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Outcomes of percutaneous fixation in the management of acetabular fractures

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Abstract

Background: One of the most difficult orthopedic injuries to treat effectively is an acetabular fracture. These fractures frequently occur from relatively minor falls, especially in elderly patients. The aim of the study was to assess managing specific acetabular fractures short-term outcomes using a technique that involves manipulative reduction and percutaneous fixation with cannulated compression screws.

Methods: This retrospective study involved 20 patients with either non-displaced or minimally displaced acetabular fractures, all of whom were treated with fixation by percutaneous screws in Shebin El-Kom Teaching Hospital. All patients underwent a comprehensive medical history review, a thorough clinical examination, and routine preoperative laboratory tests, and radiological studies of fracture pattern including plain films and computed tomography with 3D reconstruction.

Results: Intraoperative complications were encountered in 2 patients (10%). Postoperative complications were experienced in 4 patients (20%); 2 patients had fracture gapping (10%), and 2 patients had cortex penetration (10%). Delayed / difficulty in postoperative weight bearing was encountered in 3 patients (15%). Harris hip scores (HHS) ranged from 76 to 90 with a mean of 83.2±4.2 at 3 months, raised to be ranging from 80 to 96 with a mean of 83.2±4.2 at 6 months and 88 to 100 with a mean of 95.6±3.7 at 12 months postoperatively. Patients with perioperative complications showed older age, longer procedure time and longer C-arm exposure.

Conclusions: Percutaneous fixation guided by fluoroscopy is an easy and safe way to treat acetabular fractures that are not comminuted and have minor displacement.

Keywords: Outcomes, percutaneous fixation, management, acetabular fractures

Introduction

One of the most difficult orthopedic injuries to treat properly is an acetabular fracture. They frequently occur in elderly patients from relatively minor falls. One of the leading causes of acetabular fractures is high-energy trauma and typically impacts a younger population [1]. Surgery was not an option for treating acetabular fractures until the 1960s. It was then that Judet and Letournel introduced the concept of the acetabulum as having both a posterior and an anterior column arranged in an inverted Y shape. Surgeons were now able to grasp the acetabulum's three-dimensional structure thanks to this framework, with the focus shifting to the fixation of each column independently. Treatment aims at the "reduction parfaite" as its endpoint as described by Letournel, as traumatic arthritis and poor functional results can develop from even small surface irregularities (bigger than 1-2 mm) in the joint [2, 3].

Computed tomography (CT) has greatly enhanced our capacity to examine fractures by revealing their pattern, size, direction, and the existence of any free pieces. Classification systems and treatment regimens have also evolved to take advantage of this advancement in imaging [4].

Treatment approaches for acetabular fractures have advanced over time, yet there is still debate about the optimal strategy. Nowadays, displaced acetabular fractures are often treated by open reduction and internal fixation (ORIF). Contrarily, non-operative management is possible for fractures that are neither displaced nor very slightly displaced, though they necessitate several weeks of restricted weight-bearing.

The technique of percutaneous fixing was initially described in 1991 by Gay *et al*. [5] and has evolved into an effective replacement for non-invasive therapy and ORIF with a promise to reduced complications rate, improve mobility and reduce hospital stay [6]. Currently the procedure is accepted as a treatment option for minimally displaced or nondisplaced unstable acetabular fractures in patients who wish to begin mobilizing early. It is also suitable for polytrauma patients who have weight-bearing restrictions on the opposite lower extremity, and for certain types of acetabular fractures in elderly patients with significant comorbidities [6].

Although the method for percutaneously fixing the front and back acetabular columns has been extensively studied, it is still a difficult and potentially dangerous operation. The challenge arises from the variable pelvic anatomy and acetabular geometry, which complicates the placement of percutaneous screws with debate over the starting point, trajectory of insertion and whether there is a need for computer navigation assistance or arthroscopic help [6-8].

Most reported complications are related to the surgical procedure itself with misplaced screws being the most faced complication, most authors reported good overall functional outcomes and patient experience [9, 10].

This study aimed to estimate the short-term results in selected acetabular fractures management by manipulative reduction and percutaneous fixation by cannulated compression screws.

Patients and Methods

This retrospective study involved twenty patients with nondisplaced or minimally displaced acetabular fractures, all of whom were treated with percutaneous screws. The focus was on evaluating the outcomes of this fixation method in Shebin El-Kom Teaching Hospital, Egypt from 2019 through 2021. These patients were followed up to date, the follow up duration was for a minimum one year and a maximum of 2 years.

