Evaluation of Athletic Population with Hip/Hamstring/Quad Injuries

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The hip represents the most complex anatomical district from the diagnostic point of view. History and physical examination of the athletic hip are the key for the evaluation of patients presenting with hip pain. The examiner should consider that independent pathologies could show concomitant and overlapping signs and symptoms. This subchapter describes a comprehensive and systematic approach to the athlete with hip, hamstring, and tight pain.

40.1 Introduction

The study of the hip represents a daily challenge for the orthopedic specialist. Defining precisely what the patient describes as "hip pain" is an effort often overlooked. The difficulties are further amplified in athletes, of all ages and of all sport levels. Recent studies show that groin pain is described as the main symptom in 10% of sports medicine visits [1, 2]; in addition, 5–9% of adolescent athletes suffer from hip and/or pelvic girdle disorders [3]. Sports which provide for frequent accelerations, decelerations, and changes of directions are increasingly popular (for example, football, tennis, American football), with a consequent increase in the risk of overstress of the coxofemoral joint and of lesions to the surrounding structures. The hip (and in general the pelvic girdle) represents perhaps the most complex anatomical district from the diagnostic point of view, so a precise knowledge of the anatomy and biomechanics of this district is necessary. To this complex picture, the wide range of differential diagnosis is added; independent pathologies could show concomitant and overlapping signs and symptoms, while related disorders could reveal a diversified symptomatology [4, 5]. It is therefore a compelling challenge. The orthopedic surgeon will have to take on the role of the investigator, recognizing fundamental signs and symptoms, isolating the essential details, and avoiding following incorrect diagnostic indications. As said, differential diagnosis is a fundamental and very complex context (Table 40.1).

A precise physical examination and an adequate radio-diagnostic study must always be preceded by a scrupulous clinical history of the patient. The history of a patient presenting with hip pain must necessarily include age, traumatic

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Table 40.1 Differential diagnosis

Intra-articular	Extra-articular	Nonmusculoskeletal
Femoroacetabular impingement	Muscle strain	Sports hernia
Developmental hip dysplasia	Tendonitis/tendinopathy	Appendicitis
Acetabular labral tear	Ligament injury	Inflammatory bowel disease
Chondrosis	Bursitis	Diverticulitis
Legg-Calvè-Perthes disease	Pubic ramus fracture	Lymphadenitis
Osteochondritis dissecans	Apophyseal avulsion	Urinary tract infection
Avascular necrosis of femoral head	Greater trochanter pain syndrome	Prostatitis
Traumatic/stress facture	Snapping hip syndrome	Nephrolithiasis
Hip subluxation/dislocation	Lumbosacral radiculopathy	Pelvic inflammatory disease
Synovitis	Sacroiliac joint dysfunction	Ovarian cystitis
Tumor	Pelvic floor dysfunction	Ectopic pregnancy
Infection	Peripheral nerve entrapment	Urethritis

mechanism (if present and identifiable), quality, type, distribution, progression of the pain, exacerbating and alleviating factors, and associated signs and symptoms. All these data are essential to start the diagnostic investigation in the right direction, focusing on the most probable pathological situation. The location and irradiation of pain are useful information, although it is difficult to recognize and determine precisely. Anterior groin pain is often associated with intra-articular hip disorders (FAI, labral tear, intra-articular mobile bodies, osteoarthritis, etc.). Disorders of extra-articular structures can also manifest anterior pain (adductor muscles and iliopsoas). Lateral hip pain can occur in intra-articular pathological pictures but is more frequently associated with extra-articular disorders such as trochanteric bursitis and tendinopathies of the tensor fasciae latae or of the hip external rotators. Posterior pelvic pain represents the most nonspecific symptom, which best represents the difficulties to overcome towards a precise diagnosis; this clinical manifestation can be a consequence, in addition to the pathologies already mentioned (recent studies show the presence of posterior pain in 17% of patients with congenital hip dysplasia, in 38% of patients with isolated lesions of the acetabular lip, and in 29% of patients with femoroacetabular impingement), of sacroiliac joint disorders, hamstring muscle group, or spinal lumbosacral tract [6–8]. Also not to be forgotten in the clinical study are the characteristics of the pain described by the patient. Pain associated with active contractions or passive stretches of specific muscle groups is often suggestive of tendinopathies or muscle injuries. Symptoms exacerbated by coughing or sneezing can frame the diagnosis towards abdominal or intervertebral hernia disorders. Pops or blocks of movement can depend on extra-articular or intra-articular disorders; a sore and popping hip is often recognizable in sportsmen who perform frequent hip flexions and hyperextensions, such as footballers or dancers [9–11]. This symptomatology can be associated with impingement of the iliotibial band with the greater trochanter or of the iliopsoas tendon with the iliopectineal eminence [12]. Finally, burning pain is often associated with neuropathic symptoms. A hip examination must be conducted in a specific order to have a reproducibility between different observers, too. The order in which it is carried out must be simple so that the patient can easily follow the doctor's advice (Table 40.2). It starts with the standing position and then passes to sitting, prone, supine, and then lateral. In each position, specific tests can be performed (Table 40.3).

