ABSTRACT

Examination of a painful hip is fairly concise and reliable at detecting the presence of a hip joint problem. Hip joint disorders often go undetected, leading to the development of secondary disorders. Using a thoughtful approach and methodical examination techniques, most hip joint problems can be detected and a proper treatment strategy can then be implemented based on an accurate diagnosis. The purpose of this clinical commentary is to present a systematic examination process that outlines important components in each of the evaluation areas of history and physical examination (including inspection, measurements, symptom localization, muscle strength, and special tests).

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Examination of a painful hip is fairly succinct. One study demonstrated that the clinical assessment can be 98% reliable at detecting the presence of a hip joint problem; although the exam may be poor at defining the exact nature of the intra-articular disorder. However, examination of the hip region can be quite complex due to co-existent pathology, secondary dysfunction, or coincidental findings.

For example, hip joint disease may co-exist with lumbar spine disease. Considerable attention may be necessary in order to distinguish which is the major factor. Among athletes, a significant incidence of hip pathology and concomitant athletic pubalgia can occur. The symptoms can be difficult to distinguish, especially when they co-exist.

Hip joint disorders often remain undetected for protracted periods of time. In the course of compensating for their symptoms, patients often develop secondary dysfunction. This dysfunction may lead to symptoms of trochanteric bursitis or chronic gluteal discomfort. The examination findings for the secondary disorders may be more evident and mask the underlying problem with the hip.

Coincidental findings unrelated to disorders of the hip may exist. Snapping of the iliopsoas tendon and iliotibial band are usually incidental findings without clinical significance. However, this snapping can become a source of symptoms or may exist coincidentally with hip joint pathology. Once again the clinical assessment can become challenging to distinguish the features of each.

A myriad of structures may create similar or overlapping symptoms. In addition to the joint, the clinician must be cognizant of bone problems, surrounding musculotendinous and bursal structures, neurological disorders including numerous small sensory nerves, and even visceral disorders that can refer symptoms to the hip area.

**HISTORY**

As there are various disorders that can result in a painful hip, the history may be equally varied as far as onset, duration, and severity of symptoms. For example, acute labral tears associated with an injury have gone undiagnosed for decades, presenting as a chronic disorder. Conversely, patients with a degenerative labral tear may describe the acute onset of symptoms associated with a relatively innocuous episode and gradual progression of symptoms.

In general, a history of a significant traumatic event is a good prognostic indicator of a potentially correctable problem. Insidious onset of symptoms is a poor prognostic indicator and suggests either underlying degenerative disease or some predisposition to injury. Patients may recount a minor precipitating episode such as a twisting injury; however, even under these circumstances, be wary that underlying susceptibility of the joint to damage may exist and, again, a less certain prognosis. With any hip joint problem, the clinician must look closely for predisposing factors. For example, femoro-acetabular impingement is a recognized cause of joint breakdown in young adults. Often, the cause may be multi-factorial including age, rigors of sport, and joint morphology. The management strategy may have to be multi-faceted, as well. Perhaps not all factors can be identified or corrected, but the evaluation must be thorough.

Mechanical symptoms such as locking, catching, popping, or sharp stabbing in nature are better prognostic indicators of a correctable problem. Simply pain in absence of mechanical symptoms is a poorer predictor. However, the presence of a “pop” or “click” is an often over-rated feature of the hip examination. This finding may indicate an unstable lesion inside the joint, but many painful intra-articular problems never demonstrate this finding, and popping and clicking can occur due to many extra-articular causes, most of which are normal.

There are characteristic features of the history that often indicate a mechanical hip problem. These characteristics are helpful in localizing the hip as the source of trouble, but are not specific for the type of pathology. As expected, the pain is worse with activities, although the degree is variable. Straight plane activities such as straight ahead walking or even running are often well tolerated, while twisting maneuvers such as simply turning to change direction may produce sharp pain, especially turning towards the symptomatic side which places the hip in internal rotation. Sitting may be uncomfortable, especially if the hip is placed in excessive flexion. Rising from the seated position is especially painful and the
patient may experience an accompanying catch or sharp stabbing sensation. Symptoms are worse with ascending or descending stairs or other inclines. Entering and exiting an automobile is often difficult with accompanying pain, because the hip is in a flexed position along with twisting maneuvers. Dyspareunia is often an issue due to hip joint pain, commonly a problem among females, but may be a difficulty for males as well. Difficulty with shoes, socks, or hose may simply be due to pain or may reflect restricted rotational motion and more advanced hip joint involvement.

Based on the information obtained in the history, a preliminary differential diagnosis should be formulated. The history assists the examiner in performing an appropriately directed physical examination.

PHYSICAL EXAMINATION

The information obtained in the history is just a screening tool. The history helps direct the examination, but should not unduly prejudice the approach. The examiner must be systematic and thorough to avoid potential pitfalls and missed diagnoses. In reference to examination of the hip, Otto Aufranc noted that “more is missed by not looking than by not knowing.”

Inspection

The most important aspect of inspection is stance and gait. The patient’s posture is observed in both the standing and seated position. Any splinting or protective maneuvers used to alleviate stresses on the hip joint are noted. While standing, a slightly flexed position of the involved hip and concomitantly the ipsilateral knee is common (Figure 1). In the seated position, slouching or listing to the uninvolved side avoids extremes of flexion. (Figure 2).

An antalgic gait is often present, but dependent on the severity of symptoms. Typically, the stance phase is shortened and hip flexion appears accentuated as extension is avoided during this phase. Varying degrees of abductor lurch may be present as the patient attempts to place the center of gravity over the hip, reducing the forces on the joint. In addition, observation is made for any asymmetry, gross atrophy, spinal alignment, or pelvic obliquity that may be fixed or associated with a gross limb length discrepancy.

<table>
<thead>
<tr>
<th>TABLE 1: Characteristic Hip Symptoms (reprinted with permission)</th>
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<td>• Symptoms worse with activities</td>
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<td>• Twisting, such as turning or changing directions</td>
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<tr>
<td>• Seated position may be uncomfortable, especially with hip flexion</td>
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<tr>
<td>• Rising from seated position often painful (catching)</td>
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<tr>
<td>• Difficulty ascending and descending stairs</td>
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<tr>
<td>• Symptoms with entering/exiting an automobile</td>
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<tr>
<td>• Dyspareunia</td>
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<td>• Difficulty with shoes, socks, hose, etc.</td>
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Figure 1. During stance, the patient with an irritated hip will tend to stand with the joint slightly flexed. Consequently, the knee will be slightly flexed as well. This combined position of slight flexion creates an effective leg length discrepancy. To avoid dropping the pelvis on the affected side, the patient will tend to rise slightly on his or her toes. (Reprinted with permission.)

Figure 2. In the seated position, slouching and listing to the uninvolved side allows the hip to seek a slightly less flexed position. This position is usually combined with slight abduction and external rotation, which relaxes the capsule. (Reprinted with permission.)
Measurements

Certain measurements should be recorded as a routine part of the assessment. Limb lengths should be measured from the anterior superior iliac spine to the medial malleolus (Figure 3). Significant limb length discrepancies (greater than 1.5cm) may be associated with a variety of chronic conditions. Typically, if limb length difference appears to be a contributing factor, half of the recorded discrepancy should be corrected in the course of conservative treatment. Treatment with an insert is cosmetically more acceptable than a built-up shoe.

Thigh circumference, while a crude measurement, may reflect chronic conditions and muscle atrophy (Figure 4). It is important to measure the involved compared with the uninvolved side. Sequential measurement on subsequent examination may be helpful as an indicator of response to therapy. Again, circumference is a crude measure that only indirectly reflects hip function, but hip disease conversely usually affects the entire lower extremity.

Range of motion of the hip should be accurately recorded in a consistent and reproducible fashion. While reduced range of motion itself is rarely an indication for arthroscopic intervention, decreased range is often a good indicator of the extent of disease and response to treatment.

The degree of flexion and the presence of a flexion contracture are determined by using the Thomas test. Maximal extension of the uninvolved hip stabilizes the pelvis, eliminating the contribution of pelvic tilt in recording flexion of the involved hip. Conversely, maximal flexion of the uninvolved hip locks the pelvis and allows assessment for a flexion contracture of the involved hip. Extension is recorded with the patient in the prone position, raising the leg.

Several effective mechanisms exist for recording rotational motion of the hip. It is important to select one and be consistent. Flexing the hip 90° and then internally

Figure 3. Leg lengths are measured from the anterior superior iliac spine to the medial malleolus. (Reprinted with permission J. W. Thomas Byrd, M.D.)

Figure 4. Thigh circumference should be measured at a fixed position, both for consistancy of measurement of the affected and unaffected limbs, and for consistancy of measurement on subsequent examinations. A. A tape measure is placed from the anterior superior iliac spine (ASIS) toward the center of the patella. B. A selected distance below the anterior superior iliac spine is marked (typically 18cm). C. Thigh circumference is then recorded at this fixed position. (Reprinted with permission)
may ensure physiological harmony among the various structures, it also explains why muscle spasms and cutaneous sensations may accompany joint irritation.

Classic mechanical hip pain is described as being anterior, typically emanating from the groin area. The hip joint receives innervation from branches of L2 to S1 of the lumbosacral plexus, predominantly L3. Consequently, hip symptoms may be referred to the L3 dermatome, explaining the presence of symptoms referred to the anterior and medial thigh, radiating distally to the level of the knee.

Intra-capsular hip pathology almost always has a component of anterior hip pain. A sensation of deep, lateral discomfort or posterior pain may be present, but usually only in conjunction with a predominant anterior component.

**Symptom Localization**

**The One Finger Rule**

Although this rule is not as accurate when applied to the hip than to other joints, such as the knee, it is still important to ask the patient to use one finger and point to the spot that hurts the worst. This pointing provides much useful information before beginning palpation by allowing the examiner to discern the point of maximal tenderness. Consequently, this area is reserved until last when performing the examination. This information forces the examiner to be more systematic, exploring uninvolved areas first, and enhances the patient's trust by not stimulating pain at the beginning of the examination.

Hilton's law states that “the same trunks of nerves whose branches supply the groups of muscles moving a joint furnish also a distribution of nerves to the skin over the insertion of the same muscles, and the interior of the joint receives its nerves from the same source.” While this quote...
Patrick or Faber test (flexion, abduction, external rotation)

Because of the position of the hand, this sign can be misinterpreted as indicating lateral pathology such as the iliotibial band or trochanteric bursitis, but quite characteristically, the patient is describing deep interior hip pain.

**Palpation**

Palpation is usually unrevealing as far as any specific areas of discomfort related to an intra-articular source of hip symptoms. Obviously, one must be familiar with the topographical and deep anatomy in order to correlate the structures being palpated. Aufranc noted that “a continuing study of anatomy marks the difference between good and expert ability.”

Palpation is used more to assess potential sources of hip-type pain, other than the joint itself. It is important to be systematic, palpating the lumbar spine, sacroiliac (SI) joints, ischium, iliac crest, lateral aspect of the greater trochanter and trochanteric bursa, muscle bellies, and even the pubic symphysis, each of which may elicit information regarding a potential source of hip symptoms.

**Muscle Strength**

Manual muscle testing is a crude measure of hip function but may elicit useful information. If injury to a specific muscle group is suspected, resisted contraction should reproduce localized symptoms.

Active range of motion and resisted active range of motion may also reproduce joint symptoms. However, when carefully interpreted, a distinction can be made between symptoms of a muscle strain and hip pain. This differentiation may be least clear with a strain of the hip flexors. In this situation, active hip flexion reproduces pain while passive flexion should not.

**Special Tests**

Special tests include those maneuvers used to define other sources of symptoms as well as those used to define symptoms localized to the hip. The examiner should also be aware of how tests for other sources might affect a painful hip.

The passive straight leg raise is important for assessing signs related to lumbar nerve root irritation (Figure 7). The test may also provoke local joint symptoms. The
pain localized to the SI joint and the hip is usually easy. The single most specific test for hip pain is log rolling of the hip back and forth (Figure 9). Log rolling moves only the femoral head in relation to the acetabulum and the surrounding capsule. No significant excursion or stress occurs on myotendinous structures or nerves. Absence of a positive log roll test does not preclude the hip as a source of symptoms, but its presence greatly raises the suspicion.

Figure 9. The log roll test is the single most specific test for hip pathology. With the patient supine, gently rolling the thigh internally (A) and externally (B) moves the articular surface of the femoral head in relation to the acetabulum, but does not stress any of the surrounding extra-articular structures. (Reprinted with permission J. W. Thomas Byrd, M.D.)

Forced flexion combined with internal rotation is a more sensitive maneuver which may elicit symptoms associated with even subtle hip pathology (Figure 10). This test is often referred to as an “impingement test” eliciting symptoms associated with femoro-acetabular impingement. However, this maneuver is usually uncomfortable with any irritable hip and is not specific for the nature of the pathology. An accompanying pop or click may be present, but it is more important to determine if this maneuver reproduces the type of hip pain that the patient experiences with activities. This maneuver may normally be uncomfortable, so it is important to compare the response on the symptomatic and asymptomatic sides. Alternatively, forced abduction with external rotation will sometimes produce symptoms (Figure 11).

