CLINICAL TECHNIQUE

Strategies in Management of Posterosuperior Wall Fracture of the Acetabulum

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Abstract

Introduction: Posterior wall acetabular fractures remain a common entity with respect to fractures involving the acetabulum (35–47%) of which 3.76% of them involve the acetabular roof. Our study aims to identify the mechanism of injury of these injuries involving the roof of the acetabulum and the challenges in their management.

Materials and methods: This is a prospective study between January 2018 and December 2022. All surgically treated adult patients with acetabular fractures involving the posterosuperior wall or the posterosuperior wall with a posterior column were included in the study. We excluded patients with posterior, posteroinferior acetabular fractures, anterior wall fractures, column fractures, and patients medically unfit for surgery. We used a horizontal reference line connecting the superior edge of the bilateral acetabulum to evaluate the adequacy of the buttressing effect by the plate. Weller classification was used in our study.

Results: A total of 20 patients (M:F = 16:4) of mean age 36.4 (±12.6) years were enrolled for analysis. According to Waller's classification, seven patients were type I, 13 patients were type II fractures, and no type III fractures. The femoral head was found to be dislocated in 10 patients and subluxation in four patients. A total of 15 patients were stabilized using lag screws and neutralization reconstruction plate and the remaining five patients were fixed with reconstruction plate in buttress mode. The average reconstruction plate length used in our study was nine holes with a mean of four holes with two screws on an average placed in the reconstruction plate superior to the reference line.

Conclusion: Posterosuperior acetabular fractures are more commonly seen than any other types of posterior wall fractures with the hip in low flexion during the impact. In treating such injuries, it is essential to preoperatively analyze the superior fracture extension. For adequate visualization and reduction of these fractures, the incision is placed a little super-anteriorly, and the hip is maintained in flexion and abduction during fracture reduction.

Keywords: Acetabular fracture, Internal fixation, Kocher–Langenbeck approach, Posterosuperior fracture, Posterior wall.

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Introduction

Acetabular fracture occurs in younger adults due to high-velocity accidents. Posterior wall acetabular fractures remain a common entity with respect to fractures involving the acetabulum (35–47%) of which 3.76% of them involve the acetabular roof.[1,2] Anatomically three varieties of posterior wall fractures have been described by Letournel and Judet. They are posterior, posterosuperior, and posteroinferior. Fractures of the posterior superior wall extending into the dome of the acetabulum pose a great challenge to hip stability.[3] The main function of the posterosuperior acetabular wall is not only to maintain the hip joint stability but also to transfer the load of the body. Hence, accurate anatomical reduction followed by surgical stabilization of the posterior wall fractures with extension to the acetabular roof is needed to provide a stable and painless hip joint. It is very difficult to anatomically reduce these fragments because of their large fragment size and the superior extent to the acetabular roof which lies under the bulk of glutei muscles. The final outcome of surgery for these types of fractures is affected by the size of the fragment fixed and the stability of the femoral head in the hip joint after fixation. In undisplaced simple fractures without femoral head instability have a good prognosis.[4] Our study aims to find the frequent mechanism of injury for these fracture types and explore the challenges in managing these types of fractures.

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Materials and Methods

This prospective study was conducted after obtaining ethical committee approval in adherence with the Declaration of Helinski in a tertiary care hospital between January 2018 and December 2022. All surgically treated adult patients with acetabular fractures involving the posterosuperior wall or the posterosuperior wall with the posterior column with or without dislocation/subluxation of the femur head were included in our study. We excluded patients with posterior, posteroinferior acetabular fractures, anterior wall fractures, column fractures, and patients medically unfit for surgery. In our study, the posterior acetabular wall fractures were classified according to Waller's classification.[5,6]

The diagnostic approach of patients with acetabular fractures in our institution involves standard radiographs of the pelvis with both hips, iliac oblique, and obturator oblique views. These views are taken to know the fracture pattern and stability of the hip. After the patient had been resuscitated in the emergency ward further evaluation was done using the computed tomography (CT) scan with three-dimensional (3D) reconstruction to know the superior and inferior extent of the fracture line. If the patient had an associated irreducible subluxation or dislocation of the hip it was reduced in the emergency operation theatre and further reduction was maintained under continuous traction. All patients underwent surgery after getting anesthetic fitness. The surgeries were performed by various surgeons in our institution. Kocher–Langenbeck's approach with little anterosuperiorly placed skin incision than regular incision was used to fix such posterior wall fractures.

