

Fluoroscopic Guided Percutaneous Iliosacral Screw Fixation For Posterior Pelvic Injuries - A Retrospective Analysis

Dr. Aryadev Jayakrishnan¹, Dr. Hariprasad Seenappa², Dr. Tarun Somisetty³

¹Senior Resident, Dept. Of Orthopaedics, Sri Devaraj Urs Academy Of Higher Education And Researchkolar, Karnataka

²Professor, Dept. Of Orthopaedics, Sri Devaraj Urs Academy Of Higher Education And Research, Kolar, Karnataka

³Assistant Professor, Dept. Of Orthopaedics, Sri Devaraj Urs Academy Of Higher Education And Research, Kolar, Karnataka

Abstract:

Pelvic fractures represent a significant clinical challenge due to their complexity and the severe complications associated with them.⁽¹⁾ These injuries often result from high-energy trauma such as road traffic accidents, falls from heights, or crush injuries. The burden of pelvic fractures is substantial, with these injuries accounting for approximately 3-8% of all fractures.⁽²⁾ The high morbidity and mortality rates associated with pelvic fractures are primarily due to hemorrhage, associated organ injuries, and complications arising from the complex anatomy of the pelvic region.⁽³⁾ Effective management of these fractures is crucial to reduce these risks and improve patient outcomes.

INTRODUCTION:

Current management principles for pelvic fractures involve a range of strategies, from non-operative treatments to various surgical interventions.⁽⁴⁾ The standard surgical therapy for unstable posterior pelvic ring injuries has traditionally been open reduction and internal fixation (ORIF).⁽⁵⁾ This method, while effective in achieving anatomical reduction and stable fixation, has several limitations. ORIF requires extensive soft tissue dissection, which increases the risk of wound infections (reported to be as high as 25%), significant blood loss, prolonged operative time, and the potential for complications such as deep vein thrombosis, neurovascular injury, and heterotopic ossification.^(6,7) These challenges necessitate the exploration of less invasive yet equally effective treatment options.

Fluoroscopic guided percutaneous iliosacral screw fixation has emerged as a promising alternative to ORIF for the management of posterior pelvic injuries. This minimally invasive technique offers several advantages over traditional open surgery. By minimising soft tissue dissection, percutaneous fixation reduces the risk of infection and other soft tissue complications. Additionally, it allows for reduced blood loss, shorter operative times, and quicker post-operative recovery. The use of fluoroscopy provides precise guidance for screw placement, enhancing the accuracy and safety of the procedure.⁽⁸⁻¹⁰⁾ This technique is particularly beneficial for polytraumatized patients who may not tolerate the extensive surgery required for ORIF.

Given these potential advantages, it is crucial to systematically evaluate the effectiveness and safety of fluoroscopic guided percutaneous iliosacral screw fixation. Although previous studies have highlighted the benefits of this technique, comprehensive data on its clinical and radiological outcomes, particularly over long-term follow-up, are still needed. To address this gap, our study aims to assess the effectiveness and safety of this procedure, evaluate the clinical outcomes using the Visual Analog Scale (VAS) for pain and the Parker Mobility Score, and determine the radiological outcomes through postoperative CT scans for patients with posterior pelvic injuries.

METHODS:

Study Design

This study is a retrospective analysis aimed at evaluating the clinical and radiological outcomes of fluoroscopic guided percutaneous iliosacral screw fixation in patients with posterior pelvic injuries. The study protocol was reviewed and approved by the Ethics Committee of Sri Devaraj Urs Academy of Higher Education and Research.

Setting

The study was conducted at R.L. Jalappa hospital affiliated with Sri Devaraj Urs Academy of Higher Education and Research. Patient recruitment took place from June 2022 – June 2023. Follow-up

evaluations were scheduled at 6 weeks, 3 months, 6 months, and 12 months postoperatively. Data collection included preoperative assessments, intraoperative details, and postoperative outcomes.

Participants

(a) Eligibility Criteria:

Inclusion criteria: Patients with pelvic ring fractures (PRF) or acetabular fractures (AF) who required percutaneous screw fixation. Specific fracture types included fractures of the pubic rami, vertical fractures of the sacrum, crescent fractures, sacroiliac fractures with and without dislocation, and all anterior column, transverse, and both column fractures of the acetabulum.

