Posterior, Lateral, and Anterior Hip Pain Due to Musculoskeletal Origin: A Narrative Literature Review of History, Physical Examination, and Diagnostic Imaging

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ABSTRACT

Objective: The purpose of this study was to present a narrative review of the literature of musculoskeletal causes of adult hip pain, with special attention to history, physical examination, and diagnostic imaging.

Methods: A narrative review of the English medical literature was performed by using the search terms "hip pain" AND "anterior," "lateral," and "posterior." Additionally, specific entities of hip pain or pain referral sources to the hip were searched for. We used the PubMed search engine through January 15, 2016.

Results: Musculoskeletal sources of adult hip pain can be divided into posterior, lateral, and anterior categories. For posterior hip pain, select considerations include lumbar spine and femoroacetabular joint referral, sacroiliac joint pathology, piriformis syndrome, and proximal hamstring tendinopathy. Gluteal tendinopathy and iliotibial band thickening are the most common causes of lateral hip pain. Anterior hip pain is further divided into causes that are intra-articular (ie, labral tear, osteoarthritis, osteonecrosis) and extra-articular (ie, snapping hip and inguinal disruption [athletic pubalgia]). Entrapment neuropathies and myofascial pain should also be considered in each compartment. A limited number of historical features and physical examination tests for evaluation of adult hip pain are supported by the literature and are discussed in this article. Depending on the clinical differential, the gamut of diagnostic imaging modalities recommended for accurate diagnosis include plain film radiography, computed tomography, magnetic resonance imaging, skeletal scintigraphy, and ultrasonography.

Conclusions: The evaluation of adult hip pain is challenging. Clinicians should consider posterior, lateral, and anterior sources of pain while keeping in mind that these may overlap. (J Chiropr Med 2016;15:281-293)

Key Indexing Terms: *Hip; Musculoskeletal Pain; Physical Examination; Diagnostic Imaging; Femoroacetabular Impingement; Review*

INTRODUCTION

Self-reported hip pain is common, afflicting approximately 14% of the population over the age of 60 years.[1] Providing a focused differential diagnosis for a chief complaint of hip pain is challenging, and sources may originate around, or within, the bony ring between the lumbar spine and the pubic symphysis. Clinicians need to consider both local and distant osteoligamentous, tendinous, nervous, and muscular anatomy when examining patients with complaints related to the posterior, lateral, or anterior hip. Additionally, myofascial pain syndrome is a common and overlooked cause of pain.[2] Genitourinary, gastrointestinal, and vascular pathology should be excluded when examining a patient with hip pain but are beyond the scope of this review.

History and physical examination are crucial in the evaluation of any patient complaint. Unfortunately, the history and physical examination results of a patient with hip pain are typically nonspecific,[3] reflecting the complex anatomy of the hip and pelvis and the overlapping organ systems that are included in the differential diagnosis. As such, diagnostic imaging is indispensable in narrowing and arriving at an accurate differential diagnosis that will guide efficient and cost-effective treatment. Therefore, the aim of this review was to provide musculoskeletal differential

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Paper submitted January 16, 2016; in revised form June 23, 2016; accepted August 5, 2016.
1556-3707

http://dx.doi.org/10.1016/j.jcm.2016.08.004

considerations for posterior, lateral, and anterior hip pain in the adult patient.

Methods

A narrative review of the English medical literature was conducted. For the purpose of organizing hip pain into a clinically useful context, it was subdivided into posterior (ie, ischial), lateral (ie, trochanteric), and anterior (ie, inguinal) locations. Furthermore, myofascial pain was considered separately as a source of hip pain. Randomized controlled trials, cohort and case-control studies, case series, and both systematic and narrative reviews were included. Individual case reports were not included. PubMed was searched by using the search terms "hip pain" AND "posterior," "lateral," and "anterior." Specific entities known to be sources of hip pain that were not retrieved using this search format were searched for individually. Ancillary search terms included AND "diagnostic imaging" or "physical examination." Appropriate references from the retrieved items were also searched for and included. There was no initial date restriction for the PubMed search, and it ended January 15, 2016.

Results

The authors selected 116 papers to include in this narrative review.

Discussion

The following is a discussion of posterior, lateral, and anterior hip pain in an adult patient. Myofascial pain is discussed first as a separate entity because it may present in any hip compartment, although the underlying pathophysiology is constant. Additionally, there is limited information on objective clinical examination and imaging findings for the diagnosis of myofascial pain. For these reasons, myofascial pain is discussed separately, with the understanding that it should be considered in all cases of hip pain. Also, peripheral neuropathies have a similar clinical presentation, with the greatest variability being the distribution of the nerve involved. For this reason, the signs and symptoms of a peripheral neuropathy are discussed in the posterior hip pain section and are not repeated in subsequent sections. Rather, just the nerves that may be implicated, along with likely mechanisms and pertinent neurodynamic tests, are presented in the lateral and anterior hip pain sections. Tables 1, 2, and 3 provide summaries of differential diagnoses, clinical features, orthopedic testing, and diagnostic imaging for adults presenting with posterior, lateral, and anterior hip pain, respectively.

