Physical Evaluation of the Hip

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7.1 Introduction

Tennis players subject their bodies to extreme forces; the hip joint may experience forces up to five times body weight during activities such as running, jumping, and twisting [1]. One to 27% of injuries in high-level tennis players originate in the hip, pelvis, and groin [2]. Furthermore, alteration of biomechanics from any pathologic process in the hip places the tennis player at increased risk of injury to the shoulder and upper extremity by disturbing the kinetic chain [1]. This is critical, as proper hip function is critical to performance in tennis (Kibler, Presented at 2016 STMS meeting).

A detailed history and physical examination is essential to the diagnosis and treatment of hip pathology. The differential diagnosis of the painful hip is extensive and includes intra-articular and extra-articular pathology and pain referred from other locations (Table 7.1). Because radiographic abnormalities are found in up to 60% of asymptomatic patients [4] and labral tears are found in as many as 90% of magnetic resonance imaging (MRI) studies of asymptomatic volunteers [5], these studies should be utilized for confirmation of the diagnosis after completion of the physical exam and to rule out other pathology. The purpose of this chapter is to describe the history and physical examination of the hip in the tennis player.

7.2 History

Evaluation of hip pain in the tennis player begins with a careful history. The patient should relate the onset and duration of symptoms, the presence or absence of trauma (including the mechanism of injury), and if there have been any changes to their training, the surface area being played on, or mechanics. The location and character of the pain should be discerned, as well as exacerbating and alleviating factors. "Which tennis motions make the hip pain worse?" and "When does the pain occur?" (before, during, or after the match, does it improve after warming up), "Is it worse or better on any particular playing surface," are valuable questions in determining how the athlete is affected [3].

It is important to ask what prior treatments have been attempted, such as rest, ice, physical therapy, orthotics, oral medication, injections, or

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Table 7.1 Common sources of hip pain in tennis players [3]

Intra-articular	Femoroacetabular impingement Labral tears Chondral damage Loose bodies Ligamentum teres tears Hip dysplasia Hip instability
Extra-articular	Pubic symphysis dysfunction Osteitis pubis Athletic pubalgia/sports hernia/core muscle injury Inguinal or femoral hernia Iliopsoas tendonitis, strain, and tendinopathy Internal snapping hip syndrome External snapping hip syndrome Greater trochanteric pain syndrome (including trochanteric bursitis, as well as gluteus medius and minimus strain, tendinopathy, and tears) Piriformis syndrome Hamstring strain and tendinopathy
Referred	Abdominal muscle strain Abdominal—gastrointestinal Pelvis—genitourinary Lumbar spine (disc herniation or degeneration, facet arthropathy, pars injuries)

surgeries. If injections were performed, the exact location of the injection and amount and duration or relief should be recorded by either asking the patient or reviewing outside medical records. If prior surgery was performed, obtaining the outside physician's operative note and arthroscopic pictures is extremely helpful. The physician should also inquire about previous hip injuries or problems at a younger age, recalling that developmental dysplasia of the hip typically presents in infants, Legg-Calve-Perthes disease in elementary and middle-school aged children, and slipped capital femoral epiphysis (SCFE) in adolescents. A social history of steroid use, alcohol abuse, or deep sea diving may suggest avascular necrosis as the underlying cause [6].

The location and description of the pain can be helpful in determining its point of origin. Intra-articular pain typically localizes to the groin or inguinal region but may be referred to the medial thigh or lateral hip. The C-sign is noted when the patient grabs his or her hip with the thumb in the inguinal region and the long finger posterolaterally and states that the pain is at the junction of the fingers (Fig. 7.1). Pain with the hip in a flexed position such as squatting, sitting, or driving for long periods of time or arising from a seated position is often due to intra-articular pain generators. Pain resulting from twisting or pivoting on the affected hip also suggests an intra-articular source [3].

