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Title: Outcomes of Surgical Management of Acetabular Fractures Treated with Anterior Approaches

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Objectives:

In this study we aimed to evaluate the outcomes of anterior and combined approaches for treatment of acetabular fractures.

Materials and Method:

Thirty-seven acetabular fractures in 35 patients treated with an anterior approach were evaluated retrospectively. Fractures were classified according to Judet-Letournel. Early and final radiological evaluation was based on Matta's criteria. Modified Merle d'Aubigne and Postel criteria were used for functional assessment.

Results:

Eleven (30%) fractures were simple type and 26(70%) were mixed type. Two (18%) of the simple fractures were transverse and 9(82%) were anterior column fractures. Fourteen (54%) of the mixed type fractures were both column fractures, 5 (19%) were transverse+posterior wall, 5(19%) were T shaped and 2 (8%) were anterior column+posterior hemitransverse fractures. Surgical approach was ilioinguinal in 15 (43%) patients, Stoppa in 9 (26%) and combined 11 (31%). Our functional outcomes were perfect in 10 (27%) hips, good in 20 (54%), moderate in 4 (10%) and poor in 3 (8%). Our radiological results were perfect in 15 (40.5%) hips, good in 15 (40.5%), moderate in 4 (11%) and poor in 3 (8%).

Anterior surgical approaches provide satisfactory outcomes in appropriate fracture types. Posterior approach can be combined in certain fracture types. We think that rate of the requirement for a concomitant posterior approach for certain fractures of the acetabulum will decrease as experience increases.

INTRODUCTION:

Fractures of the acetabulum generally occur with high-energy injuries such as traffic accidents, but in the elderly population they can also arise with low-energy injuries associated with factors such as osteoporosis [1, 2]. Since active adult individuals are generally affected by these fractures, they lead to serious labor force and economic losses.

Acetabular fractures had been generally treated conservatively up until 50 years ago, but the poor outcomes caused by displaced fractures have led to increased interest in surgical treatment. This growing interest in surgery has also resulted in a variety of fracture classifications and surgical approaches. The aim in acetabular surgery is good reduction of the fracture, the achievement of a compatible joint and maintenance of stabilization[3]. An appropriate approach depending on fracture type must be selected for better reduction and exposure.

Ilioinguinal approach is used to treat fractures associated with the anterior aspect of the acetabulum. This approach has acceptable complication rates. It provides a wide visualization from iliac fossa to the symphysis pubis [4].

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The modified Stoppa approach is the modification of an approach which described by Rives and Stoppa for the hernia repair [5, 6]. This modification was made by Cole and Hirvensalo [7, 8]. This approach is an alternative to ilioinguinal approach at the anterior aspect of acetabulum. The modified Stoppa approach ensures access to medial wall of the acetabulum, quadrilateral surface and internal pelvis [9].

The purpose of this study was to evaluate the complications and functional and radiological outcomes of our anterior surgical approaches (modified Stoppa and ilioinguinal) in displaced fractures of the acetabulum. This paper is not a comparison of both approaches.

MATERIALS AND METHODS

Seventy-four patients were operated with a diagnosis of acetabular fracture in our department between 2011 and 2014. Sixty of these were determined to have attended regular follow-ups. Twenty-five (42%) of the 60 patients were treated with posterior approaches, 24 (40%) with an anterior approach and 11 (18%) with a combined (anterior+posterior) approach. Thirty-five cases in which an anterior approach was applied either alone or in combination with posterior approaches were evaluated retrospectively in this study. Thirty-seven acetabular fractures of 35 patients who had undergone anterior surgical approaches constituted the study material (Table 1). Surgeon's preference other than the type of fracture was the main determinant of the surgical approach in our study. Titanium alloy reconstruction plates were used for fixation.

Informed consent have been obtained from all of the patients or from the relatives of the patients before the operation.

Pelvic posteroanterior (PA) radiographs and oblique pelvic radiographs taken before and after the surgery and during clinical follow ups were evaluated. Fracture classification was based on the Judet-Letournel classification using these x-rays and preoperative computerized tomography (CT) images [3].