Myofascial Pain

The high prevalence of myofascial pain in patients with various musculoskeletal complaints deserves special emphasis.[4-6] Myofascial pain syndrome is conceptualized by the trigger point and is characterized by complex motor and sensory abnormalities producing local and referred pain.[7,8] High-quality studies on myofascial pain syndrome specific to hip pain are lacking. A recent review article emphasizes the role of the myofascial system in pelvic pain, a condition that has significant overlap with hip pain.[9] Also, trigger point injections into the musculature of the anteromedial hip appear to be effective at relieving the groin pain that accompanies chronic pelvic pain.[10,11] One case series (level IV evidence) reported a significant reduction in posterolateral hip pain in patients with confirmed acetabular labral tears after myofascial treatment.[12] Common trigger points referring to the posterolateral and anterolateral hip include the gluteal muscle group (maximus, medius, minimus) and the piriformis, tensor fascia latae, and quadratus lumborum muscles. The iliopsoas and proximal adductor tendons can refer pain into the anteromedial hip and thigh.[8,13,14]

Although considerable investigation is required to establish the etiology and prevalence of myofascial hip pain, failure to diagnose and properly treat this entity may result in chronicity of the patient's complaint. For example, in patients suffering from tension headaches, longstanding muscle pain has been proposed as a key etiologic agent in the transition from an acute state to a chronic state.[15]

Imaging of patients with myofascial pain and a related trigger point is challenging. In 1 study of the trapezius muscle, in which ultrasound (US) elastography and Doppler imaging were used, investigators were able to demonstrate that active trigger points (identified by manual palpation) were larger and showed greater resistance to blood flow compared with latent trigger points.[16] The visualization of these trigger points was inferred by examining the elastographic map of the trapezius muscle after applying external vibration. Magnetic resonance (MR) elastography has also been used to examine palpated taut bands and demonstrated that these structures are significantly stiffer relative to controls.[17,18] Despite the potential of US and MR elastography, there are currently no imaging modalities available in daily clinical practice to reliably image myofascial pain syndrome, and clinicians must rely on trigger point evaluation during physical examination.

Posterior Hip Pain

Posterior hip pain is an under-recognized manifestation of femoroacetabular joint disease. More commonly accepted sources include referral from the lumbar spine and sacroiliac joint (SIJ). Additionally, proximal hamstring tendinopathy, sacral stress fractures, piriformis syndrome, tendinopathy of the obturator internus/gemelli complex, and ischiofemoral impingement should be considered. Sciatic and pudendal neuropathies can also refer pain to the posterior hip.

Table 1. *Differential Diagnosis, Clinical Features, Orthopedic Testing, and Diagnostic Imaging for an Adult Presenting With Posterior Hip Pain* [a]

Differential	Clinical Features/Orthopedic Testing	Diagnostic Imaging [b]
Femoroacetabular pathology	Under-recognized cause of posterior hip pain Consider especially if posterior pain presents with concomitant anterior hip pain or if posterior pain is exacerbated with hip motion	MRA (labral tear); MRI; R
Spinal or SIJ pathology	Centralization of symptoms with repeated spinal movement favor spinal involvement and should be done to exclude spine referral Composite testing of positive thigh thrust, distraction, compression, sacral thrust, and Gaenslen test favors SIJ origin, especially when symptoms are not reproduced with spinal movement	MRI; R
Proximal hamstring tendinopathy	Previous hamstring injury, pain with activity, and pain while seated Symptoms may mimic sciatica Active, passive, and resisted range of motion tests and tenderness with palpation	MRI; US
Sacral stress fracture	Fatigue fracture: • Common in athletes, especially female athletes with RED-S Insufficiency fracture: • Osteoporotic females most at risk Positive fulcrum, pelvic shear, adductor squeeze, and FABERE tests or pain while standing on the affected limb Tenderness with direct palpation Mimics other hip pathologies including sciatica	MRI; R (specific only); SS
Piriformis syndrome	Tenderness with palpation of the muscle Positive Freiberg sign, Pace sign, Beatty sign, and FADDIR [c] test	Primarily used to exclude other sources of hip pain
Obturator internus/ gemelli complex tendinopathy	Similar HPE features for piriformis syndrome	Primarily used to exclude other sources of hip pain
Ischiofemoral impingement	Often presents with concomitant anterior hip pain	MRI
Sciatic neuropathy	Typically there is a history of total hip arthroplasty Neurodynamic testing using the straight leg raise	MRI; US
Pudendal neuropathy	Accompanying perineal pain Symptoms elicited with palpation of inferomedial sciatic notch/ischial spine Passive internal and external rotation of the hip and resisted hip abduction and adduction at 90 degrees of hip extension may elicit symptoms	MRI; US

Abbreviations: *CTA*, computed tomographic arthrography; *FABERE*, flexion-abduction-external rotation, extension; *FADDIR*, flexion-adduction-internal rotation; *HPE*, history and physical examination; *MRA*, magnetic resonance arthrography; *MRI*, magnetic resonance imaging; *R*, radiography; *RED-S*, relative energy deficiency in sport; *SIJ*, sacroiliac joint; *SS*, skeletal scintigraphy; *US*, ultrasonography.

[a] Myofascial pain syndrome should be considered in each compartment.

[b] Diagnostic imaging recommendations discussed in the manuscript are listed in alphabetical order and not in order of utility.

[c] Video 1.

Femoroacetabular joint derangement (ie, osteoarthritis [OA], osteonecrosis, labral tear) needs to be considered in the differential diagnosis of posterior hip pain. In a study of 51 patients treated with fluoroscopically guided intra-articular joint injections for radiographically identifiable hip pathology, 71% experienced symptoms in the posterior hip, whereas only 55% experienced anterior hip pain.[19] Similarly, 20% of patients with either labral tears or early hip joint degenerative changes experienced posterior hip pain.[20] Most of the patients with posterior hip pain in that study experienced concomitant anterior hip pain.[20] Sakamoto et al. investigated regional pain patterns of the hip, both at rest and with motion, in patients with either hip OA or osteonecrosis and found that approximately 19% of these patients experienced posterior hip pain at rest and that 37% had posterior hip pain with motion.[21] Evaluation of femoroacetabular OA and acetabular labral tears are discussed with anterior hip pain.

