

Outcome of unstable isolated fractures of the posterior acetabular wall associated with hip dislocation

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Abstract

Background Traumatic hip dislocation with fracture of the posterior acetabular wall is associated with high rates of residual invalidity.

Methods The records of patients who underwent surgical treatment of traumatic dislocation of the hip associated with an isolated fracture of the posterior acetabular wall from 1999 to 2009 were reviewed. There were 30 men and 12 women, who at the time of the trauma had a mean age of 42 years (range 21–65). Mean follow-up duration was 5 years (range 2–10). Pre-operative fracture evaluation was based on the classification of Judet et al. which divided this fractures into three types: type 1 is characterized by a single fracture line separating a single bone fragment from the remaining part of the posterior wall; type 2 fracture involves several fragments of the posterior wall and in type 3, a type 1 or type 2 fracture is associated with a sunk cancellous area in the acetabular wall medial to the fracture line but not affected by it, due to the shear impact of the femoral head at the time of dislocation. Clinical evaluation of the outcome was according to the criteria of Merle D'Aubigné and Postel as modified by Matta. Outcomes were divided into excellent/good and fair/poor. Since

treatment was standard, data were further analyzed to assess the relative importance of age, sex, follow-up duration, sciatic nerve lesion on admission and mechanism of injury, using the Chi-square test.

Results Full clinical recovery without sequelae or radiographic abnormalities was achieved by 10 patients, 8 with type 1 fracture and 2 with type 2 fracture. A good outcome was seen in 13 patients, 3 with type 1 fracture, 9 with type 2 fracture and 1 with type 3 fracture. Eight patients, 3 with type 2 fracture and 5 with type 3 fracture, had a fair outcome. Only follow-up ≥ 6 years influenced outcome significantly ($p > 0.005$).

Conclusion Our conclusions in light of our experience are that in type 1 lesions, anatomical reduction and stabilization achieve excellent outcomes, both clinical and radiographic; type 2 fractures pose greater prognostic problems because their outcome is determined by the success of the reduction and fixation of a multi-fragment fracture; finally, different considerations apply to type 3 fractures, which present varying degrees of comminution and an impacted acetabular surface: their outcome depends on the quality of the anatomical and morphological restoration of acetabular congruence.

Keywords Unstable fractures · Traumatic hip dislocation · Acetabular wall · Isolated fractures · Outcome

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Introduction

Posterior wall fractures are common and comprise approximately 24 % of all acetabular fractures sec Letournel and Judet [1] and about 25 % of all acetabulum fractures sec Moed [2]. In this study, we consider only isolated unstable fractures associated with hip dislocation. In all cases, the

hip dislocation was posterior. After initial successful closed reduction confirmed by plain radiographs in the emergent setting, CT with 3D reconstruction is obtained for a more detailed evaluation of morphologic features of the fracture. Therefore, CT should be considered today an essential test in pre- and post-operative study of these lesions. Other aspects still controversial concern the treatment of these lesions. In this retrospective study, we want to clarify some diagnostic, prognostic and therapeutic aspects of traumatic dislocation of the hip associated with fracture of the posterior acetabular wall based on our experience and the literature.

Methods

The records of all the patients who underwent surgical treatment for traumatic dislocation of the hip associated with an isolated fracture of the posterior acetabular wall from 1999 to 2009 were retrieved from the departmental archives. Only isolated unstable fractures that were managed surgically over the last 10 years were included (Figs. 1a, b, 2a, b, 3a, b). Posterior wall fractures associated with other types of acetabular lesions or without hip dislocation and simple fracture dislocations were excluded. Patients were 30 men and 12 women who at the time of the trauma had a mean age of 42 years (range 21–65), with a particularly high incidence of individuals in the third and fourth decade of life. Mean follow-up duration was 5 years (range 2–10). The mechanism of injury was a car accident in 30 cases, a motorcycle accident in 6, an accidental fall from a height in 4 cases and a sport-related trauma in 2 cases (a cyclist and a skier). In all 42 cases, the femoral head had dislocated posteriorly. Nine patients (about 21 %) had sciatic nerve paralysis on admission.