Table 40.2 The complete form for hip/hamstrings/quad injuries

Physical examination

Name _____ Surname _____ - Date of birth ___/___/___
H:___ cm W:___ Kg BMI: ___

Standing examination

Shoulder height: equal/not equal
Iliac crest height: equal/not equal
Active forward _____*
Spine straight / scoliosis —> structural / non structural
Hyperkyphosis +/- Hyperlordosis +/-
Iperlaxity test: thumb test +/- elbows recurvatum +/- Knees recurvatum +/-
Gait
Gait: normal antalgic abductor deficient (Trendelemburg)
Pelvic wink arm swing short stride length short stance phase
Foot progression angle: external neutral hyperpronation
Single leg Stance Phase Test (Trendelenburg test) Right Left None

Seated examination

Neurologic findings:			
Motor: _____			
Sensory: _____			
Deep tendon reflexes	Patella	Achilles	
Straight leg Phase:	Right	Left	
Seated R.O.M.	Right	Left	
Internal rotation:	External rotation:	Internal rotation:	External rotation
		Right +/-	Left +/-
Active slump test		☐	☐
Seated piriformis stretch test		☐	☐

Prone examination

		R +/-	L
Ely's test (rectus contracture)		☐	☐
Craig's test (femoral anteversion)		☐	☐
Palpation			
SI joint		☐	☐
Bursae Ischium		☐	☐
Spinous processes	level_____		
Muscle soreness		Right +/-	Left +/-
Hamstrings		☐	☐

(continued)

Table 40.2 (continued)

Supine Examination

Skin inspection: none/_____			
Lymphatic system: _ lymphedema	no lymphedema	pitting edema 1+ 2+	
Leg lenghts: R___cm	L___cm	equal/not equal	
R.O.M.	Right	Left	
Flexion	_____	_____	
Abduction	_____	_____	
Adduction	_____	_____	
	Right +/-	Left +/-	
Thomas test (hip flexion contracture)	☐	☐	
Modified Thomas test (quad injury)	☐	☐	
FABER test	☐	☐	
FADDIR test	☐	☐	
DIRI test	☐	☐	
DEXRIT test	☐	☐	
Posterior rim impingement test	☐	☐	
Log-roll test	☐	☐	
Apprehension sign	☐	☐	
Dial test	☐	☐	
Stinchfield's test (straight leg raise against resistance)	☐	☐	
Resisted knee extension test	☐	☐	
Heel strike	☐	☐	
Femoral nerve tinel	☐	☐	
Abdomen soreness	☐	☐	
Adductor tubercle soreness	☐	☐	
Pubic symphysis soreness	☐	☐	
Muscle soreness	Right +/-	Left +/-	
Iliopsoas	☐	☐	
Quadriceps	☐	☐	
Abductors	☐	☐	
Neurologic findings	Right +/-	Left +/-	
Lasegue	☐	☐	
Dandy	☐	☐	

Table 40.2 (continued)

Lateral examination

Palpation	tender	not tender
SI joint	☐	☐
Ischium	☐	☐
Great trochanter	☐	☐
ASIS	☐	☐
Piriformis	☐	☐
Sciatic nerve	☐	☐
Gluteus Max (insertion into ITB)	☐	☐
Glutes medius	☐	☐
Abductor strength: R L	R L	R L
straigth leg. ____ ____	Gluteus medius ____ ____	Gluteus max ____ ____
	R +/-	L +/-
FADDIR test	☐	☐
Lateral rim impingement	☐	☐
Gluteus Max. contracture test	☐	☐
Gluteus Med. contracture test	☐	☐
Tensor fascia lata contracture test	☐	☐
Passive adduction test	☐	☐
Active piriformi test	☐	☐
Muscle soreness	Right +/-	Left +/-
Gluteus med	☐	☐
Gluteus max	☐	☐
Tensor fascia lata	☐	☐
Piriformis	☐	☐

