Open reduction and internal fixation of femoral head fractures

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Background
Fracture of the femoral head is a relatively rare injury, which is often associated with a poor functional outcome. The treatment of femoral head fractures is a controversial subject in many respects.

Patients and methods
Ten patients with a fracture dislocation of the hip were admitted to the Zagazig University Hospital. Each fracture type was classified according to the Pipkin classification; six of the ten patients had a Pipkin Type II, two patients had a Pipkin Type I, and two patients had a Pipkin Type III fracture. All the fractures were associated with a posterior dislocation. There were no instances of damage of the sciatic nerve. The average age of the patients at the time of injury was 37 years (range 27–66 years). The vast majority (six patients) sustained the injury in a car accident. The anterior approach was used in all the cases. Outcome was assessed on the basis of physical and radiographic evaluation, in addition to the Merle d'Aubigné and Postel and the Thompson and Epstein scores.

Results
Follow-up of at least 2 years was available for all patients (average follow-up 64 months, range 24–55 months). The overall outcome, irrespective of the fracture type or treatment, was excellent/good in 50%, fair in 30%, and poor in 20%.

Complications
There were four post-traumatic (presurgical) sciatic nerve injuries; they recovered almost completely. There were no surgical nerve injuries. One patient developed (Brooker I) heterotopic ossification. Two cases of avascular necrosis were seen; one of these had an unreduced fracture dislocation for 7 days.

Conclusion
We believe that newer techniques and approaches allow us to improve the outcome of femoral head fractures. Anatomic reduction leading to a perfectly congruent joint is the goal of treatment. Careful evaluation of the reduction (preoperatively and postoperatively) using computed tomography scan is mandatory. When surgery is required, it is very important to use an approach that provides an excellent view of and access to the fracture, thus allowing perfect anatomic reduction and fixation.

Keywords:
femoral head, fracture, internal fixation

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A fracture of the femoral head, is a rare lesion. A fracture involving only the head has been found to be associated with 10% of all posterior dislocations of the hip [1].

Many authors believe that the head fragment should be treated by open reduction and internal fixation to achieve better results [2–4].

Kelly and Yarborough [5] published data on 27 cases observed from 1956 to 1969. On the basis of their series, they made specific recommendations and described a method of open reduction and screw fixation, which was used in seven cases. In this procedure, the retained fragment was not detached from its connection to the ligamentum teres or retinaculum before it was reduced and fixed with screws. In 1973, however, Sarmiento and Laird [6] described a case in which the head fragment was detached from the ligamentum teres and retinaculum and was then reduced and fixed with screws. After 8½ years, this patient achieved a good result.

In Epstein's extensive series of traumatic dislocation of the hip head [7], there were 46 cases in which there was an associated fracture of the femoral head. Fourteen of these 46 fracture-dislocations were treated by closed reduction, with eight poor, six fair, and no good results. Fifteen were treated initially by closed reduction and subsequently by open reduction, with seven poor, three fair, and five good results. In all five of the hips with good results, the detached fragment, which included less than one-third of the femoral head, was excised. Another 17 hips were treated by primary surgical procedures. Of these 17, eight had good, two had fair, and seven had poor results. In the seven with poor results, either the femoral head fragment included more than one-third of the

femoral head or there was an associated fracture of the femoral neck. Internal fixation was not used in any case.

More recently, Roeder and DeLee [8] reported 13 fractures of the femoral head associated with posterior dislocation of the hip. Four were classified as Pipkin Type I fractures – the type that was studied. Of these four, one was treated by closed reduction and the other three were treated by immediate or delayed open reduction. The results were good in three and poor in one.

Treatment protocols for femoral head fractures are difficult to establish because of their limited incidence and the different outcome classifications used in the literature. A review of the literature by Brumback *et al.* [9] 15 years ago resulted in a total of 144 reported Pipkin cases. However, because of the lack of illustrations, radiographs, descriptions, and follow-up, only 78 (54%) of these could be used in their analysis of outcomes. More recently, a review in the German literature led to similar difficulties [10].