The diagnostic approach to these patients at our institution involves a standard X-ray examination of the affected hip (Fig. 1b) and a standard CT examination (Fig. 2b) with 3D reconstruction (Fig. 3b) of both hips. We find that in this type of lesion, CT is more informative than Judet X-ray views. The diagnostic advantages of CT include better depiction of fracture morphology, size of the posterior fragments and small areas of impaction; clearer visualization of type and extent of fragment displacement, and easier identification of intra- and/or extra-articular bone fragments. Pre-operative fracture evaluation was based on the classification of Judet et al. [3], which is still the most widely used. In their system, fractures are divided into three types: type 1 is characterized by a single fracture line separating a single bone fragment from the remaining part of the posterior wall; type 2 fracture involves several fragments of the posterior wall; in type 3 a type 1 or type 2 fracture is associated with a sunk cancellous area in the

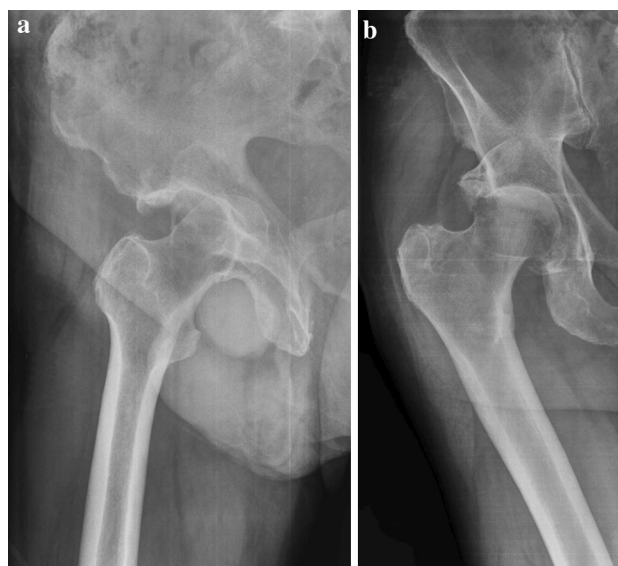


Fig. 1 X-rays showing right hip dislocation and a fragment of the posterior portion of acetabulum (a), X-rays after reduction in dislocation (b)

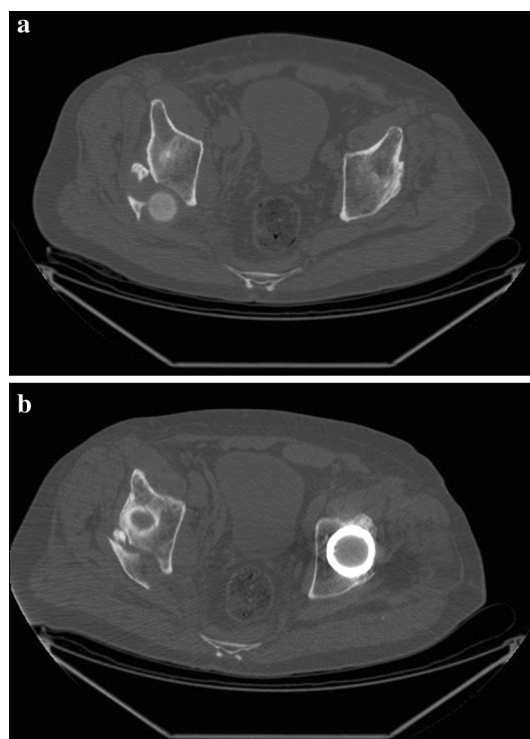
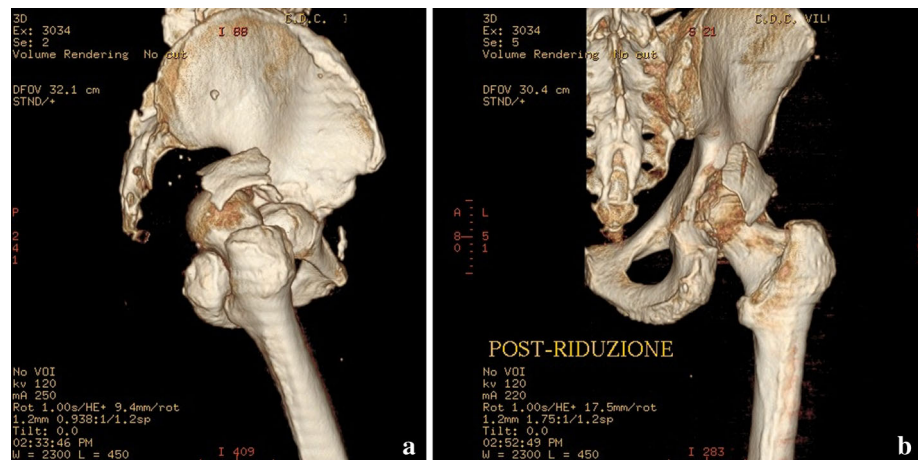