Postoperatively the fracture reduction and stabilization were analyzed using plain radiographs of the pelvis with both hips, iliac, and obturator oblique views to know the superior extent of the plate, and the number of screw holes and screws superiorly from the fracture site. We used an imaginary line drawn horizontally at the level of the superior edge of the acetabulum connecting both sides and the number of screw holes and screws above this line is taken for the superior extent of the plate. The postoperative protocol followed in all our patients includes mobilization in the bed from day 1, crutch ambulation in a nonweight bearing mode for the initial 4 weeks followed by toe touch weight bearing as tolerated for the next 4–6 weeks, and then gradually proceed to full weight bearing according to the fracture healing on subsequent radiological examination. We did not use routine prophylaxis for heterotopic ossification. Full weight bearing was allowed in all patients at the end of 3–4 months after ensuring radiological union. We followed up with the patients till fracture union. Any complications that occurred in these patients during this period such as implant loosening, fracture displacement, postoperative infection, and iatrogenic nerve injury were also analyzed. We used the IBM Statistical Package for the Social Sciences (version 25, Armonk, United States) to perform any statistical analysis. We presented the descriptive statistic measures using percentage, mean, and standard deviation.

Results

We included 20 patients who met our inclusion criteria for the study. The included patients had a mean age of 36.4 (±12.6) years with 16 male and four female patients. The injury was most common among motorcyclists and bicyclists (82%). According to Waller's classification, seven individuals had type I fractures, 13 were type II fractures, and no type III fractures. The femoral head dislocation was noted in 10 patients and subluxation in four patients. There were associated fractures of the ipsilateral patella fracture in three patients, the posterior column in six patients, the shaft of the femur on the ipsilateral side in two patients and contralateral side in one patient, ipsilateral sacroiliac joint disruption in one patient, sciatic nerve neuropraxia was seen in one patient. All patients were fixed by open reduction using the Kocher–Langenbeck approach and internal fixation with a 3.5 mm reconstruction plate system. A total of 15 patients were fixed with a neutralization plate to support the lag screws for the large posterior wall fragment. The remaining five patients were fixed with a reconstruction plate in buttress mode (Fig. 1). The average plate length used was nine holes with a mean of four holes lying above the line from the apex of the tangential line connecting the superior edge of the acetabulum on both sides as shown in Figures 2 and 3 screws placed superiorly in the plate on average in every case. All the included patients achieved union at a mean duration of 3.6 (±1.6) months without any postoperative complications. Two patients had postoperative sciatic nerve neuropraxia which recovered in 3 months.

Discussion

The most common mechanism of injury for posterior wall acetabulum fractures noted in our series was motor vehicle collision. Acetabular fractures occur secondary to either high-velocity accelerating or deceleration accidents. During the time of injury the force exerted on the hip transfers through the head of the femur to the acetabulum resulting in fracture of the acetabulum but the type of the fracture sustained depends on the position and flexion angle of the hip during the impact.[7] In our study patients with posterosuperior acetabular fractures had less hip flexion compared to posteroinferior and posterior acetabular fractures (Fig. 4) because most of them were involved in two-wheeler accidents where the hip is maintained in

