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Outcome after Surgical Management of Acetabular Fractures: A 7-Year Experience

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ABSTRACT

Objective: To determine the functional and radiologic results of surgical treatment in patients with acetabular fractures.
Methods: This was a retrospective cross-sectional study. We retrospectively reviewed medical records of patients operatively treated acute acetabular fractures at a level I trauma center (Shahid Rajaee) and an orthopedic center (Shahid Chamran) both in southern Iran (Shiraz) with minimally 1 year follow up over a period of 7 years from April 2009 to March 2016. Functional and radiographic outcomes, and complication were considered as main outcomes.
Results: A total number of 79 patients completed the study. Fifty-five patients were operated through Kocher–Langenbeck approach, and 18 were operated through the standard ilioinguinal approach, and 6 patients were operated through the standard ilioinguinal approach combined with Kocher–Langenbeck approach. The mean follow-up of patients was 45.6 months. The average operative time was 162.4±78.5 min, and the median blood loss was 500 ml. Functional results were excellent in 41 patients (51.9%), good in 12 (15.2%), fair in 13 (16.5%), and poor in 13 patients (16.5%). Radiologic results were excellent in 27 cases (34.2%), good in 17 cases (21.5%), fair in 18 cases (22.8%), and poor in 16 (16.5%). Osteoarthritis of hip (60.8%) and AVN of head of femur (22.8%) were two most common complications. In addition, there wasn't any significant difference between surgical approaches regarding clinical and radiographic outcomes.
Conclusion: The operative treatment for acetabular fractures gives universally satisfactory results. Thereafter, this study provides evidence that ilioinguinal approach is a good choice for anterior fractures, Kocher–Langenbeck is a good choice for posteriors fractures, and combined approach may be a good choice in the management of acetabular fractures involving two columns.

Keywords: Acetabular fracture; Internal fixation; Open reduction; Ilioinguinal approach; Kocher–Langenbeck approach.

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Introduction

Acetabular fractures are growing in developing countries with increasing incidence of high-energy trauma like road traffic accidents or falls from a significant height [1, 2]. According to epidemiology data, the incidence of acetabular fractures is approximately three per 100 000 per year [3]. They usually result from intense injuries and often occur in multiple trauma patients [4]. However, fragility acetabular fractures in osteoporotic patients can occur as a result of simple low energy falls from standing height or minor trauma [5].

Management of acetabular fractures are difficult regarding the complicated anatomy of the acetabular region. These fractures are always a challenging topic for the trauma and orthopedic surgeons. Before the 1964 study [6], most acetabular fractures were treated with closed reduction. Nowadays, open reduction and internal fixation is the standard treatment for displaced acetabular fractures. Generally, surgical approaches to the acetabulum can be classified as anterior, posterior, extensile, or combined and mostly include the ilioinguinal, iliofemoral, extended iliofemoral, Kocher-Langenbeck, triradiate, and combined anterior and posterior approaches [7, 8]. Because of the original description by Letournel in 1961 [9], the ilioinguinal approach has remained the most common approach for anterior acetabular fixation, and the Kocher-Langenbeck approach [6] is considered as the golden standard for posterior access. However, the decision for use of an appropriate approach substantially depend on the type and nature of each acetabular fracture. The approach to be selected should provide a sufficient angle of visualization, allow anatomic reduction, and to permit control of the fracture area. For example, an extended or combined approach can be used in the patients with wide displacement in both the anterior and posterior columns of the acetabulum [10, 11].

The most studies reported good to excellent functional outcomes in 71–88% patients after surgical treatment of acetabular fractures [12-15]. The important prognostic factors to influence clinical outcome include associated fracture type, damage to the femoral head, associated injuries, dislocation at the time of injury, inadequate fracture reduction, age, development of heterotopic ossification, and a delay in surgical treatment [16-21]. In addition, the surgeon's training and expertise is a crucial factor [22]. The practical skills of the surgeon help him to choose the most appropriate approach for achieving favorable treatment outcomes.

There are several studies on the outcome of operative management of acetabular fractures in different parts of the world [9-21], however limited data are available in our country about this mater. Thereafter, the aim of this study is to report our results of a 7-year experience of surgical treatment for acetabular fractures in the elderly population at two tertiary referral centers of Southern Iran.