Specific tests

	R +/- L
Philippon internal rotation test	☐ ☐
McCarthy's sign	☐ ☐
IFI test	☐ ☐
Dynamic Trendelemburg	☐ ☐
Scours	☐ ☐
Foveal distraction	☐ ☐
Bicycle	☐ ☐
Pace sign	☐ ☐
ABDEER	☐ ☐
Supine abduction external rotation	☐ ☐
Fulcrum	☐ ☐
Long stride test	☐ ☐

Table 40.3 Specific tests' description

Test	Patient position	Description	Positive test	Assessment
Log roll test	Patient in supine position with knee and hip extended.	The examiner passively internally and externally rotates the leg while stabilizing the knee and ankle	A positive test reproduces anterior or lateral hip pain	Intra-articular hip disease
Anterior hip impingement test	Patient in supine position.	The examiner passively flexes the hip and knee and internally rotates and adducts the hip.	A positive test reproduces anterior or lateral hip pain	Intra-articular hip disease, in particular impingement and/or an anterosuperior labral tear
Internal rotation over pressure test	Patient in supine position.	The examiner flexes passively the hip and the knee to 90 degree then internally rotates the hip to and range of motion and applies a posterior force.	A positive test reproduces anterior or lateral hip pain	Intra-articular hip disease
Hip scour test	Patient in supine position.	The examiner moves passively the hip in flexion and adduction end range of motion. A downward force is applied along the axis of the femur while moving the hip in a circular fashion.	A positive test reproduces groin, lateral hip or posterior pelvic pain	Intra-articular hip disease
FABER test / Patrick test	Patient in supine position.	The examiner rests the ankle of the leg on the opposite knee in a"figure 4" position; the opposite ASIS is stabilized with one band, and the other hand applies pressure to the knee downward	A positive test for hip disease reproduces anterior or lateral hip pain. A positive test for SI joint or low back disease reproduces posterior pelvic pain	Hip disease or SI and low back disease
Stinchfiled resisted hip flexion test	Patient in supine position.	The patient flexes the hip to 30 degree against resistance with the knee extended.	A positive test reproduces anterior or lateral hip pain	Intra-articular hip disease Hip flexors disease
Thomas test	Patient in sitting position at the edge of the table	The patient flexes the contralateral knee to the chest and rolls onto the back while allowing the tested hip to remain extended and hanging off the edge of the table.	Lack of full hip extension indicates hip flexion contracture, while abduction of the leg indicates ITB tightness	Hip flexors contracture
Ober test	Patient in lateral position with the tested leg up. Hip and knee of the lower leg are flexed	The examiner passively extends the patient's upper leg with the knee flexed at 90 degree; while supporting the knee, the examiner slowly lowers the leg	If the ITB is shortened, the leg remains abducted	ITB tightness
Posterior hip impingement test	Patient in prone position with hip and knee extended	The examiner passively extends, adducts, and externally rotates the hip	a positive test reproduces anterior hip or posterior pelvic pain	Intra-articular hip disease in particular posterior wall or labral pathologies
Trendelemburg sign	Patient in standing position	the examiner places the hands on the top of both iliac crests while the patient stands on the tested leg in a single leg stance	the test is positive if the pelvis droops on the non stance side (hip abductor weakness on the side of the stance leg)	hip abductor weakness
Ely's test	Patient in prone position	The examiner passively flexes the knee.	The test is positive if the hip flexes as the knee flexes indicating a tight rectus femoris	Rectus femoris contracture
Piriformis test	Patient in lateral position with the tested leg up. Hip and knee of the upper leg are flexed	The examiner places a hand on the great trochanter with the thumb on the piriformis insertion. The patient actively external-rotates the hip	If the piriformis is tight pain is elicited. If the sciatic nerve is compressed the patient describes radicular-like symptoms	Contracture of the piriformis muscle or sciatic nerve compression

