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Navigating the nonarthritic hip: Labral tears and femoroacetabular impingement

Nonarthritic hip pain is difficult to diagnose and requires a thorough history, a physical examination, and appropriate imaging modalities.

ABSTRACT: Hip pain is a common symptom presented to primary care physicians. The diagnosis is often difficult when the pain is not associated with arthritic changes. Patients with nonarthritic hip pain, more specifically femoroacetabular impingement, typically present with anterior hip pain that is worse in the position of impingement. Physical examination is typically positive for decreased range of motion and pain using the flexion, adduction, and internal rotation test. Diagnosis can be made with a thorough history, a physical examination, and radiographic imaging with anteroposterior pelvis and modified Dunn views. MRI arthrography should be avoided in any patient with signs of osteoarthritis on initial films. First-line treatment is nonoperative and can be commenced pending referral to orthopaedics. Proper workup, including history, physical examination, and appropriate imaging, can help identify patients who may be suitable for hip arthroscopic surgery and provide timely referral to an orthopaedic surgeon.

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Hip pain is a common symptom presented to primary care physicians and can be debilitating for patients of all ages. Since Sir John Charnley's early success with total hip replacement, the procedure has proven tremendously successful and has undergone innovation over the last half century in the management of the arthritic hip. However, it fails to provide a good solution for patients suffering from nonarthritic hip pain. The understanding of nonarthritic hip pain and the recognition of diagnoses and their management have increased since the turn of the 21st century, which has fostered surgical innovation.[1]

Hip arthroscopy has rapidly gained popularity in the management of young adult nonarthritic hip pain, most commonly for femoroacetabular impingement and labral pathology. Its use increased eighteenfold in the United States between 1999 and 2009, and a similar trend occurred in the United Kingdom in more recent years.[2,3] The procedure allows for the visualization and management of intra-articular pathology without open exposure. In the right setting, it may provide excellent outcomes, with high satisfaction rates in patients, and may allow for a return to function and sporting activities at a high level.

Differential diagnosis is expansive and includes pathologies that involve intra-articular and extra-articular structures. The spectrum of intra-articular causes of nonarthritic hip pain ranges from acetabular dysplasia (under-coverage of the hip) to femoroacetabular impingement (premature abutment of the femoral head on the acetabulum due to bony prominence). These morphologies can affect the articular cartilage and acetabular labrum, which may cause pain. The extra-articular causes of hip pain can be viewed with an anatomic approach outside the hip joint. Some examples include tendon pathologies (degenerative changes, tears, or traumatic ruptures), inflammation of the bursae, and neurological and vascular causes. A detailed analysis of extra-articular hip pain is beyond the scope of this article.

Due to the complex nature of hip pain, accurate diagnosis is important to formulate a treatment plan. Improper imaging can result in irrelevant incidental findings, patient anxiety, and inappropriate surgical referrals. Contrarily, delay in referral for patients with abnormal pathology can result in prolonged disability and delay to surgery and return to activities.[4,5] The purpose of this article is to review the workup of nonarthritic hip pain, with the goal of facilitating optimal and timely care in the community in partnership with orthopaedic surgeons.

Hip anatomy

The hip is a ball-and-socket synovial joint formed primarily of hyaline cartilage on the femoral head and acetabulum **[Figure 1]**.[6] The acetabular rim has a triangular fibrocartilage, known as the labrum, that encircles the entire acetabulum except for the inferior portion.[6] It functions mainly to add stability to the hip, and it maintains the joint's negative pressure with its sealing effect.[6] This, in turn, resists the distracting forces and evenly distributes compressive loads to ultimately reduce stress on the surrounding cartilage.[7]

Anterior structures are mainly the hip flexors, including the iliopsoas, sartorius, and rectus femoris.[8] Laterally, the most prominent structure is the greater trochanter, which is the insertion point of a large portion of the hip abductors (gluteus medius and minimus) and external rotators. Superficial to it lies the trochanteric bursa. The short external rotators of the hip lie posteriorly, including the piriformis muscle. Posteromedially, the proximal hamstring (semimembranosus, biceps femoris, and semitendinosus) tendons originate at the ischial tuberosity.[9]