Postoperative reduction was based on the Matta reduction criteria on pelvic PA and oblique X-rays; 0-1 mm displacement was assessed as anatomical, 2-3 mm as successful and more than 3 mm as poor. Functional evaluation was performed with control forms based on Matta's modified Merle d'Aubigne and Postel criteria at final check-ups [10].

Radiological evaluations were performed on the basis of Matta's radiological assessment scale [11].

The Brooker classification was used for heterotopic ossification evaluation [12].

Statistical analysis was performed on SPSS 18 software ANOVA, the chi square test and Fisher's Exact test were used for hypothesis testing. P values <0.05 were regarded as significant.

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Ethics committee approval was granted from the ethical committee with file number of B.30.2.ATA.0.01.00/207/28.

RESULTS

Thirty-seven acetabular fractures of 35 patients who had undergone anterior surgical approach were evaluated; 10 patients were female (29%) and 25 were male (71%), patients' mean age was 38.3 (17-71) years and mean duration of follow-up was 21.3 (12-47) months. Twenty (54%) fractures were in the right hip and 17 (46%) in the left.

In terms of causes of fractures 17 (48%), acetabular fractures were due to in-vehicle traffic accidents (IVTA) in 17 (48%) patients, to falls from high places in 15 (43%), and to other causes in 3 (9%) (The one patient dropped a heavy weight on himself and two fell from horses).

Hip dislocation was present in two patients. These were reduced in the emergency department, and skeletal traction was applied until surgery with wire passed through the supracondylar region.

Sciatic nerve symptoms were present in two patients at time of presentation. These had resolved entirely in one patient at final check-up, and partially in the other.

Acetabular fracture was an isolated injury in 13 patients, while other accompanying injuries were present in the other 22 (63%), including upper and lower extremity fractures, genitourinary system injury, vertebral compression fractures and pelvic injuries (sacroiliac dislocation, pubic diastasis and sacrum fracture) (Table 2).

Eleven (30%) fractures were simple type and 26 (70%) were complex type. Two (18%) of the simple fractures were transverse and 9 (82%) were fractures of the anterior column. Fourteen (54%) of the complex fractures involved fractures of both columns, 5 (19%) were T-shape fractures, 5 (19%) were transverse+posterior wall fractures and 2 (8%) were anterior column +posterior hemitransverse fractures. Fracture types and approaches applied are shown in Table 3.

The mean time between trauma and surgery was 6.3 days (range 2-17 days). Surgical approach was ilioinguinal in 15 (43%) patients, modified Stoppa in 9 (26%) and combined in 11 (31% ilioinguinal+Kocher-Langenbeck). Combined approaches were performed in the same day and in the same session. The second surgical approach (Kocher Langenbeck) was added in the same session in cases which adequate reduction was not obtained with a single approach. Fixation was performed with screws and plates in all cases, and screw fixation alone was not used in any case (Figure 1-2).

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Anatomical reduction was determined in 15 (40.6%) of 37 acetabulum fractures, successful displacement in 16 (43.2%) and poor displacement in 6 (16.2%).

Paresthesia in the lateral hip associated with injury to the nervus cutaneus femoris lateralis was observed in one patient undergoing ilioinguinal surgery, and this persisted at 12th-month follow-up. Intra-articular screw was determined following ilioinguinal surgery in one patient with transverse and posterior wall fracture; the incision was re-opened on the second day after surgery and the screw was removed.

Superficial (ilioinguinal) infection developed in one (2.9%) of the 35 patients, and this was treated with dressing and antibiotic therapy. No DVT was observed in any case, and radiological screening was not performed.

Heterotopic ossification was determined in 3 (8.6%) of the 35 patients. Brooker grade I heterotopic ossification (combined approach) was observed in one case, grade II (combined approach) in one case and grade IV (ilioinguinal) in one case. Post-traumatic arthritis was determined in 3 (8.1%) hips.

Functional evaluation of fractures at final check-ups based on modified Merle d'Aubigne and Postel criteria revealed perfect functional outcomes in 10 (27%) hips, good outcomes in 20 (54%), moderate outcomes in 4 (10%) and poor outcomes in 3 (8%).

When the final radiological tests were evaluated based on Matta's criteria, radiological outcomes were perfect in 15 (40.5%) hips, good in 15(40.5%), moderate in 4 (11%) and poor in 3 (8%).

