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Original Article

Factors affecting the functional outcome of surgically managed displaced acetabular fractures

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Abstract: Purpose of study: To evaluate the impact of various factors on functional outcome of surgically managed displaced acetabular fractures. Methods: In this prospective study 50 cases of surgically managed displaced acetabular fractures were followed up to a mean of 28.6±4 months (18-48 months). The effect of age, associated injuries, fracture pattern (elementary/associated type), time to surgery (<2 weeks/>2 weeks), accuracy of reduction (anatomical/imperfect/poor), gender and associated hip dislocation on the clinical outcome was evaluated using Harris hip score and modified Postel Merle d'Aubigné score. Results: The mean age was 36.6±11.9 years (range 19-67 years). There were 76% (n=38) males and 24% (n=12) females. 82% (n=41) patients sustained fracture due to motor vehicle accident. 60% of the cases had associated injuries. The mean Harris hip score at final follow-up was 80.96±8.9 and mean modified Merle d'Aubigné and Postel score was 15.1±2.4. The Harris Hip score and modified Postel Merle d'Aubigné score was significantly affected by presence of associated injuries (P=0.0025 and 0.0037 respectively), time to surgery (P=0.0087 and 0.0093 respectively), fracture pattern (P=0.015 and 0.023 respectively), associated hip dislocation (P=0.011 and 0.008 respectively), accuracy of reduction (P<0.05) and age (P<0.05), but gender (P=0.78 and 0.93 respectively) didn't have any significant effect on the clinical outcome. Conclusion: The presence of associated injuries, concomitant hip dislocation, associated type of fracture patterns, elderly age (more than 60 years), sub optimal fracture reduction and delay in surgery beyond 2 weeks are factors that lead to statistically significant suboptimal functional scores.

Keywords: Acetabular fracture, surgery, factors, outcome

Introduction

Acetabular fractures are fractures that extend into the hip joint and pose a challenge to orthopaedic trauma surgeons. Fractures of acetabulum and pelvis constitute only 2% of all fractures but they are associated with significant morbidity and mortality due to associated visceral and other musculoskeletal injuries [1-3]. Judet et al. in 1960s classified these fractures and their work helped in understanding the surgical approaches, reduction techniques, complications, and results of acetabular fractures [4]. Matta not only disseminated the teachings of Judet and Letournel but expanded upon these reduction and fixation principles. He determined the most important load-bearing portion of the radiographic acetabulum and defined the roof-arc angles which aided in quantitating femoral head congruency with the fractured acetabulum. These measurements were established as a guide for operative versus conservative management [5, 6]. Undisplaced fractures of acetabulum are managed conservatively but the conservative management of displaced acetabular fractures in one study was found to be inferior compared to that of operative treatment [7]. In other study good to excellent functional results have been reported in up to 80% of operatively treated acetabular fractures at 20 years follow-up [8]. With studies like these there has been a shift in paradigm from conservative management to operative management of displaced acetabular fractures. Though the surgical management in displaced acetabular fractures has improved the functional outcome but it has been found that the outcome is dependent on many variables which include bone stock, intra-articular comminution, associated inju-

ries, accurate reduction, rigid fixation and patient comorbidities. Ragnarsson B et al. conducted a retrospective study on 60 cases of operated acetabular fractures and found that there was a high co relation between non anatomic reduction and coxarthrosis [9]. Matta et al. analysed 204 acetabular fractures and suggested that in order to have a satisfactory clinical outcome the reduction should be such that residual displacement if any should be less than 3 mm [10]. Hassan R et al. report 15 year follow up of 67 patients of surgically managed acetabular fractures, they concluded that a congruent reduction lead to a favourable outcome [11]. Most of the literature on outcome of surgically managed acetabular fractures have addressed anatomical reduction as the single most important factor predicting the eventual outcome. But do other factors like age of the patient, timing of surgery, presence of associated injuries, gender, accuracy of reduction and associated hip dislocation have any effect on the ultimate functional result? Keeping this in mind and with less number of studies in India determining the effect of these variables on outcome, we undertook this study to evaluate the effect of these variables on the functional outcomes by taking into consideration both the Harris hip score and modified Merle d'Aubigne and Postel score [12, 13].