Figure 10. Forced flexion combined with internal rotation is often very uncomfortable and will usually elicit symptoms associated with even subtle degrees of hip pathology. (Reprinted with permission J. W. Thomas Byrd, M.D.)

An active straight leg raise or straight leg raise against resistance often elicits hip symptoms (Figure 12). This maneuver generates a force of several times the body weight across the articular surfaces and actually can generate more force than walking.

Figure 11. Flexion combined with abduction and external rotation similarly is often uncomfortable and may reproduce catching type sensations associated with labral or chondral lesions. (Reprinted with permission J. W. Thomas Byrd, M.D.)

Figure 12. An active straight leg raise, or especially a leg raise against resistance, generates compressive forces of multiple times body weight across the hip joint. Consequently, this movement is often painful, especially when there is even a mild degree of underlying degenerative disease. (Reprinted with permission J. W. Thomas Byrd, M.D.)
The Trendelenburg test is used to assess for gross abductor weakness. This weakness may develop as a chronic condition secondary to joint disease or may represent a neuromuscular disorder. The patient stands on the affected leg and lifts the contralateral leg off of the ground. With adequate abductor strength the pelvis should remain level. With gross abductor weakness the pelvis drops towards the contralateral side (Figure 13).

Various maneuvers may create a click or popping sensation. This popping may reflect an unstable labral tear or chondral fragment. However, the origin of these clicks or pops is often unclear and do not uniformly reflect an intra-articular lesion.

Snapping of the iliopsoas tendon is a common incidental finding without clinical significance. However, the snapping can become painful and can be difficult to distinguish from an intra-articular problem. The snapping is sometimes subtle, better experienced by the patient than detected by the examiner; but is often quite prominent with a distinct audible component. The characteristic examination maneuver for creating the snap is bringing the hip from a flexed, abducted, externally rotated position into extension with internal rotation (Figure 14). The snapping occurs as the iliopsoas tendon transiently lodges on the anterior aspect of the hip capsule or pectineal eminence. Often this snapping is a dynamic process better demonstrated by the patient than can be elicited by the examiner. The maneuver performed by the patient can be variable in sitting, standing, or lying down; but the snapping invariably occurs when going from flexion to extension. It is important not to misinterpret snapping of the iliopsoas tendon as an intra-articular problem, but it is also likely that numerous intra-articular disorders get misdiagnosed as a “snapping hip syndrome.” For recalcitrant symptomatic snapping of the iliopsoas tendon, fluoroscopy with iliopsoas bursography and ultrasound can often substantiate the source. However, these studies may not be conclusive, therefore, the history and examination findings remain the most reliable clinical assessment tool.

Figure 13. The patient stands on the affected right leg, lifting the left leg off of the ground. With normal abductor strength, the pelvis should remain level. However, as illustrated here, with abductor weakness, the pelvis drops towards the contralateral side, reflecting a positive Trendelenburg test. (Reprinted with permission J. W. Thomas Byrd, M.D.)

Figure 14. A.B. Snapping of the iliopsoas tendon may be elicited as the hip is brought from a flexed, abducted, externally rotated position into extension with internal rotation. (Reprinted with permission J. W. Thomas Byrd, M.D.)
Snapping due to the iliotibial band is more easily distinguished from a hip joint disorder because of its lateral location. These patients frequently present with a sensation that their hip is subluxing or dislocating. The process is dynamic in that the patient can demonstrate much more vividly than can be detected by the examiner. The visual appearance is created by the tensor fascia lata flipping back and forth across the greater trochanter, and not instability of the hip. With the patient in the lateral position, the snapping may be created by flexing and extending the hip, moving the abductor mechanism across the greater trochanter (Figure 15). Ober testing to assess for tightness of the abductor mechanism can be performed by lowering the leg on the table.

Figure 15. With the patient on their side, snapping of the iliotibial band can sometimes be elicited with flexion and extension of the hip. The Ober test is performed by lowering the knee to the table, assessing for tightness of the abductor mechanism. (Reprinted with permission J. W. Thomas Byrd, M.D.)

Good generalizations exist regarding snapping hip syndromes. If you can hear it from across the room it is the iliopsoas tendon, and if you can see it from across the room it is the iliotibial band.

Athletic pubalgia occurs most often in male athletes. The symptoms emanate from the groin and the findings can be confused with a hip joint problem. This condition often co-exists with hip joint pathology in an athletic population. Diminished rotational motion of the hip is compensated by increased pelvic motion. This motion places more stress on the pelvic stabilizers and can result in soft tissue breakdown of the lower abdominal muscles, pelvic floor, and adductor origins. This condition is characterized by localized soft tissue tenderness to palpation on examination (Figure 16); and absence of discomfort with passive range of motion that would be observed in patients with hip joint pathology. Resisted sit ups, hip adduction, and sometimes hip flexion may also precipitate symptoms associated with this soft tissue disorder.

Figure 16. Tenderness to palpation reflects an extra-articular process which, among athletes, may commonly include athletic pubalgia. (Reprinted with permission J. W. Thomas Byrd, M.D.)

CONCLUSIONS
Historically, hip joint problems in athletes have been largely neglected. This neglect has been due to a combination of factors including poor assessment skills and, without interventional methods to address these problems, little incentive has existed to pursue an investigation. Arthroscopy has defined the existence of numerous intra-articular disorders that previously went undetected and untreated. This information has served to enhance clinical assessment skills and has stimulated advancements in investigative studies. Using a thoughtful approach and methodical examination techniques, most hip joint problems can be detected. A proper treatment strategy can then be implemented including the role of conservative measures and interventional methods based on an accurate diagnosis.

REFERENCES


ABSTRACT

Among people who participate in sports, extra-articular soft tissue injuries around the hip are common. The hamstring, quadriceps, adductor, and abductor muscle groups are often the site of soft tissue injury. Overlapping conditions make it difficult to identify the primary cause of hip pain and dysfunction. A proper evaluation and diagnosis of the impairment are crucial for the selection of interventions and quick return to play. The purpose of the clinical commentary is to present an evidence based stepwise progression in the evaluation and treatment of several common soft tissue injuries of the hip.

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Soft tissue injuries around the hip are common, particularly among people who participate in sports. The hip has four sets of strong muscles surrounding the joint: the hamstring sets posteriorly, quadriceps muscles anteriorly, adductor muscles medially, and abductors laterally. Each of these sets of muscles are often the site of soft tissue injury. The hamstring and quadriceps muscle groups are particularly at risk for muscle strains because they cross both the hip and knee joints. These muscles are also used for high-speed activities such as track and field events, football, basketball, ice hockey, and soccer.

**MUSCLE STRAINS**

The most common mechanism of injury for muscle strains in the hip area occur when a stretched muscle is forced to contract suddenly. A fall or direct blow to the muscle, overstretching, and overuse can tear muscle fibers, resulting in a strain. The risk of muscle strain increases if the patient has had a history of injury to the area, inadequate warm-up before exercising, or attempts to do too much too quickly. Strains may be mild, moderate, or severe depending on the extent of the injury. Pain over the injured muscle is the most common symptom of a hip strain. Contracting the muscle increases the pain level. Swelling may also be present, depending on the severity of the strain. A loss of strength in the muscle may also exist.

Evaluation of hip muscle strains can be challenging. A muscle that is painful during contraction and painful when stretched may be strained. Specific exercises or stretches which stress the involved muscle can help determine which muscle is injured. An X-ray may be used to rule out the possibility of a stress fracture of the hip, which has similar symptoms, including pain in the groin area with weight bearing. In most cases, no additional tests are needed to confirm the diagnosis.

In general, treatment and rehabilitation are designed to relieve pain, restore range of motion, and restore strength – in that order. The use of RICE (rest, ice, compression, elevation) is the standard protocol for mild to moderate muscle strains. Gentle massage of the area with ice may help to decrease swelling. Non-steroidal anti-inflammatory drugs (NSAIDs) can be taken to reduce swelling and ease pain. Compression shorts or a wrap bandage may also be helpful in decreasing swelling and providing support. If walking causes pain, weight bearing should be limited and crutches should be considered for the first day or two after the injury.

**Adductor Muscle Strains**

The group of muscles along the inner thigh is referred to as the adductor muscle group. This group of six muscles includes the pectineus, adductor longus, adductor brevis, adductor magnus, gracilis, and obturator externus. All of the adductor muscles are innervated by the obturator nerve except for the pectineus, which gets its motor intervention from the femoral nerve. These muscles originate in the inguinal region at various points on the pubis. The muscles travel inferior to insert along the medial femur. The main action of this muscle group is to adduct the thigh in the open kinetic chain and stabilize the lower extremity to perturbation in the closed kinetic chain. Each individual muscle can also provide assistance in femoral flexion and rotation. The adductor longus is thought to be the most frequently injured adductor muscle. The lack of mechanical advantage may make the adductor muscles more susceptible to strain.

Adductor muscle strains can result in missed playing time for athletes in many sports. Adductor muscle strains are encountered more frequently in ice hockey and soccer. These sports require a strong eccentric contraction of the adductor musculature during competition. Adductor muscle strength has been linked to the incidence of adductor muscle strains. Specifically, the strength ratio of the adduction to abduction muscles groups has been identified as a risk factor in professional ice hockey players. Intervention programs can lower the incidence of adductor muscle strains but not avoid injury altogether. Therefore, proper injury treatment and rehabilitation must be implemented to limit the amount of missed playing time and avoid surgical intervention.

Symptoms of a groin strain include pain on palpation of the adductor tendons or the insertion on the pubic bone, or both, and groin pain during adduction against resistance. Groin strains, and muscle strains in general, are graded as a first degree strain if there is pain but minimal loss of strength and minimal restriction of motion. A second-degree strain is defined as tissue damage that compromises the strength of the muscle, but not including complete loss of strength and function. A third degree strain denotes complete disruption of the muscle tendon unit; including complete loss of function of the muscle. A thorough history and a physical examination is needed to differentiate groin strains from athletic pubalgia, osteitis pubis, hernia, hip-joint osteoarthritis, rectal or testicular referred pain, piriformis syndrome, or presence of a co-existing fracture of the pelvis or the lower extremi-
ties. Imaging studies can sometimes be useful to rule out other possible causes of inguinal pain.

The exact incidence of adductor muscle strains in sport is unknown – due, in part, to athletes playing through minor groin pain and the injury going unreported. In addition, overlapping diagnosis can also skew the exact incidence. Groin strains are among the most common injuries seen in ice hockey players, accounting for 10% of all injuries in elite Swedish ice hockey players. Furthermore, Molsa reported that groin strains accounted for 43% of all muscles strains in elite Finish ice hockey players. Tyler et al. published that the incidence of groin strains in a single National Hockey League team was 3.2 strains per 1000 player-game exposures. In a larger study of 26 National Hockey League teams, Emery et al. reported the incidence of adductor strains in the National Hockey League has increased over the last six years. The rate of injury was greatest during the preseason compared to regular and postseason play. Prospective soccer studies in Scandinavia have reported a groin strain incidence between 10 and 18 injuries per 100 soccer players. Ekstrand and Gillquist documented 32 groin strains in 180 male soccer players, representing 13% of all injuries over the course of one year. Adductor muscle strains, certainly, are not isolated to these two sports.

Risk Factors

Previous studies have shown an association between strength and flexibility and musculoskeletal strains in various athletic populations. Ekstrand and Gillquist found that preseason hip abduction range of motion was decreased in soccer players who subsequently sustained groin strains compared with uninjured players. This study is in contrast to the data published on professional ice hockey players that found no relationship between passive or active abduction range of motion (adductor flexibility) and adductor muscle strains.

Adductor muscle strength has been associated with a subsequent muscle strain. Tyler et al. found preseason hip adduction strength was 18% lower in NHL players who subsequently sustained groin strains compared with the uninjured players. The hip adduction to abduction strength ratio was also significantly different between the two groups. Adduction strength was 95% of abduction strength in the uninjured players but only 78% of abduction strength in the injured players. Additionally, in the players who sustained a groin strain, preseason adduction to abduction strength ratio was lower on the side which subsequently sustained a groin strain compared with the uninjured side. Adduction strength was 86% of abduction strength on the uninjured side but only 70% of abduction strength on the injured side. Conversely, another study on adductor strains on ice hockey players found no relationship between peak isometric adductor torque and the incidence of adductor strains. Unlike the previous study this study had multiple testers using a hand held dynamometer, which would increase the variability and decrease the likelihood of finding strength differences. However, results reported by Emery et al. demonstrated that players who practiced during the off season were less likely to sustain a groin injury as were rookies in the NHL. The final risk factor was the presence of a previous adductor strain. Tyler et al. also linked pre-existing injury as a risk factor, in their study four of the nine groin strains (44%) were recurrent injuries. This results is consistent with the results of Sward et al. who reported a 32% recurrence rate for groin strains in Australian rules football.