No statistically significant relation was determined between time from trauma to postoperative reduction (Spearman's test p: 0,089).

A significant correlation was observed in our study between quality of reduction achieved after surgery and radiological results (p: 0.001).

DISCUSSION

Since fractures of the acetabulum occur with high-energy injuries, they are frequently accompanied by other injuries. Additional injuries were present in 63% of our patients. The treatment of accompanying injuries is generally of a higher priority. Acetabulum surgery is not usually a procedure needing to be performed on an urgent basis, although unnecessary delays must also be avoided. Chondrolysis and osteonecrosis are known to increase when surgery is delayed [3]. In our study the mean time between trauma and surgery in our study was 6.3 days (range, 2-17).

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Thirty patients were operated within the first nine days, and five patients after 10 or more days. No statistically significant relation was determined between time from trauma to surgery and functional and radiological results, which we attribute to the small number of cases undergoing late procedures.

The aim of treatment in displaced fractures of the acetabulum is a complete and stable anatomical reduction, and a pain-free and functional hip as a result [10]. The best approach for complete anatomical reduction must be selected with care.

An ilioinguinal approach can be used in fractures of both columns, and in anterior column+posterior hemitransverse, anterior column, transverse, T-shape and anterior wall fractures 11. The ilioinguinal approach offers a number of advantages, including rapid return of muscle functions in the postoperative period, good cosmetic results and rare ectopic bone formation, suitability in several types of fracture, and low complication rates. However, it also has disadvantages, such as inability to visualize the joint and fragments being propelled into the joint during reduction [11].

Although not equal to the classic ilioinguinal approach, the modified Stoppa approach represents a potential alternative when anterior access to the acetabulum is required. The modified Stoppa approach can be used in fractures of the anterior wall, the anterior column, both columns, anterior column and posterior hemitransverse fractures, and in some transverse and T-shape fractures. This approach is practicable in transverse and T-shape fractures if the fracture line in the posterior column is high and close to the sciatic notch. Since the inguinal canal and its contents are not opened, it is a less invasive surgical procedure than the inguinal approach [13]. In our study, personal preference of the surgeon was the main factor in the choice between ilioinguinal and modified Stoppa.

Letournel reported a combined approach requirement of 10% in their series [4]. In our series, ilioinguinal or Stoppa was chosen as the first approach in all types of fractures in which anterior column was affected. When the posterior component was not sufficiently reduced or fixed from the anterior approach, a posterior approach was added (%31). We think that, this difference in rates of combined approach requirement will decrease as experiences increases.

Intra-articular screw malposition in acetabular fracture surgery, has been reported up to 7% [14, 15]. In our series an intra-articular screw was observed in one case in which an ilioinguinal approach was applied. Functional outcome was poor at 12th-month follow-up. This was one of the first cases, and the complication was not encountered subsequently.

Heterotopic ossification is seen at a level of approximately 14-50% following extensive approaches if prophylaxis is not performed, and at a level of 25% in the Kocher-Langenbeck approach without prophylaxis [16]. It is very rare in the ilioinguinal approach if the outer table of the ilium is not opened. Heterotopic ossification occurs within the first 3 months after trauma in the great

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majority of cases [17]. Indomethacin and low-dose radiotherapy have been described as effective in reducing clinically significant heterotopic ossification [18]. However, some studies have also questioned the effectiveness of prophylaxis. Matta and Siebenrock determined no effectiveness of indomethacin compared to placebo [19]. Karunakar et al. reported similar results in a similar study [20]. We did not use heterotopic ossification prophylaxis in any of our patients. We determined grade 1-2 (combined surgical approach) heterotopic ossification in two of our patients and grade 4 heterotopic ossification in one patient. The ilioinguinal approach was performed in our patient with grade 4 heterotopic ossification. This patient had additional injuries in the pelvis and was intubated and monitored for 4 days in intensive care.

Avascular necrosis has been reported at a level of 5.6% in patients undergoing surgery for fracture of the acetabulum, and to be more common in subjects with traumatic hip dislocation compared to those without hip dislocation [21]. Avascular necrosis developed in one of the 37 acetabular fractures in our study. Traumatic hip dislocation was present in this case.

