

Treatment of Femoral Head Fractures

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Summary: Femoral head fractures are associated with posterior and anterior dislocations of the hip. Treatment of these high-energy injuries is controversial with widely variable outcomes. When surgical intervention is indicated, there are multiple approaches that can be successfully and safely used for definitive fixation. The choice of surgical approach is both surgeon and final construct dependent.

Key Words: femoral head fracture · surgical dislocation · direct anterior approach · hip dislocation.

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Dislocations of the native adult hip joint comprise approximately 5% of all joint dislocations. The hip joint is inherently stable owing to bony and soft tissue contributions to stability. The combination of a large femoral head with a relatively narrow femoral neck creates a deeply seated joint. The labrum acts to further deepen the acetabulum and the thick capsule is a static restraint to dislocation. The increasing energy of survivable injuries including motor vehicle crashes, pedestrians struck, motorcycle accidents, and high-velocity sporting activities, such as skiing and football, have increased the incidence of traumatic hip dislocations despite these constraints.¹

Concomitant fractures that occur with traumatic hip dislocations are estimated to be between 40% to 75%.² Associated fractures include: acetabular, femoral head, femoral neck, and femoral shaft fractures. A recent meta-analysis of femoral head fracture treatment found that 84% of patients were victims of motor vehicle accidents and 11.7% of patients with hip dislocations had a concomitant femoral head fracture.³

Femoral head fractures were first described by Birkett in 1896 after a postmortem examination, but have been difficult to study owing to the paucity of volume at individual trauma centers.⁴ No prospective, randomized study has been published, and the most data come from retrospective reviews of the experience of individual surgeons. The most common clinical outcome tool used was described by Thomson and Epstein in 1951, but their review of 240 traumatic dislocations of the hip provided little insight into the treatment of femoral head fractures.⁵

Pipkin developed the following classification scheme in 1957 based on the treatment of 25 hips by multiple surgeons:

| Type | Description |
|------|---|
| I | Dislocation with fracture of the femoral head caudad to the fovea. |
| II | Dislocation with fracture of the femoral head cephalad to the fovea. |
| III | Dislocation with fracture of the femoral head and the femoral neck. |
| IV | Dislocation with fracture of the femoral head and ipsilateral acetabulum. |

Pipkin advocated emergent treatment of femoral head fractures beginning with an initial closed reduction of the hip dislocation followed by an open reduction for retained fragments, or an inability to obtain or maintain a concentric reduction and comminution.⁶ Since that time, over 300 publications in the English literature have provided neither a uniform classification system with prognostic value nor a validated outcome measure.^{7,8} Much of the surgical literature has focused on the concept of using an operative approach that minimizes the risk of iatrogenic injury to the vascular supply to the femoral head. The goal of this review of techniques is to describe the surgical approaches that can be used for the treatment of femoral head fractures, provide the justification for, and the results associated with each surgical approach.

TREATMENT

Acute Treatment

The initial treatment of a femoral head fracture associated with a hip dislocation begins with appropriate imaging and a careful evaluation of the images to rule out an ipsilateral femoral neck fracture. If a femoral neck fracture is present a closed reduction should not be attempted owing to the possibility of displacing the femoral neck fracture.

The urgency of reduction of a hip dislocation is controversial. Ideally a closed reduction of a hip dislocation in the absence of a femoral neck fracture should be carried out as soon as possible. It is postulated that a delay in greater than 12 hours may be associated with a more than 3-fold increase in risk of osteonecrosis. Given the vascular supply to the femoral head a hip dislocation may disrupt the blood supply to the femoral head if disrupted, but there is no way to predict which dislocated hip will have a vascular injury that will cause femoral head AVN.^{2,9}

A certain percentage of hip dislocations will be irreducible by closed means. A prospective collection of traumatic hip dislocations in Level One trauma centers from 1990 to 1996 in Toronto yielded a 13% rate of irreducible ones. There was no consensus for a prereluction factor that might be identified as a predictor of this problem; however, only 6/23 of the affected patients had a satisfactory outcome.¹⁰ Mehta and Routt¹¹ described a clinical picture consistent with an irreducible dislocation that always requires an open reduction secondary to the femoral head buttonholing superiorly between the labrum and the superior margin of the acetabulum. In all cases, the involved limb was positioned with

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the hip in a slightly flexed position without any adduction or internal rotation and had little or no motion. X-rays showed the femoral head tightly opposed to the pelvis, and the femoral head fragment was always contained in the acetabulum. (Fig. 1) These patients required an open reduction and internal fixation through a Smith-Petersen approach.