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<th>Adductor Strain Injury Prevention Program</th>
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<tbody>
<tr>
<td><strong>Warm-up</strong></td>
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<tr>
<td>• Bike</td>
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<td>• Adductor stretching</td>
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<td>• Sumo squats</td>
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<td>• Side lunges</td>
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<td>• Kneeling pelvic tilts</td>
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<td><strong>Strengthening program</strong></td>
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<tr>
<td>• Ball squeezes (legs bent to legs straight) with different ball sizes</td>
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<td>• Concentric adduction with weight against gravity</td>
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<tr>
<td>• Adduction in standing on cable column or elastic resistance</td>
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<td>• Seated adduction machine</td>
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<tr>
<td>• Standing with involved foot on sliding board moving in sagittal plane</td>
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<td>• Bilateral adduction on sliding board moving in frontal plane (i.e. bilateral adduction simultaneously)</td>
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<td>• Unilateral lunges with reciprocal arm movements</td>
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<td><strong>Sports specific training</strong></td>
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<td>• On ice kneeling adductor pull together</td>
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<td>• Standing resisted stride lengths on cable column to simulate skating</td>
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<td>• Slide skating</td>
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<td>• Cable column crossover pulls</td>
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<td><strong>Clinical Goal</strong></td>
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Prevention
Now that researchers can identify players at risk for a future adductor strain, the next step is to design an intervention program to address all risk factors. Tyler et al\textsuperscript{14} were able to demonstrate that a therapeutic intervention of strengthening the adductor muscle group could be an effective method for preventing adductor strains in professional ice hockey players. Prior to 2000 and 2001 seasons, professional ice hockey players were strength tested. Thirty-three of these 58 players were classified as “at risk” (which was defined as having an adduction to abduction strength ratio of less than 80%) and placed on an intervention program. The intervention program consisted of strengthening and functional exercises aimed at increasing adductor strength. (Table 1) The injuries were tracked over the course of the two seasons. Results indicated three adductor strains which all occurred in game situations. This gives an incidence of 0.71 adductor strains per 1,000 player game exposures. Adductor strains accounted for approximately 2% of all injuries. In contrast, 11 adductor strains and an incidence of 3.2 adductor strains per 1,000 player game exposures occurred in the previous two seasons prior to the intervention. In those prior two seasons adductor strains accounted for approximately 8% of all injuries. Injury rate after intervention was also significantly lower than the incidence reported by Lorentzon et al\textsuperscript{17} who found adductor strains to be 10% of all injuries. Of the three players who sustained adductor strains, none of the players had sustained a previous adductor strain on the same side. One player had bilateral adductor strains at different times during the first season. This data demonstrated that a therapeutic intervention of strengthening the adductor muscle group can be an effective method for preventing adductor strains in professional ice hockey players.

Rehabilitation
Despite the identification of risk factors and strengthening intervention for ice hockey players, adductor strains continue to occur in all sports.\textsuperscript{13} The high incidence of recurrent strains could be due to incomplete rehabilitation or inadequate time for complete tissue repair. Hömlich et al\textsuperscript{8} demonstrated that a passive physical therapy program of massage, stretching, and modalities was ineffective in treating chronic groin strains. By contrast, an 8-12 week active strengthening program consisting of progressive resistive adduction and abduction exercises, balance training, abdominal strengthening, and skating movements on a slide board proved more effective in treating chronic groin strains. An increased emphasis on strengthening exercises may reduce the recurrence rate of groin strains. An adductor muscle strain injury program, progressing the athlete through the phases of healing has been developed by Tyler et al\textsuperscript{14} and anecdotally seems to be effective. (Table 2) This type of treatment regime combines modalities and passive treatment immediately, followed by an active training program emphasizing eccentric resistive exercise. This method of rehabilitation program has been supported throughout the literature.\textsuperscript{9,13}

Sports Hernia
A sports hernia occurs when weakening of the muscles or tendons of the lower abdominal wall occur. This part of the abdomen is the same region where an inguinal hernia occurs, called the inguinal canal. When an inguinal hernia occurs, sufficient weakening of the abdominal wall exists to allow a pouch, the hernia, to be felt. In the case of a sports hernia, the problem is due to a weakening or tear in the abdominal wall muscles, but no palpable hernia exist.

The symptoms of a sports hernia are characterized by pain during sports movements, particularly twisting and turning during single limb stance. This pain usually radiates to the adductor muscle region and even the testicles, although it is often difficult for the patient to pin-point. Following sporting activity, the person with a sports hernia will be stiff and sore. The day after competition, mobility and practice will be difficult. Any exertion that increases intra-abdominal pressure, such as coughing or sneezing can cause pain. In the early stages, the patient may be able to continue playing their sport, but the problem usually gets progressively worse.

The diagnosis of a sports hernia is based on the patient’s history and clinical signs when all other causes are ruled out. Currently, no clinical special tests exist with a high degree of specificity to diagnose this pathology. In addition, an MRI is usually not helpful in further differentiation. Therefore, this pathology is a diagnosis of exclusion. Non-operative treatment usually involves a short period of rest followed by physical therapy focusing on abdominal strengthening which may temporarily alleviate the pain, but definitive treatment remains surgical repair and rehabilitation.

Hamstring Muscle Strain
The hamstrings are actually comprised of three separate
Table 2. Adductor Strain Post Injury Program

<table>
<thead>
<tr>
<th>Phase I (Acute)</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>• RICE (rest, ice, compression and elevation) for first ~48 hours after injury</td>
<td></td>
</tr>
<tr>
<td>• NSAIDs</td>
<td></td>
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<tr>
<td>• Massage</td>
<td></td>
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<tr>
<td>• TENS</td>
<td></td>
</tr>
<tr>
<td>• Ultrasound</td>
<td></td>
</tr>
<tr>
<td>• Submaximal isometric adduction with knees bent with knees straight progressing to maximal isometric adduction, pain free</td>
<td></td>
</tr>
<tr>
<td>• Hip passive range of motion (PROM) in pain-free range</td>
<td></td>
</tr>
<tr>
<td>• Nonweight-bearing hip progressive resistive exercises (PREs) without weight in anti-gravity position (all except abduction).</td>
<td></td>
</tr>
<tr>
<td>Pain-free, low load, high repetition exercise</td>
<td></td>
</tr>
<tr>
<td>• Upper body and trunk strengthening</td>
<td></td>
</tr>
<tr>
<td>• Contralateral lower extremity strengthening</td>
<td></td>
</tr>
<tr>
<td>• Flexibility program for noninvolved muscles</td>
<td></td>
</tr>
<tr>
<td>• Bilateral balance board</td>
<td></td>
</tr>
<tr>
<td><strong>Clinical Milestone</strong></td>
<td></td>
</tr>
<tr>
<td>• Concentric adduction against gravity without pain</td>
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</table>

<table>
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<tr>
<th>Phase II (Subacute)</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>• Bicycling/Swimming</td>
<td></td>
</tr>
<tr>
<td>• Sumo squats</td>
<td></td>
</tr>
<tr>
<td>• Single limb stance</td>
<td></td>
</tr>
<tr>
<td>• Concentric adduction with weight against gravity</td>
<td></td>
</tr>
<tr>
<td>• Standing with involved foot on sliding board moving in frontal plane</td>
<td></td>
</tr>
<tr>
<td>• Adduction in standing on cable column or elastic tubing</td>
<td></td>
</tr>
<tr>
<td>• Seated adduction machine</td>
<td></td>
</tr>
<tr>
<td>• Bilateral adduction on sliding board moving in frontal plane (i.e. bilateral adduction simultaneously)</td>
<td></td>
</tr>
<tr>
<td>• Unilateral lunges (sagittal) with reciprocal arm movements</td>
<td></td>
</tr>
<tr>
<td>• Multiplane trunk tilting</td>
<td></td>
</tr>
<tr>
<td>• Balance board squats with throwbacks</td>
<td></td>
</tr>
<tr>
<td>• General flexibility program</td>
<td></td>
</tr>
<tr>
<td><strong>Clinical Milestone</strong></td>
<td></td>
</tr>
<tr>
<td>• Involved lower extremity PROM equal to that of the uninvolved side and involved adductor strength at least 75% that of the ipsilateral abductors</td>
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<table>
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<tr>
<th>Phase III (Sports Specific Training)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>• Phase II exercises with increase in load, intensity, speed, and volume</td>
<td></td>
</tr>
<tr>
<td>• Standing resisted stride lengths on cable column to simulate skating</td>
<td></td>
</tr>
<tr>
<td>• Slide board</td>
<td></td>
</tr>
<tr>
<td>• On ice kneeling adductor pull togethers</td>
<td></td>
</tr>
<tr>
<td>• Lunges (in all planes)</td>
<td></td>
</tr>
<tr>
<td>• Correct or modify ice skating technique</td>
<td></td>
</tr>
<tr>
<td><strong>Clinical Milestone</strong></td>
<td></td>
</tr>
<tr>
<td>• Adduction strength at least 90-100% of the abduction strength and involved muscle strength equal to that of the contralateral side</td>
<td></td>
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</table>
muscles: the biceps femoris, semitendinosus and semimembranosus. These muscles originate just underneath the gluteus maximus on the pelvic bone and attach on the tibia. The hamstrings are primarily fast-twitch muscles, responding to low repetitions and powerful movements. The primary functions of the hamstrings are knee flexion and hip extension.

Hamstring muscle strains commonly result from a wide variety of sporting activities, particularly those requiring rapid acceleration and deceleration. An eccentric load to the muscle causes the majority of these injuries. Garrett demonstrated that, in young athletes, hamstring muscle strains typically involve myotendinous disruption of the proximal biceps femoris muscle. Other authors have also shown experimentally that the weak link of the muscle complex is the myotendinous junction. Although apophyseal fractures of the ischial tuberosity have been reported in young athletes, the majority of hamstring muscle strains are first and second degree strains.

Hamstring muscle strains are among the most common injuries in sports involving high-speed movement and physical contact. Hamstring strains are by far the most commonly seen muscle strains in Australian rules football with an incidence of 8.05 injuries per 1000 player-game-hours. Soccer players are also susceptible to hamstring strains with an incidence of 3.0 per 1000 player-game-hours for hamstring strains. Overall, any athlete who sprints as part of their sport may contribute to the incidence of hamstring strains.

Risk Factors
Factors causing hamstring muscle injury have been studied for many years. Age and previous injury were identified as the main risk factors for hamstring strains injury among elite football players from Iceland. It has been suggested that muscle weakness, strength imbalance, lack of flexibility, fatigue, inadequate warm-up, and dyssynergic contraction may predispose an athlete to a hamstring strain.

Fatigue has been implicated in the pathogenesis of muscle strain injury. Because muscle strains have been observed to occur either late in training or late in competitive matches, muscle fatigue has been indicated as a risk factor. Another study suggests that the injuries occur either early in games or training or late in games or training with inadequate warm-up and muscle fatigue, respectively, being the hypothesized reasons. However, little quantitative data exists to support these statements. Croisier suggests that the persistence of muscle weakness and imbalance may give rise to recurrent hamstring muscle injuries and pain. These authors feel that when there is insufficient eccentric braking capacity of the hamstring muscles compared with the concentric motor action of the quadriceps muscles, the muscle may be at risk for injury.

Ekstrand and Gillquist prospectively studied male Swedish soccer players and found hamstrings to be the muscle group most often injured. The authors noted that minor injuries increased the risk of having a more severe injury within two months. Others have noted a recurrence rate of 25% for hamstring injuries in intercollegiate football players.

Prevention
Most clinicians prescribe warm-up and stretching to help reduce the incidence of muscle strains. The evidence supporting this idea is weak and largely based on retrospective studies. In fact, following hamstring injury, the affected extremity and muscle group are significantly less flexible than the uninjured side, but no differences in isokinetic strength exist. However, Jonhagen et al found decreased flexibility and lower eccentric hamstring torques in runners who sustained a hamstring strain when compared with uninjured subjects matched for age and speed. The role of stretching and warm-up in injury prevention needs to be better understood so that optimal strategies can be developed.

Rehabilitation
No consensus exists for rehabilitation of the hamstring muscles after strain. However, a rehabilitation program consisting of progressive agility and trunk stabilization exercises has been shown to be more effective than a program emphasizing isolated hamstring stretching and strengthening in promoting return to sports and preventing injury recurrence in athletes suffering an acute hamstring strain. The aim of the physical therapy is to restore full pain free range of motion and strength throughout the range of motion. In addition, as a complement to the usual restoration of function, restoration of eccentric muscle strength and correction of agonist/antagonist imbalances in the rehabilitation process. We recommend the inclusion of eccentric exercises at an elongated position of the hamstring muscles,
sub-maximally, as soon as the patient can tolerate. The rationale is based on basic science animal research and imaging studies of human muscle tissue that have indicated incomplete healing following muscle strains. Fibrosis at the injury site is thought to be related to the risk of re-injury. Based on these observations, interventions aimed at remodeling the muscle tissue may be effective in reducing the risk associated with a history of a prior muscle strain. Eccentric muscle contractions have been shown to result in muscle-tendon junction remodeling in an animal model and more recently have been shown to cause intramuscular collagen remodeling in humans. Therefore, an eccentrically based training program for previously injured muscles could theoretically reduce recurrence rates and would be worth studying in future research.

