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Functional and radiological outcome of acetabular fractures and the factors affecting the outcome

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Abstract
Introduction: The relative infrequency and complexity of acetabular fractures provide challenge for trauma surgeons. These fractures are the result of high velocity injuries, management may be complicated by other injuries. Operative treatment has become standard for displaced acetabular fractures. Aim of treatment is to maintain a stable congruent joint.
Materials & Methods: We studied 105 closed acetabular fractures treated by various modalities from August 2009 to June 2012.Specific criteria were used to choose the treatment modality. Clinical outcome was graded using Merle D'Aubigne-Postel scoring system. Radiological outcome was evaluated by Matta's criteria.
Results: Posterior wall fracture was most common fracture pattern followed by transverse fracture.49 patients were treated conservatively & 56 with surgical intervention. Average time to fracture union was 18 wks. We had good to excellent functional outcome in 89 patients, fair to poor results in 16 and good to excellent radiological outcome in 97 patients, fair outcome in 8. Outcome was better in patients with isolated acetabular fracture, elimentary type of fractures, those operated between 5-10days. Two patients had iatrogenic sciatic nerve injury, two had infection, three had heterotopic ossification, two had AVN of femoral head, four had OA of hip joint.
Conclusion: Conservative treatment is a safe, effective and cost-efficient treatment modality in minimally displaced fractures. Surgery provides good to excellent medium term results only if the fracture in reduced anatomically. The outcome results are influenced by the age of the patient, fracture pattern, associated injuries, delay to surgical fixation & articular cartilage damage.

Keywords: functional, radiological outcome, factors affecting

Introduction
The relative infrequency and complexity of acetabular fractures provide a challenge for trauma surgeons [1] Acetabular fractures often result from high-impact falls or motor vehicle accidents that transmit force most commonly from an impact to the greater trochanter or the flexed knee. [2, 3] These intra-articular fractures may result in a disabling, traumatic arthropathy. They commonly occur in a younger adult population [4].
Examination should include assessment of sciatic, femoral, and obturator nerve function. The peroneal segment of the sciatic nerve is at greatest risk, about 12% [2]. Radiographic evaluation includes AP radiographs of the pelvis, and internal and external Judet views (AP radiographs centered on the hip with the pelvis rotated 45° internally and externally). A CT scan further characterizes the injury.
In young patients, the management may be complicated by other injuries [4]. Until the 1960s, the vast majority of patients with acetabular fractures were treated conservatively. Thanks to the impressive efforts of Letournel and Judet (who also introduced the most frequently used classification system), operative treatment has become standard for displaced acetabular fractures. The aim of treatment is to maintain a stable congruent joint. Nonoperative management of displaced acetabular fractures has been associated with significant complications and poor outcomes. The majority of patients with displaced acetabular fractures treated nonoperatively were reported to have developed stiff, painful, and arthritic hip joints, which negatively impacted their functional capacity [5-10].

Operative treatment is complex due to the complex three-dimensional anatomy, limitations of the surgical approaches & extensive dissection of the large muscles about the hip [11-14]. The relative merit of each surgical option must be considered, and the decision is often a compromise of exposure vs. complications. Outcome of acetabular fractures is dependent on the quality of surgical reduction and fixation.

In this study we assessed the clinical and radiological outcome of acetabular fractures treated by both conservative and surgical approaches. We also evaluated the factors affecting the outcome of the acetabular fractures. There was no comparison made between operative and non-operative methods as the indications were different for both.

Materials and Methods

Our study was a retrospective analysis of a total of 105 closed acetabular fractures treated by various modalities prospectively from August 2009 to June 2012.

Radiographic evaluation included plain antero posterior X ray of the pelvis, oblique Judet views (obturator oblique& iliac oblique) and CT scan of the pelvis with 3D reconstruction. Fractures were classified based on *Letournel and Judet Classification.* Of the 105 fractures, there were 67 elementary type (25 posterior wall, 12 posterior column, 1 anterior wall, 10 anterior column, 19 transverse fractures) and 38 associated type acetabular fractures (11 posterior wall with column, 4 anterior wall/column with posterior hemitransverse, 4 tansverse with posterior wall, 11 T shaped and 8 both column fractures). Associated injuries were carefully assessed. 42 patients had associated injuries in the upper limbs, lower limbs, head, chest, abdomen or spine.

