Posterior Iliac Crescent Fracture-dislocation: Is It Only Rotationally Unstable?

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**Abstract**

Posterior iliac crescent fracture-dislocation is generally considered rotationally unstable and vertically stable. The current study (1) investigated whether vertical instability may occur in posterior iliac crescent fracture-dislocation and (2) analyzed the clinical features of vertically unstable iliac crescent fracture-dislocation as well as treatment strategies. Patients with pelvic fracture who were treated in the authors’ department from June 2009 to June 2012 were retrospectively reviewed. This study analyzed the clinical features, including incidence, hemodynamic state, associated injuries, injury severity score, and treatment methods for vertically unstable iliac crescent fracture-dislocation. Four patients had vertically unstable fracture-dislocation, accounting for 12.9% of all iliac crescent fracture-dislocations. All 4 patients were hemody-namically unstable on admission and had complications of associated injuries with a higher injury severity score. In 3 of the 4 patients, iliac crescent fracture-dislocations were reduced via the posterior approach at the initial stage and these patients underwent fixation with a plate. The remaining patient was initially given transcondylar traction because of severe complications and underwent open reduction and internal fixation (ORIF) via a posterior approach at a later stage. The outcomes of all 4 patients were rated as good or excellent by the Kobbe rating system at the last follow-up. Vertical instability may occur in iliac crescent fracture-dislocation. The authors propose ORIF of the fracture-dislocation via a posterior approach. When initial surgery is not possible because of severe associated organ injuries, the authors propose transcondylar traction to allow reduction of the sacroiliac joint and ORIF at a later stage.

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Major pelvic ring fracture is a variable condition that is difficult to treat and is often associated with substantial morbidity and mortality. These injuries typically result from high-energy trauma that is most often generated by a traffic accident, crush trauma, or fall from a great height. Many classification schemes have been developed for pelvic fractures, and they are generally associated with the direction of the impact on the pelvic ring and the degree of instability. Burgess et al, and Manson et al classified pelvic ring disruptions into 3 main groups: anteroposterior compression, lateral compression, and vertical shear fractures, based on the mechanism of injury. Lateral compression injury patterns account for more than 50% of all pelvic ring injuries. Posterior iliac crescent fracture-dislocation is generally considered a subtype of lateral compression injury patterns (lateral compression type 2). It has been defined as a posterior fracture-dislocation of the sacroiliac joint in which there is variable disruption of the sacroiliac ligament complex that produces a crescent-shaped fracture of the posterior iliac crest. The crescent-shaped stable posterior iliac component remains firmly attached to the dorsal sacrum via the posterior sacroiliac ligamentous complex. Posterior iliac crescent fracture-dislocation is generally considered rotationally unstable and vertically stable and is coded as Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) 61-B2.2 and 61-B2.3. Currently, it is unclear whether vertical instability may occur in posterior iliac crescent fracture-dislocation.

Because posterior iliac crescent fracture-dislocation involves the sacroiliac joint, which is a major weight bearing articulation, if not appropriately treated, the potential for posttraumatic arthritis and chronic instability is considerable. Open reduction and stable internal fixation (ORIF) is necessary to achieve a congruous articular surface and to reestablish rotational posterior pelvic stability. Open reduction and internal fixation of these injuries can be performed via several different methods, including percutaneous sacroiliac screw and plate fixation via an anterior or posterior approach. Each established method has its indications and popularity. In 2008, Day et al. described a pelvic crescent fracture classification system based on the extent and location of sacroiliac joint involvement and found that this classification system is useful for selection of the most appropriate surgical approach. Type I fractures involve less than one-third of the sacroiliac joint, resulting in a large, stable, crescent-shaped posterior iliac fragment, and the authors recommended ORIF through a lateral surgical interval via an ilioinguinal approach. Type II fractures involve the middle third of the sacroiliac joint, resulting in a moderately sized, stable, crescent-shaped posterior iliac fragment, and the authors recommended ORIF via a posterior dorsal surgical approach. Type III fractures involve more than two-thirds of the sacroiliac articulation, resulting in a small, posterior iliac crescent-shaped fragment, and the authors recommended percutaneous iliosacral screw fixation. However, Calafi and Routl recently reported that the classification system proposed by Day et al does not cover all of the types of pelvic crescent fracture. They reported that 12 cases of the 100 crescent fractures that they described could not be classified according to the Day scheme. If vertical instability occurs in posterior iliac crescent fracture-dislocation, it is unclear whether this kind of fracture-dislocation pattern would fall into Day’s classification system and what method should be used for treatment.

