Original article

Percutaneous Screw Fixation of Acetabular Fractures

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Background

Aims: To investigate the use of PCS fixation for acetabular fractures including indications, preoperative planning, operative technique, and complications during the study period.

Setting and design; Retrospectively we used PCS for fixations of several types of acetabular fractures either nondisplaced, minimally displaced guided by fluoroscopy.

Patients and methods; The study included 20 patients after obtaining informed consent who underwent acetabular fixation by anterior column, posterior column, supra-acetabular screws, combination of all and combination of plate and screw between June 2015 and June 2018.

Statistical analysis used: The software for statistical package for social sciences for windows 10 was used for all statistical calculations. Each variable was tested for its normal value using the Mann-Whitney Test and exact P values were calculated. Significance was set at the P value of less than 0.05 level.

Results; All cases had good to excellent functional results according to the modified Merle d'Aubigné Hip Score. We managed to mobilize all patients out of bed from the 2nd day of surgery and to avoid a 2nd approach for transverse fractures by the screw.

Conclusion: Our results show that PCS under fluoroscopic control is a safe technique to treat some pattern of acetabular fractures and with some tips and tricks surgical and fluoroscopy time can be minimized.

Key-words

Acetabular fracture - Minimally invasive technique - Percutaneous fixation.

Key Messages

PCS fixation of acetabular fractures using fluoroscopic guidance is a safe and relatively easy surgical procedure to treat minimally displaced fractures with several advantages

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Introduction

The goal of treatment of acetabular fractures relies on restoration of articular anatomy with stable internal fixation, allowing early mobilization of the patient. [1]

The advantage of percutaneous fixation is the immediate stability obtained which leads to early weight bearing mobilization. Other important advantages over formal open procedures are the decreased operative morbidity, blood loss, time to perform the procedure, wound healing, infection and blood loss are all complications that are more attributable to the open procedure than to the actual fractures themselves. [2]

Where fractures are amenable and/ or patients have contra-indications to major procedures, percutaneous procedures should ideally be used. It was found in the early results of many studies that patients enjoyed a shorter hospital stay and decreased morbidity when treated with percutaneous techniques for acetabular column fractures. [2]

Subjects and Methods

We retrospectively studied 20 cases of our patients were percutaneous acetabular screw were done during the period from January 2017 and January 2019 after obtaining informed consent for the procedure and for taking intraoperative photos. The preoperative, operative and postoperative follow up data and imaging studies were collected from the patient's files and the computerized system and by contacting the patients. We included in the study the twenty Patients who were regularly following up with no missing data. Patients who did not show during the follow up or had missing data were excluded from the study. The follow up period was for a minimum of six months.

At the six month the modified Merle d'Aubigné hip Scoring system was calculated for evaluation the bony and functional results (Table 1).

The fracture patterns were either: Nondisplaced (1-3 mm), minimally displaced (3-5 mm) fractures or displaced both-column or transverse fractures with one column fixed through open reduction and internal fixation and the other column with percutaneous fixation.[2]

Preoperative planning included x ray of the pelvis including AP and oblique views and CT to properly assess the safety of surgical corridors and intra columnar size for fitting columnar screws. [2,5]

We used partially threaded 7.3 mm cannulated screws with 2.8 guide wire to determine the initial trajectory under fluoroscopic guidance (Figure 1). In obese patients an external fixator sleeve was used to allow proper orientation and directional control.[6]

All cases were done under general anesthesia in supine position on a flat top radiolucent table. The operative side were positioned near the edge of the table for easier access to the hip for anterior and

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Table 1 The Modified Merle d'Aubigné Hip Score

Criteria	Assessment	Score (Points)
Pain	No pain	6
	Slight or intermittent	5
	Pain after ambulation, but disappears	4
	Moderately severe, permits ambulation	3
	Severe with ambulation	2
	Severe, prevents ambulation	1
ROM (%)	95-100	6
	80-94	5
	70-79	4
	60-69	3
	50-59	2
	<50	1
Ability to walk	Normal	6
	No cane but slight limp	5
	Long distance with cane or crutch	4
	Limited even with support	3
	Very limited	2
	Unable to walk	1
Clinical score	Excellent	18
	Good	15-17
	Fair	13-14
	Poor	<13

supraacetabular screws (Figure 5). Before patient preparation and draping C arm views were checked to ensure proper antero-posterior, Judet oblique (iliac and obturator), pelvic inlet and outlet views were obtained. Pelvic region tell the umbilicus were draped. For posterior column screw the distal aspect of the ischial tuberosity were ensured to have good exposure prior to draping and the patient's hip were checked to ensure hip flexion more than 100° and abduction without interference (Figure 6,7). The entire surgical procedure was performed under frequent fluoroscopic control to verify safe screw placement.

