CQ HAND + UPPER LIMB
SPECIALIST ORTHOPAEDIC SURGEON

EVIDENCE SUMMARY

Femoroacetabular impingement

Anatomy & Pathophysiology

DEFINITIONS AND CLASSIFICATION

- Femoroacetabular impingement (FAI) is defined as a dynamic mechanical conflict between the proximal femur and the acetabulum [9].
- Intra-articular FAI occurs when the femoral head-neck junction abuts against the acetabular rim [9].
- Extra-articular FAI occurs due to conflicts between the lesser trochanter and ischium, greater trochanter and supra-acetabular region, or femoral neck and anterior-inferior iliac spine [9].
- Three types of FAI are recognized: cam, pincer, and combined cam/pincer [2].
- Combined cam/pincer deformities are common [2].
- Cam impingement is characterized by femoral-based abnormalities such as an aspherical femoral head, reduced head-neck offset, or femoral retroversion [2].
- Pincer impingement is characterized by acetabular-based disorders such as acetabular retroversion, global overcoverage, or acetabular protrusio [2].
- Cam impingement is most common in young males [5].
- Pincer impingement is most common in middle-aged females [5].

CAM IMPINGEMENT PATHOPHYSIOLOGY

- In cam impingement, the aspherical femoral head creates a shearing force along the acetabular cartilage during hip flexion [5].
- This shearing force results in articular cartilage delamination [5].
- Cam impingement may also result in avulsion of the labrum [5].
- The typical injury pattern with cam impingement is a tear at the base of the labrum at the labral-chondral junction [10].
- In cam impingement, the acetabular labrum is relatively spared compared to the adjacent articular cartilage [10].
- Cam deformity is typically located anterolateral on the femoral neck [5].

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PINCER IMPINGEMENT PATHOPHYSIOLOGY

- Pincer impingement results from acetabular overcoverage causing abnormal contact between the acetabular rim and the femoral head-neck junction [5].
- Pincer impingement causes intrasubstance tears of the labrum, typically in the anterosuperior quadrant [5].
- In pincer impingement, the anterosuperior femoral head is levered against the acetabular rim [5].
- A contrecoup cartilage lesion may occur in the posteroinferior acetabulum due to levering of the femoral neck on the acetabular rim [5].
- In pincer impingement, the labrum suffers more damage than the adjacent articular cartilage, which is relatively spared [10].
- Pincer impingement may worsen over time due to reactive bone growth at the acetabular rim or calcification of the labrum [10].

ETIOLOGY AND DEVELOPMENT

- The origin of cam deformities is controversial and has been the focus of investigations [9].
- Cam deformity can be secondary to pediatric hip diseases including slipped capital femoral epiphysis (SCFE) and Legg-Calvé-Perthes disease (LCPD) [9].
- Idiopathic cam deformity is suggested to be the most common acquired hip deformity in adolescents [9].
- Intense physical activity during adolescence may cause mechanical overloading across the epiphyseal plate, leading to increased epiphyseal extension [9].
- Increased epiphyseal extension can broaden the head-neck junction, flattening the physiological convexity or creating a convex cam morphology [9].
- A 2.8 relative risk of cam deformity in the siblings of affected individuals suggests genetic contributions [18].
- Cam deformity is more prevalent in adolescents who practice impact physical activities such as basketball, hockey, and soccer [9].
- Studies of young athletes demonstrate a lack of cam deformity in skeletally immature individuals but a presence after physeal closure [18].
- A cross-sectional MRI study found that abnormal alpha angles were not present in any hips with open physes, but 14% of hips with closed physes had cam deformities [10].
- Daily activity levels for patients with cam deformities are significantly higher than for those without deformity [10].

PREVALENCE IN ASYMPTOMATIC POPULATIONS

- The prevalence of FAIS deformity in asymptomatic adults is estimated at approximately 14%, with 24% in males and 5% in females [18].
- Males are three to five times more likely to have cam deformities than females [18].
- Cam deformity is more likely to be bilateral in males than in females [18].