All other fracture dislocations should undergo an urgent closed reduction under adequate conscious sedation in either the emergency department or the operating room. In all cases of irreducible hip dislocations, forced reductions and repeated attempts should be avoided as they can lead to iatrogenic femoral neck fracture, nerve entrapment, and excessive injury to the femoral head articular cartilage.^{6,11}

After reduction, all patients need an AP pelvis x-ray to check that the hip is grossly reduced followed by a computerized tomography scan (CT) with ≤ 2 mm cuts to look for retained intraarticular fragments, evaluate the reduction and position of the femoral head fragment(s), and to look for ipsilateral fractures. The indication for urgent surgical treatment after a closed reduction include: a displaced femoral neck fracture, postreduction joint asymmetry, a progressive sciatic nerve injury, nonanatomic reduction of the femoral head fracture or an acetabulum fracture, and/or intraarticular fragments.^{8,12}

There is no consensus regarding that fracture fragments should be stabilized and which fragments are amenable to excision. In general it is felt that Pipkin Type I fractures can be debrided and that Pipkin Type II fragments require fixation, but we and other investigators believe that any fracture fragment that can be anatomically reduced and stabilized should be (Fig. 2).¹³

If surgery is needed there are multiple approaches to the hip joint that can be used. Historically, it was believed that because most hip dislocations are posterior that the vascular supply would be disrupted posteriorly, and therefore that the anterior blood supply should not be jeopardized by using an anterior surgical approach. We now know that the blood supply to the femoral head in an adult primarily originates from the medial circumflex femoral artery. Therefore, any approach that preserves this vascular anatomy is appropriate



FIGURE 1. An anteroposterior radiograph of the pelvis showing a left hip dislocation with a fracture of the femoral head. The injured limb is positioned in neutral rotation with the femoral head fragment in the acetabulum. This is consistent with the irreducible hip dislocation pattern.

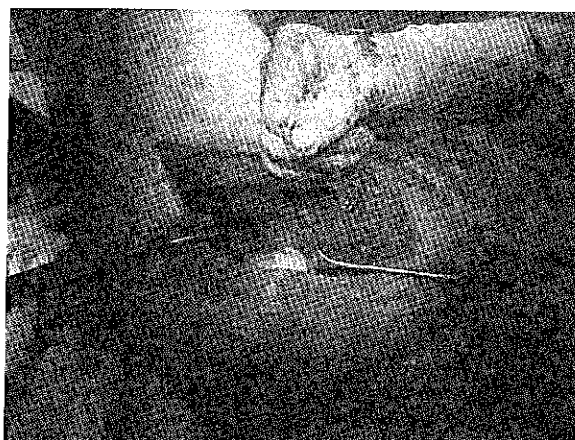


FIGURE 2. Surgical hip dislocation. The patient is in the lateral decubitus position. Hip flexion and external rotation with traction allows for an anterior dislocation of the femoral head for reduction and fixation of femoral head fractures.

for definitive treatment, and the surgical exposure should be selected based on the fracture pattern rather than concern about damage to the blood supply to the femoral head. The keys to avoid damage to the vascular supply include preserving of the quadratus lumborum muscle and the distal 10 mm of the short external rotator muscles (superior gemellus, obturator internus, and inferior gemellus).

Surgical Approaches

We will describe the Smith-Petersen approach, the Direct Anterior Approach and the Surgical Dislocation of the Hip. Each of these approaches has benefits and risks. A review of 153 cases from 11 retrospective series found that the major late complications included: avascular necrosis, osteoarthritis, and the formation of heterotopic ossification. There was a significantly higher incidence of avascular necrosis after a Kocher Langenbeck approach but the surgical hip dislocation approach did not share this risk and provided a wider exposure. The anterior approaches did not have a risk of avascular necrosis but did have a trend toward an increased risk of heterotopic ossification, although this finding did not reach statistical significance.³ At our institution our preference is to use the Direct Anterior Approach with or without a fracture table for the fixation of a typical anteriorly based femoral head fracture. If posterior fixation of an acetabular fracture is needed then a surgical hip dislocation is used, and when an irreducible fracture dislocation is present as described by Mchta, a Smith-Petersen approach will be done.