Materials and Methods

Study Population

After obtaining Institutional Review Board approval, a retrospectively collected database at a level I trauma center (Shahid Rajaee) and an orthopedic center (Shahid Chamran) both in southern Iran (Shiraz) was electronically searched, and medical records of all operatively treated acute acetabular fractures over a period of 7 years from April 2009 to March 2016 were reviewed. Exclusion criteria included: patients aged less than 16 years at the time of their injury, those who were managed conservatively, incomplete document, and less than 1-year follow up or lost from the outpatient follow-up.

Study Protocol

Patients initially were stabilized if required, then the patients were preoperatively evaluated with physical exam, AP pelvis radiograph, Judet pelvis radiographs, and a CT scan with thin cuts and 3D reconstructions as part of the standard protocol for these injuries. Indications for surgical approach unless contraindicated by underlying medical conditions were unstable fracture dislocation of hip and fracture involving weight bearing area, displaced fracture >2mm within superior articular surface, fracture involving >25% surface of posterior wall, retained intra articular fragments and lack of secondary congruence or loss of congruence of joint on any view. The fractures were classified into posterior wall, posterior column, anterior wall, anterior column, transverse or five associated patterns (T-shaped, posterior column with posterior wall, transverse with posterior wall, anterior with posterior hemitransverse, associated both column) according to Judet *et al*., [6]. In our centers, open reduction and internal fixation was carried out using the ilioinguinal approach in anterior fractures, the Kocher–Langenbach approach in the posterior fractures, and combined approaches in the extensile and bicolumnar fractures. All operations were performed by attending orthopedic surgeons specializing in the treatment of acetabular fractures.

Baseline characteristics of them including: age, gender, mechanism of injury, fracture pattern, site of fracture, associated injuries, surgical approach, delay from admission to time of surgery, operation time, blood loss during operation were obtained from their medical records. Moreover, intraoperative complications were extracted from medical records.

Standard radiographs included AP pelvis, and Judet pelvis were taken at all outclinic consultations. We considered 12 months as minimum time of follow up. At the time of the most recent follow up, each patient was clinically and radiographically evaluated. Radiological results were assigned according to the criteria described by Matta., [23] Excellent indicates

a normal-appearing hip joint, good indicates mild changes with minimal sclerosis and joint narrowing, fair denotes intermediate changes with moderate sclerosis and joint narrowing (<50%), and poor denotes advanced changes. The functional outcomes were assessed using Merle d'Aubigne and Postel's system modified by Matta [24] (Table 1). In addition, postoperative complications included heterotopic ossification, osteoarthritis of hip, and avascular necrosis of head of femur were evaluated.

Statistical Analysis

All statistical analyses were performed with the statistical Package for Social Sciences version 17.0 (SPSS Inc., Chicago, IL, USA). Values were expressed as mean ± standard deviation (SD) for the quantitative variables and percentages for the categorical variables. The significance of differences between results within groups were assessed using One-Way ANOVA or Mann-Whitney U test. A *p*-value of less than 0.05 was considered statistically significantly.

Results

Baseline Characteristics

There were 163 patients with acetabular injury managed operatively in Shahid Rajaee hospital, and 60 patients operated in Shahid Chamran hospital. After excluding incomplete document, and patients with less than 1-year follow up or missed follow up, 79 patients were ultimately reviewed for this study.

The mean age of the patients was 36.84±12.92 years old, ranging from 16 to 68 years. There were 65 (82.3%) men and 14 (26.5%) women among the patients. Sixty five patients (82.3%) had acetabular injury related with road traffic accidents and twelve (15.2%) of them had falls from a significant height. Sport related injury was associated in two patients. The side of fracture was left in 45 (57%) patients and right in 34 (43%) patients. Associated injuries were seen in 32 of the patients (32.9%). Lower extremities injury (12.6%) was the most common associated injuries, followed by upper extremities injury (10.2%), head injury (8.8%), and thoracic injury (3.7%), whereas both abdominal injury (2.5%) and vertebral injury (2.5%) were the least common. The frequency of fracture patterns included posterior wall in 34/79 patients (43%), both column in 17/79 patients (21.5%), posterior column/posterior wall in 7/79 patients (8.9%), posterior column in 6/79 patients (7.6%), T-type in 5/79 patients (6.3%), anterior column in 3/79 patients (3.8%), transverse/posterior wall in 3/79 patients (3.8%), anterior column/posterior hemitransverse in 2/79 patients (2.5%), anterior wall in 1/79 patients (1.3%), and also transverse in 1/79 patients (1.3%). Table 1 represents baseline characteristics of the study patients.