There were 22 patients with associated posterior dislocation of the hip & 9 with central fracture dislocation of the hip. The dislocation was reduced within 6hrs of injury in 25 patients, between 6 to 12 hrs in 5 patients and between 12 to 18 hrs in 1 patient. The late reductions were due to late presentation of the patient to our institution. All associated hip dislocations were reduced by closed methods & were put on upper tibial skeletal traction. Post reduction patients were again assessed for distal neuro vascular deficits and stability of the hip joint without traction.

49 patients were treated conservatively & 56 patients were treated with surgical intervention. Undisplaced fractures or minimally displaced fractures (2 mm displacement), fractures not involving the weight-bearing dome of the acetabulum as determined on CT or by roof-arc angles, (Roof arcs >45 degrees, No fracture involvement in cranial 10 mm of joint on CT), cases of secondary congruence, posterior wall fractures involving less than 40% of width of wall on CT scan and patients not willing for surgery were treated conservatively. They were put on skeletal traction for 3 wks, then rehabilitated with ROM exercises, partial weight bearing mobilization for 4wks. After confirming the fracture union by repeat X rays, weight bearing mobilization was started.

Patients who did not meet the above mentioned criteria were planned for surgery. Mean time of surgical fracture fixation was 8 days (5 to 15 days). Of which 28 patients were operated between 5 to 7 days, 19 patients between 7 to 10 days and 9 patients between 10 to 15 days. This time delay was for the resolution of the contusion around the hip & for the adequate treatment of the associated life threatening injuries.

All cases were operated by a single surgeon. The appropriate surgical approach was decided by the fracture pattern. Fractures involving the anterior wall, anterior column, some cases of anterior wall with posterior hemitransverse and transverse fracture with mainly anterior involvement were operated by anterior ilioinguinal approach. Fractures involving the posterior wall, posterior column, posterior wall with posterior column and transverse fracture with mainly posterior involvement were operated by posterior Kocher Langenback approach. Both column fractures, T shaped fractures, cases of transverse fractures and anterior column with posterior hemitransverse which could not be reduced by single approach required both anterior and posterior approaches.

Anterior ilioinguinal approach was used in 8 patients, Posterior Kocher Langenbach approach was used in 36 cases. In 12 patients combined anterior and posterior approachs were used.

Post-operatively drain was removed on 2nd post-operative day. All patients received IV antibiotics (3rd generation cephalosporins) for 3 days and indomethacin 75mg daily for 6wks. No patients received DVT prophylaxis. Mobilization depended upon the stability of the fracture fixation. Non weight bearing mobilization from 2nd day in case of secure fixation. Delayed mobilization in patients with associated spine, pelvic, upper limb injuries. Mobilization was guarded in case where the fracture fixation was insecure with skeletal traction on for 1-2 wks.

Post-operative follow-up ranged from 9 to 36 mths with a mean of 18 mths. Patients were called for follow up monthly for first 6 mths, followed by 3 monthly for next 2 visits, followed by 6mthly visit thereafter. At each follow up X ray of the pelvis AP and Judet views taken and were assessed for maintenance of fracture reduction, joint space, AVN/OA changes, fracture union, signs of heterotopic ossification. Patients were also assessed for the amount & cause of pain (if present), ROM of hip & knee, wound status, local signs of infection, walking ability.

The clinical outcome was then graded as excellent, good, fair, poor based on Merle D'Aubigne—Postel scoring system which included 3 parameters - pain, range of motion of hip & walking ability [15]. (Table-1) (18- Excellent, 15 to 17- good, 13 to 14- fair, <13- poor).