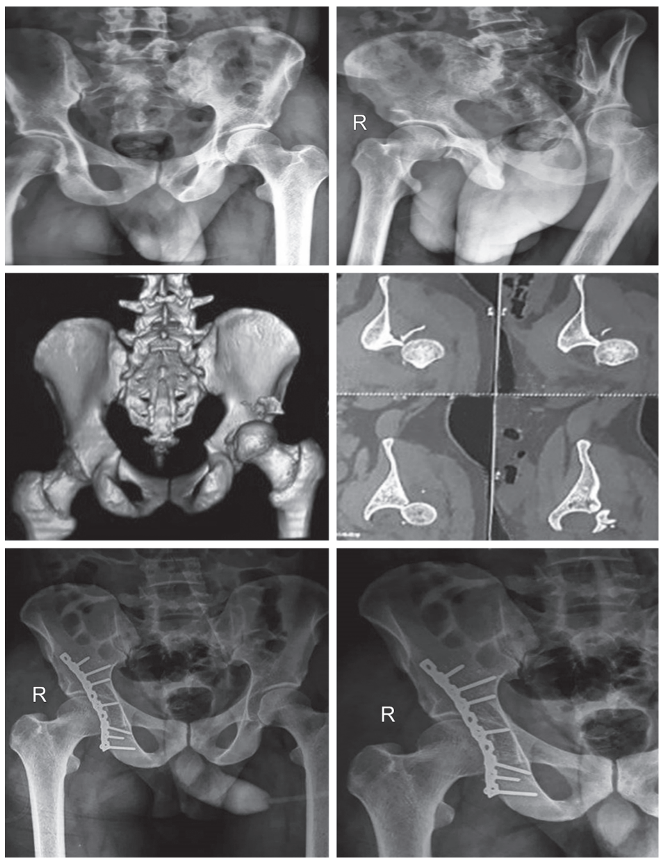


Fig. 1: Shows the illustration of the preoperative radiographs, 3D-CT, and postoperative radiographs of an illustrative case with posterosuperior acetabular wall fracture fixed with a reconstruction plate

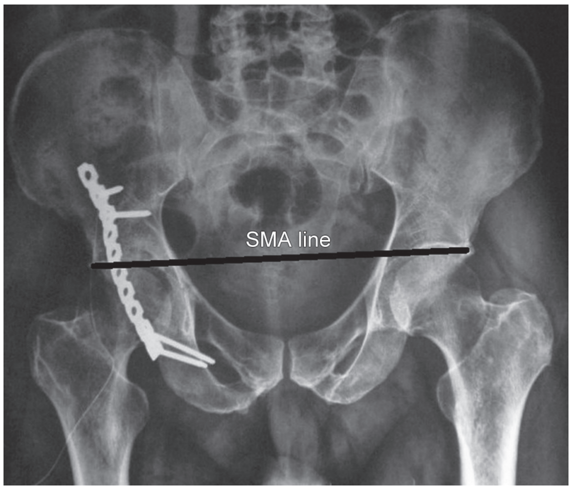


Fig. 2: Shows the method of evaluation of the length of the plate and screws fixed to buttress the superior wall of the acetabulum by an imaginary line (SMA line) connecting the superior margin of the acetabulum on both sides

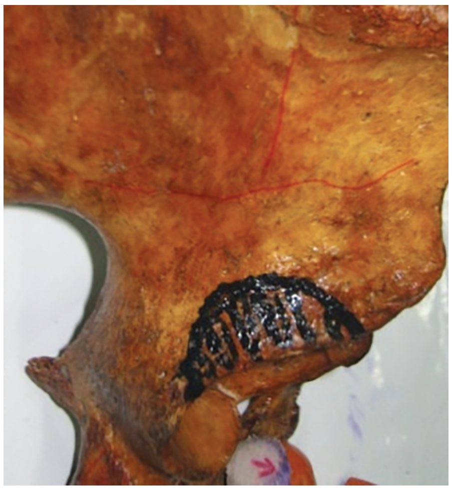


Fig. 3: Shows the bone model marking of the posterosuperior acetabular fracture

less flexion compared to four-wheeler accidents where a higher hip flexion is maintained during the impact. The major determinant of the outcome of posterior wall fracture of the acetabulum (Fig. 3) with the extension of the fracture line to the posterosuperior acetabular roof is mainly influenced by the preoperative evaluation of the type of fracture and fracture reduction accuracy with stable internal fixation achieved after surgery.

Accurate radiographic evaluation and classification remain the keystone in preoperative diagnosis. Letournel and Judet[3] classification has revolutionized the management of such injuries. Waller's classification of the posterior acetabular fractures has led to improvement in the management of these injuries.[5] The most common complications after posterior wall acetabular fractures with or without dislocation include chronic hip pain, heterotopic ossification, secondary arthritis, impingement, infection, avascular necrosis, and sciatic nerve palsy.[8]

With the utility of 3D reconstruction CT-scan, the preoperative evaluation of the extent of the posterior acetabular fracture superiorly and posterior wall fragment size could be ascertained precisely.[9–11] Biomechanical studies have shown the displacement forces at the posterosuperior wall fracture site to be significantly higher than those at the posteroinferior wall fracture site.[12,13]