Fig. 7.1 The C-sign. Patients with intra-articular hip pain may grasp their lateral hip, forming the shape of a "C" with the thumb and fingers. They note that the pain is deep inside, where their thumb and fingers would meet

Extra-articular or referred pain will have varying complaints. Pain in the lower abdomen or adductor tubercle may indicate pubic symphysis dysfunction, athletic pubalgia/core muscle injury/sports hernia, osteitis pubis, or inguinal hernia, while pain in the lateral hip suggests trochanteric bursitis or gluteus medius syndrome. Pain in the buttocks or thigh may be coming from the proximal hamstrings, piriformis, or ischiofemoral impingement or referred from the lumbar spine. Neurologic complaints of numbness, weakness, back pain, or symptoms worsening with coughing or sneezing most likely result from lumbar spine pathology.

Mechanical symptoms may be intra- or extra-articular in origin. Chondral flaps and labral tears within the joint can cause painful catching or clicking in the hip, but are not visible and rarely audible. Audible popping felt in the groin while bringing the hip from flexion to extension is caused by the iliopsoas tendon sliding over the iliopectineal eminence or femoral head, known

as internal snapping of the hip. External snapping of the hip, on the other hand, results from a tight iliotibial band sliding over the greater trochanter, is visible and palpable in the lateral hip, and will often be accompanied by the patient complaining that "my hip joint is dislocating."

Traumatic posterior hip dislocation from playing tennis, to our knowledge, has not been reported in the literature, though the senior author has seen a tennis player who sustained a posterior hip subluxation playing tennis. Atraumatic microinstability of the hip, however, may be a source of hip pain and results from repetitive microtrauma, ligamentous laxity, hip dysplasia, or a combination of the above factors [7]. Microinstability is more common in females than males, and patients may complain of a sensation of instability in the hip. Particular hip positions or movements which cause the hip to feel unstable should be recorded, and any personal or family history of ligamentous laxity or Marfan or Ehlers-Danlos syndrome must be noted as well [8].

7.3 Physical Examination

The key to the physical examination is to determine if the pain originates from intra-articular or extra-articular pathology and to confirm the pain is not referred from the spine, gastrointestinal or genitourinary systems, or lower abdomen. Intra-articular pathologies tend to be aggravated by passive motion of the hip joint, while extra-articular causes are often painful to palpation or manual strength testing [3]. Both hips should be inspected, palpated, measured for range of motion and strength, and subjected to provocative tests in five different positions. The senior author and others have found the most efficient order of exam begins in the standing position followed by seated, supine, and lateral and ends with prone examinations [9].

First observe the patient during the history part of the evaluation. Are they slouched to prevent flexion of the hip, or are they listing to stay off the buttock on one side? Are they constantly moving side to side?

7.3.1 Standing Examination

Begin by asking the patient to stand with their back facing toward the examiner. Observe the patient arising from the seated position, making note of over-reliance on the arms to push up out of the chair and if the patient splints or compensates for the affected hip. With the feet (with shoes off) shoulder width apart, palpate the iliac crests to assess for leg length discrepancy. In patients with equal leg lengths, the height of the iliac crests will be the same. When the iliac crests are at different heights, a leg length discrepancy exists. Incremental wooden blocks placed under the short side heel will aid in orthotic considerations for patients whose leg lengths are unequal [9].

Hip abductor strength is measured with the Trendelenburg test (Fig. 7.2). While palpating the iliac crests and posterior superior iliac spines, the patient is asked to sequentially lift each knee. The iliac crest will rise up in patients with normal hip abductor strength. If the iliac crest does not rise, or if the athlete shifts their upper body toward the standing leg, the hip abductors are weak [10].

Gait evaluation involves observation of the patient walking from the front and the back. Key points of gait evaluation include foot rotation (internal/external progression angle), pelvic rotation, stance phase, hip motion, and stride length. The foot progression angle will detect osseous or static rotatory malalignment. A pelvic wink is the result of excessive rotation toward the affected hip to obtain terminal hip extension. Pelvis wink during gait may be the result of intra-articular hip pathology, abnormal femoral version, and ligamentous laxity of the hip. An antalgic gait is characterized by a shortened stance phase on the painful side limiting the duration of weight bearing [9].