Rehabilitation would start with relative rest and protection of the injured muscle phase lasting from 1 to 3 days. Returning to exercise in this stage can lead to re-injury and disruption of the healing tissue. Multigange isometrics should be initiated to properly align the regenerating muscle fibers and limit the extent of connective tissue fibrosis. Rest, ice, compression, and elevation, along with anti-inflammatory medication, is helpful during the immediate stages of treatment. Heat, electrical stimulation, and ultrasound modalities can also be used in conjunction with each other during the rehabilitation program to facilitate a return to competition. Heat is effective at increasing tissue temperature prior to stretching and exercise. Electric stimulation can be used to control edema and pain. Ultrasound is used as a deep-heating agent during the subacute phase to decrease spasm and prevent soft-tissue shortening.

An effective strengthening program should treat the hamstrings as a two-joint muscle and focus on concentric and eccentric contractions. Although lack of flexibility has been identified as a factor leading to hamstring injuries, the effectiveness of pre-exercise muscle stretching in reducing injuries has recently been questioned. In fact, Worrell et al cites decreased strength and power up to one hour following passive stretching. In theory, this decrease in force production is thought to result from the relaxation of the muscle tendon unit. Therefore, prior to athletic competition, a general warm-up (jogging, cycling) to increase tissue temperature, followed by dynamic stretching that includes sports-specific movements is recommended. Examples of dynamic stretches for the legs include forward or backward lunges, high-knee marching, and straight-leg kicks. Static stretching should be performed after the athletic activity.

**Quadriceps Muscle Strain**

The quadriceps is a group of four muscles that sit on the anterior aspect of the thigh: the vastus medialis, intermedius and lateralis, and rectus femoris. The quadriceps attaches to the front of the tibia via the patella tendon and originate at the top of the femur. The exception is the rectus femoris which actually crosses the hip joint and originates on the pelvis. The function of the quadriceps, as a whole, is to extend the knee. The rectus femoris functions to extend the knee but also acts as a hip flexor because the muscle crosses the hip joint. Any of these muscles can strain (or tear), but probably the most common is the rectus femoris. The grading system is the same as the adductor strains. A grade III tear is felt as an abrupt, sudden, acute pain that occurs during activity (often while sprinting). The injury may be accompanied by swelling or bruises on the thigh. The rehabilitation of quadriceps strains follow the same principles as the rehabilitation process of adductors and hamstring muscle strains.

**Hip Bursitis**

Bursae are lined with synovium and are synovial fluid filled sacs that exist normally at sites of friction between tendons and bone as well as between these structures and the overlying skin. A bursae is analogous to filling a balloon with oil and rubbing it between your fingers. The purpose of the bursae is to dissipate friction caused by two or more structures moving against one another. The development of a bursitis is the product of one of two mechanisms. The most common mechanism is inflammation secondary to excessive friction or shear forces as a result of overuse. Post-traumatic bursitis is the other mechanism and stems from direct blows and contusions that cause bleeding in the bursae with resultant inflammation. The three major bursae around the hip joint that are susceptible to bursitis are the iliopsoas bursae, ischial bursae, and the greater trochanteric bursae.

**Trocanteric Bursitis**

The greater trochanteric bursae lies between the gluteus maximus, tensor fascia lata (TFL), and the surface of the greater trochanter. Its location on the lateral aspect of the hip exposes it to contact injuries in sports such as football, soccer, and ice hockey. More commonly, trochanteric bursitis is seen in the clinic as an overuse injury found in
runners, bike riders, and cross-country skiers. The problem may also be found in individuals with an increased Q-angle, prominent trochanters, or a leg-length discrepancy. Repetitive motion of hip flexion and extension on an excessively compressed bursae can give rise to irritation and inflammation. This problem can occur with tightness in tissues around the hip, for example the iliotibial band (ITB) pulling across the hip or hip adductors bringing the thigh into a more midline position. Poor running mechanics or continuous running on banked surfaces that brings the lower extremity into an increased adducted position can also cause undue pressure at the hip.

Signs and symptoms of trochanteric bursitis include warmth and reported pain at the greater trochanter region of the hip. Pain with hip abduction resistance, palpable tenderness at lateral hip, pain with gait, and possible swelling or ecchymosis at the surface of the greater trochanter, as well as pain with lying on affected side may be present.

Intervention begins by taking a thorough history from the patient to determine activity level, length of onset, or mechanism of possible traumatic incident. Examination is then performed to check for range of motion (ROM), tenderness, tightness, and weakness in surrounding soft tissue structures. It is necessary to analyze gait and stair patterns as well as possibly analyzing running mechanics if subjective complaints warrant.

Initial home rehabilitation for the individual will consist of rest, ice, and NSAIDs. Clinical treatment will emphasize modalities for inflammation (i.e ultrasound), stretching of appropriate structures such as the IT band and adductors, as well as slow integration into progressive resistive exercises for encompassing hip musculature. If the underlying cause is due to a leg-length discrepancy, the problem should be corrected with the appropriate device. Upon normalization of ROM and flexibility, a gradual return to sport specific activities should be implemented. Full return to sports should emphasize prevention with a regular stretching program or appropriate padding for traumatic injuries.

Ishial Bursitis
While uncommon, ischial bursitis may occur as a complication of an injury to the hamstring insertion into the ischial tuberosity such as a direct trauma, fall, or hit. The symptoms include pain while sitting and localized tenderness. It is important to distinguish this bursitis from a hamstring tear at the origin. Initial treatment consists of rest, ice, and NSAIDs. A sitting cushion may be utilized as needed. General stretching of the hamstrings and progressive resistant exercises are implemented as pain subsides.

Iliopsoas (Iliopectineal) Bursitis
Iliopsoas (iliopectineal) bursitis is most often due to excessive activity, possibly due to irritation by the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the iliopsoas muscle passing over the 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perform a biomechanical assessment. The information gathered in this portion of the examination can be used to guide specific elements of the treatment program. Muscle-tendon length and strength, joint mobility testing, and palpation of the injured area are key to a proper examination. Biomechanical assessment of the patient includes both static (posture) and dynamic (gait/functional movement) elements. Particular areas of attention during the examination include observation of genu recurvatum, knee flexion contracture, overpronation of the foot, hip flexion contracture, and the amount of internal or external rotation present in the lower extremity during static stance. Also take note of leg length. Gait analysis allows the clinician to confirm the findings of static examination and to observe if a movement dysfunction is present. Functional movements (eg, squatting, stair ascent/descent) may further demonstrate to the clinician the severity of the movement dysfunction.46

Once identification of contributing factors has been completed, treatment can be directed toward those factors. Intervention during the acute phase consists of standard anti-inflammatory care and the elimination of activities that exacerbate symptoms. Physical therapy modalities (eg, ice, ultrasound, electrical stimulation, iontophoresis) may be used during this time.40,41 Activity modification depends on the severity of the pathology. Crutches may be used in severe cases, while simply decreasing the time and intensity of the aggravating activity is commonly used in less acute cases. Muscle weakness and tightness in the thigh or pelvis is addressed with a strengthening and stretching program. Overpronation may require a foot orthotic to assist with foot stabilization. Leg length deformities commonly require a lift in the shoe to assist with balancing the entire lower extremity. For those patients with a symptomatic snapping hip and trochanteric bursitis unresponsive to conservative therapy, a surgical procedure has been described as an effective method of treatment in this specific population.47

**CONCLUSION**

In conclusion, proper treatment of soft tissue injuries of the hip starts with a thorough evaluation of the entire kinetic chain. Often, overlapping conditions exist around the hip joint making it difficult to identify the primary cause of the hip pain and dysfunction. Once a diagnosis has been made, an evidence based stepwise progression as outlined in this paper is paramount for returning the athlete to the playing field quickly and safely.

**REFERENCES**


ABSTRACT

Sports related injuries to the hip have received relatively little attention, in the part because the clinical assessment, imaging studies, and surgical techniques are less sophisticated. The evolution of hip arthroscopy has offered a less invasive technique that allows for recognition and treatment of hip pathologies that previously went unrecognized. The success of hip arthroscopy is dependent on proper patient selection based on the patient’s history and diagnosis. The purpose of this clinical commentary is to outline mechanisms of injury and specific lesions that can be addresses using hip arthroscopy.

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INTRODUCTION
Sports related injuries to the hip joint have received relatively little attention. This trend is changing but, until recently, few publications exist in peer reviewed journals and the topic has rarely been presented at scientific meetings. This lack of attention is due to three reasons. First, perhaps hip injuries are less common than other joints. Secondly, investigative skills for the hip have been less sophisticated, including clinical assessment and imaging studies. Thirdly, fewer interventional methods are available to treat the hip including both surgical techniques and conservative modalities and, thus, little impetus exists to delve into this unrecognized area.

The evolution of arthroscopy has been intimately tied to sports medicine. The motivating principle has been a less invasive technique that facilitates quicker return to unrestricted athletics. It is now recognized that this basic sports medicine principle applies well to all individuals, whether the goal is to accomplish an earlier return to the workplace or simply a return to normal daily activities. However, hip arthroscopy has followed a distinctly different route. It began as a surgical alternative to only a few recognized forms of hip pathology. These pathologies included removal of loose bodies that could otherwise only be addressed by an extensive arthrotomy and arthroscopic debridement for degenerative arthritis in an effort to postpone the need for hip arthroplasty. 

Neither of these early indications found much application in an athletic population. However, as the basic methods of hip arthroscopy were developed, arthroscopy became an option for select cases of unexplained hip pain. Arthroscopy revealed numerous intra-articular sources of disabling hip symptoms that were previously unrecognized but are potentially amenable to arthroscopic intervention. These pathologies include tearing of the acetabular labrum, traumatic injury to the articular surface, and damage to the ligamentum teres, among others.

The indications for hip arthroscopy fall into two broad categories. In one category, arthroscopy offers an alternative to traditional open techniques previously employed for recognized forms of hip pathology such as loose bodies or impinging osteophytes. In the second category, arthroscopy offers a method of treatment for disorders that previously went unrecognized including labral tears, chondral injuries, and disruption of the ligamentum teres. Most athletic injuries fall into this latter category. In the past, athletes were simply resigned to living within the constraints of their symptoms, often ending their competitive careers, diagnosed as a chronic groin injury. Based on the results of arthroscopy among athletes, it is likely that many of these careers could have been resurrected with arthroscopic intervention.

MECHANISM OF INJURY
The mechanism of injury can be as varied as the sports in which athletes participate. In general, hip disorders attributable to a significant episode of trauma tend to respond better to arthroscopy. This positive response is because, other than the damage due to trauma, the athlete usually has an otherwise healthy joint. Insidious onset of symptoms usually suggests either underlying disease or some predisposition to injury that cannot be fully reversed and may leave the joint vulnerable to further deterioration in the future. Therefore, individuals who simply develop progressive onset of symptoms in absence of injury tend to experience a less complete response. Even an acute injury such as a twisting episode, which is known to cause a tear of the acetabular labrum, may be more likely if the labrum is vulnerable to injury and may represent a less certain response to surgery. This vulnerability can be due to abnormal labral morphology or underlying degeneration.

However, these broad generalizations must be tempered in the competitive athlete. Individuals who participate in contact and collision sports simply may not be able to recount which traumatic episode led to the onset of symptoms. Remember that significant intra-articular damage can occur from an episode without the athlete developing incapacitating pain. The athlete may be able to continue to compete and subsequently undergo work-up only when symptoms fail to resolve. Injury can occur from any contact or collision sport or sports involving forceful or repetitive twisting of the hip. The aging joint may also be more vulnerable. These parameters do not exclude many sports.

A particular entity that has been identified associated with acute chondral damage is a lateral impact injury to the area of the trochanter (Figure 1). Because young adult males are more apt to be participating in contact and col-
collision activities where this mechanism is frequent, this injury is most commonly encountered in this population. With good body conditioning and little adipose tissue overlying the trochanter, much of the force of the blow is delivered directly to the bone. This force is then transferred, unchecked, into the hip joint, resulting in either shearing of the articular surface on the medial aspect of the femoral head at the tide mark, or compression of the articular surface on the superior medial acetabulum, exceeding its structural threshold. The result is a full thickness articular fragment from the femoral head or articular surface breakdown of the acetabulum, possibly with loose bodies, depending on the magnitude of acetabular chondral, or chondro-osseous cell death (Figures 2 and 3). This mechanism is dependent on peak bone density as otherwise the force would result in fracture rather than delivery of the energy to the surface of the joint. The injury usually results in immediate onset of symptoms but may not be disabling. The problem may be assessed as a groin pull, with work-up ensuing only when symptoms persist.