Table 1: Merle D'Aubigne-Postel scoring system

Score	Pain	Hip Range Of Motion	Walking Ability
0	Disabling pain at rest	Ankylosis in poor position	No walking possible
1	Pain interfering with sleep	No movement, slight deformity	Only with 2 crutches or frame
2	Pain that prevents walking	Flexion > 40°	Minimal walking with one cane
3	Pain tolerable with limited activity	Flexion 40°–60°	Walking for <1 hour with one cane
4	Pain that disappears with rest	Flexion 60°–80°	Short walk without cane but marked limp
5	Mild pain with normal activity	Flexion 80°–90° + 15° abduction	Walks without cane but noticeable limp
6	No pain	Flexion >90° + 30° abduction	Normal

The Radiological outcome was evaluated by Matta's criteria which included 3 parameters- osteophytes, joint space narrowing & sclerosis. Based on which it has been graded as excellent, good, fair & poor [16]. (Table-2) Postoperative CT

scans were not obtained for any of these patients and the articular reduction was assessed only on the initial postoperative plain radiographs (anteroposterior, iliac oblique, obturator oblique).

Table 2: Matta's radiological criteria

Grade	Osteophyte	Joint Space Narrowing	Sclerosis
Excellent	None	Normal	None
Good	Small	>2mm	Minimal
Fair	Moderate	<50%	Moderate
Poor	Large	>50%	Severe With Femoral Head Collapse

Results

This series consists of 105 cases of acetabular fractures of the treated by both operative and non-operative modalities. Age of the patients ranged from 22 to 61 years with a mean age of 41.5 years. Road traffic accident was the most common mode of injury followed by fall from height, sports injury & assault. There were no cases of pathological fractures. Average time to fracture union was 18 weeks (ranging from 16 to 20 weeks). There were no cases of delayed union or non-union. (Table: 3)

Table 3: Time to fracture union in associated and elimentary type fractures

	Time To Union	
	Conservative	**Surgery**
Associated Fracture Type		
Posterior Wall With Column	20 WKS	19 WKS
Anterior Column With Posterior Hemitransverse	16WKS	17 WKS
Transverse With Posterior Wall	18 WKS	18 WKS
T Shaped	17 WKS	17 WKS
Both Column	18 WKS	18 WKS
Elimentary Fracture Type		
Posterior Wall	20 WKS	18 WKS
Posterior Column	18WKS	18 WKS
Anterior Wall	16 WKS	16 WKS
Anterior Column	16 WKS	16 WKS
Transverse	18 WKS	17 WKS

At the final follow up the range of motion, pain and walking ability was assessed for each patient and was scored as per Merle d'Aubigne and Postel scoring system, from 0 to 6.(Table:4) The mean ROM score was 5.23, mean pain score was 5.38 and the mean score for the walking ability was 5.37.

Table 4: Scores as per Merle d'Aubigne scoring system

	Number Of Patients		
Merle d'Aubigne score	**ROM Parameter**	**Pain Parameter**	**Walking Ability Parameter**
0	0	0	0
1	0	0	0
2	0	0	0
3	5	4	5
4	9	10	10
5	32	29	31
6	59	62	59

We had excellent results in 39 patients, good in 50 patients, fair in 9 and poor in 7 patients. Among the 56 patients who were treated surgically 20 had excellent, 26 had good, 5 fair & 5 poor results. Of the 49 conservatively treated patients 19 had excellent, 24 good, 4 fair & 2 poor results. We had good to excellent results in 89 (84.76%) patients and fair to poor results in 16 (15.24%) patients in terms of functional outcome. (Table:5) We had good to excellent results in 97(92.38%) patients & fair outcome in 8(7.62%) in terms of radiological outcome. (Table:6)

Table 5: Functional outcome as per Merle d'Aubigne scoring system.

	Conservative	Operative	Total	Percentage
Excellent	19	20	39	37.14%
Good	24	26	50	47.62%
Fair	4	5	9	8.58%
Poor	2	5	7	6.66%

Table 6: Radiological outcome as per Matta's criteria

	Number Of Patients	Percentage
Excellent	**64**	**60.95%**
GOOD	33	31.43%
FAIR	8	7.62%
POOR	0	0

Associated Injuries

Of the 45 patients (42.86%) with associated injuries, 31 patients were operated. 31 of 56 (55.36%) patients who were operated had associated fractures. We had 73.33% good to excellent results in patients having associated injuries and 93.33% good to excellent results in patients without associated injuries (isolated acetabular fractures).

