

Open surgery for hip impingement

Mechanical impingement of the proximal femur against the acetabular rim is now recognized as a common cause of labral tears and degenerative changes in the hip. Open surgery is successful in treating this condition if damage to the articular cartilage surface is minimal.

Acetabular labral tears have been recognized for some time as a cause of hip pain (Altenberg, 1977; Suzuki et al, 1986; Ikeda et al, 1988; Fitzgerald, 1995). Impact of the proximal femur against or under the acetabular rim has more recently been recognized as a common underlying cause of labral tears in the non-dysplastic hip (Ito et al, 2001, 2004), which is associated with an increased incidence of chondral damage (Johnston et al, 2008) and is a common cause of hip osteoarthritis (Ganz et al, 2003; Leunig et al, 2003; Tanzer and Noiseux, 2004). Damage to the acetabular rim is now recognized as part of a sequence of events resulting in hip osteoarthritis (Tannast et al, 2008).

Surgical intervention has been shown to be successful at treating painful symptoms and stopping radiographical progression of osteoarthritic changes in the short to medium term if articular cartilage degeneration is minimal and acetabular dysplasia is not a feature (Beck et al, 2004; Murphy et al, 2004). Surgery should aim to repair the damage that has occurred and to normalize the underlying structural abnormalities (Tanzer and Noiseux, 2004). Open surgery provides a safe and effective visualization and access to the entire hip joint to allow this treatment to occur but as yet no long-term study exists to assess the potential long-term benefit.

Presenting symptoms

Femoroacetabular impingement commonly presents as a deep intermittent groin discomfort during or after activity (Philippon et al, 2007). It affects active younger adults and older adolescents but may present in patients of any age usually presenting with hip osteoarthritis.

Cam impingement usually affects the anterior hip, presenting as intermittent discomfort in the groin during or after repetitive or persistent hip flexion. Sprinting or kicking sports, ascending hills or stairs, prolonged sitting in low chairs, driving or getting in and out of low vehicles are common exacerbating activities. In women, it is common to experience groin discomfort during sexual intercourse with the hip flexed. Pain may be referred down the anterior thigh, to the region of the symphysis pubis and to the ipsilateral testicle in men.

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Pincer impingement most commonly occurs in the anterior quadrant with similar symptoms as for cam impingement. When the acetabulum functionally over-covers the posterior aspect of the hip, however, posterior impingement and acetabular rim damage may occur (Pfirrmann et al, 2006) and symptoms may be experienced in the buttock or sacro-iliac region. These symptoms are more common in women, occur when the hip is repeatedly hyperextended as in fast walking or walking downhill and are often difficult to differentiate from pain referred from the low back and sacro-iliac joint.

Mechanical symptoms of catching, clicking and a feeling of giving way are commonly associated with labral tears secondary to hip impingement.

Examination

The hip is examined in a methodical manner, which should include an assessment of rotational abnormalities in the femur. Hip flexion, adduction and internal rotation most commonly replicate the pain experienced during anterior hip impingement (Eijer et al, 2001; Philippon et al, 2007). In flexion, the hip is progressively rotated from external to internal rotation while moving from abduction to adduction. Using this technique, it is possible to identify the most likely position of impingement and the most likely area of acetabular rim injury. A similar examination of the hip in hyperextension may help with the diagnosis of posterior impingement.

Further examination focusses on excluding other pathology that may mimic intra-articular hip pain including:

- Referred pain from spinal pathology
- Pain from hip abductor mechanism pathology (Cvitanic et al, 2004)
- Snapping psoas syndrome (Kouvalchouk et al, 1998)
- Inguinal and femoral hernias
- Piriformis syndrome (Parziale et al, 1996).

Investigations

X-ray

The most obvious bony abnormalities of the proximal femur responsible for impingement have long been recognized as causing hip osteoarthritis and are readily seen on a plain X-ray of the pelvis (Harris, 1986). The more subtle abnormalities have only been recognized over the last 10 years and remain frequently unrecognized by most orthopaedic surgeons and radiologists. This is partly because of a lack of radiological pattern recognition in this relatively new field and partly because of a lack of high quality imaging being performed.

