Femoroacetabular impingement in young adults: assessment and management

ABSTRACT

Femoroacetabular impingement is a cause of hip pain in young adults as a result of premature dynamic contact between the femur and acetabulum that occurs within the physiological range of hip motion. Diagnosis is made by patient history, clinical examination and radiographic findings. Cross-sectional imaging with computed tomography and magnetic resonance arthrography may be necessary in selected patients. Femoroacetabular impingement can be treated non-operatively with physiotherapist-led conservative care including analgesia and intra-articular steroid injections. Arthroscopic hip surgery aiming to restore pain-free functional range of movement and repair damaged labrum can help in selected patients with no pre-existing osteoarthritis. This review outlines the clinical assessment, investigations and management of femoroacetabular impingement in young adults.

Femoroacetabular impingement is a cause of hip pain in young adults and is the result of abnormal premature dynamic contact between the femur and acetabulum that occurs within the physiological range of hip motion (Röling et al, 2016). Abnormalities can be identified on either the femoral or acetabular side but are often seen on both sides (Gosvig et al, 2010; Jaberi and Parvizi, 2007). However, radiographic criteria used to define femoroacetabular impingement vary in the literature and the true effects of those abnormalities remain unclear. This abnormal contact can lead to acetabular chondral lesions and/or labral lesions, leading to hip pain and the development of osteoarthritis of the affected hip, particularly with femoral-sided abnormalities (Ganz et al, 2003; van Klij et al, 2018). This review focuses on the clinical assessment and management of femoroacetabular impingement in young adults.

Pathogenesis and epidemiology

There are two primary mechanisms of femoroacetabular impingement: pincer and cam-type impingement. Pincer impingement is the result of contact between an abnormal acetabular rim and femoral head–neck junction. This is typically caused by a globally deep acetabulum or focal anterosuperior overcoverage as a result of acetabular retroversion. It leads to labral bruising and degenerative tearing and may eventually result in ossification of the labrum. Cam impingement is the result of contact between an abnormal femoral head–neck junction and the acetabulum. This is typically the result of an aspherical anterolateral head–neck junction or a sequelae of childhood hip disease. This leads to shearing stress to the anterosuperior acetabulum, with chondral delamination and labral detachment or tearing in some cases. However, most patients with femoroacetabular impingement have a combination of both cam and pincer impingements (*Figure 1*).

The exact epidemiology of femoroacetabular impingement remains unclear. Patients with femoroacetabular impingement often have a history of performing activities that require extremes of hip motion, particularly flexion and rotation, such as female dancers, gymnasts and male athletes (Palmer et al, 2018). In a magnetic resonance imaging-based study looking at the development of cam morphology and its relationship to sporting activity, a strong dose–response relationship was found. Men participating in competitive sport are at particularly high risk of developing cam morphology and secondary hip pathology (Palmer et al, 2018).

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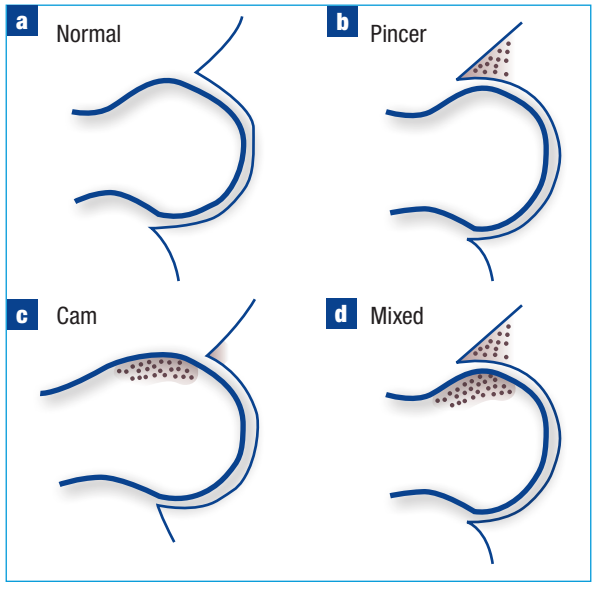

Figure 1. Schematic representation of cross-sectional anatomy of (a) normal hip; (b) pincer lesion which is acetabular-based with anterior overcoverage; (c) cam lesion which is femoral head-based and (d) mixed pincer and cam which is seen in the majority of cases.