Time To Surgery

We had 92.85% good to excellent results in patients who were operated between 5-7 days, 89.47% good to excellent results in patients operated between 7-10 days & 33.33% good to excellent results in patients operated between 10-15 days.

Type of Fracture

Of the 67 elementary type fractures we had good to excellent results in 61 patients (91.04%) and of the 38 associated type fractures we had good to excellent results in 28 patients (73.68 %).

Discussion

Surgical treatment of displaced acetabular fractures is beyond any doubt the treatment of choice, because it allows anatomical reconstruction of the hip joint [2, 3, 17-20]. Undisplaced & minimally displaced fractures do well with a trial of conservative management [2, 3, 21]. We did not compare between the two modalitites of treatment as the indications of both were different as per our treatment protocol mentioned. We had good to excellent results in 89 (84.76%) patients and fair to poor results in 16 (15.24%) patients. 43(87.75%) patients treated conservatively & 46(82.15%) patients treated surgically had good to excellent results. We had good to excellent results in 97(92.38%) patients & fair outcome in 8(7.62%) in terms of radiological outcome. The fair radiological outcome was due to inability to achieve anatomical reduction in 8 patients.

In 44 fractures, only a single approach was used. 12 fractures required a combined anterior and posterior approach. Of which in 7 patients fracture was first fixed with anterior ilioinguinal approach followed by Posterior Kocher Langenbach (Fig:1).

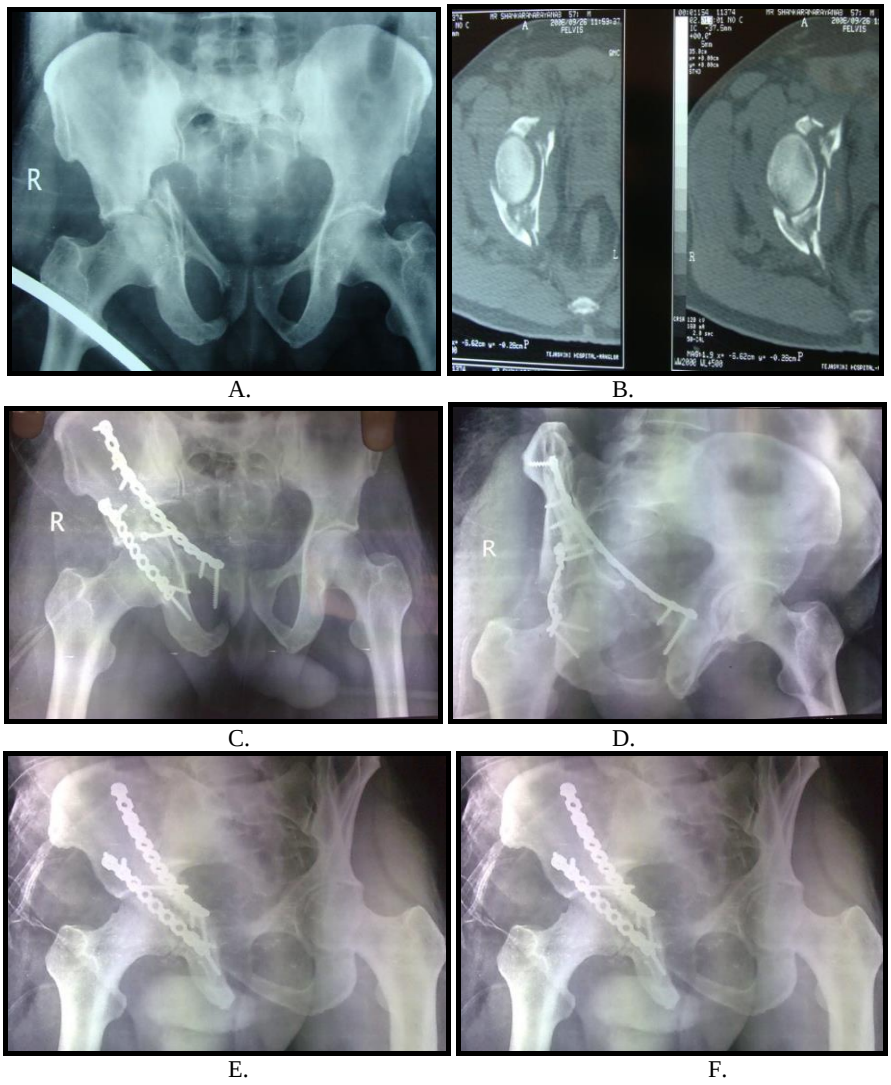

Fig 3: 52yrs old male with H/O RTA. Pre-operative radiograph (a) and CT scan (b) showing 'T' shaped fracture.It was opearted on 6th day post injury with both anterior and posterior approaches. Post-operative radiographs AP view (c) and Judet views (d)

