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CLINICO-RADIOLOGICAL OUTCOME OF MINIMALLY INVASIVE PERCUTANEOUS FIXATION IN PELVI-ACETABULAR FRACTURES

Orthopaedics

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ABSTRACT

Background: Pelvi-acetabular fractures are complex injuries with high morbidity. Minimally invasive percutaneous fixation offers a safer alternative with fewer complications and quicker recovery compared to open reduction method. **Methods:** A prospective study was conducted from February 2023 to Sept 2024 at a tertiary centre in Central India, involving 30 adults with radiologically confirmed Pelvi-acetabular fractures treated using percutaneous fixation. Outcomes were assessed using the Majeed score and Matta criteria at 1.5, 3, and 6 months. **Results:** Most patients were males (83.3%), aged 18–40, with road traffic accidents being the common cause (63.3%). A total of 47 screws were placed with minimal blood loss (20.4 ml/screw), short incisions (2.2 cm), and average hospital stay of 3.53 days. At 6 months, 66.7% had excellent Majeed scores and 73.3% had excellent Matta scores. **Conclusion:** Percutaneous fixation is safe, effective, and promotes faster recovery in Pelvi-acetabular fractures.

KEYWORDS

Pelvi-acetabular fractures, minimally invasive procedures, percutaneous fixation, Majeed criteria, Matta scoring.

INTRODUCTION

Pelvic ring and acetabular fractures are complex injuries often resulting from high-energy trauma and are associated with significant morbidity and mortality due to extensive haemorrhage and damage to surrounding organs. Available data indicate that acetabular fractures (AF) occur in 0.5%–8% of all trauma patients, and unstable pelvic ring fractures (PRF) have been reported to have a mortality rate of up to 8.3% in large population-based studies.

Early surgical stabilisation of PRF and AF was considered essential for improved outcomes, as it facilitates early ambulation, reduces pain and hospital stay, and lowers long-term complications. While open reduction and internal fixation (ORIF) has been the standard, it is associated with significant soft tissue disruption, risk of injury to vital structures, increased blood loss, infection, deep vein thrombosis, and heterotopic ossification.

In recent years, minimally invasive procedures have emerged as effective alternatives for the management of selected pelvic and acetabular injuries. These techniques aim to achieve stable fixation with reduced surgical exposure, thereby minimising soft tissue trauma, preserving the vital structures and decreasing perioperative morbidity[1]. Minimally invasive approaches can include percutaneous screw fixation, limited open reduction with indirect instrumentation, or small-incision-assisted reductions ,.

Percutaneous fixation, however, requires precise preoperative planning and advanced intraoperative imaging, and there remains a risk of mal-reduction, neurovascular injury, or hardware-related complications[2]. Furthermore, there is a paucity of data available in the Indian literature evaluating the clinical and radiological outcomes of these less invasive interventions.

With this background, we evaluated the Clinico-radiological outcomes of minimally invasive percutaneous procedures in the management of pelvic ring and acetabular fractures at a tertiary care centre in Central India.

MATERIAL AND METHODS

This prospective observational study was conducted at MGM Medical College and Maharaja Yashwant Rao Hospital, Indore, India, from February 1, 2023, to September 30, 2024. The Institutional Scientific Review and Ethics Committee approved the study.

A total of 30 adult patients with Pelvi-acetabular fractures fitting in the AO classification were included, except AO 61 A1 and 61 A3. Patients in whom the fracture was not reducible by closed methods and those with associated lower limb fractures were excluded from the study. After hemodynamic stabilisation, relevant demographic and clinical data were recorded using a pre-designed, structured proforma. Radiological assessment included standard anteroposterior, inlet, outlet, iliac oblique, and obturator oblique views of the pelvis, along with 3D computed tomography (CT) for precise fracture classification and surgical planning.

All Patients were operated under spinal anaesthesia by a single senior surgeon with extensive experience in Pelvi-acetabular injuries. The patient was positioned in either supine or lateral position according to fracture location and fixation needs. In cases requiring fracture reduction, a minimal incision was made and instruments such as Hohmann's spikes, ball spikes, Schanz screws, and Steinmann pins were used to achieve reduction, which was confirmed fluoroscopically under C-arm guidance in multiple standard pelvic views. Fixation was done using 6.5 mm partially threaded cannulated screws, 4 mm cannulated cancellous screws.

