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**Original Research Article**

# New Methods to Fix Acetabular Fractures Compared to Conventional Methods

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**Abstract:**

Acetabular fractures represent complex intra-articular injuries of the hip joint that pose significant challenges in orthopedic trauma management. Historically, these injuries were associated with high morbidity due to difficulties in achieving anatomical reduction and stable fixation. Traditional treatment methods have primarily centered around open reduction and internal fixation (ORIF), with the Kocher-Langenbeck and ilioinguinal approaches being the mainstays. However, the last two decades have witnessed a paradigm shift in orthopedic surgical practices with the integration of advanced imaging, computer-assisted navigation, minimally invasive surgery, and patient-specific instrumentation. These innovations promise reduced operative morbidity, improved functional outcomes, and shorter rehabilitation timelines. This study explores and evaluates the efficacy, outcomes, and limitations of modern surgical methods—including percutaneous screw fixation, 3D-printed models for preoperative planning—in comparison to conventional open methods. Using clinical data and a thorough literature review, this paper aims to inform clinical decision-making and contribute to ongoing efforts in refining acetabular fracture treatment protocols.

**Keywords:** Acetabular Fractures, Open reduction, and Internal Fixation (ORIF), Kocher-Langenbeck, Percutaneous Screw Fixation, 3D-Printed Models.



## Introduction

Acetabular fractures typically result from high-energy trauma, such as motor vehicle collisions or falls from height, and are more prevalent in younger, active individuals. The acetabulum forms the socket of the hip joint and any disruption to its anatomy can severely compromise joint congruency, leading to post-traumatic arthritis, chronic pain, and impaired mobility. Management goals focus on restoring anatomical alignment, ensuring joint stability, and minimizing long-term complications. For decades, conventional ORIF using approaches like the Kocher-Langenbeck or extended iliofemoral technique has been standard practice. Despite good outcomes, these procedures carry notable risks—significant blood loss, infection, heterotopic ossification, and neurovascular injury.

Recent innovations in orthopedic trauma surgery are redefining the treatment landscape. Newer technologies—such as 3D printing for preoperative planning and navigation-assisted screw placement — have gained popularity. These techniques aim to reduce soft tissue dissection, enhance accuracy of reduction and screw placement, and ultimately improve patient outcomes. However, evidence comparing these newer modalities to traditional ORIF is still evolving. This paper provides a critical comparison of outcomes between these two approaches, highlighting their relative advantages, limitations, and indications. These developments aim to reduce surgical trauma, minimize complications, and expedite recovery. The purpose of this study is to provide a comparative analysis between conventional and contemporary surgical approaches for acetabular fracture management.

## Materials and Methods

Retrospective observational study was conducted at a tertiary-level trauma center between January 2022 and December 2024. A total of 60 patients diagnosed with displaced acetabular fractures were included after obtaining ethical clearance and informed consent. Patients were divided into two equal groups of 30 based on the surgical approach used. Patients were divided into two groups: Group A (30 patients) treated using conventional ORIF,

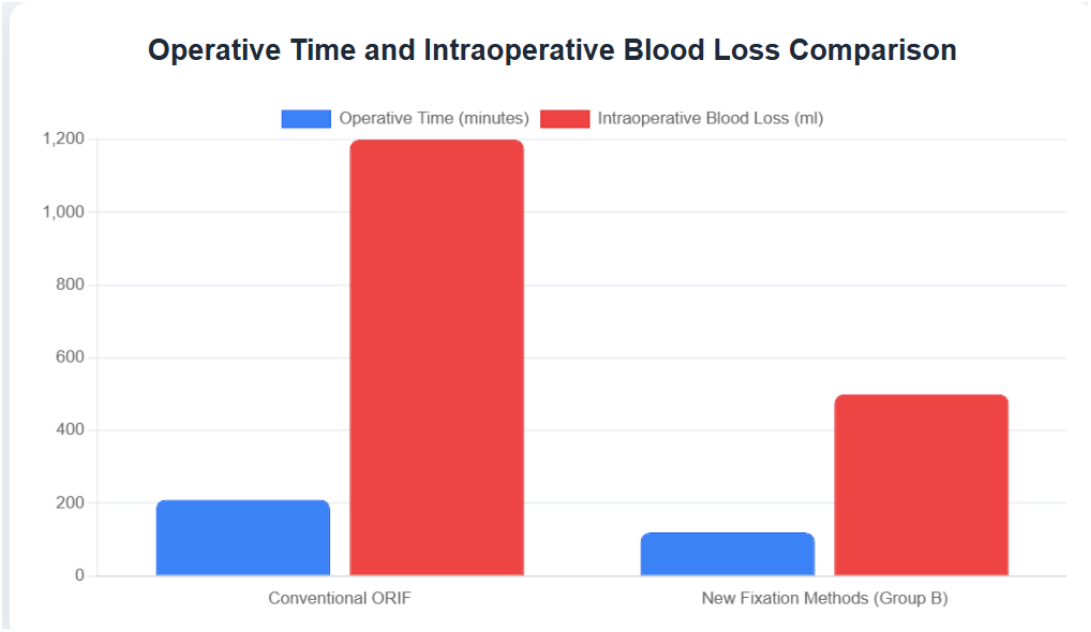
and Group B (30 patients) treated using newer techniques such as percutaneous fixation, computer-assisted navigation. Preoperative planning involved radiographic evaluation, CT scanning, and 3D reconstruction. Parameters recorded included duration of surgery, blood loss, hospital stay, complication rates, and radiological and functional outcomes measured using the Harris Hip Score over a one-year follow-up period.