The prevalence of asymptomatic femoroacetabular impingement is unknown. Laborie et al (2011), in a study of 2081 healthy young adults with an average age of 18.6 years, reported the prevalence of pincer morphology to be 34.3% in men and 16.6% in women. Many hips with radiographic features of femoroacetabular impingement may be asymptomatic for decades, and do not rapidly progress to osteoarthritis (Bardakos and Villar, 2009). Allen et al (2009) analysed the contralateral hip in patients with symptomatic femoroacetabular impingement and found deformities suggestive of femoroacetabular impingement, although the hip was asymptomatic in most cases. In other words, some hips with radiographic features of femoroacetabular impingement remain asymptomatic and some hips with rather mild radiographic abnormalities become symptomatic. Further long-term studies are needed to better understand the natural history of this condition and the implications for clinical management.

History and clinical examination

Patients typically are young to middle aged presenting with anterior groin pain (*Table 1, Figure 2*). Pain is often exacerbated by prolonged sitting, arising from a chair, putting on shoes and socks, getting in and out of a car, and sitting with crossed legs. The pain is typically exacerbated by activity owing to the dynamic abnormal contact between the femur and acetabulum. Clinical examination includes assessment of gait, hips, spine, knees and the neurovascular system. Hip examination should be systematic and follows the principle of look, feel, move and special tests. Surgical scars and muscle wastage in young patients may suggest previous surgery for developmental hip dysplasia, slipped upper femoral epiphysis, Perthes' disease, avascular necrosis or trauma. Palpation may reveal superficial tenderness around muscle insertions as a result of strain or tendinopathy.

Stiffness or overall restriction of hip movement suggest advanced osteoarthritis of the hip. However, restriction in flexion and internal rotation may be seen in patients with femoroacetabular impingement. This forms the basis for the anterior impingement test or FADIR (flexion adduction internal rotation) test (Klaue et al, 1991). This is performed with the patient supine, and the hip is passively flexed to 90°, 10–15° hip adduction and internal rotation. A positive test reproduces the anterior groin pain indicating an anterolateral acetabular rim or labral pathology with high positive predictive value (Hananouchi et al, 2012). However, this test, while highly sensitive, lacks specificity for femoroacetabular impingement in isolation and is better used as a screening test (Burnett et al, 2006; Shanmugaraj et al, 2018).

Numerous other specialist tests are described in the literature which may reflect the difficulty of establishing the diagnosis of femoroacetabular impingement by clinical examination alone. For example, the FABER (flexion abduction internal rotation) test, which is performed with the hip flexed to 90°, abducted and externally rotated. A positive test reproduces pain in the hip or lower back, or demonstrates a limited range of hip movement and can suggest intra-articular hip pathology or sacroiliac disease. Similarly, the Stinchfield test is a resisted hip flexion test performed with the patient supine with the knee extended, active hip flexion is resisted by the examiner past 30–45° which can elicit pain suggesting intra-articular hip pathology.

A more effective approach is the combination of history, examination findings of limited flexion and/or internal rotation, and the radiographic assessment. Finally, assessment of the rotational profile of the extremity is necessary which includes assessment of femoral anteversion, tibial torsion and foot alignment which may reveal other structural abnormalities that could have an impact on the treatment plan.