Informed written consent was obtained from all patients before the study. The research was conducted with approval from the Ethics Committee of the Faculty of Medicine, Shebin El-Kom Teaching Hospital.

Inclusion criteria were patients who suffered elemental anterior column fractures, elemental posterior column fractures or transverse pattern fractures according to OTA classification and those with skeletally mature pelvic bones.

Exclusion criteria were complex pattern and comminuted acetabular fracture and patients who did not complete a minimal follow up period of twelve months.

Prior to surgical interventions, A comprehensive medical history was obtained from all patients, including details about the mechanism of injury, their previous ambulatory status, and any existing comorbidities, a through clinical evaluation, with stress on neurovascular status, associated injuries and local skin condition, routine preoperative laboratory investigations, and radiological studies of fracture pattern including plain films and computed tomography with 3D reconstruction.

Mapping of bony corridors for screw insertion

We utilized CT based mapping of acetabular columns method wich was described by Chacko *et al* [11]. 3D volume reconstructions of the pelvis were utilized to measure the anterior and posterior acetabular columns. This imaging technique enabled accurate assessment of these structures:

Operative technique: After room setup with the suitable view, The patient was placed on a radiolucent surgical table in the supine position after being catheterized and general anesthesia used for the procedure. The operating side was placed close to the table's edge to make hip access easier. For the inlet view, the arms were abducted and put on the armrests so they wouldn't get in the way of the C-arm. For retrograde screw insertion, before draping, it was crucial to access the tip of the ischial tuberosity. During the surgery, it was essential that the patient's hip be able to bend beyond 90° and abduct freely [12]. The surgical site was prepared and draped. The ipsilateral hemi pelvis 10 cm above the iliac crest, the buttock and proximal thigh were left exposed during the procedure. First, the area was prepared by placing sterile towels, which were secured with staples to keep towel clips out of the C-arm’s view. Next, U-drapes were arranged around the surgical field, and the area was then prepped. To outline this procedure, you need to identify several key landmarks: the lateral side of the femur, the greatest trochanter, and the most distal part of the ischial tuberosity. Furthermore, be sure to mark both the anterior inferior iliac spine and the anterior superior iliac spine [13].

Reduction maneuvers

Closed reduction: The preservation of the hip's soft-tissue architecture is crucial for a successful closure reduction. The chance of a successful closed reduction is increased if surgery is performed shortly after the accident. The fracture hematoma starts to assemble, making closed reduction difficult, if treatment is delayed for more than a few days. Regardless of the severity or age of the injury, there is no magic move that can fix every acetabular fracture. A distal pin or a Schanz pin placed laterally along the femoral neck can be used to apply traction inline. Both the helper and the skeleton attachments to the table are capable of applying this traction. Mechanical traction offers the benefit of maintaining a consistent fixed position, while manual traction by assistants can lead to fatigue and loss of reduction over time, often resulting in difficulties with critical hardware placement and causing frustration for the surgeon.

Limited access open reduction

In many cases, even with recent fractures, closed maneuvers alone are often insufficient to achieve a proper reduction. Consequently, instruments may need to be inserted through stab wounds or limited surgical openings. It is crucial for the surgeon to be mindful of the structures that could be affected by percutaneously placed tools. Surgeons who are not well-versed in the three-dimensional anatomy of the pelvis should avoid attempting this procedure [14].

Percutaneous approaches

The standard procedure requires a little lateral incision that is 1.5 to 2 inches in length, lying in line with the crest and immediately next to the anteroposterior iliac spine. After the abdominal oblique muscles are carefully separated from the bone using a sharp tool, the next step is to slide a Cobb elevator along the inner table of the crest to the anterior column. For the iliopsoas muscle to relax, the hip is flexed. Along the quadrilateral plate and the inner surface of the posterior column, the Cobb elevator is guided even farther downwards once it reaches the pelvic brim, potentially until it reaches the smaller sciatic notch. This technique may be seen with the use of an AP image intensifier and an iliac oblique view. A modified pelvic clamp with a long straight tine can be positioned along the quadrilateral surface or the pecten pubis, using the image intensifier for precise alignment with the fracture lines. Additionally, the iliac wing can be repositioned with the use of a ball spike or clamp tine introduced via a stab wound on the side of the hip.