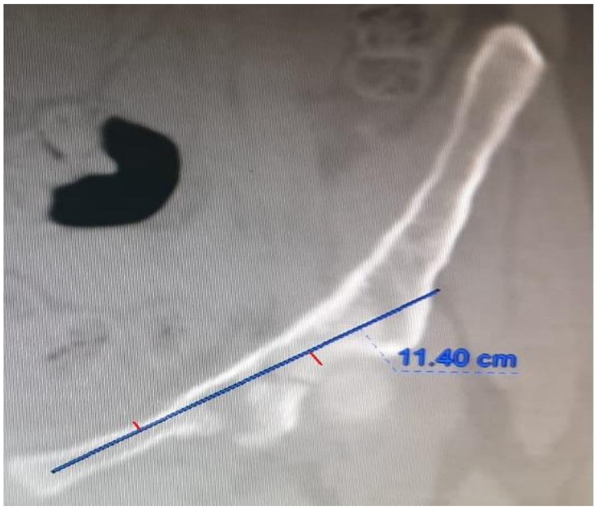

Figure 1 Anterior column measurement

Figure 2 Posterior column measurement

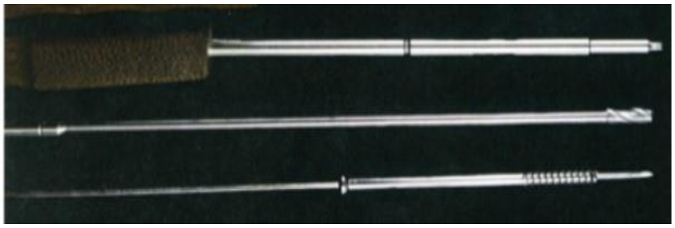

Figure 3 Instruments used

Figure 4 External fixator sleeve

Figure 5 Intraoperative positioning for anterior column screw

Figure 6 Intraoperative positioning for posterior column screw

Figure 7 Intraoperative positioning for bilateral posterior column screws

Figure 8 Entry point marking on skin for anterior column screw

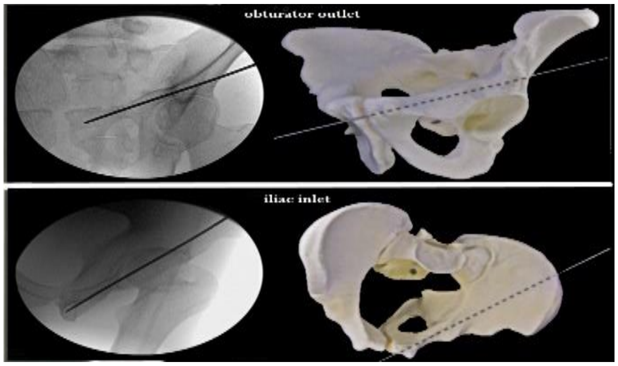

Figure 9 Obturator outlet and iliac inlet for anterior column screw

We did all anterior column screw in antegrade fashion from the lateral iliac surface using an entry point proximal to the acetabulum aiming toward the pubic symphysis. The entry point were located at the junction of a line drawn along the lateral border of the femur through the greater trochanter and a line from the pubic symphysis through the anterior inferior iliac spine (Figure 8). To visualize their trajectory obturator oblique view was used to confirm position of the guide-wire in the cephalocaudal plane and an inlet iliac view to confirm position in the antero-posterior plane (Figure 9). [2] When passing along the superior ramus, the passage of the guidewire was followed by flipping between inlet view to assure that no penetration toward the bladder and outlet view to show the superior/inferior path of the guidewire (Figure 10). [6]

The posterior column screw was performed with the hip held by an assistant in 120 degree of flexion with knee flexed. The first step was to locate the ischial tuberosity. To help identifying the entry point, an obturator oblique and iliac oblique views were obtained with the hip flexed. This retrograde fixation was carried out under fluoroscopic control with the iliac and obturator oblique views to help guide the wire trajectory in the AP and lateral dimensions (Figure 11, 12). Lateral view of the pelvis was used preventing penetration of the pelvic brim (Figure 13). Before fixation, the hip was moved to verify that there is no intra-articular penetration. An obturator oblique view was used to verify the wire trajectory in the AP dimension to avoid wire placement too anteriorly and violating the hip joint or too posterior passing in to sciatic notch. [6,7,8]