Fig. 2 CT scan showing right hip dislocation and a fragment of the posterior portion of acetabulum (a), CT scan after reduction in dislocation (b)

acetabular wall medial to the fracture line but not affected by it, due to the shear impact of the femoral head at the time of dislocation. We had 11 type 1, 15 type 2 and 16 type 3 fractures.

Fig. 3 CT with 3D reconstruction showing right hip dislocation and a fragment of the posterior portion of the acetabulum (a), 3D CT scan after reduction in dislocation (b)



Their management upon presentation to the ED was closed reduction within 6 h of the dislocation. All dislocations were reduced. The time between dislocation reduction in the ED and surgical reduction in the posterior wall fracture ranged from 4 to 14 days, depending on the clinical condition of the polytrauma patient. In the interval, the leg was placed in skeletal traction to prevent secondary dislocation or a secondary cartilage injury due to joint instability. For the fracture reduction, the patient was placed in prone position, the fracture was exposed using a posterior access according to Iselin [4] after isolation of the sciatic nerve. Nine of our patients had sciatic nerve paralysis on admission, 6 had partial paralysis of the tibial portion and 3 had complete paralysis. During the operation, we first isolate the sciatic nerve, which though bruised, generally preserves its original length. We subsequently explore the joint cavity for any loose fragments, then address the anatomical reconstruction of the posterior acetabular wall and fracture synthesis (Fig. 4a–c). We always carefully preserve the residual capsular insertions on the fragment, avoiding excessive fragment dissection to prevent acetabular necrosis. The medial circumflex femoral artery, which supplies the femoral head, is identified and carefully avoided.

Intra-articular fragments were depicted on CT scans in 12 patients (28.5 %) and removed. Eight of the 11 type 1 fractures were managed with 2 (7 patients) or 3 (1 patient) interfragmentary screws. In the remaining 3 cases, we used an interfragmentary screw and a plate with screws for better stabilization. The 15 type 2 lesions were reduced and stabilized with plate and screws; in 6 patients plaque application was preceded by interfragmentary fixation of the larger fragments. In 10/16 type 3 fractures, the articular plane had to be raised and the fracture synthesized with plate and screws. In the other 6 patients, a residual