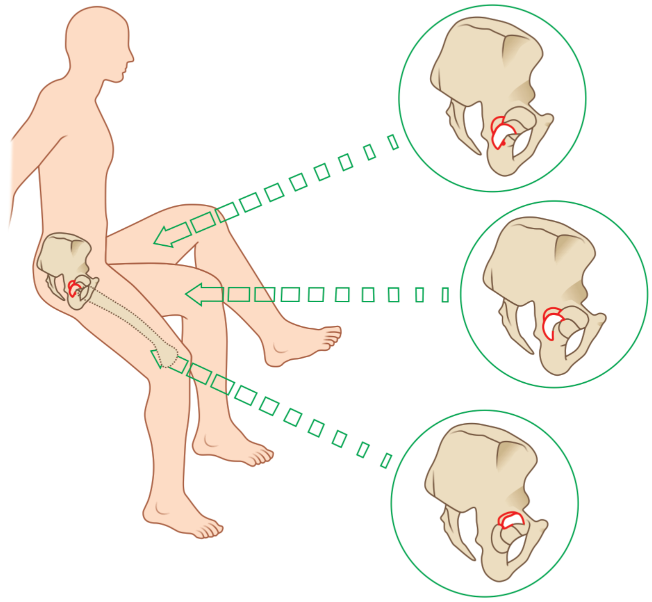


Fig. 4: Shows with increasing flexion of the hip the force acting on the femur produces a posterior wall of acetabular fracture in posterosuperior, posterior and posteroinferior accordingly[25]

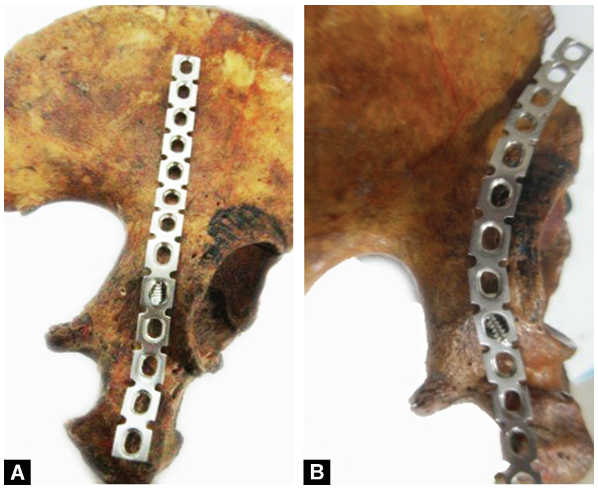
It is always essential to identify the fractures that could be treated nonoperatively from those that require surgical fixation. Instability of the hip joint due to posterior superior wall fracture was considered the main indication for surgical management.[2,14,15] Firoozabadi et al.[16] considered anatomic factors to predict the stability of the hip in patients having fracture of the posterior acetabular wall through the version of the acetabulum, superior fracture exit point, lateral center edge angle, and femoral head coverage along with history of instability or dislocation. Their study showed a significant increase in hip instability when the fractures extended into the dome of the acetabulum. With the use of this parameter, the misidentification of an unstable hip joint as stable can be avoided. Fractures that exit the dome of the acetabulum are significantly at very high-risk for instability.[16,17]

The goal of surgical management of these fractures involves anatomic restoration of the joint surfaces to attain a stable, mobile, and painless hip. Adequacy of reduction of the fragment will determine long-term outcomes.[4,18] For surgical management of the posterior wall of the acetabulum fracture, an appropriate approach must be selected based on the position of the fracture lines as noted on the preoperative CT scans. Appropriate fracture visualization is necessary to anatomically reduce the fragments and to achieve appropriate stabilization of the fractures of the posterior wall extending to the roof of the acetabulum. This may be difficult because of the big bony fragment and bulky muscles preventing proper visualization of the fracture exit point superiorly. The posterosuperior fracture can displace postoperatively if the fragment is not adequately buttressed and if early weight bearing is initiated before the signs of fracture union. So to know the adequacy of the buttressing effect of the plate on this fracture fragment, we have used the superior extent of the plate from the apex of the acetabulum as an indirect indicator. This is calculated by an imaginary horizontal line drawn connecting the superior edge of the acetabulum in the X-ray pelvis anteroposterior view. In our study average plate length used was nine holes with a mean of four holes lying above the line from the apex of the horizontal line connecting the superior edge of the acetabulum on both sides and two screws placed superiorly in the plate on average in every case.

