Femoroacetabular impingement
AN ARTHROSCOPIC SOLUTION

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Young adults with hip pain secondary to femoroacetabular impingement (FAI) are rapidly being recognised as an important cohort of orthopaedic patients. Interest in FAI has intensified over the last decade since its recognition as a precursor to arthritis of the hip and the number of publications related to the topic has increased exponentially in the last decade. Although not all patients with abnormal hip morphology develop osteoarthritis (OA), those with FAI-related joint damage rapidly develop premature OA. There are no explicit diagnostic criteria or definitive indications for surgical intervention in FAI. Surgery for symptomatic FAI appears to be most effective in younger individuals who have not yet developed irreversible OA. The difficulty in predicting prognosis in FAI means that avoiding unnecessary surgery in asymptomatic individuals, while undertaking intervention in those that are likely to develop premature OA poses a considerable dilemma. FAI treatment in the past has focused on open procedures that carry a potential risk of complications.

Recent developments in hip arthroscopy have facilitated a minimally invasive approach to the management of FAI with few complications in expert hands. Acetabular labral preservation and repair appears to provide superior results when compared with debridement alone. Arthroscopic correction of structural abnormalities is increasingly becoming the standard treatment for FAI, however there is a paucity of high-level evidence comparing open and arthroscopic techniques in patients with similar FAI morphology and degree of associated articular cartilage damage. Further research is needed to develop an understanding of the natural course of FAI, the definitive indications for surgery and the long-term outcomes.

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While joint replacement has been instrumental in restoring function in patients with advanced osteoarthritis (OA), orthopaedic surgeons have striven to preserve the young adult joint. It is difficult to reach consensus on the ideal treatment for disorders of the hip joint in younger individuals and clinicians treating these patients rely on critical evaluation of current evidence and careful patient selection to determine the best course of management.

Femoroacetabular impingement (FAI) is increasingly recognised as an important cause of labral tears, chondral lesions hip pain in young adults and a leading cause of early OA. Different surgical techniques for the management of FAI have evolved rapidly over the last decade. The aim of FAI surgery is to correct symptomatic anatomical abnormalities and reduce secondary damage early on, preventing progression to severe OA while minimising complications associated with surgery. The difficulty lies in knowing when and whether to intervene, especially in young adults, a significant proportion of whom may have radiological features consistent with FAI but no symptoms. In this article, we review the indications, advantages and disadvantages, and outcomes of open, combined and arthroscopic surgical techniques in the management of FAI.

Femoroacetabular impingement

FAI was first recognised by Ganz et al3 as the predominant cause of labral tears in non-dysplastic hips and as a precursor to premature OA. Two types of impingement are described; cam and pincer (Fig. 1).

Cam-type FAI occurs when a non-spherical femoral head abuts against the acetabular rim during flexion and internal rotation.4 There is displacement of the labrum towards the capsule resulting in damage primarily in the transition zone between the fibrocartilage component of the labrum and the articular hyaline cartilage.5 The acetabular labrum is relatively spared in cam-type impingement and the damage predominantly occurs at the
chondrolabral junction over the anterior-superior acetabulum. Treatment involves dealing with the central compartment of the hip joint as well as managing the cam lesion in the peripheral compartment.

The pincer lesion is more complex; there is local or global acetabular overcoverage or acetabular retroversion that results in abnormal contact between a normal femoral head and a region of acetabular prominence during the extremes of hip movement. The labrum gets crushed between the femoral neck and acetabular rim, leading to subsequent labral failure followed by ossification, which can exacerbate the overcoverage.3 There is usually linear impact anteriorly over the acetabular rim with chronic leverage of the head at extremes of hip motion. This eventually results in chondral injury at the posterior–medial femoral head and the corresponding posterior-inferior acetabulum (a ‘contre-coup’ lesion).1,5 Pincer-type lesions generally produce less chondral damage but far more labral damage than cam-type impingement. Preservation of the labrum in pincer type FAI is challenging and requires considerable surgical expertise. It is however desirable since there is strong evidence to suggest that labral repair or reattachment results in better outcomes both in terms of hip scores and medium term hip joint preservation when compared with labral excision or debridement.6,7

Researchers have found that simultaneous femoral and acetabular lesions occur in up to 86% of FAI cases, whereas pure cam- or pincer-type impingement is seen in 9% and 5% of cases respectively.5 Conventional radiographs, CT scans, MRI and arthrography are useful for the evaluation of both the structural abnormalities and the pathological changes associated with FAI.

Surgical techniques
The aims of surgery in FAI are to improve head neck offset, improve joint clearance, and prevent femoral or acetabular
abutment while simultaneously addressing the secondary pathology. Open, arthroscopic and combined techniques have been described.