Ice hockey is a sport with a particularly high prevalence of hip pathology. Hip flexibility is a premium consideration in this sport. The joint is subjected to violent and repetitive torsional maneuvers and is also subjected to relatively high velocity impact loading. Thus, the labrum is susceptible to tearing from the twisting maneuvers while the articular surface is vulnerable to impact injury. Often, acute episodes are simply superimposed on the cumulative effect of years of exposure (Figure 4).

Golf is another illustrative sport that seems to have a predilection for precipitating hip symptoms. It is not a contact or collision sport, but the golf swing does incorporate a significant element of twisting of the hip joint. Additionally, golf is a sport where participants can compete with advancing age, even at the professional level. Thus, there is a greater susceptibility to injury of an aging hip as well as the cumulative effect of repetitive trauma over a prolonged career. Tennis shares many of these same attributes.
Figure 3. **A.** AP radiograph left hip unremarkable. **B.** Radionuclide scan reveals increased activity, left hip. **C.** MRI remarkable for pronounced asymmetric effusion, left hip. **D.** CT coronal reconstruction demonstrates loose bodies. **E.** Follow-up radiograph 13 months post-injury reveals secondary changes with superolateral osteophyte formation on the femoral head. **F.** Loose bodies are evident (*) originating from the acetabulum. Scoring of the femoral head is also evident (arrow) due to third body wear. (Reprinted with permission J.W. Thomas Byrd, M.D.)

Figure 4. Three NHL hockey players were referred, each with a two week history of hip pain following an injury on the ice. Each case demonstrated MRI evidence of labral pathology (arrows). These cases were treated with two weeks of rest followed by a two week period of gradually resuming activities. Each of these athletes was able to return to competition and have continued to play for several seasons without needing surgery. **A.** Coronal image of a left hip demonstrates a lateral labral tear (arrow). **B.** Coronal image of a right hip demonstrates a lateral labral tear (arrow). **C.** Sagittal image of a left hip demonstrates an anterior labral tear with associated paralabral cyst (arrow). (Reprinted with permission J.W. Thomas Byrd, M.D.)
Femoro-acetabular impingement (FAI) is a condition that warrants particular attention. Abnormal morphology of the joint can lead to labral and articular breakdown commonly encountered in active individuals (Figure 5). Two types of impingement exist. Pincer impingement occurs from a bony prominence of the anterior acetabulum that crushes the labrum when it is compressed against the proximal femur during hip flexion. Cam impingement is created by a non-spherical femoral head that engages against the articular cartilage of the acetabulum during flexion and results in shear failure of the surface.

Pincer impingement is most common in females, especially as they approach middle age. Cam impingement is seen more frequently in young adult males. Cam impingement is also a cause of early onset osteoarthritis of men in their fifth and sixth decades. However, joint destruction is being observed among males in their second and third decades, accelerated by the intensity of competitive sports and activities.

Athletic pubalgia is characterized by a constellation of tendonopathy surrounding the insertion of the lower abdominal muscles, the origin of the hip adductors, and the pelvic floor. A significant correlation of FAI and athletic pubalgia in high demand athletes, predominantly male. Diminished hip range of motion is compensated by increasing pelvic motion, which overworks the pelvic stabilizers and results in tissue breakdown of the pelvic structures, culminating in athletic pubalgia. Clinically, difficulty exists in distinguishing the two conditions. The two conditions commonly co-exist, but can also occur separately.

Historically, rupture of the ligamentum teres is associated with hip dislocation. Although this injury can occur without dislocation, occurrence has been described only as

Figure 5. A. Normal joint morphology. B. Pincer lesion created by prominence of anterior acetabulum. C. Joint damage and pain is created by crushing of the labrum underneath the pincer lesion with hip flexion. D. Cam lesion is characterized by bony prominence of anterolateral femoral head/neck junction. E. Pathology and pain develops due to shearing of the acetabular articular surface by a bump during hip flexion. F. Combined pincer and cam impingement can occur. (Reprinted with permission J.W. Thomas Byrd, M.D.)
case reports.10-13 Disruption appears to be attributable to a twisting injury and is increasingly recognized as a source of intractable hip pain. In a review of 23 cases of traumatic injury to the ligamentum teres, 17 (74%) occurred without accompanying dislocation of the hip.14

PATIENT SELECTION
Successful hip arthroscopy is most clearly dependent on proper patient selection. A well-executed procedure will fail when performed for the wrong reasons. Patient expectation is paramount. The athlete should have reasonable goals and knows what can be accomplished with arthroscopy, which is only partially dictated by the nature of the pathology. Remember that much is not fully understood regarding the pathomechanics, pathoanatomy, and natural history of many of these lesions that are now being surgically addressed. However, an increasing amount of clinical experience exists upon which patients can be offered reasonable statistical data on likely outcomes.

Athletes are often set apart by their drive, discipline, and motivation as they push their bodies to their physiologic limits. However, the most uniquely challenging aspect of deciding on surgical intervention in this population is time constraints: How quickly does the surgeon decide to operate and how quickly will the patient recover? This decision is a year round issue, whether it is attempting to return for the current season, preparing for the upcoming season, or simply resuming the necessary off-season conditioning regimen. With the exception of loose bodies, no literature exists to suggest that harm is caused by not recommending early surgical intervention for most of the problems that are now being recognized.15 Most disorders will declare themselves over time through failure of response to conservative measures but unfortunately, for athletes, time is often not an ally.

Extra-articular injuries far outnumber intra-articular problems in the hip region. Thus, it is best to temper the interest to perform an extensive intra-articular work-up for every athlete with pain around the hip. However, in our study of athletes who underwent arthroscopy with documented pathology, the hip was not initially recognized as the source of symptoms in 60% of the cases. These athletes were managed for an average of seven months before the hip was considered as a potential contributing source.5 The most common preliminary diagnoses were various types of musculotendinous strains. Thus, it is prudent to at least consider possible intra-articular pathology in the differential diagnosis when managing a strain around the hip joint. Thoughtful follow-up and re-assessment is critical when these injuries do not respond as expected.

A careful history and examination will usually indicate whether the hip is the source of symptoms. Single plane activities such as straight ahead running are often well-tolerated while torsional and twisting maneuvers are more problematic in precipitating painful symptoms. Stairs and inclines may be more troublesome, and the same athlete who can run pain-free on level surfaces may have more difficulty running hills. Prolonged hip flexion such as sitting can be uncomfortable and catching symptoms are often experienced when rising from a seated or squatted position.

Hip symptoms are most commonly referred to the anterior groin and may radiate to the medial thigh. However, a very characteristic clinical feature which has been described is the “C-sign”16 A patient describing deep interior hip pain will grip their hand above the greater trochanter with their thumb lying posteriorly and the fingers cupped within the anterior groin. It may appear that they are describing lateral pain such as from the iliotibial band or trochanteric bursa, but characteristically, they are reflecting pain within the joint.

On examination, log rolling the leg back and forth is the most specific maneuver for hip pathology since this rotates only the femoral head in relation to the acetabulum and capsule and does not stress any of the surrounding neurovascular or musculotendinous structures. More sensitive examination maneuvers include forced flexion combined with internal rotation or abduction combined with external rotation. Sometimes these movements will produce an accompanying click, but it is more important to determine if these maneuvers reproduce the athlete’s pain.

For long-standing conditions, athletes may secondarily develop extra-articular symptoms of tendinitis or bursitis or may have a co-existent extra-articular pathology. A useful test for distinguishing the intra-articular origin of symptoms is a fluoroscopically guided intra-articular injection of anesthetic. The hallmark is temporary alleviation of symptoms during the anesthetic effect. With the more
recent technology of gadolinium arthrography (MRA) combined with magnetic resonance imaging (MRI), it is important that anesthetic be included with the injection to elicit this useful diagnostic response.\textsuperscript{17}

**SPECIFIC LESIONS**

Loose bodies represent the clearest indication for hip arthroscopy but are not a common problem among athletes (Figure 6).\textsuperscript{1} The work of Epstein et al\textsuperscript{15} has demonstrated the importance of removing loose bodies to prevent the secondary damage they can cause. Loose bodies can occur from trauma, disease such as synovial chondromatosis, or other disorder such as osteochondritis dissecans.\textsuperscript{1, 18-19} Recovery can be complete within weeks but depends on the amount of associated damage. Loose bodies can secondarily develop as a consequence of degenerative arthritis. In this setting, the results of loose body removal are not favorable because the degenerative disease cannot be corrected.

Labral lesions are the most common hip pathology, present in 61% of athletes undergoing arthroscopy.\textsuperscript{5} Labral debridement has resulted in 82% successful outcomes at 10 year follow-up when arthritis is not present (Figure 7).\textsuperscript{20}

![Figure 6](image)

**Figure 6.** A 20 year old male with a three month history of acute left hip pain. A. AP radiograph demonstrates findings consistent with old Legg-Calvé Perthes disease. B. Lateral view defines the presence of intraarticular loose bodies (arrows). C. CT scan substantiates the intraarticular location of the fragments (arrows). D. Arthroscopic view medially demonstrates the loose bodies. E. Viewing anteriorly, the anterior capsular incision is enlarged with an arthroscopic knife to facilitate removal of the fragments. F. One of the fragments is being retrieved. G. Loose bodies are able to be removed whole. (Reprinted with permission.\textsuperscript{3})
However, not all labral tears are the same with regards to etiology, associated pathology, treatment, and outcomes. Arthritis is a poor prognostic indicator, and various studies have demonstrated that articular damage is present in association with more than half of all labral tears. Often it is the extent of articular pathology that is the limiting factor as far as the success of arthroscopic intervention. Use of MRIs and MRAs are best at identifying labral lesions, but poor at demonstrating accompanying articular pathology. Thus, the uncertain presence of articular damage is often the “wild card” in predicting the outcome of arthroscopy and should temper the surgeon’s enthusiasm for predicting uniform success in the presence of imaging evidence of labral damage.

Imaging (MRI and MRA) evidence of labral pathology must be carefully interpreted. Studies have shown evidence of labral abnormality even among asymptomatic volunteers and labral degeneration occurs naturally as part of the aging process. It is uncertain whether labral tears will spontaneously heal, but observations have been made among athletes of tears that became clinically asymptomatic without surgery.

A common etiologic factor in the association of co-existent labral and articular pathology, may be FAI. Pincer impingement caused by an overhanging lip of bone from the acetabulum can be corrected by reshaping the acetabular rim. Cam impingement, the most common type among athletes, is corrected by contouring the bony prominence at the junction of the femoral head and neck to recreate the spherical shape of the femoral head.

Recovery from simple labral debridement can be as little as one to two months. Correcting impingement results in a more protracted recovery, partly because of the more extensive nature of the procedure, but also the severity of the joint damage is usually more extensive. The bone must be allowed to remodel for three months and return to competitive activities is anticipated at four to six months.

The severity of associated articular damage also influences the recovery. Full thickness Grade IV articular loss with exposed subchondral bone is best treated with microfracture. This surgery is used to stimulate a fibrocartilaginous healing response and requires protected weightbearing for the first two months post-op while the defect matures. This surgery is an imperfect solution, but offers 86% positive results and is presently the standard of the industry. Microfracture is a harbinger of a more prolonged recovery, not because of the procedure but because of the severity of the problem for which it is implemented.

Related to labral repair, the technology developed in the shoulder has been readily applied to the hip. However, labral function and pathogenesis of labral lesions in the hip is different and the understanding of which are amenable to repair is less clear. As the selection process improves, the results of labral repair will become more favorable. Recovery requires more time to protect the repair site.
Figure 8. A 23 year old elite professional tennis player sustained an injury to his right hip.  

A. Coronal MRI demonstrates evidence of labral pathology (arrow).  
B. Arthroscopy reveals the labral tear (arrows), but also an area of adjoining Grade IV articular loss (*).  
C. Microfracture of the exposed subchondral bone is performed.  
D. Occluding the inflow of fluid confirms vascular access through the areas of perforation. The athlete was maintained on a protected weight-bearing status emphasizing range of motion for 10 weeks with return to competition at three and a half months. (Reprinted with permission J.W. Thomas Byrd, M.D.)

Figure 9. A 16 year old high school football player develops acute onset of right hip pain doing squats.  

A. Sagittal image MR arthrogram demonstrates a macerated anterior labrum (arrows).  
B. Viewing from the anterolateral portal, a macerated tear of the anterior labrum is probed along with articular delamination at its junction with the labrum  
C. The damaged anterior labrum has been excised, revealing an overhanging lip of impinging bone from the anterior acetabulum.  
D. Excision of the impinging portion of the acetabulum (acetabuloplasty) is performed with a burr. (Reprinted with permission J.W. Thomas Byrd, M.D.)
Figure 10. A 20 year old hockey player with a four year history of right hip pain. 