7.3.2 Seated Examination

Inspect the patient in a seated position for abnormal posture. Patients with piriformis syndrome may lean away from the affected hip, while patients with femoroacetabular impingement (FAI) slouch

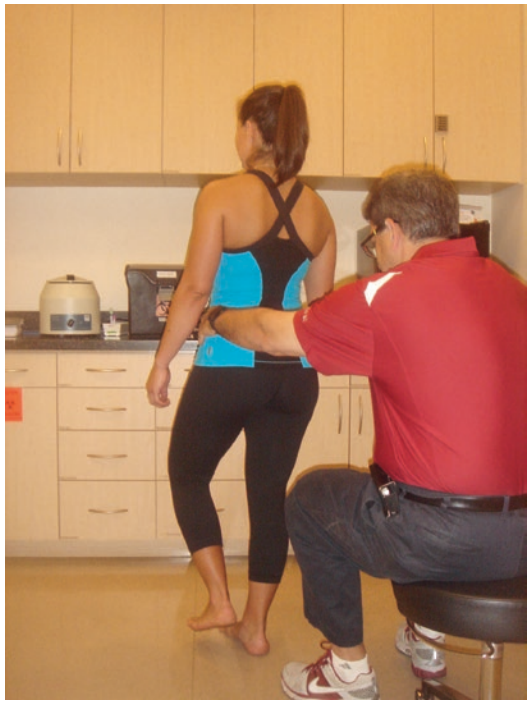

Fig. 7.2 Trendelenburg sign and leg length discrepancy. Evaluating the patient from the back, standing on both legs, the examiner evaluates the iliac crest heights for determination of leg length discrepancy. Next, the athlete lifts one knee while the examiner still has their hands on the iliac crests and posterior iliac spines. The iliac crest on the side the leg is lifted should rise up, indicative of good strength on the contralateral hip abductors. If it does not raise or if the athlete shifts their upper body toward the standing leg, then there is hip abductor weakness [3]

to reduce hip flexion. A neurovascular examination should be performed, including pulses, deep tendon reflexes, sensation and manual motor testing, and seated straight leg raise test. The strength of the iliopsoas is assessed by having the patient raise the knee off the table (Fig. 7.3). Pain with resisted hip flexion suggests tendonitis or bursitis of the iliopsoas. Passive hip ROM in internal rotation (IR) and external rotation (ER) should be recorded in the seated position—as the ischium is stable, reducing compensatory motion [3].

7.3.3 Supine Examination

Inspect the anterior hip, inguinal region, and pubic symphysis, and palpate the inguinal canal,

Fig. 7.3 Iliopsoas strength test—resisted hip flexion while seated is useful to evaluate the iliopsoas for weakness as well as pain

pubic bone, pubic symphysis, rectus abdominis, and adductor longus. Tenderness at the superficial inguinal ring with swelling that becomes more prominent with Valsalva maneuvers is indicative of an inguinal hernia. Osteitis pubis presents with tenderness over the pubic bone and pain with a pelvic compression test, performed by pushing the anterior superior iliac spines toward the midline (this can also be done in the lateral position). The pubic symphysis stress test creates a shear force at the pubic symphysis by grabbing the superior border of the pubic bone on one side, the inferior border of the pubic bone on the contralateral side, and pressing the two hands together. A positive test recreates the patient's pain at the pubic symphysis. Hesselbach's test (Fig. 7.4) is performed by palpating the edge of the rectus abdominis insertion into the pubis while the patient performs a sit up. Exacerbation of the patient's symptoms with this maneuver is consistent with athletic pubalgia/core muscle injury/sports hernia. Tenderness over the adductor longus which worsens with resisted hip adduction at 0° or 90° of hip flexion indicates tendinopathy or tearing of the adductor longus [3].

Range of motion of the hip is measured in flexion, extension, adduction, abduction, and internal and external rotation with the hip flexed to 90° and in neutral flexion-extension are recorded, and it should be noted if the patient experiences discomfort at the end range of motion. Normal range of motion values is listed

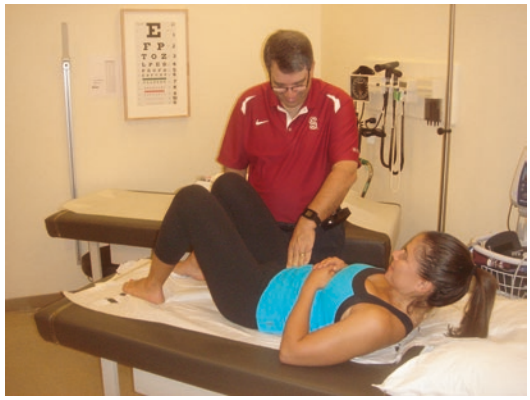

Fig. 7.4 Hesselbach's test. This test is performed by palpating the edge of the rectus abdominis insertion while the patient performs a sit up. Exacerbation of the patient's symptoms with this maneuver is consistent with athletic pubalgia/core muscle injury/sports hernia