A systematic approach to the plain radiographic evaluation of these patients is essential and has recently been published by the Academic Network for Conservational Hip Outcomes Research (ANCHOR) study group (Clohisy et al, 2008).

Magnetic resonance imaging

To identify the most subtle cam imperfections in proximal femoral anatomy, a magnetic resonance imaging (MRI) arthrogram is required with intra-articular contrast. This investigation includes a sequence of radial scans to allow a tangential view perpendicular to the acetabular rim and a detailed analysis of the proximal femoral morphology (Leunig et al, 1997; Locher et al, 2002). The authors include slices through the distal femur to detect femoral torsion deformities, which they believe to be relevant to the appreciation of function in the hip.

Computed tomography

Three-dimensional reconstruction of computed tomography scans has proved useful in the recognition of subtle femoral deformities and in preoperative planning in complex deformities. It is not routinely performed, but may in the future assist in accurate preoperative planning and intraoperative execution.

Surgical technique

Open surgical hip dislocation using the trochanteric flip approach is based on protecting the known vascularity of the femoral head (Gautier et al, 2000) and has been shown to maintain intra- and postoperative oxygenation to the femoral head (Steffen et al, 2008). The exposure of the hip joint is excellent, no muscles are divided and once the greater trochanter has healed, the hip is returned to an anatomically near normal state.

Preparation

Anaesthesia should provide intraoperative muscle relaxation. The patient is positioned in the lateral decubitus position to allow the operated hip to flex to at least 100°. An anterior sterile leg bag accommodates the leg while the hip is dislocated.

Superficial dissection

The lateral skin incision is longitudinal along the anterior third of the greater trochanter curving slightly posteriorly along the proximal half of the incision. Between two and four perforating branches from the inferior gluteal artery are identified perforating the fascia lata in a longitudinal alignment. These vessels identify Gibson's plane between the gluteus maximus and the tensor fascia lata, which is opened proximally to the iliac crest and distally to expose 5 cm below the trochanteric ridge.

The hip is fully extended and internally rotated using a padded Mayo table to support the foot. This relaxes the soft tissues on the posterior aspect of the hip and aids visualization of the deep dissection.

The plane between piriformis and gluteus minimus is initially developed. No mobilization of piriformis or any of the other short external rotators is performed to avoid damage to the deep branch of the medial femoral circumflex artery, which is the predominant blood supply to the femoral head. Vastus lateralis is elevated off the femur distal to the greater trochanter. The line of the trochanteric osteotomy is marked from just below the trochanteric ridge distally, to the proximal aspect of the greater trochanter.

A fine broad saw is used to perform the osteotomy with the hip internally rotated to 30°. The saw exits the trochanter distally and anteriorly in the distal aspect of the trochanter only. Proximally, the saw blade does not exit anteriorly to protect the deep fibres of gluteus minimus. These cross anterior to the osteotomy from posterior to insert on the anterior aspect of the greater trochanter and are susceptible to being sectioned by the saw if it exits at this point. The osteotomy is completed using a broad osteotome leaving a ridge on the anterior proximal aspect of the trochanter preventing anterior translation of the trochanteric fragment after reduction and fixation.

External rotation of the hip mobilizes the trochanter anteriorly with minimus, medius and vastus lateralis attached. Gluteus minimus is dissected anteriorly exposing the hip capsule. The capsule is opened by sharp dissection with a vertical incision in the line of the femoral neck. The distal extent of this incision must remain 10 mm anterior to the insertion of the piriformis tendon insertion on the femur to avoid damage to the retinacular blood supply to the femoral head while the proximal extent must be performed carefully to avoid damage to the reflected head of rectus femoris and the acetabular labrum. Anteriorly, the ileofemoral ligament is released off the intertrochanteric line. Posteriorly, the capsule is dissected off the acetabular rim.

A pointed retractor is introduced anteriorly between the labrum and the capsule to visualize the dynamics of the articulation and note the areas of impingement.

The hip is dislocated by external rotation after careful division of ligamentum teres and the leg placed into the sterile anterior leg bag. The femoral head is tucked under the belly of gluteus maximus to expose the acetabulum and protect the femoral articular cartilage from dehydration. This is aided by the assistant lifting the knee and leaning against it to translate the head posteriorly. The labrum and articular surface are visualized and probed to assess the site and extent of injury. A number of procedures may be necessary on the acetabular side dependent on the anatomical and pathological abnormalities.