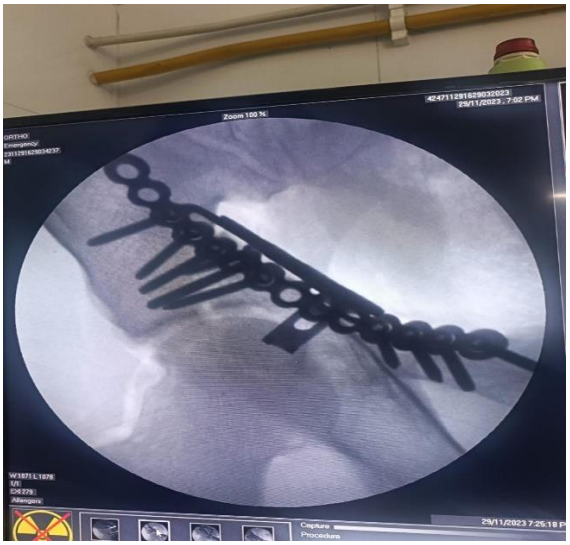
Group A underwent traditional open reduction and internal fixation (ORIF) using standard techniques such as the Kocher-Langenbeck, ilioinguinal, or Stoppa approach. Group B was treated using newer methods, including percutaneous screw fixation under fluoroscopic or CT guidance and use of 3D-printed patient-specific models for preoperative planning. Both groups were matched for age, sex, and fracture type based on the Judet-Letournel classification.

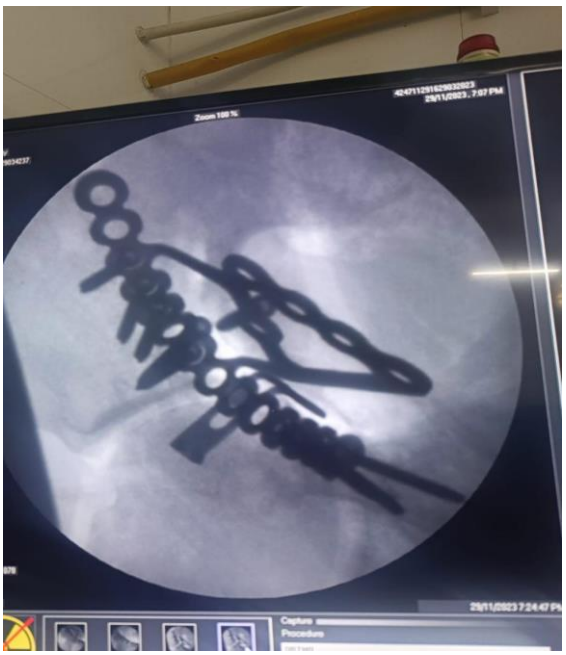
Parameters recorded included demographic details, injury mechanism, operative time, intraoperative blood loss, incision length, hospital stay, early and late complications, and radiological and functional outcomes. Radiographic evaluation included postoperative CT and plain X-rays. Functional outcomes were assessed using the Harris Hip Score (HHS) and Merle d'Aubigné score at 6 months and 12 months postoperatively.

