

Original Research Article

Impact of delay from trauma to surgery on radiological and functional outcomes in posterior wall acetabular fractures treated by open reduction and internal fixation

Shah M. Faisal Eskander^{1*}, M. Asadullah², M. Masud Rana², Mohammad Osman Gani¹,
Abu Zihad Mohammad Salim², M. Monir Us Saleheen², Seemran Faisal³

¹Department of Orthopedic Surgery, Enam Medical College Hospital, Savar, Bangladesh

²Department of Orthopedic, Enam Medical College, Savar, Bangladesh

³Department of Economics and Social Sciences, Brac University, Dhaka, Bangladesh

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*Correspondence:

Dr. Shah M. Faisal Eskander,

E-mail: smfaisal666@gmail.com

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ABSTRACT

Background: Posterior wall acetabular fractures are the most common acetabular subtype and often result from high-energy trauma in young adults. Surgical timing and reduction quality are thought to influence prognosis, but evidence specific to posterior wall fractures remains limited.

Methods: This prospective observational study included 20 patients with posterior wall acetabular fractures treated by open reduction and internal fixation (ORIF) at Dhaka Medical College Hospital between August 2020 and March 2022. Demographic, injury-related, and operative variables were recorded. Outcomes were assessed using the Matta radiographic criteria and Merle d'Aubigné-Postel functional scores. Statistical associations were analyzed using chi-square or Fisher's exact tests.

Results: The mean age was 38.3 ± 10.2 years; 90% were male, and 90% sustained injuries from road traffic accidents. The mean trauma-to-surgery delay was 12.8 ± 3.6 days. Anatomical reduction was achieved in 80%. Radiological outcomes were excellent or good in 85%, while functional outcomes were excellent or good in 90%. Overall, 90% achieved satisfactory results. Surgical delay >15 days was significantly associated with poorer functional ($p=0.036$) and overall outcomes ($p=0.012$). Anatomical reduction significantly predicted excellent outcomes across all domains ($p<0.05$). Hip dislocation, gross fragment displacement, and abdominal injury were additional predictors of poor results. Complications were rare (20%).

Conclusions: Early surgical intervention and anatomical reduction are essential for optimizing radiological, functional, and overall outcomes in posterior wall acetabular fractures. Delay beyond two weeks and poor reduction quality substantially compromise recovery.

Keywords: Anatomical reduction, Functional outcomes, Open reduction and internal fixation, Posterior wall acetabular fracture, Surgical delay

INTRODUCTION

Acetabular fractures, although relatively uncommon, represent severe injuries with substantial functional and socioeconomic implications. They typically occur in young, active individuals following high-energy trauma

such as motor vehicle accidents or falls from height, and their management requires highly specialized surgical expertise. Among the various fracture patterns, posterior wall acetabular fractures are the most frequently encountered subtype, accounting for approximately 25-30% of cases.¹ This fracture pattern is particularly

important because even small posterior wall fragments can destabilize the hip joint, leading to recurrent dislocations and subsequent post-traumatic arthritis if not treated appropriately.² Given that these injuries predominantly affect working-age adults, delayed or poor outcomes result in prolonged disability, unemployment, and increased healthcare utilization, underscoring their significance from both clinical and socioeconomic perspectives.³

The primary objective of management in displaced posterior wall fractures is to restore hip stability and joint congruity. Open Reduction and Internal Fixation (ORIF) remain the gold standard treatment, with evidence consistently showing that anatomical reduction and stable fixation are the most critical determinants of outcome.⁴ Postoperative assessment is conventionally performed using both radiographic and functional metrics. Radiological outcomes are typically graded using the Matta criteria, which classify reduction quality based on residual displacement, while functional outcomes are most reliably captured by the Merle d'Aubigné and Postel scoring system, which assesses pain, gait, and mobility. Multiple studies have demonstrated that these measures are strongly correlated and provide complementary insights into patient recovery.^{5,6} Accordingly, successful surgical management requires not only fracture fixation but also precise anatomical restoration to optimize long-term joint preservation.