Acetabular findings and procedures

In cam impingement it is usual to find labral type 1 tear separation from the adjacent articular cartilage at the watershed (Seldes et al, 2001). It is common to find articular cartilage debonded from subchondral bone (so-called 'carpet lesion') (*Figure 1*), but uncommon to find complete detachment of the labrum from the acetabular rim.

In pincer impingement, it is common to find a thick patulous labrum with intra-labral type 2 tears (Seldes et al, 2001). Alternatively, the labrum may be practically non-existent in the impingement area (Beck et al, 2005). Acetabular overcoverage is not usually associated with separation of the labrum from the articular cartilage and anterior cartilage debonding unless a significant cam deformity is present. However, it is common to find chondral degeneration on the posterior aspect of the femoral head (Pfarrmann et al, 2006) (*Figure 2*).

If the anterior labral-chondral junction is breached in what appears to be a pincer type hip, the surgeon should be vigilant to consider that the hip may be impinging along the posterior acetabular margin in extension with a tendency to sublux anteriorly. The hypertrophied labrum may in this situation be acting as a stabilizer of the joint as found in a dysplastic acetabulum. Excessive femoral antetorsion or femoral neck anteversion should be excluded in this situation.

Rim recession

If rim trimming is required or if a labral tear is found, the labrum is formally detached from the rim for the extent of the tear and for 5 mm either side of the tear, resembling a meniscal bucket handle tear (*Figure 3*). The bony rim is then trimmed back with a sharp chisel or a high-

speed burr. The extent of this recession is planned from the preoperative imaging. The acetabular centre-edge angle should remain at 30° or above to avoid creating acetabular undercoverage in any area.

Chondral flaps

Articular cartilage flaps should be left in place unless they are severely fragmented. As this tissue receives its nourishment from synovial fluid, the authors do not consider it necessary to attempt to reattach it to the underlying bone surface. Once the cause of damage has been removed, it may be able to act as normal cartilage despite being debonded. Removal of a large chondral flap may expedite degeneration of the joint.

Cysts

Labral cysts are simply dealt with by sharp dissection but intra-osseous bone cysts are more problematic. Non-inflammatory subchondral cysts are usually found in the anterolateral acetabular quadrant (Bredella and Stoller, 2005) and are in the authors' experience always associated with acetabular articular cartilage separation from the labrum and debonding from the subchondral bone surface (*Figure 4*). The authors consider this finding preoperatively to be highly significant as a predictor of the severity of articular cartilage injury and of a risk of an unsatisfactory outcome, although some patients have had a good result in the mid term. If the rim recession deroofs the subchondral cyst, bone grafting harvested from the femoral osteochondroplasty is performed.

Labral repair

Bone anchors are inserted along the rim of the acetabulum and non-absorbable sutures are used to reattach the labrum with the suture entering the base of the labrum and the knot being tied on the peripheral surface of the labrum to avoid abrasion of femoral head cartilage against the suture material.

In cases in which the labrum is irreparable, the authors have used ligamentum teres as an autograft to bridge the gap between areas of preserved labral tissue (*Figure 5*).

Figure 1. Large chondral flap adjacent to severe labral tear.

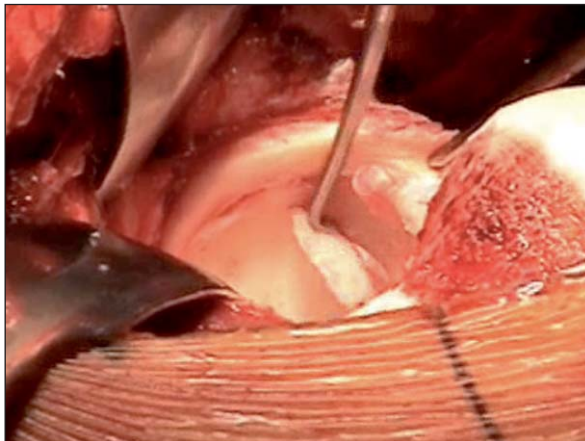
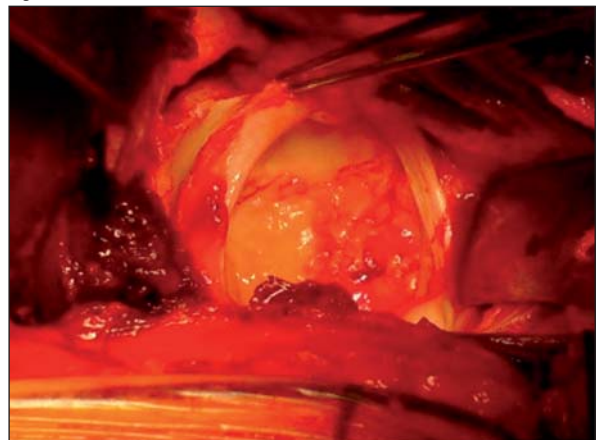