Exclusion criteria: Patients were excluded if they had hemodynamic instability or a definitive indication for open reduction internal fixation (ORIF).

(b) Sources and Methods of Selection:

Patients diagnosed with PRF and AF were initially identified based on clinical suspicion and confirmed through x-rays and computed tomography (CT) scans. These fractures were classified using the Young-Burgess classification for PRFs and the Judet and Letournel classification for AFs. Written informed consent was obtained from all patients or their legal guardians prior to inclusion in the study.

Outcomes:

Clinical Outcomes: Visual Analog Scale (VAS) for Pain: Pain intensity was measured using a VAS, where 0 represented no pain and 10 represented the worst pain imaginable. This scale was administered during each follow-up visit at 6 weeks, 3 months, 6 months, and 12 months postoperatively. Parker Mobility Score: This score was used to assess the mobility of patients, focusing on their ability to perform daily activities. The Parker Mobility Score was recorded at the same intervals as the VAS.

Radiological Outcomes:

Radiological Outcomes: Radiological outcomes were assessed using postoperative CT scans to evaluate the quality of fracture reduction and healing in patients with posterior pelvic fractures. The Tornetta and Matta criteria were employed to categorize the quality of reduction into three groups: anatomical reduction (< 1 mm displacement), satisfactory reduction (1-3 mm displacement), and unsatisfactory reduction (> 3 mm displacement). Postoperative CT scans were performed immediately after surgery and during follow-up visits to monitor the progress of fracture union and detect any complications.

Study variables:

Demographic data (age, gender), fracture classification (Young-Burgess for PRF and Judet and Letournel for AF), and the specifics of the surgical procedure (type and placement of screws). Factors such as patient comorbidities, the extent of fracture displacement, and variations in surgical technique were also recorded. Operation Time was measured from the first fluoroscopic exposure after patient positioning until the last suture was placed. Intraoperative blood loss was calculated based on the difference in weight between dry and blood-soaked gauzes. All patients who received postoperative intravenous antibiotics for 24 hours were considered as antibiotic usage. Anticoagulation Therapy referred to administration of Low molecular-weight heparin for at least one week (1 to 6 weeks), depending on the patient's condition. Assessment methods were consistent across all patients, with no variation in the procedures or tools used for measurement, ensuring comparability of data.

Study Procedure

Patients were recruited based on specific inclusion and exclusion criteria to ensure a homogeneous study population. Inclusion criteria included patients aged above 18 years with confirmed posterior pelvic ring fractures. To minimize selection bias, the same surgeon performed all procedures, and standardized measurement tools and protocols were used across all patients. Identical radiological and clinical assessments were conducted at each follow-up. Outcome assessments were conducted at 6 weeks, 3 months, 6 months, and 12 months postoperatively. Clinical outcomes were measured using the Visual Analog Scale (VAS) and Parker Mobility Score at each time point. Radiological outcomes were assessed through postoperative CT scans to monitor fracture union and detect any complications such as avascular necrosis, hardware failure, post-operative infection, and post-traumatic arthritis. Ethics approval for the study was obtained from the institutional review board, and informed consent was obtained from all patients.

Surgical Technique

The fluoroscopic-guided percutaneous iliosacral screw fixation technique was employed to stabilize posterior pelvic ring fractures. Under general anesthesia, patients were positioned supine on a radiolucent table. Using fluoroscopic guidance, a percutaneous approach was made to insert iliosacral screws through

small skin incisions. The screws were placed across the sacroiliac joint to achieve stable fixation. Intraoperative fluoroscopy ensured accurate placement and alignment of the screws, minimizing the risk of neurovascular injury and ensuring optimal stabilization of the fracture. Postoperative CT scans confirmed the correct placement of the screws and the quality of reduction.