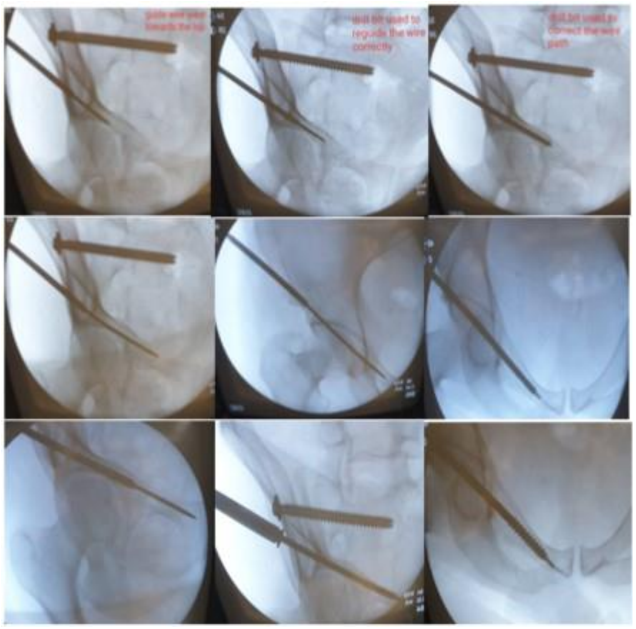

Figure 10 Anterior column screw technique, drill bit used to redirect the guidewire away from hip

