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Predictors of Clinical Outcomes In Surgically Treated Displaced Acetabular Fractures: A Single-Center Prospective Study

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Background: Acetabular fractures represent challenging injuries requiring complex surgical interventions to restore joint congruity and function. This prospective study aims to evaluate the functional and radiological outcomes of surgically treated displaced acetabular fractures and identify factors that predict clinical results.
Methods: A prospective analysis of 118 patients with displaced acetabular fractures treated surgically at a single tertiary care center was conducted over an 18-month period. Patients were followed for 12 months postoperatively. Fractures were classified according to the Letournel and Judet system. Functional outcomes were assessed using the Modified Harris Hip Score, while radiological outcomes were evaluated using Matta's reduction criteria. Statistical analysis was performed to identify factors associated with clinical outcomes.
Results: The mean age was 41.36 years, with males comprising 73.7% of patients. Road traffic accidents (53.4%) were the predominant injury mechanism. Associated both-column fractures (25.4%) were most common, followed by T-type fractures (24.6%). The Modified Stoppa approach was most frequently employed (54.2%). According to the Modified Harris Hip Score, 48.3% of patients achieved excellent results, 34.7% good, 11.9% fair, and 5.1% poor. Anatomical reduction (<1mm displacement) was achieved in 65.3% of cases. Marginal impaction (p=0.01), initial displacement magnitude (p=0.02), and quality of reduction (p=0.001) showed significant associations with functional outcomes. However, demographic factors, fracture patterns, and surgical approaches did not significantly influence results.
Conclusion: Surgical management of displaced acetabular fractures

yields favorable outcomes in the majority of cases. The quality of reduction is the most critical determinant of functional recovery, emphasizing the importance of anatomical reduction as the primary surgical objective. Marginal impaction and initial displacement magnitude are additional important predictors of outcome. These findings highlight key factors that surgeons should consider when managing these complex injuries to optimize patient recovery.

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INTRODUCTION

Acetabular fractures have a reported incidence of 3/100,000 person-years and typically result from high-energy trauma such as motor vehicle accidents or falls from significant heights [1]. These injuries often accompany trauma to other body regions, affecting the patient's quality of life, duration of hospitalization, complication rates, and overall healthcare costs [2].

The past decade has witnessed an increasing frequency of polytrauma and pelvic injuries due to a surge in high-speed motor vehicle accidents and high-velocity falls. Improved emergency trauma care and healthcare infrastructure have contributed to increased survival rates among these polytrauma patients [3]. Acetabular fractures represent approximately 10% of pelvic injuries, with over 80% occurring in automobile accidents and 10.7% resulting from falls [4]. These fractures constitute roughly 1-3% of all skeletal fractures and account for 2% of all hospital admissions for orthopedic care [5].

Mortality rates for acetabular fractures vary from 8% to 50% depending on the mechanism of injury and associated injuries. However, this rate has declined over time, from a reported 87% before 1890 to approximately 10% currently [6,7,8]. Hemodynamically stable patients have a relatively low mortality rate of 3.4%, while hemodynamically unstable patients face a much higher rate of 42% [5].

The socioeconomic impact of acetabular fractures is substantial, with patients requiring a median leave of absence from work of 180 days [9]. Only 75% of patients return to their previous employment, and 10% become completely unable to work [9]. Additionally, these patients experience a notable decrease in exercise frequency and intensity following injury [10].

Acetabular fractures are complex intra-articular injuries that may result in devastating arthropathy if not managed appropriately [11]. Historically, conservative management was the standard of care. However, with the pioneering work of Letournel and Judet, surgical intervention for displaced acetabular fractures has become the norm [12]. The goal of treatment is to maintain a stable, congruent joint, as non-operative management of displaced acetabular fractures has been associated with significant complications and unfavorable outcomes [13]. Reports indicate that most patients treated non-operatively for displaced acetabular fractures developed painful, stiff, arthritic hip joints with significantly reduced work capacity [14].

Surgical management of acetabular fractures presents significant challenges for orthopedic surgeons due to complex anatomy, steep learning curves, varied fracture patterns, and difficult access to fracture sites [15]. The presence of polytrauma further complicates patient positioning during surgery. Surgical intervention for displaced acetabular fractures has evolved over the past 40 years to become the "gold standard" [16,17]. Early open reduction and internal fixation can achieve good clinical outcomes and significant fracture reduction [16,17,18,19]. However, selecting the appropriate surgical approach is crucial and

depends on accurate fracture classification and assessment of dislocation degree [20].