Operation Characteristics

There was an average delay of 7.25 days (ranged from 1 to 22 days) from admission to time of surgery. The surgeries lasted 162.4±78.5 (range, 75 to 450) min on average, and the median estimated intraoperative blood loss was 500 (range, 100 to 2500) mL. The number of 55 patients were operated through Kocher–Langenbeck approach, and 18 patients were operated through the standard ilioinguinal approach, whereas the other 6 patients were operated through the standard ilioinguinal approach combined with Kocher–Langenbeck approach (Table 2).

Clinical and Radiographic Outcomes

The mean follow-up of patients was 45.6 months (range 12–88 months) with a median of 40 months. According to the Merle d'Aubigne and Postel scoring system modified by Matta, the clinical outcome was excellent in 41 cases (51.9%), good in 12 cases (15.2%), fair in 13 cases (16.5%) and poor in 13 cases (16.5%). According to principles developed by Matta, the radiological result was excellent in 27 cases (34.2%), good in 17 cases (21.5%), fair in 18 cases (22.8%), and poor in 16 (16.5%) (Table 3).

Complications

Intraoperative complication was seen in 4 patients (5.1%) who developed sciatic nerve palsy, however the incidence of postoperative complications was

Table 1. Grading system of Merle D'Aubigné and Postel as modified by Matta et al.

Pain	Points	Ambulation	Points	Range of motion (%)	Points	Clinical grade (final score)
No pain	6	Normal	6	100	6	Excellent (18)
Slight or intermittent	5	No cane but slight limp	5	80	5	Good (15-17)
Mild after ambulation but disappears with rest	4	Long distances with cane or crutch	4		-	Fair (13-14)
Moderately severe, permits ambulation	3	Limited even with support	3	60	3	Poor (≤12)
Severe with ambulation	2	Very limited	2		-	
Severe, prevents ambulation	1	Bedridden	1	≤40	1	

Table 2. Baseline & operation characteristic of the study patients

Characteristics	Patients (n=79)	Characteristics	Patients (n=79)
Age	36.84±12.92	**Associated injuries**	
Gender (M/F)	65/14	Lower extremities injury	10 (12.6%)
Mode of injury		Upper extremities injury	8 (10.2%)
Road traffic accidents	65 (82.3%)	Head injury	7 (8.8%)
Falls from a significant height	12 (15.2%)	Thoracic injury	3 (3.8%)
Sport related injury	2 (2.5%)	Abdominal injury	2 (2.5%)
Side of fracture		Vertebral injury	2 (2.5%)
Left	45 (57%)	**Time to surgery (days)**	7.25
Right	34 (43%)	**Operation time (min)**	162.4±78.5
Fracture pattern		**Intraoperative blood loss (ml)**	684.2±506.1
Posterior wall	34 (43%)	**Surgical approach**	
Posterior column	6 (7.6%)	Kocher-Langenback (KL)	55 (69.6%)
Anterior wall	1 (1.3%)	Ilioinguinal (II)	18 (22.7%)
Anterior column	3 (3.8%)	2 approach (KL + II)	6 (7.6%)
Both column	17 (21.5%)		
Posterior column with posterior wall	7 (8.9%)		
T-type	5 (6.3%)		
Transverse/posterior wall	3 (3.8%)		
Anterior column with posterior hemitransverse	2 (2.2%)		
Transverse	1 (1.3%)		