Despite consensus on the need for surgical fixation, the optimal timing of ORIF in acetabular fractures remains a matter of debate. Early fixation has been associated with several theoretical and practical advantages, including facilitation of easier reduction, decreased risk of soft-tissue contracture, and lower incidence of heterotopic ossification.^{7,8} However, in clinical practice, early surgery is often precluded by the presence of polytrauma, associated systemic injuries, or logistical barriers such as operating room availability (Moore, Simske, and Vallier, 2020). As a result, delayed fixation is not uncommon, yet concerns persist that increasing intervals between injury and surgery may compromise reduction quality, elevate complication risk, and ultimately worsen functional outcomes.⁹

Existing literature presents conflicting evidence regarding the relationship between surgical delay and outcome. Several studies suggest that delays exceeding 10-14 days markedly reduce the likelihood of achieving anatomical reduction, leading to inferior functional recovery and increased rates of secondary procedures such as total hip replacement.¹⁰ Conversely, other reports have failed to find a statistically significant association, attributing variability instead to factors such as patient physiology, fracture complexity, and the presence of concomitant injuries.¹¹ One reason for this inconsistency is the heterogeneity of prior studies, many of which combine different acetabular fracture patterns and apply variable definitions of “early” versus “late” fixation, thereby limiting the comparability of findings.¹²

Importantly, relatively few studies have specifically focused on posterior wall acetabular fractures, despite their distinct biomechanical and prognostic characteristics. Evidence-based guidance tailored to this fracture type remains scarce, leaving clinicians to extrapolate from mixed cohorts with potentially divergent pathomechanics.¹³ This gap is clinically significant because posterior wall fractures are uniquely susceptible to recurrent hip instability and avascular necrosis, particularly when associated with delayed reduction of concomitant dislocations.⁴ As a result, there is an urgent need for fracture-pattern-specific data to guide decision-making regarding surgical timing.

The present study seeks to address this gap by evaluating the impact of delay from trauma to surgery on radiological and functional outcomes in patients with posterior wall acetabular fractures treated with ORIF. In addition to examining the relationship between surgical delay and outcomes, the study also considers the influence of confounding variables such as hip dislocation, fracture displacement, and postoperative complications. By focusing exclusively on posterior wall fractures, this work aims to provide more precise, clinically actionable evidence on the prognostic significance of surgical timing. Establishing such evidence is vital not only for improving patient care and functional recovery but also for optimizing surgical prioritization and resource allocation in modern trauma systems.

METHODS

This prospective observational study was designed to evaluate the association between radiological quality of reduction and functional outcomes following open reduction and internal fixation (ORIF) for posterior wall acetabular fractures. The study was conducted in the Department of Orthopaedic Surgery at Dhaka Medical College Hospital, Dhaka, Bangladesh, over a 20-month period from August 2020 to March 2022. A total of 20 patients who met the eligibility criteria and provided informed consent were included. Convenience sampling was used. Inclusion criteria were patients aged 18-60 years of both sexes with radiologically confirmed posterior wall acetabular fractures treated with ORIF within three weeks of injury. Patients younger than 18 or older than 60 years, those with active or latent infections, open fractures, debilitating comorbidities, pathological fractures, or those who declined consent were excluded. All patients underwent comprehensive evaluation, including demographic details, mechanism of injury, associated injuries, and clinical examination. Mechanisms of injury were categorized into high-energy trauma (e.g., road traffic accidents) and low-energy trauma (e.g., falls). Radiological evaluation included standard pelvic anteroposterior X-rays and computed tomography (CT) scans. Fractures were classified according to the Letournel and Judet classification system.¹⁴ Surgical planning was based on the fracture pattern, and the Kocher-Langenbeck approach was employed in most cases.¹⁵ The primary

surgical goal was anatomical reduction of the articular surface with stable fixation of the posterior wall. The quality of reduction was evaluated using the Matta radiographic criteria, which classify reductions as excellent (<1 mm displacement), good (2-3 mm), or fair (>3 mm).¹⁶ Postoperative radiographs were obtained immediately after surgery and during follow-up, and the evaluations were independently reviewed by two experienced radiologists to minimize observer bias. Functional outcomes were assessed using the Merle d'Aubigné and Postel scoring system.^{17,18} This system evaluates three domains pain, mobility, and walking ability each scored on a scale of 1 to 6. The total score ranges from 3 to 18 and is categorized as excellent (15-18), good (12-14), fair (9-11), or poor (<9). Higher scores indicate better hip function.

Ethical approval was obtained from the Institutional Review Board of Dhaka Medical College. Written informed consent was obtained from all participants after explaining study objectives, procedures, risks, and benefits in the local language. Patient confidentiality was maintained throughout the study.

Data were collected prospectively using a structured case record form, which included demographic variables, clinical characteristics, operative details, and outcome measures. Statistical analysis was performed using SPSS version 26. Descriptive statistics were used for baseline variables and expressed as means with standard deviations or frequencies with percentages, as appropriate. Associations between clinical and operative variables with radiological and functional outcomes were assessed using chi-square tests or Fisher's exact tests. A p value <0.05 was considered statistically significant. Results were presented in tables and figures for clarity.