In other 5 patients fracture fixed first with Posterior Kocher Langenbach approach followed by anterior ilioinguinal. In 1 patient where anterior followed by posterior fixation was attempted due to irreducibility of the posterior column mostly due to the mal fixed anterior column, the anterior fixation had to be redone followed by posterior.

In 32 pts non weight bearing mobilisation started from 2nd post-operative day with hip & knee exercises. In 15 patients mobilisation was delayed due to associated upper limb, pelvic or spine injuries and were mobilized in-bed and bedside. In 9 patients mobilisation was guarded wherein we felt the fracture fixation was insecure. Hence were put on skeletal traction for 10 to 14 days. After which the skeletal traction was removed & then patients were started on hip ROM exercises & quadriceps strengthening exercises. Following which patients were allowed bed to chair transfer for 4wks. Graded weight bearing mobilization started thereafter after repeat check X rays.

A few series in the past have tried to assess the factors that affect the outcome of the acetabular fractures, [2, 3, 22]. and they predicted that type of fracture, displacement and comminution as well as concomitant injuries, age and patient conditions have been said to affect clinical outcome. Letournel and Judet[2] showed that the accuracy in reduction in acetabular fractures surgery was directly related to clinical outcome and that perfect reduction and stable fixation is the ultimate goal in any operative intervention.

We analysed the a few important factors which affected our functional and radiological outcome.

AGE: Patients under 50 years of age had a better outcome than patients above 50 years. Patients under 40 yrs had a mean functional score of 17.03 as compared to those above 50yrs who had a mean score of 15.83. This was statistically significant. This could be due to the fact that complex fracture pattern was slightly more common after 50 years of age and also that reconstruction is difficult with osteoporotic and comminuted bones. Similar observation were also noted by Liebergall *et al* [23] and Matta [3, 18] in their studies. But Matta *et al* [3] concluded that a statistically significant association between age and outcome disappeared after controlling for quality of reduction.

Type of Fracture: All the fractures were classified based on Letournel And Judet Classification. According to which, there were 67 elementary type and 38 associated type acetabular fractures. The patients with simple fracture pattern did better than those with associated type of complex fracture. 91.05% patients with simple elimentary type fractures had good to excellent results & 73.69% with associated type fractures had good to excellent results. This result was statistically significant. We felt this may be partly due to inability to achieve anatomical reduction in complex fractures & also associated type fractures being representative of higher

velocity injuries. Murphy *et al* [22] had similar results in his series. But the difference in the duration of fracture union was not statistically significant & there was no major difference between the two fracture types.

Delay To Surgery: We had 92.85% good to excellent results in patients who were operated between 5-7 days, 89.47% good to excellent results in patients operated between 7-10 days & 33.33% good to excellent results in patients operated between 10-15 days. As the delay to surgery increased the outcome score decreased. But this difference was statistically insignificant between those who were operated in 5-7 days & those who were operated in 8-10 days. The difference was highly significant when operated after 11 days. This was mainly because the timing of surgery has a bearing on the surgeon.s ability to obtain an accurate reduction & the mobility of the fracture decreased with time from injury. Many of the authors agree with our observations & obtained good results when treated with in first 10-14 days [3, 21, 24, 25, 26]. Brueton [28] reported that the average time to surgery for fractures with an acceptable reduction was 11 days, whereas for unacceptable reductions the time to surgery was 17 days. Likewise, Letournel [2] reported an anatomic reduction rate of only 52% in fractures that were operated on more than 21 days from the time of injury.