Spinal and SIJ pathology commonly refers to the posterior hip.[22,23] Despite the difficulty in differentiating these anatomical structures through history and physical examination findings, several significant clinical features have been identified. Centralization of symptoms from repeated lumbar movements (McKenzie assessment) has high sensitivity and specificity for nerve root pain associated with symptomatic discs.[24] In the absence of centralization of posterior hip symptoms, 3 or more positive SIJ provocation tests have been shown to detect the presence of SIJ pathology and have a combined sensitivity of 91%, specificity of 78%, positive likelihood ratio of 4.12, and negative likelihood ratio of 0.12.[25,26] The suggested composite testing of the SIJ includes the thigh thrust, distraction, compression, sacral thrust, and Gaenslen tests.[26] When the McKenzie assessment is completed to rule out discogenic referral, the diagnostic accuracy of this composite testing improves, with higher reported specificity (87%) and positive likelihood ratio (6.97).[26] Therefore, it seems that in cases of posterior hip pain, evaluation of the spine and SIJ should be done together to either include or

Table 2. *Differential Diagnosis, Clinical Features, Orthopedic Testing, and Diagnostic Imaging for an Adult Presenting With Lateral Hip Pain* [a]

Differential	Clinical Features/Orthopedic Testing	Diagnostic Imaging [b]
Gluteal tendinopathy/proximal iliotibial band pathology/trochanteric bursitis	Tendinopathy most common Pain around the greater trochanter that may radiate into the lateral thigh to the level of the knee Pain characterized as burning or deep dull ache over the posterior hip or lateral thigh that can become sharp when moving the hip from flexion to extension Active abduction of the hip, prolonged sitting, climbing stairs, and side-lying typically exacerbate symptoms Trendelenburg sign, resisted hip abduction, resisted hip internal rotation and the resisted hip external derotation tests	MRI; US
External snapping hip	Observed snapping over the greater trochanter with related pain	Typically diagnosed clinically MRI; US
Lateral femoral cutaneous neuropathy	Sensory for anterolateral thigh to the knee Risk factors include: Prior hip or spine surgery, obesity, pregnancy, tight fitting clothes or other objects such as police belts, iliacus hematoma Neurodynamic testing with side-lying hip extension and adduction	MRI; US
Iliohypogastric neuropathy	Sensory along the superolateral gluteal region Neurodynamic testing is similar to lateral femoral cutaneous nerve with addition of trunk extension and lateral bending.	MRI; US

Abbreviations: *CTA*, computed tomographic arthrography; *MRA*, magnetic resonance arthrography; *MRI*, magnetic resonance imaging; *R*, radiography; *SS*, skeletal scintigraphy; *US*, ultrasonography.

[a] Myofascial pain syndrome should be considered in each compartment.

[b] Diagnostic imaging recommendations discussed in the manuscript are listed in alphabetical order and not in order of utility.

exclude these structures as pain generators. Plain film radiography can provide an inexpensive means of evaluating for lumbar spine or SIJ degenerative disease. Imaging findings include narrowing or loss of joint space, surrounding reactive bony sclerosis, and osteophyte formation.[27] Subchondral cysts may be present if the joint involved is a synovial joint.[27] If inflammatory arthritides are considered, MR imaging (MRI) would be the favored initial imaging modality because of its high sensitivity and ability to detect concurrent noninflammatory causes of pain.[28,29] When degenerative disease is absent, posterior hip pain originating from the spine is usually secondary to a herniated disc, in which case MRI can be used to confirm the diagnosis.[30]

Proximal hamstring tendinopathy is sometimes referred to as hamstring syndrome and can produce symptoms mimicking sciatica in addition to focal posterior hip pain.[31,32] The clinical features of proximal hamstring tendinopathy include previous injury, pain during activity, and pain with prolonged sitting.[32-34] The clinical examination may reveal tenderness or pain elicited with palpation, muscular defect over the ischial tuberosity against resisted knee flexion or hip extension, and pain with passive stretching of the muscle.[32,33] Peripheral neuropathy tests should be negative, and rarely are there any strength deficits with knee flexion or hip extension.[33] Both US and MRI can be used to diagnose proximal hamstring tendinopathy, with MRI currently considered more sensitive than US and better suited for a broader range of body types.[35] On MRI, symptomatic proximal hamstring tendons demonstrate significant increases in width and thickness, peritendinous high T2-weighted signal with a feathery appearance, and ischial tuberosity edema.[36] US features of proximal hamstring tendinopathy include peritendinous edema, hypoechoic areas within the tendon, tendon thickening, and echogenic foci consistent with calcifications.[35] These findings are consistent with both the tendon disrepair and degenerative tendinopathy stages in a proposed pathology continuum.[37,38]

Sacral stress fractures can be either insufficiency or fatigue fractures. Insufficiency fractures are more common and are most often seen in older women with osteoporosis.[39,40] Fatigue-type sacral stress fractures are prevalent in athletic populations, and as such, the clinical history should rule out recent changes in training volume and repetitive movements.[41] Although more common in females, athletes with relative energy deficiency in sports may be more prone to insufficiency type stress fractures occurring in the pelvis. Clinicians should obtain a history regarding training regimens, nutritional habits, menstrual cycles, and previous fracture history to formulate appropriate differential diagnoses.[41,42] Despite a thorough history and physical examination, the diagnosis of sacral stress fractures is often delayed because their presentation is similar to other differentials of low back and buttock pain (including sciatica), and no single clinical test is accurate.[43] Positive fulcrum, pelvic shear, adductor squeeze, and flexion-abduction-external rotation tests or pain while standing on the affected limb might be present with sacral stress fractures.[43] Point tenderness may be elicited with direct palpation.[43] As such, diagnostic imaging should be

