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Surgical treatment of acetabulum posterior wall fractures: Comparison between undercountering and marginal impaction reconstruction method with odd methods



Emre Gültaç^a, Serkan İltar^a, Ahmet Özmeriç^{a,*}, Aykut Koçak^a,
Nevres Hürriyet Aydoğan^b, Kadir Bahadır Alemdaroğlu^a

^a Department of Orthopaedics, Ankara Training and Research Hospital, Ankara, Turkey

^b Department of Orthopaedics, Muğla Sıtkı Kocman University, Muğla, Turkey

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ABSTRACT

Background: Modern treatment principles for posterior wall fractures have become widespread in the last decade in many countries by means of international or local courses. The purpose of this study was to compare the clinical and radiologic outcomes of acetabulum posterior wall fractures using unconventional methods of fixation, including plates placed in unusual directions, or, in the case of reoperation, only interfragmentary screws. In addition, we examined acetabulum posterior wall fractures treated by open reduction and internal fixation with standard undercountered plates from ischion to iliac bone in latter cases.

Methods: Twenty-one patients who had open reduction and internal fixation of an unstable unilateral fracture of the posterior wall of the acetabulum between 2009 and 2013 were included. Group 1 was composed of 10 former patients who were treated with unconventional methods that included a compression technique with a direct plate or solely screw fixation. Group 2 was composed of latter 11 patients who were treated with standard surgery that included undercountered plates oriented from the ischial tuberosity to the iliac bone proximally and reconstruction of marginal impaction if necessary. The functional outcome was evaluated with the use of the clinical grading system adopted by Merle d'Aubigné and Postel. The Kellgren–Lawrence radiologic criteria were used for the radiologic assessments. The reduction of the fracture, posterior dislocation, marginal impaction, mean fracture particle amount, trochanteric osteotomy and avascular necrosis were compared between the two groups and examined with the Mann–Whitney *U* test.

Results: In Groups 1 and 2, the median score of the modified Merle d'Aubigné and Postel clinical scoring system was 16 (8–18) and 18 (14–18), respectively. The clinical scores between the two groups were statistically significant ($p < 0.01$). When two groups were compared using the Kellgren–Lawrence radiographic criteria for the development of osteoarthritis, the median value in Groups 1 and 2 was 3 (0–4) and 1 (0–3), respectively ($p < 0.01$).

Conclusions: This study displays the evolution of the surgical treatment of acetabular fractures of the posterior wall in our clinic. The older methods failed in terms of exposure, diagnosis of fracture anatomy and fixation techniques. Patients treated after the surgeons took courses in this field showed evidence of superior clinical and radiological scores. We attribute these benefits to exposure, definition and treatment of marginal impaction and fixation principles.

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1. Introduction

Although the operative treatment of acetabular fractures has become widespread in the last three decades, only a few centres have the technical expertise to effectuate a prompt treatment of these fractures.^{1,2} Currently, open reduction and rigid fixation is

* Corresponding author. Department of Orthopaedics and Traumatology, Ankara Training and Research Hospital, 06534, Ankara, Turkey.

E-mail address: aozmeric77@yahoo.com (A. Özmeriç).

typically the first choice in the treatment of acetabular fractures.^{2,3} In Turkey especially in the last 5 years, the standard surgical techniques have become more common since the introduction of the AO trauma and the Turkish Society of Orthopaedics and Traumatology (TOTBİD) pelvis and acetabular fractures courses.

Posterior wall fracture is among the most commonly seen types of acetabular fractures. This type of fracture is also the most frequently underestimated and may often be met with suboptimal care because of the simple appearance of the fracture pattern even without awareness of marginal impaction or other features. However, current studies show that progressive posttraumatic osteoarthritis can develop after displacements of more than 1 mm; also, functional and radiologic scores decrease after non-anatomical reduction.^{4,5} Anatomical reduction and marginal impaction reconstruction of the weight-bearing surfaces of the acetabulum (acetabular roof), consistence of femoral head and condition of the acetabulum are important factors in retaining normal hip functions.⁶

Considering the simplicity of the fracture pattern in posterior wall fractures, we wanted to determine if it is necessary to rigidly comply with the AO trauma and Letournal fixation principles or if unconventional surgical methods would also work. The objective of our study was to compare the treatment of acetabular posterior wall fractures with unconventional methods in former patients and standard methods in latter patients, by means of clinical, functional and radiological criteria.