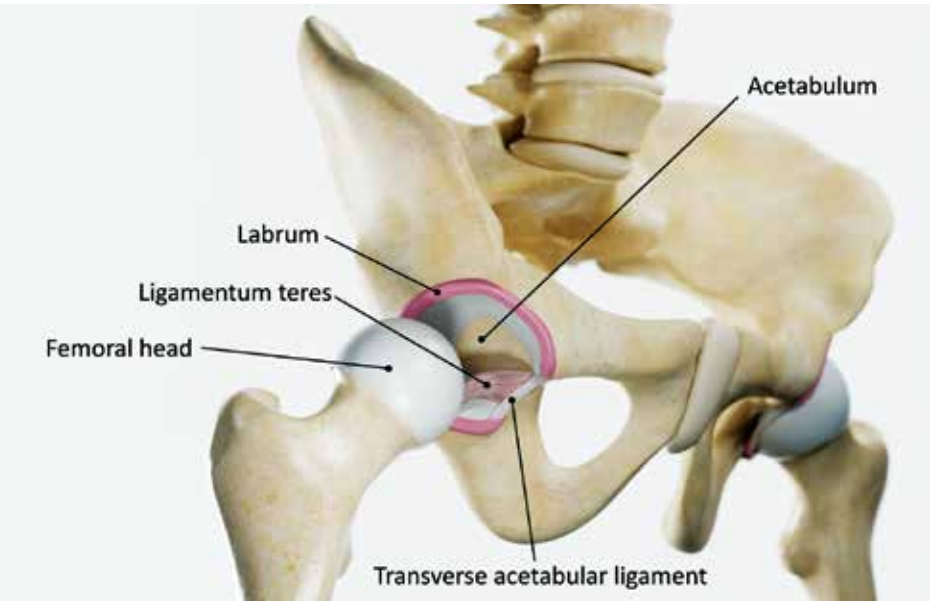

FIGURE 1. Anatomy of the hip.

Pathophysiology

Abnormal bony anatomy on the femoral head or acetabulum can cause mechanical impingement known as femoroacetabular impingement. A loss of sphericity that creates a prominence of bone on the anterosuperior femoral head is known as a cam deformity; an overhang at the acetabular rim is known as a pincer deformity.[10] These entities can occur in isolation or in combination.[11] These morphologies may cause increased mechanical stress on the hip joint and labrum and can contribute to pain at extreme ranges of motion and to labral tears.[10]

A large proportion of the asymptomatic population has imaging findings that are consistent with femoroacetabular impingement and labral pathology. A systematic review conducted in 2015 noted that the prevalence of asymptomatic cam and pincer deformities was 37% and 67%, respectively.[12] Labral tears were found in 69% to 85% of asymptomatic patients in a cross-sectional study.[13] These findings underscore the importance of obtaining a proper patient history and performing a relevant physical examination to aid in appropriately diagnosing a patient with symptomatic femoroacetabular impingement and/or a labral tear, as asymptomatic labral tears are not indicated for repair.

Differential diagnosis for nonarthritic hip pain

Causes of hip pain can be categorized based on the location of the pain. Most commonly, pain in the hip is felt laterally, posteriorly, or anteriorly.

Lateral hip pain is most often caused by trochanteric bursitis. Degeneration or tears of abductor tendons can also cause lateral hip pain and snapping.

Posterior hip pain can be referred from the spine or can originate at the sacroiliac joints or the ischial tuberosity and proximal hamstring tendons. Piriformis syndrome and ischiofemoral impingement would also result in posterior hip pain.