Table 7.2 Normal range of motion values of the hip [3]

Flexion	110°–120°
Extension	10°–15°
Abduction in extension	30°–50°
Adduction in extension	30°
External rotation in flexion	40°–60°
Internal rotation in flexion	30°–40°

in Table 7.2. Groin pain at maximal hip flexion which improves with hip abduction may indicate FAI secondary to a low-lying anterior inferior iliac spine (AIIS), while obligate abduction and external rotation while the hip is being flexed is known as Drehmann's sign, seen in patients with SCFE. Hamstring tightness is assessed by flexing the hip to 90° and passively extending the knee from 90° of flexion until muscle tightness resistance is felt. This is the popliteal angle, and an angle greater than 60° is considered tight in general, though less degrees may also be indicative of tightness for some patients, and thus, contralateral hamstring tightness should be measured as well.

The Thomas test (Fig. 7.5) is utilized to evaluate for hip flexion contracture, which may be found in association with abdominal muscle strains. The flexion/adduction/internal rotation (FADIR) test, also known at the impingement test (Fig. 7.6), is very sensitive for intra-articular hip pathology, but is not specific for FAI. The

Fig. 7.5 Thomas test. This test evaluates for hip flexion contracture. The patient pulls the knee of one leg up to his/her chest. If there is no flexion contracture, the contralateral extended hip and extremity will be flat on the examination table. Care is taken to be sure the lumbar spine is flat against the examination table during this test and can be assessed by the examiner placing their hand underneath the athlete's lower back

Fig. 7.6 Flexion/adduction/internal rotation (FADIR) or "impingement" test. The hip is flexed to 90°, adducted, and internally rotated. This test is sensitive to intra-articular pathology, but is not pathognomonic for femoroacetabular impingement

dynamic labral stress test, or scour maneuver (Fig. 7.7), pinches the labrum between the femoral neck and acetabulum and may indicate a symptomatic labral tear if it reproduces the patient's pain. The Stinchfield test (Fig. 7.8) is performed by having the patient perform a resisted straight leg raise and may be positive with either intra-articular (labral tear) or extra-articular pathology, such as rectus femoris or iliopsoas strains or tendonitis. The foveal distraction

Fig. 7.7 Labral stress test or scour maneuver. The patient's hip is flexed, abducted, and externally rotated to start (**a**). The hip is then adducted and internally rotated (**b**) while extending the hip (**c** and **d**). The hip is then passively ranged from flexion through a wide arc of abduction and external rotation toward hip extension

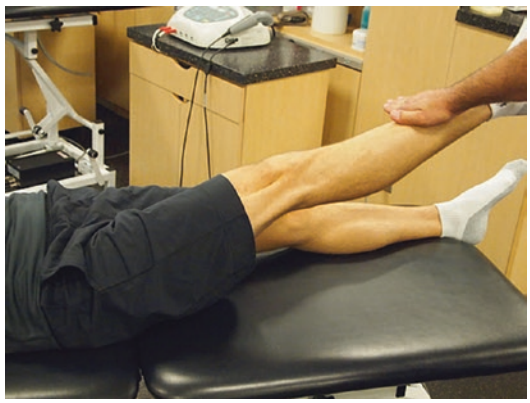

Fig. 7.8 Stinchfield test. This test is performed with a straight leg raise against resistance. Pain while performing this test may indicate either intra-articular hip pathology or hip flexor inflammation or injury

test is performed by placing axial traction on the leg with the hip in 30° of abduction, which reduces intra-articular pressure. Relief of pain during this maneuver also indicates in intra-articular source of hip pain.

The Patrick test (Fig. 7.9) and Gaenslen's test (Fig. 7.10) are used to evaluate the sacroiliac joint. The Byrd test (Fig. 7.11) attempts to reproduce internal snapping of the hip by having the patient actively flex and externally rotate the hip, followed by abduction and then extending and internally rotating the hip as the hip is adducted to the starting position. The examiner should palpate the groin during this maneuver to feel for popping or clicking of the iliopsoas in the front of the hip, though the snap is usually audible.

