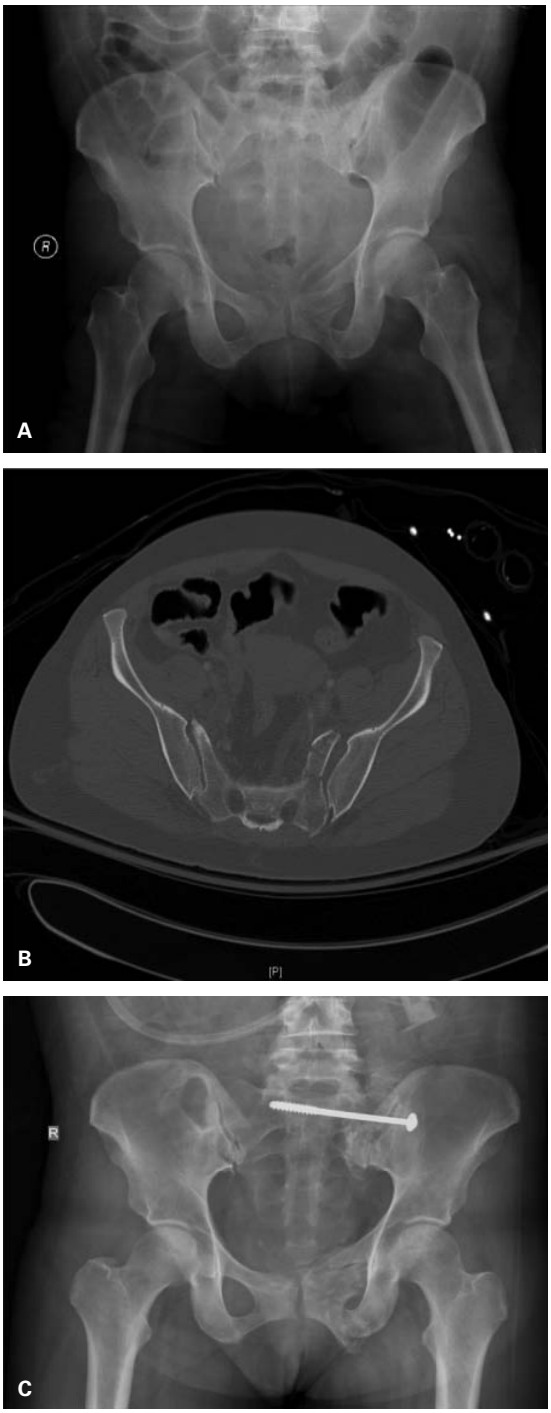

Figure 1. Pelvic radiograph (A) and CT scan (B) of a 49 year old female after a motor vehicle crash showing a displaced left inferior ramus fracture, superior ramus fracture, and a posterior ring injury which was treated with a sacroiliac screw (C).

Corresponding author:
P. Maxwell Courtney, MD
Department of Orthopaedic Surgery
University of Pennsylvania
3400 Spruce Street,
2 Silverstein
Philadelphia, PA 19104
Paul.Courtney@uphs.upenn.edu

Table 1. Summary of patient data with displaced inferior ramus fractures.

Gender	Number (%)
Male	44 (47)
Female	49 (53)
Age	**Number (%)**
18-30	25 (27)
31-45	27 (29)
46-60	35 (38)
> age 60	6 (6)
Mechanism	**Number (%)**
Fall	27 (29)
Motor vehicle accident	43 (46)
Pedestrian struck by vehicle	13 (14)
Other	7 (8)
Associated Injuries	**Number (%)**
Superior ramus fracture	71 (76)
Bilateral inferior ramus fracture	12 (13)
Posterior ring injury	63 (68)
Surgical fixation of posterior ring	37 (40)
Unstable posterior ring injury	38 (41)

patients were found to have a displaced inferior ramus fracture on pelvic plain radiograph. Patients under age 18, those with a concurrent acetabular fracture, or without a CT scan were excluded. Ninety-three patients met the inclusion criteria. Complete pelvic radiographs and computed tomography (CT) scans were then evaluated for additional pelvic ring injuries.

The inferior ramus fracture was classified anatomically as parasymphyseal or shaft. We defined a posterior ring injury as a fracture of the sacrum, any displacement of the sacroiliac joint, or fracture of the ilium with extension into the sacroiliac joint. The AO/OTA classification of the pelvic ring injury was noted by two of the authors. Patients requiring operative fixation of the posterior ring or those with AO/OTA type C injury who expired prior to fixation were deemed to have an unstable injury. The data was analyzed using the chi-square test to determine associations with posterior ring injury and instability. A logistic regression analysis was performed to identify any potential correlation with age and posterior ring disruption. A p-value of 0.05 was used to determine statistical significance.

Results

Of our original 155 patient series with a displaced inferior ramus fracure, 60 patients (39%) were found to have an acetabular fracture. We looked closer at the 93 patients with isolated ring injuries, where 71 patients had a superior ramus fracture and 12 patients had bilateral inferior ramus fractures. There were 44 men and 49 women with an average age of 44 (range 18-64) at the time of injury. No statistically significant correlation was found between age and incidence of posterior ring injury or pelvic instability. The most common mechanism of injury was a motor vehicle accident in 43 patients, followed by a fall in 27 patients.