Anterior hip pain, if not arthritic or related to avascular necrosis, can be caused by tendinitis of the iliopsoas hip flexor muscle or intra-articular derangement such as femoroacetabular impingement or labral tears. Pathologies to rule out include neoplasm and fractures (from trauma or stress reaction).

Initial workup

Patient history

Patient age is an important factor in differentiating the common causes of hip pain. Skeletally mature patients who are younger than 50 years of age most commonly have pain related to musculoskeletal strains, femoroacetabular impingement, and labral pathology.[14] Patients 50 years of age or older more commonly have pain related to degenerative changes and osteoarthritis.

Patients should be asked about any history of trauma to the hip or surrounding areas, including the spine and knee. The location of pain and time of pain onset should be clarified, as well as alleviating and aggravating factors. It is also important to assess the impact this pain has on the patient's quality of life, vocation, and ability to perform activities of daily living and participate in recreational activities and sports.

Patients who present with femoroacetabular impingement typically have insidious onset of symptoms to the anterior hip that are exacerbated with joint loading

and movement, particularly hip rotation and flexion.[14] The pain typically starts during recreational activities but can progress to affect activities of daily living.[14] These patients often present with pain while sitting for prolonged periods due to the abutment of the impinging bone to the labrum and cartilage. Patients with intra-articular hip pain typically describe the pain by cupping their hand over the greater trochanter, known as the "C-sign"[14] **[Figure 2, left]**. Other symptoms include clicking, snapping, or catching in the affected hip.[14]

Physical examination

Examination of the hip should begin with an inspection of the surrounding soft tissues to determine whether there is any deformity, edema, ecchymosis, or muscle atrophy. Comparison to the contralateral hip is useful in detecting minor disparities. The patient's gait pattern should be assessed to determine whether they have an antalgic or Trendelenburg gait. A positive Trendelenburg gait and sign occurs when the contralateral hip swings inferiorly when the patient is standing on the affected limb **[Figure 2, centre and right]**. A positive test indicates weakness in the abductor muscles.

This examination should be followed by palpation of the hip joint, which should focus on palpating the anterior hip, greater tuberosity, and ischial tuberosity, and posteriorly at the hip external rotators. Point tenderness at the greater tuberosity is indicative of trochanteric bursitis or abductor (gluteal) tendon pathology. Ischial tuberosity pain is associated with proximal hamstring pathology, such as tendinopathy or tear.

Taking the patient through all ranges of motion can help differentiate between intra-articular and extra-articular pain. Pain with flexion and internal rotation of the hip indicates intra-articular pathology. Decreased hip internal rotation may be a clinical sign of impingement or arthritis.

There are many tests for the hip that can direct a care provider to certain pathologies. The flexion, abduction, and external rotation (FABER) test positions the patient's hip in flexion, abduction, and external rotation and rests the ipsilateral ankle on the contralateral knee **[Figure 3, left]**. Pain anteriorly is suggestive of intra-articular pathology; pain posteriorly suggests pain deriving from the sacroiliac joints or lower lumbar region. The flexion, adduction, and internal rotation (FADIR) test positions the patient's hip in flexion, adduction, and internal rotation **[Figure 3, right]**. Pain in this position is a positive test and indicates intra-articular pathology, including labral tears and femoroacetabular impingement but also osteoarthritis or inflammation. The Ober test is done with the patient in the lateral position, with the affected hip up. The patient's leg is positioned in an adducted and extended position. Pain laterally or the inability to passively adduct the hip past midline suggests a positive test. A positive test indicates tightness of the iliotibial band/fascia lata and can be

FIGURE 2. C-sign (left) and Trendelenburg sign (centre and right).

FIGURE 3. Flexion, abduction, and external rotation test (left) and flexion, adduction, and internal rotation test (right).

present in the setting of external snapping hip syndrome or greater trochanteric pain.