The logroll test is a sensitive test for intra-articular pain in patients with acute hip injuries. A modified logroll test evaluates for hip instability. With the patient relaxed, the external rotation position of the foot is noted. The foot is passively

Fig. 7.9 FABER test/Patrick's test. In this test, the patient's buttock is off the edge of the table, and then the ipsilateral leg is brought into a "figure-of-4" position (flexion, abduction, and external rotation—FABER). While stabilizing the contralateral anterior superior iliac spine with one hand, the examiner applies a downward force to the knee with the other hand. Posterior pain is often elicited as a result of sacroiliac pathology, while anterior pain may be the result of pubic symphysis pain or anterior labral damage

Fig. 7.10 Gaenslen's test. The patient lies supine with the buttock off the edge of the table. The ipsilateral leg is then extended toward the floor. This maneuver stresses the sacroiliac joint and is positive if the patient experiences posterior hip pain on the provoked side

internally rotated then released to fall back into external rotation. Anterior hip pain and external rotation of the foot past 75° suggests iliofemoral ligament laxity which may be consistent with anterior microinstability of the hip. The hyperextension-external rotation test (Fig. 7.12) also evaluates for anterior instability of the hip. During this test, the patient lies supine with the pelvis at the end of the examination table with the legs dangling free. The hip not being examined is flexed and held by the patient stabilizing the pelvis, while the contralateral hip is externally rotated in hyperextension. Anterior groin pain may indicate and anterior labrum tear and/or anterior microinstability [3].

7.3.4 Lateral Examination

Palpation of the trochanteric bursa, gluteus medius, and piriformis is performed in the lateral position. Ober's test (Fig. 7.13) evaluates for contracture of the iliotibial band. External snapping hip syndrome should be investigated by having the patient simulate pedaling a bicycle with their upper leg. A positive test reproduces snapping of the iliotibial band over the greater trochanter. Instability testing in the lateral position as described by Guanche (Fig. 7.14) involves applying an anterior force to the posterior greater trochanter with the hip in an extended, abducted, and externally rotated position [11]. Anterior hip pain indicates a positive test.

7.3.5 Prone Examination

Hip instability may also be tested in the prone position, as described by Domb (Fig. 7.15). With the hip in external rotation, an anteriorly directed force is applied to the posterior greater trochanter. A positive test results in anterior hip pain [11].

Internal and external rotation of the hip should be measured in the prone position with the knee flexed to 90°. Craig's test is performed by internally rotating the foot until the trochanter is felt most prominently laterally. Femoral version may then be estimated by noting the angle between the axis of the tibia and an imaginary vertical line, which normally is between 10° and 20°. Ely's test assesses for rectus femoris contracture by maximally flexing the knee in the prone position. A negative test demonstrates full flexion of the knee to the thigh with no movement in the