Table 1. Comparison of cam and pincer lesions*

Cam (femoral head-based)	Pincer (acetabular-based)
Young athletic males	Active middle-aged females
Decreased head-to-neck ratio	Anterosuperior acetabular rim overhang
Aspherical femoral head	Acetabular retroversion
Decreased femoral offset	Acetabular protrusio
Femoral neck retroversion (previous slipped upper femoral epiphysis)	Coxa profunda

**80% of lesions are mixed*

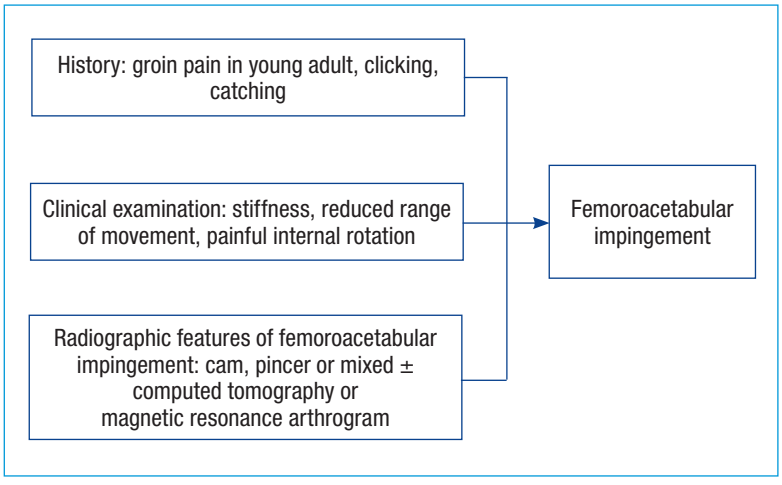

Figure 2. Diagnosis of femoroacetabular impingement based on a combination of history, clinical examination and radiographic findings.

Radiographs and imaging studies

Once femoroacetabular impingement is suspected clinically, an anteroposterior radiograph of the pelvis and a lateral femoral neck view of the symptomatic hip are routinely performed to obtain an overview of the hips.

A pelvic radiograph (*Figure 3*) allows an overall assessment of the pelvis and hips, and exclusion of other painful conditions such as fracture, acetabular dysplasia and osteoarthritis. This radiograph should be centred on the pubic symphysis, without rotation, and with neutral pelvic tilt. The distance between the superior border of

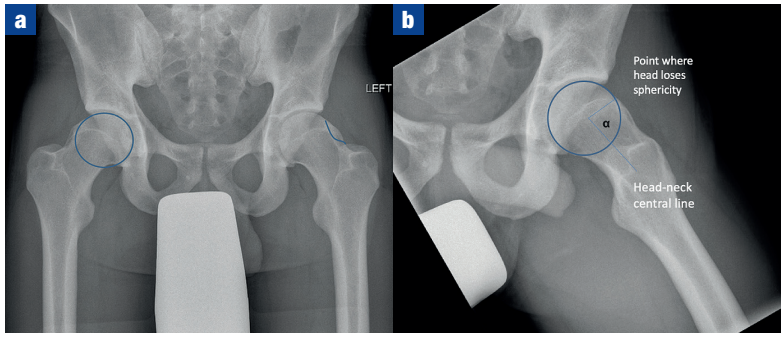

Figure 3. **a.** Anteroposterior radiograph of both hips demonstrating bilateral cam lesions in a 21-year-old man with symptomatic left hip. **b.** Lateral radiograph of the left hip of the same patient demonstrating an increased alpha angle (angle between axis of femoral neck and junction of spherical portion of femoral head; alpha angle >55° is considered abnormal).

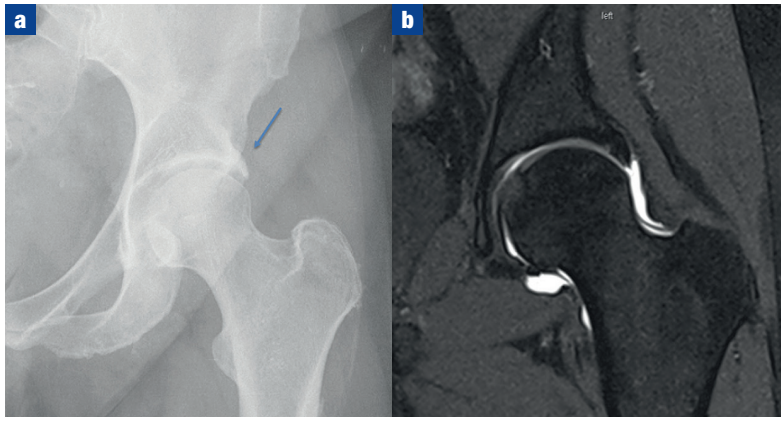

Figure 4. **a.** Anteroposterior radiograph of a symptomatic left hip in a 38-year-old woman with pincer-type femoroacetabular impingement. **b.** Magnetic resonance imaging arthrogram of the same hip further delineating the pincer lesion without labral tears.