SI sacroiliac, *ASIS* anterior superior iliac spine, *ITB* iliotibial band

40.2 Standing Examination

The patient in this position indicates the point where he/she has pain with one finger; a characteristic sign that can be identified in this moment is the "C sign" [13]. The patient will hold their hand in the shape of a C and place it above the greater trochanter with the thumb positioned posterior and fingers extending to the groin. This finding can be misinterpreted as lateral soft-tissue pathology; however, the patient often describes deep interior hip pain [14]. The iliac crest heights and shoulder height are noted to evaluate leg-length discrepancies as the patient stands. Wooden tablets can be used as elevations to be placed under the feet to bring the shoulders and iliac spines to level and therefore determine any possible limb-length discrepancy. In this phase, it is also useful to evaluate the presence of eventual imbalances of the spinal column as scoliosis. At this stage of the physical examination, any abnormalities in the load are also assessed; this often helps to detect hip pathology owing to the transfer of dynamic and static load to the ligamentous and osseous structures [15]. A full gait of 6–8 stride lengths is observed from behind and the front of the patient. Particular attention should be paid to the rotation of the feet in all phases of the step. The foot progression angle will detect osseous or static rotatory malalignment. A shortened stance phase is very important to note because it can be indicative of neuromuscular abnormalities, trauma, or leg-length discrepancies. A step study can give many clues about the underlying pathology. An antalgic gait is characterized by a shortened stance phase on the painful side limiting the duration of weight-bearing [16]. A short-leg gait is evidenced by the drop of the shoulder in the direction of the short leg. Note also the alignment of the patellae, whose internal rotation or external rotation may indicate a patella-femoral malalignment. After observing the gait, we can conduct more detailed tests. The Trendelenburg test or single leg stance phase test (for description, see the table below) is conducted on both legs, with the non-affected leg examined first to establish a baseline reference for the patient's function. The abductor

Table 40.4 Normal hip motions and normal measurements for active range of motion [17]

Motion	Normal values	Comment
Flexion	110–120	Measure flexion with the knee flexed to prevent limitation caused by hamstring tightness
Extension	0–15	Increased lordosis of the lumbar spine may falsely compensate for decreased hip extension
Abduction	30–50	During active hip abduction, pelvic motion signifies the limit of abduction. Assess this motion by placing a hand on the patient's anterior-superior iliac spine
Adduction	30	Starting from neutral, the limit of adduction occurs when the pelvis moves
External rotation	40–60	Values may vary with increased femoral neck anteversion or retroversion. Test can be performed with the patient supine or prone
Internal rotation	30–40	Values may vary with increased femoral neck anteversion or retroversion. Tests can be performed with the patient supine or prone

deficient gait is an unbalanced stance phase attributed to proprioception disruption or abductor weakness. The abductor deficient gait may present in two ways: with a shift of the pelvis away from the body ("dropping out" of the hip on the affected side) or with a shift of the weight over the adducted leg (shift of the upper body "over the top" of the affected hip) [13]. A specific test during gait is the long stride test, for the ischiofemoral impingement, in which a long step causes pain (Table 40.4).

40.3 Seated Examination

During the physical examination in a sitting position, all possible vascular and nervous system problems must be analyzed; it is important to observe the state of the soft tissues, too. The strength in extension against knee resistance and the bilateral patella-femoral reflexes of the knee should be evaluated. In this position, it is essential to evaluate the passive intra- and extra rotation. In fact, the sitting position ensures that the ischium is square to the table, thus providing sufficient stability at 90 degree of hip flexion [13]. Passive and active intra-rotation should be examined gently and compared with the contralateral side. An increase in intra-rotation and a decrease in external rotation can be a manifestation of excessive femoral anteversion. A decrease in intra-rotation can indicate an intra-articular pathology. At the end of the seating position examination, iliopsoas contracture test is performed (Fig. 40.1).

Fig. 40.1 Iliopsoas contracture test: reflecting the affected hip; note the internal rotation of the contralateral hip

40.4 Prone Examination

The prone examination involves palpation of four distinct areas: gluteus maximus origin, suprasacroiliac joint, sacroiliac joint, and spine (facets). The femoral anteversion test (traditionally known as Craig test) will test the femoral anteversion or retroversion [19]. With the patient in the prone position, the knee is flexed to 90° and the examiner manually rotates the leg while palpating the greater trochanter so that it protrudes most laterally. Femoral version is assessed by noting the angle between the axis of the tibia and an imaginary vertical line, which normally is between 10 and 20°. This test will help to identify cases of retroversion. The rectus contracture test

(also known as Ely test; see table below): restriction of hip flexion is indicative of a rectus femoris contracture [20].

