Section: Orthopedics

Original Research Article

FUNCTIONAL AND RADIOLOGICAL OUTCOME OF PERCUTANEOUS SCREW FIXATION IN ACETABULAR FRACTURES

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Abstract

Background: Motor vehicle accidents and high-velocity injuries like falls from height have increased the incidence of pelvic injuries over the past decade. The primary goal in the treatment of pelvic fractures is the restoration of hemodynamic stability. The secondary goal is the reconstruction of stability and symmetry of the pelvic ring. The study aims to analyze the functional and radiological outcome of percutaneous screw fixation in acetabular fractures. **Materials and Methods:** This case series study includes 30 acetabular fractures operated with percutaneous screw fixation in the Dept of orthopedics, TVMCH. The implants used were 6.5 cannulated cancellous screws. Clinical outcome was determined using Modified merle d' Aubigne and postal clinical grading system. **Result:** Patients were followed up every month for two years. X-rays are taken during each follow-up to assess the fracture union, and patients are examined clinically by assessing the Range of movements, Pain during movements. In our study, the mean age group was 46 years, with road traffic accidents being the predominant mode of injury. Male: female ratio is 5:1. 21 cases had functional outcomes, and 8 cases had a good outcome. One patient developed a superficial infection, and one patient had revision surgery. **Conclusion:** This study showed that acetabular fractures that are minimally displaced and non-comminuted are best treated with percutaneous screw fixation, thereby allowing the patient for early rehabilitation and mobilization. It also provides the best alternative to morbid individuals in which blood loss and soft tissue damage are prevented.

INTRODUCTION

Acetabular fractures are still among the most challenging orthopedic injuries to treat correctly. Acetabular fractures are commonly caused by high-energy trauma, such as vehicle collisions, in which the femoral head transmits axial stress through the acetabular articular surface. The question of which fractures may be managed conservatively and which ones need surgery has been hotly contested for many years.[1] The intricacy of fractures is decreased by using required seat belts. Every year, there are roughly 3 in 100,000 acetabular fractures. Due to their tremendous energy, acetabular fractures frequently coexist with other organ damage. Because the cartilage injury from these fractures might eventually produce incapacitating osteoarthritis, they have a relatively high morbidity rate.[2]

Even though open reduction and internal fixation (ORIF) is the gold standard of care for displaced acetabular fractures, percutaneous techniques are used to treat less-severe fractures because they cause less damage to soft tissue and require less time in the operating room and less blood loss than open surgery. Further to internal fixation and open reduction, percutaneous fixation has been employed as an adjuvant.[1] Patients who are elderly, morbidly obese, or have several injuries where blood loss is likely are good candidates for percutaneous fixation. Obesity shortens lifespan and is linked to various medical and surgical comorbidities. There is a growing demand for clear literature to help with fracture care in this patient population as the prevalence of obesity in this nation keeps rising.[3]

The first evaluation starts with adhering to trauma assessment and resuscitation procedures. Determining the injury's mechanism is important since it can inform therapy.[2] Fracture reduction can be accomplished using closed techniques or through a safe window. Percutaneously corrected anterior and posterior column fractures can be done either anterogradely or retrogradely. Percutaneous fixation is not advised for fractures of the posterior wall and the impacted acetabular dome. 96% of simple fracture cases and 64% of patients with concomitant fractures had an anatomical reduction. The inlet-iliac view and the outlet-obturator view of fluoroscopy can guide the placement of percutaneous screws in acetabular fractures. As the orthopedic surgeon must think in three dimensions and comprehend the important anatomical landmarks shown in the radiographic visualization picture, this treatment necessitates lengthy radiographic exposure to aid the placing of the screws and has a steep learning curve.[4]

ORIF in displaced fractures cannot yet be replaced by percutaneous surgery. Treatment of acetabular fractures appropriately necessitates much experience. Lately, acetabular screws have been placed more accurately by percutaneous means thanks to computer-assisted orthopedic surgery. Successful joint unity depends on the acetabular dome's anatomical reduction and steady osteosynthesis, allowing appropriate body weight transfer. [5] This study evaluates the functional and radiological outcome of acetabular fractures treated with percutaneous screw fixation and reduces the risk of intraoperative and post-operative complications of the open technique.