Associated Injuries: 45 of the 105 patients had associated injuries. Few of them had multiple associated injuries. We observed a statistically significant difference in the outcome of patients with & without associated injuries. Patients with associated injuries had 73.33% good to excellent results as compared to those without (isolated acetabular fracture) who had 93.33% good to excellent results. After analyzing these fractures we found that the difference in the outcome was probably due to the more delay in the surgical fixation of fractures which again might be due to the life threatening or a more serious injury elsewhere which requires primary attention. Also all the 3 parameters of the Merle d' Aubigne' scoring system (pain, ROM, walking ability) will be affected by the concurrent injuries to other parts of the body & indirectly influence the outcome of the acetabular fracture per se. It was also observed that patients with associated injuries have more complex fracture pattern due to the higher velocity of injury which in turn was difficult to reduce anatomically & has a negative effect on the outcome. Similar observations were made by Rice *et al* [27] in his series.

Correlation between clinical and radiological outcome

We had positive correlation between clinical & radiological score. This means to say that the patients with anatomical reduction of the joint did well clinically. But this not true for all cases. Of the 8 patients with fair radiological outcome (2 conservative, 6 operative) 2 of them did well clinically. Also of the 92% patients who had good to excellent radiological outcome about 83% of them did well. But these difference in the clinical & radiological outcome were statistically insignificant & the clinical and radiological outcome correlated well.

We had patients with non-anatomic reduction & good short term clinical outcome. These patients require further follow up to exact outcome of the hip. Also we had patients with anatomical reduction with fair clinical outcome. This was probably because of the associated injuries as mentioned before & significant chondral injury of the femoral head. Many studies had similar results. [2, 3, 19, 21, 27, 29].

Two patients with displaced fracture who were treated conservatively had poor clinical & fair radiological outcome. In both cases patients refused surgery.

We had complications in 13(12.38%) patients. There were 4 early surgical complications had 9 late complications.

2 (3.5%) patients had iatrogenic sciatic nerve injury (incomplete peroneal component involvement) which was managed non-operatively and recovered fully over 6mths.

Also of the 11 patients with pre-operative peroneal component involvement (presented with foot drop & sensory loss) 9 patients recovered fully over 6 mths & 2 patients recovered with a residual sensory deficit. Both the patients had posterior dislocation of hip & in 1 patient it was reduced after 12hrs of injury due to late presentation to us.

There were 2 (3.5%) superficial wound infections in our series of which in one patient it healed with appropriate intravenous antibiotics & in the other patient mesh was exposed anteriorly. It healed by intravenous antibiotics, debridement & secondary suturing (Fig: 2).

Fig 2: Superficial wound infection with wound dehiscence in case of ilioinguinal approach.

3 patients had heterotopic ossification Brooker grade 2-3 [30]. All patients were operated with a posterior KL approach. (Fig: 3) Two of them had good range of movements did not have any impact on functional outcome. One pt had restricted hip movements but did not affect his activities of daily living. There is a gross varying incidence of HO in literature ranging from 25% [20] to 80% [31, 32] with KL approach. Despite this, clinically significant heterotopic ossification may develop in less than 5% of patients; some may require additional surgery to regain hip motion [20, 31, 32, 33]. Hence heterotopic ossification correlated poorly with the functional outcome & had minimal impact on the Merle d'Aubigne' score.

Fig 3: Case of grade 3 heteriotoipic ossication after KL approach.

We had 2(1.9%) patient with avascular necrosis of the femoral head 2 years after the surgery. Of which one patient was a 56yrs old male, presented to us with a posterior dislocation (which was reduced after 12hrs) with posterior wall fracture treated surgically with posterior approach. Another patient was 58yrs old who had posterior dislocation with posterior wall fracture treated conservatively.

We had 4(3.8%) cases of symptomatic arthritis in our series. All the 3 presenting with pain & X ray changes of early OA. Two of which were displaced fractures treated conservatively wherein the patients refused surgical intervention. 2 patients treated surgically had OA changes wherein the anatomical reduction of the joint was not obtained. Both cases were operated after 10 days. All the 4 patients were aged >50yrs.