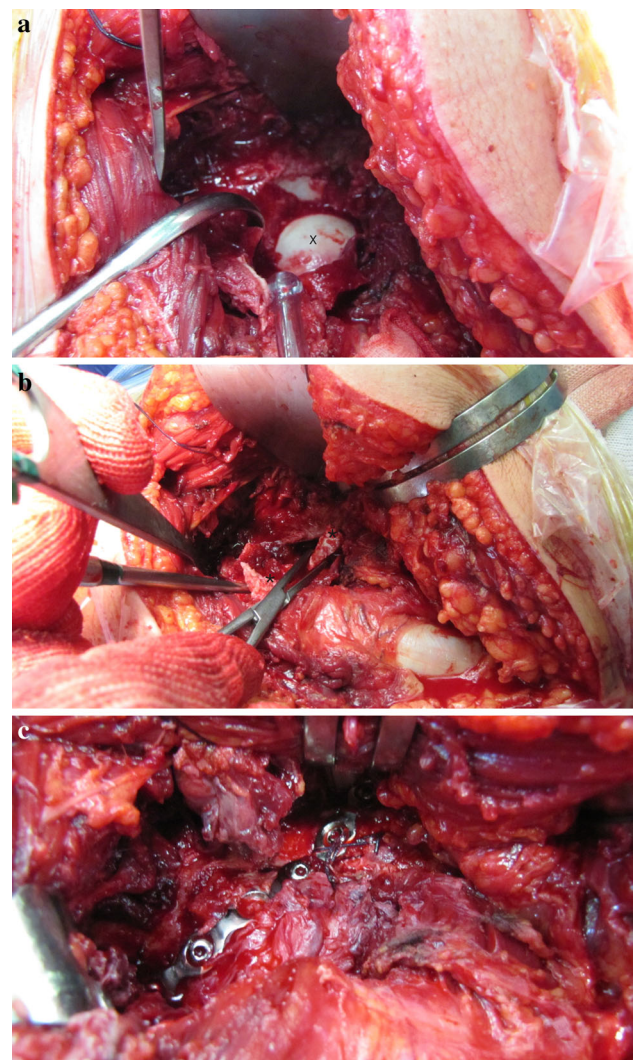


Fig. 4 Intra-operative photograph: joint cavity: X = femoral head (a) Asterisk loose fragments (b); anatomical reconstruction and fracture synthesis (c)

subchondral bone substance defect of the acetabulum remaining after raising the articular plane was filled with spongy bone grafts from the iliac crest; the fracture was then stabilized with plate and screws. Two patients had post-operative palsy of the tibial portion of the sciatic nerve (Table 1).

Clinical evaluation of the outcome was according to the criteria of Merle D'Aubigné and Postel [5], as modified by Matta [6]. The method considers pain, ambulation and range of motion (ROM), which are assigned scores ranging from 6 to 2 (pain) and from 6 to 1 (ambulation and ROM). The final score is calculated by adding the points assigned to all three parameters. Full scores (18 points) correspond to excellent outcomes; scores of 15–17 to good outcomes; scores of 13–14 to moderate outcomes and scores <13 to poor outcomes.

Instrumental evaluation of the outcome was performed using CT scan in the immediate post-operative and standard X-ray views at 1, 3, 6, 12 months and 2 years after surgery. The results rated according to the criteria described by Matta [6]: *excellent*: normal acetabulofemoral joint; *good*: minimum subchondral sclerosis and joint space narrowing not exceeding 1 mm; *fair*: moderate subchondral sclerosis and joint space narrowing not exceeding 50 %; *poor*: marked sclerosis and disappearance of the joint line. For the sake of simplicity, outcomes were divided into excellent/good and fair/poor. Since treatment was standard, data were further analyzed to assess the relative importance of age, sex, follow-up duration, sciatic nerve lesion at admission and mechanism of injury, the Chi-square test. Each of these factors was analyzed to see

whether there is an association between this and the final results. We chose a level of probability of $p < 0.05$.

This study was approved by the Research Ethics Board at Ospedali Riuniti Hospital.

Results

Full clinical recovery without sequelae or radiographic abnormalities (excellent outcome) was achieved by 10 patients, 8 with type 1 fracture and 2 with type 2 fracture. A good outcome was seen in 13 patients, 3 with type 1 fracture, 9 with type 2 fracture and 1 with type 3 fracture (score 15–17 points). These patients had some slight difficulty in walking on rough ground, modest pain with the leg extended and minimum limitation of daily activities; their radiograms depicted modest arthritic changes characterized principally by joint space narrowing (1 mm) and minimum subchondral sclerosis (Fig. 4). Eight patients, 3 with a type 2 fracture and 5 with a type 3 fracture had a fair outcome (clinical score 13–14 points). Their radiographs documented moderate subchondral sclerosis and joint space narrowing not exceeding 50 %. In the remaining 11 cases (1 type 2 and 10 type 3 fractures), the clinical outcome was poor with painful joint stiffness, pain on ambulation and considerable limitations in daily activities (score <13 points) documented by X-ray findings of severe osteoarthritis (OA), marked sclerosis and joint space effacement, which in 5 cases was complicated by advanced femoral head necrosis. These 11 patients underwent successful total hip replacement. The 11 patients who had