2. Methods

Twenty-one acetabular posterior wall fractures were treated between 2009 and 2013 in our clinic; all had at least 18 months follow-up. Cases were divided into two groups: 10 patients in Group 1 and 11 patients in Group 2. Patients in Group 1 were treated with unconventional methods, including direct compression plates or solely interfragmentary screws, between May 2009 and December 2011. Patients in Group 2 were treated with standard surgery, which included marginal impaction reconstruction and undercountering plate for fixation, between December 2011 and December 2013. Mean follow-up time was 24 months (12–60 months). Nineteen patients were male, 2 patients were female and the average age was 34.9 (19–67). Fourteen patients had posterior dislocation of the hip joint with acetabulum fracture; in these cases, closed reduction was applied in the emergency department (Table 1). Traffic accidents (14 patients) were the primary cause of the acetabular fractures. Seven patients had more than one injury, five of whom required additional surgical procedures (see Table 2).

Antero-posterior, 45° oblique Judet (obturator and iliac oblique) pelvis X-rays and pelvic computed tomography (CT) was obtained from each patient in the emergency department. Surgical treatment indications were displacements of more than 3 mm, presence of free fracture particles in the joint and posterior instability. Time from the accident to the operation was a maximum of 3 weeks with an average time of 5 days. Preoperatively, one patient had a sciatic nerve injury that was healed 8 months after surgery. Subcutaneous enoxaparin (Clexane, Aventis Intercontinental, France)

and intravenous antibiotic prophylaxis were given after the injury.

A Kocher–Langenbeck incision was used in all cases. After reaching the fracture line, reduction was obtained with direct manipulation and indirect traction. In the fixation of the fractures, 3.5 mm screws and reconstruction plates were used.

In Group 1, trochanteric osteotomy was used for nine patients in Group 1. Articular surfaces were corrected if fragmented; corrections to marginal impactions were attempted if necessary. Solely interfragmentary screws were used in two patients, and unconventionally located plates were used in eight patients. Plates were bended neutrally to match the contours of the posterior wall surface without undercountering.

In Group 2, marginal impactions were corrected by an incomplete curved osteotomy from 8 to 10 mm away from the articular cartilage; the created gap site was supported by impacted iliac bone autograft. The reconstruction plates were located from the ischial tuberosity to the iliac bone with the undercountering method supplying direct compression to the posterior wall fragment in a standard manner in all of Group 2. The first screw was placed from the most distal hole on the ischial tuberosity. The plate was located 5–10 mm away the bone surface at the most proximal point. The second screw was placed proximal to the fragment, supplying contact of the plate with the bone when tightened. Thus, the belly of the plate compressed the fragment towards the femoral head. Trochanteric osteotomy was not used in Group 2.

Postoperatively, all patients were followed without skeletal traction; rehabilitation began with isometric exercises. Patients were mobilised without weight-bearing and using two crutches. Weight-bearing was started step-by-step at 8 weeks postoperative, and after 12 weeks, patients were allowed full weight-bearing. Clinical and radiological assessments were made at 1, 3, 6, 12 and 18 months after surgery. The average follow-up period was 24 months. The Merle d'Aubigné and Postel criteria were used for the clinical examination, and the Kellgren–Lawrence radiologic criteria were used for the radiologic assessments. Data were examined statistically with Mann–Whitney *U* test.

3. Results

Nineteen patients were male (90%), and 2 patients were female (10%); the mean age was 34.9 (19–67). *Posterior dislocation* was detected in eight patients in Group 1 (72%) and six patients in Group 2 (54%). There was no statistically significant difference between the two groups ($p > 0.05$) (Table 1).

The median fragment number and free fragment in joint was both 2 in each group ($p > 0.05$). When the preoperative CT scans were examined, *marginal impaction* was detected in six and eight patients in Groups 1 and 2, respectively. No statistically significant difference was found between the two groups ($p > 0.05$) (Table 1). Marginal impaction reconstruction was achieved in only 2/6 of the patients in Group 1. For 4/6 patients, marginal impaction was either not recognised or not able to be corrected because there was a residual step more than 1 mm was detected in their postoperative X-rays. Upon follow-up of these four patients, avascular necrosis of the femoral head had developed in two of them and total hip arthroplasty applied to these patients. In Group 2, marginal impaction reconstruction was successful for all the patients with marginal impaction (Table 1) (Fig. 1a–c).