RESULTS

Table 1 summarizes the baseline characteristics of the study cohort. The mean age of participants was 38.3 years (SD $\pm$ 10.2, range 18-60), with the majority (65%) between 31-40 years. Males predominated (90%), and over half of the patients were service workers. Road traffic accidents accounted for 90% of injuries, while falls were less frequent (10%). The left hip was more often affected (70%) than the right (30%). Most patients had no associated injuries (70%), although abdominal (20%) and chest injuries (10%) were recorded. Hip dislocation was present in 15% of cases. The majority of fractures exhibited low fragment displacement (85%), with only 15% gross displacement. Acetabular involvement exceeded 50% in 85% of patients (mean index 58.3%), while posterior wall involvement was $\leq$ 50% in 85% (mean 41.8%).

The mean interval from trauma to surgery was 12.8 days (SD $\pm$ 3.6, range 8-20). More than half of the patients underwent fixation within 15 days, with 35% operated within 10 days, 45% between 11-15 days, and 20% after

more than 15 days. Anatomical reduction was achieved in 80% of cases, while 15% had imperfect and 5% had poor reduction according to Matta's criteria. Postoperative complications were uncommon, with 80% of patients experiencing none. Heterotopic ossification occurred in 10% of patients, and both avascular necrosis and sciatic nerve palsy were reported in one patient each (5%).

Table 1: Baseline characteristics of the cohort (n=20).

Characteristics	Value
Age group, N (%)	
$\leq$ 30	2 (10.0)
31-40	13 (65.0)
41-50	3 (15.0)
>50	2 (10.0)
Mean $\pm$ SD age	38.25 $\pm$ 10.19
Sex, N (%)	
Male	18 (90.0)
Female	2 (10.0)
Occupation, N (%)	
Service worker	11 (55.0)
Business owner	5 (25.0)
Housewife	2 (10.0)
Student	2 (10.0)
Mode of injury, N (%)	
Road traffic accident	18 (90.0)
Fall from height	2 (10.0)
Affected side, N (%)	
Left	14 (70.0)
Right	6 (30.0)
Associated injuries, N (%)	
None	14 (70.0)
Abdominal	4 (20.0)
Chest	2 (10.0)
Hip dislocation, N (%)	
Present	3 (15.0)
Absent	17 (85.0)
Fragment displacement, N (%)	
Low displacement	17 (85.0)
Gross displacement	3 (15.0)
Acetabular fracture index (%), N (%)[*]	
$\leq$ 50	3 (15.0)
>50	17 (85.0)
Mean $\pm$ SD (range)	58.25 $\pm$ 11.39 (30-70)
Posterior wall involvement (%), N (%)[#]	
$\leq$ 50	17 (85.0)
>50	3 (15.0)
Mean $\pm$ SD (range)	41.75 $\pm$ 11.39 (30-70)

Data are n (%) unless otherwise indicated; Continuous variables are mean $\pm$ SD (range); ^{*}Acetabular fracture index= estimated percentage of acetabular circumference involved; [#]Posterior wall involvement=estimated percentage of posterior wall involved

Radiological outcomes assessed by Matta's criteria showed that 45% of patients achieved excellent reduction,

40% had good results, and 15% were graded as fair. Functional evaluation using the Merle d'Aubigné-Postel score demonstrated excellent results in 50% of patients, good in 40%, and fair in 10%. When overall outcomes were considered, 90% of patients achieved satisfactory results, while only 10% were categorized as unsatisfactory.

Table 2: Operative profile (n=20).

Variables	Value
Trauma-to-surgery delay, days	12.8±3.57 (range 8-20)
Delay categories, N (%)	
≤10 days	7 (35.0)
11-15 days	9 (45.0)
>15 days	4 (20.0)
Quality of reduction, N (%)*	
Anatomical	16 (80.0)
Imperfect	3 (15.0)
Poor	1 (5.0)
Postoperative complications, N (%)	
None	16 (80.0)
Heterotopic ossification	2 (10.0)
Avascular necrosis	1 (5.0)
Sciatic palsy	1 (5.0)

Data are n (%) unless otherwise indicated; Continuous variables are mean±SD (range); *Reduction quality definitions: Anatomical=0-1 mm residual displacement; Imperfect=2-3 mm; Poor =>3 mm (Matta criteria)

Table 3: Distribution of postoperative outcomes (n=20).