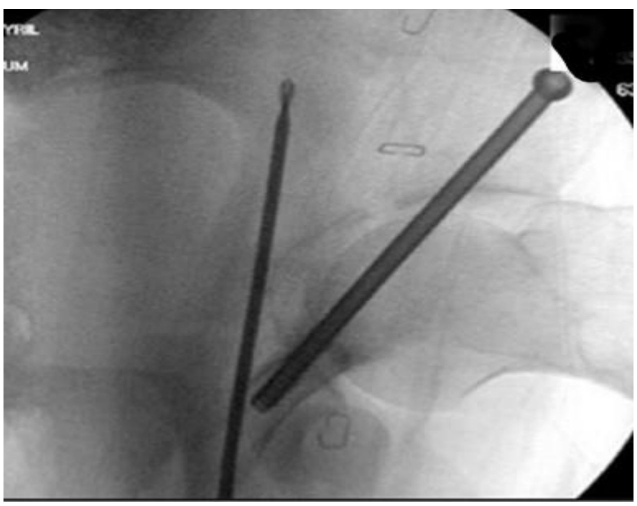

Figure 11 Iliac view for posterior column screw

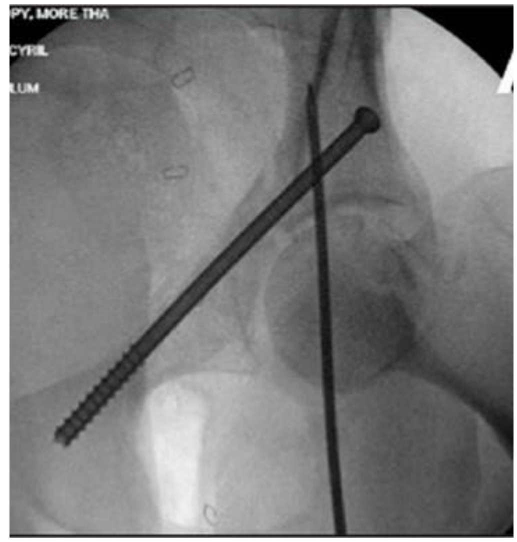

Figure 12 Obturator view for posterior column screw

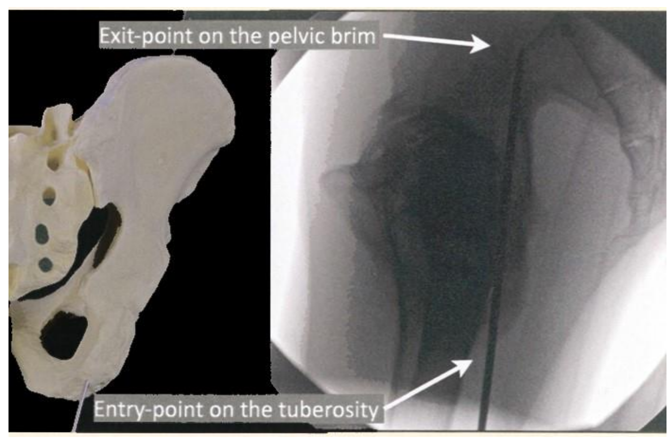

Figure 13 Lateral view for posterior column screw

Figure 14 Entry point identification by Teardrop view for supraacetabular screw

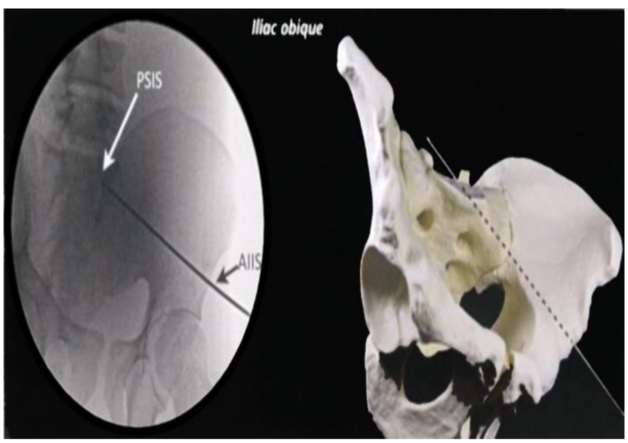

Figure 15 Iliac oblique view shows the wire passing safely above the sciatic notch and then its exit-point from the PSIS for supraacetabular screw

Figure 16 Guide wire passage end in the down the wing view for supraacetabular screw

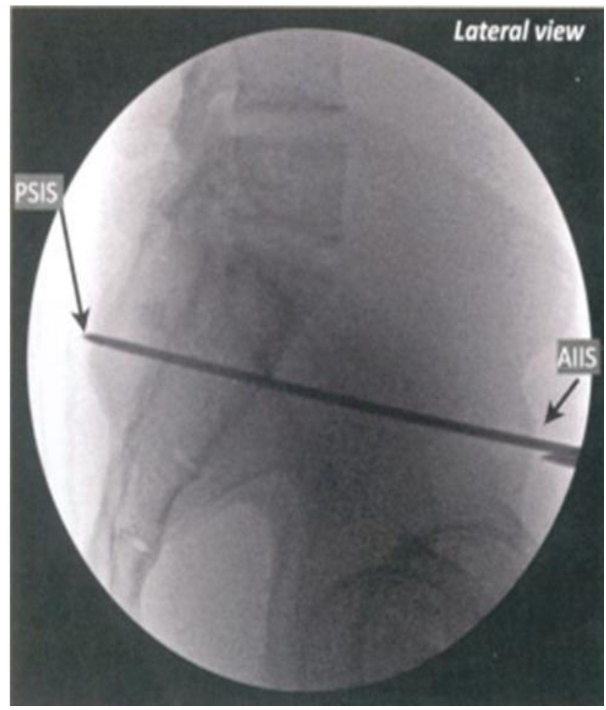

Figure 17 True lateral view for supraacetabular screw

Supraacetabular Screw was used to secure a coronal plane fracture involving the supraacetabular dome. It was inserted from the anterior-inferior iliac spine toward the posteriorsuperior iliac spine. Entry was adjusted with teardrop view (figure 14). Then guidewire passage was guided by iliac oblique (figure 15) and down the wing views (figure 16). In obese patients or those with obscuring bowel contents a true lateral view were used to show the entry and exit points more clearly (figure 17).[9]

Results

The research was carried out on the 20 patients. Of these, 3 (15%) were females and 17 were males (85%). The mean age of the patients was 36 years with the youngest patient being 18 and the oldest 70 years old. The injury mechanism was RTA in 12 patients (60%) and falling from height in the rest (40%) (Table 2). 13 patients (65%) had isolated acetabular fractures and 7 patients (35%) had associated fractures (table 3). We performed all the operations in supine position. Anterior and supra-acetabular screws were inserted by antegrade technique and posterior screws by retrograde technique.

Table 2 Shows the Mode Of Trauma And Its Frequency

Mode of trauma			
		Frequency	Percent
Valid	FFH	8	40.0
	RTA	12	60.0
	Total	20	100.0

Two patients had bilateral fractures, five patients had unilateral fracture on the left side and thirteen patients had unilateral fracture on the right

Patients were encouraged to ambulate early with toe touch weight bearing as tolerated with a walker or crutches.

side. Fracture pattern varied between isolated anterior column (8 patients), isolated posterior column (one patient), T type, transverse, transverse with posterior wall, transverse with quadrilateral plate and bi-column fractures (table 4).