Surgical Hip Dislocation

Originally described for nontrauma proximal femur surgery, the surgical hip dislocation has been advocated as a utilitarian approach to the hip joint, the femoral head, and the posterior acetabulum.^{14,15} The patient is positioned in the lateral decubitus position. A Kocher-Langenbeck or Gibson incision is made through the skin with sharp dissection to and through the deep fascia. A greater trochanter (GT) osteotomy is then made in the interval between the piriformis insertion and the gluteus medius musculature. A 1.5-cm sleeve of GT bone is removed with the tendinous insertion of the gluteus medius and the vastus lateralis attached to the sliver of GT, and leaving the insertions of the short external rotators left attached

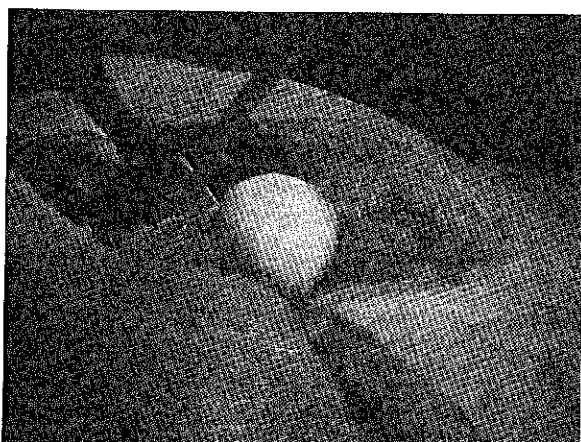


FIGURE 3. The dislocated femoral head through the surgical dislocation approach. This may present difficulties in accessing an anteroinferiorly based fracture of the femoral head.

to the intact proximal femur to protect the vascular supply to the femoral head. The osteotomized GT fragment is subluxed anteriorly and the gluteus minimus is elevated to visualize the hip capsule. A Z-shaped capsular incision is made extending from the posterior margin of the acetabulum in an anterior direction parallel across the anterolateral femoral neck and distally to the level of the lesser trochanter. The capsular incision is remote from the medial femoral circumflex artery as long as it remains anterior to the lesser trochanter (Fig. 2). Hip flexion and external rotation will facilitate dislocation of the hip anteriorly (Fig. 3). Femoral head fractures and intraarticular injuries can be fully visualized using this approach. This approach can also be used for fixation of fractures of the posterior acetabulum by dividing the short external rotators no less than 8 to 10 mm from their insertion on the proximal femur to expose the posterior column and wall of the acetabulum.¹⁴

Smith-Peterson Approach

The patient is positioned supine on a radiolucent table with a bump under the ipsilateral buttocks (Fig. 4). The incision begins by paralleling the iliac crest to the level of the anterosuperior iliac spine and then heads distally toward the lateral patella for approximately 12 cm. The bulge of the tensor fascia latae is used for the distal extent of the incision and is accentuated by internal rotation of the lower extremity. The interval between the sartorius and the tensor fasciae latae is developed by incision of the fascia over the tensor musculature because the lateral femoral cutaneous nerve of the thigh runs with the sartorius and can be retracted medially. Dissection is carried down to the level of the direct and indirect heads of the rectus tendon that are tagged, incised, and retracted distally. The iliopsoas is elevated off the anterior capsule that is incised in a T-shaped fashion parallel to the femoral neck and perpendicular to that limb just lateral to the acetabulum to avoid injury to the superior labrum. Further proximal development of this exposure can be performed with elevation of the musculature of the tensor fascia latae and the gluteus medius off the lateral aspect of the iliac crest in a subperiosteal fashion. Irrigation and debridement of the joint, dislocation of the hip anteriorly and fixation of femoral head fracture components can then be carried out.^{9,11}

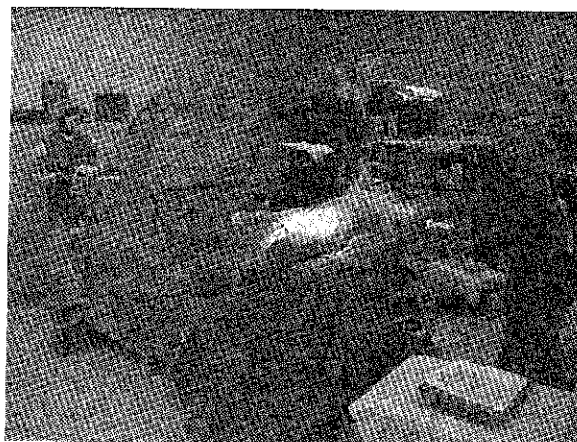


FIGURE 4. Patient positioning for an anterior approach on a radiolucent table with the limb draped free.