In the current study, all patients with posterior iliac crescent fracture-dislocations treated in the authors’ department from June 2009 to July 2012 were retrospectively reviewed. The principal aims were: (1) to clarify whether vertical instability occurs in posterior iliac crescent fracture-dislocation and (2) to determine the clinical features of vertical unstable posterior iliac crescent fracture-dislocation as well as to investigate treatment strategies.

**Materials and Methods**

This study was reviewed and approved by the Ethical Committee of the Daping Hospital, Third Military Medical University, Chongqing, China. Patients with pelvic fracture treated in the authors’ department from June 2009 to June 2012 were retrospectively reviewed. The mechanism of injury, hemodynamic state at admission, type of pelvic fracture, associated injuries, injury severity score, and outcome were analyzed.

The number of hemodynamically unstable patients was recorded. After initial necessary resuscitation, routine radiographic examination and spiral 3-dimensional computed tomography (CT) were performed in all patients. The AO/OTA classification system was used for all patients. The Day classification scheme was used to categorize the posterior iliac crescent fracture-dislocations based on CT scans. Vertical instability was defined as displacement of the sacroiliac joint vertically more than 1 cm based on radiographic and CT examinations.

If the patient was assessed as having a vertically unstable iliac crescent fracture-dislocation based on the results of radiographic and CT examination, thorough evaluation was performed to determine whether the patient could undergo surgery at the initial stage. If so, the crescent fracture-dislocation was reduced via a posterior surgical approach within 5 days of injury. A 5-cm-long vertical posterior iliac incision was made, and the muscle was retracted laterally. The vertical fracture-dislocation was visualized directly and could be easily reduced through the application of lower extremity traction and reduction forceps. After reduction, the fracture was fixed with a plate.

Patients whose overall condition precluded surgery at the initial stage under-
went external fixation of the pelvis and transcondylar traction. ORIF was performed at a later stage.

Rehabilitation was initiated as soon as the patient’s overall condition allowed. It consisted of supervised range of motion and resistance exercises, along with protected weight bearing on the injured side for 6 weeks after surgery, followed by progressive weight bearing during the subsequent 6 weeks.

Follow-up visits were routinely conducted 1 month, 2 months, 3 months, 6 months, and 1 year after discharge. Clinical results and radiology were the parameters used to evaluate patient recovery. The methods proposed by Kobbe et al were used to rate patient status. In brief, the ratings of the radiologic and clinical results were assessed as 1 score on a 7-point scale, in which the maximum of 7 points represented an excellent result, 6 points represented a good result, 4 or 5 points represented a fair result, and 1 to 3 points represented a poor result. The ratings included a work and social integration section in which a score of 3 points was considered a good outcome, a score of 2 points was considered a fair outcome, and a score of 1 point was considered a poor outcome.

RESULTS

In total, 152 patients with pelvic fracture were treated in the department between June 2009 and June 2012. Thirty-one posterior iliac crescent fracture-dislocations were identified, for an incidence of 20.4%. Among these cases were 24 male and 7 female patients, with an average age of 41.2 years (range, 10-52). The mechanism of injury included motor vehicle accident (20 cases), fall from a great height (7 cases), and heavy object crush injury (4 cases).

A total of 27 patients had rotationally unstable iliac fracture-dislocations, and 4 had vertically unstable iliac fracture-dislocations. The number of vertically unstable iliac fracture-dislocations accounted for 12.9% of all posterior iliac crescent fracture-dislocations. In rotationally unstable iliac fracture-dislocations, there was no obvious vertical displacement of the sacroiliac joint. In contrast, the displacements in vertically unstable iliac fracture-dislocations were more than 1 cm. They were accompanied by fracture of the anterior pelvic ring or acetabulum, which disrupted the pelvic ring both anteriorly and posteriorly, allowing vertical displacement of the sacroiliac joint.