We used anterior column screw fixation in 9 patients, posterior column screw in 2 patients, simultaneous anterior and posterior column screws in 5 patients, simultaneous anterior column, supra-acetabular screws in 2 patients, simultaneous anterior column, posterior column and supraacetabular screws in 2 patients (table 5).

Table 3 Patterns of Associated Injuries And Its Frequency

Associated injury			
		Frequency	Percent
Valid	bilateral femur	1	5.0
	fracture femur + sacroiliac joint	1	5.0
	iliac wing fracture	1	5.0
	None	13	65.0
	sacroiliac joint	1	5.0
	sacral fracture	1	5.0
	sacro iliac joint	2	10.0
	Total	20	100.0

Table 4 Fracture Pattern and Its Frequency

Fracture pattern		Frequency
Valid	Ant column fracture	8
	Bi-column fracture	2
	Posterior column fracture	1
	T type fracture	1
	Transverse + posterior wall	2
	Transverse + quadrilateral plate	1
	Transverse fracture	5
	Total	20

Table 5 Type of Screw Used and Its Frequency

Type of fixation		Frequency
Valid	Anterior, posterior & supra-acetabular screw	2
	Anterior & posterior screws	5
	Anterior & supra-acetabular screws	2
	Anterior screw	9
	Posterior screw	2
	Total	20

In 4 patients of 20 the screw was inserted as augmentation to fixation of transverse fracture of the acetabulum, with one variant, plate fixation posterior and percutaneous screw anterior (3 patients) and other variant, plate fixation anterior and percutaneous screw posterior (1 patient).

Operation time for the screw in our patients was on average 45 minutes (25 – 90 minutes). The operation time was measured from the first fluoroscopic exposure after patient positioning till the last suture.

We used 7.3 mm partially threaded cannulated screws in all patients with average length

of 110 mm for anterior column screw and 120 mm for posterior and supraacetabular screws.

In all cases, immediate postoperative radiographs showed that the screws were successfully placed across the fracture line.

16 of our patients were out of bed the second postoperative day. They were allowed toe-touch weight bearing (TTWB) with the aid of a walker. The rest of our patients had to stay in bed or mobilized wheel chair due to bilateral fracture, other comorbidities or fractures. (Table 6)

The average duration of admission for our patients was 8 days. We followed the patients for at least 6 months (average 14±3.5 month) and in each follow up, we assessed the union, pain, walking ability and return to preoperative activities. The fractures showed union at a mean of 12 weeks postoperatively (range 8—15 weeks).

All the patients without associated fractures could walk fully without any significant pain and had full range of motion of the hip and painless hip movement. 18 patients had normal gate pattern, 2 patients had limping one of them because of knee problem associated with the index injury and the other one had associated bilateral fracture femur. The 20 patients got back to their preoperative activities.

Table 6 Post-Operative Physiotherapy in Relation To Associated Injury

Crosstab

			Associated injury No	Associated injury Yes	Total
Postoperative physiotherapy	PT in bed	Count	2	2	4
		% within Postoperative physiotherapy	50.0%	50.0%	100.0%
		% within Associated injury	15.4%	28.6%	20.0%
	TTWB	Count	11	5	16
		% within Postoperative physiotherapy	68.8%	31.3%	100.0%
		% within Associated injury	84.6%	71.4%	80.0%
	Total	Count	13	7	20
		% within Postoperative physiotherapy	65.0%	35.0%	100.0%
		% within Associated injury	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	p value	p value	p value
Pearson Chi-Square	.495(b)	1	0.482		
Continuity Correction(a)	0.014	1	0.907		
Likelihood Ratio	0.478	1	0.489		
Fisher's Exact Test				0.587	0.439
N of Valid Cases	20				

a. Computed only for a 2x2 table
b. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.40.

The modified Merle d'Aubigné hip score was applied for all patients. The final results after 6 months follow up showed; 13 patients had excellent score and 7 patients had good score. The patients with less than excellent score had either associated fracture in the acetabulum, pelvis or the lower limb.

The soft tissue dissection was very limited. Two patients had complication of minimal medial cortical pelvic penetration during insertion of posterior column screw with no hazards to the patient (Figure 25) and two patients had mild limping after 6 months follow up. None of the patients suffered neurovascular or urinary injuries related to screw insertion. No infection, bedsores or pulmonary infections were reported (Table 7).