Materials and methods

This prospective study was conducted in our tertiary care hospital between January 2016 to August 2018 after getting approval from institutional ethical committee. A written informed consent was obtained from all the participants. A total of 55 patients were initially recruited into the study after fulfilling the inclusion critera.

Inclusion criteria

Patients above 18 years of age having closed displaced fractures (displacement >2 mm) and roof arc angles <45 degrees, posterior wall or both column fractures were included in the study.

Exclusion criteria

Those patients having pathological fracture, combined pelvi acetabular injury or with previous history of hip injuries and/or pre-existing hip osteoarthritis were excluded from the study.

Preoperative protocol

Patients were initially managed as per ATLS protocol. Radiographs were taken which included X-ray of pelvis with both hip joints and Judet views of acetabulum. CT scan of acetabulum with 3D reconstruction was done to better understand the fracture anatomy. The fractures were classified using Letournel and Judet classification [14]. Patients were operated between 3-25 days.

Operative procedure

All patients were operated under combined caudal and spinal anaesthesia by a single surgeon. Sub inguinal approach was used for fractures needing anterior exposure and Kocher Langenbeck approach for fractures needing posterior exposure. Fractures were fixed using 3.5 mm Recon plates and 4 mm screws (lag screw). The procedure was done using image intensifier.

Postoperative protocol and follow-up

In the post-operative period X rays were done and assessed for quality of reduction which was categorised as anatomical, imperfect or poor [15]. Static quadriceps exercises and ankle pumps were started from 1st post-operative day. Patients were mobilised non-weight bearing from 2nd post-operative day depending on the tolerance of pain limits and were kept non-weight bearing for 6 weeks. After which partial weight bearing was started and gradually increased to full weight bearing at 12 weeks post-operatively. The mean duration of follow up was 28.6±4 months (range 18-48 months). Clinical outcome was measured at final follow-up using Harris hip score and modified Merle d'Aubigne and Postel score. Complications if any were noted during follow-up. Indomethacin 75 mg was given daily for prophylaxis of heterotopic ossification for 4 weeks while enoxaparin 40 mg was given as subcutaneous injections for prophylaxis of deep venous thrombosis for 10 days.

Statistical analysis

The statistical software use for descriptive statistics was SPSS version 23 for windows. Data was analysed statistically by finding the mean, standard deviation and percentage of the parameters studied. Multiple logistic regres-

Table 1. Agedistribution

Age group in years	Percentage (Number)
<40	54% (27)
40-60	32% (16)
>60	14% (7)

Table 2. Associated injuries

Injury type	Percentage (Number)
Fractures of lower extremity	20% (10)
Thoracic injuries	12% (6)
Sciatic nerve injury	8% (4)
Abdominal injuries	12% (6)
Head injury	8% (4)

sion analysis was done using Kruskall-Wallis test to evaluate the effects of patient related factors (age, sex, associated injury, associated hip dislocation) and clinical variables (time to surgery, fracture pattern, accuracy of reduction) on functional outcome scores (Harris hip score and modified Merle d'Aubigne and Postel score). All the inferences were drawn at 0.05 level of significance.

Results

Patient demographics

55 patients with displaced acetabulum fractures were treated surgically by open reduction and internal fixation. Out of these 5 patients were lost to follow up at varying times during the study period, and hence have been excluded from the final analysis which was computed for the remaining 50 patients only. 76% (n=38) were males and 24% (n=12) were females. 82% (n=41) patients sustained fracture due to motor vehicle accident whereas 18% (n=9) due to fall from height. The mean age was 36.6±11.9 years (range 19-67 years). Distribution of patients according to age group is shown in **Table 1**. Right acetabulum was fractured in 54% (n=27) and left acetabulum in 46% (n=23) patients. The pattern of associated injuries is shown in **Table 2**. Concomitant dislocation of the ipsilateral hip was present in 20% (n=10) patients.

Fracture pattern and approaches utilised

42% (n=21) had elementary fracture type and 58% (n=29) had associated fracture type (**Table 3**). Posterior wall fracture was the most common type of fracture seen in 24% (n=12) patients followed by both column seen in 20% (n=10) patients. 8% (n=4) patients had sciatic nerve injury pre-operatively.