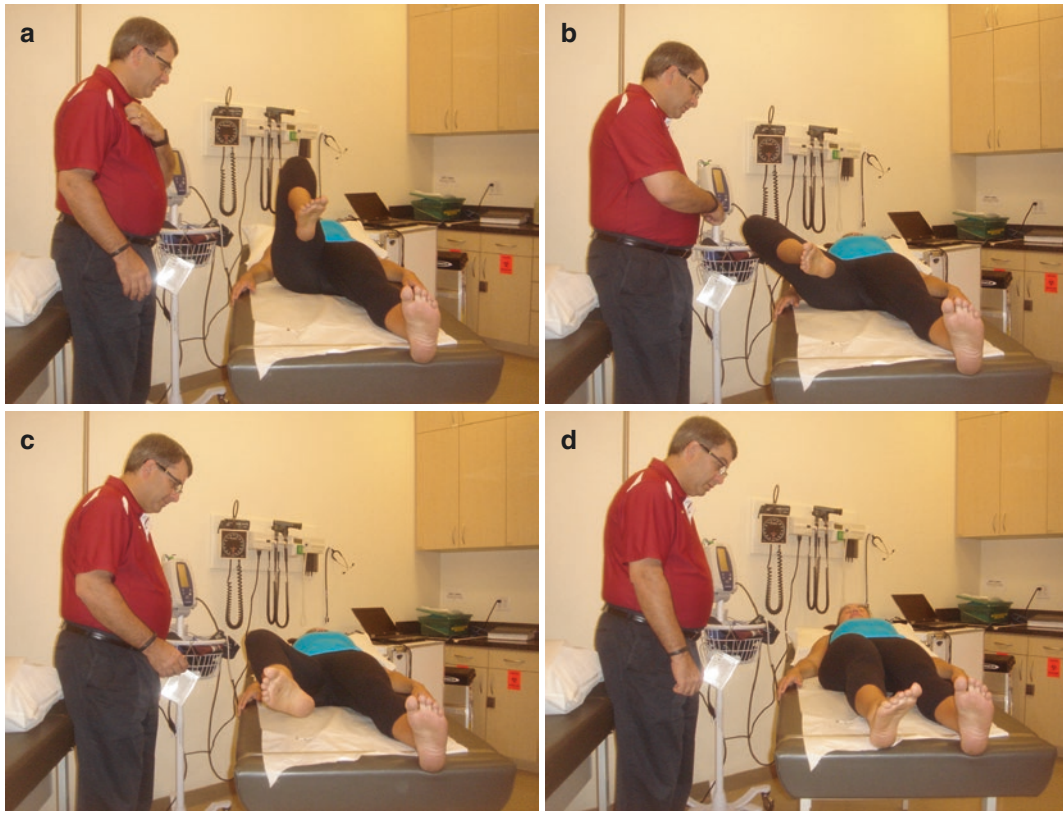

Fig. 7.11 Byrd test. While the examiner palpates the groin, the patient actively brings the hip into (**a**) flexion, then (**b**) abducts, and (**c**) externally rotates while (**d**) extending the hip. This test is used to detect popping of the iliopsoas tendon over the iliopectineal eminence or femoral head, known as internal snapping of the hip

Fig. 7.12 Hyperextension-external rotation test. The patient lies supine with the pelvis at the end of the examination table, and the lower extremities are dangling free. The hip not being examined is flexed and held by the patient while the other extremity is externally rotated while in hyperextension. Anterior hip pain may be the result of an anterior labral tear and/or anterior microinstability

Fig. 7.13 Ober test. This test is for hip abductor tightness or iliotibial band contracture. With the patient in the lateral decubitus position, the hip and knee are first flexed, then the hip abducted, then extended, and let fall into adduction. Inability of the knee to drop below neutral indicates tightness of the iliotibial band

Fig. 7.14 Abduction-extension-external rotation test. In this test, the patient's hip is held in abduction, extension, and external rotation, and then an anteriorly directed force is applied to the greater trochanter. Pain in the groin or anterior hip indicates anterior labral tear and/or anterior microinstability

Fig. 7.15 Prone instability test. With the patient prone, and the hip externally rotated, an anterior force is directed against the posterior aspect of the greater trochanter. Pain in the anterior hip indicates anterior labral tear and/or anterior microinstability

pelvis. Any limitation of knee flexion or elevation of the buttocks from the table is a positive test for rectus femoris contracture [12].

Palpating the gluteus maximus with the index finger of one hand and the hamstring muscle belly with the index finger of the other hand while asking the patient to raise his or her flexed knee off the table will allow differentiation of which muscle fires first to extend the hip. Normally, the gluteus maximus will fire first, known as gluteal dominance. If the hamstrings contract before the gluteus maximus, the patient is hamstring dominant. Hamstring-dominant patients will benefit from referral to a physical therapist for neuromuscular reeducation to achieve gluteal dominance. Finally, tenderness over the ischial tuberosity or pain with resisted hamstring firing may be found in patients with proximal hamstring tendinopathy or tearing.

7.4 Summary

Hip pain in the tennis player comprises an extensive differential diagnosis. The deep location of the hip joint, its thick soft tissue envelope, and the potential for referred pain patterns highlight the importance of performing a comprehensive history and physical examination. Proper execution of the history and physical examination techniques detailed in this chapter, in combination with confirmatory imaging and diagnostic injection tests, allows the physician to formulate the correct diagnosis and initiate appropriate treatment.

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