Table 7 Complications In Relation to Associated Injury

Crosstab

			Associated injury No	Associated injury Yes	Total
Complication	medial cortex penetration	Count	2	0	2
		% within Complication	100.0%	0.0%	100.0%
		% within Associated injury	15.4%	0.0%	10.0%
	mild limping	Count	1	1	2
		% within Complication	50.0%	50.0%	100.0%
		% within Associated injury	7.7%	14.3%	10.0%
	None	Count	10	6	16
		% within Complication	62.5%	37.5%	100.0%
		% within Associated injury	76.9%	85.7%	80.0%
Total		Count	13	7	20
		% within Complication	65.0%	35.0%	100.0%
		% within Associated injury	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	p value
Pearson Chi-Square	1.319(a)	2	0.517
Likelihood Ratio	1.955	2	0.376
N of Valid Cases	20		

4 cells (66.7%) have expected count less than 5. The minimum expected count is .70.

Discussion

Percutaneous management of acetabular fractures has been described few reports in the orthopaedic literature, the available accounts have been confined to the fixation of non-displaced or minimally-displaced fractures, most reports focus on the surgical technique. Improvements in fluoroscopic imaging have facilitated the placement of screws in various trajectories around the acetabulum. [10,11,12]

In 1992 Gay were the first to describe the percutaneous screw fixation technique for acetabular fractures. Their technique involved placing 2 cannulated screws above the acetabular roof. [13] Starr modified the technique by using 3 screws, he advocated PSF to stabilize acetabular fractures in patients whose fractures were nondisplaced or minimally displaced (<2 mm). [11] The aim of his technique was to prevent fracture displacement, which would require open reduction and internal fixation, and also to stabilize undisplaced or minimally displaced acetabular fractures in patients suffering from a contralateral injury that precluded weight bearing.

In our study procedure we used anterior column, posterior column and supraacetabular screws either separately (Figure 18) or in combination (Figure 19) aiming for early mobilization of the patients and avoiding unnecessary use of another approach to the acetabulum in certain situations like associated fracture femur (Figure 20), associated sacral fracture, sacroiliac injury or iliac wing fracture (Figure 21) and bilateral acetabular fractures (Figure 22).

Percutaneous screw fixation of acetabulum as an adjunct to traditional open reduction and internal fixation was described in literature. [14, 15] we used the combination of percutaneous screw and plate in 4 patients with transverse acetabular fracture; 3 of them had associated posterior wall fracture and was fixed by posterior plating and augmented anteriorly by anterior column screw (Figure 23) and 1 patient with transverse fracture associated with quadrilateral plate fracture was fixed anteriorly by plating and augmented posteriorly by posterior column screw (Figure 24).