Front pelvic ring fractures affecting the superior rami and acetabulum fractures involving the front column are treated with anterior column screws. You have two options for inserting these screws: either going antegrade, from the gluteus medius pillar to the symphysis, or going retrograde, the opposite way.

Fractures of the posterior column, such as the back half of a hemitransverse or transverse fracture, need the use of the posterior column screw. You have two options for inserting this screw: antegrade or retrograde. In any case, the screw must be positioned behind the acetabulum and in front of both sciatic notches. Towards the ischial tuberosity or away from the iliac fossa.

Acetabular fractures involving an anterior column reaching up to the iliac wing can be stabilized using the Lateral Compression (LC) II screw, which was originally used for crescent or Young-Burgess LC type II fractures. The patient must be in the supine position in order to place this screw. Specifically, it is located in the bone column that spans the distance between the front and back of the iliac spines.

Post-operative care

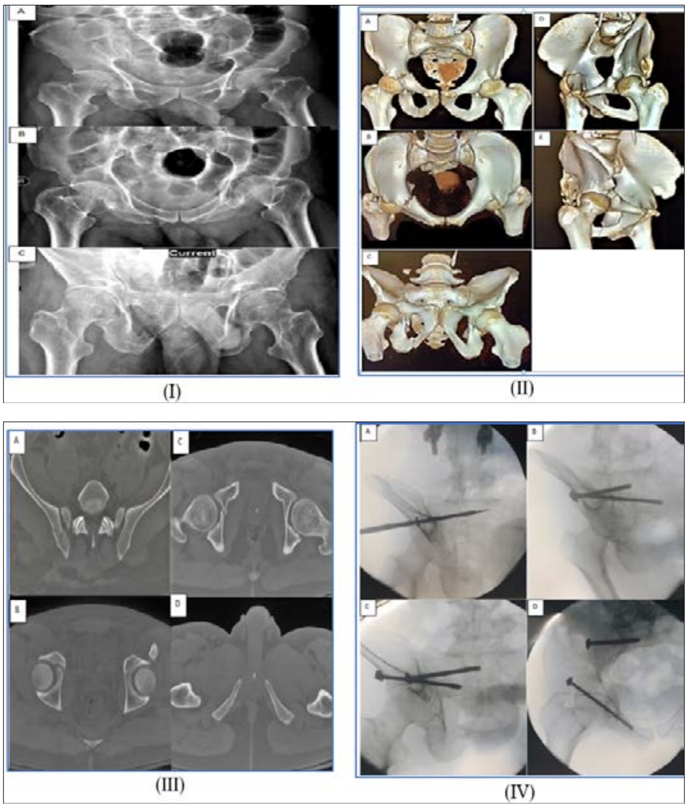
DVT prophylaxis as well as pain control are continued. Patients are generally advised to start walking as soon as possible. Depending on the specific fracture pattern, the quality of the reduction, and any associated injuries, they may bear weight as tolerated using a walker or crutches. Typically, patients remain in the hospital for 1 to 2 days after surgery for pain management. It's crucial to monitor for symptoms such as gastrointestinal issues, fever, and wound drainage, which could indicate bowel perforation. Postoperative radiographic imaging of the pelvis is conducted to evaluate the final reduction, and a CT scan may be needed in some cases. wound care is carried out in OPD and stitches are removed after 2 weeks. Patients were reviewed at regular intervals, clinical as well as radiological examination of the hip were carried out. Hip function is assessed using Harris hip score [15], the score was recorded at 3 month, 6 month and one year post operatively

Statistical analysis

Software developed by IBM and published in Armonk, New York, USA, SPSS v26 was used for statistical analysis. For quantitative variables, we used unpaired Student's t-test to compare the two groups. The results were shown as means and standard deviations (SD). Analyzed with the Chi-square test or Fisher's exact test when necessary, qualitative variables were shown as percentages and frequencies (%). When the two-tailed P value was less than 0.05, it was deemed numerically significant.

