Posterior Acetabular Column and Quadrilateral Plate Fractures: Fixation With Tension Band Principles

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abstract

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Acetabular fractures can be classified into 5 simple and 5 associated fracture patterns. A significant amount of variation and complexity exists in these fractures patterns. Fractures of the posterior wall are the most common acetabular fractures. Comminution of the quadrilateral plate adds to fracture instability, and more rigid and stable internal fixation is mandatory. The goal of this study was to assess the results of reconstruction of comminuted posterior wall fractures of the acetabulum associated with quadrilateral plate fractures using the tension band technique.

Twelve patients (9 men and 3 women) were included in the study. Mean patient age was 38.6 years (range, 24-47 years). Minimum follow-up was more than 2 years postoperatively. Reconstruction of the fracture included anatomic reduction of the fracture and fixation with a buttress plate for the posterior column and a prebent one-third tubular plate for the quadrilateral plate fracture. Clinical results were excellent in 58% of patients and good in 17% of patients. Radiologic results were excellent in 50% of patients and good in 17% of patients. Radiologically, based on the fracture gap postoperatively, 8 (66%) patients showed anatomic reduction, 2 (17%) showed good reduction, and 2 (17%) showed poor reduction.

The study confirms that this method of reconstruction facilitates accurate and firm reduction of displaced posterior wall fractures of the acetabulum.

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Acetabular fractures can be classified into 5 simple and 5 associated fracture patterns. A significant amount of variation and complexity exists in these fractures patterns. Most acetabular fractures involve the posterior wall. Although such fractures may appear to be simple on plain radiographs, many surgeons face difficulties when reducing the fragments. Most posterior wall fractures are comminuted or associated with an impaction injury of the articular surface into the underlying cancellous bone along the margin of the fracture line. The soft tissues are frequently detached from fragments at the time of injury or intraoperatively. In addition, postoperatively it is difficult to know the exact quality of the reduction and the shape and congruity of the articular surface of the acetabulum due to its 3-dimensionally complex shape and the interfering effect of metals on the radiologic images. Accurate evaluation of the resulting union and the likelihood of future osteoarthritis and differentiating between avascular necrosis of the femoral head and true posttraumatic arthritis are also hindered. Therefore, surgeons should make every effort to obtain a stable congruous hip joint with complete union of the fragments during the primary surgery because a second surgery is not feasible.

**Materials and Methods**

Twelve patients (9 men and 3 women) were included in the study. Mean patient age was 38.6 years (range, 24-47 years). The right side was affected in 5 patients and the left side in 7 patients. The mechanism of injury was a motor vehicle accident in 7 patients, motorcycle accident in 3 patients, and pedestrian accident in 2 patients. Associated injuries were found in 8 patients: extremity injuries in all 8 patients, abdominal injuries in 2 patients, chest injury in 1 patient, and head injury in 1 patient. Posterior dislocation was found in 7 patients and central dislocation was found in 5 patients. No cases of anterior dislocation occurred. All dislocated hips were reduced within 6 hours of admission to the hospital. Skeletal traction was performed for all patients until surgery. Sciatic nerve injury was observed in 2 patients at the time of injury. Average time from injury to surgery was 6 days (range, 3-12 days).

Plain radiographs (anteroposterior and Judet views) and computed tomography scans of the affected hip were obtained for all patients on the day of admission according to standardized trauma protocol (Figures 1, 2).

Fractures were classified according to the Letournel-Judet system. Three (25%) fractures were posterior wall fractures and 9 (75%) were complex fractures associated with other types of fractures involving both columns. In all patients, fracture of the quadrilateral plate was noted.

A control group of 10 patients (7 men and 3 women) who sustained posterior wall fractures with quadrilateral plate fractures treated with buttress plates was studied for comparison. Mean patient age at the time of injury was 44.3 years (range, 22-62 years). Six fractures involved the right side and 4 involved the left side. The mechanism of injury was road traffic accidents in all patients. The fractures were classified according to the Letournel-Judet system. Six (60%) fractures were simple posterior wall fractures and 4 (40%) were complex fractures associated with other types of fractures.

**Surgical Technique**

All patients were operated through a posterior approach. After cleaning the soft tissue debris between the fractured fragments, the extent of marginal impaction was identified by applying gentle traction at the hip joint. The posterior wall fragments and their attached capsular ligaments were reduced and held with a pointed pusher. Using a pusher instrument to maintain the fragment in its reduced position while creating a pilot hole and drilling the fragment reduced the necessity of temporary fixation with Kirschner wires, and 2.7-mm lag screws were used for stabilization of the fragments. When the
fragments were large, 2 or three 3.5-mm cortical screws were used for firm fixation. After fixation, intra-articular reduction was confirmed with gentle traction at the hip joint and a stability test. Care was taken to confirm that the lag screws placed close to the posterior rim were extra-articular. The outer surfaces of the reduced fragments were supported with buttress plating. The plate was slightly contoured to provide compression of the posterior acetabular wall. Then, a one-third tubular plate prebent to 90° was placed at the edge of the quadrilateral plate to conduct a tension band effect for secure holding of the fractured plate and fixed with 2 or three 3.5-mm screws (Figure 3).