Fracture reduction without articular step-off is vital for good functional outcomes. Accurate reduction improves results and reduces the prevalence of advanced arthritic conditions [14,21]. The rate of total hip arthroplasty following acetabular fixation ranges from 8% to 34%, while the incidence of radiographic arthritis is reported between 20% and 40% [22,23]. Treatment decisions are also influenced by patient age, comorbidities, fracture stability, and bone quality.

Functional outcome assessment has evolved from evaluating basic parameters like walking capacity, pain threshold, and ability to return to work to more sophisticated numerical grading systems. Currently, the most widely accepted methods for measuring outcomes in acetabular fractures are the Modified Harris Hip Score and Matta's radiological criteria [24].

Despite advances in surgical techniques and implants, predicting outcomes following acetabular fracture surgery remains challenging. Multiple factors may influence functional recovery, including patient demographics, fracture characteristics, surgical timing, quality of reduction, and postoperative complications. Understanding these predictors is crucial for optimizing treatment protocols and improving patient outcomes.

This prospective study aims to evaluate the radiological and functional outcomes of surgically treated displaced acetabular fractures and identify factors that predict clinical outcomes. By analyzing a cohort of patients treated at a single trauma center, we seek to determine which variables significantly influence recovery and functional results, thereby contributing to the development of evidence-based management strategies for these complex injuries.

MATERIALS AND METHODS

Study Design and Patient Population

This prospective study was conducted at the Department of Orthopaedics, Level 1 Trauma Center, over a period of 18 months after obtaining Institutional Ethics Committee approval. All patients with displaced acetabular fractures who fulfilled the inclusion and exclusion criteria during the study period and provided written informed consent were enrolled.

The inclusion criteria were patients aged 18 to 80 years with displaced acetabular fractures. Patients who did not consent to participate, those with associated vascular injuries, and those deemed unfit for surgery were excluded from the study.

Clinical and Radiological Assessment

All patients underwent thorough clinical examination, focusing on pelvi-acetabular compression tests, limb length discrepancy, bleeding per urethra, distal neurovascular status, and presence of open fractures or Morel-Lavallee lesions.

Standard radiographic evaluation included anteroposterior (AP) view of the pelvis with both hips, Judet views (iliac and obturator oblique), and three-dimensional computed tomography (3D CT) of the pelvis [26]. Fractures were classified according to the Letournel and Judet classification system [12].

Additionally, routine blood investigations and other relevant tests were performed to assess surgical fitness.

Treatment Protocol

Operative Treatment

Surgical intervention was indicated for fractures with more than 2 mm displacement in the weight-bearing area, inability to maintain joint congruency out of traction, large posterior wall fragments, documented posterior instability under stress examination, or for removal of loose fragments from the joint.

The surgical approach was determined based on the fracture pattern, degree of displacement, and surgeon's preference. The approaches used included the Modified Stoppa

approach, Kocher-Langenbeck (KL) approach, and dual approaches. When necessary, posterior column plating was performed in conjunction with the Modified Stoppa approach.

All surgeries were performed by the same team of surgeons experienced in acetabular fracture management. Patients were positioned according to the selected approach, and fracture reduction was achieved using standard reduction techniques and appropriate fixation methods.

Postoperatively, patients received appropriate antibiotic coverage, analgesia, and deep vein thrombosis prophylaxis when indicated. Mobilization protocols included non-weight-bearing exercises initially, with progressive weight-bearing based on radiological evidence of healing.

Follow-up and Outcome Assessment

Patients were followed for 6 months postoperatively, with scheduled appointments at 6 weeks, 12 weeks, and 24 weeks. At each follow-up, clinical and radiological assessments were performed.

Functional Outcome Assessment

Functional outcomes were evaluated using the Modified Harris Hip Score (MHHS) [27]. The MHHS evaluates pain, limp, support required for ambulation, distance walked, ability to climb stairs, put on footwear, sit comfortably, use public transportation, absence of deformity, and range of motion. Scores were categorized as follows:

- 90-100: Excellent
- 80-89: Good
- 70-79: Fair
- <70: Poor

Radiological Outcome Assessment

Radiological outcomes were assessed using Matta's radiological criteria [28], which evaluate reduction quality based on the residual displacement of fracture fragments:

- <1 mm: Anatomical reduction
- 1-3 mm: Imperfect reduction
- 3 mm: Poor reduction

Additionally, radiographs were evaluated for osteophyte formation, joint space narrowing, and sclerosis, and were graded as excellent, good, fair, or poor.