Case presentation

An RTA victim who is 52 years old, the patient suffered an isolated atypical lateral compressing injury of his right hemiplevis that resulted in a minimally displaced low fracture of anterior column and an ipsilateral sacroiliac injury, the patient was haemodynamically stable. In order to reduce the acetabular fracture to a more anatomical location and allow early weight bearing, CRIF of the fractures was used. The procedure took place on the 4th post injury day, Fixation was accomplished using a percutaneous iliosacral screw and a percutaneous anterior column screw. In order to reduce the acetabular fracture to a more anatomical location and allow early weight bearing, CRIF of the fractures was used, discharged on the 3rd day with no wound or bowel complications progressed to full weigh bearing by the 3rd week. Figure 1



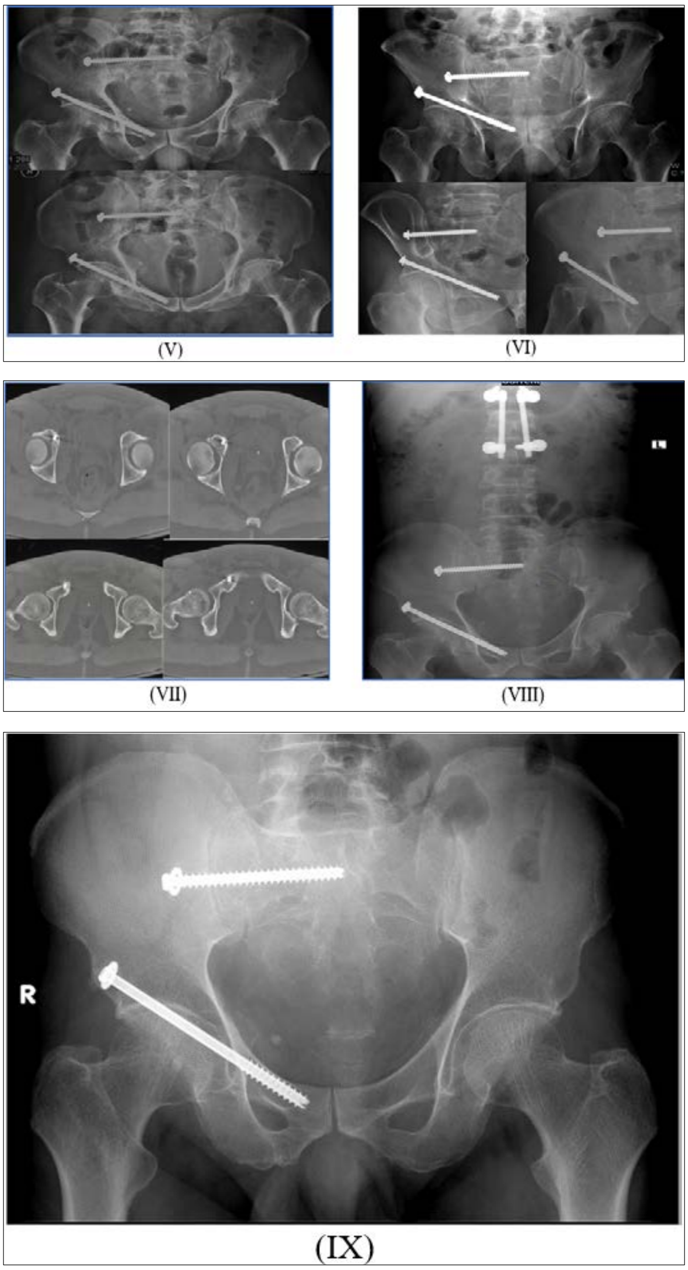


Fig 1: I: preoperative x ray. A anteroposterior view, B Inlet view, C outlet view. II: preoperative CT 3D reconstruction a AP projection, B inlet view, C outlet view, D right iliac view, E right obturator view. III: preoperative axial CT A showing iliosacral injury. B, C showing anterior column injury, D showing ischial ramus injury. IV: intraoperative fluoroscopic images A down the wing view showing fracture reduction by ilioscral compression, B final reduction and screw position on down the wing view to insure sacroiliac compression, B obturator Outlet view, D inlet view to insure position of anterior column screw. V: immediate post-operative X ray A Ap view, B inlet view. VI: immediate post-operative x ray A outlet view, B obturator oblique view, C iliac oblique view. VII: 1 postoperative axial ct showing fracture reduction and anterior column screw position. VIII: 3 month postoperative xray Ap view. XI: 6 month postoperative xray Ap view

Results: The age of patients varied from 18 to 70 years with an average of 40.35±16.1. There was male predominance, with 90% of the study patients were males. The mechanisms of injury were road traffic injury (60%) and fall from height (40%). The highest injured acetabular portion was the anterior column (40%). Associated injuries were encountered in 45% of the patient, ipsilateral sacroiliac joint injury was the most common associated injury (25% of cases). According to OTA classification, the highest proportion of patients were of A3 type (40%). The time from trauma to surgery ranged from 4 to 12 days, with a mean of 6.8±2.3. Table 1.