The lumbar spine, the ipsilateral knee, and the contralateral hip should be included in the examination. The hip examination should involve a thorough neurovascular examination of the affected limb.[14]

A systematic review by Haldane and colleagues showed that 65% of patients with femoroacetabular impingement reported hip and groin pain, 57% of patients had a positive FADIR test, and 41% had a positive FABER test.[15] The most common physical findings for patients with femoroacetabular impingement syndrome are decreased internal rotation of the hip at 90-degree flexion and a positive FADIR test.

Imaging

Initial radiographic workup for nonarthritic hip pain should begin with radiographs of the affected hip. These should include a weight-bearing anteroposterior pelvis view and a modified Dunn view of both hips. These views should be standard for imaging atraumatic hip pain in patients younger than 50 years of age. Initial imaging can identify other causes of hip pain, including osteoarthritis, dysplasia, stress fracture, or neoplasm.[16] The contralateral hip serves as a comparative platform to aid in the understanding of bony architecture. If the patient is unable to weight-bear at the time of imaging, supine anteroposterior pelvis imaging should be performed to rule out a fracture.[16] It is important that the entire pelvis is included in the radiograph to assess the various bony relationships.

On the anteroposterior standing pelvis view, the lateral centre edge angle is measured to assess lateral acetabular femoral head coverage **[Figure 4]**. An angle of more than 40 degrees represents acetabular over-coverage and pincer deformity.[16] A cam deformity, historically described as a pistol grip deformity, can also be noted on the anteroposterior pelvis view.

A modified Dunn view is obtained by having the patient lie supine with the hips flexed to 45 degrees and abducted to 20 degrees. This allows for more precise assessment of a cam deformity. On this view, the alpha angle and femoral head–neck offset are used to delineate the deformity.

An alpha angle of more than 55 degrees is abnormal and associated with a cam deformity.[15] The alpha angle and head–neck offset are described and illustrated in **Figure 4.** A head–neck offset value of less than 8 mm is abnormal and suggestive of a cam deformity.[17]

If the patient's history, physical examination, and radiographs are suggestive of nonarthritic intra-articular hip pathology, a referral to a musculoskeletal expert such as a sports medicine physician or an orthopaedic surgeon should be obtained. Alternatively, a multidisciplinary model of care is suggested for efficient screening and triaging of nonarthritic hip pain, such as that provided by the Vancouver Hip Institute. It is then that a clinical decision should be made regarding the indications for further imaging modalities, such as an MRI arthrogram.

Concrete indications for MRI and MRI arthrography have not been well established in the literature. An MRI arthrogram is

FIGURE 4. Left: Standing anteroposterior pelvis X-ray with lateral centre edge angle, which is measured by drawing a vertical line from the centre of the femoral head superiorly. A second line is then drawn from the centre of the femoral head to the most lateral aspect of the acetabular rim. The angle between the two lines is the lateral centre edge angle. An angle of more than 40 degrees represents acetabular over-coverage and pincer deformity.[16] **Right:** Modified Dunn view with illustrated alpha angle (right hip) and head–neck offset measurement (left hip). The alpha angle is measured by initially drawing a circle of best fit around the femoral head. A line is drawn up the centre of the femoral neck to the centre of the femoral head. A second line is then drawn from the centre of the femoral head to the point at which the femoral head extends past the margin of the drawn circle. The angle between these two lines is the alpha angle. The head–neck offset is calculated by drawing two parallel lines, one on the femoral neck axis at the anterolateral aspect of the femoral neck and the other at the anterolateral edge of the femoral head. The distance between these two lines is the head–neck offset. A value of less than 8 mm is abnormal and suggestive of a cam deformity.[16]

typically indicated for patients who are suspected to have intra-articular nonarthritic hip pathology.[17] This is especially important for patients who may be undergoing arthroscopic treatment.[16] An MRI arthrogram involves an intra-articular gadolinium injection, which allows for visualization of cartilage and the acetabular labrum, which aids in preoperative surgical planning.[17] Sixty-nine percent to 85% of asymptomatic adults will have a labral tear on MRI; therefore, many labral tears seen on MRI or MRI arthrogram may be incidental, and interpretation needs to be made in consideration of the entire clinical picture.[13]