the pubic symphysis and the tip of the coccyx should be approximately 1–3 cm (Clohisy et al, 2008). A number of lateral projections are described in the literature with varying sensitivity and specificity. Most notable of these is the Dunn view which has high sensitivity and specificity for diagnosing cam deformities. This is obtained with the patient supine and the symptomatic hip flexed (90°) and abducted 20° with neutral rotation.

However, pincer or cam morphology can be better assessed through cross-sectional imaging, either computed tomography or magnetic resonance arthrogram (Kassarjian et al, 2005). Magnetic resonance arthrogram (*Figure 4*) allows accurate assessment of the articular cartilage and the labrum, but should be interpreted with caution as 30–60% of asymptomatic patients have labral tears on magnetic resonance arthrograms (Smith et al, 2011). When computed tomography scans are performed, limited images of the femoral condyles should be included to allow assessment of the femoral version, and three-dimensional reformatting of computed tomography images improves the appreciation of the deformity. More recently, computed tomography images have been used to create three-dimensional printing models to help surgical planning (Verma et al, 2018) (*Figures 5* and *6*). Interpreting cross-sectional imaging requires specialist input from musculoskeletal radiologists and treating surgeons and should therefore be arranged in the secondary or tertiary settings.

Management and clinical outcomes

Once the diagnosis of femoroacetabular impingement has been established, treatment is tailored to the patient's symptoms. Although femoroacetabular impingement comprises morphological abnormalities, many patients with pronounced abnormalities remain asymptomatic. Further, the role of correcting the morphological abnormalities in changing the natural history of femoroacetabular impingement remains unclear.

Non-operative management of femoroacetabular impingement consists of:

- Activity modification
- Avoiding painful activities such as deep hip flexion, aggressive hip flexion-based weight training, and other athletic activities that aggravate symptoms
- Physiotherapy and anti-inflammatories and/or analgesics as well as intra-articular corticosteroid injections (X-ray or ultrasound-guided) in selected cases.

Evidence suggests that non-operative management is beneficial in the majority of patients with femoroacetabular impingement, particularly in the initial stages (Casartelli et al, 2011; Wall et al, 2013; Diamond et al, 2015; Fairley et al, 2016). Targets for physiotherapy include weakness of hip muscles seen in patients with femoroacetabular impingement as well as abnormal gait patterns (Kennedy et al, 2009; Diamond et al, 2015). In a prospective study of 93 hips in 73 young adults who were managed non-operatively, 82% of patients had significant improvements in outcome scores at a mean follow up of 2 years (Pennock et al, 2018).

Operative management of femoroacetabular impingement aims to achieve a functional range of motion that is free of bony impingement. This generally involves resecting cam and pincer lesions and repairing any damage to the labrum using anchors or debridement of degenerative labral tears. A theoretical long-term goal of surgery is to avoid or delay the onset of osteoarthritis by restoring impingement-free motion of the hip joint, but there are currently no data to support this.

Surgical techniques include open surgical dislocation of the hip, arthroscopic techniques or a combination of the two, dependent on many variables including patient and surgeon factors. A systematic review of 16 studies (nine which looked at open surgical hip dislocations, 600 hips, average follow up 4.8 years *vs* seven which looked at hip arthroscopies, 1484 hips, average follow up 4.2 years) with the need for a hip replacement as an end point found no statistically significant differences between the two; advanced age and pre-existing chondral injury were risk factors for progression to hip replacements after both treatments. However, hip arthroscopy was associated with a higher general health-related quality of life score on the 12-Item Short-Form Survey physical component score (Nwachukwu et al, 2016).