Data Collection and Analysis

Data were collected through personal interviews, specific examinations, and investigations. Information recorded included demographics, etiology, mode of injury, time of injury, time of intervention, associated injuries, length of hospital stay, surgical approach, quality of reduction, and complications.

The data were coded and entered into Microsoft Excel spreadsheets. Statistical analysis was performed using IBM SPSS Statistics Version 25 (IBM Corporation, NY, USA). Descriptive statistics included computation of percentages, means, and standard deviations. Normality of data distribution was checked using the Kolmogorov-Smirnov test. The chi-square test was used for qualitative data comparison of clinical indicators. A p-value of ≤ 0.05 was considered statistically significant.

RESULTS

Demographic and Injury Characteristics

A total of 118 patients with displaced acetabular fractures were included in this study. The mean age was 41.36 ± 14.36 years (range: 15-80 years), with the majority (50.8%) belonging to the 20-40 years age group, followed by 40-60 years (35.6%), over 60 years (9.3%), and under 20 years (4.2%). Males constituted 73.7% (n=87) of the study population, while females represented 26.3% (n=31).

Road traffic accidents (RTAs) were the predominant mode of injury (53.4%, n=63), followed by falls from height (FFH) (46.6%, n=55). Regarding comorbidities, 83.9% of patients had no underlying medical conditions, while 5.1% had diabetes mellitus, 4.2% had

hypertension, and 6.8% had both diabetes and hypertension.

The majority of patients (92.4%, n=109) were hemodynamically stable at presentation, while 7.6% (n=9) were unstable. Clinical findings included limb length discrepancy in 25.3%, and distal neurovascular deficit in 7.3%. Morel-Lavallee lesions were observed in 4.2% of cases.

Fracture Characteristics

According to the Letournel and Judet classification, associated both-column (ABC) fractures were most common (25.4%, n=30), followed by T-type fractures (24.6%, n=29), anterior column-posterior hemitransverse (ACPHT) fractures (19.5%, n=23), anterior column fractures (11.0%, n=13), transverse with posterior wall fractures (6.8%, n=8), posterior wall fractures (5.9%, n=7), transverse fractures (4.2%, n=5), and posterior column with posterior wall fractures (2.5%, n=3).