Rehabilitation

Patients entered an institutional physical therapy program on the basis of a gradual improvement of hip range of motion and quadriceps and gluteus muscles strengthening exercises. They were instructed to use crutches until unprotected, full weight bearing was permitted after the fractures had healed.

Postoperative Assessment

Postoperative patient evaluation was clinical and radiological. Clinical grade was based on the system of D’aubigne and Postel as modified by Matta. The grading system assigns a maximum of 6 points for each parameter of pain, gait, and range of motion. The 3 parameter values are then added, and the total is classified as excellent (18 points), very good (17 points), good (15 or 16 points), fair (13 or 14 points), or poor (less than 13 points).

Radiologically, the quality of the reduction and the congruency of the hip joint were evaluated using the postoperative radiographs or computed tomography scans. The radiologic criteria after open reduction and internal fixation were based on the fracture gap remaining at the fracture site after reduction: anatomic (0-1 mm), good (2-3 mm), and poor (more than 3 mm). The radiologic grade at last follow-up was based on the criteria of Matta: excellent (a normal appearing hip joint), good (mild changes with minimal sclerosis and joint narrowing less than 1 mm), fair (intermediate changes with moderate sclerosis and joint narrowing less than 50%), and poor (advanced changes).

Average follow-up was 34 months (range, 29-46 months).

RESULTS

Clinical results at final follow-up were excellent and very good in 7 (58%) patients, good in 2 (17%), fair in 2 (17%), and poor in 1 (8%) (Figures 4, 5). Radiologically, based on the fracture gap postoperatively, 8 (66%) patients showed anatomic reduction, 2 (17%) showed good reduction, and 2 (17%) showed poor reduction. According to the radiologic criteria of Matta, 6 (50%) patients had excellent results, 3 (25%) had good results, 2 (17%) had fair results, and 1 (8%) had poor results.

Two patients experienced wound infections postoperatively. One required debridement and suction irrigation of the wound without the need for hardware removal. Two patients had sciatic nerve palsy; the nerves were explored intraoperatively and were contused but intact. The 2 patients were cured completely at final follow-up. One patient experienced avascular necrosis of the femoral head and early arthritic changes.

Regarding the control group treated with buttress plates, clinical results at final follow-up were excellent and very good in 5 (50%) patients, good in 1 (10%), fair in 2 (20%), and poor in 2 (20%). Radiologically, 4 (40%) patients had excellent results, 2 (20%) had good results, 1 (10%) had fair results, and 3 (30%) had poor results.

DISCUSSION

Acetabular fractures are severe injuries often occurring in polytrauma patients as a result of a high-energy trauma such as motor vehicle accidents or falls from a height. Less often they occur as a result of a minor trauma in older patients presenting with osteopenic bone. Anatomic reduction of the acetabulum and stable fixation are the primary goals of acetabular trauma surgery. Open reduction and internal fixation with several available ap-
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In the current study, 75% of patients had good results in only 68% to 82% of patients. This difference in outcome has been explained by comminution of the posterior wall. The spring effect is produced by bending the plate into a slightly convex position, and, as the plate is secured to the posterior column, compression of the fragment occurs by the hooks. In the current series, the authors prebent the plate at the level between the second and third holes to 90° and applied it to the inner edge of the quadrilateral plate to create a tension band effect, which has a more stabilizing effect on the construct beside the buttress plating of the posterior acetabulum. It is important to achieve stable fixation of the wall considering the amount of force delivered to it, especially during the immediate postoperative period and the early rehabilitation period when range of motion is started. A study by Goulet et al demonstrated that fixation with spring plates and reconstruction plates has a higher load to failure than reconstruction plates alone, especially in concentrically comminuted fractures.

In a recent meta-analysis, all fractures of the acetabulum (3670 cases) were found to be classifiable according to Letournel’s classification. Fractures of the quadrilateral plate are normally associated with pelvic column disruption and can be classified as such.

The quadrilateral plate is nonweight bearing and out of the acetabular roof arc, so it can be treated conservatively in cases of isolated injury. However, in cases of displaced posterior column fractures, stable internal fixation is mandatory to allow early range of motion and weight bearing.

Comminuted quadrilateral plate fracture with medial displacement is a technically difficult fracture to treat. Minimal bone stock, proximity to the hip joint with limited surgical access, and difficulty in obtaining a stable fixation at this area contribute to the surgical challenge of open reduction and internal fixation. Fixation of a medial buttress plate in an infrazytineal fashion is a well-described technique to address such fractures. However, this plate alone may be inadequate to buttress all the fragments in a grossly comminuted quadrilateral plate fracture. An additional spring plate is often placed underneath the infrazytineal plate to hold the fracture fragments.

Figure 5: Anteroposterior radiograph 2 years postoperatively. The patient was pain free with adequate range of motion.

Figure 4: Anteroposterior (A) and lateral (B) radiographs 6 months postoperatively.

**Conclusion**

Reconstruction of a comminuted quadrilateral plate associated with posterior wall fractures of the acetabulum via the prebent plate using a tension band effect with buttress plate provides a stable fixation of the posterior wall amenable to early range of motion and weight bearing.

**References**