Outcome types	Number (%)
Radiological outcome (Matta criteria)	
Excellent	9 (45.0)
Good	8 (40.0)
Fair	3 (15.0)
Functional outcome (Merle d'Aubigné-Postel score)	
Excellent	10 (50.0)
Good	8 (40.0)
Fair	2 (10.0)
Overall outcome	
Satisfactory	18 (90.0)
Unsatisfactory	2 (10.0)

Table 4 demonstrates the relationship between trauma-to-surgery delay and postoperative outcomes. Radiological outcomes tended to worsen with increasing delay: excellent reductions were most frequent in patients operated within 10 days (44.4%) and declined to 22.2% in those treated after 15 days, though this trend did not reach statistical significance (p=0.073). In contrast, functional outcomes showed a significant association with surgical timing (p=0.036); all patients with delays over 15 days had fair outcomes, with no excellent or good scores observed. In earlier groups, 40% achieved excellent function in both

the ≤10 and 11-15-day categories. Overall outcomes also significantly deteriorated with delay (p=0.012); 100% of patients with delays over 15 days experienced unsatisfactory results, while none in the earlier groups did. These findings support the association between earlier surgical intervention and improved functional and overall outcomes.

Table 4: Association of trauma-to-surgery delay with outcomes (n=20).

Outcome types	Delay ≤10 days (n=7)	Delay 11-15 days (n=9)	Delay >15 days (n=4)	P value
Radiological outcome (Matta), N (%)				
Excellent	4 (44.4)	3 (33.3)	2 (22.2)	0.073
Good	2 (25.0)	6 (75.0)	0 (0.0)	
Fair	1 (33.3)	0 (0.0)	2 (66.7)	
Functional outcome (Merle d'Aubigné–Postel), N (%)				
Excellent	4 (40.0)	4 (40.0)	2 (20.0)	0.036*
Good	3 (37.5)	5 (62.5)	0 (0.0)	
Fair	0 (0.0)	0 (0.0)	2 (100)	
Overall outcome, N (%)				
Satisfactory	7 (38.9)	9 (50.0)	2 (11.1)	0.012*
Unsatisfactory	0 (0.0)	0 (0.0)	2 (100)	

Data are n (%) within each delay group; Radiological outcomes by Matta criteria; Functional outcomes by Merle d'Aubigné-Postel score; Overall outcome classified as satisfactory vs unsatisfactory; P values by χ^2 or Fisher's exact test as reported; P<0.05 considered statistically significant.

Figure 1 illustrates the distribution of radiological, functional, and overall outcomes across three trauma-to-surgery delay categories: ≤10 days (n=7), 11-15 days (n=9), and >15 days (n=4). In terms of radiological outcomes assessed by Matta criteria, patients in the ≤10-day group showed a relatively balanced distribution, with 4 (57.1%) achieving excellent reduction, 2 (28.6%) good, and 1 (14.3%) fair. The 11-15-day group demonstrated the highest proportion of good reductions, with 6 (66.7%) good and 3 (33.3%) excellent results, and no fair outcomes observed. Conversely, in the >15-day group, radiological outcomes were less favorable, with 2 (50.0%) rated as excellent and 2 (50.0%) as fair, and notably no good reductions achieved. Functional outcomes, evaluated by the Merle d'Aubigné-Postel score, showed a clear negative impact of surgical delay. Among patients operated within 10 days, 4 (57.1%) had excellent and 3 (42.9%) had good functional outcomes, with none falling into the fair category. Similarly, in the 11-15-day group, 4 (44.4%) achieved excellent and 5 (55.6%) good outcomes. However, in the >15-day group, both patients (100%) had fair functional outcomes, and none achieved excellent or good scores, indicating a significant functional decline with delayed intervention. The overall outcome analysis further underscored this trend. All patients in the ≤10 day and 11-15-day groups had satisfactory outcomes (100% each). In contrast, among those with delays exceeding 15

days, only 2 (50.0%) had satisfactory outcomes, while the remaining 2 (50.0%) were classified as unsatisfactory.

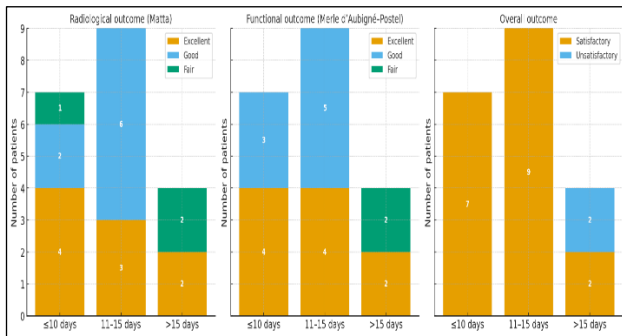


Figure 1: Outcomes by delay among different outcome categories.