Any significant radiographic signs of osteoarthritis will preclude the patient from being a candidate for hip preservation procedures done through arthroscopy. MRI in the setting of degenerative changes is an inefficient use of resources and often results in noncontributing incidental findings.[18] One hundred percent of patients with moderate osteoarthritis on X-ray will have a labral tear reported on MRI arthrogram, and 93.3% of patients 50 years of age and older will have a labral tear on MRI arthrogram. There are very few indications for an MRI arthrogram in this population unless it will change management by the treating hip expert.[19]

Diagnostic injections

Intra-articular diagnostic hip injections can be useful in further aiding the diagnosis of intra-articular pathology. They can be done with ultrasound or fluoroscopic guidance. An injection in the hip joint of 4 to 6 mL of local anesthetic (with or without steroid) followed by an improvement in the patient's pain can confirm the presence of intra-articular pathology.[17] For documentation purposes, it is imperative that the patient keeps a pain diary for 24 hours following the injection.[17] Pain relief with a diagnostic injection supports the diagnosis of intra-articular pathology and femoroacetabular impingement, whereas minimal pain relief postinjection is predictive of poor outcomes from hip arthroscopy.[20]

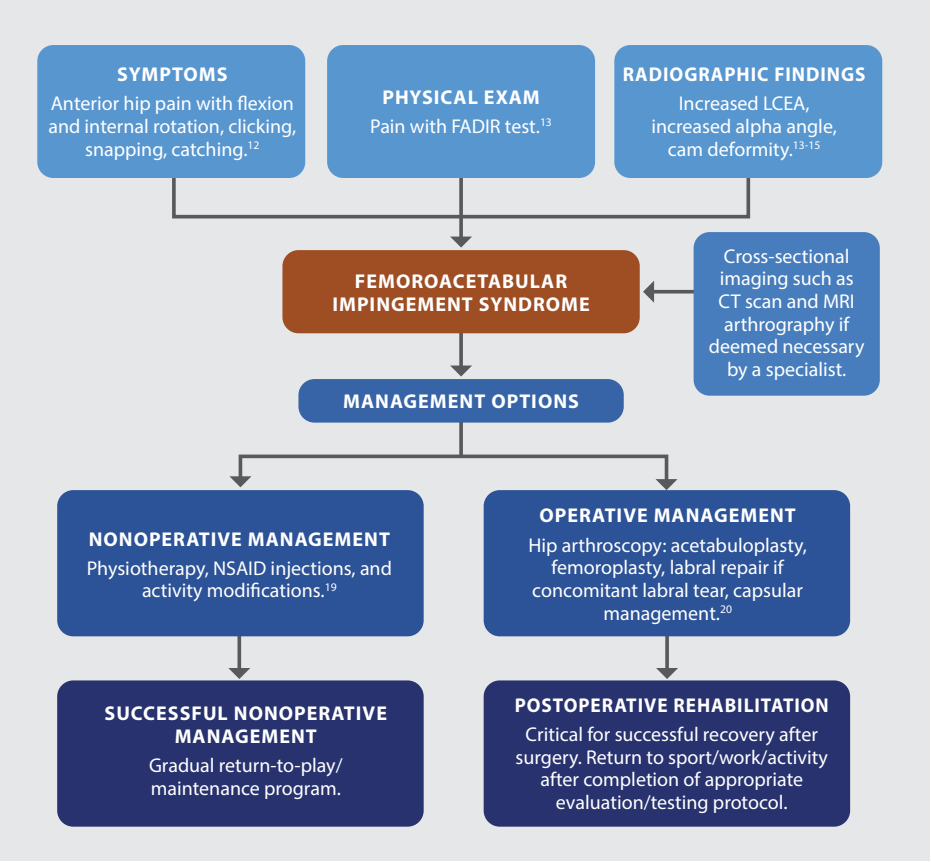

FIGURE 5. Femoroacetabular impingement syndrome.
FADIR = flexion, adduction, and internal rotation.
LCEA = lateral centre edge angle.