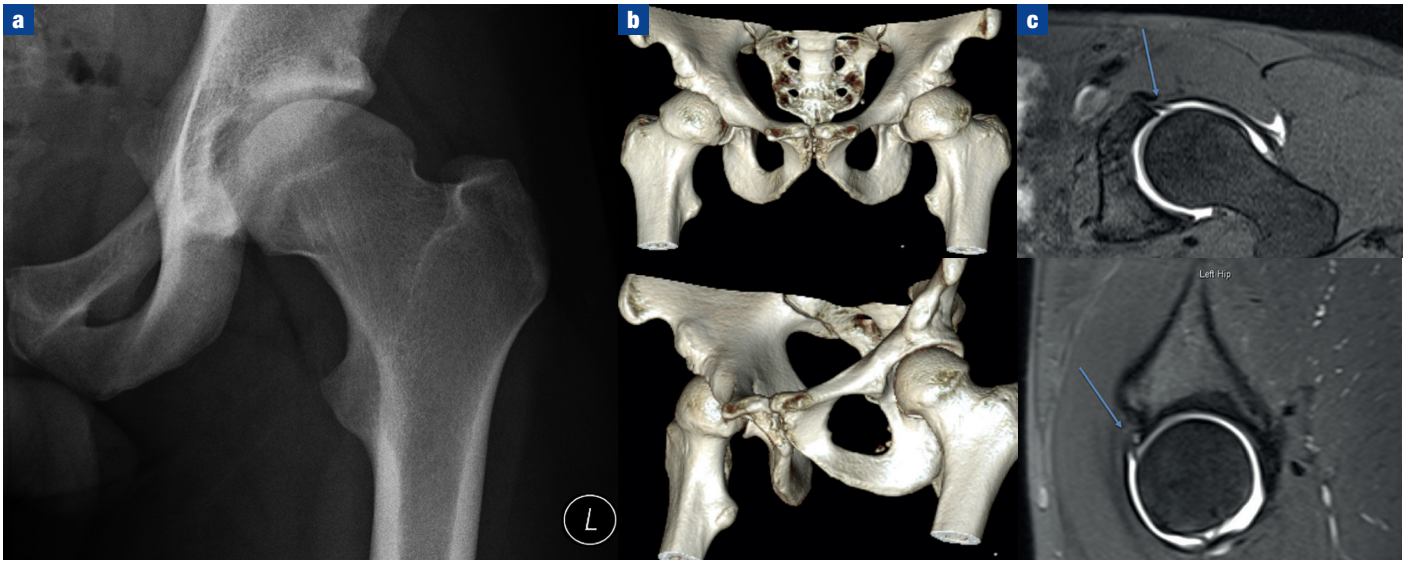

Figure 5. a. Anteroposterior radiograph of symptomatic left hip in a 25-year-old man with radiographic features of femoroacetabular impingement. **b.** Three-dimensional reconstruction (computed tomography scan) showing bilateral large cam lesions involving the superior lateral aspects of both femoral head-neck junctions with an element of pistol-grip deformity and little irregularity of the superior margins of both acetabulae. The alpha angle was 71° on the left side; **c.** Sagittal and axial T2-weighted magnetic resonance arthrogram of the patient's left hip with evidence of anterior-superior labral tear as a result of the abnormal cam lesion with no evidence of degenerative changes or cartilage abnormality. This patient was a good surgical candidate and underwent arthroscopic resection of his cam lesion and labral repair. Interestingly, despite similar radiographic appearances of the right side, it was asymptomatic.

Griffin et al (2018) published their multicentre, assessor-blinded randomized controlled trial comparing hip arthroscopy (n=171) with best conservative care (n=177) for the treatment of femoroacetabular impingement (UK FASHIoN), the largest trial of its kind to date. Their primary outcome measure was patient-reported International Hip Outcome Tool (iHOT-33) at 12 months. Both groups gained significant improvements in their scores compared to their baseline. At 6 months follow up, there were no statistically significant differences between conservative care and hip arthroscopy. At 12 months, the hip arthroscopy group had better improvement in iHOT-33 but reported surgery-related complications (25% numbness in groin, foot or leg, 9% superficial wound problems, 1% hip septic arthritis, 6% other surgery-related complications). General quality of life measures were similar between the two groups throughout.