Sample Size:

Based on the study by Hussain Wahab et al., where 93.3% of patients reported excellent or good outcomes according to the Majeed score during the postoperative period, the sample size for this study was calculated. Assuming an alpha error of 0.05 (95% Confidence level) and an expected proportion with good clinical outcomes of 93.3%, with an absolute precision of 5%, the minimum required sample size was determined to be 97 subjects. The sample size calculation was based on the following formula:

The sample size was derived from the following formula:

$$n = \frac{Z_{1-\alpha/2}^2 P(1-P)}{d^2}$$

Z is the critical value for alpha error

1- $\alpha/2$: Desired Confidence level

d is the absolute precision

p is the expected proportion with pneumothorax

Statistical Analysis

Descriptive statistics were utilized to summarize the demographic characteristics, injury mechanisms, and associated injuries of the study participants, with frequencies and percentages calculated for categorical variables. The Chi-Square test was employed to examine the associations between different types of injuries and mechanisms of injury. Clinical outcomes, measured by the Visual Analog Scale (VAS) and Parker Mobility Score at various time points (6 weeks, 3 months, 6 months, and 12 months), were analyzed using repeated measures ANOVA to account for correlations between repeated measurements on the same individuals. Significant changes over time were identified with a p-value threshold of <0.001. Radiological outcomes, including the quality of fracture reduction based on the Tornetta and Matta criteria, healing status, and complications, were reported using frequencies and percentages. All statistical analyses were performed using SPSS version 21. A p-value of <0.05 was considered statistically significant for all comparisons.

RESULTS:

The study included 97 patients with posterior pelvic ring fractures. Patients were aged 25-60 years, with 4.1% aged 25-30, 26.8% aged 31-40, 37.1% aged 41-50, and 31.9% aged 51-60. The sex distribution was nearly equal, with 51.5% male and 48.5% female. Mechanisms of injury included motorbike accidents (28.9%), falls from height (26.8%), run-over injuries (22.7%), falls of heavy objects or blunt trauma (13.4%), and car accidents (8.3%) (Table 1).

Table 1: Description of the study participants (n=97)

Characteristics	Number of patients	Percentage
Age groups		
25 – 30 years	4	4.1
31 – 40 years	26	26.8
41 – 50 years	36	37.1
51 – 60 years	31	31.9

Sex		
Male	50	51.5
Female	47	48.5
Mechanism		
Motor bike accident	28	28.9
Fall from height	26	26.8
Run over injuries	22	22.7
Fall of heavy object/blunt trauma	13	13.4
Car accident	8	8.3

Orthopedic injuries included acetabulum fractures (18.6%), femur neck or shaft fractures (20.6%), tibia fractures (10.3%), humerus fractures (10.3%), and distal radius or ulnar fractures (7.2%). Non-orthopedic injuries included pneumothorax and ribs fractures (15.5%), lung contusions (8.2%), urological injuries (7.2%), facial bones fractures (6.2%), abdominal viscera injuries (6.2%), and head injuries (10.3%) (Table 2).

Table 2: Associated injuries

Associated Orthopedic injury	Number of patients	Percentage
Acetabulum fracture	18	18.6
Femur neck / shaft fracture	20	20.6
Tibia fracture	10	10.3
Humerus fracture	10	10.3
Distal radius/ ulnar fracture	7	7.2
Non-Orthopedic Injuries		
Pneumothorax and ribs fracture	15	15.5
Lung contusion without pneumothorax	8	8.2
Urological injury	7	7.2
Facial bones fracture	6	6.2
Abdominal viscera injury (spleen/liver/kidney)	6	6.2
Head injury (sub-Dural hematoma, temporal bone fracture, scalp hematoma)	10	10.3