The highest percentage of patients did not need reduction maneuver (65%). In those who underwent reduction, closed manipulation was the most commonly used maneuver (30%). About half of the patients needed one implant (45%). This was mainly Antegrade anterior column screw (35%). 50% of the individuals in the study needed two or three implants. A median length of 10 cm was found among screws with a diameter of 6.5 mm and a length ranging from 9 to 12 cm. the procedure time varied from 40 to 130 minutes, with an average of 94.3±37. The C-arm use ranged from 50 to 170. Table 2.

Table 1: Participants demographic data and basal clinical profile

Study patients (n = 20)	
Age in years	40.35±16.1
Gender, n (%)	
Male	18 (90%)
Female	2 (10%)
Basal clinical profile	
Mechanism of injury, n (%)	
Fall from height (FFH)	8 (40%)
Road traffic injury (RTA)	12 (60%)
Injured portion, n (%)	
Anterior column	8 (40%)
Anterior column and posterior hemitransverse	2 (10%)
Both columns	4 (20%)
Posterior column	2 (10%)
Transverse	4 (20%)
Associated injuries, n (%)	
Ipsilateral iliac wing	1 (5%)
Ipsilateral sacroiliac joint	5 (25%)
Ipsilateral femur	2 (10%)
Contralateral pupic ramus	1 (5%)
Contralateral acetabulum	1 (5%)
Fracture sacrum	1 (5%)
Bilateral femur	1 (5%)
None	11 (55%)
OTA classification, n (%)	
A2	2 (10%)
A3	8 (40%)
B1	4 (20%)
B3	2 (10%)
C	4 (20%)
Time from trauma to surgery in days	6.8±2.3

Data are presented as mean ±SD or frequency (%).

Table 2: Participants surgical profile

	Study patients (n = 20)
Reduction maneuver, n (%)	
Closed manipulation	6 (30%)
Percutaneous manipulation	1 (5%)
Not needed	13 (65%)
Implant, n (%)	
Antegrade anterior column screw	7 (35%)
Antegrade anterior column screw + LC2 screw	3 (15%)
Antegrade anterior column screw + Retrograde posterior column screw	5 (25%)
Antegrade anterior column screw + Retrograde posterior column screw + LC2 screw	2 (10%)
Retrograde posterior column screw	2 (10%)
Retrograde posterior column screw + LC2 screw	1 (5%)
Procedure time in minutes	80±30.2
C-Arm use in seconds	94.3±37

Data are presented as mean ±SD or frequency (%).

Intraoperative complications were encountered in 2 patients (10%). One of them showed difficulty in positioning and imaging due to marked central obesity, and the other showed failure to produce compression at fracture site. Postoperative complications were experienced in 4 patients (20%); 2 patients had fracture gapping (10%), and 2 patients had cortex penetration (10%). Delayed / difficulty in postoperative weight bearing was encountered in 3 patients (15%). Harris hip scores (HHS) ranged from 76 to 90 with a mean of 83.2±4.2 at 3 months, raised to be ranging from 80 to 96 with a mean of 83.2±4.2 at 6 months and 88 to 100 with a mean of 95.6±3.7 at 12 months postoperatively. Table 3.

Table 4 establishes that no substantial difference was found in distribution the patients' sex, mechanism of injury, presence associated injuries, the site of injury, reduction maneuver, implant or OTA classification. Patients with perioperative complications showed older age, longer procedure time and longer C-arm exposure. Both groups were comparable in time from trauma to surgery and HHSs.

Table 3: Prevalence of perioperative complications and hip functional outcome

		Study patients (n = 20)
Intraoperative complications, n (%)	Yes	2 (10%)
	No	18 (90%)
Postoperative complications, n (%)	Yes	4 (20%)
	No	16 (80%)
Ability to start early postoperative weight bearing, n (%)	Yes	3 (15%)
	No	17 (85%)
Harris hip score at 3 months		83.2±4.2
Harris hip score at 6 months		83.2±4.2
Harris hip score at 12 months		95.6±3.7

Data are presented as mean ±SD or frequency (%).