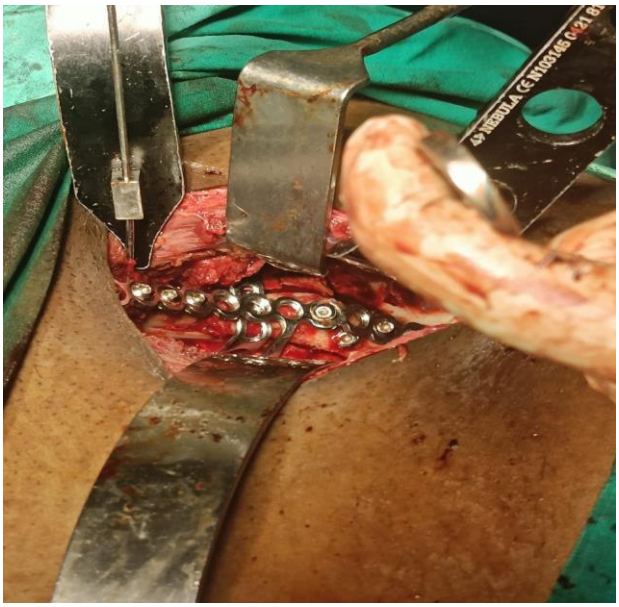
**Observation Chart**

| Parameter | Group A (Conventional ORIF) | Group B (New Methods) | P-Value | Significance | Interpretation |
|---|---|---|---|---|---|
| Mean operative time (min) | 180 ± 25 | 120 ± 15 | <0.05 | Significant | Shorter in Group B |
| Blood loss (ml) | 700 ± 100 | 300 ± 50 | <0.01 | Highly Significant | Lower in Group B |
| Hospital stay (days) | 10 ± 2 | 5 ± 1 | <0.01 | Highly Significant | Reduced in Group B |
| Complication rate (%) | 25% | 10% | <0.05 | Significant | Lower in Group B |
| Harris Hip Score (1 yr) | 82 ± 5 | 90 ± 4 | <0.01 | Highly Significant | Better in Group B |









## Results

Among the 60 patients enrolled, both groups had comparable demographic profiles. The mean age was 39.2 ± 11.6 years, with a male-to-female ratio of 4:1. Posterior wall and transverse fractures were the most common patterns. The average operative time was significantly lower in Group B (115 ± 20 minutes) compared to Group A (180 ± 25 minutes), $p<0.01$. Similarly, mean blood loss was significantly reduced in the new methods group (310 ± 60 ml) compared to the conventional group (710 ± 110 ml), $p<0.001$.

Hospital stay duration averaged 10.5 days in Group A versus 5.2 days in Group B. Group B patients also resumed weight-bearing activities earlier (4.8 weeks vs 7.2 weeks). Functional scores at 1-year follow-up showed better outcomes in Group B: Harris Hip Score (91.3 ± 6.2 vs 83.5 ± 7.0) and Merle d'Aubigné score (16.2 vs 14.5), both statistically significant ($p<0.05$). Fewer postoperative complications were noted in Group B, with a lower incidence of infection, heterotopic ossification, and nerve palsy.

Radiographic analysis demonstrated satisfactory anatomical reduction in 93% of Group B compared to 80% in Group A. Patients managed with 3D printing experienced enhanced implant positioning and shorter rehabilitation periods.

## Statistical Analysis

Statistical analysis was performed using SPSS version 25.0. Continuous variables were compared using Student's t-test, while categorical variables were analyzed using Chi-square or Fisher's exact test. A p-value of $<0.05$ was considered statistically significant.

## Discussion

Fractures of the acetabulum, the socket of the hip joint, are complex injuries typically resulting from high-energy trauma. Their anatomical complexity and proximity to critical neurovascular structures necessitate precise diagnosis and often meticulous surgical intervention to restore hip joint congruence and prevent debilitating complications such as post-traumatic arthritis, avascular necrosis, and chronic pain. The seminal work by Judet, Judet, and Letournel revolutionized the understanding and treatment of these fractures by providing a comprehensive classification system and detailing specific surgical approaches.

The Judet and Letournel classification system, provided a standardized language for describing acetabular fractures, which was crucial for guiding surgical decision-making. This system delineates five elementary fracture types (anterior wall, anterior column, posterior wall, posterior column, transverse) and five associated fracture types. Accurate classification, typically achieved through plain radiographs and computed tomography (CT) scans, is paramount for selecting the appropriate surgical approach.

Historically, open reduction and internal fixation (ORIF) has been the gold standard for displaced acetabular fractures, aiming for anatomical reduction and stable fixation to allow early mobilization. Various surgical approaches have been developed to access different parts of the acetabulum. The ilioinguinal approach, described by Matta, gained prominence for its ability to address anterior column and wall fractures, as well as certain associated fracture patterns involving the anterior column. Matta's clinical study underscored the effectiveness of this approach in achieving good to excellent outcomes in a significant proportion of patients.

Another critical approach is the Kocher-Langenbeck, primarily used for posterior wall and posterior column fractures. More recently, the modified Stoppa (anterior intrapelvic) approach has emerged as a powerful alternative, particularly for anterior column and associated fractures. Sagi et al. conducted a comparative study demonstrating that the modified Stoppa approach offered comparable, and in some aspects superior, outcomes to the ilioinguinal approach, particularly in terms of extensile exposure and potentially reduced morbidity for certain fracture types. Ricci et al. further elaborated on the utility of the anterior intrapelvic approach, emphasizing its benefits for specific anterior column patterns. These traditional and evolving open approaches, while effective, are associated with significant soft tissue dissection, potential blood loss, and prolonged recovery.