Table 3. Clinical and radiographic outcomes and surgical complications

Variables	Patients (n=79)
Clinical outcome	
Excellent	41 (51.9%)
Good	12 (15.2%)
Fair	13 (16.5%)
Poor	13 (16.5%)
Radiological outcome	
Excellent	27 (34.2%)
Good	17 (21.5%)
Fair	18 (22.8%)
Poor	16 (16.5%)
Complications	
Sciatic nerve palsy	4 (5.1%)
Osteoarthritis of hip	48 (60.8%)
AVN of head of femur	18 (22.8%)
Infections	5 (6.3%)
Heterotopic ossification	12 (15.2%)
PE	1 (1.3%)

relatively high. The number of 48 patients (60.8%) developed osteoarthritis of hip. Avascular necrosis of head of femur was observed in 18 cases (22.8%). Five patients (6.3%) experienced soft tissue infections, all of whom treated with superficial wound debridement and antibiotic therapy. Heterotopic ossification was recorded in 12 patients (15.2%). One patient (1.3%) was diagnosed with a nonfatal pulmonary embolus (Table 3).

Patients' Characteristics and Outcomes in Each Fracture Patterns

In second part of the study we separately determined characteristics, clinical and radiographic outcomes of the patients according fracture patterns (Table 4). The longest operation time was seen in the patients with transverse/posterior wall fractures (mean=450±238.3). Also, the most bleeding during surgery was in the patients with anterior column fractures (mean=1400±700 ml). Osteoarthritis of hip was the most common complications in all fracture patterns. Excellent clinical outcome was founded in more than 50% of the patients with posterior wall, both column, transverse/posterior wall, and transvers fractures. Moreover, more than 50% of the patients with transverse/posterior wall and transvers fractures had excellent radiographic outcomes.

Comparing Surgical Approaches

In another analysis, we compared clinical and radiographic outcomes, and frequency complications of the patients between different surgical approaches (Table 5). In all surgical approaches, more than 50% of the patients had excellent and good clinical and radiographic outcomes. There wasn't any significant difference between surgical approaches regarding clinical and radiographic outcomes. However, rate of infections and pulmonary embolism in the patients operated with combined approach were significantly more than other approaches (p<0.001, for both).

Discussion

Acetabular fracture is intra-articular fracture, and it was historically an enigma for the orthopedic surgeons [23]. However, the trend changed with development of imaging modalities, fracture classification as described by Judet [6], and introducing surgical management by Letournel [9]. Nowadays open reduction internal fixation is gold standard and broadly used for the displaced acetabulum fractures. There are various surgical

Table 4. Characteristics, clinical and radiographic outcomes of the patients according fracture patterns.

	Posterior wall (n=34)	Posterior column (n=6)	Anterior wall (n=1)	Anterior column (n=3)	Both column (n=17)	Posterior column/ Posterior wall (n=7)	T-type (n=5)	Transverse/ posterior wall (n=3)	Anterior column/ posterior hemitransverse (n=2)	Transverse (n=1)
Age	37.6±12.5	36.3±13.4	68	41.6±25.5	35.5±9.1	28.1±9.9	34.4±10.8	28.3±10.1	57.5±14.8	45
Gender (M/F)	29/5	6/0	1/0	2/1	11/6	7/0	5/0	2/1	1/1	1/0
Side of fracture										
Left	17	4	1	2	8	4	5	2	1	1
Right	17	2	-	1	9	3	-	1	1	-
Associated injuries										
Yes	12	2	1	2	6	5	2	1	1	-
No	-	-	-	-	-	-	-	-	-	-
Injury Surgery Interval (days)	6.1±3.6	5.6±2.6	3	9±7.2	8.1±4.2	9±6.5	12.6±2.3	5.3±2.3	7	7
Operation time (min)	129.4±50.4	116.2±22.5	180	190±45.8	181.5±66.8	195.7±100	240±42.4	450±238.3	315±75.1	120
Blood loss (ml)	502.9±330.2	441.6±120.1	400	1400±700	714.7±340.3	907.1±612.6	1020±843.8	1100±1016.5	1150±636.3	500
Clinical outcome										
Excellent	21 (61.7%)	2 (33.3%)	-	1 (33.3%)	10 (58.8%)	2 (28.5%)	1	2 (66.6%)	1 (50%)	1 (100%)
Good	3 (8.8%)	2 (33.3%)	-	1 (33.3%)	3 (17.6%)	2 (28.5%)	1	-	-	-
Fair	5 (14.7%)	2 (33.3%)	-	1 (33.3%)	1 (5.8%)	-	3	-	1 (50%)	-
Poor	5 (14.7%)	-	1 (100%)	-	3 (17.6%)	3 (42.8%)	-	1 (33.3%)	-	-
Radiological outcome										
Excellent	13 (38.2%)	1 (16.6%)	-	1 (33.3%)	6 (35.3%)	2 (28.5%)	-	2 (66.6%)	1 (50%)	1 (100%)
Good	8 (23.5%)	1 (16.6%)	-	1 (33.3%)	4 (23.5%)	1 (14.3%)	1 (20%)	-	1 (50%)	-
Fair	7 (20.6%)	4 (66.6%)	-	1 (33.3%)	2 (11.7%)	1 (14.3%)	3 (60%)	-	-	-
Poor	5 (14.7%)	-	1 (100%)	-	5 (29.4%)	3 (42.8%)	1 (20%)	1 (33.3%)	-	-
Complications										
Sciatic nerve palsy	2 (5.8%)	-	-	-	1 (5.8%)	1 (14.3%)	-	-	-	-
Osteoarthritis of hip	19 (55.8%)	5 (83.3%)	1 (100%)	2 (66.6%)	9 (52.9%)	5 (71.4%)	5 (100%)	1 (33.3%)	1 (50%)	-
AVN of head of femur	7 (20.5%)	-	-	-	6 (35.3%)	3 (42.8%)	1 (20%)	1 (33.3%)	-	-
Infections	-	-	-	-	3 (17.6%)	-	1 (20%)	1 (33.3%)	-	-
Heterotopic ossification	5 (14.7%)	1 (16.6%)	-	-	3 (17.6%)	1 (14.3%)	1 (20%)	1 (33.3%)	-	-
PE	-	-	-	-	1 (5.8%)	-	-	-	-	-