Table 4: Comparison between patients according to the occurrence of perioperative complications

	Perioperative complications		Chi-Square	P-value
	No	Yes		
Sex				
Female	2 (100%)	0 (0%)	0.74	0.39
Male	13 (72.2%)	5 (27.8%)		
Injury mechanism				
FFH	5 (62.5%)	3 (37.5%)	1.1	0.29
RTA	10 (83.3%)	2 (16.7%)		
Associated injuries				
No	7 (63.6%)	4 (36.4%)	1.17	0.28
Yes	8 (88.9%)	1 (11.1%)		
Affected portion				
Anterior column	7 (87.5%)	1 (12.5%)	8.7	0.07
Anterior column and posterior hemitransverse	1 (50%)	1 (50%)		
Both columns	4 (100%)	0 (0%)		
Posterior column	2 (100%)	0 (0%)		
Transverse	1 (25%)	3 (75%)		
Reduction maneuver				
Closed manipulation	5 (83.3%)	1 (16.7%)	0.61	0.74
Not needed	10 (76.9%)	3 (23.1%)		
Percutanous manipulation	0 (0%)	1 (100%)		
Implant				
Antegrade anterior colum screw + LC2 screw	2 (66.7%)	1 (33.3%)	5.1	0.41
Antegrade anterior colum screw + Retrograde posterior column screw	2 (40%)	3 (60%)		
Antegrade anterior colum screw + Retrograde posterior column screw + LC2 screw	2 (100%)	0 (0%)		
Antegrade anterior column screw	6 (85.7%)	1 (14.3%)		
Retrograde posterior column screw	2 (100%)	0 (0%)		
Retrograde posterior column screw + LC2 screw	1 (100%)	0 (0%)		
OTA Classification				
A2	2 (100%)	0 (0%)	6.8	0.15
A3	7 (87.5%)	1 (12.5%)		
B1	1 (25%)	3 (75%)		
B3	1 (50%)	1 (50%)		
C	4 (100%)	0 (0%)		
Total	15 (75%)	5 (25%)		
Age	39.6±15.9	42.6±18.3	0.35*	0.73
Time to surgery (days)	7±2.5	6.2±1.3	35.5#	0.86
Procedure time (minutes)	72.7±30.9	102±13	2*	0.057
C-Arm use (seconds)	86.7±37.9	117±24.4	1.7*	0.11
HHS at 3 months	82.8±4.6	84.4±42.6	0.05*	0.48
HHS at 6 months	91±4.3	93.2±3.3	25.5#	0.29
HHS at 12 months	95.7±3.7	95.2±3.7	33#	0.68

Data are presented as mean ±SD or frequency (%), HHS: Harris hip score, FFH: fall from height, RTA: road traffic injury.

Discussion

Using the least invasive technique of percutaneous screw fixation in conjunction with traditional 2D fluoroscopy, our study focused on the care of acetabulum fractures that were either not displaced or just slightly displaced. Achieving anatomic or near-anatomic reduction of the articular surface is the therapeutic goal for acetabular fracture. The quality of the reduction of the articular surface is critical, but so is the avoidance of problems due to surgical exposures. As a result, it makes sense to find a way to treat minimally displaced fractures that need fixing while minimizing surgical exposure [16].

Percutaneous acetabular fractures management has been scarcely reported in orthopaedic literature, most accessible studies involving the subject focused on the surgical technique itself. Gay *et al.* [5] detailed the procedure for fixing acetabular fractures with percutaneous screws. Two cannulated screws were inserted above the acetabular roof as part of their procedure. In order to stabilize acetabular fractures in patients whose fractures were either not displaced or just slightly displaced (<2 mm), Starr *et al*. [16] proposed percutaneous screw fixation, which involved modifying the procedure by use three screws. Stabilizing acetabular fractures that were either not displaced or very slightly displaced in patients with contralateral injuries that prevented them from bearing weight was another goal of this treatment. Fracture displacement necessitates open reduction and internal fixation, which this technique aimed to avoid. Utilizing anterior column, posterior column, and supra acetabular screws, our study employed all of these approaches with the goal of facilitating early patient mobility.