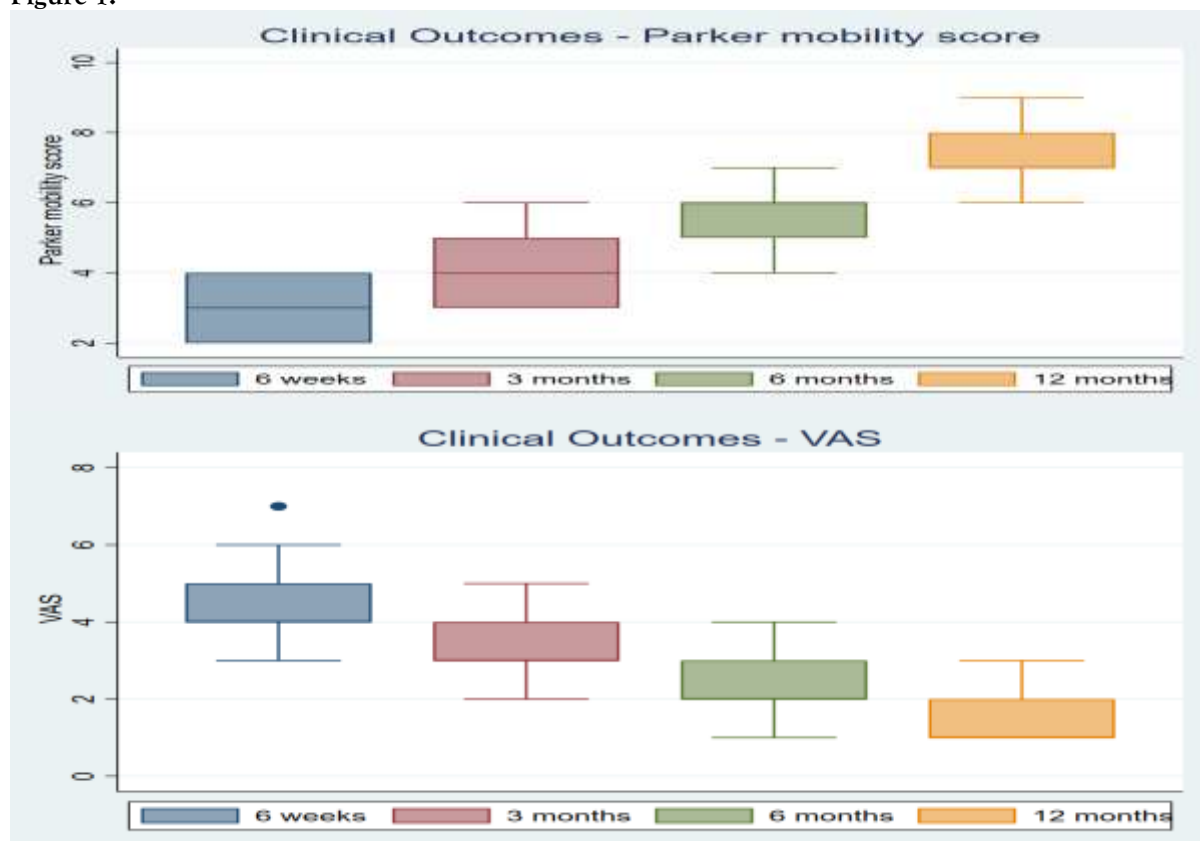
Clinical outcomes showed significant improvement over time. The median VAS score, which measures pain intensity, decreased from 4 (IQR 4-5) at 6 weeks to 1 (IQR 1-2) at 12 months, indicating a substantial reduction in pain levels (Figure 1). Similarly, the Parker Mobility Score, which assesses functional mobility, improved from a median of 3 (IQR 2-4) at 6 weeks to 7 (IQR 7-8) at 12 months, reflecting significant gains in patients' ability to move independently (Figure 2). These changes were statistically significant, with p-values <0.001 for both measures, showing progressive improvement in both pain and mobility over the follow-up period (Table 3).

Table 3: Clinical outcomes (VAS & Parker mobility score)

Time point	VAS	Parker mobility score
6 weeks	4 (4 - 5)	3 (2 - 4)
3 months	3 (3 - 4)	4 (3 - 5)
6 months	2 (2 - 3)	6 (5 - 6)
12 months	1 (1 - 2)	7 (7 - 8)
p-value [#]	<0.001	<0.001

Repeated measures ANOVA

Figure 1:



Radiological outcomes assessed the quality of reduction, healing, and complications. According to the Tornetta and Matta criteria, anatomical reduction was achieved in 50 patients (51.5%), satisfactory reduction in 35 patients (36.1%), and unsatisfactory in 12 patients (12.4%). Complete healing was observed in 70 patients (72.2%), partial healing in 20 patients (20.6%), and non-union in 7 patients

(7.2%). Complications included avascular necrosis in 5 patients (5.2%), hardware failure in 3 patients (3.1%), post-operative infection in 4 patients (4.1%), and post-traumatic arthritis in 7 patients (7.2%) (Table 4).