A. AP radiograph is unremarkable. 

B. Frog lateral radiograph demonstrates a morphological variant with bony build up at the anterior femoral head/neck junction (arrow) characteristic of cam impingement. 

C. A 3D CT scan further defines the extent of the bony lesion (arrows). 

D. Viewing from the anterolateral portal, the probe introduced anteriorly displaces an area of articular delamination from the anterolateral acetabulum characteristic of the peel back phenomenon created by the bony lesion shearing the articular surface during hip flexion. 

E. Viewing from the peripheral compartment the bony lesion is identified (*) immediately below the free edge of the acetabular labrum (L). 

F. The lesion has been excised, recreating the normal concave relationship of the femoral head/neck junction immediately adjacent to the articular surface (arrows). Posteriorly, resection is limited to the mid portion of the lateral neck to avoid compromising blood supply to the femoral head from the lateral retinacular vessels. 

G. Post operative 3D CT scan illustrates the extent of bony resection. (Reprinted with permission J.W. Thomas Byrd, M.D.)
Injury to the ligamentum teres is the third most common problem encountered among athletes undergoing hip arthroscopy. The disrupted fibers catch within the joint and can be quite painful. Resection of these disrupted fibers has found remarkable success based on the magnitude of improvement with a 93% successful outcome (Figure 12).14

Clinical and radiographic evidence of arthritis is a poor prognostic indicator of the results of arthroscopy.2,21,33,34 Advanced disease with complete joint space loss is a contraindication because of uniformly unsuccessful results. Lesser disease may serve only as a relative contraindication depending on the goals of the procedure and the expectations of the athlete. For example, labral debridement or loose body removal in the presence of arthritis will not result in the same successful outcomes that have been reported for athletes in absence of arthritic changes. The expectations of the athlete must be more modest and practical. Otherwise, the procedure will be a failure by not accomplishing the desired outcome.

Hip instability can occur; but is much less common than instability in the shoulder. The primary reason is due to the inherent stability provided by the constrained ball and socket bony architecture of the hip joint. Also, the labrum is not as critical to stability of the hip as it is in the shoulder as no true capsulolabral complex exists. On the acetabular side, the capsule attaches directly to the bone, separate from the acetabular labrum.27 An entrapped labrum has been reported as a cause of an irreducible posterior dislocation and a Bankart type detachment of the posterior labrum has been identified as a cause of recurrent posterior instability.35,36 These circumstances have only rarely been reported, but may be recognized with increasing frequency as the understanding and intervention of hip injuries evolves.

**Figure 11.** A 37-year-old female with recalcitrant mechanical right hip pain. **A.** Sagittal MRA image demonstrates an anterior labral tear (arrow). **B.** Arthroscopy reveals a traumatic detachment of the anterior labrum (probe). **C.** An anchor has been placed with suture limbs passed in a mattress fashion through the detached labrum. **D.** The labrum has been re-approximated to the articular edge. **E.** Viewing the peripheral aspect of the labrum, demonstrates the suture on its capsular surface, avoiding contact with the articular surface of the femoral head. (Reprinted with permission J.W. Thomas Byrd, M.D.)
Instability may occur simply due to an incompetent capsule. This instability is seen in hyperlaxity states and less often encountered in athletics. The most common cause is a collagen vascular disorder such as Ehlers-Danlos syndrome. With normal joint geometry, thermal capsular shrinkage has been met with successful results (Figure 13). If subluxation or symptomatic instability is due to a dysplastic joint, it is likely that bony correction for containment is necessary to achieve stability.

Based on this author’s observations, posterior instability is associated with macrotrauma. Mechanisms of injury include dashboard injuries and axial loading of the flexed hip encountered in collision sports. Atraumatic instability, or instability due to repetitive microtrauma, is anterior and develops when the normally occurring anterior translation of the femoral head exceeds the physiologic threshold and becomes pathological. Symptoms may be due to primary instability, secondary intra-articular damage, or a combination of both.

**Figure 12.** A 16 year old cheerleader has a two year history of catching and locking of the left hip following a twisting injury. A. Arthroscopic view from the anterolateral portal reveals disruption of the ligamentum teres (*). B. Debridement is begun with a synovial resector introduced from the anterior portal. The acetabular attachment of the ligamentum teres in the posterior aspect of the fossa is addressed from the posterolateral portal. (A,B reprinted with permission J. W. Thomas Byrd, M.D. C reprinted with permission Byrd JWT, Jones KS14)

**Figure 13.** A 19 year old female had undergone two previous arthroscopic procedures on her right hip for reported lesions of the ligamentum teres. Following each procedure, she developed recurrent symptoms of “giving way.” A. Radiographs revealed normal joint geometry. B. She was noted to have severe diffuse physiologic laxity best characterized by a markedly positive sulcus sign. C. With objective evidence of laxity and subjective symptoms of instability, an arthroscopic thermal capsulorrhaphy was performed, accessing the redundant anterior capsule from the peripheral compartment. Modulation of the capsular response was controlled by a hip spica brace for eight weeks postoperatively with a successful outcome. (Reprinted with permission J.W. Thomas Byrd, M.D.)
In general, for properly selected cases, hip arthroscopy has a high rate of improvement, but does not always assure returning to the rigors of athletic activities. Among a heterogeneous group of athletes, 93% were improved, but only 76% returned to their sport symptom-free and unrestricted or at an increased level of performance. Eighteen percent either chose to not return or were unable to return to their primary sport. Among a group of elite athletes, 96% were improved, but only 85% were able to successfully return to their sport.

CONCLUSIONS

Hip joint problems in athletes may go unrecognized for a protracted period of time. With an increased awareness of intra-articular disorders, these problems are now being diagnosed earlier. However, understanding of the pathogenesis and natural history of many of these lesions is incomplete, and may influence the strategies of both surgical and conservative treatment. Nonetheless, arthroscopy has defined numerous sources of intra-articular hip pathology. In many cases, operative arthroscopy has been met with significant success. For some athletes, arthroscopy offers a distinct advantage over traditional open techniques, but for many, arthroscopy offers a method of treatment where none existed before.

REFERENCES


CLINICAL COMMENTARY

REHABILITATION AFTER ARTHROSCOPY OF AN ACETABULAR LABRAL TEAR

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ABSTRACT

Over the past few years, arthroscopy of the hip joint is becoming more common as a technique in both the diagnosis and treatment of hip pain. A frequent cause of hip and groin pain is a tear of the acetabular labrum. Patients with labral tears complain of pain in the groin region and pain with clicking in the hip without a history of pain prior to the original onset. Once a patient presents with signs and symptoms of hip pain that are greater than four weeks in conjunction with indicative findings of a labral tear by way of MRI, he or she may be considered a good candidate for arthroscopy of the hip joint. Little evidence exists in the current literature on rehabilitative procedures performed after arthroscopy of the acetabular labrum. The purpose of this clinical commentary is to suggest a rehabilitation protocol after acetabular labral debridement or repair.

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INTRODUCTION
Arthroscopy of the hip joint has become a common technique used over the past few years in both the diagnosis and treatment of hip pain. One of the more frequent diagnoses of hip and groin pain is a tear of the acetabular labrum. The most common etiology in patients with mechanical hip symptoms is the existence of a labral tear and can be related to intra-articular snapping hip syndrome up to 80% of the time. In 59 patients undergoing hip arthroscopy, 59% had a tear of the acetabular labrum. Likewise, a significant correlation exists between the tear and complaints of clicking and giving-way. In an athletic population, among eighteen patients presenting with a complaint of pain in the groin region, four (22%) were found to have a tear in the acetabular labrum. All of the patients with a tear reported pain with clicking in the hip, but did not have a history of pain prior to the original onset. In addition, of 45 professional athletes who presented with femoroacetabular impingement, all had a tear in the labrum. The presence of hip labral tears is also high in the general population. Of 100 patients (39±13 years of age) who presented with mechanical symptoms of pain, clicking, and locking in the hip, 66% were found to have labral tears.

The mechanism of injury for an acetabular labral tear often involves repetitive twisting, cutting, and pivoting movements in addition to repetitive flexion at the hip. However, the history of the mechanism associated with injury is not always apparent to the patient. Instead, patients will present with insidious complaints of groin pain and mechanical symptoms of clicking, locking, and giving way. Additional causes of acetabular labral tears may include femoral acetabular impingement, capsular laxity/joint hypermobility, hip dysplasia, and joint degeneration. The mechanism of femoral acetabular impingement occurs when the anterior superior portion of the labrum is pinched or squeezed by the edge of the acetabulum and the anterior neck of the femur. This type of mechanism is described as either cam or pincer. In cam, an abnormal femoral head is wedged against the acetabulum in motions such as forced or excessive flexion. On the other hand, pincer femoral acetabular impingement is the result of an irregular projection of the acetabular rim that contacts the head of the femur during movement.

Upon examination, the clinical characteristics of a tear in the acetabular labrum can vary. In 66 patients with a labral tear (confirmed arthroscopically) who were retrospectively examined, 61% had an insidious onset of symptoms while, 86% reported the symptoms as moderate to severe. Similarly, the most common location was in the groin, with either sharp or dull pain which was activity-related and included painful mechanical locking.

DIAGNOSIS
Because pain in the hip can arise from a variety of different sources, identification of a labral tear can be challenging and is often misdiagnosed. Using plain radiography is not always sufficient for identifying a labral tear. However, structural abnormalities of the hip such as a retroverted acetabulum or coxa valga have been found in a high percentage (87%) of those patients with labral tears. As these abnormalities are more closely scrutinized, earlier detection of a tear may be possible.

Acetabular labral tears are most reliably diagnosed arthroscopically. However, with the development of musculoskeletal imaging, correctly diagnosing a tear has become more manageable. Magnetic resonance imaging (MRI) and arthrography (MRA) are regularly used to evaluate and diagnose hip labral pathology. The MRI has been shown to accurately assess the presence of both hip labral and articular cartilage damage. Using MRI, labral pathologies were identified correctly in 94% and 95% of the cases respectively by two radiologists. Likewise, a high agreement exists between MRI and arthroscopy in the identification of chondral pathology. The MRA can provide an extension of MRI by allowing an in vivo image of the hip joint that can often be difficult to see secondary to the depth of the articulation. In fact, a significant correlation between the grade of cartilage loss with the grade of labral tear has been shown, causing the authors to suggest an MRA may be indicated if the presence of bone marrow edema is discovered with a routine MRI.

SURGICAL INTERVENTION
Once a patient presents with signs and symptoms of hip pain that are greater than four weeks in conjunction with indicative findings of a labral tear by way of MRI or MRA, he or she may be considered a good candidate for arthroscopy of the hip joint. Arthroscopic techniques for treating hip labral pathologies are becoming more routine in both adults and children. In the case of an acetabular labral lesion, surgical intervention may involve debridement or repair. Be aware, however, conditions such as acetabular dysplasia, femoral acetabular...
either the supine or lateral position. In the supine position, a standard fracture table is used with an oversized perineal post to apply traction. The affected hip is placed into slight extension and adduction to allow approach to the joint. Care is taken to minimize pressure in the perineal area as well as to carefully monitor the amount and duration of traction to avoid neurologic complications. The procedure is performed under the guidance of fluoroscopy. After an adequate amount of distraction is obtained, a 14 or 16 gauge spinal needle is inserted into the joint to break the vacuum seal and allow further distraction. Three portals are generally used, the anterolateral (which is established first), the anterior, and the distal lateral accessory or paratrochanteric portal.

After complete evaluation of the joint, including the articular cartilage surfaces of the acetabulum and femoral head, ligament fraying or tearing, and assessment of the posterior recess, any labral abnormality may then be addressed. Most labral tears occur in the anterior superior or quadrant of the acetabulum. Acute, longitudinal, and peripheral tears are most amenable to repair. For repair of a detached labrum, the edges of the tear are delineated and suture anchors are placed on the top of the acetabular rim in the area of detachment. Conversely, if the tear in the labrum has a secure outer rim and is still attached to the acetabulum, a suture in the midsubstance of the tear can be used to secure the tissue. Radial splits, significantly macerated or degenerative labral tissue, or labral tissue that appears unviable should be debrided. Not uncommonly, chondral lesions may be noted adjacent to labral pathology that may require either debridement, common microfracture, or other cartilage resurfacing techniques. The natural history of untreated labral tears is unknown. Recently, authors have attempted to correlate the presence of labral tears with the development of degenerative osteoarthritis of the hip joint. Although this correlation remains unclear, some observations suggest labral lesions may be a contributing factor to the evolution and progression of osteoarthritis. Although debridement may be successful from the standpoint of pain relief, the

surgery could potentially lead to joint load alteration and the progression of articular cartilage changes. In addition, alterations to the structure of the labrum, or disruption in the acetabular labral junction, may lead to the loss of the pressurized fluid film layer within the joint and uneven force distribution across the articular cartilage surfaces of the acetabulum and femoral head.