**Open surgery.** Open surgical dislocation of the hip allowing a 360° view of the femoral head and acetabulum was initially described by Ganz et al\(^8\) in 2001. The authors found no cases of avascular necrosis using this technique in 219 patients. This work is instrumental in our understanding of FAI and their technique has remained the gold standard for open surgical treatment. Beck et al\(^9\) have reported results of surgical dislocation and offset creation in 19 patients with a mean age of 36 years. At a mean follow-up of 4.7 years, open surgery yielded good to excellent results in patients with early Tönnis grade 1 OA.\(^9\) The authors concluded that the procedure is not suitable for patients with advanced OA.\(^10\)

**Mini-open and combined surgical approaches.** ‘Mini-open’ anterior approaches that facilitate an excellent view of the hip joint have been described.\(^11,12\) They are considered minimally invasive in that they avoid muscle dissection and dislocation of the hip. Ribas et al\(^12,13\) have successfully used this technique over the last ten years and shown reduced post-operative rehabilitation times and statistically significant improvements in hip internal rotation (23°, \(p = 0.006\), flexion (21°, \(p = 0.011\)), Western Ontario and McMaster Universities osteoarthritis index (WOMAC)\(^14\) and Merle d’Aubigné–Postel scores\(^15\) in patients treated early.

Combined surgical techniques for the treatment of FAI include an initial arthroscopic assessment and management of intra-articular pathology followed by a mini-open approach for enhanced joint visualisation and proximal osteochondroplasty of the femoral head-neck junction.\(^16-19\) This combined technique was originally described by Clohisy and McClure in 2005.\(^20\) Hartmann and Gunther\(^21\) reported good results in 2009 at 15 months’ follow-up on a series of 33 patients undergoing arthroscopically assisted anterior decompression for FAI.\(^22\) In the same year successful results were similarly reported by Laude, Sariali and Nogier\(^18\) and Lincoln et al.\(^16\)

**Arthroscopic management of FAI.** There has been a rapid shift from open surgery to combined approaches and finally to arthroscopy alone for the management of FAI. Once a procedure held in low regard by many, it is now considered the standard of treatment. Arthroscopy is associated with minimal soft tissue trauma and can be performed on an outpatient basis. Although considered ‘the modern solution’, it still has a significant learning curve associated with it. The technique continues to evolve worldwide and arguably represents the most rapidly growing field in orthopaedic surgery.\(^23\) Konan, Rhee and Haddad\(^24\) estimated the surgeon’s learning curve for hip arthroscopy to be approximately thirty cases. A compound annual procedural growth rate of 30.3% is predicted worldwide between 2009 and 2014.\(^25\) Larson and Giveans\(^26\) have reported statistically significant short-term improvements (\(p < 0.001\)) all outcome measures studied including the Harris hip score,\(^27\) Short-Form 12,\(^28\) visual analogue score for pain and impingement\(^29\) following arthroscopic FAI treatment in young adults. These findings were confirmed by Philippou et al\(^30-32\) who subsequently showed similar results in both adolescents and patients aged > 50 years with FAI and joint space > 2 mm. However, 43% of patients aged > 50 years with < 2 mm of joint space required total hip replacement within three years. The indications for arthroscopic FAI surgery have therefore expanded and now include a wider age group of patients. A recent systematic

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**Table I. Advantages and disadvantages of various surgical approaches for treatment of femoroacetabular impingement**

<table>
<thead>
<tr>
<th>Approach</th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Open surgery</td>
<td>360° access to hip joint</td>
<td>Higher blood loss</td>
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<tr>
<td></td>
<td>Addresses intra- and extra-articular pathologies</td>
<td>Longer hospital stay and rehabilitation</td>
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<td></td>
<td>Allows the use of templates for precision of osteoplasty</td>
<td>Sacrifices ligamentum teres</td>
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<td></td>
<td></td>
<td>Risk of avascular necrosis</td>
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<td></td>
<td></td>
<td>Soft-tissue damage</td>
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<td></td>
<td></td>
<td>Requires trochanteric osteotomy (risk of nonunion)</td>
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<tr>
<td>Combined</td>
<td>No trochanteric osteotomy or dislocation</td>
<td>Longer operating time</td>
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<tr>
<td></td>
<td>Better visualisation of femoral neck</td>
<td>Blood loss</td>
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<tr>
<td></td>
<td></td>
<td>Multiple scars</td>
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<td></td>
<td></td>
<td>Risks associated with arthroscopy</td>
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<td></td>
<td></td>
<td>Limited access to central compartment</td>
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<tr>
<td>Arthroscopy</td>
<td>Day procedure</td>
<td>Limited access to central compartment</td>
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<tr>
<td></td>
<td>Shorter rehabilitation time</td>
<td>Traction nerve injuries</td>
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<tr>
<td></td>
<td>Minimum soft-tissue damage</td>
<td>Steep learning curve</td>
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<td></td>
<td></td>
<td>Specialised equipment</td>
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<tr>
<td></td>
<td></td>
<td>Lateral femoral cutaneous nerve injury (entry portal)</td>
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<td></td>
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<td>Risk of abdominal/pelvic compartment syndrome</td>
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</table>
review comparing open dislocation, arthroscopy and combined approaches for symptomatic FAI demonstrated that all methods were relatively safe and effective in the short- and mid-term. It must however be noted that despite the advantages conferred by arthroscopy, it may not be suitable for all joint morphologies. Patients with severe acetabular retroversion for instance may still require open joint preservation procedures (e.g. reverse peri-acetabular osteotomy). The advantages and disadvantages of each of the different surgical techniques used are summarised in Table I.