Intraoperative parameters including surgical incision length, duration of surgery, fluoroscopy time, and estimated blood loss (calculated using the difference in weights of dry and soaked gauze) were documented. Postoperatively, in-bed isometric exercises and physiotherapy was initiated the next day after surgery. Suture was removed at two weeks, and partial weight-bearing ambulation was advised for the first four weeks. Gradual weight-bearing was allowed thereafter based on clinical and radiological union.

Patients were followed up at 6 weeks, 3 months, and 6 months postoperatively.

RESULTS

Out of the 30 patient's majority were male (83.3%), and most patients (60%) were between 18 and 40 years of age. The predominant cause of injury was road traffic accidents (63.3%), followed by falls from height (36.7%). A Lateral Compression Type 2 injury was the most common (25%), followed by Vertical Shear (20%), Lateral Compression Types 3 and 1 (20% and 10%), and Anteroposterior Compression Type 2 (20%) as per Young and Burgess classification. As per AO classification most common fracture type is 61 B2(30%) followed by

61 C1 (23.3%),61 A2 (10%),61 B1 (10%),61 B3(13.3%),61 C2(10%),61 C3(3.3%) respectively. [Table 1]

A total of 47 percutaneous screws were inserted in 30 patients. The most used were sacroiliac (13 cases) and anterior column screws (12 cases). Posterior column and lateral column 2 screws were used in 7 cases each, followed by magic screws (6 cases) and transverse supra-acetabular screws (2 cases). Anterior column screws had the longest insertion time (32 minutes) and highest fluoroscopic exposure (6 minutes). [Table 1]

* Screws used are not mutually exclusive; One patient can have one or more screw used.

Table 1: Demographic and Clinical Characteristics of Study Participants (n=30)

Parameter	Category	Frequency(n)	Percentage (%)
Gender	Males	25	83.3
	Females	5	16.7
Age Group	18 to 40years	18	60.0
	>40years	12	40.0
Mode of Injury	Road Traffic Accidents (RTA)	19	63.3
	Fall from Height	11	36.7
Type of Fracture (Young and Burgess classification)	Vertical Shear (VS)	6	20.0
	Lateral Compression Type 1	3	10.0
	Lateral Compression Type 2	9	25.0
	Lateral Compression Type 3	6	20.0
	Antero-posterior compression Type 2	6	20.0
AO classification	61 A2	3	10.0
	61 B1	3	10.0
	61 B2	9	30.0
	61 B3	4	13.3
	61 C1	7	23.3
	61 C2	3	10.0
	61 C3	1	3.3
Type of Screw used*	Sacro-iliac	13	27.6
	Anterior column	12	25.5
	Posterior column	07	14.8
	Lateral column	07	14.8
	Magic screws	06	12.7

The minimally invasive approach was reflected by a mean incision length of just 2.2 cm and an average blood loss of 20.4 ml per screw insertion. The average hospital stay was 3.53 days. [Table 2]

Table 2. Operative and Postoperative Parameters – Mean Values and Standard Deviations

Parameters		Mean	Standard Deviation
Length of incision (cm)		2.2	1.28
Intra-operative blood loss (ml)		20.4	10.5
Duration of post-operative hospital stay (days)		3.53	1.14
OT time (in screw corridor) (in minutes)	Sacro-iliac	28	8
	Anterior column	32	10
	Posterior column	22	6
	Lateral column	24	8
	Magic screws	18	2
	Transverse supraacetabular screw	20	4
Fluoroscopy time (in minutes)	Sacro-iliac	5.2	1.5
	Anterior column	6	2.2
	Posterior column	3.7	1
	Lateral column	4	1.5
	Magic screws	3	0.8
	Transverse supraacetabular screw	3.5	1.2