Direct Anterior Approach to the Hip

This approach was originally described by a German surgeon named Heuter Volkmann in the 1800's for drainage of tuberculosis from the hip. It has subsequently been described by Robert Judet in 1947 for total hip arthroplasty and has been adapted for visualization of the femoral neck and femoral head fractures while minimizing soft tissue trauma. The exposure exploits the distal limb of the Smith Peterson approach that is centered over the hip joint.^{16,17} It can be carried out either on an orthopedic specialty fracture table or freehand on a radiolucent table.

The affected extremity and lower abdomen are prepped and draped. The extremity is positioned in slight internal rotation and hip flexion to accentuate the bulge of the tensor fascia latae. A 10 cm incision is made from a point 2-cm posterior and 1 cm distal to the tip of the anterosuperior iliac spine that extends laterally along the tensor in the direction of the lateral femoral condyle. Sharp dissection is carried out to the level of the fascia of the thigh. The fascia overlying the tensor musculature is incised in line with the incision and atraumatic clamps are applied to the fascia medially. The musculature of the tensor fasciae latae is elevated from the medial aponeurosis to expose the deep layers. A Cobra retractor is placed over the superolateral femoral neck after blunt dissection down to the capsule, which is usually intact.

A small periosteal elevator is used to bluntly dissect the iliopsoas and rectus femoris muscles from the underlying hip capsule. A Cobra retractor is placed along the inferomedial hip capsule into the path cleared by the elevator, to expose the femoral neck. The lateral circumflex vessels are visualized in the distal aspect of the wound and coagulated and divided. These steps expose of the capsule and the origin of the vastus lateralis.

At this point, an L-shaped capsulotomy can be made across the trochanteric ridge at the insertion of the vastus lateralis extending proximally parallel to the greater trochanter. The anterior and lateral margins of the capsule are tagged for later repair. The Cobra retractors can then be moved to a position within the capsule and the femoral head can be visualized. The capsule is then carefully elevated preserving the underlying articular cartilage. The hip joint can be distracted and the joint can be visualized and debrided of all intraarticular debris. External rotation and hip extension can be used to dislocate the hip and visualize the femoral head fracture (Fig. 5).



FIGURE 5. Fixation of a femoral head fracture through a direct anterior approach with the hip dislocated. The fracture has been stabilized using mini-fragment screw fixation with the screw heads buried below the articular surface.

After femoral head fracture debridement or fixation, the head of the femur can be relocated by reapplying gentle traction and internally rotating (Fig. 6). The overlying capsule is repaired carefully and a deep surgical drain is left in place. The closure is completed with the closure of the fascia, the subcutaneous tissues, and the skin.

Fixation Techniques

There is no consensus regarding the optimal method for fixation of fractures of the femoral head. The 2 most common methods used are:



FIGURE 6. Intraoperative radiograph after reduction of the femoral head after fixation visualized in Figure 5.

- (1) Using mini-fragment screws with the screw heads countersunk below the level of the intact cartilage and
- (2) Variable pitch headless screws to achieve fracture compression.

When a displaced femoral neck fracture is present in addition with a femoral head fracture, hip arthroplasty may be considered, particularly for the “older” patient. Osteochondral allograft has also been reported in the literature and short-term outcomes have shown reasonable functional outcome despite poor radiologic findings.¹⁸

Long-term outcomes are exceptionally difficult to discern from the literature, and are dependent upon the evaluation tool used. In the 1974 review of the outcomes of these fractures, Epstein in showed that in closed treatment of patients followed for at least 1 year, that 100% of the 17 patients treated closed had a fair or poor result. Of those treated with closed reduction followed by operative excision or repair only 4/13 attained a good clinical result. In general, the most significant distinction is between Pipkin 1 and 2 fractures versus Pipkin 3 and 4 in which the outcomes of treatment clearly favor the first group. In the more complex fracture patterns, primary arthroplasty may play a more important role.³

CONCLUSIONS

Femoral head fracture dislocations represent some of the most challenging injuries treated by orthopedic trauma surgeons. Keys to treatment include accurate diagnosis and evaluation of prereduction radiographs followed by a prompt reduction of the hip joint. Surgical treatment can be facilitated through several approaches that should be based on the fracture pattern and surgeons experience.

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