Group 2 had significantly higher scores according to the *Modified Merle d'Aubigné and Postel Clinical Scoring System* with a median score of 18 (14–18) compared with Group 1 which had a median score of 16 (8–18) ($p < 0.01$).

Group 2 had significantly lower osteoarthritis scores than Group 1 according to the *Kellgren–Lawrence radiologic criteria*; the median scores were 3(0–4) and 1(0–3) in Groups 1 and 2, respectively

Table 1
Demographic data of patients.

	Group 1 (11 patient)	Group 2 (10 patient)	p
Fracture with dislocation	8	6	$p = 0.546$
Median fragment number	2	2	$p = 0.49$
Free fragment in joint	2	2	$p = 0.49$
Marginal impaction	6	8	$p = 0.228$

Table 2
Parameters related to the form of surgical treatment.

	Group 1 (11 patient)	Group 2 (10 patient)	
Modified Merle D'Aubigne and Postel Clinical Scoring System	16(8–18)	18(14–18)	$p = 0.008$
Kellgren–Lawrence Radiologic Criteria for Osteoarthritis	3(0–4)	1(0–3)	$p = 0.005$

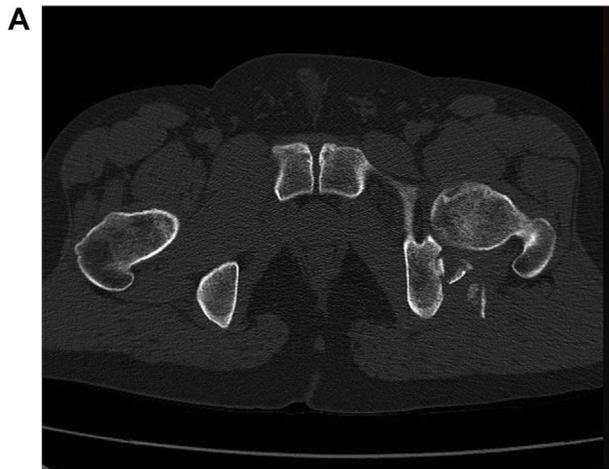


Fig. 1A. Preoperative CT view of a patient with posterior wall fracture and severe marginal impaction.



Fig. 1B. Intraoperative marginal impaction was corrected and grafted by autograft, which was harvested from ipsilateral iliac crest (dotted area). The impacted articular surface (arrows) was restored by using the femoral head as a scaffold.

($p < 0.01$).

During postoperative follow-up, six patients had *heterotopic ossification* (5 patients grade 1, 1 patient grade 2), whereas there was no heterotopic ossification in Group 2. There were statistically significant differences between the two groups ($p < 0.01$).

4. Discussion

The simple appearance of posterior wall fractures may result in their suboptimal treatment because of discrete preference in fixation techniques. This study indicates that older methods of exposure diagnosing the fracture anatomy and fixation techniques were not adequate for treatment of posterior wall fractures of the acetabulum. We appreciate the efforts of the pioneers of these techniques and dedicated education modern surgery of the acetabular surgery. The results of our study clearly indicate that cases performed after surgeons underwent specific AO trauma and TOTBID

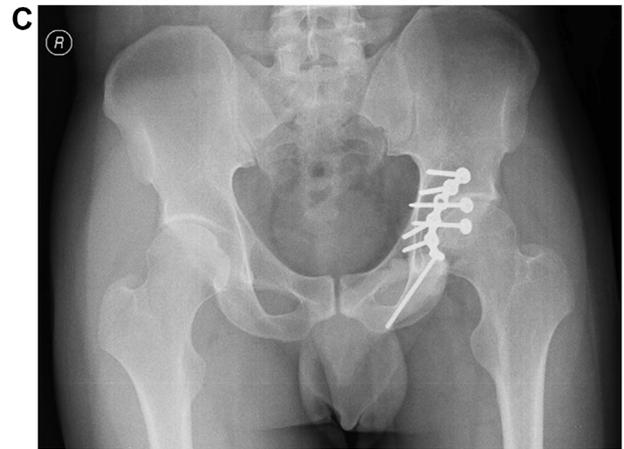


Fig. 1C. Postoperative x-ray of the same patient. A 3.5 mm reconstruction plate from ischial tuberosity to iliac bone and two interfragmentary lag screws were placed.