Exposure of the posterior wall of the acetabulum and the acetabular roof can be done by the traditional Kocher–Langenbeck, modified Kocher–Langenbeck approach,[19] and Chloros[20] approach. However, Moed[21] described a trochanteric osteotomy along with the conventional Kocher–Langenbeck approach using which the joint can be visualized directly without subjecting the femoral head to avascular necrosis but this method has a high-risk of nonunion of trochanteric fragments and femoral head avascular necrosis if trochanteric osteotomy was not performed properly.[22] In our study we used Kocher–Langenbeck approach for all patients in a floppy lateral position with minimal soft-tissue stripping. To improve the visualization and fracture fixation, we placed the skin incision anterosuperior than that used in the regular Kocher–Langenbeck approach. During surgery, the hip was held in flexion and abduction to help in the reduction of the fracture by relaxing the gluteus muscles. This facilitates easy retraction of soft tissues; hence, tissue damage due to retraction is reduced during plate fixation as the long reconstruction plate had to extend more superiorly to buttress the fracture fragments.

We used a plate that was long enough to buttress the complete posterosuperior fragment and it was slightly under-bent to aid in fracture compression. The important aspect is not only to prebent the reconstruction plate but also needs correct contouring (C-bend) to accommodate the plate superiorly to prevent overhang (Fig. 5). The ectopic ossification occurring in the Kocher–Langenbeck approach is mainly due to the manipulation, increased stretching, and posterior abductor muscle fibers injury during the visualization, fragment reduction, and fixation of screws during the bridge plating process.[23]

The average thickness of the posterosuperior acetabular wall was significantly larger than the acetabular posteroinferior wall so a lag screw insertion is mostly done in patients with big posterior wall fragments. Saterbak et al.[24] found that posterior wall comminution into three or more fragments and fracture extension to the acetabular dome or ischium are some of the risk factors for early failure but in our study, there was no early failure because of the rigid buttressing effect of the plate on fracture fragments through extension of the reconstruction plate superior to fracture line.



Figs 5A and B: (A) Shows that regular contour does not buttress the posterosuperior fragment; (B) Shows that to support the posterior fragment plate has to get the C-bend and countered well to match the posterior curvature of the wall

Our study has certain limitations. First, only a limited sample size was involved in the current analysis. Second, we did not present the long-term functional outcomes of the included patients since this is a study on the nature of the fracture, their mechanism of injury, and intraoperative strategies involved in their management. However, we followed all the patients till fracture union.

Conclusion

We conclude firstly, that most of the posterosuperior acetabular fractures are due to road traffic accidents involving two-wheelers who sustained trauma in low hip flexion. The weight-bearing acetabular dome is commonly involved in these fractures and they are more prone to instability if not anatomically reduced and buttressed. Secondly, in treating these types of fractures it is crucial to preoperatively analyze the superior extent of the fracture line so that it can be anatomically buttressed with proper prebending and contouring of the long reconstruction plate to avoid overhang. Thirdly, the postoperative buttressing effect by the plate can be assessed by a line drawn through the level of the superior edge of the acetabulum. Fourthly, for adequate visualization and fixation of these types of fractures involving the roof of the acetabulum a little anterosuperior placed skin incision than the regular Kocher–Langenbeck is needed. Finally, during the reduction of the fracture fragment positioning the hip in flexion and abduction aids in good visualization and reduction of the fracture fragment by relaxing the soft tissues.

Informed Consent

Obtained from all the included patients.

Institutional Ethical Committee Approval

Institutional Ethical Committee (IEC) number—IEC/2018/E3/0012.

Authors Contribution

Conceptualization

Dr KP and Dr SM; methodology—Dr KP and Dr SM; software—Dr SM; validation—Dr SM; formal analysis—Dr KP and Dr SM; investigation—Dr KP and Dr SM; resources—Dr KP and Dr SM; data curation—Dr SM and Dr KP; writing–original draft—Dr SM and Dr KP; writing–review and editing—Dr SM and Dr KP; visualization—Dr SM; supervision—Dr KP; and project administration—Dr KP and Dr SM.

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