Kocher Langenbeck approach was used in 42% (n=21) and Sub-inguinal approach used in 16% (n=8) patients while in remaining 42% (n=21) patients both Kocher Langenbeck and Sub-inguinal approaches were used.

Time to surgery and accuracy of reduction

Average time interval between sustaining fracture and surgical intervention was 9.42±5.8 days (range 3-25 days). 66% (n=33) patients were operated before 2 weeks and 34% (n=17) were operated 2 weeks after sustaining the injury because of associated injuries. Anatomical reduction was achieved in 62% (n=31), imperfect reduction was achieved in 22% (n=11) and poor reduction was achieved in 16% (n=8). Effect of time to surgery on accuracy of reduction is shown in **Table 4**.

Clinical outcome scores

The mean Harris hip score at final follow-up was 80.96±8.9 and mean modified Merle d'Aubigné and Postel score was 15.1±2.4. As per Harris Hip score 28% (n=14) cases had excellent, 38% (n=19) had good, 20% (n=10) had fair and 14% (n=7) had poor results. As per modified Merle d'Aubigné and Postel score 20% (n=10) cases had excellent, 48% (n=24) had good, 20% (n=10) had fair and 12% (n=6) had poor results (Supplementary Data).

The effect of various variables on the functional outcome is shown in **Table 5**. Both the scores were significantly ($P<0.05$) affected by associated injuries, time to surgery, accuracy of reduction, fracture pattern and associated dislocation while gender didn't have any significant effect on functional outcome.

There was a statistically significant difference in the functional outcome between patients who were less than 40 years and those who were more than 60 years of age ($P<0.05$ for both for Harris hip score & modified Merle d'Aubigné and Postel score). Though the outcome in age group of <40 years was better than age group 40-60 but it was not statisti-

Table 3. Fracture type percentage

Elementary	Percentage (Number)	Associated	Percentage (Number)
Posterior wall	24% (12)	Both column	20% (10)
Transverse	12% (6)	Posterior wall + transverse	14% (7)
Posterior column	4% (2)	T type	12% (6)
Anterior column	2% (1)	Posterior colum + posterior wall	6% (3)
Anterior wall	-	Anterior column + posterior hemitransverse	6% (3)
Total	42% (21)		58% (29)

Table 4. Time to surgery and accuracy of reduction

Time to surgery	Anatomical (Number)	Imperfect (Number)	Poor (Number)
<2 weeks	56% (28)	6% (3)	4% (2)
>2 weeks	6% (3)	16% (8)	12% (6)

cally significant (P=0.12 & 0.33 for Harris hip score & modified Merle d'Aubigné and Postel score respectively) and similarly it was better in age group of 40-60 when compared with age group >60 but was not statistically significant (P=0.088 & 0.097 for Harris hip score & modified Merle d'Aubigné and Postel score, respectively).

Complications

6% (n=3) of cases had iatrogenic sciatic nerve injury, 4% (n=2) of cases developed deep infection which responded to antibiotics as per the culture and sensitivity report, 10% (n=5) of cases developed avascular necrosis, 4% (n=2) of cases had heterotopic ossification and 16% (n=8) of cases developed secondary arthritis.

Discussion

The management of displaced acetabular fractures remains a challenging task for orthopaedic surgeons because of the complex nature of trauma. The predictors of functional outcome after surgical treatment may be either surgeon dependent or surgeon independent [16]. Variables such as mechanism of injury, sciatic nerve injury, dislocation, femoral head damage, fracture pattern, associated injuries, the patient's age and comorbidities are not under surgeon's control. But, the timing of surgery, quality of reduction and fixation are surgeon-dependent variables which can affect the final outcome [9-11, 15, 17, 18].

The epidemiological data like age, gender, mode of injury, fracture pattern, time to surgery and associated injuries as compared to other studies has been shown in **Table 6** [19-22].