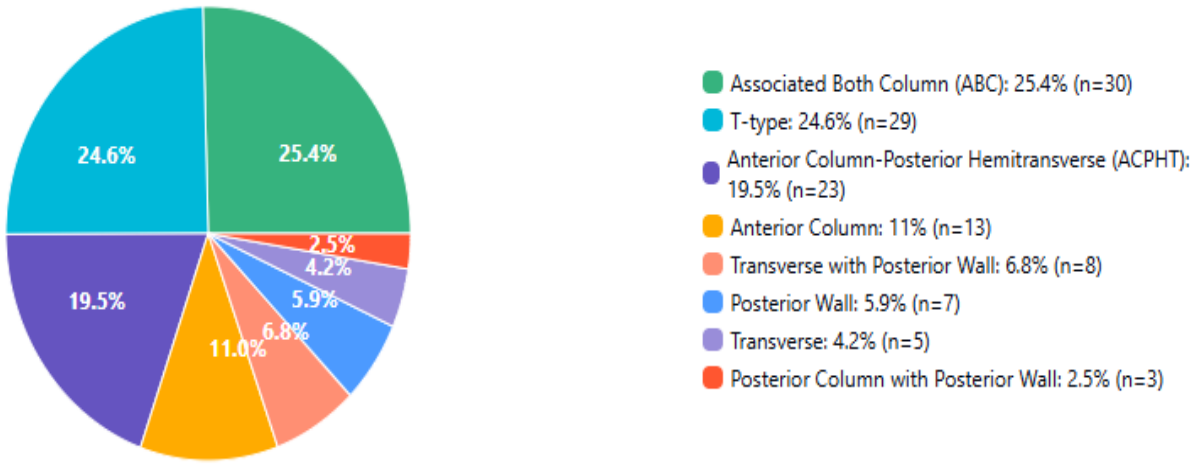

Figure 1: Pie chart or bar graph showing distribution of fracture patterns

Radiographic evaluation revealed that 41.5% (n=49) of patients had displacement less than 20mm, 44.9% (n=53) had displacement between 20-40mm, and 13.5% (n=16) had displacement greater than 40mm. Posterior wall fractures were present in 39.0% (n=46) of cases, head protrusion in 40.7% (n=48), posterior dislocation in 8.5% (n=10), marginal impaction in 28.0% (n=33), and head impaction in 11.9% (n=14).

Treatment Characteristics

All patients underwent surgical management with a mean delay in surgery of 1.22 ± 1.77 days. The surgical approaches employed included Modified Stoppa in 54.2% (n=64), Kocher-Langenbeck in 29.7% (n=35), and dual approach in 16.1% (n=19). Posterior column plating with Modified Stoppa approach was performed in 23.7% (n=28) of cases.

Intraoperative blood transfusion was required in 43.2% of patients, with 29.7% (n=35) receiving one unit, 10.2% (n=12) receiving two units, and 3.4% (n=4) receiving three units. The mean hospital stay was 7.15 ± 2.26 days, with 35.6% of patients requiring ICU care (26.3% for one day, 6.8% for two days, and 2.5% for three days).

Deep vein thrombosis prophylaxis was administered to 14.4% (n=17) of patients,

primarily those over 60 years, with multiple fractures, polytrauma, or more than two risk factors.

Postoperative Outcomes

Radiological Outcomes

According to Matta's reduction criteria, 65.3% (n=77) of patients achieved anatomical reduction (<1mm displacement), 30.5% (n=36) had imperfect reduction (1-3mm displacement), and 4.2% (n=5) had poor reduction (>3mm displacement).

Functional Outcomes

Based on the Modified Harris Hip Score, 48.3% (n=57) of patients achieved excellent results, 34.7% (n=41) had good results, 11.9% (n=14) had fair results, and 5.1% (n=6) had poor results. The mean time to return to work was 19.25 ± 2.32 weeks. Only 1.7% (n=2) of patients needed to change their profession, and 2.5% (n=3) reported changes in their economic status.

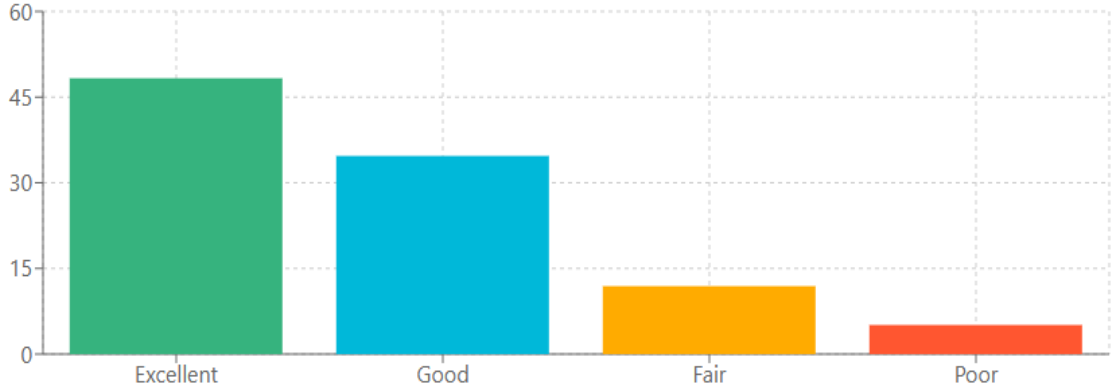

Figure 2: Bar graph showing functional outcome distribution

Factors Influencing Outcomes

Table 1 presents the association between age and functional outcomes, showing no statistically significant relationship (p=0.55). Similarly, gender (p=0.67) and mode of injury (p=0.32) did not significantly influence functional outcomes.

Table 1: Association between Age Category and Harris Hip Score

Age Category	Excellent/Good (n=98)	Fair/Poor (n=20)	Total (n=118)	p-value
<20 years	3 (3.1%)	2 (10.0%)	5 (4.2%)	0.55
20-40 years	51 (52.0%)	9 (45.0%)	60 (50.8%)	
40-60 years	35 (35.7%)	7 (35.0%)	42 (35.6%)	
>60 years	9 (9.2%)	2 (10.0%)	11 (9.3%)	

The type of fracture also showed no significant association with functional outcomes (p=0.39), as illustrated in Table 2.