With controversies on the classification, treatment, and outcome of these fractures, we aimed to critically review our own experience to help optimize the results in these often severe injuries.

Patients and methods

From June 2006 to December 2009, 10 patients with a fracture dislocation of the hip were admitted to the Zagazig University Hospital. Each fracture type was classified according to the Pipkin classification [11]; six of the 10 patients had a Pipkin Type II, two patients had a Pipkin Type I, and two patients had a Pipkin Type III fracture. All the fractures were associated with a posterior dislocation. There were no instances of damage of the sciatic nerve. There were two women and eight men. The average age at the time of injury was 37 years (range 27–66 years). The vast majority (six patients) sustained the injury in a car accident. The anterior approach was used in all the cases; trochanteric osteotomy was performed in one patient.

Surgical technique

In the anterior exposure, the hip was dislocated by flexion, adduction, and external rotation. The detached fragment of the head, which remained in the acetabulum when the hip was dislocated, was removed by sectioning the ligamentum teres and was then reattached with two screws. One screw (Herbert screw) was placed in the fovea and the other (stainless steel) in the inferior subcapital area of the femoral neck, where it would not come into contact with articular cartilage or the weight-bearing surface in eight patients. In two patients, two Herbert screws and one stainless-steel screw were used. The acetabulum was carefully debrided of bone fragments and torn pieces of capsule and synovial tissue, and the femoral head was reduced. All capsular incisions or tears were sutured, all muscle tears were repaired, and the trochanter was reattached using the tension-band technique in one patient. After open reduction and

Table 1 Merle d 'Aubigné and Postel score [12]

Pain	Mobility	Ability to walk
0. Intense and permanent	Ankylosis with bad position of the hip	None
1. Severe even at night	No movement; pain or slight deformity	With crutches only
2. Severe when walking, prevents any activity	Flexion under 40° with limited activity	With canes only
3. Tolerable	Flexion between 40 and 60°	With one cane, less than 1 h
4. Mild when walking, disappears at rest, patient can reach his foot for a short time	Flexion between 60 and 80°	Without a cane and with a limp
5. Mild and not constant; normal activity abduction of at least 15°	Flexion between 80 and 90°	Without cane, but with slight limp
6. None	Flexion more than 90°; abduction to 30°	Normal

A total of 18 points is classified as excellent, 15–17 as good, 12–14 as fair, and less than 12 as poor.