Figure 1: A patient with rotationally unstable iliac crescent fracture-dislocation. Anteroposterior radiograph of the pelvis showing no vertical displacement of the sacroiliac joint (a). Horizontal computed tomography section of the pelvis showing the iliac crescent fracture fragment (white arrow). The fractured sacrum (black arrow) shows that the patient may have had lateral compression violence (b). Anteroposterior radiograph of the pelvis showing that the patient was treated with a sacroiliac screw for the iliac crescent fracture-dislocation (c).

Figure 2: Three patients with vertical unstable iliac crescent fracture-dislocation. Preoperative anteroposterior radiograph of the pelvis showing vertical displacement of the sacroiliac joint (a). Preoperative coronal computed tomography section of the pelvis confirming vertical displacement of the sacroiliac joint (b). Preoperative 3-dimensional constructed computed tomography image of the pelvis showing right iliac crescent fracture-dislocation. The fracture fragment is displaced cephalad approximately 3 cm (c). Preoperative 3-dimensional constructed computed tomography scan of another patient showing right iliac crescent fracture-dislocation. The fracture fragment is displaced cephalad approximately 1.5 cm (d). Preoperative 3-dimensional constructed computed tomography scan of the third patient showing left iliac crescent fracture-dislocation. The fracture fragment is displaced cephalad approximately 1.5 cm (e). Postoperative anteroposterior radiograph of the third patient showing a plate to fix the crescent fracture-displacement (f).
and the mean injury severity score in the 4 patients with vertically unstable iliac crescent fracture-dislocations was 28.5 (Figure 4).

On admission, the 4 patients with vertically unstable iliac crescent fracture-dislocations had hemorrhagic shock and required aggressive resuscitation, with an average of 3000 mL of crystalloid fluid and 3 units of blood. In contrast, only 2 patients with rotationally unstable iliac fracture-dislocations had hemorrhagic shock and required an average of 1300 mL of crystalloid fluid and 0.4 units of blood (Figure 4).

After successful resuscitation, all patients underwent routine radiographic examination and 3-dimensional CT scan. Based on the radiographic and CT scan results, the fracture types of the 4 patients were classified as AO/OTA 61-C1.2 (3 cases) and AO/OTA 61-C2.2 (1 case). Based on the Day classification, there were 4 type II and 1 type III crescent fractures (1 patient had bilateral iliac crescent fracture-dislocations) (Figure 3a).

Three of the 4 patients were considered suitable candidates for surgery at the initial stage. Within 5 days of injury, the vertical fracture-dislocations were reduced via a posterior approach and the dislocated sacroiliac joints were fixed with a plate (Figure 2f).

The other patient had severe hemothorax, lung contusion, fracture of the left femur and humerus, and severe impairment of hepatic function. External fixation of the pelvis and transcondylar traction were applied at the initial stage. At 14 days after injury, the vertical fracture-dislocations were reduced via a posterior approach and then a plate to fix both sides of the sacroiliac joint was applied because the patients had bilateral crescent fracture-dislocations (Figure 3).

All 4 patients with vertically unstable iliac crescent fracture-dislocations were followed up for more than 12 months. The displaced iliac fracture-dislocations in the 4 patients who had vertical instability were reduced during surgery and showed no loss of reduction during follow-up. At the last follow-up visit, 1 of these patients reported bearable discomfort but no pain in the sacrococcygeal region. Radiographic examination showed healing of the fracture and a good Kobbe rating. The other 3 patients were considered to have excellent outcomes at the last follow-up visit, according to Kobbe rating.

**DISCUSSION**

In general, posterior iliac crescent fracture-dislocation is considered rotationally unstable and vertically stable and is usually classified as AO/OTA 61-B2.2 and 61-B2.3. However, the current study showed that vertical instability may occur in posterior iliac crescent fracture-dislocation. The current findings showed
that the fractured fragment remained connected to the sacrum, whereas the sacroiliac joint was totally disrupted and the sacroiliac joint was dislocated vertically. The 4 patients who had vertical instability were considered to have AO/OTA 61-C2.2 and 61-C1.2 type fractures. All 4 patients could be categorized according to Day’s classification scheme.