In another recent multicentre, assessor-blinded pragmatic randomized controlled trial of patients with symptomatic femoroacetabular impingement (FAIT trial), Palmer et al (2019) compared physiotherapy tailored to individual patient needs (n=88) *vs* arthroscopic surgery (n=100). The primary outcome measure was the hip outcome score activities of daily living subscale (HOS ADL) at 8 months post-randomization. Patients in the surgical group achieved higher scores (78.4 (95% confidence interval 74.4–82.3) *vs* 69.2 (95% confidence interval 65.2–73.3)). This difference was statistically and clinically significant. While some studies reported good short- to medium-term outcomes following hip arthroscopy, higher failure rates have been reported for patients with mild osteoarthritis, or even the finding of mild intra-operative acetabular wear, and hip acetabular dysplasia (McCarthy and McMillan, 2013; Ross et al, 2014; Davies et al, 2018). Further long-term follow up is planned from these trials which will shed more light on the effect of surgery on the natural history of femoroacetabular impingement compared to conservative care.

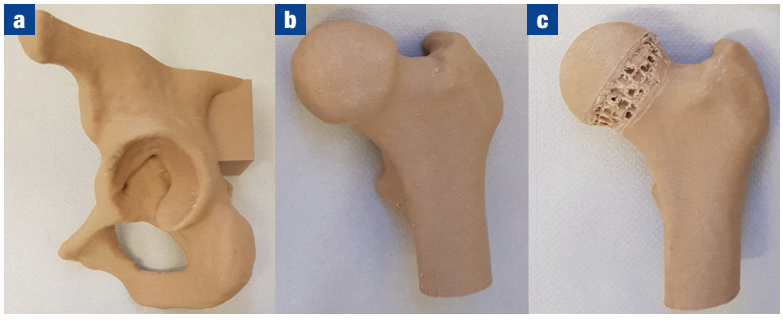

Figure 6. a and **b.** Three-dimensional printed model of the patient in *Figure 5* demonstrating the significant cam lesion. **c.** Following resection of the cam as part of preoperative planning.

Conclusions

Femoroacetabular impingement is a cause of hip pain in young adults as a result of abnormal contact between the proximal femur and the acetabulum. Diagnosis is made by patient history, clinical examination and radiographic findings. It can be treated non-operatively with physiotherapist-led conservative care including analgesia and intra-articular steroids injections. Arthroscopic hip surgery, aiming to restore pain-free functional range of movement and repair damaged labrum, can help in selected patients with no pre-existing osteoarthritis. However, what remains unclear is how best to identify patients and their

KEY POINTS

- Femoroacetabular impingement is a cause of hip pain in young adults as a result of abnormal contact between the proximal femur and the acetabulum.
- Diagnosis is made by patient history, clinical examination and radiographic findings. It can be treated non-operatively with physiotherapist-led conservative care including analgesia and intra-articular steroids injections.
- Arthroscopic hip surgery, aiming to restore pain-free functional range of movement and repair damaged labrum, can help in selected patients with no pre-existing osteoarthritis.
- The effect of treatment on the natural history of hip impingement remains unclear.

specific characteristics that may benefit from one method of treatment over another and the effect of treatment on the natural history of hip impingement. **BJHM**

Conflict of interest: none.