Arthritis is reported to be the most common complication after surgical treatment of acetabular fractures and is present in 15% to 45% of acetabular fractures followed for more than 5 years [2, 23]. Matta [3] reported that with anatomic reductions, arthritis developed in only 16% of patients, as opposed to 45% in those not reduced anatomically. Likewise, Letournel[2] reported a 10% rate after perfect reductions and 36% after imperfect reductions. The presence of subchondral impaction, fracture comminution and intra-articular fracture fragments influences outcome despite anatomical reduction [2, 3, 18, 23, 34]. The diagnosis of arthritis was made 10 years or less after surgery in 80% of patients who had imperfect reductions, but more than 10 years after surgery in 50% of those who had a perfect reduction [2, 3].

There were no cases of DVT, pulmonary embolism, fixation failures or intraarticular hardwares in the joint.

There were a few limitations of this study. Short term nature of the study. Because of which the complication rates of our study is less as compared to the standard series. Complications like osteoarthritis, avascular necrosis are noted on a long term follow up basis. The scoring system of Merle d'Aubigné is difficult to interpret especially when associated with other injuries which influence the parameters of its scoring system.

As the post-operative CT scans were not taken & instead post-operative radiographs were used to analyze the anatomicity of the reduction, there are chances of missing a small step off or incongruity of the joint. Hence the exactness of the radiological outcome can be questioned. As we have included undisplaced & minimally displaced fractures in our study which most of the times have a good outcome, probably would have added to our good to excellent results. The outcome of the individual fracture patterns could not be compared in this series because of the small sample sizes in many sub groups which on comparison will not yield a statistically significant result.

Conclusion

Acetabular fractures are complex injuries and should be viewed as an operative problem unless the criteria for nonoperative management are met. Conservative treatment is a safe, effective and cost-efficient treatment modality in minimally displaced fractures. Surgery provides good to excellent medium term results only if the fracture in reduced anatomically. The outcome results are influenced by the age of the patient, fracture pattern, associated injuries, delay to surgical fixation & the articular cartilage damage. Anatomical reduction is considered to be the main factor governing the functional outcome of the acetabular fractures. We had good to excellent results in our series of acetabular fractures which are comparable to the standard series [3, 18].

However, long term follow ups of the patients are required to determine the effectiveness of the reduction in preventing the late complications like AVN and osteoarthritis of hip and will hence determine the more accurate outcome of our acetabular fractures. Finally the determination of the functional outcome of the acetabular fracture is complicated due to the presence of associated injuries which have their influence on the outcome.

Conflict of interest: We declare that we have no conflict of interest related to the publication of this manuscript.

Reference

1. McMaster J, Powell J. Acetabular fractures, Current Orthopaedics. 2005; 19:140-154.
2. Letournel E, Judet R. Fractures of the Acetabulum. New York: Springer-Verlag, 1993.
3. Matta JM. Fractures of the acetabulum: accuracy of reduction and clinical results in patients managed operatively within three weeks after the injury. J Bone Joint Surg Am. 1996; 78:1632-1645.
4. Jimenez ML, Tile M, Schenk RS. Total hip replacement after acetabular fracture. Orthop Clin North Am. 1997; 28:435-446.
5. Armstrong JR. Traumatic dislocation of the hip joint. Review of one hundred and one dislocations. J Bone Joint Surg [Br]. 1948; 30:430-445.
6. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: Treatment by mold arthroplasty. J Bone Joint Surg [Am]. 1969; 51A:737-755.
7. Larson CB. Fracture dislocation of the hip. Clin Orthop. 1973; 92:147-154.
8. Rowe CR, Lowell JD. Prognosis of fractures of the acetabulum. J Bone Joint Surg [Am]. 1961; 43:30-59.
9. Nerubay J, Glancz G, Katznelson A. Fractures of the acetabulum. J Trauma. 1973; 113:1050-1062.
10. Stewart MJ, Milford LW. Fracture dislocation of the hip. An end results study. J Bone Joint Surg [Am]. 1954; 36:315-343.
11. Bost FC, Schottstaedt ER, Larsen LJ. Surgical approaches to the hip joint. American Academy of Orthopaedic Surgeons Course Lect 1954; 11:131-142.
12. Gibson A. Surgical approaches: the posterolateral approach to the hip joint. American Academy of Orthopaedic Surgeons Course Lect. 1953; 10:175-179.
13. Mayo KA. Surgical approaches to the acetabulum. Tech Orthop. 1990; 4:24-35.
14. Mehlman CT, Meiss L, DiPasquale TG. Hyphenated-history: the Kocher-Langenbeck surgical approach. J Orthop Trauma. 2000; 14:60-64.
15. Merle d'Aubigné R, Postel M. Functional results of hip arthroplasty with acrylic prosthesis. J Bone Joint Surg Am. 1954; 36:451-476.
16. Matta JM. Operative treatment of acetabular fractures through the ilioinguinal approach. A 10-year perspective. Clin Orthop Relat Res. 1994; (305):10-19.
17. Moed BR, Carr SE, Watson JT. Open reduction and internal fixation of posterior wall fractures of the acetabulum. Clin Orthop Relat Res. 2000; (377):57-67.
18. Matta JM, Merritt PO. Displaced acetabulum fractures. Clin Orthop. 1986; 230:83-97.
19. Mayo KA. Open reduction and internal fixation of the acetabulum. Results in 163 fractures. Clin Orthop. 1994; 305:31-37.
20. Giannoudis PV, Grotz M, Papakostidis C, Dinopoulos H.