Table 5: Association of quality of reduction with outcomes (n=20).

Outcome type	Anato-mical (n=16)	Imperfect (n=3)	Poor (n=1)	P value
Radiological outcome (Matta), N (%)				
Excellent	9 (100.0)	0 (0.0)	0 (0.0)	0.049*
Good	6 (75.0)	1 (12.5)	1 (12.5)	
Fair	1 (33.3)	2 (66.7)	0 (0.0)	
Functional outcome (Merle d'Aubigné-Postel), N (%)				
Excellent	10 (100)	0 (0.0)	0 (0.0)	0.005*
Good	6 (75.0)	1 (12.5)	1 (12.5)	
Fair	0 (0.0)	2 (100.0)	0 (0.0)	
Overall outcome, N (%)				
Satisfactory	16 (88.9)	1 (5.6)	1 (5.6)	0.002*
Unsatisfactory	0 (0.0)	2 (100.0)	0 (0.0)	

Table 5 demonstrates a strong association between the quality of reduction and postoperative outcomes. Radiologically, all patients with anatomical reduction (n=16) achieved excellent or good results, with 9 (56.3%) rated excellent and 6 (37.5%) good, while only 1 (6.3%) was fair. In contrast, those with imperfect reduction (n=3) predominantly had fair radiological results (66.7%), with only one good outcome, and none achieved excellent results. The single patient with poor reduction was classified as good radiologically. This difference was statistically significant ($p=0.049$). Functional outcomes followed a similar pattern: all patients with anatomical reduction achieved either excellent (62.5%) or good (37.5%) function, while imperfect reductions resulted mainly in fair outcomes (66.7%). The single case with poor reduction had only a good outcome, with no excellent or fair results. This association was highly significant ($p=0.005$). Overall outcome analysis further highlighted the impact of reduction quality, as all anatomical reductions were satisfactory (100%), whereas imperfect reductions were unsatisfactory in all cases (100%). The sole poor reduction also led to an unsatisfactory result.

This relationship reached strong statistical significance ($p=0.002$). These findings confirm that anatomical reduction is critical to achieving favorable radiological, functional, and overall outcomes.

Table 6: Association of selected injury-related characteristics with outcomes (n=20).

Variable	Radiological outcome (p)	Functional outcome (p)	Overall outcome (p)
Hip dislocation (present vs absent)	0.019*	0.001*	<0.001*
Fragment displacement (gross vs low)	0.019*	0.001*	<0.001*
Abdominal injury (present vs absent)	0.061 (ns)	0.016*	0.012*

P values from χ^2 or Fisher's exact tests as reported; ns=not significant ($p>0.05$); Only variables with significant or near-significant associations across outcomes are shown; mode of injury, side, chest injury, and % fracture involvement were not significant and are omitted for clarity

Table 6 summarizes the associations between key injury-related characteristics and postoperative outcomes. The presence of hip dislocation was significantly associated with worse radiological ($p=0.019$), functional ($p=0.001$), and overall ($p<0.001$) outcomes. Similarly, cases with gross fragment displacement showed significantly poorer radiological ($p=0.019$), functional ($p=0.001$), and overall outcomes ($p<0.001$) compared to those with low displacement. Abdominal injuries were not significantly associated with radiological outcomes ($p=0.061$), but had a statistically significant negative impact on both functional ($p=0.016$) and overall outcomes ($p=0.012$). Other variables such as mode of injury, fracture side, presence of chest injury, and extent of fracture involvement did not show statistically significant associations with any outcome domains and were therefore excluded from the table for clarity.

DISCUSSION

This study evaluated the impact of trauma-to-surgery delay on radiological and functional outcomes following ORIF for posterior wall acetabular fractures. The findings highlight the crucial role of surgical timing, anatomical reduction, and injury severity in determining prognosis, while also demonstrating low complication rates when managed appropriately.