In our study the mean modified Postel Merle d'Aubigné score was 15.1±2.4. Excellent score was seen in 20% (n=10), good in 48% (n=24), fair in 20% (n=10) and poor in 12% (n=6) patients. Meena et al. in their study reported a score of 15.7±2.2 at final follow-up with excellent scores seen in 22.9% patients (n=27), good in 44.2% (n=52), fair in 16.9% (n=20) and poor in 16.1% (n=19) patients [22]. Their results were almost comparable to the present study.

In the present study, as per the Harris hip score 28% (n=14) patients showed excellent results, 38% (n=19) good, 20% (n=10) fair and 14% (n=7) poor. Sahu RL reported excellent Harris hip score in 60.86% patients, good in 21.73%, fair in 8.69%, and poor in 8.69% [20].

In the present study the scores were significantly lower in those with associated injuries as compared to those without associated injuries. Similar negative impact on functional outcome was reported by Meena et al. and Moed et al. [22, 23].

Age was found to affect the final outcome in our study. Elderly patients had lower functional outcome scores as compared to younger patients. The scores were higher in age group of <40 years when compared to those between 40-60 years, further this group of patients had better scores when compared to those >60 years age group. However, statistically significant differences in scores was only found between patients less than 40 years and those more than 60 years (P<0.05). Though Meena et al. did not find any significant difference in outcome of elderly (>50 years) versus younger (<50 years) patients [22]. The differ-

Table 5. Effect of variables on outcome scores

Variable		Mean Harris hip score	*p*-value	Modified Merled'Aubigné and Postel score	*p-value*
Associated injuries	No	87.5±6.7	P=.0025	16.4±1.1	P=.0037
	Yes	75.2±7.8		13.1±2.1	
Time to surgery	<2 weeks	85.28±7.1	P=.0087	16.6±1.4	P=.0093
	>2 weeks	71±7.6		13.4±2.1	
Accuracy of reduction	Anatomical	86.56±6.5	P_{12}=.032	16.7±0.8	P_{12}=.017
	Imperfect	73±8.6	P_{23}=.024	14.8±2.1	P_{23}=.021
	Poor	64.3±6.2	P_{13}=.0054	11.7±1.9	P_{13}=.001
Age in years	<40	86±7.1	P_{12}=.12	16±1.5	P_{12}=.33
	40-60	82±6.7	P_{23}=.088	14.2±1.9	P_{23}=.097
	>60	73±8.4	P_{13}=.009	12.2±2.1	P_{13}=.002
Fracture pattern	Elementary	87±5.2	P=.015	16.1±1.3	P=.023
	Associated	71±7.6		14.4±1.9	
Gender	Male	82±7.9	P=.78	15.7±1.7	P=.93
	Female	80.8±7.4		15.5±1.6	
Associated dislocation	No	85±8.1	P=.011	16.2±1.3	P=.008
	Yes	79±8.2		14.2±2	

Table 6. Epidemiological parameters of our study in comparison to others

	Mean age in years	Males	Motor vehicle accident as a cause	Fracture type Elementary/Associated type	Time to surgery	Associated injuries
Present study	36.6	76%	82%	42%/58%	9.42±5.8	60%
Anizar-Faizi A et al. [19]	36.16	76.7%	86.7%	56.7%/43.3%	16.1	-
Sahu RL [20]	44	65.2%	65.21%	-	4.15	56.49%
Giannoudis et al. [21]	38.6	69.4%	80.5%	41%/59%	8.9±2.9	-
Meena et al. [22]	38.75	83.9%	83.9%	45.8%/54.2%	9.69	51.69%

ence in the present study was probably due to the fact that we divided the patients into three age groups. This was done in order to better understand the effect of age on the outcome, if any. Another reason for this difference may be the variation in the extent to which elderly patients participated in the standard rehabilitation protocol.

Time interval to surgery had significant impact on outcome as scores in our study were significantly better in patients operated within 2 weeks of sustaining the fracture than those who were operated later than 2 weeks. Similar results were reported by Meena et al. [22]. Outcome of late surgical reconstruction of acetabular fracture has been found to be less satisfactory [17, 24]. In Letournel's original series, the outcome of all reconstructions which were undertaken beyond three weeks were found to be significantly worse [25]. Similar impact was seen in study by Jhonson et al. [26].