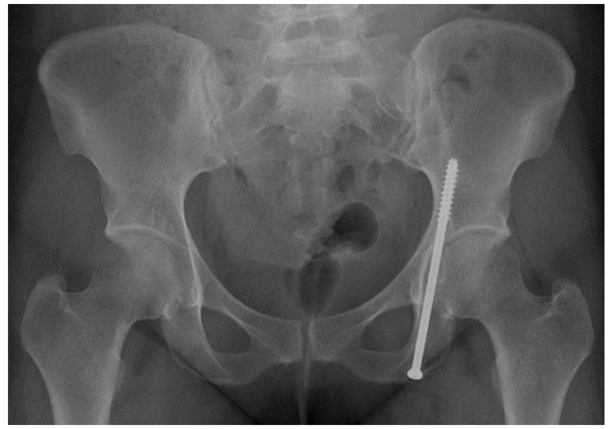

Figure 18 Isolated posterior column screw

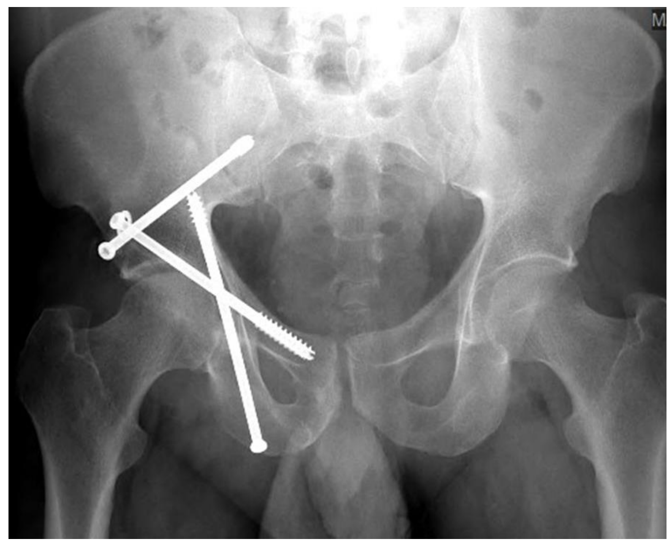

Figure 19 Combination of anterior , posterior and supraacetabular screw

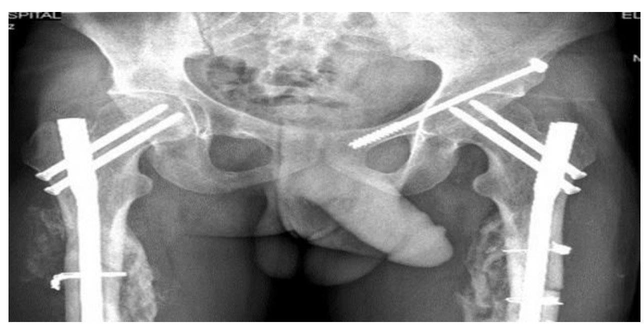

Figure 20 Associated bilateral fracture femur with nondisplaced transverse fracture left acetabulum