MATERIALS AND METHODS

Our study is a case series study on the functional and radiological outcome of percutaneous fixation of acetabular fracture done under the department of orthopedics, Tirunelveli medical college, from Dec 2020 to Dec 2022. According to the Judet and Letournel categorization, our study comprises a total of 30 individuals that were hospitalized with acetabular damage, including simple and related fractures. After determining whether injuries were life-threatening and administering CPR, a thorough clinical and radiological evaluation was conducted in our study. Following receiving clearance from the institutional board, the patients were prospectively enrolled. Patient demographics, fracture mechanism, fracture pattern, and surgical results were all noted. Pre-operative X-ray radiography, computed tomography images, and three-dimensional (3D) reconstructions were used to evaluate every patient.

Inclusion criteria: Aged 18 to 80 years, patients with Undisplaced fractures. (<2mm), Displaced fractures (<5mm) of anterior, posterior, and Transverse fractures. (Augmentation), Displaced both-column fractures with acceptable secondary congruence were included in the study. Displaced fractures in the morbidly obese (BMI>40), Fracture less than three weeks.

Exclusion criteria: Patients with Ages <18 and >80, Displaced (>5mm) fracture, Unstable posterior wall component, impacted acetabular dome, Quadrilateral surface involvement, an Incarcerated fragment in the acetabulum, and Fractures older than three weeks were all not included in the study.

RESULTS

Surgical Approach

Approach for antegrade anterior column screw fixation

1. Position & Entry Point

Supine position with a Liquid pad under the ipsilateral buttock, placing pelvis inclined 300. The entry point for the screw is made at the Junction of two imaginary lines, one drawn along the lateral border of the femur passing through the greater trochanter and another drawn from the pubic symphysis to the anterior inferior iliac spine [Figure 1].

Figure 1: Entry point for screw fixation

2. Guide Wire Insertion

Then 3 mm k wire is inserted with its position checked under obturator and inlet views. A triple sleeve exchanges the k wire with a 1.8 mm guide wire. The tip of the guide wire should reach the medial superior pubic ramus. The position of the guide wire confirmed in

- The obturator oblique: cephalocaudal plane. It helps to determine the position of the guide wire above the hip joint.
- Inlet view -anteroposterior plane. It helps to determine the position of the guide wire within the ramus [Figure 2].

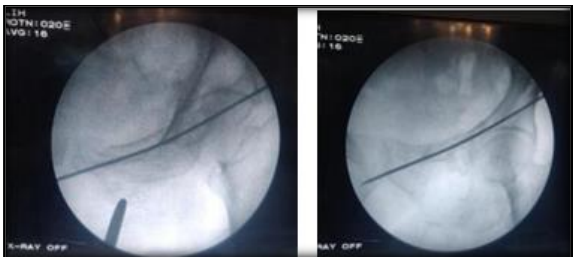

Figure 2: Obturator and inlet view for anterior column screw fixation

3. Drilling Near Cortex

After insertion of the guide wire, a drill bit for a 6.5-mm screw is passed along the trajectory mentioned above. The position is checked in the obturator oblique view and the pelvic inlet views alternatingly. Only The lateral cortex is drilled to

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achieve compression over fracture fragments. [Figure 3].

Figure 3: Drilling near the cortex

4. Screw Insertion

Screw length is measured by placing identical guide wire till the entry point and measuring the difference. Then 6.5-mm partially threaded cannulated screw of adequate length is inserted over the guidewire under C-arm guidance. Mobility of the hip joint is checked immediately after surgery, confirming that the screw has not penetrated the hip joint [Figure 4].

Figure 3: Screw Insertion for the antegrade anterior column

Retrograde anterior column fixation:

1. Patient position & entry point

The patient is placed in a Supine position. The point of entry for the retrograde acetabulum screw is one cm medial to the pubic tubercle. Male patients are at risk of spermatic cord injury as the spermatic cord is located lateral to the pubic tubercle

2. Guide wire insertion

Then 1.8 mm guide wire is inserted similarly to the antegrade method, and the position of the guide wire is confirmed in the obturator oblique and inlet view. [Figure 5].

Figure 5: Guide wire insertion in obturator oblique and inlet view

3. Drilling of cortex & screw insertion

The medial cortex is then drilled with a cannulated drill bit. After drilling the medial cortex, a 6.5-mm partially threaded cannulated cancellous screw is inserted under C-arm guidance [Figure 6].