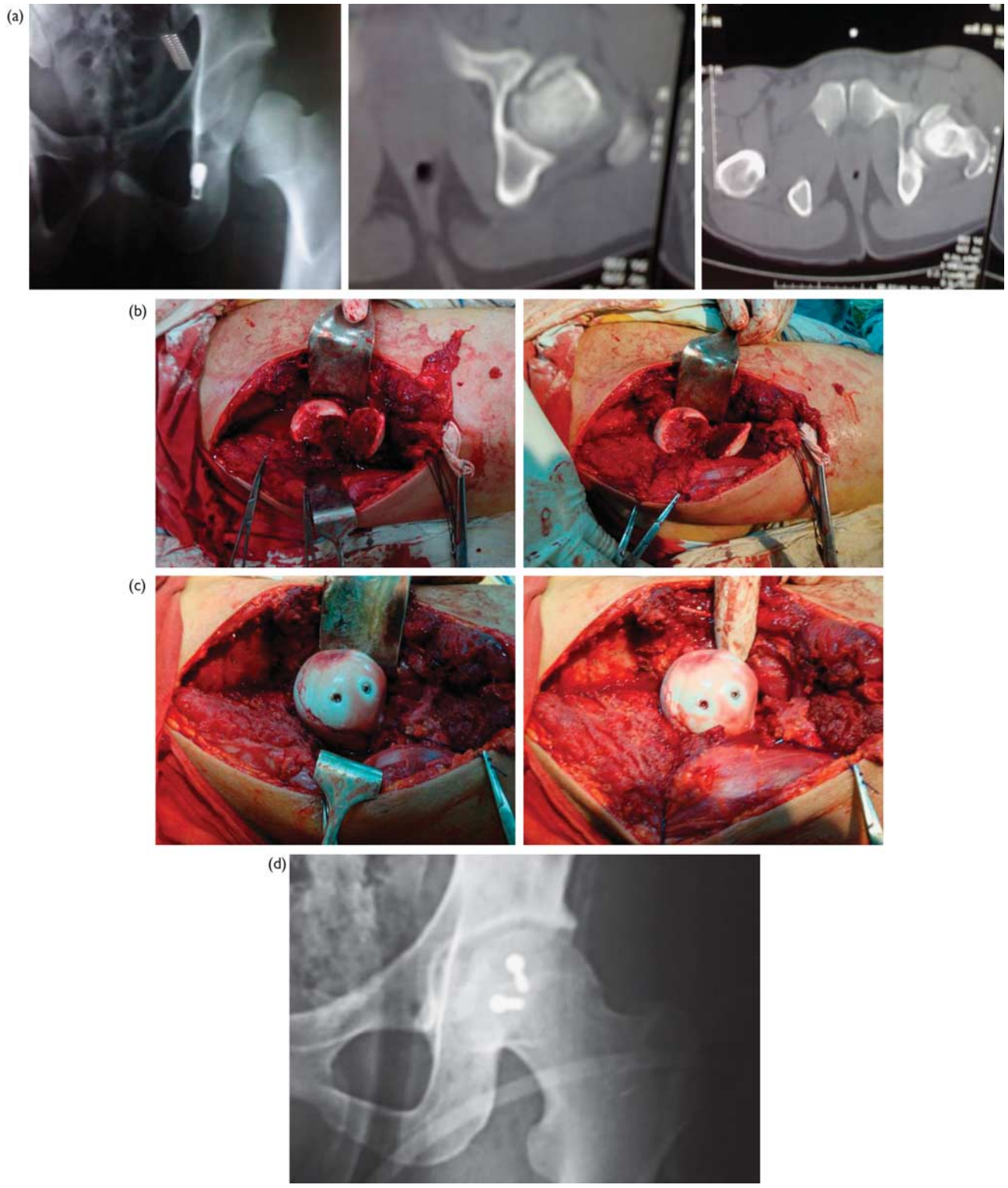
Table 2 Thompson and Epstein score [13]; the lower of the two determines the final score

Excellent	Normal femoral head–acetabular relationship
No pain	Normal joint space
No limp	Normal femoral head density
Full hip motion	No spur formation
	No soft tissue calcification
Good	Normal femoral head–acetabular relationship
No pain	Minimal joint space narrowing
Slight limp	Mild deossification
At least 75% of normal hip motion	Minimal spur formation
	Minimal capsular calcification
Fair	Normal femoral head–acetabular relationship
Pain, but not disabling	Moderate joint space relationship
Antalgic gait	Mottling of the femoral head
Moderate limitation of hip motion	Moderate spur formation
	Moderate soft tissue calcification
	Depression of subchondral bone in femoral head
Poor	Marked loss of joint space
Disabling pain	Increased density of femoral head
Marked limitation of hip motion	Subchondral cyst formation
Adduction contracture	Redislocation gross deformity of the femoral head
	Severe spur formation
	Acetabular sclerosis

Table 3 Results of the current study by fracture classification

	Pipkin type		
Results (%)	I	II	III
Excellent/good	2/2 (100%)	3/6 (50%)	
Fair	0	2/6 (33%)	1 (50%)
Poor	0	1/6 (17%)	1 (50%)