Allen D, Beaulé PE, Ramadan O, Doucette S. Prevalence of associated deformities and hip pain in patients with cam-type femoroacetabular impingement. J Bone Joint Surg Br. 2009 May;91-B(5):589–594. https://doi.org/10.1302/0301-620X.91B5.22028

Bardakos NV, Villar RN. Predictors of progression of osteoarthritis in femoroacetabular impingement. J Bone Joint Surg Br. 2009 Feb;91-B(2):162–169. https://doi.org/10.1302/0301-620X.91B2.21137

Burnett RSJ, Rocca GJD, Prather H, Curry M, Maloney WJ, Clohisy JC. Clinical presentation of patients with tears of the acetabular labrum. J Bone Joint Surg. 2006 Jul;88(7):1448–1457. https://doi.org/10.2106/JBJS.D.02806

Casartelli NC, Maffiuletti NA, Item-Glatthorn JF, Staehli S, Bizzini M, Impellizzeri FM, Leunig M. Hip muscle weakness in patients with symptomatic femoroacetabular impingement. Osteoarthritis Cartilage. 2011 Jul;19(7):816–821. https://doi.org/10.1016/j.joca.2011.04.001

Clohisy JC, Carlisle JC, Beaulé PE et al. A systematic approach to the plain radiographic evaluation of the young adult hip. J Bone Joint Surg Am. 2008 Nov;90 Suppl 4:47–66. https://doi.org/10.2106/JBJS.H.00756

Davies O, Grammatopoulos G, Pollard TCB, Andrade AJ. Factors increasing risk of failure following hip arthroscopy: a case control study. J Hip Preserv Surg. 2018 Jun 22;5(3):240–246. https://doi.org/10.1093/jhps/hny020

Diamond LE, Dobson FL, Bennell KL, Wrigley TV, Hodges PW, Hinman RS. Physical impairments and activity limitations in people with femoroacetabular impingement: a systematic review. Br J Sports Med. 2015 Feb;49(4):230–242. https://doi.org/10.1136/bjsports-2013-093340

Fairley J, Wang Y, Teichtahl AJ et al. Management options for femoroacetabular impingement: a systematic review of symptom and structural outcomes. Osteoarthritis Cartilage. 2016 Oct;24(10):1682–1696. https://doi.org/10.1016/j.joca.2016.04.014

Ganz R, Parvizi J, Beck M, Leunig M, Nötzli H, Siebenrock KA. Femoroacetabular impingement: a cause for osteoarthritis of the hip. Clin Orthop Relat Res. 2003 Dec;(417):112–120. https://doi.org/10.1097/01.blo.0000096804.78689.c2

Gosvig KK, Jacobsen S, Sonne-Holm S, Palm H, Troelsen A. Prevalence of malformations of the hip joint and their relationship to sex, groin pain, and risk of osteoarthritis: a population-based survey. J Bone Joint Surg Am. 2010 May;92(5):1162–1169. https://doi.org/10.2106/JBJS.H.01674

Griffin DR, Dickenson EJ, Wall PDH et al; FASHIoN Study Group. Hip arthroscopy versus best conservative care for the treatment of femoroacetabular impingement syndrome (UK FASHIoN): a multicentre randomised controlled trial. Lancet. 2018 Jun;391(10136):2225–2235. https://doi.org/10.1016/S0140-6736(18)31202-9

Hananouchi T, Yasui Y, Yamamoto K, Toritsuka Y, Ohzono K. Anterior impingement test for labral lesions has high positive predictive value. Clin Orthop Relat Res. 2012 Dec;470(12):3524–3529. https://doi.org/10.1007/s11999-012-2450-0

Jaberi FM, Parvizi J. Hip pain in young adults: femoroacetabular impingement. J Arthroplasty. 2007 Oct;22(7) Suppl 3:37–42.e1. https://doi.org/10.1016/j.arth.2007.05.039

Kassarjian A, Yoon LS, Belzile E, Connolly SA, Millis MB, Palmer WE. Triad of MR arthrographic findings in patients with cam-type femoroacetabular impingement. Radiology. 2005 Aug;236(2):588–592. https://doi.org/10.1148/radiol.2362041987

Kennedy MJ, Lamontagne M, Beaulé PE. Femoroacetabular impingement alters hip and pelvic biomechanics during gait. Gait Posture. 2009 Jul;30(1):41–44. https://doi.org/10.1016/j.gaitpost.2009.02.008