Posterior iliac crescent fracture-dislocations are generally considered to result from relatively low-energy trauma and therefore are not associated with lifethreatening injuries and hemodynamic instability.8,9,17 All 22 patients in the series of Borrelli et al8,9 were hemodynamically stable in the field, and none required an anterior pelvic external fixator, arteriography, or embolization to control bleeding. The possible mechanism for vertically unstable posterior iliac crescent fracture-dislocation is that both lateral compression and vertical shear trauma occurred in these 4 patients, resulting in both vertical and rotational instability. Moreover, higher-energy trauma was always the cause. Currently, more higher-impact injuries occur due to increasing motor vehicle accidents, and the force of the trauma that caused the injury has increased in the present compared with historical trauma; thus, the pelvis might be affected by both rotational and vertical trauma. This was confirmed by the finding that the mean injury severity score was higher in the 4 patients with vertically unstable posterior iliac crescent fracture-dislocation; all 4 patients were hemodynamically unstable and required aggressive fluid resuscitation.

The different clinical features of vertically unstable posterior iliac crescent fracture-dislocation call for different treatment strategies. First, combined measures are warranted to prevent bleeding because patients with vertically unstable pelvic fracture are more susceptible to hemodynamic instability. Bleeding in severe pelvic fracture occurs mainly from 4 sources: injured intra-abdominal organs, venous vessels of the presacral plexus, small vessels from the fracture fragments, and arteries originating from the internal iliac artery.18,19 The authors routinely perform digital subtracted angiography along with CT in patients with major pelvic fracture; if bleeding from the arterial branches is identified, transcatheter arterial embolization is performed to control the arterial bleeding in most cases.18,20 External fixation is then performed to minimize bleeding from the unstable fracture fragments.18 Regarding bleeding of venous vessels of the presacral plexus, the authors believe that hemodynamic stability can be achieved in most cases by the tamponade effect of the retroperitoneum. In extremely rare conditions when the retroperitoneum is damaged, there is no tamponade effect and retroperitoneal packing is indicated.18,21

Second, the greater number of associated injuries and the higher injury severity score in vertically unstable posterior iliac crescent fracture-dislocations means that definite and aggressive surgery for pelvic fracture-dislocation may be impossible in some cases. Under such circumstances, the authors propose transcondylar traction at the initial stage, which could reduce the vertical fracture-dislocation, making surgery easier at a later stage.22

Third, the authors propose reduction of the vertically unstable crescent fracture-dislocation via a posterior approach. The advantages include direct visualization and reduction of the fracture-dislocation with the help of reduction forceps. Closed reduction plus percutaneous iliosacral screw, posterior reduction, and an anterior approach have been advocated by different groups.23-25 In early series, the posterior approach to pelvic ring injuries exhibited soft tissue and infectious complication rates of 18% to 27%. However, Stover et al25 suggested that, with proper patient selection and certain surgical techniques, there is minimal risk of catastrophic wound complication rates or high infection rates, as reported by others. In all 4 patients in the current study, the fracture-dislocations were well reduced and fixed via the posterior approach, and no complications, such as wound infection or loss of reduction, occurred.

The current study has several limitations. First, because the series was examined retrospectively, a control group was not available for direct comparison. Second, the relatively short mean follow-up period (12 months) prevented inference of concrete conclusions regarding specific treatment guidelines. A prospective comparison study with a longer follow-up time is warranted.

**CONCLUSION**

Vertical instability may occur in iliac crescent fracture-dislocation. The authors propose ORIF of the fracture-dislocation via a posterior approach. When initial surgery is not possible because of severe associated organ injuries in vertically unstable iliac crescent fracture-dislocation, the authors propose transcondylar traction to allow reduction of the sacroiliac joint and ORIF at a later stage.

**REFERENCES**


25. Moon CN, Merkle PF. A level one trauma center’s experience with the posterior approach to the pelvis. *Orthopedics* 2002; 25(2):159-162.