Figure 2. Isolated chondral damage to posterior femoral head in pincer impingement hip.



Figure 3. Acetabular labrum detached to recess acetabular rim.



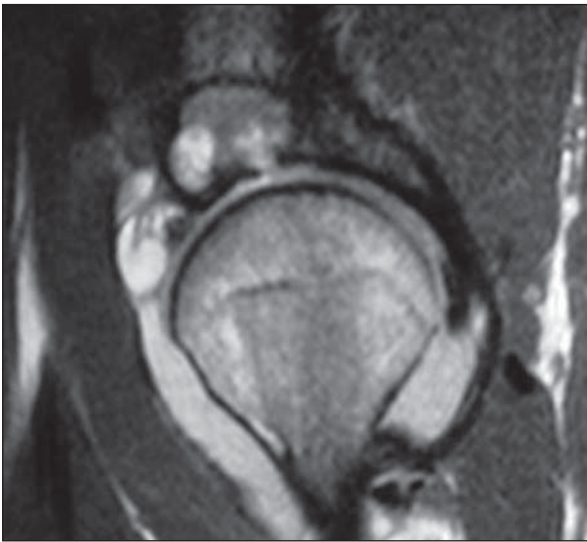


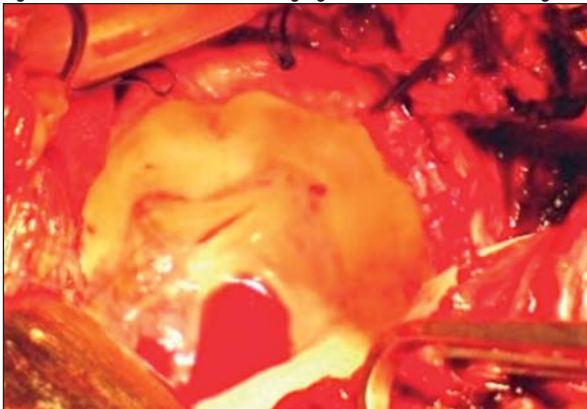
Figure 4. Anterior subchondral and paralabral cysts indicate full thickness chondral damage and a risk of a poor outcome with impingement surgery.

Femoral findings and procedures

Femoral sphericity is assessed using incremental gauges. The superior aspect of the femoral head is templated to assess the optimal radius of curvature and where this curvature terminates (Figure 6). All cartilage and bone distal to this is removed, avoiding the posterolateral vascular retinaculum carrying the terminal branches to the femoral head. If the cam deformity continues in the area of the vessels, the debridement commences proximally and proceeds down as far as the insertion of these vessels only. Correction of the deformity should be regularly checked using templates to ensure all non-spherical surfaces are removed (Figure 7a and b). No more than 30% of the diameter of the femoral neck should be removed to avoid femoral neck fracture (Mardones et al, 2005). The cancellous bone surface is sealed with bone wax and the hip carefully reduced to avoid disrupting the labral repair. The hip is then put through a full range of movement to check that impingement no longer occurs.

Using this technique, extensive anatomical correction can be performed in hips that have previously suffered

Figure 5. Labral reconstruction using ligamentum teres as an autograft.



from Perthes' disease (Figure 8a and b) or slipped capital femoral epiphysis.

Closure

The hip capsule is closed with three interrupted sutures along the vertical split and two sutures along the acetabular rim attaching the capsule to the iliac periosteal soft tissue.