Operative treatment of displaced fractures of the acetabulum. A meta-analysis. J Bone Joint Surg Br. 2005; 87:2-9.
21. Paul Tornetta III. Displaced Acetabular Fractures: Indications for Operative and Nonoperative Management. J Am Acad Orthop Surg. 2001; 9:18-28.
22. Murphy D, Kaliszer M, Rice J, McElwain JP. Outcome after acetabular fracture Prognostic factors and their inter-relationships. Injury, Int. J Care Injured. 2003; 34:512-517.
23. Liebergall M, Mosheiff R, Low J. Acetabular fractures: clinical outcome of surgical treatment. Clin Orthop. 1999; 366:205-216.
24. Brumback RJ, Holt ES. Acetabular depression fracture accompanying posterior fracture dislocation of the hip. J Orthop Trauma. 1990; 4(1):42-48.
25. Efstathios Katsoulis, Peter V. Giannoudis Impact of timing of pelvic fixation on functional outcome,. Injury, Int. J Care Injured. 2006; 37:1133-1142.
26. Moroni A, Caja VL, Sabato C, Zinghi G. Surgical treatment of both-column fractures by staged combined ilioinguinal and Kocher- Langenbeck approaches**.** Injury. 1995; 26(4):219-224.
27. Rice J, Kaliszer M, Dolan M, Cox M, Khan H, McElwain JP. Comparison Between Clinical and Radiologic Outcome Measures After Reconstruction of Acetabular Fractures**.** Journal of Orthopaedic Trauma 16(2):82-86.
28. Brueton RN. A review of 40 acetabular fractures: The importance of early surgery. Injury. 1993; 4:171-174.
29. Rommens M, Ingelfinger P, Nowak TE, Kuhn S. Traumatic damage to the cartilage influences outcome of anatomically reduced acetabular fractures: A medium-term retrospective analysis. J, Injury, Int. J Care Injured. 2011; 42:1043-1048.
30. Brooker AF, Bowerman JW, Robinson RA. Ectopic ossification following total hip replacement: incidence and method of classification. J Bone Joint Surg Am. 1973; 55:1629-1632.
31. Kaempffe FA, Bone LB, Border JR. Open reduction and internal fixation of acetabular fractures: Heterotopic ossification and other complications of treatment. J Orthop Trauma. 1991; 5:439-445.
32. Bosse MJ, Poka A, Reinert CM, Ellwanger F, Slawson R, McDevitt ER. Heterotopic ossification as a complication of acetabular fracture: Prophylaxis with low-dose irradiation. J Bone Joint Surg Am. 1988; 70:1231-1237.
33. Ghalambor N, Matta JM. Heterotopic ossification following operative treatment of acetabular fracture: An analysis of risk factors. *Clin Orthop.* 1994; 305:96-105.
34. Matta JM, Mehne DK, Roffi R. Fractures of the acetabulum. Early results of a prospective study. Clin Orthop and Related Res. 1986; 205:241-250.