Figure 1



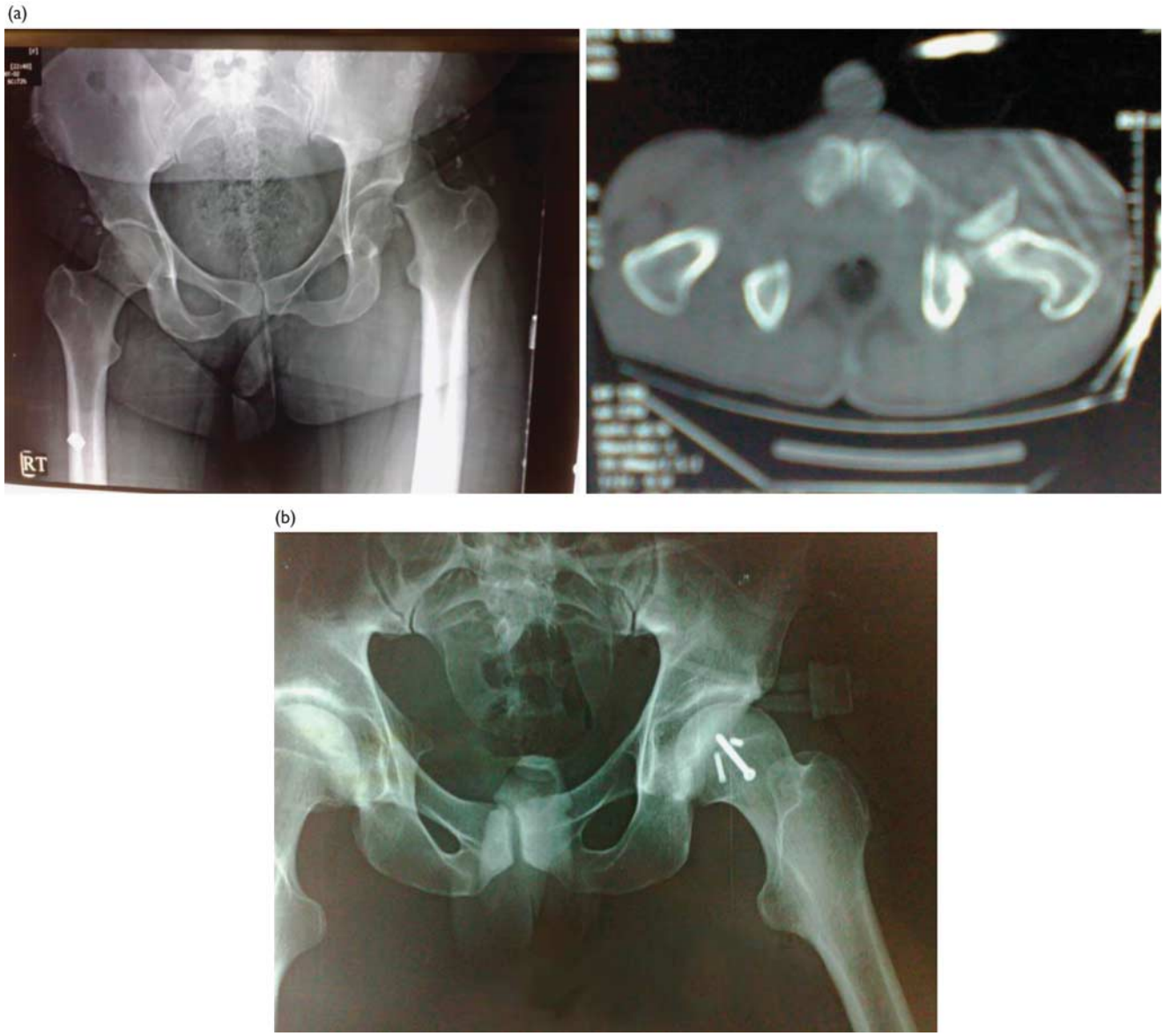
A 40-year-old male patient with a Pipkin Type I fracture of the femoral head. (a) Preoperative AP radiograph and computed tomography of the fracture femoral head. (b) Intraoperative photo. (c) Intraoperative photo after fixation. (d) Postoperative AP radiograph 6 months after the operation. AP, anterior–posterior.

internal fixation with screws, rehabilitation exercises were started after 7–10 days in balanced suspension, when gentle flexion and rotation of the hip caused no pain. All patients used two crutches for 6 months (Figs 1 and 2).