Table 5. Comparing clinical and radiographic outcomes, and frequency complications of the patients between different surgical approaches.

	Kocher–Langenbeck (n=55)	Ilioinguinal (n=18)	Kocher–Langenbeck combined Ilioinguinal (n=6)	*p* value
Clinical outcome				0.82
Excellent	29 (52.7%)	9 (50%)	3 (50%)	
Good	8 (14.5%)	4 (22.2%)	0	
Fair	9 (16.4%)	3 (16.7%)	1 (16.7%)	
Poor	9 (16.4%)	2 (11.1%)	2 (33.3%)	
Radiological outcome				0.77
Excellent	18 (32.7%)	6 (33.3%)	3 (50%)	
Good	12 (21.8%)	5 (27.8%)	0	
Fair	14 (25.5%)	3 (16.7%)	1 (16.7%)	
Poor	10 (18.2%)	4 (22.2%)	2 (33.3%)	
Complications				
Sciatic nerve palsy	3 (5.5%)	0	1 (16.7%)	0.18
Osteoarthritis of hip	34 (61.8%)	11 (61.1%)	3 (50%)	0.31
AVN of head of femur	12 (21.8%)	4 (22.2%)	2 (33.3%)	0.81
Infections	1 (1.8%)	0	4 (66.7%)	<0.001
Heterotopic ossification	9 (16.4%)	2 (11.1%)	1 (16.7%)	0.29
PE	0	0	1 (16.7%)	<0.001

approaches for treatment of displaced acetabular fractures. Choosing the appropriate surgical approach is main to achieve better anatomical reduction of acetabular and satisfactory postoperative function. Ilioinguinal and Kocher–Langenbeck approaches are more popular among orthopedic surgeons. Anterior wall, anterior column and anterior column/posterior hemitransverse fractures could be treated with the ilioinguinal approach. Posterior wall, posterior column, and posterior column and wall fractures could be treated with the Kocher–Langenbeck approach. While, four remaining fracture types (transverse, transverse/posterior wall, T-shape and both column fractures) involved two columns. Thereafter, the combination of an anterior and posterior approach should be used for those complex fractures. In this study, we present our experience of using the surgical approaches for acetabular fractures, and assess the clinical and radiographic outcomes, and complications of the patients.