- A review of 473 CT scans showed that 40% of asymptomatic hips had radiographic findings associated with FAI [16].
- In asymptomatic adolescents, the rate of cam deformity (α angle ≥ 55°) was 16.8%, pincer deformity (lateral center edge angle ≥ 40°) was 32.4%, and mixed-type deformity was 6.1% [16].
- Cam morphology is substantially more common in males, while pincer deformities are equally distributed among males and females [16].
- More than 90% of asymptomatic adolescents have at least one radiographic parameter suggesting FAI, and 50% have two [5].
- The prevalence of coxa profunda is the same in asymptomatic patients as in those with diagnosed FAI [5].

PROGRESSION TO OSTEOARTHRITIS

- FAI is recognized as a common cause of hip dysfunction and secondary osteoarthritis [2].
- In patients under 50 years of age undergoing total hip replacement for osteoarthritis, 97% had radiographic signs of cam, pincer, or mixed type impingement after excluding developmental dysplasia, SCFE, and Perthes disease [10].
- A cam deformity with an alpha angle of more than 60 degrees had an adjusted odds ratio of 3.67 for development of end-stage osteoarthritis [10].
- An alpha angle of more than 83 degrees had an adjusted odds ratio of 9.66 for development of end-stage osteoarthritis [10].
- In a 20-year longitudinal study of 1003 women, each degree increase in the alpha angle over 65 degrees was associated with a 5% increase in the risk of developing osteoarthritis [10].
- In a comparison of hips undergoing total hip arthroplasty for osteoarthritis to nonarthritic hips, 20% of arthritic hips had evidence of acetabular retroversion, compared to 5% of asymptomatic hips [10].
- Deep acetabular sockets had an adjusted risk ratio of 2.4 for the development of osteoarthritis in the Copenhagen Osteoarthritis Study [10].
- Chondrolabral damage occurs in asymptomatic patients with FAI and progresses within five years in those younger than 20 years [22].
- Chondrolabral damage develops within five years in patients treated with in situ pinning for SCFE, as the acquired deformity causes cam-type impingement [22].

EXTRA-ARTICULAR IMPINGEMENT

- Subspine impingement is an extra-articular form of impingement occurring between the femoral head-neck junction and a prominent anterior-inferior iliac spine (AIIS) [17].
- The prevalence of subspine impingement is reported to be 23.7% [17].
- Three variants of AIIS morphology are described: type I (smooth ilium wall), type II (AIIS prominence extends to or above acetabular rim), and type III (AIIS extends distally to acetabular rim) [17].
- Pathologic AIIS morphology can be developmental (types I and II) or arise following pelvic osteotomy or prior rectus femoris injury/avulsion (type III) [17].

- Ischiofemoral impingement occurs between the lesser trochanter and the ischium [17].
- Trochanteric-pelvic impingement occurs between the greater trochanter and the ilium [17].
- Intra-articular steroid injection typically provides no relief or only partial relief of symptomatic extra-articular impingement [17].

Classification

- Three types of femoroacetabular impingement (FAI) are recognized: cam, pincer, and combined cam/pincer [2].
- Cam impingement is characterized by femoral-based abnormalities, including an aspherical femoral head, reduced head-neck offset, and femoral retroversion or relative retroversion [2].
- Cam impingement results in repetitive abutment of the acetabular rim and the femoral head-neck junction [2].
- Pincer impingement is characterized by acetabular-based disorders, including acetabular retroversion, global overcoverage, and acetabular protrusio [2].
- Pincer impingement creates abnormal abutment of the acetabular rim and the femoral head-neck junction [2].
- Combined cam/pincer deformities are common in patients with FAI [2].
- Subspinal impingement morphology is a frequent finding in patients with symptomatic FAI evaluated by computed tomography [24].
- A decrease in femoral anteversion is considered a useful criterion to suspect subspinal impingement morphology [24].