In the present study anatomic reduction became difficult with delay in time to surgery. We were able to achieve anatomical reduction in 28 out of 33 patients who were operated within 2 weeks and only in 3 patients out of 17 who were operated 2 weeks later. Madhu et al. found that anatomic reduction was more likely if surgery was performed within 15 days for elementary fractures and within 5 days for associated fractures [24]. Matta found that rate of anatomic reduction decreases with delay in surgery [15].

The effect of accuracy of reduction had significant effect on outcome scores in our study. The patients with anatomic reduction had significantly better scores than those with imperfect/

poor reduction. Similar impact of accuracy of reduction was found by Matta [15]. We observed significantly better results in elementary fractures as compared to associated fractures. Meena et al. reported that the final outcome was not affected by the fracture types [22]. Most of the published articles have reported poorer outcome with posterior column, posterior column + posterior wall and T-type fractures [16, 23].

Concomitant hip dislocation was present in 20% (n=10) of our patients which was lower than as seen in a study by Briffa et al. (33%) and Meena et al. (41%) [16, 22]. Hip dislocation was found to significantly affect the final outcome scores in our study as was also seen in study by Meena et al. [22].

Hip dislocation compromises vascularity of the femoral head, is seen with high velocity injury, fracture comminution, articular impaction and cartilage damage, hence leading to poor outcomes [27].

Gender didn't impact the outcome scores in our study.

Anizar-Faizi A et al. observed deep infection in two patients (6.7%) iatrogenic sciatic nerve injury in three patients (10.0%) avascular necrosis (AVN) of femoral head in five (16.7%) heterotopic ossification in one patient (3.3%) and degenerative changes of hip joint in 16 patients (43.3%) [19]. We observed deep infection in 4% (n=2) patients, iatrogenic sciatic nerve injury in 6% (n=3), avascular necrosis in 10% (n=5), heterotopic ossification in 4% (n=2) and degenerative arthritis in 16% (n=8). Mesbahi SAR et al. reported osteoarthritis of hip in 60.8% and AVN of head of femur in 22.8% cases which was higher than our study [28]. Giannoudis et al. reported the rate of osteoarthritis to range between 10-30% depending on the accuracy of reduction [21]. This reflects low rate of complications in the form of avascular necrosis and degenerative arthritis in the present study.

The surgeon used the sub-inguinal approach for anterior exposure [29]. This is a retroperitoneal approach below the inguinal ligament. The osteotomy of the ASIS relaxes the inguinal ligament and flexion of the affected hip provides an excellent view of the anterior and medial wall. The quadrilateral plate can be well visualised and felt through the middle window and makes fixation and reduction of fractures of this region much easier. This approach also offers the additional advantage of giving access to the anterior joint capsule, should an arthrotomy of the hip joint be required to inspect the interior of the joint. Another advantage is that the closure is anatomical and does not require the repair of the inguinal canal.

Limitations of the study is that the authors did not take into account the effect of acetabular dome impaction, cartilage damage and fracture comminution on the outcome. In addition to it we did not see the outcome based on radiology and hence the comparison of radiological and functional outcome could not be done.

Conclusion

The authors conclude that presence of associated injuries, concomitant hip dislocation, associated type of fracture patterns, elderly age (more than 60 years), sub optimal fracture reduction and delay in surgery beyond 2 weeks are factors that lead to significantly suboptimal functional scores. The limitation of the present study is that there was no comparative arm and we did not compare the final radiological outcome with functional outcome.

Disclosure of conflict of interest

None.