The cohort was composed primarily of young, active adults, with a mean age of 38.3 years and 65% of patients aged 31-40 years. This demographic pattern is consistent with global evidence showing that acetabular fractures disproportionately affect younger males engaged in high-energy trauma, particularly road traffic accidents.^{4,14} In

this series, 90% of injuries were caused by road traffic accidents, reaffirming the burden of high-energy trauma as the main etiological factor. Hip dislocation and gross fragment displacement were each present in 15% of cases, both of which were later shown to significantly worsen outcomes. Similar associations have been demonstrated in prior studies, where hip dislocation and large posterior wall involvement predicted instability, poorer functional recovery, and higher complication risks.^{9,19}

The mean delay to surgery in this cohort was 12.8 days, with 35% operated within 10 days, 45% within 11-15 days, and 20% beyond 15 days. Although radiological outcomes were not statistically associated with delay, there was a trend toward poorer reductions in patients treated later. More importantly, functional and overall outcomes were significantly compromised when surgery was delayed beyond 15 days. All patients in this late group had fair functional results and unsatisfactory overall outcomes. This finding supports earlier reports that delays beyond 10-14 days increase the technical difficulty of reduction due to soft tissue contracture and fracture consolidation, leading to worse results.^{20,21} Pascarella et al similarly emphasized that delays negatively influence functional recovery even when radiological reductions appear adequate.⁴ These data reinforce the need for timely surgical intervention when patient and logistical conditions permit.

Anatomical reduction was achieved in 80% of patients and proved to be the strongest predictor of favorable outcomes. All excellent radiological and functional results occurred exclusively in this group, while imperfect and poor reductions consistently yielded unsatisfactory outcomes. The association was statistically significant across radiological ($p=0.049$), functional ($p=0.005$), and overall domains ($p=0.002$). These results align with established literature, where residual displacement beyond 2 mm correlates with arthritis progression and impaired function.^{10,22} More recent studies also reaffirm anatomical reduction as the key modifiable determinant of long-term success in posterior wall acetabular fractures.^{5,6}

Radiological outcomes in the present series were excellent or good in 85% of patients, and functional results were satisfactory in 90%. These figures compare favorably with published data, where satisfactory outcomes are typically reported in 80-85% of surgically treated posterior wall fractures.^{4,23} The low incidence of complications in this study (20%) also mirrors other reports. Heterotopic ossification (10%), avascular necrosis (5%), and sciatic palsy (5%) were infrequent, consistent with contemporary literature demonstrating improved safety of ORIF in expert centers.²⁴ These findings are echoed in Rahman's study of volar buttress plating for distal radius fractures, where 83% of patients had no postoperative complications and functional recovery was satisfactory in 80%.²⁵ Although involving a different anatomical site, both studies emphasize that when stable fixation and anatomical reduction are achieved, complications remain

uncommon and recovery is favorable across orthopedic trauma contexts. The influence of injury-related factors was also evident. Hip dislocation and gross fragment displacement significantly predicted poorer radiological, functional, and overall outcomes. Abdominal injury was additionally associated with inferior functional and overall recovery, though not with radiological quality. These findings suggest that systemic injury burden and local joint instability are both critical determinants of prognosis. Prior evidence concurs, with hip dislocation recognized as a major risk for avascular necrosis and poor function, while gross displacement has been shown to hinder joint congruity and stability.^{26,27}

Taken together, the present study demonstrates that favorable outcomes in posterior wall acetabular fractures are most reliably achieved through early surgical intervention and precise anatomical reduction. Although radiological appearances may sometimes remain preserved with moderate delay, functional recovery is significantly impaired when surgery is deferred beyond two weeks. Additionally, patient outcomes are strongly influenced by the severity of the initial injury, including dislocation and displacement, highlighting the need for early recognition and meticulous surgical planning. These results are consistent with, and add to, the growing body of literature that underscores timing and reduction quality as central to prognosis in acetabular fracture surgery.

The main limitation of the study was its single-center design and relatively small sample size, which may limit the generalizability of the findings to the broader population.

CONCLUSION

This study demonstrates that timely surgical intervention and anatomical reduction are the most critical determinants of favorable outcomes in posterior wall acetabular fractures managed with ORIF. While radiological results were not significantly affected by surgical delay, functional and overall outcomes were markedly compromised when surgery was performed beyond 15 days after injury. Anatomical reduction was strongly associated with excellent radiological, functional, and overall outcomes, whereas imperfect or poor reductions consistently led to unsatisfactory results. Additionally, injury-related factors such as hip dislocation, gross fragment displacement, and abdominal injury significantly predicted poorer outcomes. Postoperative complications were infrequent, further supporting the safety of ORIF in experienced hands. These findings underscore the importance of early recognition, timely surgical planning, and precise anatomical reduction to optimize patient recovery.

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