Table 3. *Differential Diagnosis, Clinical Features, Orthopedic Testing, and Diagnostic Imaging for an Adult Presenting With Anterior Hip Pain* [a]

Differential	Clinical Features/Orthopedic Testing	Diagnostic Imaging [b]
Hip OA	Anterior or posterior hip pain Persistent deep groin pain that is worse with activity Increased pain on internal rotation, and concurrent morning stiffness lasting <60 minutes. Hip internal rotation of <15° with a coexisting limitation of flexion less than or equal to 115° Trendelenburg sign, resisted hip abduction, and FABERE tests	MRI; R
FAI	More prevalent in athletes (eg, hockey, soccer, dance, and golf) Persistent stiffness and intermittent groin pain during early stages Later stages may reveal sharp pain and mechanical symptoms (ie, catching, locking, instability) Flexion, adduction, and internal rotation and flexion internal rotation tests have high sensitivity only Thomas test has high sensitivity and specificity for intra-articular pathology	MRA; R
Acetabular labral tear	Different types of tears exist (post-traumatic; associated with FAI; capsular laxity/hip hypermobility; dysplasia; and degenerative) Central groin and peritrochanteric pain more common. Unlikely to present with anterior thigh or ischial pain (compare with OA). Flexion, adduction, and internal rotation and flexion internal rotation tests have high sensitivity only Thomas test has high sensitivity and specificity for intra-articular pathology If clicking, catching, or locking of the femoroacetabular joint occur during testing likelihood of labral tear is increased	CTA; MRA
Internal snapping hip	Reproducible snap with hip flexion and concomitant pain	US
Stress fracture	Both fatigue and insufficiency stress fractures of the femoral neck, pubic rami, or acetabulum may cause anterior hip pain. For all stress fractures, a high index of suspicion is paramount for early detection Femoral neck: • Tension-side femoral neck stress fractures have higher risk of complication • Fatigue-type stress fractures are seen in young, active individuals. • Insufficiency-type stress fractures are seen in older patients with osteoporosis • PPPT and stress fracture (fulcrum) test Pubic rami: • Presents with anteromedial hip pain • Positive fulcrum, pelvic shear, adductor squeeze, and FABERE tests or pain while standing on the affected limb • Tenderness with direct palpation Acetabulum: • Rare compared to femoral neck or pubic rami	MRI; R (specific only); SS
ONFH	Associated conditions (ie, trauma, corticosteroid use, alcoholism), although commonly idiopathic Deep groin pain accentuated with axial loading of the femur Evaluate the contralateral hip in nontraumatic cases	MRI; R
Hip joint laxity	Seen more commonly in female ballet dancers and gymnasts Beighton scale may be appropriate to evaluate global hypermobility Anterior, posterior, lateral hip apprehension tests Often associated with anterior impingement	MRA; MRI
Inguinal disruption (athletic pubalgia)	Anterior hip pain in an athlete not originating from the femoroacetabular joint Male athletes more common Point tenderness over the pubic tubercle and conjoint tendon Pain exacerbated with a resisted curl-up, resisted hip flexion and/or adduction, and the Valsalva maneuver Adductor squeeze test performed in 90° of hip flexion demonstrates high sensitivity but low specificity for pubic aponeurosis and adductor pathology Exclude inguinal hernia	CTA; MRI; US
Femoral, obturator, ilioinguinal, and genitofemoral neuropathy	Consider if prior hip replacement or inguinal hernia surgery Neurodynamic testing with the femoral nerve tension test	MRI; US

Abbreviations: *CTA*, computed tomographic arthrography; *FABERE*, flexion-abduction-external rotation, extension; *FAI*, femoroacetabular impingement; *MRA*, magnetic resonance arthrography; *MRI*, magnetic resonance imaging; *OA*, osteoarthritis; *ONFH*, osteonecrosis of the femoral head; *PPPT*, patellar-pubic percussion test; *R*, radiography; *SS*, skeletal scintigraphy; *US*, ultrasonography.

[a] Myofascial pain syndrome should be considered in each compartment.

[b] Diagnostic imaging recommendations discussed in the manuscript are listed in alphabetical order and not in order of utility.

sought when clinical suspicion arises.[43,44] Radiography is specific but insensitive for detection of sacral stress fractures. However, radiography may demonstrate a horizontal or vertical sclerotic line indicative of fracture.[39] Magnetic resonance imaging and skeletal scintigraphy (SS) both demonstrate high sensitivity for stress fracture detection, although MRI has the additional value of evaluating the surrounding soft tissue structures that may be contributing to the patient's complaint. On MRI, high-signal reactive edema surrounding a low-signal fracture line will be seen on fluid sensitive T2-weighted or inversion recovery-weighted sequences. It is important that the imaging plane be dedicated for evaluation of the sacrum (ie, coronal oblique). With SS, the classic "Honda sign" is seen.[39]