Results

The outcome was assessed on the basis of two commonly used evaluations: the Merle d'Aubigné and Postel score (Table 1) [12] and the Thompson and Epstein score (Table 2) [13]. The Merle d'Aubigné and Postel score is

Figure 2



A 35-year-old male patient with a Pipkin Type I fracture of the femoral head. (a) Preoperative AP radiograph and computed tomography of the fracture femoral head. (b) Postoperative AP radiograph. AP, anterior–posterior.

based equally on pain, mobility, and walking ability on a scale of 0–6 points each for a maximum of 18 points.

For outcome evaluation, the categories 'excellent' (18 points) and 'good' (15–17 points) were combined. The Thompson and Epstein score consists of the determination of clinical and radiographic scores, each of which is given a rating of excellent, good, moderate, or poor. The worst of these (usually the radiographic one) determines the final score. Although some reports classify a hip prosthesis as a good result, we believe that with the exception of a Pipkin III fracture in an elderly patient, the goal of treatment in Pipkin fractures should be to preserve the joint. In our patient analysis, therefore, we considered an arthroplasty as a poor outcome, whether it was carried out primarily or as a salvage option. A similar scenario holds true for a hip arthrodesis.

The incidence of complications including heterotopic ossification (HO), avascular necrosis (AVN), and post-traumatic arthrosis was also documented.

For the HO, the classification of Brooker *et al.* [14] was used, whereas for post-traumatic arthrosis, we followed the classification of Thompson and Epstein [13].

Follow-up of at least 2 years was available for all the patients (average follow-up 64 months, range 24–55 months).

The overall outcome, irrespective of the fracture type or treatment, was excellent/good in 50%, fair in 30%, and poor in 20% (Table 3).

There were four post-traumatic (presurgical) sciatic nerve injuries; they recovered almost completely. There were no surgical nerve injuries. There was (Brooker I)

Table 4 Literature review of the complication rates associated with femoral head fractures

References	Total number of patients	Nerve injury (%)	HO (%)	AVN (%)	PTA (%)
Brumback *et al.* [9]	19	21	11 (I–II)	0	11 (severe)
Butler *et al.* [22]	10			10	
DeLee *et al.* [25]	13	7	7	13	54
Dreinhöfer *et al.* [26]	22		54 (I)	9	18 (mild)
			23 (II)		5 (moderate)
Epstein *et al.* [17]	46	11		24	24
Hougaard and Thomson [23]	18		2	12	0
Lang Stevenson and Getty [24]	7		6	14	29
Marchetti *et al.* [15]	33	15	14	10	72 (mild)
Maroske *et al.* [27]	11	27	15 (I)		22 (mild)
Pape *et al.* [28]	14			57	36 (mild)
Pipkin [11]	25			8	8
Roeder and DeLee [8]	13	23	16 (IV)	0	31
Schönweiß *et al.* [29]	14	14	8	14	64 (mild)
Stockenhuber *et al.* [21]	8		2 (I)	13	13 (mild)
Swiontkowski *et al.* [16]	24		38 (I)	8	8
Stannard *et al.* [3]	22		17 (III)	23	
Yoon *et al.* [4]	27			7	

AVN, avascular necrosis; HO, heterotopic ossification; PTA, posttraumatic arthrosis.

HO in one patient and in two patients, AVN was seen; one patient had an unreduced fracture dislocation for 7 days at ~1 year, AVN of the entire femoral head was evident, and they had severe pain. A total hip arthroplasty was performed at that time of the short follow-up.