Clinical Presentation

HISTORY AND SYMPTOMS

- Patients with symptomatic femoroacetabular impingement (FAI) frequently present with activity-related groin pain that is exacerbated by hip flexion activities [2].
- Patients may report difficulty with prolonged sitting, walking, running, or pivoting [2].
- The onset of symptoms is often insidious or follows minor trauma [2].
- Patients may complain of pain with sitting, driving, or putting on socks and shoes [7].
- Mechanical symptoms secondary to labral and articular cartilage disease are common in symptomatic FAI [2].
- Most patients with symptomatic impingement present with activity-related groin pain [4].
- Active adolescents and young adults who report hip and/or groin pain should be assessed for FAI syndrome (FAIS) [4].

PHYSICAL EXAMINATION

- A mild, intermittent limp is common in patients with FAI, occurring in up to 75% of patients [23].
- Abductor weakness on the affected side is often seen with a positive Trendelenburg sign [23].
- Restricted hip motion is a defining feature of symptomatic FAIS [4].
- Affected individuals often have less than 100° of straight flexion and less than 10° of internal rotation with the hip at 90° of flexion [23].
- Bilateral disease is seen in approximately 75% of patients, but is symptomatic in fewer than 25% [23].
- Patients with FAI will exhibit restricted hip internal rotation in 90° of flexion [2].
- The anterior impingement test (flexion, adduction, internal rotation) elicits pain in the anterior groin and is present in most patients (88%) with symptomatic FAIS [23].
- The anterior impingement test is not specific for FAI and may be positive in any patient with a labral or chondral injury [23].
- The subspine impingement test involves maximal anterior groin pain with direct hip flexion beyond 90° while maintaining neutral rotation and abduction [23].
- Intra-articular anesthetic injection can be used to diagnose FAI; substantial or complete relief signifies an intra-articular source of pathology [23].
- Little to no pain relief following intra-articular injection warrants assessment for extra-articular sources of impingement or other pelvic or lumbar pathology [23].

IMAGING AND DIAGNOSTIC FINDINGS

- The AP pelvis view is used to assess acetabular anatomy, including version, acetabular coverage, and femoral head sphericity [2].
- Lateral views, most commonly the 45° Dunn view and frog-leg lateral, are used to assess femoral head sphericity and head-neck offset [2].
- MRI or magnetic resonance arthrography provides information regarding the integrity of the acetabular labrum and articular cartilage [2].
- Low-dose CT with three-dimensional reformats is particularly useful in surgical planning of complex or borderline deformities [2].
- A "pistol-grip deformity," demonstrating a nonspherical femoral head, is seen in cam impingement [5].
- A crossover sign, where the anterior wall crosses lateral to the posterior wall, is classically seen with acetabular retroversion that causes pincer impingement [5].
- An alpha angle of more than 50 degrees is typical in hips with loss of sphericity [7].
- The prevalence of coxa profunda has been demonstrated to be the same in asymptomatic patients as in those with diagnosed FAI [5].
- There is a high rate of false-positive radiographic findings for FAI [5].

Investigations

CLINICAL PRESENTATION AND HISTORY

- Most patients with symptomatic femoroacetabular impingement (FAI) present with activity-related groin pain that is exacerbated by hip flexion activities [2].
- Patients with symptomatic FAI frequently report difficulty with prolonged sitting, walking, running, or pivoting [2].
- The onset of symptoms in FAI is typically insidious or follows minor trauma [2].
- Approximately 80% of patients with symptomatic impingement present with pain in the anterior groin or lateral hip [12].
- Approximately 25% of patients with symptomatic impingement report pain in the lumbar spine, buttock, or referred pain to the knee [12].
- Patients with symptomatic impingement often display the classic "C" sign when describing the location of pain [12].
- Pain in FAI is often worse with activity such as running, cutting, and pivoting, and is exacerbated in positions of hip flexion such as prolonged sitting or squatting [12].