Piriformis syndrome is a well-described clinical entity. Hypertrophy, hypertonicity, or variant anatomy of the piriformis muscle is thought to generate not only posterior hip pain but also pain consistent with sciatica, possibly as a result of local entrapment of the sciatic nerve.[45] Fluctuating unilateral or bilateral buttock and sciatica-like pain throughout the day is often the primary complaint. Pain is elicited in up to 92% of individuals with external palpation of the piriformis muscle posterior to the hip joint or sciatic notch.[46,47] Several clinical tests have been designed to tense or engage active contraction of the piriformis muscle, such as the Freiberg sign, Pace sign, Beatty sign, and the flexion-adduction-internal rotation test.[46-48] Although well described clinically, use of imaging to diagnose piriformis syndrome remains difficult and so it is used to exclude other spinal and pelvic pathologies.[45] Currently, piriformis syndrome remains a diagnosis of exclusion.[45] Similarly, tendinopathy of the obturator internus/gemelli complex of muscles can mimic piriformis syndrome and produce retro-trochanteric pain.[49,50] Again, definitive imaging findings have yet to be established. The only deep external rotator to have predictable diagnostic imaging findings when pathology is present is the quadratus femoris muscle. When the lesser trochanter approximates the ischial tuberosity, entrapment of this muscle may occur. This clinical scenario, termed *ischiofemoral impingement*, is a well-known source of posterior hip pain and is characterized by ipsilateral groin pain with ipsilateral quadratus femoris muscle edema or atrophy and narrowing of both the ischiofemoral and quadratus femoris spaces on MRI.[51,52] Edema within the iliopsoas or proximal hamstring tendons, bursa-like formations, and reduced volume of these muscles with fatty infiltration may also be seen.[51]

Neuropathies can occur in any hip compartment. A thorough history and physical examination focusing on the patients' presenting symptoms, medical history, and functional limitations are critical for appropriate management and prognosis. The primary objective for the clinician is to determine the anatomical distribution, type of nerve fiber compromised, and the severity of the presentation.[53] Clinical observation should evaluate for atrophy, inflammation, and skin morphology, and physical testing should be used to assess the character of pain (eg, burning, ache, paresthesia), evaluate reflexes, and identify affected dermatomes and myotomes. History and physical examination are designed to tense (neurodynamic testing), perturb (Tinel test), or compress specific nerves via local palpation to see if they can elicit the presenting complaint.[53] Imaging findings of neuropathy include a focal increase in T2-weighted signal intensity with increased cross-sectional area at MRI, or increased cross-sectional area with attenuated echo of the nerve with US imaging.[54,55] Often, secondary signs of neuropathy, such as segmental denervation, including edema or fatty degeneration, are the only visible imaging abnormalities.[54,55]

Sciatic and pudendal neuropathy may refer pain to the posterior hip. Sciatic neuropathy is a rare complication of total hip arthroplasty.[56] The pudendal nerve may become entrapped in an anatomical space known as the Alcock canal, and either perineal or posterior hip pain are possible sequelae with pudendal neuropathy.[57] In sciatic neuropathy, radicular pain may present along the course of the nerve as it travels from the sciatic notch, down the posterior aspect of the thigh, and, depending on tibial or common fibular (peroneal) nerve involvement, into the medial or lateral aspect of the leg and into the foot.[58] Neurodynamic testing for the sciatic nerve involves the active or passive straight leg raise and may be modified to bias the tibial or common fibular nerves with internal or external rotation of the foot, respectively.[59] In pudendal neuropathy, pain and paresthesia may present when palpating the nerve inferomedial to the sciatic notch or at the ischial spine resulting in referral to the perineum or genitals. Although there is no single neurodynamic test for this nerve, symptoms may be elicited with passive internal and external rotation of the hip and resisted hip abduction and adduction at 90 degrees of hip extension.[60]

Lateral Hip Pain

The most common causes of lateral hip pain are tendinosis of the gluteus medius and minimus and thickening of the iliotibial band.[61] Trochanteric bursitis, a term well known among clinicians, represents a less common cause of lateral hip pain. Other differentials to consider include external snapping hip and neuropathy of the iliohypogastric or lateral femoral cutaneous nerves. An acetabular labral tear (discussed in the anterior hip pain section) may refer to the lateral hip. Also, considerable overlap exists between sources of posterior and lateral hip pain.[62]

In those with gluteal tendinopathy, clinical history may reveal pain around the greater trochanter, and the pain may radiate into the lateral thigh to the level of the knee.[63] Sometimes associated with greater trochanteric bursitis, pain may also be characterized as a burning or deep, dull

ache over the posterior hip or lateral thigh and can become sharp when moving the affected hip from flexion to extension.[64] The most aggravating factors include active abduction of the hip, prolonged sitting, climbing stairs, and side-lying positions.[64,65] A recent systematic review and meta-analysis by Reiman et al. deemed 4 clinical tests to be both valid and reliable for the diagnosis of gluteal tendinopathy: Trendelenburg sign, resisted hip abduction, resisted hip internal rotation, and the resisted hip external derotation tests (Video 2).[66] The most clinically reliable test was the external derotation test, with a specificity of 97.3%, sensitivity of 88%, positive likelihood of 32.6, and negative likelihood of 0.12.[66] In a retrospective review of the US examinations of 877 patients with greater trochanteric pain syndrome, Long et al. found that 50% had tendinosis of the gluteal tendons, 28.5% had a thickened iliotibial band, 20% had trochanteric bursitis, and only 0.5% had gluteal tendon tears.[61] Gluteal tendinosis is diagnosed with US as a thickened tendon with loss of the normal fibrillar tendon architecture with or without superimposed calcifications.[61] Iliotibial band thickening is demonstrated at US examination by fusiform thickening at the level of the greater trochanter. Trochanteric bursitis is defined as anechoic or hypoechoic fluid within the bursa.[61] On MRI, gluteal tendinopathy is usually diagnosed when high signal is present within the tendons on T1-weighted images, whereas fluid-sensitive images remain normal.[67]