Klaue K, Durnin CW, Ganz R. The acetabular rim syndrome. A clinical presentation of dysplasia of the hip. J Bone Joint Surg Br. 1991 May;73-B(3):423–429. https://doi.org/10.1302/0301-620X.73B3.1670443

Laborie LB, Lehmann TG, Engesæter IØ, Eastwood DM, Engesæter LB, Rosendahl K. Prevalence of radiographic findings thought to be associated with femoroacetabular impingement in a population-based cohort of 2081 healthy young adults. Radiology. 2011 Aug;260(2):494–502. https://doi.org/10.1148/radiol.11102354

McCarthy J, McMillan S. Arthroscopy of the Hip. Orthop Clin North Am. 2013 Oct;44(4):489–498. https://doi.org/10.1016/j.ocl.2013.06.002

Nwachukwu BU, Rebolledo BJ, McCormick F, Rosas S, Harris JD, Kelly BT. Arthroscopic versus open treatment of femoroacetabular impingement. Am J Sports Med. 2016 Apr;44(4):1062–1068. https://doi.org/10.1177/0363546515587719

Palmer A, Fernquest S, Gimpel M et al. Physical activity during adolescence and the development of cam morphology: a cross-sectional cohort study of 210 individuals. Br J Sports Med. 2018 May;52(9):601–610. https://doi.org/10.1136/bjsports-2017-097626

Palmer AJR, Ayyar Gupta V, Fernquest S et al; FAIT Study Group. Arthroscopic hip surgery compared with physiotherapy and activity modification for the treatment of symptomatic femoroacetabular impingement: multicentre randomised controlled trial. BMJ. 2019 Feb 07;364:l185. https://doi.org/10.1136/bmj.l185

Pennock AT, Bomar JD, Johnson KP, Randich K, Upasani VV. Nonoperative management of femoroacetabular impingement: a prospective study. Am J Sports Med. 2018 Dec;46(14):3415–3422. https://doi.org/10.1177/0363546518804805

Röling MA, Mathijssen NMC, Bloem RM. Incidence of symptomatic femoroacetabular impingement in the general population: a prospective registration study. J Hip Preserv Surg. 2016 Aug;3(3):203–207. https://doi.org/10.1093/jhps/hnw009

Ross JR, Clohisy JC, Baca G, Sink E; ANCHOR Investigators. Patient and disease characteristics associated with hip arthroscopy failure in acetabular dysplasia. J Arthroplasty. 2014 Sep;29(9) Suppl:160–163. https://doi.org/10.1016/j.arth.2014.03.054

Shanmugaraj A, Shell JR, Horner NS, Duong A, Simunovic N, Uchida S, Ayeni OR. How useful is the flexion-adduction-internal rotation test for diagnosing femoroacetabular impingement: a systematic review. Clin J Sport Med. 2018 Mar 28. https://doi.org/10.1097/JSM.0000000000000575

Smith TO, Hilton G, Toms AP, Donell ST, Hing CB. The diagnostic accuracy of acetabular labral tears using magnetic resonance imaging and magnetic resonance arthrography: a meta-analysis. Eur Radiol. 2011 Apr;21(4):863–874. https://doi.org/10.1007/s00330-010-1956-7

van Klij P, Heerey J, Waarsing JH, Agricola R. The prevalence of cam and pincer morphology and its association with development of hip osteoarthritis. J Orthop Sports Phys Ther. 2018 Apr;48(4):230–238. https://doi.org/10.2519/jospt.2018.7816

Verma T, Mishra A, Agarwal G, Maini L. Application of three dimensional printing in surgery for cam type of femoro-acetabular impingement. J Clin Orthop Trauma. 2018 Jul;9(3):241–246. https://doi.org/10.1016/j.jcot.2018.07.011

Wall PDH, Fernandez M, Griffin DR, Foster NE. Nonoperative treatment for femoroacetabular impingement: a systematic review of the literature. PM R. 2013 May;5(5):418–426. https://doi.org/10.1016/j.pmrj.2013.02.005