Table 2: Association between Fracture Type and Harris Hip Score

Fracture Type	Excellent	Good	Fair	Poor	Total	p-value
ABC	17 (30.4%)	8 (19.0%)	5 (35.7%)	0 (0.0%)	30 (25.4%)	0.39
ACPHT	13 (23.2%)	6 (14.3%)	3 (21.4%)	1 (16.7%)	23 (19.5%)	
Anterior column	5 (8.9%)	4 (9.5%)	2 (14.3%)	2 (33.3%)	13 (11.0%)	
PC with PW	1 (1.8%)	2 (4.8%)	0 (0.0%)	0 (0.0%)	3 (2.5%)	
Posterior wall	2 (3.6%)	4 (9.5%)	1 (7.1%)	0 (0.0%)	7 (5.9%)	

T-type	8 (14.3%)	15 (35.7%)	3 (21.4%)	3 (50.0%)	29 (24.6%)	
Transverse	4 (7.1%)	1 (2.4%)	0 (0.0%)	0 (0.0%)	5 (4.2%)	
Transverse with PW	6 (10.7%)	2 (4.8%)	0 (0.0%)	0 (0.0%)	8 (6.8%)	

ABC: Associated Both Column; ACPHT: Anterior Column-Posterior Hemitransverse; PC: Posterior Column; PW: Posterior Wall

Similarly, the surgical approach used (Dual, Modified Stoppa, or Kocher-Langenbeck) showed no significant association with outcomes (p=0.68), nor did the use of posterior column plating with the Modified Stoppa approach (p=0.66).

However, significant associations were found between functional outcomes and certain radiological parameters. Marginal impaction demonstrated a statistically significant relationship with functional outcomes (p=0.01), with 50% of patients in the fair/poor category having acetabular fractures associated with marginal impaction, compared to 23.5% in the excellent/good category (Table 3).

Table 3: Association between Marginal Impaction and Harris Hip Score

Marginal Impaction	Excellent/Good (n=98)	Fair/Poor (n=20)	Total (n=118)	p-value
No	75 (76.5%)	10 (50.0%)	85 (72.0%)	0.01
Yes	23 (23.5%)	10 (50.0%)	33 (28.0%)	

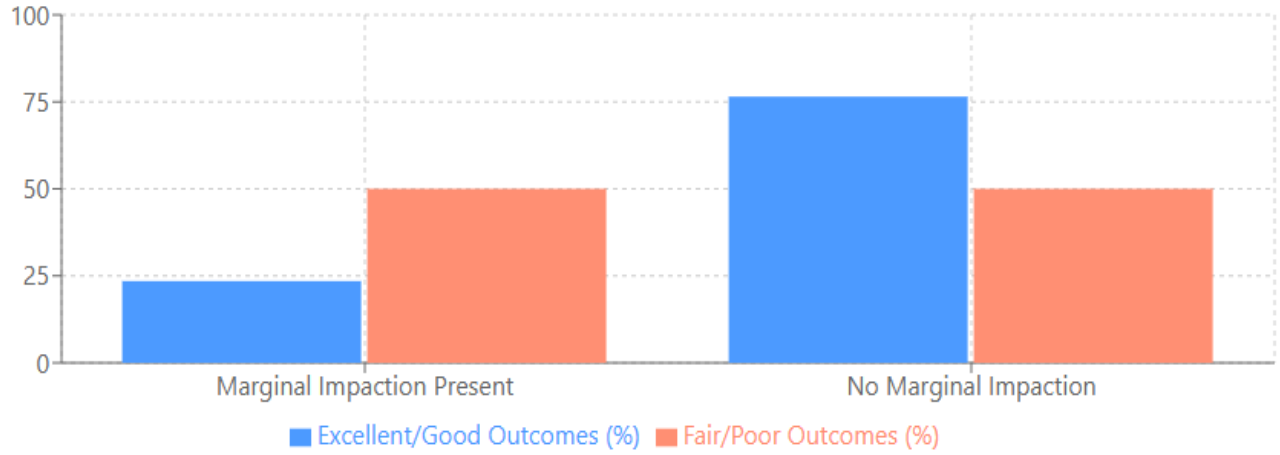

Figure 3: Bar graph showing relationship between marginal impaction and functional outcomes

Initial displacement categories were also significantly associated with outcomes (p=0.02). Patients with displacements less than 20mm and between 20-40mm had better outcomes compared to those with displacements greater than 40mm (Table 4).