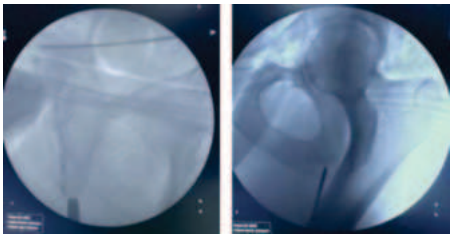
Clinical outcomes assessed by the Majeed criteria showed marked functional improvement over time, with excellent outcomes in 66.7% at 6 months, and poor outcomes dropping to 3.3%. The mean Majeed score improved from 62 to 86. Radiological scoring suggested excellent outcomes rose by 73.3% by 6 months, while poor outcomes reduced from 20% to just 3.3% at 6 months. [Table 3]

Table 3. Clinical and Radiological Outcome Distribution as per Majeed and Matta Criteria

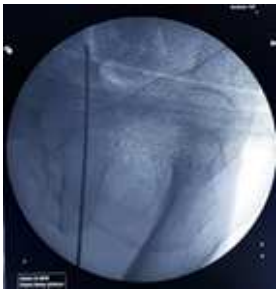
Outcome Category	1.5 Months	3 Months	6 Months
Clinical Outcome (Majeed Criteria)			
Excellent (≥ 85)	00	15	20
Good (70–84)	04	10	08
Fair (55–69)	19	03	02
Poor (< 55)	07	02	01
Average Majeed Score	62	78	86
Radiological Outcome (Matta Criteria)			
Excellent	00	18	22
Good	06	07	07
Fair	18	03	00
Poor	06	02	01

In this study, most patients (27 out of 30) experienced no postoperative complications. However, erectile dysfunction was reported in 2 patients, while 1 patient had screw breakage observed at the 3-month follow-up.

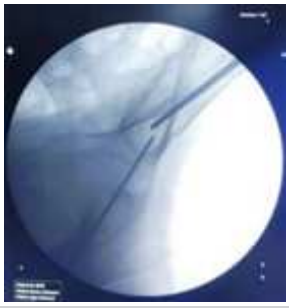
Fig 1A. Preoperative 3D CT of the pelvis with Lateral compression type 2, 61 B2



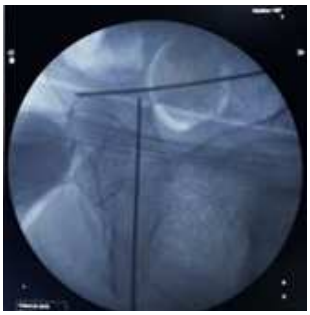
For posterior column screw starting point was at Ischial tuberosity on Iliac oblique view and confirmed in Obturator outlet view.



The iliac oblique view confirmed that the guide wire is extra-articular.



Obturator outlet view confirmed that the guide wire is with in posterior column corridor. For lateral column, entry was made on the Obturator outlet view at the tear drop.



The iliac oblique view confirmed that the guide wire was away from the Sciatic notch.

Fig 1B. Intra-op fluoroscopy images

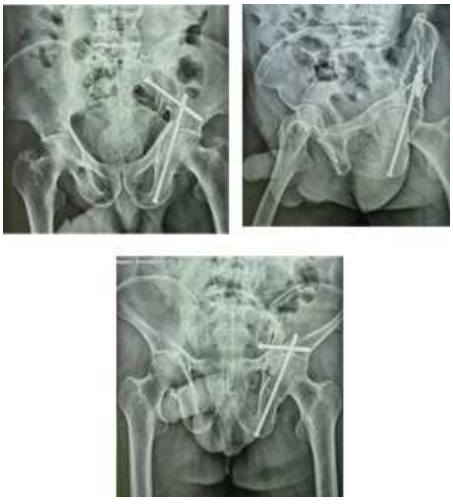


Fig 1C. Immediate Post Op X-rays

Fig 1D. X-rays at the 6-month follow-up.