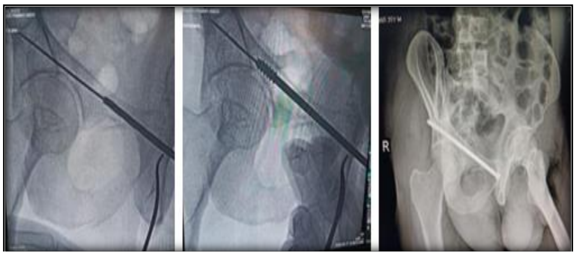

Figure 6: Cortex and screw insertion drilling

Posterior column fixation

1. Position & entry point

The patient is placed in a supine position with the hip and knee of the affected limb flexed to 90 degrees. The ischial tuberosity is identified by flexing the patient's hip and knee to 90 degrees. The entry point for the screw is approximately 1cm posterior to the distal aspect of the ischial tuberosity, thereby ensuring the correct trajectory of the screw remains extra-articular [Figure 7].

Figure 7: Position and entry point in posterior column fixation

2. Guide wire insertion

Then 3 mm k wire is inserted with its position checked under iliac oblique, obturator, and lateral views. A triple sleeve exchanges the k wire with a 1.8 mm guide wire. The iliac oblique view ensures the guide wire remains posterior to the acetabulum and does not enter the greater sciatic notch. The obturator oblique view and AP view of the pelvis ensure that the guide wire does not exit the medial or lateral cortices of the ischium. Finally, a lateral view of the hip – is to determine whether the guide wire is between the hip joint anteriorly and the greater sciatic notch posteriorly [Figure 8].

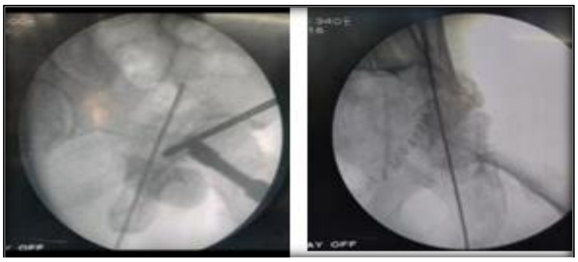

Figure 8: Guide wire insertion

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3. Drilling of cortex & screw insertion

A drill bit for a cannulated 6.5-mm screw is advanced in the ischial ramus proximally, and its position is checked under C- the arm using obturator oblique and iliac oblique views. A 6.5 mm cannulated screw is then inserted [Figure 9].

Figure 9: Drilling of the cortex and screw fixation

4. Instruments used

Triple sleeve, k wires were used for temporary fixation. The implants used were standards and about 6.5mm long cannulated cancellous partial threaded screws of size > 110mm [Figure 10].

Figure 10: Instruments used in the screw fixation

Observations

In our study, 30 patients with simple and complex acetabular fractures were operated on using percutaneous screw fixation. They were followed up on an average of 12 months ranging from 6 to 2 years. Out of 30 cases, 47% (14 cases) belong to the age group of fewer than 40 years, and 53% (16 cases) belong to the age group of more than 40 years. The female-to-male ratio was about 1:5. Our study's most common mode of injury was a road traffic accident.

The common fracture pattern was the Anterior column (20 cases), followed by transverse fractures (6 cases) [Table 1].

Table 1: Fracture patterns, approach, complications, and injuries among patients

		No. of patient
Type of fracture	Anterior column	20
	Posterior column	1
	Both column	1
	Transverse	6
	Anterior column with posterior hemitransverse	1
	T type	1
Approach	ANTEROGRADE ANTERIOR COLUMN	20
	RETROGRADE ANTERIOR COLUMN	2
	RETROGRADE POSTERIOR COLUMN	3
	BILATERAL ANTERIOR COLUMN	2
	ANTERIOR + POSTERIOR COLUMN	3
Complications	SUPERFICIAL INFECTION	1
	MAL POSITION OF THE SCREW	1
Injuries	SI JOINT DISRUPTION	12
	PATELLA #	2
	SUBTROCHANTER/ INTERTROCHANTER #	2
	ILIAC WING	2
	PUBIC DIASTASIS	2
	BLADDER INJURY	2
	POSTERIOR HIP DISLOCATION	1
	BB FOREARM #	1
	ACL INJURY	1

Out of 30 cases, 24 anterior column screws were inserted, of which 20 were inserted in an antegrade manner, including two bilateral fixations and two retrogrades. Three posterior column screws and 3 column screws were inserted.

No life-threatening injuries were associated with any of the patients, and they were hemodynamically stable. The cases were operated on within three weeks from the day of injury. The average intraoperatively time was about 90 minutes, ranging from 30 mins to 3 hrs. One patient had the post-operative complication of surgical site infection, which was treated with intravenous antibiotics. One patient inserted retrograde for anterior column fracture had a screw outside the ramus for which screw revision was done.