Table 1 Synopsis of the results

Type of fractures	Sex (M/W)	Mechanism of injury	Follow-up (years)	Clinical evaluation	N. SPE-paralysis
Type I	8 Men	7-Car accident	2–10	8-Excellent outcomes (18 points)	1-Partial (pre.)
11	3 Women	1-Motorcycle accident		3-Good outcomes (15–17 points)	1-Full (pre.)
		2-Fall from a height			1-Partial (post.)
		1-Sports (skier/cyclist)			
Type II	10 Men	11-Car accident	2–10	2-Excellent outcomes (18 points)	3-Partial (pre.)
15	5 Women	2-Motorcycle accident		9-Good outcomes (15–17 points)	1-Full (pre.)
		1-Fall from a height		3-Moderate outcomes (13–14 points)	
		1-Sports (skier/cyclist)		1-Poor outcome (<13 points)	
Type III	12 Men	12-Car accident	2–10	1-Good outcomes (15–17 points)	2-Partial (pre.)
16	4 Women	2-Motorcycle accident		5-Moderate outcomes (13–14 points)	1-Full (pre.)
		1-Fall from a height		10-Poor outcomes (<13 points)	1 (post.)
Total	30 Men 12 women	30-Car accident	2–10	10-Excellent outcomes (18 points)	6-Partial (pre.)
42		6-Motorcycle accident		13-Good outcomes (15–17 points)	3-Full (pre.)
		4-Fall from a height		8-Moderate outcomes (13–14 points)	2-Partial (post.)
		2-Sports (skier/cyclist)		11-Poor outcomes (<13 points)	



Fig. 5 Radiographic follow-up of the right acetabular fractures at 2 years

sciatic nerve paralysis, traumatic in 9 and post-operative in 2 cases, recovered in less than 2 years; there were 7 full and 4 partial recoveries. The long-term complications experienced by our patients were post-traumatic hip joint OA (14, or 37.5 % of patients with fracture type 3), femoral head necrosis (11.9 %) and sciatic nerve palsy (26 %). Data analysis of the independent variables (age, sex, sciatic nerve injury and mechanism of injury) showed that none of these factors significantly affected outcome, only follow-up ≥ 6 years influenced it significantly. Therefore, we think that outcomes are mainly influenced by the surgical technique and the accuracy of reduction. These two factors were initially evaluated by CT scan, and then to follow up with radiograph (Fig. 5).

Discussion

Traumatic dislocation of the hip associated with fracture of the posterior acetabular wall is a common and extensively described lesion [1, 2, 6–11]. Nonetheless some diagnostic and therapeutic issues are still debated.

The diagnostic aspects essentially involve the precise identification of lesion type, due to the limitations of conventional radiography. The diffusion of CT, which provides greater information about fracture characteristics, degree of fragment displacement, acetabular impaction and number and size of intra-articular fragments, has largely solved this problem; CT should therefore be employed both in the work-up and in the follow-up of these fractures [12]. Several authors described methods to evaluate hip stability based on the size of the posterior wall fracture fragment as determined by CT [13, 14]. These authors concluded that posterior wall fractures involving less than 20 % of the

posterior wall showed stable to a CT evaluation those involving greater than 40–50 % are unstable [13–16]. Opinions are discordant in fractures involving between 20 and 50 % of posterior wall of acetabulum. There are numerous methods to evaluate the stability of the hip after reduction in the femoral head in order to guide about the type of treatment.

Moed et al. [17] believe that dynamic stress examination under general anesthesia is a predictive method to evaluate the hip stability in posterior wall fractures.

Clinical outcome is importantly affected by the accuracy of anatomical reconstruction. Matta [6] reported significantly worse long-term outcomes if anatomical reduction was associated with displacement ≥ 3 mm compared with displacement of 1 mm. Other researchers [18] believe that a displacement of 2 mm may justify non-surgical treatment. Pantazopoulos et al. [19] described excellent results in 90 % of patients whose fracture was reduced anatomically; interestingly, 50 % of patients with a residual fragment displacement of 1–3 mm had excellent results. It is also important to distinguish the displacement of fracture fragments in the presence of gaps or steps. According to Rickman and Bircher [10], a gap of 2 mm does not involve significant joint incongruity, whereas Letournel and Judet [1] reported that a residual step exceeding 2 mm leads to a poor outcome.