In agreement with the previous reports, our study confirmed that most of the fractures were caused by road traffic accidents or falls from a significant height [14-20]. Additionally, the posterior wall (43%) and both column (21.5%) were two most common fracture patterns in our papulation. This is similar what was reported by major previous studies [1-3, 23, 24]. In contrast, anterior wall fractures had the most frequency in a Germany's population, however they just included elderly patients [25]. The most common approach used in our centers was that of Kocher-Langenbeck in about 70% of the patients, probably due to higher frequency of posterior fractures, and greater familiarity with this approach among our surgeons.

Our results showed about 67% excellent to good clinical outcomes at minimally 1 years postoperatively. The quality of reduction and clinical outcome are strongly correlated with the fracture type, and posttraumatic arthritis. Therefore, a comparison with other studies should be treated with caution. Whereas, the results from most of them are in line with our 67%. For example, Gupta *et al*., [1] reported 74%, Mayo reported 75% [26], and Briffa reported 72% excellent to good clinical outcomes [27]. While, studies who used modification approaches such as modified Stoppa or modified ilioinguinal approach indicated more than 80% excellent or good results [28, 29]. When we compared clinical outcomes between ilioinguinal and Kocher–Langenbeck approaches, the patients treated with ilioinguinal approach had slightly better clinical outcome with less rate of complications in comparing Kocher–Langenbeck approache. Anterior column fractures are intuitively easier to reduce and fix through an anterior approach and this may be one potential source of our outcome differences.

As mentioned by Matta *et al*., [24] the main complication following a fracture of the acetabulum is post-traumatic osteoarthritis. The incidence of osteoarthritis in our series was 60.8%, which is considerably higher than that reported by Isaacson *et al*., [30] 52% and the 21.6% reported by Negrin *et al*., [31]. Iatrogenic nerve injury included sciatic nerve, femoral nerve and lateral cutaneous nerve of thigh are possible complication during acetabular surgery. In our series, the overall incidence of sciatic nerve palsy was 5.1%, and other nerve damage wasn't seen. Nerve damage was 6% in a study by Shrestha *et al*., [32], and reported 12% in another study [27]. It mention that there wasn't any nerve damage in ilioinguinal approach, and it was seen in posterior approach. This is similar what were reported by

previous studies who treated the patients through anterior approach [29, 33].

The incidence of deep vein thrombosis and pulmonary embolism are conflicting in Asian population. Sen R *et al*., [34] reported 28.5% venous thromboembolism and 17.8% pulmonary embolism among the patients who had undergone acetabular surgery without chemical prophylaxis. In our study, all patients received mechanical prophylaxis and chemical prophylaxis unless contraindicated, and just one patients developed pulmonary embolism. This is in concordance with result of an Indian study [32]. In addition, deep infection wasn't seen in our study, and just 6.5% of the patients affected by superficial infection. This rate is acceptable in comparing other studies which were reported infection rate of 3-11% [1, 27, 32].

Heterotopic ossification following acetabular fracture surgery may be related with increased postoperative pain, and affected functional outcomes [35]. Moreover, it seem that race is an important factor. According to previous study, African American patients are considerably more likely to develop severe heterotopic ossification when compared to Caucasian patients [36]. In the current study, 15.2% of our patients developed heterotopic ossification. Whereas 37.9% of the patients were affected by heterotopic ossification in an Austrian study, and it was 25.6% in a study reported by Shrestha *et al*., [32].

The main limitations of the present study were that it was retrospective and that the number of patients in each of the surgical approaches was limited. Acetabular fractures are rarely seen. Usually they result from high-energy trauma with associated injuries and high risk of mortality, so many patients need to ICU care for a long time. On the other hand, the number of patients with incomplete documents or who were lost to follow up was high in this study. For all these reasons, the number of the patients were reduced.

In conclusion, a good to excellent functional outcome was seen in more than 60% of the patients and a good to excellent radiological outcome was seen in more than 50%of the patients treated surgically. Moreover, the rate of complication was acceptable in our study. In summary, the operative treatment for acetabular fractures gives universally satisfactory results. Thereafter, this study provides evidence that ilioinguinal approach is a good choice for anterior fractures, Kocher–Langenbeck is a good choice for posteriors fractures, and combined approach may be a good choice in the management of acetabular fractures involving two columns.

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