There may be a large difference among the treatment aims of younger people with comparable fracture patterns and older patients with acetabular fractures. Mechanical stabilization and concentric, non-anatomic reduction of the acetabulum, for instance, might be a justifiable alternative to bed rest with or without skeletal traction for some patients, allowing them to be mobile with modified weight-bearing status. By accomplishing this, the patient's prognosis for problems including decubitus ulcers, venous thromboembolism, and chest infections may be greatly enhanced. Weaknesses in strength, agility, and balance, changes in mental state, and neurological problems are common among the elderly. Nonoperative treatment is not likely to be followed by these patients, and they run the danger of additional fracture displacement due to falls or involuntary weight bearing on the afflicted limb [17].

After percutaneous screw "fixation of acetabular fractures," Mouhsine and colleagues reviewed 21 elderly patients in a row [12]. There were no difficulties during or after the procedure, and there was no sign of implant failure or secondary fragment displacement on radiographs in this series. In our study we had four geriatric patients non had any secondary displacement after full weight bearing 2nd day of surgery. However one patient suffered minimal screw penetration of the lateral cortex of the anterior column which went asymptomatic. In our study we used screws with diameter of 6.5 mm and the length ranged from 9 to 12 cm with a median of 10 cm.

The advancement of fluoroscopic imaging has made it possible to implant screws in a variety of acetabulum trajectories. The inlet, exit, iliac oblique, and obturator oblique views of the pelvis are just a few of the planes that surgeons doing this treatment need to be familiar with. The use of intra-operative fluoroscopy for assessing reduction and verifying extra-articular implant placement was argued to be just as beneficial as CT. Due to the greater radiation exposure for the patient and surgeon, limited imaging planes, and the need for exact oblique projections for optimum viewing, this type of imaging is often reserved for more complex procedures involving soft tissues. The surgeon can reduce radiation exposure by employing an external fixator drill guide; to insert a guide wire, he or she must retain one hand on the handle and keep the guide pointed in the right direction while adjusting the C-arm location [18]. According to our research, one of the primary reasons for the increase in operating time and imagine exposure is the failure to keep the guide wire at the entrance site when adjusting the c-arm position.

Mouhsine *et al*. [12] found that percutaneous screwing performed only using fluoroscopy took an average of 62 seconds fluoroscopically and 30 minutes surgically (60). Our study found that the average operation time was 94.3±37 minutes, with a range of 40 to 130 minutes. The average duration of C-arm use was 94.3±37 seconds, ranging from 50 to 170 seconds.

Other studies have observed controlled weight bearing at 2 weeks post-percutaneous screw fixation, although complete weight bearing was not permitted until 4 weeks post-fixation. During our trial, we began weight bearing with a protected toe touch on the second day following surgery and progressed to full weight bearing after six weeks. On the second day of surgery, we began geriatric patients on a cautious rehabilitation program that included protected full weight bearing. This approach was backed by Starr *et al*. [16] who described two elderly patients who experienced small reductions due to unprotected weight bearing following percutaneous screw fixation.

In the future, orthopedic surgeons will have a valuable tool in percutaneous screw fixation of acetabular fractures to treat certain types of fractures. This technique has the potential to help older patients who are unable to undergo extensive surgical procedures or endure long periods of bed rest with conservative treatment, as well as patients with polytrauma or bilateral acetabulum fractures. We believe that this procedure can produce excellent results in selected patients with mildly displaced acetabular fractures.

Conclusions

Treatment of non-comminuted and/or slightly displaced acetabular fractures by percutaneous fixation under fluoroscopic guidance is a safe and straightforward surgical procedure. This has the potential benefit of facilitating early weight bearing and movement out of bed. It is preferable to perform percutaneous techniques when the fractures are receptive and/or when patients do not qualify for larger operations. Early results from several studies indicated that patients treated with percutaneous methods for acetabular column fractures had a shorter hospital stay and less morbidity. People treated with percutaneous fixation have reported reduced residual displacement, improved functional results, and early pain relief compared to those treated with older procedures, but the learning curve can be high.

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Conflict of Interest: Nil

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CT	Computed tomography
DVT	Deep vein thrombosis
FFH	Fall from height
HHS	Harris hip scores
OPD	Outpatient department
ORIF	Open reduction and internal fixation
OTA	Orthopaedic trauma association's
RTA	Road traffic injury

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