pelvis and acetabular fracture courses benefitted more from surgery as compared with our previous cases. These benefits can be explained as follows: (A) *Exposure*: Trochanteric osteotomy, which was widely used in Group 1, increased heterotopic ossification compared with Group 2. However, in Group 2, better reconstruction could be achieved without using an osteotomy. (B) *Definition and treatment of the marginal impaction*: where 4/6 were either not diagnosed or could not be corrected properly. (C) *Fixation principles*: Acetabular posterior wall fractures treated with marginal impaction reconstruction and the undercountering technique had better clinical and radiological scores than those with unconventional methods.

Precise reduction of the articular surface of posterior wall fractures is crucial, as the posterior wall comprises a large portion of the articular surface, which is particularly loaded in the flexion position. The reduction can be extremely difficult as these fractures are usually complex and involve more than one fragment. As the fracture mechanism is generally a posterior dislocation of the hip, marginal impaction often occurs. If this impaction is not corrected, a residual step remains permanently.^{6,7} In this study, we corrected marginal impactions in all Group 2 patients with incomplete curved osteotomy using a curved osteotome from 8 to 10 mm away from the articular cartilage supported by iliac bone autografts. In Group 1, marginal impaction was detected in six patients and reconstruction was applied in only two of them. For the anatomic restoration, if the clinician has a high index of suspicion, then the presence of marginal impaction should be detected.

Group 2 had favourable results without any trochanteric osteotomies. We attribute this to not having additional exposure and favourable vision to see the plate settlement area. Furthermore, trochanteric osteotomy can not provide additional contribution for even large-sized posterior wall fractures, which necessitates plate settlement more proximally under the origin of the gluteal muscles.

Reduction quality is directly related to clinical and radiological results.⁸ Careful preoperative planning should be undertaken in order to reveal the exact pathology.⁹ In 1986, Matta et al.¹⁰ were the first to classify acetabular articular reduction according to residual

displacement. In their initial work, they described an anatomic reduction as ≤ 1 mm of maximal articular displacement on any of the three plain radiographic views of the acetabulum. A maximal articular displacement of 1–3 mm was considered a satisfactory reduction, and a maximal articular displacement of >3 mm was considered an unsatisfactory reduction.¹¹ Later In 1996, Matta et al.¹² reported on the long-term outcomes in 259 patients with 262 displaced acetabular fractures that were all treated with open reduction and internal fixation within 21 days after the injury. The quality of the initial surgical reduction was the factor commonly associated with the eventual development of posttraumatic osteoarthritis as well as with the eventual development of a fair or poor clinical outcome. In our study, on the postoperative X-rays, a residual step more than 1 mm was detected in four patients in Group 1. Two of these patients developed avascular necrosis of the femoral head and went to have total hip arthroplasty. In one of them, non-union of the posterior wall was seen in the arthroplasty operation. Thus, the undercounting method should be the fixation method of choice for acetabular posterior wall fractures. After posterior wall fragment reduction, an undercounted reconstruction plate should be placed from the ischial tuberosity to the iliac bone. Firstly, screw must be placed to ischial tuberosity and the second screw must be placed to proximal plate screw holes. This technique prevents the posterior wall fragment displacement by compressing on the wall fragment under plate, and thus, a more stable than fixation is achieved then with compression plates or interfragmentary screws.

5. Conclusions

This study displays the evolution of the surgical treatment of acetabular fractures of the posterior wall in our clinic. Older treatment methods failed in terms of exposure, diagnosis, fracture anatomy and fixation techniques, whereas patients treated after their surgeons took specific courses in this field had improved

clinical and radiological scores. We attribute these benefits to exposure, definition and treatment of the marginal impaction and fixation principles.

Conflicts of interest

The authors have none to declare.

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