Table 4: Association between Displacement Category and Harris Hip Score

Displacement Category	Excellent/Good (n=98)	Fair/Poor (n=20)	Total (n=118)	p-value
<20mm	44 (44.9%)	5 (25.0%)	49 (41.5%)	0.02
20-40mm	52 (53.1%)	12 (60.0%)	53 (54.2%)	
>40mm	2 (2.0%)	3 (15.0%)	5 (4.2%)	

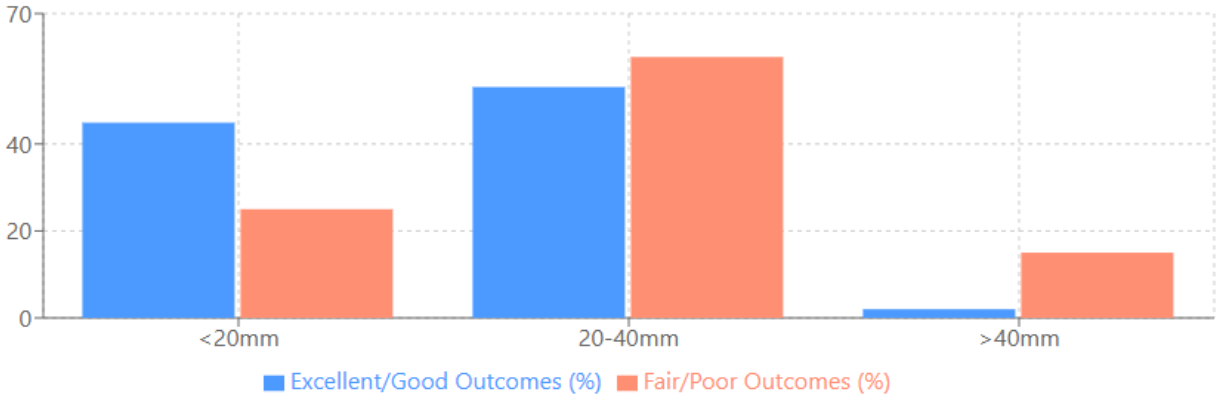

Figure 4: Bar graph showing relationship between displacement category and functional outcomes

Most importantly, reduction quality according to Matta's criteria showed a strong correlation with functional outcomes (p=0.001). Of the patients with excellent/good outcomes, 72.4% had anatomical reduction (<1mm), compared to only 30.0% in the fair/poor group (Table 5).

Table 5: Association between Matta's Reduction Criteria and Harris Hip Score

Matta's Reduction Criteria	Excellent/Good (n=98)	Fair/Poor (n=20)	Total (n=118)	p-value
<1mm	71 (72.4%)	6 (30.0%)	77 (65.3%)	0.001
1-3mm	25 (25.5%)	11 (55.0%)	36 (30.5%)	
>3mm	2 (2.0%)	3 (15.0%)	5 (4.2%)	