In external snapping hip, the iliotibial band or gluteus maximus muscle rolls over the greater trochanter and creates a snap during hip extension.[68] This is readily diagnosed clinically when a snap is accompanied by pain and tenderness over the greater trochanter. In difficult cases, MRI or US imaging may be used to evaluate for abnormal thickening of the iliotibial band or gluteus maximus muscle, fluid collections, or soft tissue edema. As ultrasonography allows for dynamic imaging, it is the favored imaging modality.[68]

Entrapment of both the lateral femoral cutaneous nerve and the iliohypogastric nerve can produce pain resembling greater trochanteric pain syndrome.[62,69] Entrapment of the lateral femoral cutaneous nerve is termed meralgia paresthetica and may be secondary to obesity, pregnancy, tight-fitting clothes (including police belts), or an underlying iliacus hematoma.[69] It may also occur secondary to surgery for total hip arthroplasty or posterior lumbar spine fusion.[69] Patients presenting with entrapment of either of these nerves may present with any of the neurologic complaints mentioned earlier in the section on neuropathies of the posterior hip. Testing should elicit a specific anatomical distribution of symptoms for clinical diagnosis. Neurodynamic testing for the lateral femoral cutaneous nerve is described as follows: The patient assumes the side-lying position, with the affected hip facing up. As the clinician stabilizes the pelvis, the hip is brought into both extension and adduction. Reproduction of the patient's neurologic symptoms represents a positive result.[69] The iliohypogastric nerve may be tensioned similarly with the addition of more trunk extension and lateral bending. The lateral femoral cutaneous nerve primarily innervates the skin occupying the anterolateral thigh to the knee, and the iliohypogastric nerve innervates the skin along the superolateral buttock, directly posterior to the greater trochanter.[53] In meralgia paresthetica, where entrapment of the lateral femoral cutaneous nerve occurs at the ilioinguinal ligament, pain or paresthesia presents in the aforementioned dermatome.

Anterior Hip Pain

Patients with anterior hip pain will localize the pain to the anteromedial thigh (inguinal region) with what is known as the "C" sign at physical examination. In an older patient with limitation in hip flexion and internal rotation range of motion, OA of the femoroacetabular joint should be primarily considered, whereas acetabular labral tears must be excluded in a young patient with anterior hip pain. Other intra-articular sources of pain include femoroacetabular impingement (FAI); iliopsoas impingement and internal snapping hip; stress fractures of the femoral neck, pubic rami, or acetabulum; osteonecrosis; and capsular laxity. Osteitis pubis and combined rectus abdominis/adductor longus tendinopathy represent common extra-articular referral sources. Femoral, obturator, ilioinguinal, or genitofemoral neuropathies are also possible.

Hip OA is common, affecting 3%–9% of the Western population.[70] Most of these patients are >60 years of age, complain of persistent deep groin pain that is worse with activity, and may demonstrate a characteristic Trendelenburg gait.[70] The American College of Rheumatology supports the clinical diagnosis of hip OA when patients have hip pain, increased pain on internal rotation, and concurrent morning stiffness lasting <60 minutes. This is also supported when patients have hip internal rotation of <15° with a coexisting limitation of flexion of less than or equal to 115°.[71] Currently, 3 tests are supported by high-quality literature and are regarded most valid and reliable history and physical examination tests for this pathology. These include the Trendelenburg sign, resisted hip abduction, and flexion-abduction-external rotation tests. Only the Trendelenburg sign was found to have clinically applicable diagnostic accuracy, with a sensitivity of 55%, specificity of 70%, positive likelihood ratio of 1.83, and negative likelihood ratio of 0.82.[66] Radiography may demonstrate narrowing of the superior and medial joint space, superior and inferior acetabular and femoral osteophytes, and subchondral cysts.[72] Superolateral subluxation of the femoral head may also be present.[73] The specificity of radiographic hip OA for anterior hip pain is approximately 94%; however, sensitivity is only 16.5%.[74] In patients with hip pain suspected to be from OA, MRI is

more sensitive for early cartilage loss, and MRI in early hip OA diagnosis is currently an active area of research.[72] Acetabular dysplasia contributes to OA and should be evaluated for when images of the hips are studied.[75]

Femoroacetabular impingement is a well-known but misunderstood entity with a combination of clinical and radiographic findings. Recent evidence has suggested that FAI is more prevalent in athletes, especially in those participating in sports requiring repetitive end-range hip motions, such as hockey, soccer, dance, and golf.[76] There is a considerable variation in the clinical histories of these patients, as such factors as duration of symptoms, sport, gender, and morphologic subtypes (cam, pincer, and mixed impingement) can influence the presentation. Therefore, these patients may report persistent stiffness and intermittent groin pain during the early stages, whereas later stages may reveal sharp pain and mechanical symptoms (ie, catching, locking, and instability) with greater osteochondral insult.[76,77] Several history and physical examination tests have been developed to aid in the diagnosis of FAI and related intra-articular pathology.[66,78,79] Recent meta-analyses have identified that the flexion-adduction-internal rotation test and the flexion internal rotation test have high sensitivity (>90%) for the diagnosis of hip impingement and intra-articular pathology, including labral tear.[66,79] However, the diagnostic specificity of these tests is low, and therefore they are useful only to screen for impingement and intra-articular pathology. The Thomas test (Video 3) demonstrates value as both a screening test and a diagnostic test with respect to intra-articular hip pathology, with a specificity of 92%, sensitivity of 89%, positive likelihood ratio of 11.1, and negative likelihood ratio of 0.12.[79] Radiographs of patients with FAI show bony outgrowths at the femoral head–neck junction or acetabular overcoverage, described respectively as cam or pincer deformity.[80] Commonly both bony deformities coexist.[81] These findings are often encountered in patients without any hip pain, and therefore a clinical correlate of anterior hip pain worse with hip flexion and internal rotation must also be present to make a diagnosis of FAI.[80]