**Labral preservation**

Tears of the acetabular labrum are by far the most common indication for arthroscopic surgery to the hip in non-degenerative joints. The labrum functions as a seal, creating a uniform hydrostatic fluid pressure distribution and lubrication within the intra-articular space thereby promoting articular cartilage nutrition. The labrum acts indirectly as a shock attenuator and reduces contact stresses within the joint. It deepens the joint cavity increasing stability, particularly at extremes of hip flexion. An histological study on human cadavers has proven that the labrum contains nerve endings responsible for pain and proprioceptive feedback from the hip. A loss of these labral functions due to tears is now recognised as a precursor of early onset osteoarthritis of the hip. Treatment of tears by labral debridement, reattachment or repair is therefore likely to prevent early degenerative changes. Animal studies investigating vascularity of the acetabular labrum have shown that the labrum can heal satisfactorily after surgical repair. The same may apply to tears located at the capsular side of the labrum in humans, which has been shown to have higher vascularity when compared with the articular side.

There is emerging evidence that patients undergoing labral repair or reattachment have superior outcomes in the short and mid-term compared with labral debridement. It is important to note, however that treating labral pathology alone is not enough and that any underlying bony abnormality must also be addressed. Failure to address or undertreatment of bony impingement lesions at arthroscopy has been shown to increase failure rates and the need for revision surgery in up to 92% of primary labral repairs.

**Indications for arthroscopic treatment of FAI**

Clinicians confirm the presence of FAI based on clinical and radiographic evidence, however there are no published guidelines defining the diagnosis of FAI or definitive indications for arthroscopic intervention. Kaplan, Shah and Youm suggested that a comprehensive history, physical examination and critical analysis of key radiological indicators (including anteroposterior radiographs, alpha angle, head-neck offset, presence of bony prominences, acetabular retroversion and three-dimensional CT/MRI imaging) should be undertaken before selecting patients for surgery. However, they did not explicitly state which clinical findings or radiological indicators should be used as key indicators for arthroscopy. Martin et al showed an agreement of 65% among hip surgeons experienced in arthroscopy in diagnosing FAI based on clinical examination alone. Hack et al investigated 200 young volunteers using MRI and found cam-type impingement in 14% of asymptomatic individuals. These findings suggest that the clinical diagnosis of FAI needs further refinement and patient selection for surgery should not be based on radiological parameters alone as this would result in unnecessary surgery in a large number of asymptomatic patients. A recent systematic review of the literature on FAI has concluded that further research is needed to determine the best combination of clinical and radiographic indicators for selecting patients for arthroscopic management.

**Discussion**

Arthroscopy is not only less invasive, but also facilitates detailed visualisation of intra-articular pathology. Byrd and Jones found that the short-term outcomes of arthroscopic treatment of cam-type FAI in 200 patients are comparable with reports of open methods with the advantage of a less invasive approach. Lynch et al reported in 2013 good short- and mid-term clinical outcomes after arthroscopic treatment of pre-arthritic hip lesions.

With the recognition of FAI as a precursor to early onset OA, and an enhanced understanding of the disease process, guidelines are now required for the appropriate management of the condition. Arthroscopic treatment is becoming the treatment of choice in the management of selected patients with promising preliminary results in experienced hands. It is important to recognise that not all patients with FAI need surgical intervention. Recognition of the varying spectrum of hip pathologies that present as FAI is an important prerequisite for successful treatment. Careful patient selection is crucial and evaluation of outcomes in multicentre data such as the recently developed Non Arthroplasty Hip Register (NAHR) is needed. No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article. This paper is based on a study which was presented at the 29th Annual Winter 2012 Current Concepts in Joint Replacement meeting held in Orlando, Florida, 12th – 15th December.

**References**