With the hip abducted on a supportive Mayo table, the trochanter is reduced and fixed using three lagged 4.5 mm cortical screws. It is essential that the reduction is meticulous and tightly compressed to avoid delayed or non-union. The bursa is repaired over the screws and the wound closed in a standard fashion.

Figure 6. Assessment of sphericity using incremental gauges.

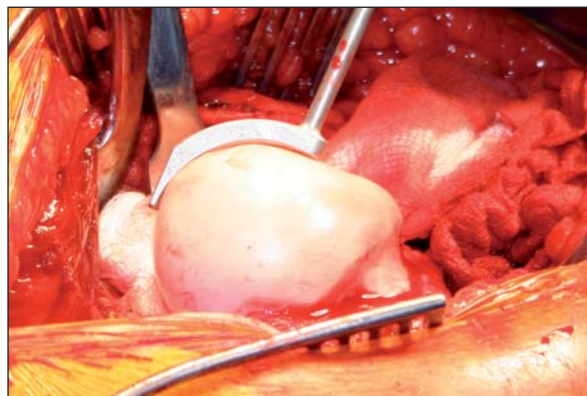
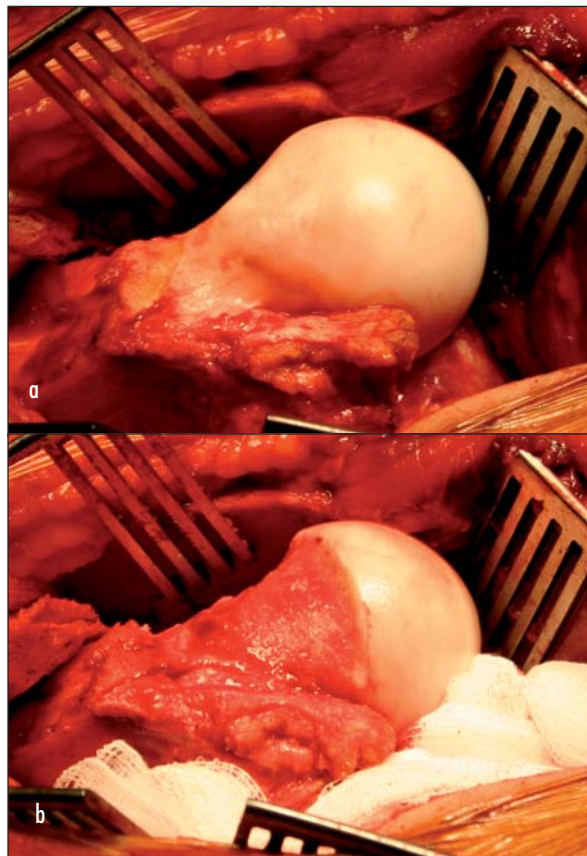


Figure 7. a. Antero-lateral cam shape femur. **b.** Non-spherical cam deformity removed.



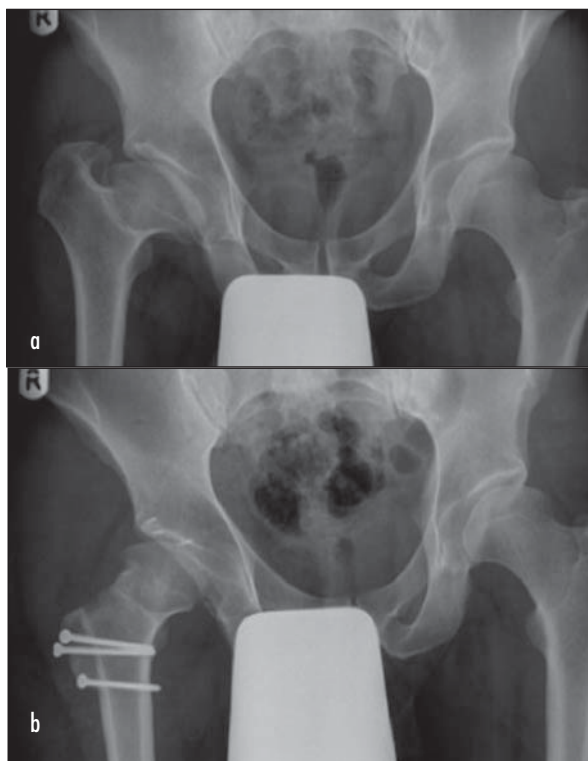


Figure 8. a. Painful Perthes' hip. b. Post open surgical correction of Perthes' hip.