These often contradictory clinical and experimental data led us to extend the surgical indication to all fractures involving >20 % of the posterior wall, even stable ones; those with a gap >2 mm and a step of 1 mm on CT; and those with acetabular impaction and/or one or more intra-articular fragments.

Any subchondral defects remaining after elevation of the impacted articular plane are filled with iliac crest or greater trochanter grafts. Their fixation is unnecessary according to some authors [10], because the femoral head preserves the articular plane and prevents fragment movement. Faced with a severely comminuted fracture with an impacted articular surface, we fill the residual subchondral cavity with spongious bone from the posterior iliac crest and use plate with screw to raise the articular plane. In our study, 10 cases with type 3 fracture had a poor clinical and radiographic outcome despite plane elevation and restoration of bone defects with a cancellous bone grafts, in line with previous reports of type 3 fractures [9].

The long-term complications experienced by our patients were post-traumatic acetabulofemoral joint OA, femoral head necrosis and sciatic nerve palsy. Post-traumatic OA had an incidence of 14 %. Arthritis was the most severe and frequent (37.5 %) sequela observed in type 3 lesions, in line with in the literature [11, 20]. The articular surface of the acetabulum, particularly in multi-fragment fractures with wall impaction (type 3), rarely escapes arthritis despite

correct anatomical reconstruction. The stress and strain associated with weight bearing and ambulation require absolute integrity of the acetabular architecture, a situation that no surgical treatment can restore, especially in type 3 lesions. However, in other lesion types even perfect reduction does not always prevent the establishment of an OA process over time, because of a number of factors that cannot be controlled: impaction of the femoral head at the time of the traumatic dislocation, pain with consequent cartilage necrosis and resorption of the posterior acetabular wall [1, 8]. Letournel and Judet found acetabulofemoral joint OA in 16 % of patients despite perfect reduction in the posterior wall after 25 years; Matta [6] reported a proportion of nearly 32 %. Our six patients underwent successful total hip replacement, even though arthroplasty is more technically challenging with traumatic than non-traumatic arthritis [21]. The incidence of femoral head necrosis was 11.9 % in our sample. Quite variable figures have been reported in the literature, ranging from 5.3 % reported by Epstein [7], to 7.5 % Letournel and Judet [1], to 9 % Giannoudis et al. [13] and up to the 26 % Daum et al. [22]. We found head necrosis in 11 % of our patients (1 type 2 and 4 type 3 fractures). The clinical and radiographic evidence of this complication appeared simultaneously over a period of 1–4 years from the trauma at variance with previous reports, where radiographic findings are described in the first year, often before the appearance of clinical symptoms [23]. Necrosis of the acetabular wall, heterotopic ossification or pseudarthrosis of the acetabulum was never observed in our patients. The risk of acetabular necrosis due to a post-traumatic ischemic insult can be increased by aggressive surgery approaches, unsuitable reduction maneuvers and fixation methods. We were careful to preserve as much as possible of the periosteal and capsular structures to protect the residual blood supply to the acetabular wall. Sciatic nerve palsy was seen in 9 patients on admission. Surgical exploration demonstrated that it was bruised but otherwise intact. Two patients had post-operative paralysis of the tibial portion of the nerve. All 11 patients recovered less than 2 years after the trauma. Our experience suggests to us that in type 1 lesions anatomical reduction and stabilization achieve excellent outcomes, both clinical and radiographic. Type 2 fractures pose greater prognostic problems because their outcome is determined by the success of the reduction and fixation of a multi-fragment fracture. Different considerations apply to type 3 fractures, which present varying degrees of comminution and an impacted acetabular surface. Their outcome depends on the quality of the anatomical and morphological restoration of acetabular congruence.

Conflict of interest The authors declare they have no conflict of interests.

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