Twelve patients had associated SI joint disruption injuries, and 2 cases had bladder injuries repaired intra-operatively. Patella, subtrochanteric, iliac wing, pubic diastasis, bladder injury in 2 patients, and posterior hip dislocation, BB forearm, BB leg, and Clavicle injuries in the patients [Table 1].

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No intraoperative and post-operative death was reported. Seventy percent of cases had an excellent score, and 26 percent had good scores based on the Modified Merle d'Aubigne Score.

RESULTS

Functional outcome was assessed using the modified merle d'Aubigne score, including walking, pain, and range of hip movement examination [Figure 11].

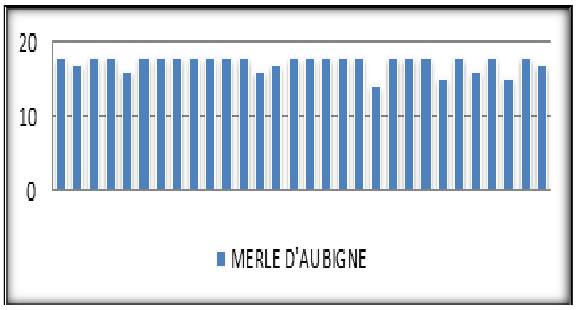


Figure 11: Modified Merle D'Aubigne Score

Out of 30 cases, 21 cases – were excellent, 3 cases – were very good, 5 cases – were good, and 1 case – was fair.

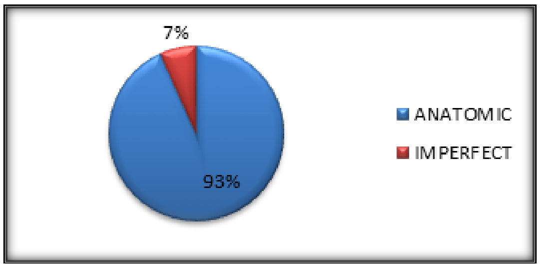
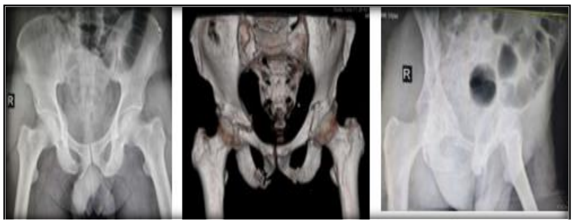


Figure 12: Distribution of outcomes

Case 1

A 39-year-old male auto driver with percutaneous screw fixation. A) Pre-treatment X-Rays, (B) Guided Percutaneous Screw Fixation, (C) Post-surgery X-Ray (1-year follow-up), (D) Flexibility assessment.



A

B

C

Figure 13: case 1 Illustration A. Pre-operative X-ray B. Post-Operative X-ray. C. 1-year follow-up D. Flexibility assessment

Case 2

In case 2, drilling and cortex screw fixation were seen. The Flexibility assessment of the patient was checked.

A

B

C

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Figure 14: Drilling and cortex screw fixation in Case 2 patient. A. Pre-operative X-ray B. Post-Operative X-ray. C. 1-year follow-up D. Flexibility assessment

DISCUSSION

The majority of acetabular fractures are managed surgically. After surgery, restoring a smooth, gliding hip surface is crucial because acetabular fractures harm the bone's cartilage surface. The energy level of the injury, the radiographic fracture pattern, the surgeon's understanding of pelvic anatomy, the timing of open reduction and internal fixation (ORIF), and the right surgical method all affect the outcome of the fixation. Acetabular injuries occur more commonly in young individuals and significantly more frequently in male patients.[6]

Early on, acetabular injuries were managed conservatively by placing the injured limb in longitudinal traction and imposing strict bed rest. With conservative care, extended bed rest and a delay in mobility are of more serious concern. This treatment is inappropriate for all fractures since it causes the fragments to lose their ability to reduce, which eventually causes post-traumatic arthritis.[7] Hence, the treatment of acetabular fractures shifted towards the surgical management for selected acetabular fractures, helping the patient in early mobilization. Operative management provides a stable fixation preventing loss of reduction between fracture fragments. Orthopedic traumatologists now have a clearer understanding of how to categorize and treat acetabular fractures because of the work of Letournel and Judet. With very few exceptions, choosing a surgical strategy for operational therapy may be predicated on accurately identifying the fracture pattern.[8] The timing of surgery and the choice of method will help achieve anatomical reduction and stop the development of post-traumatic hip arthritis. For the operating surgeon to choose the best course of action, pre-operative radiological evaluation is crucial.[9]