At least 5 different etiologies of acetabular labral tears exist. These include: post-traumatic, associated with FAI, capsular laxity/hip hypermobility, dysplasia, and degenerative.[82] Additionally, acetabular labral tears at the 3-o'clock position suggest the diagnosis of iliopsoas tendon impingement.[83] Similar to patients who present with FAI, post-traumatic labral and osteochondral injury is more prevalent in the athletic population, where repetitive, end-range hip motion is desired.[76] In contrast, degenerative labral tears are more prevalent in older adults presenting with hip OA.[70] Patients with a labral tear are reported as having either central groin or peritrochanteric pain and are less likely to have anterior thigh or ischial pain.[84] This pain profile may help distinguish patients with labral tear versus those with OA, as the latter are more likely to have concomitant anterior thigh or ischial pain.[84] As previously mentioned, there are several history and physical examination tests utilized for patients with intra-articular injury, and no single test has adequate specificity or sensitivity to diagnose a labral tear.[66,78,79] However, when several of these tests are positive, along with the presence of clicking, catching, or locking, clinical suspicion for a labral tear is increased. Standard MRI has only 30% sensitivity and 36% accuracy in the detection of labral pathology. With the addition of intra-articular contrast, sensitivity and accuracy rise to 90% and 91%, respectively.[85] It is important to note that in 1 study, acetabular labral tears were present in 31 (69%) of 45 asymptomatic volunteers undergoing hip MRI.[86] The findings of this study underscore the importance of reconciling the clinical features of the patient with the imaging findings. In patients who cannot obtain an MRI examination, computed tomography arthrography is a suitable alternative for detection of labral tears, with sensitivity and specificity values comparable with those of MR arthrography.[87,88]

Internal snapping hip occurs when the iliopsoas tendon engages the iliopectineal eminence with hip flexion.[89] Alternatively, the central iliopsoas tendon may become embedded within the substance of the iliacus muscle and produce a snap with movement.[89] Radiography may identify conditions associated with internal snapping (ie, coxa vara and acetabular dysplasia) but otherwise is of limited value. Conversely, US imaging may permit real-time visualization of the affected tissues. If there is difficulty in differentiating internal snapping hip from an intra-articular click (eg, in a labral tear), then MR arthrography would be useful to exclude the latter.[68]

Similar to sacral stress fractures, MRI and SS demonstrate high sensitivity in the detection of insufficiency or fatigue fractures of the femoral neck, pubic rami, or acetabulum.[90,91] Tests for pubic rami stress fractures are similar to those for sacral stress fractures and are discussed under that section. However, patient's with pubic rami stress fractures present with anterior hip pain extending medially to the adductor region.[91] Fractures of the acetabulum are rare but should be considered when there is suspicion for stress injury of the pelvis.[92] Specific history and physical examination for acetabular stress fracture detection are not described. Femoral neck stress fractures are further subdivided into those that are on the compression side versus tension side of the bone.[93] Tension-side stress fractures are located on the superolateral aspect of the femoral neck and have a higher risk of complications, including displacement, delayed union, nonunion, and osteonecrosis.[94] Therefore, compression-side fractures are managed conservatively, whereas tension-side fractures warrant surgical consultation.[94] Femoral neck stress fractures can be difficult to detect clinically, but signs of swelling and/or effusion with pain that worsens during activity or at night may be present in the patient history. As

with stress fractures elsewhere in the skeleton, a high index of suspicion for the diagnosis is paramount. Fatigue-type stress fractures are seen commonly in young, healthy endurance athletes or recreational runners and military recruits. Insufficiency-type stress fractures are seen in older patients with osteoporosis.[93] The patellar-pubic percussion test and the stress fracture (fulcrum) test have been reported to be most valuable during clinical examination.[3] Pooled data from 3 studies involving 782 patients have shown that the patellar-pubic percussion test has a specificity of 86%, sensitivity of 95%, positive likelihood ratio of 6.11, and negative likelihood ratio of 0.07.[66] The fulcrum test has a specificity of 75%, sensitivity of 93%, positive likelihood ratio of 1.0, and negative likelihood ratio of 0.92.[66] Magnetic resonance imaging has an advantage over SS, as it is more specific and allows for evaluation of other possible sources of anterior hip pain, such as muscle injury or acetabular labral tear.[90]

Osteonecrosis of the femoral head (ONFH) affects 10,000 to 20,000 each year in the United States.[95] Prior trauma, long-term corticosteroid use, chronic alcohol consumption, and connective tissue diseases, especially systemic lupus erythematosus, are common risk factors.[96] Osteonecrosis of the femoral head may also be idiopathic.[96] When these risk factors present along with progressive deep groin pain and are aggravated by axial loading of the femur, and several of the aforementioned femoral stress tests and/or intra-articular tests are positive, ONFH is an important differential to rule out.[97] Image staging of ONFH is done with both radiography and MRI and is useful in guiding therapy and rendering an accurate prognosis.[98] In early ONFH, plain film radiographs are normal, and MRI shows irregular marrow edema, possibly with the characteristic double line sign.[98] Later in the disease process, patchy sclerosis in the femoral head will be seen in radiography and may progress to subchondral collapse and cystic changes. Hip joint and acetabular involvement represent the last stage of ONFH.[98] In nontraumatic ONFH, the asymptomatic contralateral hip is involved in approximately 60% of cases.[99] Therefore, MRI of the contralateral hip should also be performed, and if it is normal, the likelihood of development of ONFH in the contralateral hip is low.[100]