Letournel described quality of reduction as the basic indicator of clinical success [3]. Long-term outcomes in acetabular fractures depend on quality of reduction [3, 4]. A high level of post-traumatic arthrosis is seen when reduction quality is poor. One meta-analysis assessed seven studies with a mean follow-up period of 60 months and reported an incidence of osteoarthritis of 13.5% when reduction was satisfactory (displacement <2mm) but of 43.5% when reduction was poor (>2 mm) [21]. In our study we reached similar findings, at correlation between reduction and radiological results.

Anatomic-successful reduction was achieved in 84% of acetabulum fractures in our study, perfect-good functional outcomes in 81% and perfect-good radiological outcomes in 81%. Our clinical outcomes and complication rates in anterior approaches are compatible with the previous literature.

The main limitations of this study are its retrospective nature and the small patient number. We attribute the statistically insignificant nature of relations such as those between fracture classification and functional outcome, or between age and functional outcome, to this low patient number.

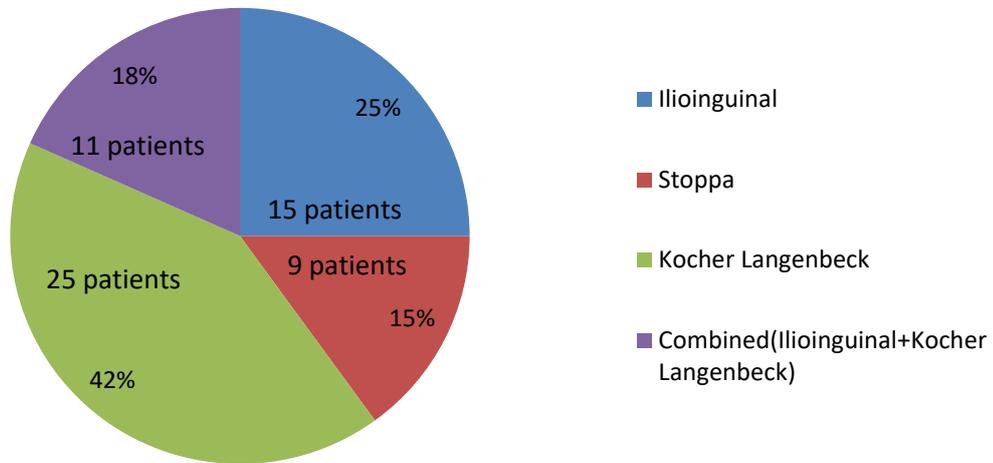
Anterior surgical approaches produce high levels of good outcomes in appropriate fracture types. We think that rate of the requirement for a concomitant posterior approach for certain fractures of the acetabulum will decrease as experience increases. The complications encountered in these approaches are within acceptable limits in terms of the anatomy of the region and the nature of the trauma.

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Table 1: Distribution of surgical approaches in 60 patients

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Approaches



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Table 2: Additional injuries observed in patients with acetabulum fractures

| Additional injury | Number of patients | % |
|--------------------------------|--------------------|------|
| Pulmonary contusion | 3 | 8.6 |
| Ureter injury | 1 | 2.9 |
| Urethra injury | 2 | 5.7 |
| Hepatic laceration | 1 | 2.9 |
| Rib fracture | 2 | 5.7 |
| Vertebral compression fracture | 2 | 5.7 |
| Femoral fracture | 3 | 8.6 |
| Distal end radius fracture | 2 | 5.7 |
| Humerus fracture | 2 | 5.7 |
| Calcaneus fracture | 2 | 5.7 |
| Double forearm fracture | 2 | 5.7 |
| Medial malleolus fracture | 1 | 2,9 |
| Other injury in the pelvis | 12 | 34.3 |

Table 3: Distribution of surgical approaches selected by type of fracture

| Fracture classification | Ilioinguinal | Stoppa | Combined |
|---|--------------|---------|----------|
| Anterior column | 2 (22%) | 7 (78%) | 0 |
| Transverse | 1 (50%) | 1 (50%) | 0 |
| Both columns | 9 (64%) | 0 | 5 (36%) |
| T-shape | 1 (20%) | 2 (40%) | 2(40%) |
| Anterior column+posteriorhemitransverse | 1 (50%) | 1 (50%) | 0 |
| Transverse+posterior wall | 1 (20%) | 0 | 4 (80%) |

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