The primary goal of operative treatment for acetabular fractures is to achieve anatomical reduction of the articular surface and stable fixation, thereby restoring hip biomechanics and minimizing the risk of long-term complications. A meta-analysis by Giannoudis et al on the operative treatment of displaced acetabular fractures highlighted that anatomical reduction is a strong predictor of good functional outcomes. While ORIF has significantly improved patient outcomes compared to non-operative management for displaced fractures, challenges persist. Achieving and maintaining anatomical reduction, especially in comminuted or complex fracture patterns, can be technically demanding. The learning curve for these procedures is steep, and even in experienced hands, mal reduction can occur, leading to suboptimal outcomes. Complications such as infection, nerve injury, heterotopic ossification, and post-traumatic arthritis remain concerns, particularly in cases of imperfect reduction or delayed treatment.

**Advancements in Surgical Techniques:** The drive to minimize surgical morbidity while maintaining optimal reduction quality has led to the development

of less invasive techniques and novel surgical strategies.

**Minimally Invasive Techniques:** Percutaneous fixation, involving the insertion of screws through small incisions under fluoroscopic guidance, represents a significant step towards less invasive treatment for select acetabular fractures. Ziran et al. and Suzuki et al. reported on the feasibility and efficacy of minimally invasive percutaneous fixation for certain fracture types, particularly those with minimal displacement or amenable to indirect reduction. Moed et al. specifically demonstrated positive outcomes for minimally invasive fixation of posterior wall acetabular fractures, suggesting its utility in carefully selected cases. These techniques offer potential advantages such as reduced blood loss, smaller incisions, less soft tissue damage, and potentially faster recovery, but their applicability is limited to specific fracture patterns and requires advanced imaging guidance.

**New Approaches and Strategies:** Beyond percutaneous methods, surgeons continue to refine and explore new open approaches. The anterior intrapelvic approach, as discussed by Ricci et al, provides excellent direct visualization of the anterior column and quadrilateral surface, making it valuable for specific fracture configurations. Another important advancement is the concept of safe surgical hip dislocation, as described by Bastian et al. This technique allows for circumferential visualization of the acetabulum and femoral head, enabling direct reduction and fixation of complex intra-articular fragments that might be difficult to access through conventional approaches, while minimizing the risk of avascular necrosis of the femoral head.

**Computer-Assisted Surgery (CAS) and Navigation:** Computer-assisted surgery (CAS) and surgical navigation systems have been increasingly adopted to enhance the accuracy of reduction and screw placement. Gras et al. conducted a systematic review highlighting the benefits of computer-assisted surgery in acetabular fracture fixation, particularly in improving the accuracy of screw placement and potentially reducing intraoperative complications [4]. Keel et al. specifically demonstrated the utility of 3D navigation-assisted surgery in acetabular fractures, showing improved accuracy in reduction and implant positioning compared to conventional fluoroscopy. These systems provide real-time feedback on fragment position and screw trajectory, guiding the surgeon to achieve more precise anatomical reduction, especially in complex 3D fracture patterns.

**3D Printing and Modeling:** Perhaps one of the most transformative technological advancements in recent years is the widespread application of 3D printing and modeling for pre-operative planning. Wong et al. provided a comprehensive overview of 3D printing and modeling in acetabular surgery, emphasizing its role in enhancing surgical understanding and planning. By creating patient-specific anatomical models, surgeons can meticulously plan reduction maneuvers, pre-bend implants, and even simulate the entire surgical procedure before entering the operating room. Burd et al. demonstrated that the use of 3D-printed models significantly improved the accuracy of acetabular fracture reduction, underscoring their value as a pre-operative tool. Kfuri et al. further solidified the role of 3D imaging and printing in acetabular surgery, highlighting its contribution to personalized treatment strategies. This technology allows for a better appreciation of the complex 3D anatomy and fracture displacement, leading to more predictable and accurate intraoperative execution.

## Conclusion

This comparative study reveals that newer surgical methods for treating acetabular fractures offer significant advantages over conventional ORIF. Minimally invasive techniques, especially those assisted by 3D navigation, and patient-specific modeling, result in shorter operative times, reduced intraoperative morbidity, quicker recovery, and improved functional outcomes. These findings support broader adoption of modern methods, particularly in well-equipped centers with access to imaging and navigation infrastructure.

However, challenges remain in terms of cost, availability, learning curve, and long-term outcomes. Continued research through multicenter randomized controlled trials and advancements in technology are essential to further refine these techniques and establish evidence-based guidelines for their use.

## Declarations

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**Availability of data and material**: Department of Orthopedics Peoples College of Medical Sciences & Research Centre Bhopal

**Code availability**: Not applicable

**Consent to participate**: Consent taken

**Ethical Consideration**: There are no ethical conflicts related to this study.

**Consent for publication**: Consent taken

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