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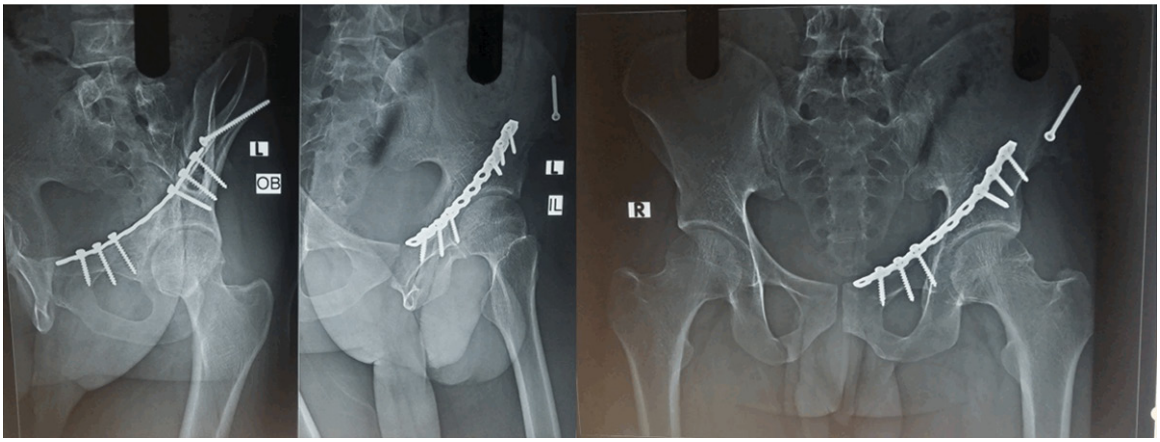
Supplementary Data

1ST DEMO CASE

Pre-op radiograph

immediate post-op radiograph

18 month follow-up radiographs

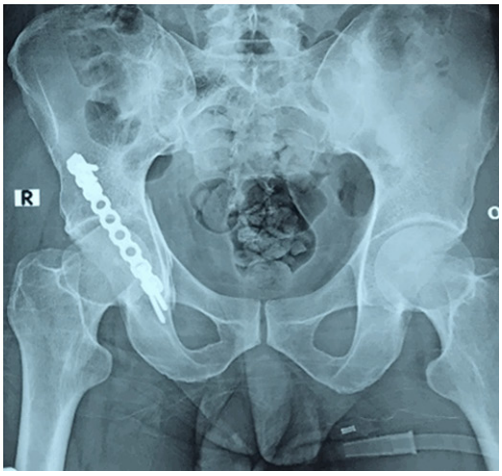


Clinical photograph at 18 months follow-up shows excellent Harris hip score and modified Merle d'Aubigné and Postel score.

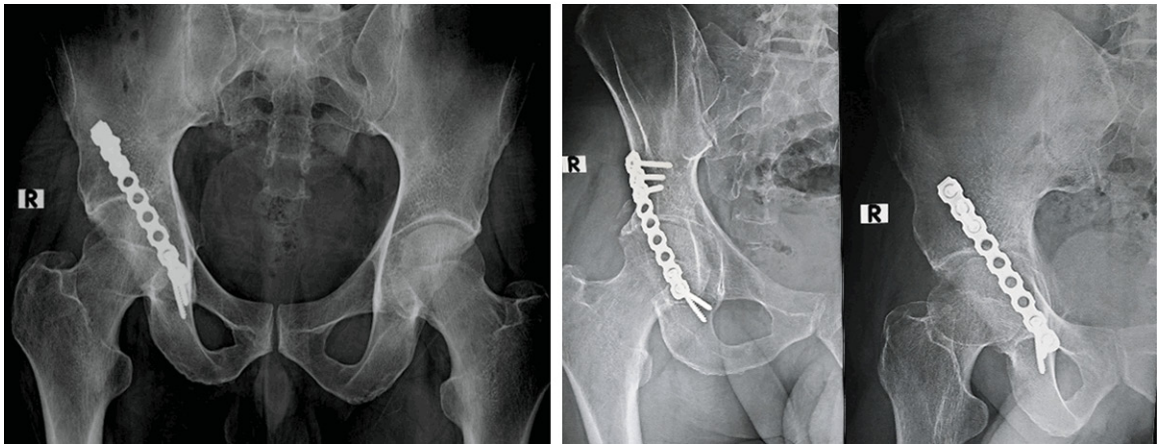
2ND DEMO CASE

PRE-OPERATIVE X-RAY

IMMEDIATE POST-OPERATIVE X-RAY



x-rays at 2.5-years follow-up



Clinical photograph at 2.5-years follow-up shows excellent harris hip score and modified Merle d'Aubigné and Postel score.