**REHABILITATION**

Little evidence exists in the current literature to support rehabilitative procedures performed after arthroscopy of the acetabular labrum. Likewise, because new surgical procedures are constantly evolving, it is the responsibility of the physical therapist to stay up to date with the most current techniques as well as to establish and maintain good communication with the orthopaedic surgeon.

Surgical techniques and outcomes have been reported in the literature with little or no attention to post-operative rehabilitation. Currently, the best evidence for post-operative rehabilitation is based upon surgeon and physical therapist experience. With a labral repair, the location and size of the tear should be noted. Most of these tears are located in the anterior or anterosuperior portion of the labrum; movements that stress this area should be avoided. However, communication with the surgeon about the location of the tear and surgical technique used is vital to the treating physical therapist.

Rehabilitation protocols following acetabular labral debridement (Table 1) or repair (Table 2) can be divided into four phases. The progression with both procedures is similar with the exception of differences which are noted within the protocol. Exercise, and particularly strengthening, progression in a repair of the labrum may be delayed by a few weeks depending upon tissue healing. The timelines for each phase are based on clinical findings and presentations of active, healthy individuals. If clinical presentation meets objective criteria an athlete may move through the phases at a faster rate, always keeping basic tissue healing physiology in mind.

**Phase I – Initial Exercises. Weeks 1 to 4.**

The primary goals immediately following acetabular labral debridement or repair are to minimize pain and inflammation, protect the surgically repaired tissue, and initiate early motion exercises. Patients are typically 50% weight-bearing for 7 to 10 days progressing to weight-bearing as tolerated. For a labral repair, the weight-bearing restrictions include toe-touch weight bearing for 3 weeks,
Table 1:

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*Courtesy of Proaxis Therapy, Spartanburg/Greenville, SC; used with permission.*
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<td>Involved knee to chest, adductor stretch</td>
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<td>Side stepping with abductor band</td>
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Courtesy of Proaxis Therapy, Spartanburg/Greenville, SC; used with permission.
but may last up to 6 weeks depending upon the progression of healing and pain level of the patient. If the surgery involved additional procedures to the hip such as a microfracture, the weight-bearing restrictions can increase to 6 more weeks. However, for purposes of this paper, labral debridement and repair will be the main focus.

It is important to maintain a symmetrical gait pattern to prevent concomitant stress throughout the lower extremity and spine. If this gait pattern is not established, a muscular imbalance of tight hip flexors and erector spinae with inhibition of the gluteals and abdominals (lower crossed syndrome) could develop. The potential ramifications include increased weight-bearing through the acetabulum with labral tissue stresses secondary to hip flexor tightness. Consequently, continued crutch use may be a necessary prophylactic. Similarly, the patient should be instructed to control the hip in all three planes of motion. Decreased core and hip strength have been implicated in alterations of lower extremity alignment during functional activities. Also, hip abductor strength has been shown to be a predictor of frontal plane motion in the knee while weak hip extendors can lead to quadriceps overuse and increased compression and shear force at the knee. A correlation between weakness in the hip and core and lower extremity injuries has been established. Thus, when these studies are considered together, the suggestion is that rehabilitation of the hip should include a component of hip and core strengthening in each phase.

Aquatic therapy is an excellent resource, if available, once surgical incisions are well-healed. Ambulation in the water allows for improvements in gait by allowing appropriate loads to the joint while minimizing unnecessary stresses to the healing tissue. Light jogging in the water using a flotation device may begin as early as 2-3 weeks if pain is not an issue. Range of motion (ROM) precautions may vary, but typically include limiting flexion beyond 90° for 10 days to avoid undue compression of the anterior labrum. If treating a labral repair, in addition to the 90° of flexion, the patient is limited to 25° of abduction and 10° of extension for 10 days to 2 weeks. An emphasis should be placed on manual therapy for pain reduction and improvements in joint mobility and proprioception. Considerations include gentle hip joint mobilizations, contract-relax stretching for internal and external rotation, long axis distraction, and assessment of lumbo-sacral mobility. Particular attention should be paid to the posterolateral soft tissue structures and the lumbo-sacral spine (as each can contribute to pain) and unnecessary hypomobility which will limit progress in future phases.

Modalities for pain control such as immediate postoperative transcutaneous electrical nerve stimulation (TENS) units (preferably applied in recovery room (based on clinical experiences of the authors)), cryotherapy, and appropriate pain management through medication are important, as well. Cautious and gentle stretching of hip muscle groups including piriformis, psoas, quadriceps, and hamstring muscles should begin with hip passive range of motion exercises, respecting the patient’s pain threshold. The risk of tissue damage must be considered, and the patient should provide verbal feedback following mobilization and ROM exercises. Prone lying for 1 to 2 hours per day and passive ROM exercises emphasizing internal rotation are beneficial to prevent adhesions. Stationary bike begins with no resistance and gradually progresses in resistance over the first 4 weeks with a seat height that limits hip flexion to less than 90°.

Strengthening in Phase I initially consists of isometric contractions for the hip adductors, abductors, extensors, and transverse abdominals, but progresses to straight leg raises for abduction, adduction, and extension. To prevent irritation of the psoas muscle, hip flexion straight leg raise is not performed early on. Seated hip flexion using a short lever arm might be an alternative. For labral debridement, closed-chain activities of low-level leg press or shuttle can also begin with limited resistance. This type of exercise allows weight-bearing through the lower extremity joints with the application of appropriate stresses to the tissue.

Criteria to progress from Phase I to Phase II require ROM of greater than or equal to 75% of the uninvolved side and the ability to demonstrate a sidelying straight leg raise (Figure 1) using the gluteus medius muscle. This straight

Figure 1: Sidelying straight leg raise.
let raise should be performed without compensation from the tensor fascia lata and quadratus lumborum.

**Phase II – Intermediate Exercises. Weeks 5-7.**
The primary focus of the second phase is to continue progressing ROM and soft tissue flexibility while beginning to transition the emphasis to strengthening. Manual therapy should continue with mobilization becoming more aggressive, as appropriate. If capsular laxity was thought to be a contributing factor to developing labral pathology, normal mobility (but not hypermobility) should be achieved. Flexibility exercises involving the piriformis, adductor group, and psoas/rectus femoris should continue. The kneeling hip flexor stretch (Figure 2) can be particularly beneficial for psoas and rectus femoris once tolerated in this phase of rehabilitation. Passive ROM exercises should become more aggressive, as needed, for internal and external rotation.

![Figure 2: Kneeling hip flexor stretch.](image)

Strengthening of the hip and core musculature progresses ensuring the patient can dissociate pelvic movements and avoid muscular compensations. The strength goal is to build an endurance base prior to progressing to more advanced exercises. Patients can begin to add gradual resistance to the bike and use the elliptical machine, as tolerated, for cardiovascular endurance. Other examples of Phase II exercises include seated resisted internal (Figure 3) and external rotation, 1/3 knee bends progressing to wall sits with an abductor band for resistance (Figure 4), sidestepping with an abductor band for resistance, and core strengthening such as bridging on two legs progressing to single-leg bridging (Figure 5). Patients can return to non-competitive free-style swimming at week 5, as symptoms allow. Criteria to progress to Phase III are a normal gait pattern with no Trendelenburg sign. In addition, the patient should have symmetrical and passive ROM measurements with minimal complaints of pain.

![Figure 3: Resisted internal rotation – sitting.](image)

![Figure 4: Wall squats with abductor band for resistance.](image)

![Figure 5: Single leg bridging.](image)
Phase III – Advanced Exercises. Weeks 8-12.
The primary objectives for Phase III are for the patient to have symmetrical ROM and begin integrated functional strengthening. Manual therapy should be performed as needed. Flexibility and passive ROM interventions should become slightly more aggressive if limitations persist. If full ROM or flexibility has not been attained at week 10, terminal stretches should be initiated, and moderate pain with stretching becomes acceptable.

Strengthening exercises should now incorporate multi-planar movements involving multiple muscles groups. Single leg activities challenging proprioception and strengthening of the hip muscles in a functional position should be performed. Examples of Phase III exercises include standing resisted hip external rotation (Figure 6), walking lunges, lunges with trunk rotation, plyometric bounding in the water, resisted sportcord walking forward/backward/sideways, and a progressive exercise ball program for advanced core strengthening. Core strengthening is an essential component to successful rehabilitation of athletes with hip pathology. As the progression to running and agility drills nears in the latter stages of the phase, athletes should be repetitively instructed on the importance of shock absorption and eccentric control during functional training. Criteria to progress to Phase IV are symmetrical ROM and symmetrical flexibility of the psoas and piriformis. No noted Trendelenburg sign should exist with these higher level functional strengthening activities.

The primary objective of this phase is a safe and effective return to competition or previous activity level. Manual therapy, flexibility, and ROM exercises can be continued as deemed appropriate by the treating physical therapist. Careful attention and frequent re-assessment of these areas should take place to prevent loss of mobility and flexibility as the activity level increases. Once patients can demonstrate good muscular endurance, good eccentric control, and the ability to generate power, running may be progressed. Straight-ahead activities can be gradually progressed to lateral agilities. The completion of a return-to-play assessment using a sportcord test (developed by Steadman Hawkins Clinic and Howard Head Sports Medicine) prior to granted clearance for athletic competition. The athlete must perform a series of dynamic functional activities with resistance from a sportcord such as single-leg squats for 3 minutes, lateral bounding for 80 seconds, and forward/backward jogging for 2 minutes each. He or she is graded on the ability to demonstrate good neuromuscular control of the lower extremity during multi-planar movements that simulate athletic activities.

Post-operative protocols following acetabular labral debridement and repair will continue to develop as these procedures become more common. Current protocols are based on basic science and clinical experience, while future studies should include objective outcome measures to determine the most appropriate post-operative progression.

REFERENCES


CASE REPORT

RETURN TO GOLF FOLLOWING LEFT TOTAL HIP ARTHROPLASTY IN A GOLFER WHO IS RIGHT HANDED

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Michael Betlach, MPT, MS
Ryan Senkarik, MSPT
Robyn Smith, MSPT, SCS
Michael Voight, DHSc, PT, SCS, OCS, ATC

ABSTRACT

**Background.** Research indicates return to golf is a safe activity following total hip arthroplasty (THA). Frequently, individuals have shown both physical faults and swing faults after THA, which can persist even following rehabilitation. Physical limitations and pain often lead to faults in the golfer’s swing, most notably “hanging back.” These problems may not be improved after surgery unless the proper re-training takes place.

**Objectives.** Using pre-surgical as well as post-surgical information, physical faults and swing faults were identified. A corrective training protocol was developed to normalize physical and swing limitations.

**Case description.** The patient is a 52-year old male golfer who underwent left total hip arthroplasty secondary to left hip osteoarthritis. Video analysis both pre and post surgery indicated the patient was “hanging back.” This “hanging back” can lead to an inefficient golf swing and potential injury. Following a physical evaluation, a training protocol was designed to correct abnormal physical findings to assist the patient in creating an efficient golf swing.

**Outcomes.** The patient was able to swing the golf club with proper weighting of the lead lower extremity, significant improvement of swing efficiency, and return to play at a zero handicap following a corrective training protocol.

**Discussion.** A return to full weight bearing, functional strength, range of motion, stability, and balance are critical to regaining the physical skills necessary to properly swing the golf club. Further, mastery of these objective components lend themselves to the trust needed to load the lead leg with confidence during the golf swing.

**Key Words:** total hip arthroplasty, golf, conditioning

**CORRESPONDENCE:**
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INTRODUCTION
Research indicates that a return to golf is a safe activity following total hip arthroplasty (THA). While golfers have reported hip pain following play, most are able to continue enjoying their sport. Unfortunately, protocols to effectively and efficiently return patients to this sport have not been found in the literature.

Osteoarthritis (OA) of the hip often leads to hip pain and loss of hip range of motion, as well as possible weakening of surrounding musculature. Kaltenborn reports loss of medial rotation, extension, abduction and lateral rotation as the capsular pattern loss of hip range of motion. This limited range of motion can lead to compensatory changes in the golf swing. Hanging back or poor weight transfer to the lead lower extremity during the downswing of the club is a commonly seen occurrence for golfers with lead hip OA. Hanging back is diagnosed with video analysis from the face-on camera position. The golfer’s lateral lead knee and hip do not match a vertical line drawn from the lateral aspect of the foot perpendicularly up to the height of the lead shoulder in the impact position. (Figures 1, 2)

Perpetuation of this swing fault can lead to a lack of power and inconsistency of ball flight. Hanging back may lead the player to manipulate the club with a premature wrist release as a compensatory mechanism to getting the club to the ball. These faulty mechanics can lead to right side lumbar injury, as weight bearing remains primarily on the trail side of the body at impact.

While optimal post THA rehabilitation and training approaches remain undefined, all protocols will need to be modified for each individual. The purpose of this case report is to describe the evaluation and application of exercises designed to return a golfer following lead hip THA back to play, while at the same time eliminate the physical swing faults in order to improve swing efficiency.