Laxity of the hip joint was initially a diagnosis established intraoperatively and is also known as atraumatic instability or microinstability. This condition is more commonly seen in young female ballet dancers and gymnasts, probably as a result of the extreme range of motion demands of their endeavors.[101] It has been recommended that screening tools, such as the Beighton scale, be performed to detect generalized laxity that may expose an underlying collagen disorder.[102,103] This recommendation is more suitable for a pediatric population and requires further validation for use in adults. Some authors have suggested the use of the anterior, posterior, and lateral hip apprehension tests to evaluate for excessive hip laxity.[102] Despite these clinical tests, many patients demonstrate nonspecific hip pain.[84] It is important to note that associated anterior acetabular impingement is common in patients with instability.[101] Magnetic resonance arthrography findings of a widened hip joint recess >5 mm and thinning of the hip joint capsule <3 mm are thought to represent hip joint laxity.[104] Also, increased femoral neck-shaft angles, reduced acetabular coverage, cam deformity, and enlargement of the ligamentum teres are recently reported MRI findings in patients with hip joint laxity.[105]

At the pubic symphysis, the rectus abdominis and adductor longus tendons become confluent and form what is known as an *aponeurotic plate*.[106] Tearing of these tissues, widening and erosion of the pubic symphysis (osteitis pubis), and tearing of the adjacent oblique aponeuroses, either in isolation or combination, produce what is known as *sports hernia*, *athletic pubalgia*, or, more accurately, *inguinal disruption*.[106,107] This condition is more common in male athletes than in female athletes and is a source of anterior hip pain not attributable to internal derangement of the femoroacetabular joint.[106] Key features from the patient history include deep abdominal or inguinal pain that presents with activity and is relieved with rest. These lesions may also be aggravated by coughing, sneezing, or straining, although it is important to remember that a true hernia rarely exists.[108-110] The clinician should, however, assess for and exclude palpable hernias or masses, swelling, and a tender or dilated superficial inguinal ring. Point tenderness over the pubic tubercle and conjoint tendon is common, and pain may be exacerbated with a resisted curl-up, resisted hip flexion and/or adduction, and the Valsalva maneuver.[110] The adductor squeeze test performed in 90 degrees of hip flexion demonstrates 85% sensitivity but limited specificity for the diagnosis of pubic aponeurosis and adductor pathology.[111] Ultrasonography can be used to detect tendon pathology, whereas MRI provides the advantage of visualizing edema within the aponeurotic plate and pubic bone marrow.[106,112] Recent data from a small sample (n = 12) suggests that computed tomography arthrography after direct pubic symphysis injection may be more sensitive than MRI for detecting adductor tendon tears and reactive changes in the pubic body.[113]

Neuropathy of the femoral, obturator, ilioinguinal, and genitofemoral nerves may cause anterior hip pain. The femoral nerve stretch test is a neurodynamic maneuver used for detection of a neuropathy. The test is performed with the patient lying prone while the knee is passively flexed. If no symptoms arise, the knee remains flexed while the hip is passively extended by the clinician. Reproduction of neurologic symptoms is considered a positive test.[114] Neurodynamic testing for the obturator, ilioinguinal, and genitofemoral nerves is not well described. A prior surgical

history of either total hip arthroplasty or especially inguinal hernia repair is common.[115,116]

Limitations

This was a narrative review and therefore was not a rigorous systematic review; by default, lower-quality studies were included. However, the aim of our work was to present a comprehensive yet practical review of studies on hip pain to serve clinicians in daily practice. Some diagnostic entities (eg, obturator internus tendinopathy) may be important to consider clinically but have been investigated very little and therefore have limited findings on history and physical examination or imaging. Another limitation is the general nature of many descriptions of the history and the physical examination. This, unfortunately, is an inherent limitation of the hip itself and was a major impetus for this review. Often a patient only presents with posterior, lateral, or anterior hip pain, and a thorough history and examination evaluating for the entities discussed here may be required to arrive at an appropriate differential diagnosis.

Conclusions

The diagnosis of hip conditions may be challenging for clinicians. Although the history and physical examination are useful, the results are often equivocal. Diagnostic imaging is used routinely to achieve a differential diagnosis and thus increase the specificity, advance a diagnosis, and aid in the development of a prognosis. Furthermore, once a diagnosis is established, imaging may be used to monitor treatment response. This review has presented the diagnostic possibilities of the musculoskeletal causes of posterior, lateral, and anterior hip pain. Myofascial pain can be a cause of acute and chronic musculoskeletal symptoms and can present in any hip compartment.

Supplementary data

Supplementary data to this article can be found online at doi:10.1016/j.jcm.2016.08.004.

Funding Sources and Conflicts of Interest

No funding sources or conflicts of interest were reported for this study.

Contributorship Information

Concept development (provided idea for the research): P.J.B., K.D., N.W.K.
Design (planned the methods to generate the results): P.J.B., K.D., N.W.K.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): P.J.B., K.D., N.W.K.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): P.J.B., K.D., N.W.K.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): P.J.B., K.D., N.W.K.
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Writing (responsible for writing a substantive part of the manuscript): P.J.B., K.D., N.W.K.
Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): P.J.B., K.D., N.W.K.

Practical Applications

- Sources of hip pain can be divided into those which are posterior, lateral, and anterior.
- Overlap amongst these 3 compartments exists.
- Myofascial pain and peripheral neuropathies can be included in each section.
- This review summarizes relevant historical features, orthopedic testing, and diagnostic imaging recommendations for the evaluation of hip pain.

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