Discussion

Femoral head fractures are usually the result of high-energy trauma, such as that sustained in motor vehicle accidents, and occur in 7–13% of posterior hip dislocations. Well-known sequelae of the femoral head fractures include HO, AVN, and post-traumatic arthritis [3,11]. Despite advances in diagnostic and surgical techniques, treatment outcomes are fraught with complications, and treatment options remain the subject of debate [15].

In the literature, open reduction internal fixation (ORIF) has been recommended for Pipkin fractures with a large fragment [15,16]. Surgical options include fixation with Herbert screws or countersunk 4.0-mm cancellous screws (for reducible fractures) and hemiarthroplasty (for early postoperative mobility in elderly patients). Cannulated 3-mm screws with washers are contraindicated, because screw-washer dissociation can lead to articular cartilage damage and loss of fixation [15]. Fragment excision, although controversial, may be performed if the fragment is less than one-third the size of the head [8,15,17]. However, there may not be a statistically significant difference in the outcomes when excision is compared with fixation of the fractured fragment [9,15].

The optimal surgical approach for femoral head fractures is debated, with disagreements centering on the potential for increased AVN and HO. Epstein [11,18] believed that using the anterior approach for open reduction of Pipkin fractures may compromise the remaining anterior vessels and potentially increase the risk for AVN; in contrast, the posterior approach makes optimal visualization and treatment of the fracture fragment more difficult. Swiontkowski *et al.* [16] found that using the anterior approach significantly decreased the operative time and blood loss while improving visualization. They also found that, although HO was higher in patients treated with a posterior approach compared with an anterior approach, the two groups did not differ in long-term functional outcomes and AVN rates. Radiotherapy (single 800 cGy dose) and indomethacin have both been shown to be of benefit for HO prophylaxis [19,20].

A recent comparative study between anterior and posterior approaches for Pipkin I and II fractures showed that the use of the anterior approach resulted in less blood loss, shorter operating times, and better visualization. However, more HO after the anterior approach was observed [16]. Another common criticism of an anterior-based approach is that it will damage most, if not all, of the remaining blood supply to the femoral head that was dislocated posteriorly [1,17,18]. However, this theory has not been strongly supported in the recent literature, which shows that there is little to no interference with the blood supply to the femoral head by this approach [21].

Similar to what is encountered in the literature, our series of 10 posterior hip dislocations with femoral head fractures predictably involved different fracture types, mechanisms of injury, and treatments, making statistical analysis and/or recommendations solely on the basis of our series impossible.

The reported complication rates of AVN (0–24%), post-traumatic arthrosis (0–72%), nerve injury (7–27%), and HO (2–54%) with this injury and its subsequent treatment have varied [8,22–24].

Table 4 summarizes the complication rates reported in the literature. It is noteworthy that the reported rates for post-traumatic arthrosis and AVN of the hip might be somewhat skewed in the older reports, as the determination for these conditions was generally made on the basis of plain radiographs instead of the newer modalities such as SPECT scanning and MRI, which are better able to distinguish between the two [26]. The old belief that an

anterolateral approach after posterior hip dislocation increases the risk of AVN does not seem to hold true.

Interestingly, Stannard *et al.* [3] recently showed that the Kocher–Langenbeck approach was associated with a 3.2 times higher incidence of AVN compared with the anterior approach.

A course of indomethacin (25 mg orally 3/day) can be given if the patient has previously been shown to form heterotopic bone and/or has a head injury.

Conclusion

We believe that newer techniques and approaches lead to improved outcomes of femoral head fractures. Anatomic reduction leading to a perfectly congruent joint is the goal of treatment. Careful evaluation of the reduction (preoperatively and postoperatively) using computed tomography scan is mandatory. When surgery is required, it is most important to use an approach that provides an excellent view of and access to the fracture, thus allowing as perfect an anatomic reduction and fixation as possible.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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