PHYSICAL EXAMINATION

- Patients with FAI exhibit restricted hip internal rotation in 90° of flexion [2].
- The impingement test, performed by flexion, adduction, and internal rotation of the hip, elicits pain but is not specific for FAI [2].
- A positive anterior impingement test is defined as reproduction of symptoms with passive flexion, adduction, and internal rotation [5].
- Patients with FAI generally have more passive external rotation than internal rotation [5].
- A FABER (flexion, abduction, external rotation) test may show an increased knee-to-table distance on the affected side in patients with FAI [7].
- Palpation of the hip typically does not reproduce tenderness in patients with FAI [7].
- Asymmetrical range of motion between the hips is a characteristic finding in FAI [7].

PLAIN RADIOGRAPHY

- Standard preoperative radiographs for FAI include a standing AP pelvis, false-profile, Dunn views, and frog-lateral views [14].
- For an accurate standing AP pelvis view, the coccyx should be centered in the midline with its tip within 1 to 3 cm of the pubic symphysis [14].
- A crossover sign, where the anterior wall crosses lateral to the posterior wall, is classically seen with acetabular retroversion causing pincer impingement [5].

- The alpha angle is determined on lateral radiographs, and values greater than 50° indicate cam deformity [14].
- The 45° Dunn view has been shown to be more sensitive in detecting the presence and severity of cam deformity than the 90° Dunn view [14].
- The frog-lateral view has improved specificity for cam morphology compared with the Dunn view [14].
- On the AP pelvis view, a lateral center edge angle (LCEA) greater than 40° indicates pincer morphology [14].
- A crossover sign combined with an ischial spine sign and a posterior wall sign is indicative of true acetabular retroversion [14].
- The false-profile view is obtained with the patient rotated at an angle of 65° between the pelvis and x-ray source to profile the anterior acetabulum [14].
- An anterior center edge angle greater than 40° on the false-profile view indicates excessive anterior overcoverage [14].
- Radiographic findings concerning for acetabular undercoverage include an LCEA less than 20° and a Tönnis angle greater than 10° [14].
- An anterior center edge angle less than 20° on the false-profile view is indicative of acetabular undercoverage [14].

ADVANCED IMAGING

- The sensitivity of MRI to acetabular rim chondral lesions is limited [2].
- CT can provide additional information about femur-acetabulum mismatch [5].
- Magnetic resonance arthrogram can be used to provide information about cartilaginous and labral injuries [5].
- In asymptomatic adolescents, the rate of cam deformity (defined as an α angle $\geq 55°$) was 16.8%, pincer deformity (defined as a lateral center edge angle $\geq 40°$) was 32.4%, and mixed-type deformity was 6.1% [16].
- In a study of 96 asymptomatic hips with radiographic findings consistent with FAI, 82.3% of patients remained free of radiographic arthritic changes at a mean follow-up of 18.5 years [16].
- Subspinal impingement morphology was a frequent finding in patients with symptomatic FAI evaluated by computed tomography using a three-dimensional dynamic study [24].
- A decrease in femoral anteversion was considered a useful criterion to suspect subspinal impingement morphology [24].

DIAGNOSTIC INJECTIONS

- Anesthetic intra-articular and extra-articular injections can aid in the diagnosis of combined FAI and athletic pubalgia [13].
- Initial management of FAI is typically conservative, including diagnostic or therapeutic injections [5].