Table 4: Radiological outcomes

Radiological Outcome	Number of Patients	Percentage
Quality of Reduction (Tornetta and Matta Criteria)		
Anatomical Reduction (< 1 mm)	50	51.5%
Satisfactory Reduction (1-3 mm)	35	36.1%
Unsatisfactory Reduction (> 3 mm)	12	12.4%
Healing		
Complete Healing	70	72.2%
Partial Healing	20	20.6%
Non-union	7	7.2%
Complications		
Avascular Necrosis	5	5.2%
Hardware Failure	3	3.1%
Post-operative Infection	4	4.1%
Post-traumatic Arthritis	7	7.2%

DISCUSSION:

This study demonstrated that fluoroscopic-guided percutaneous iliosacral screw fixation for posterior pelvic ring fractures is both effective and safe. Among the 97 patients, significant improvements were observed in both pain and mobility over the 12-month follow-up period. The median Visual Analog Scale (VAS) score for pain decreased from 4 at 6 weeks to 1 at 12 months, while the Parker Mobility Score improved from 3 to 7 over the same period. Radiologically, 51.5% of patients achieved anatomical reduction, and 72.2% demonstrated complete healing. These results underscore the potential of this minimally invasive technique to enhance recovery while reducing the complications associated with traditional open surgery. The low rates of complications, such as avascular necrosis (5.2%) and hardware failure (3.1%), further support its efficacy and safety.

The findings align with previous research indicating the benefits of percutaneous iliosacral screw fixation. Similar studies have reported high rates of satisfactory anatomical reduction and reduced complication rates compared to open reduction and internal fixation (ORIF).^(5,11) For instance, Kanakaris NK et al. highlighted the high success rates of ORIF but also pointed out the significant risks associated with extensive soft tissue dissection.⁽¹²⁾ In contrast, our study confirms that percutaneous fixation achieves comparable, if not better, outcomes with fewer complications. Chen JP et al. and Roux C et al emphasized the reduced infection rates and faster recovery times associated with minimally invasive techniques, findings that our study corroborates.^(13,14)

The significant improvement in clinical outcomes can be attributed to the minimally invasive nature of the percutaneous technique, which minimizes soft tissue damage and preserves vascular integrity. This likely contributes to the lower rates of postoperative infection and faster healing times observed in this study. The precise screw placement facilitated by fluoroscopic guidance ensures optimal stabilization of the pelvic ring, crucial for effective fracture healing and early mobilization.⁽¹⁰⁾ Additionally, the reduced operative time and blood loss inherent in this technique likely contribute to the overall positive outcomes, particularly in polytraumatized patients who are less able to tolerate the physiological stress of extensive surgery.⁽¹⁵⁾ The high rates of anatomical and satisfactory reductions observed (51.5% and 36.1%, respectively) suggest that this technique allows for excellent control and alignment of fracture fragments, critical factors in the healing process and the prevention of long-term complications such as post-traumatic arthritis.

The results have significant implications for clinical practice. The demonstrated effectiveness and safety of fluoroscopic-guided percutaneous iliosacral screw fixation suggest that it should be considered a first-line treatment for posterior pelvic ring fractures, especially in patients who may not tolerate open surgery well. The reduction in pain and improvement in mobility observed in this study indicate that patients can expect a better quality of life and faster return to normal activities compared to traditional surgical methods. Additionally, the lower complication rates associated with this technique could translate to reduced healthcare costs and resource utilization, making it a cost-effective option. These findings could influence treatment guidelines and protocols, encouraging the adoption of minimally invasive techniques as standard practice for appropriate candidates.

One of the major strengths of this study is its relatively large sample size, enhancing the generalizability of the findings. The use of standardized classification systems (Young-Burgess for PRFs and Judet and Letournel for AFs) and consistent follow-up protocols ensure the reliability and comparability of the data. Additionally, the single-surgeon approach minimizes variability in surgical technique, further strengthening the study's findings. However, as a retrospective analysis, the study is subject to inherent biases, such as selection bias and information bias. The lack of a control group undergoing traditional ORIF limits the ability to make direct comparisons between the two techniques. Future prospective, randomized studies are needed to validate these findings further.

CONCLUSION:

In conclusion, this study supports the use of fluoroscopic-guided percutaneous iliosacral screw fixation as an effective and safe treatment for posterior pelvic ring fractures, offering significant improvements in clinical and radiological outcomes. It is recommended that this minimally invasive technique be considered a standard treatment option for appropriate patients with posterior pelvic ring fractures. Further research, including randomized controlled trials, is necessary to continue validating these outcomes and refining surgical techniques.

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