Rehabilitation

The trochanteric osteotomy is protected by partial weight bearing on crutches for 6 weeks.

Active hip abduction is discouraged but range of movement exercises are commenced immediately post-surgery. Continuous passive movement is used for 2 days post-surgery when on bed rest. Patients are usually safely mobile and suitable for discharge on the third day post-surgery.

Once the osteotomy is radiologically united at 6 weeks, full weight bearing and progressive physiotherapy is commenced. The authors advise against impact activities for 2 months post-surgery to protect the femoral neck, but rehabilitation with resistance training and range of movement exercises are encouraged as soon as the osteotomy is noted to be completely healed.

Results and complications

The results of open surgery in the mid term are well documented and are summarized in *Table 1*. Non-union of the trochanter is a rare complication in this group as long as there is meticulous attention to the detail of performing the osteotomy and its reduction and compression at closure. Avascular necrosis of the femoral head is exceedingly rare and there are no reports of deep infection as yet. A common complaint is of trochanteric discomfort from the trochanteric screws and approximately 25% of patients require removal of the screws at a later date.

Discussion

The degree of damage a hip sustains through hip impingement is not simply a function of the anatomical abnormality, but is dependant also on the type of activity being undertaken. The more severe the anatomical imperfection and the higher the range of movement, the more likely the damage to the acetabular rim structures.

A further factor to consider is the natural resilience of the labral tissue and the adjacent articular cartilage. Cartilage resilience to fracture is dependant on the dimensions and internal structure of the collagen fibres (Shen et al, 2008), the inherent toughness of the surface articular cartilage matrix (Stok and Oloyede, 2003) and the age of the cartilage (Broom et al, 1996; Flachsmann et al, 2000). This may explain why some active individuals with significant anatomical abnormalities do not develop symptomatic hip impingement.

Conclusions

Hip impingement is now well recognized as a condition that causes painful damage to the acetabular rim and progressive degeneration of the articular surface of the hip.

The technique of open surgical hip dislocation is well described and has been proven to be a safe surgical approach allowing the surgeon to undertake a wide range of treatments within the hip joint. Accurate diagnosis requires a thorough understanding of the subtle imperfections that conspire against the long-term survival of the natural hip in the highly active young adult. Successful treatment requires detailed knowledge of

Table 1. Publications with results of open surgical hip dislocation treatment of hip impingement

Study	No of hips	Age	Mean follow-up (months)	Outcomes	Failures	Comment
Beck et al (2004)	19	36	57	70% good or excellent	5 of 19	
Murphy et al (2004)	23	35	60	65% good or excellent	7 of 23	
Bizzini et al (2007)	4	22	32	100% return to sport	0	
Beaulé et al (2007)	37	41	36	82% good or excellent	6 of 37	
Espinosa et al (2006)	25	30	24	76% good or excellent	4% poor results	Labral debridement
Espinosa et al (2006)	35	30	24	94% good or excellent	6% moderate results	Labral refixation
Peters and Erickson (2006)	30	31	32	85% good or excellent	8 developed osteoarthritis	Four converted to THR

THR= total hip replacement

these imperfections, the manner in which they interact and the limits of treatable damage.

The long-term results of this technique are eagerly awaited and comparison with arthroscopic techniques will be required to assess the role of each technique. **BJHM**

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KEY POINTS

- Femoroacetabular impingement commonly presents as a deep intermittent groin discomfort during or after activity.
- Mechanical impact of the proximal femur against or under the acetabular rim is a common underlying cause of acetabular labral tears in the non-dysplastic hip.
- Damage to the acetabular rim is part of a sequence of events causing hip osteoarthritis.
- Subchondral bone cysts are always associated with articular cartilage debonding from the subchondral bone surface.
- Open surgical hip dislocation using the trochanteric flip approach is based on protecting the known vascularity of the femoral head.
- Surgery should aim to repair the damage that has occurred and to normalize the underlying structural imperfection.
- Failure of surgery is related to the degree of damage present in the hip at the time of the primary procedure.