40.5 Supine Examination

First of all, it is appropriate to measure the length of the lower limbs, comparing the spinomalleolar distance. The passive ROM in hip flexion is then examined, with the knee flexed. In addition to the amplitude of the articular excursion, it is useful to also observe the position of the pelvis since it could compensate for a hip flexion deficit by starting to rotate. The Thomas test is done by having the patient extend and relax the leg down towards the table, while holding the contralateral leg in full flexion. The inability of the thigh to reach the table shows a hip flexion contract [13]. Abduction and passive adduction are also tested. It is also useful to make a palpation of the abdomen to document the tension and any painful points; this is also to exclude any inguinal hernias [21]. It is useful to ask the patient to actively flex the back from the supine position and simultaneously palpate the abdomen to exclude any abdominal fascial hernias that can cause delays related to the pelvis. During this phase, articular sclerosis or snapping sensations can be felt; it is advisable to identify the movements with which this happens and reproduce them several times to identify if it is an internal or external snap. If it is an internal snap that has come from the iliopsoas tendon, many times this will be eliminated with a simultaneous abdominal contraction. A bicycle test (conducted in the lateral position) can help to distinguish the pop internally from the external pop of coxa with the externus one belonging to the subluxing iliotibial band over the greater trochanter. The FABER test (Patrick test) (for the description of the specific tests, see the table below) is helpful to distinguish hip versus lumbar complaints [22]. In the presence of hip pain, if the test is positive, it can be associated with musculotendinous or osseous posterior lateral acetabular incongruence or ligamentous injury. The DIRI test is also conducted in a supine position; positivity is determined if the same type of pain complained by the patient is re-created. Finally, the Tinel test for the femoral nerve is done. This test is found to be positive with hip flexion contractures of greater than 25°, as a result of the proximity of the psoas tendon and the femoral nerve. A heel strike is carried out by striking the heel abruptly, which if painful is indicative of some type of trauma or a stress fracture. After that, we can do the fulcrum test where the patient complains pain. The patient is seated on the examination table with his/her lower legs dangling. The examiner places one of his/her arms under the symptomatic thigh. The palm of the hand is facing up and touching the patient's leg. This arm will serve as a fulcrum. At one side of the fulcrum, the force is created by the patient's body weight. If the patient complains pain, a stress fracture or a traumatic incomplete fracture must be suspected [17].

The log roll test [14] involves passive intra- and extra-rotation of the femur, with the leg lying in an extended position. This test is conducted bilaterally, and any side-to-side differences of this maneuver can alert the examiner of the presence of laxity, effusion, or internal derangement. The straight leg raise against resistance test (also known as the Stinchfield test) is useful to evaluate the hip flexor/psoas strength [23]. A positive test is noted with recreation of the pain or weakness and is a sign of an intra-articular problem because of increasing compressive force across the hip joint or the psoas placing pressure on the labrum. The PRI [13] test or the lateral rim impingement test that is its variation is conducted with the patient at the edge of the examining table so that the examined leg hangs freely at the hip. The patient draws up both legs into the chest, eliminating lumbar lordosis. The affected leg is then extended off the table, allowing for full extension of the hip, abducted and externally rotated. This test causes a hip extension evaluating the congruence of the femoral neck and the posterior acetabular wall.

40.6 Lateral Examination

The objective examination in lateral decubitus begins with the evaluation of the healthy contralateral side and proceeds with the palpation of the area below and above the sacroiliac joint, of the abductor muscles, and in particular of the gluteus maximus which course must also be felt. Then we proceed with palpation of the ischium to exclude avulsion of the hamstring proximal tendons. Finally, we proceed with the palpation of the Valleix points along the course of the sciatic nerve, and therefore the piriform and gluteus medius muscles and the tensor fasciae latae must be evaluated. This must be done naturally on both sides. An active piriformis test (Fig. 40.2) is conducted by the patient pushing the heel down into the table, abducting and externally rotating the leg against resistance, while the examiner checks the piriformis [18, 24]. The Ober test (see in the table below) or passive adduction test is conducted with the leg in three positions: extension (tensor fasciae latae contracture test), neutral (gluteus medius contracture test), and flexion (gluteus maximus contracture test). Gluteus medius tension is assessed with knee flexion to relax the iliotibial band. The gluteus maximus is melted with the tensor fasciae latae anteriorly [25]. To distinguish the contribution of only the gluteus maximus when conducting the gluteus maximus contracture test, the hip is flexed and the knee is extended. If adduction cannot occur in this position, the gluteus maximus portion is contracted. The passive assessment of FADIR (this test can also be made in supine position) is done in a dynamic manner (see description in the table below). The difference from supine to lateral position is the position of the pelvis. The supine position eliminates lumbar lordosis, whereas the lateral tests the normal dynamic pelvic inclination. Pelvic inclination may affect testing, and both positions are helpful in evaluation [13, 21, 22]. The lateral rim impingement test is conducted with the hip externally rotated and passively abducted. The examiner cradles the patient's lower leg with one arm and monitors the hip joint with the opposing hand. The examiner passively brings the affected hip through a wide arc from flexion to extension in continuous abduction while externally rotating the hip [13]. The test is positive if the patient's pain is reproduced.

Fig. 40.2 Active piriformis test

40.7 Conclusions

A thorough knowledge of the anatomy and biomechanics of the hip is fundamental for a correct understanding of the pathology. A schematic and rigorous physical examination helps us to make a correct diagnosis.

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