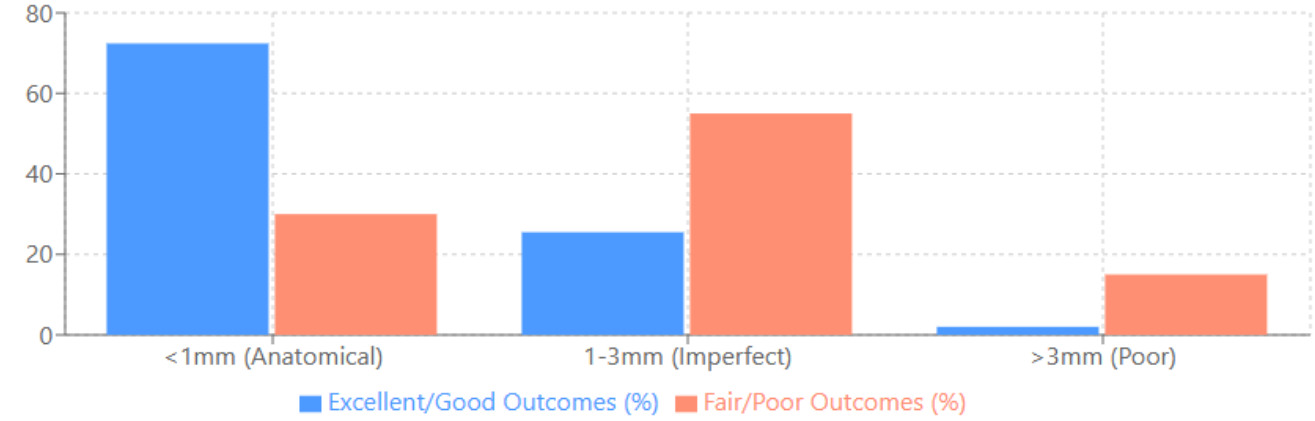

Figure 5: Bar graph showing relationship between reduction quality and functional outcomes

The presence of posterior wall fractures showed no significant association with functional outcomes (p=0.54), with 37.8% of patients with excellent/good outcomes and 45.0% of patients with fair/poor outcomes having posterior wall fractures.

These results suggest that while demographic factors and fracture patterns do not significantly influence functional outcomes, radiological parameters such as marginal impaction, initial displacement, and especially reduction quality are important predictors of functional recovery following surgical management of displaced acetabular fractures.

DISCUSSION

Acetabular fractures present significant challenges in orthopedic trauma management, often requiring complex surgical interventions to restore articular congruity and joint stability. This study evaluated the functional and radiological outcomes of surgically treated displaced acetabular fractures and identified factors that predict clinical results.

Our study included 118 patients with a mean age of 41.36 years, with the highest incidence in the 20-40 years age group (50.8%). This demographic profile is consistent with Suzuki et al.'s findings of a mean age of 36.3 years [56], reflecting the vulnerability of working-age individuals to high-energy trauma. The male predominance (73.7%) in our cohort aligns with previous studies, including V. Trikha et al.'s report of 87.8% male patients [57], and likely results from greater male participation in high-risk activities and occupations in the Indian context.

Road traffic accidents were the most common injury mechanism (53.4%), followed closely by falls from height (46.6%). These findings are comparable to Fadi M. AlRousan et al.'s study reporting 56.7% RTAs and 42.6% falls [59]. However, our RTA proportion is lower than the 75% reported by Phruetthiphat et al. [58], possibly reflecting regional variations in transportation patterns and infrastructure.

In our series, the most prevalent fracture pattern was associated both-column (ABC) fractures (25.4%), followed by T-type fractures (24.6%). This distribution differs from Briffa N et al.'s findings, which identified T-type and transverse fractures as the most common patterns [59], and from Fadi M. AlRousan et al.'s report of posterior wall fractures being predominant (37.6%) [60]. The high proportion of complex fracture patterns in our cohort may reflect referral bias, as our institution serves as a level 1 trauma center receiving complex cases from peripheral centers.

The mean surgical delay in our study was remarkably short at 1.2 days, compared to Phruethiphat et al.'s 3.5 days [58] and V. Trikha et al.'s 7.8 days [57]. This reflects our institutional protocol emphasizing early surgical intervention for acetabular fractures to optimize outcomes. The Modified Stoppa approach was our most frequently employed surgical technique (54.2%), contrasting with Paksoy et al.'s study where the Kocher-Langenbeck approach was dominant (42%) [61]. This difference highlights the evolution of surgical preferences and the growing recognition of the Modified Stoppa approach's advantages for anterior column and quadrilateral surface access.

Regarding functional outcomes, 83% of our patients achieved good or excellent results according to the Modified Harris Hip Score, which compares favorably with previous studies. Frietman et al. reported 74% good or better outcomes [67], Giannoudis et al. found 73% good or better results [68], and Dodd et al. observed 70% excellent or better scores. These consistent findings across studies suggest that surgical management of acetabular fractures, when appropriately executed, yields satisfactory functional outcomes in most patients.

Our study revealed several important predictors of functional outcomes. While demographic factors (age, gender) and fracture patterns showed no significant association with functional results, radiological parameters emerged as crucial determinants. Marginal impaction demonstrated a statistically significant relationship with outcomes ($p=0.01$), with 50% of patients in the fair/poor category having associated marginal impaction. This finding emphasizes the importance of recognizing and addressing marginal impaction during surgical planning and execution.