Treatment

NON-OPERATIVE MANAGEMENT

- The 2016 Warwick Agreement defined FAI syndrome as a diagnosis related to the triad of symptoms, clinical signs, and imaging findings [8].
- Evidence supports the use of formal physical therapy interventions postoperatively versus self-directed rehabilitation [8].
- Nonsurgical rehabilitation for FAI syndrome should focus on activity modification, treatment of physical impairments, and optimization of joint function [8].
- Activities that place the hip in a position of impingement should be minimized as an initial recommendation when treating FAI syndrome [8].
- Combined positions of flexion, adduction, and internal rotation are commonly associated with increased symptoms in FAI [8].
- Deep squatting, lunging, cycling, and hurdling are examples of activities that may require modification during rehabilitation for FAI [8].
- Individuals with FAI syndrome have been noted to have particular deficits of the abductors, external rotators, flexors, and extensors of the hip compared with a control group [8].
- Uncontrolled pelvic motion in the frontal and transverse planes can contribute to the pain associated with FAI [8].
- Individuals with FAI syndrome have been found to have reduced posterior pelvis excursion and altered pelvifemoral coordination in both weight-bearing and non-weight-bearing tasks [8].
- Strengthening exercises for FAI should be advanced to include weight-bearing activities that challenge the patient to control excessive adduction and internal rotation of the hip [8].
- Exercises that maximize gluteal recruitment and minimize use of the tensor fascia lata should be emphasized in FAI rehabilitation [8].
- Resisted clam shell, resisted sidestep, unilateral bridge, and quadruped hip extension exercises are examples of exercises used to maximize gluteal recruitment in FAI rehabilitation [8].
- Exercises to strengthen the lumbopelvic muscles should be considered for patients with FAI [8].
- Appropriate lumbopelvic control can help decrease the occurrence of excessive anterior pelvic tilt associated with impingement secondary to altered acetabular orientation [8].
- Patients with FAI syndrome may demonstrate impaired hip and pelvic musculature flexibility [8].
- Treating hip flexor tightness should be a priority in flexibility activities for FAI because excessive tightness can be associated with anterior pelvic tilt [8].
- Anterior pelvic tilt has been correlated with the occurrence of FAI earlier in hip range of motion [8].
- Clinicians must be cautious to avoid placing patients in positions associated with symptomatic impingement when prescribing stretching activities for FAI [8].

- Joint mobilization may be indicated for patients with FAI when examination suggests a loss of capsular mobility [8].
- Examination findings suggesting a loss of capsular mobility in FAI include loss of passive range of motion, a capsular end-feel with passive range of motion assessment, and a decrease in symptoms with manual distraction of the hip joint [8].
- Soft-tissue mobilization can be useful for patients with FAI when tissue restricts joint mobility [8].
- A loss of motion associated with an elastic end-feel coupled with an immediate response to manual treatment of the target tissue indicates soft-tissue mobilization as a potentially useful intervention for FAI [8].

OPERATIVE MANAGEMENT

- Hip arthroscopy is an effective treatment modality for FAI syndrome [4].
- Both arthroscopic and open techniques are effective in the surgical management of FAI syndrome [4].
- Failure to address all the components of osseous impingement is a prime reason for continued pain and dysfunction following hip arthroscopy [4].
- Residual deformity is a leading cause of continued pain after the surgical management of FAI syndrome [4].
- In the absence of preexisting chondral disease, residual impingement is the leading cause of continued postoperative pain and revision surgery [21].
- A recent randomized clinical trial reported that hip arthroscopy led to a greater improvement than physical therapy [21].
- The current literature does not support prophylactic cam or pincer decompression in asymptomatic patients [21].

OUTCOMES AND PROGNOSTIC FACTORS

- Reduced pain and improved function are reported in 68% to 96% of patients following surgical treatment of FAI syndrome [21].
- Approximately 75% of athletes are able to return to competition at the same level or better following surgical treatment of FAI syndrome [21].
- The long-term effect of hip arthroscopy and its potential to alter the natural history of FAI syndrome and prevent early degenerative joint disease remain to be determined [21].
- Ten-year outcomes on 145 patients reported a 76% survivorship following surgical treatment of FAI syndrome [21].
- The presence of preoperative osteoarthritis (Tönnis grade $\geq$ 2 or Outerbridge grade $\geq$ 3) is the strongest predictor of poor outcome following hip arthroscopy for FAI syndrome [21].
- Older age, a longer duration of symptoms, more severe preoperative pain, and poorer functional scores are factors associated with a poorer outcome following surgical intervention for FAI syndrome [21].
- Older age, preexisting osteoarthritis, and a longer duration of symptoms are risk factors for poor outcomes following surgical intervention for FAI syndrome [4].

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