Sixty-three (68%) patients were found to have a posterior ring injury on additional radiographs and CT scan, with 60% of these injuries being unstable. Patients with concurrent superior ramus fractures were statistically more likely to have a posterior ring injury ($p<0.001$) and an unstable pelvis ($p=0.013$). Those with bilateral displaced inferior ramus fractures had a higher rate of posterior ring injury which approached statistical significance ($p=0.057$). Of those with a displaced unilateral inferior ramus fracture, parasymphyseal involvement was associated with higher incidence of posterior ring injury ($p=0.047$) and pelvic instability ($p=0.028$).

Discussion

Injury to the bony pelvis has previously been described by the mechanism of injury and the degree of instability which results. Tile described pelvic injuries as stable, rotationally unstable but vertically unstable, or rotationally and vertically unstable.[5] Young and Burgess further described pelvic injuries by the mechanism of injury: lateral compression (LC), anteroposterior compression (APC), vertical shear (VS) fractures, and those with a combined mechanism (CM).[6] Both systems base the degree of instability of the pelvic ring on the location of the fracture and relate radiographic findings to the direction of the force which created such an injury. Fractures to the anterior pelvic ring can occur infrequently in isolation and are often associated with disruption of the ring in another location. In isolation, these fractures are considered rotationally and vertically stable (Tile A) and are treated non-operatively in the majority of cases. Disruption of both the anterior and posterior ring often results in instability requiring operative fixation.

While the anterior ring is often a neglected entity in pelvic trauma, it can be a marker for additional injuries of the ring. The authors hypothesized that displaced inferior ramus fractures are a marker for instability of the pelvic ring. Sixty-three of the 93 patients in our case series had an injury to the posterior ring, 37 required surgical stabilization of the posterior ring, and one sustained a fatal AO/OTA type C pelvic ring injury. The high incidence of an unstable posterior ring injury should prompt all clinicians evaluating pelvic trauma to closely scrutinize all patients with an inferior ramus fracture for further injuries to the pelvic ring. When looking at the subset of unilateral inferior ramus fractures, parasymphyseal involvement was more likely to have a posterior ring injury and pelvic instability than inferior ramus shaft fractures. These parasymphyseal patterns are more likely to act as a Young and Burgess APC injury.

Both the Tile and Young and Burgess systems rely on three plain films of the pelvic ring and were not created with the consideration of CT imaging. In a single retrospective study,

Table 2. Additional radiographic findings with incidence of posterior ring injuries and instability.

	Posterior Ring Injury	P value	Unstable Injury	P value
Superior ramus fracture	56 (79)	< 0.001	34 (48)	0.013
Bilateral inferior ramus fracture	11 (92)	0.057	7 (58)	0.186
Unilateral inferior ramus fracture				
Parasymphyseal	20 (80)	0.047	14 (56)	0.028
Shaft/Root	32 (57)		17 (30)	

37 of 53 patients with any pubic ramus fracture were found to have evidence of a posterior ring injury on CT,[7] but none of those patients underwent operative treatment. The authors did not recommend routine use of CT scanning for patients with isolated ramus fractures. Our data contradict this study, as 41% of all patients in our series with displaced inferior ramus fractures required surgical fixation. We, therefore, recommend CT scans in all patients with a displaced inferior ramus fracture found on plain radiographs.

While acknowledging the retrospective nature of the study, we present the first case series of patients with displaced inferior ramus fractures to determine the incidence of posterior ring injury and pelvic instability. There exists considerable debate whether AO/OTA type B fractures are inherently stable or unstable, and in practice, it is difficult to determine which of these fracture patterns are truly unstable. As our marker for instability, we used the clinical judgment of two fellowship-trained orthopaedic traumatologists at our institution if they chose to pursue surgical stabilization of the posterior ring. Concurrent acetabular fractures are a confounding variable of pelvic stability and were excluded from the study.

Conclusion

Patients with displaced inferior pubic ramus fractures warrant a detailed examination of their posterior ring to identify instability, particularly in those with associated superior ramus fractures, bilateral inferior ramus fractures, and parasymphyseal injuries.

References

1. Koval KJ, Aharonoff GB, Schwartz MC, et al. Pubic rami fracture: a benign pelvic injury? *Journal of Orthopaedic Trauma.* 1997;11(1):7–9.

2. Scheyerer MJ, Osterhoff G, Wehrle S, et al. Detection of posterior pelvic injuries in fractures of the pubic rami injury. *International Journal of the Care of the Injured.* 2012;43:1326–9.

3. Lefaivre KA, Padalecki JR, Starr AJ. What constitutes a Young and Burgess lateral compression-I (OTA 61-B2) pelvic ring disruption? A description of computed tomography-based fracture anatomy and associated injuries. *J Orthop Trauma.* 2009 Jan;23(1):16-21.

4. Phieffer LS, Lundberg WP, Templeman DC. Instability of the posterior pelvic ring associated with disruption of the pubic symphysis. *Orthop Clin North Am.* 2004 Oct; 35(4):445-9.

5. Tile M. Pelvic ring fractures: should they be fixed? *J Bone Joint Surg Br.* Jan 1988;70(1):1-12.

6. Burgess AR, Eastridge BJ, Young JW, et al. Pelvic ring disruptions: effective classification system and treatment protocols. *J Trauma.* Jul 1990;30(7):848-56.

7. Schädel-Höpfner M, Celik I, Stiletto R, et al. Computed tomography for the assessment of posterior pelvic injuries in patients with isolated fractures of the pubic rami in conventional radiography. *Chirurg.* 2002 Oct;73(10):1013-8.