Initial displacement magnitude was significantly associated with functional results (p=0.02), with displacements greater than 40mm yielding poorer outcomes. Most notably, reduction quality according to Matta's criteria strongly correlated with functional recovery (p=0.001). Anatomical reduction (<1mm displacement) was achieved in 72.4% of patients with excellent/good outcomes but in only 30.0% of those with fair/poor results. This finding aligns with Matta's foundational work emphasizing the critical importance of accurate reduction for optimal outcomes [14, 23].

Unlike some previous studies, our results showed no significant association between functional outcomes and the surgical approach used, the presence of posterior wall fractures, or the use of posterior column plating with Modified Stoppa approach. This contrasts with Ziran et al.'s findings regarding the impact of surgical approaches but may reflect advancements in surgical techniques and fixation methods.

Our socioeconomic findings are particularly encouraging, with only 1.7% of patients requiring occupational changes and 2.5% reporting economic status alterations. This stands in contrast to Nico Hinz et al.'s observation of a minimum 20% drop in earning capability [66]. The excellent occupational reintegration in our cohort may be attributed to early surgical intervention, quality of reduction, and comprehensive rehabilitation protocols.

Several factors may influence the clinical course of acetabular fractures. Non-modifiable variables include patient age, comorbidities, injury mechanism, femoral head damage, marginal impaction, dislocation, and associated injuries. Modifiable factors include surgical timing, approach selection, reduction quality, and fixation adequacy. Our study reinforces the paramount importance of achieving anatomical reduction, particularly in cases with significant initial displacement or marginal impaction.

This study has several limitations. First, the follow-up period of 12 months may be insufficient to capture long-term complications such as post-traumatic arthritis or avascular necrosis. Second, as a single-center study, the results may not be generalizable to all populations or healthcare settings. Third, the evaluation of reduction quality was based on plain radiographs, which may not detect subtle incongruities visible on advanced imaging modalities.

Despite these limitations, our findings contribute valuable insights into the management and outcome prediction of displaced acetabular fractures. The strong correlation between reduction quality and functional results reaffirms the fundamental principle that anatomical reduction should remain the primary surgical objective in these complex injuries.

CONCLUSION

This prospective study of 118 patients with displaced acetabular fractures demonstrates that surgical management yields favorable functional and radiological outcomes in the majority of cases. Our findings indicate that 83% of patients achieved good to excellent functional results according to the Modified Harris Hip Score, with most patients returning to their previous occupations without significant economic impact.

The analysis identified three key predictors of functional outcomes following surgical management of displaced acetabular fractures: marginal impaction, initial displacement magnitude, and most critically, the quality of reduction achieved during surgery. Anatomical reduction (residual displacement <1mm) strongly correlated with superior functional recovery, reinforcing the principle that meticulous reduction should remain the primary surgical objective for these complex injuries.

Interestingly, demographic factors (age, gender), fracture pattern according to the Letournel and Judet classification, and surgical approach showed no significant association with functional outcomes. This suggests that with appropriate surgical technique and anatomical reduction, good results can be achieved across various patient populations and fracture types.

The Modified Stoppa approach proved to be a versatile and effective surgical technique for managing a wide range of acetabular fractures, particularly those involving the anterior column and quadrilateral surface. This approach, used in more than half of our cases, facilitated accurate reduction and stable fixation with acceptable complication rates.

Our study demonstrates that early surgical intervention, precise reduction, and appropriate fixation are fundamental in optimizing outcomes following acetabular fractures. The significant correlation between radiological parameters and functional results emphasizes the importance of surgical quality in determining the prognosis of these challenging injuries.

These findings have important clinical implications for orthopedic trauma surgeons. Recognizing marginal impaction, accurately assessing initial displacement, and prioritizing anatomical reduction can guide surgical decision-making and help predict functional outcomes. Future research with longer follow-up periods, multicenter designs, and advanced imaging modalities will further enhance our understanding of these complex fractures and refine management strategies.

In conclusion, despite the significant challenges that acetabular fractures present to orthopedic surgeons, a structured approach with emphasis on anatomical reduction can yield satisfactory functional outcomes and facilitate patients' return to pre-injury activities and occupations.

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