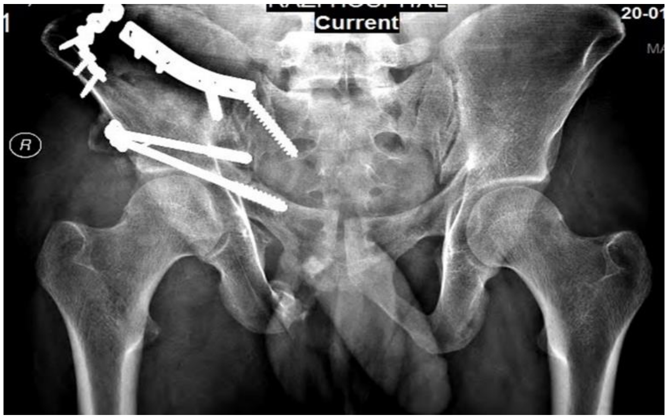

Figure 21 Associated sacral and iliac wing fracture

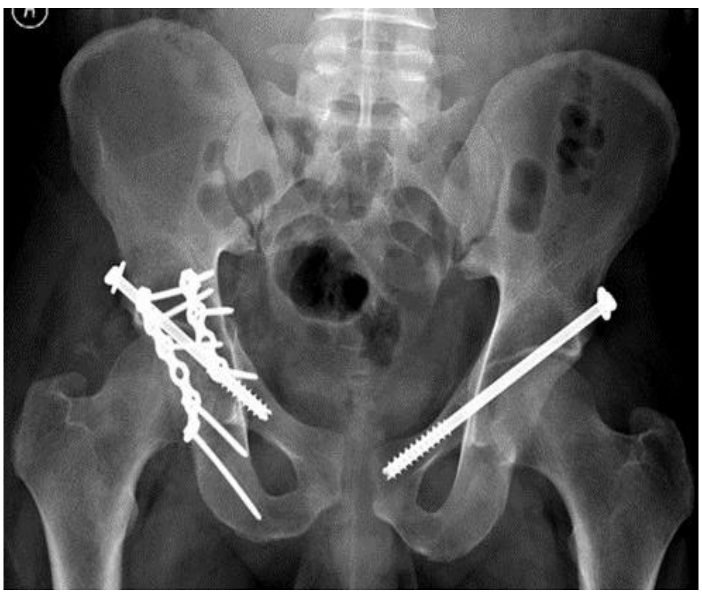

Figure 22 Bilateral acetabular fractures

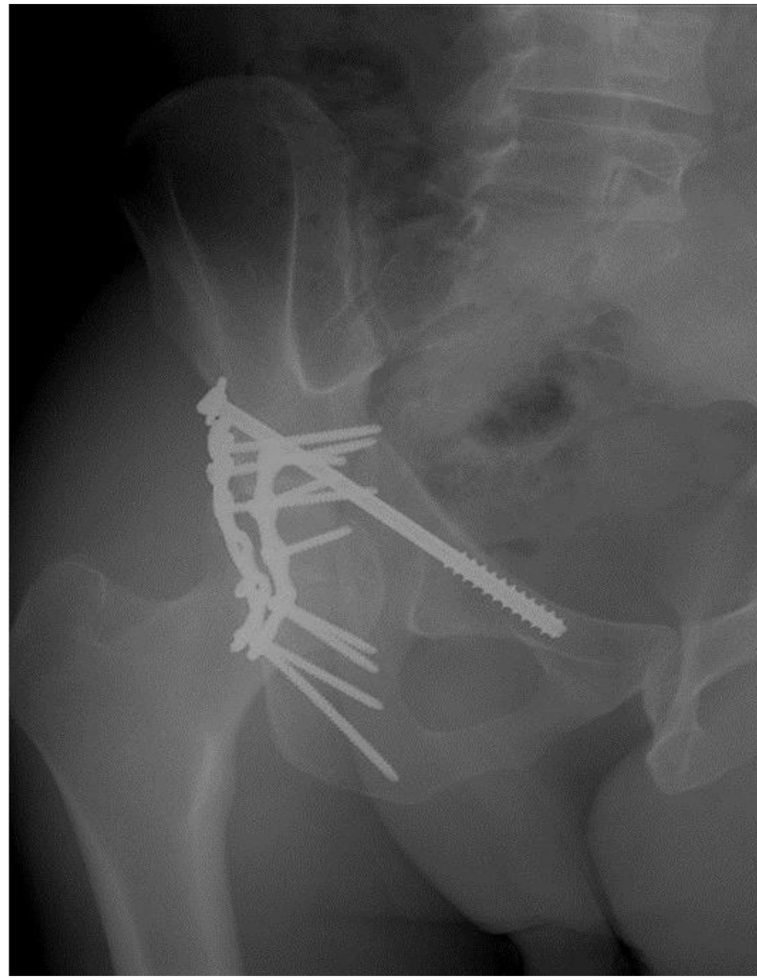

Figure 23 Anterior augmentation of transverse fracture

Figure 24: Posterior screw for augmentation of transverse fracture

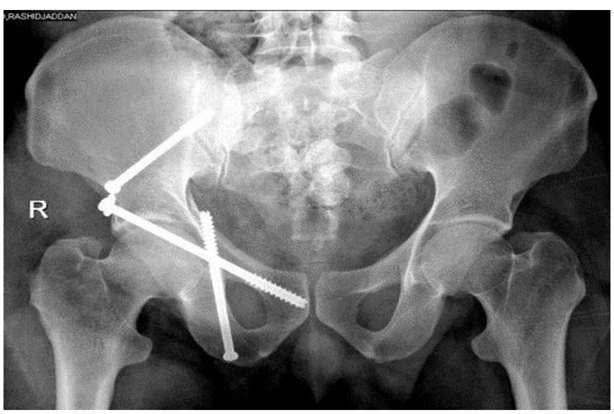

Figure 25 Penetration of medial wall by posterior column screw

Surgeons who perform this kind of procedures must be familiar with the 3D anatomy of the pelvis and pelvic radiographic anatomy in multiple planes including inlet, outlet, iliac oblique and obturator oblique views. Norris advocated that intra-operative fluoroscopy was as useful as CT for the evaluation of reduction and confirmation of extra-articular placement of implants However, such imaging is generally available in only one plane at a time and exposes both the patient and the surgeon to radiation, particularly because of the increased soft-tissue mantle and the precise oblique projections necessary for adequate viewing.[17)] A technique to lower radiation exposure is by using an off-set guide like an external fixator sleeve specially for anterior column screw where it is difficult to maintain guidewire tip at entry site without sliding down, the surgeon has to keep one hand on the handle and has to maintain the direction of the sleeve while changing the C-arm position to enable guide wire insertion. In our study we found that C arm is enough for insertion of the screws and failure to maintain the guide wire at the entry site during changing the C arm position is a major cause to increase operative time and image exposure.

Controlled weight bearing at 2 weeks after PSF has been reported., in other studies total weight bearing was allowed only after 4 weeks. In our study we started protected toe touch weight bearing 2nd day of surgery and full weight bearing at average 8 weeks. In one geriatric patient we started protected full weight bearing 2nd day of surgery, this rather conservative rehabilitation regimen is supported by Starr, which mentioned two elderly patients with minor losses of reduction because of unprotected weight bearing after percutaneous screw fixation.

We believe percutaneous screw fixation of acetabulum can produce excellent results in selected patients with mildly displaced acetabular fracture and will become an important part of the orthopedic surgeon's tools for the treatment of certain acetabular fractures in the future.

Conclusion

In conclusion, we find percutaneous screw fixation of acetabular fractures using fluoroscopic guidance to be a safe and relatively easy surgical procedure to treat non-comminuted and minimally displaced fractures. It offers the advantage of allowing early weight bearing, early rehabilitation, pain control and avoiding a second approach in certain situations.

Conflict of interest

The authors declare that they have no conflict of interest.

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