DISCUSSION

Our study found that 83.3% of the patients were male, with the majority (60%) aged between 18 and 40 years, reflecting a young, active demographic profile. Road traffic accidents (63.3%) were the predominant cause of injury. Since young males in the working age group are more prone to road traffic accidents in our setup up the injury is common in this patient subset. These findings are consistent with the results of Zhou K et al., Qoreishi M et al., and Zarei M et al.,all of whom reported a higher prevalence among males and similar age distributions. Malik A et al.also observed that males formed most cases with a mean age of 35.5 years.

Fractures were categorised using the Young and Burgess classification, with LC type 2 being the most common, followed by APC type 2, LC type 3, and vertical shear injuries and AO classification. In a study by Zhou K et al., Fracture classification followed the AO and Orthopaedic Trauma Association system, which reported various subtypes, including A1 (7 cases), A2 (2 cases), A3 (1 case), B2 (6 cases), and other B and C type fractures. Similarly, a study by Qoreishi M.et al. found that 28.7% of patients had LC fractures, 18.9% had combined LC and acetabular (ACF) fractures, 5.6% had combined LC and VS fractures, and 20.3% had APC fractures, while 21.7% had isolated acetabular fractures.

A total of 47 screws were placed in 30 patients. Sacroiliac screws (13) and anterior column screws (12) were most common, with others including posterior column, lateral column 2, magic, and supra-acetabular screws. Anterior column screw placement required the longest average surgical (32 min) and fluoroscopic (6 min) times. Initially, longer durations were noted, reflecting the learning curve. Our results are comparable to Zhou K et al., who reported 23.3 min per screw for anterior fixation, and Qoreishi M et al., who observed an average of 32 ± 8 min. The mean incision length was 2.2 cm, with average blood loss of 20.4 ml per screw and hospital stay of 3.53 days. This is consistent with Zhou K et al. 2 cm, 22.3 ml and Scolaro et al., who reported blood loss <50 ml in all cases. Zarei M et al. noted a hospital stay of 3.5 days, aligning closely with our study. No patient in our study required a blood transfusion because of operative blood loss. Intra medullary screws needed for such fixation were generally long and range from 40 -150 mm, but in our study, we observed that in our patient subset the most commonly used screws were around 100 – 120 mm specially in Sacro Iliac fixations involving both the sides. The screws traversing both the fracture fragments work as a strong construct restricting fracture displacement and allowing weight bearing comparable to plate fixation. Since we allowed early partial weight bearing, we noted early and consistent improvement in our functional scores. At 1.5 months, most patients had fair outcomes (mean score 62), which progressed to excellent (mean score 86) by 6 months. Similar findings were reported by Soetjahjo B et al.(57.2% excellent outcomes) and Weiqiang Gao et al., where 73.3% had excellent and 26.7% good outcomes.

The radiographic evaluations showed consistent improvement over time. Excellent outcomes increased from 0% at 1.5 months to 66.7% at 6 months. Our results are comparable to Chen J et al. [24], who reported 82.4% good/excellent results, and Yu Y et al., with 96.1% excellent/good outcomes.

The available literature on percutaneous fixation has reported the incidence of nerve injury and hardware failures up to 3 percent. However, most patients (27/30) had no complications. Erectile dysfunction was seen in 2 cases improved with time, psychiatric consultation and medication. One patient had implant failure with screw breakage at 3 months follow up. No infections or malunion or non-unions were noted. In contrast to Qoreishi M et al. where rates of iatrogenic nerve injury and hardware failure were reported 0-7.2% and 0.29% respectively[1]. Scolaro et al. and Weiqiang Gao et al. reported screw loosening in 1 case, pain over lumbosacral region in 3 cases after tiredness and mild claudication in 2 cases out of 15 patients. We believe that with more experience better understanding of intra-operative imaging, the chances of complications and be further reduced.

Our study had a few limitations, including the absence of BMI data and subgroup analysis based on fracture types, which may limit interpretability. A small sample size and relatively short follow-up were key shortcomings.

In summary, our study supports the efficacy and safety of minimally invasive percutaneous fixation in managing Pelvi-acetabular fractures. These techniques offer favourable Clinico-radiological outcomes with reduced morbidity and faster recovery, making them a viable alternative to traditional open procedures. However, careful patient selection and surgical planning remain essential for optimal results.

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