Acetabular fractures with more than 2 mm displacement or those affecting the weight-bearing dome are often treated with open reduction and internal fixation. Open reduction and internal fixation of acetabular fractures are associated with multiple complications like femoral neurovascular injury, spermatic cord injury, sciatic nerve injury, and heterotrophic classification. Open reduction methods have higher intraoperative blood loss and the post-operative infection rate. Also, patients with acetabular fractures on immobilization for a longer period can develop deep vein thrombosis.[10] The percutaneous technique of acetabular fracture fixation helps to overcome the above-said complications of open reduction. This fixation method is mainly indicated for undisplaced and minimally displaced acetabular fractures. By reducing the blood loss and infection rate, percutaneous acetabular fixation are indicated in elderly and morbidly obese (BMI > 40) patients.[2] Six of the seven acetabular fractures we described in this study were displaced. Significantly, no infections, fatalities, neurologic damage, or instances of DVT or PE could be definitively established. No instances of heterotopic ossification needed device removal or excision at the time of follow-up.[11]

In our study, the mean age group was 46 years, with road traffic accidents being the predominant mode of injury. Male: female ratio is 5:1. Pre-operative evaluation involves Standard pelvic trauma series – Anteroposterior, inlet, and outlet views, judet views like obturator oblique and iliac oblique views, and 3D reconstruction CT imaging. The fracture pattern determines the surgical outcome, displacement of fracture fragments, the timing of surgery from the onset of injury, stability of the hip joint, and post-operative complications. Many studies on percutaneous screw fixation showed excellent functional outcomes. Tempelaere et al. reported the outcomes of percutaneous posterior fixation of pelvic ring fractures were evaluated in 11 patients after four years with good radiological and functional results. Two sacroiliac screws are more stable than one, but they are insufficient to keep a vertically displaced fracture from reducing.[12] Yu YH and Tseng IC, in the year 2011, published an article on the augmented use of percutaneous screw fixation for complex acetabular fractures.[13] In 2014 Anthony E. Bozzio, MD, and Frank B. Wydra published articles on various surgical methods for percutaneous acetabular fixation.[1]

In longitudinal investigations and case reports of certain fractures, the early outcomes of percutaneous treatment have reduced hospital stay and morbidity. Fluoroscopic imaging advancements have made surgery easier, and trauma surgeons commonly employ Carm fluoroscopy for percutaneous implantation of screws in different trajectories around the pelvis and acetabulum.[14] According to a study, in some types of fractures, the ilioinguinal approach modification is a helpful complement to the current methods. It is not meant to replace the original traditional technique entirely but to offer a useful and convenient substitute for the harder original exposure. It provides greater room for growth as well.[15]

In our study, 24 patients were operated on for anterior column fixation. Of these, 20 were operated on in an antegrade manner, 2 in a retrograde manner, and two were operated on bilaterally. One patient had a misdirection of the screw, which was revised later. No patient had a life-threatening complication. Patients were mobilized earlier, and full weight bearing was started around 6 to 8 weeks, depending on associated injuries. The average time for surgery was around 1 hour. 6.5 cannulated cancellous partially threaded screws with sizes averaging about 120 mm (115 to 135 mm screw sizes were used). There was no screw breakage or migration of the screw in any of the cases.

CONCLUSION

This study achieved an acceptable result with few problems for appropriate acetabular fractures using percutaneous screw fixation. With a solid understanding of acetabular geometry, this minimally invasive method provides excellent exposure for the anterior and posterior columns of the acetabulum. The goal of treating acetabular fractures is to preserve articular unity and offer a secure fixation. We can improve patient's quality of life with reduced tissue damage and near-normal anatomical reduction. This method has the benefits of early weight bearing, quick recovery, reduced risk of blood loss and neurovascular injury, little soft tissue damage, and avoiding a second approach. It has drawbacks such as rough selection criteria, more C-arm exposure, and a steep learning curve. We conclude that acetabular fractures that are minimally displaced and non-comminuted are best treated with percutaneous screw fixation, allowing the patient to begin rehabilitation and movement as soon as possible. It also offers the finest option for sick patients by preventing blood loss and soft tissue injury.

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