Femoroacetabular impingement syndrome

When evaluating a patient with potential femoroacetabular impingement, it is important to differentiate between positive imaging findings associated with impingement and femoroacetabular impingement syndrome. In 2016, an international consensus endorsed by 25 clinical societies stated that for a diagnosis of femoroacetabular impingement syndrome, a patient must have positive symptoms, a physical examination, and imaging findings. Without all of these, femoroacetabular impingement syndrome cannot be diagnosed.[16] **Figure 5** illustrates all components associated with the appropriate diagnosis of femoroacetabular impingement syndrome and outlines treatment modalities.[16]

Management

Nonoperative management. First-line treatment for femoroacetabular impingement syndrome should be nonoperative measures consisting of physical therapy, activity modifications, walking aids, and pain relief with anti-inflammatories.[21] Physical therapy should incorporate core and hip-specific exercises and activity modifications to avoid positions that cause impingement (e.g., deep squats). The exercise program should be performed 3 to 5 times per week to ensure the best opportunity to relieve symptoms.[21,22] A weight loss program specific to each patient may be beneficial to off-load the hip joint and relieve pain.[22]

All of these interventions should be initiated while the patient is waiting for referral to a specialist; none of them will exacerbate the patient's condition. The Vancouver Hip Institute provides a

helpful resource for nonoperative treatments at www.vancouverhipinstitute.ca/hip-preservation/treatment-options/non-surgical-treatment-options.

Operative management. Patients are candidates for operative management of femoroacetabular impingement syndrome if they have a history, a clinical examination, and imaging findings consistent with the diagnosis, have exhausted all nonoperative measures, and continue to have symptoms that affect their quality of life.[23] Any significant arthritic changes seen on radiographic imaging preclude the patients from hip arthroscopy.[18]

Patients are typically treated with hip arthroscopy, femoroacetabuloplasty, and labral repair. Femoroacetabuloplasty consists of arthroscopic removal of abnormal bony morphology that is generating hip impingement. Femoroplasty refers to the excision of the cam deformity; acetabuloplasty refers to the removal of the pincer deformity. Patients are typically partial flat-foot weight-bearing in a hip brace for several weeks. Return to full activities typically occurs around 6 months postoperatively after successful completion of rehabilitation and, preferably, a return-to-play assessment.[23] Each surgeon has a specific postoperative protocol that patients will follow with guidance from a physiotherapist. The Vancouver Hip Institute provides a postoperative rehabilitation protocol at www.vancouverhipinstitute.ca/wp-content/uploads/2022/08/Post-Op-Hip-Instructions.pdf.

We recommend withholding any discussion of operative treatment options with patients pending referral to a specialist. In our experience, this can lead the patient to create a premature notion of a treatment plan that may or may not be indicated and could lead to anxiety and possible distrust of the hip specialist if no surgery is indicated. Treatment options will be discussed in detail once all history, physical examination findings, and pertinent imaging have been reviewed.

Summary

Nonarthritic hip pain is difficult to diagnose and requires a thorough history, a physical examination, and appropriate imaging modalities. Specifically, femoroacetabular impingement can cause anterior hip pain, decreased range of motion, and pain in extreme rotations in young, nonarthritic patients. Proper workup and diagnosis, as we have outlined, can help identify potential patients suitable for hip arthroscopic surgery and provide timely referral to an orthopaedic surgeon with a subspecialty in the procedure. ■

Any significant arthritic changes seen on radiographic imaging preclude the patients from hip arthroscopy.

Competing interests

None declared.

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Correction: This article has been revised. The authors requested the highlighted change postpublication: "A head–neck offset value of ~~more~~ less than 8 mm is abnormal and suggestive of a cam deformity."