CASE DESCRIPTION
The patient is a 52-year old male golfer who underwent left minimally invasive total hip arthroplasty secondary to OA of the left hip. A modified Harris Hip outcome score was calculated prior to surgery and found to be 72.6 out of a possible 100 points. (Table 1) Following surgery, the patient underwent 2 weeks of home health physical therapy. This was followed with an active rest period performing a home exercise program and walking. The patient was then released to swing the golf club at 7 weeks post-op. At 8 weeks a golf specific physical evaluation was performed. Physical, video, and kinematic data was re-collected 12 weeks status post surgery.
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<tr>
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<tr>
<td>44 None ignores</td>
<td>Stairs</td>
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<td>40 Slight, occasional, no compromise in activity</td>
<td>2 Normally with banister</td>
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<tr>
<td>30 Mild, no effect on ordinary activity, pain after activity, uses aspirin</td>
<td>1 Any method</td>
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<tr>
<td>20 Moderate, tolerable, makes concessions, occasional codeine</td>
<td>0 Not able</td>
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<td>10 Marked, serious limitations</td>
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<td>0 Totally disabled</td>
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<td>8 Slight</td>
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<td>0 Severe</td>
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<td>7 Cane, long walks</td>
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<td>5 Can, full time</td>
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<td>4 Crutch</td>
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<tr>
<td>2 2 canes</td>
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<td>0 2 crutches</td>
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<th>Distance Walked</th>
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<tr>
<td>8 6 blocks</td>
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<td>5 2-3 blocks</td>
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<tr>
<td>2 Indoors only</td>
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<tr>
<td>0 Bed and chair</td>
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| Total Points     | x 1.1                          |
| Total Score      |                                |

Note: The Harris hip score includes 91 points for pain and function and 9 points for range of motion and deformity. Arthroscopy is principally indicated for pain and function. Consequently, the section for range of motion and deformity has been deleted. The multiplier (1.1) is used to give a total possible score of 100.
PHYSICAL EVALUATION
A subjective history was taken including past medical, exercise, and golf history. The patient was evaluated using the Titleist Performance Institute (TPI) Medical Evaluation and standard physical therapy impairment testing.

Hip Passive Range of Motion (PROM)
Range of motion on the left was less than the right for flexion (85 degrees on left, 115 degrees on right) and adduction (50 degrees left, and 55 degrees right). Range of motion was found to be the same on the left and right for extension (-10°), external rotation (50°), and internal rotation (21°).

Pelvic Tilt Test
The pelvic tilt test was used to assess overall mobility of the hips and lumbar spine and the ability to control the position of pelvic posture in the sagittal plane. The ability to move and control the position of the pelvis is critical for optimal power transfer from the lower body to the upper body in the golf swing.

The patient was able to achieve a pelvic neutral position in standing; however, limited anterior and posterior pelvic tilt was noted. This limitation of motion is indicative of weakness of the abdominal and gluteal muscles as well as tightness of the erector spinae and hip flexors. A lack of smoothness and the presence of jerky movement was also noted during alternating between the two tilt positions. In addition, bilateral hamstring cramping was noted during testing. Cramping of the hamstrings is commonly seen in subjects who are hamstring dominant. These subjects try to control pelvic tilt through the hips and knees.

Pelvic Rotation Test
The pelvic rotation test checks the player’s ability to rotate their lower body independently from their upper body. This rotation is an important skill to properly sequence the downswing and requires good mobility of the spine, hips, and pelvis.

The patient displayed a choppy limited rotation to both the right and left with more lateral than rotatory movement occurring. This lack of rotatory motion is most likely due to the limitation with hip internal rotation. In addition, the lateral shifting is usually indicative of the lack of ability to activate the oblique abdominals and hip rotators to isolate pelvic rotation.

Overhead Deep Squat Test
The overhead deep squat test is one of the more informative tests performed on the golfer. The deep squat portion of the test is used to assess bilateral, symmetrical mobility of the hips, knees, and ankles. If the golfer is unable to complete the deep squat with the heels on the ground, then it is almost impossible to for them to maintain their posture during the golf swing. The golfer will have a tendency to thrust their lower body toward the golf ball and raise up on their torso during the downswing (early extension). This movement is usually due to either tightness in their calf muscles or lack of pelvic stability due to weakness of their core.

Due to THA precautions still being observed, this test was modified to a 1/3 depth squat. Poor stability of the left hip led to decreased femoral control as demonstrated by femoral adduction and internal rotation. This can be viewed best by observing the client face on.

Single Leg Balance Test
The single leg eyes closed balance test is used to assess the golfer’s overall balance. This test will highlight any proprioceptive imbalance from left to right as well as overall stability of the core. The client was scored in the 0-5 second range for both the left and right.

Wobble Board Test
Front to back balancing was more difficult than side to side.

Leg Lowering Test
This test is used to assess how the golfer uses their abdominals and overall stability of the core. The abdominal muscles are used to stabilize the spine and pelvis, rotate the torso, and maintain a neutral posture throughout the golf swing. With the patient lying supine in a hook lying position, a blood pressure cuff is placed under the lumbar spine and inflated to 40mmHg. The client is then instructed to contract their abdominals and slowly slide one leg to the ground. This is then repeated with the opposite leg.

During this test, three things were observed: First, how do they engage their abdominals? As the client initially...
engages the abdominals, the pressure within the cuff should elevate between 40-50 mmHg without modifying the lumbar lordosis. If the pressure in the cuff drops, it is usually indicative of an anterior pelvic tilt caused by the over-activation of the hip flexors or erector spinae rather than the abdominals. This anterior pelvic tilt causes an increase in the lumbar lordosis and, thus, a pressure drop. If the pressure increases above 50 mmHg, it is usually indicative of the client performing a posterior pelvic tilt with the pelvis when engaging the abdominals. This demonstrates an abnormal sequence of recruitment with the client also activating the hamstring muscles and quite possibly the psoas major muscle to produce a posterior pelvic tilt.

Second, can their abdominals work independent of hip extension? In other words, can the client maintain a good abdominal brace with movement of the lower extremity? When you ask the client to slide their leg all the way down, hip extension should occur. Normally, hip extension should not affect pelvic or lumbar spine motion, especially when the abdominals are actively bracing the spine and pelvis. If the musculature of the hip is shortened and pulls on the lumbar spine and pelvis, the abdominals must resist this tension. If the mmHg in the blood pressure cuff drops during hip extension, then either the lack of mobility in the hip musculature or lack of strength of the abdominals is evident. Weak abdominals can be the main reason for loss of stability during this test however, any restriction in hip mobility will make extension of the hip difficult to isolate without movement of the pelvis and lumbar spine.

Third, is there an asymmetry between the left and right hip? In other words, if the mmHg in the blood pressure cuff drops during left hip extension, but does not during right hip extension, then an asymmetry exists.

The client demonstrated a pressure increase above 50 mmHg with the initial engagement or bracing of the abdominal musculature. In addition, with hip extension pressure was lost for both the right and left sides: Pressure lost: Left 21-40 mmHg; Right 21-40 lbs mmHg

**Bridge with Leg Extension Test**

This test evaluates stability in the pelvis, lumbar spine, and core musculature. In addition, this test will highlight any inhibition or weakness of the gluteus maximus muscle due to over recruitment of the synergistic muscles, such as the hamstring and erector spinae muscles. As the client attempts to single leg bridge and hold the position with the contralateral leg extended for 10 seconds, observe for a drop of the pelvis on the leg extension side (contralateral to the stance leg) or ipsilateral pelvic shaking which is indicative of weakness of the gluteals muscle on the ipsilateral or stance side. Another key indicator is hamstring cramping in the down or stance leg, which also indicates inhibition of the gluteals and recruitment of the synergistic muscles. Weakness in the right gluteals can cause the player to lose lower body stability in their backswing and may limit their power on the downswing. Weakness in the left gluteals can cause instability in the left leg through impact or forward movement toward the golf ball during the downswing. The client demonstrated bilateral gluteal inhibition with hamstring cramping.

**VIDEO**

Video analysis of the patient prior to training was performed. The patient was found to demonstrate the swing fault of hanging back.

**KINEMATIC SEQUENCE**

In sports such as golf that need to create maximal speed of a distal segment or implement (club, bat, racquet, etc), it is generally found through motion analysis techniques, that a precisely timed sequence of body segment motions exists progressing from the proximal, large segments to the distal, smaller segments. In biomechanical literature this is often called “proximal-to-distal-sequencing,” “kinetic linking,” or the “kinematic sequence.” The kinematic sequence (swing signature) is one of the most important pieces of information that used to assess the golf swing. Using data collected from 3-D motion analysis systems, the efficiency of a golfer’s swing can be determined how golfers generate speed and transfer this speed or energy throughout their bodies can be assessed.

In analyzing how speed is transferred to the club head, it was discovered that all great ball strikers have the exact same kinematic sequence or the same basic signature of generating speed and transferring this speed throughout their body. What style they use to complete this signature is completely unique to each player. During the downswing in golf, all body segments must accelerate and
decelerate in the correct sequence with precise and specific timing so that the club arrives at impact accurately and with maximal speed. This sequence (Figure 3) of speed generation is: lower body first (red line on graph), trunk or torso second (green line), arms third (blue line), and the club last (maroon line) (pelvis, torso, arms, club). This motion must occur sequentially with each peak speed being faster but later (shifted to the right slightly) than the previous one. Each segment of the body builds on the previous segment, increasing speed up the chain (red is less than green, which is less than blue, which is less than maroon). This sequence reflects as efficient transfer of energy across each joint and facilitates an increase in energy from the proximal segment to the distal one. Each segment of the chain slows down once the next segment begins to accelerate in order to facilitate acceleration of the next segment. All of the body segments peak and then decelerate before impact, with the club speed peaking at impact.

The kinematic sequence for this client was measured at the Titleist Performance Institute using a full-body 12-sensor analysis using the AIM-3D golf swing biomechanics system (Advanced Motion Measurement LLC; Phoenix, AZ) and the Liberty electromagnetic tracking hardware (Polhemus Inc; Phoenix, AZ). As shown in Figure 4, this golfer had an improper kinematic sequence. While the pelvis did peak first, the second segment to peak was the arms, followed by the torso, and lastly the club head (pelvis, arms, torso, club head). If the timing and energy transfer is wrong, energy can be dissipated instead of added, as a result speed will be lost. Also if one body part has to compensate because another is not doing its job, injury may result. As noted on the proper kinematic sequence (Figure 3), after the peak is reached, each segment should decelerate rapidly. The kinematic sequence of a golfer with lead hip OA may be illustrated by an initial normal pelvic acceleration followed by a flattened slope and an extended or flattened deceleration slope. This lack of rapid deceler-
3. The patient exhibited decreased lumbo-pelvic mobility and stability in non-weight bearing and weight bearing positions as demonstrated by the pelvic tilt, pelvic rotation, and bridging with leg extension tests. The client had difficulty with full sagittal plane pelvic excursion as well as poor neuromuscular control through his available range. Inability to achieve a posterior pelvic tilt at impact can have a negative influence on the right side of the lumbar spine; especially true when combined with hanging back.

4. The patient exhibited deficits with balance. Proper balance and proprioceptive ability is necessary during static positions at address, as well as dynamic positions of the golf swing.

5. Upon 2-D video analysis the patient displayed less than normal transfer of weight to his lead lower extremity. Hanging back produces loss of power/distance and ball flight inconsistencies. Further 3-D kinematic sequence analysis revealed an improper order of activation/sequencing: Pelvis-arms-torso-club head.

INTERPRETATION OF FINDINGS

Five significant findings exist including four physical faults and one swing fault.

1. The patient displayed a lack of full hip extension along with inhibition of the gluteal musculature. This is an aspect of “lower crossed syndrome” which increases the probability of developing low back pain. The lower crossed syndrome, first described by Czech physical therapist Vladamir Janda, can be defined as a pattern of muscle imbalances leading to increased lumbar lordosis due to over active lumbar musculature and subsequent reciprocal inhibition of the abdominal musculature. The hip flexors are tight and the gluteals are inhibited. In this case, the patient presented with normal anterior pelvic tilt in standing but decreased lumbar lordosis. He also demonstrated inhibited abdominals during pelvic tilt activity which may be indicative of overactive global lumbar musculature. The global lumbar muscles include the spinalis, longissimus, and iliocostal muscles. The hip flexors were shortened and overactive, the gluteus maximus muscle was inhibited secondary to a loss of hip extension, and the hamstring musculature was over-utilized.

2. The patient also displayed limited hip internal rotation. Loss of hip internal rotation can lead to undue stress on the lower back during the golf swing and swing faults such as lateral movement away, from, or toward the target, and loss of spine angle. This subject was able to avoid these faults; however, limited lead hip internal rotation can also lead to a hanging back swing fault. This fault is possibly due to the golfer’s anticipation of discomfort that is associated with forced internal rotation.

INTERVENTION

At 8 weeks post-op, training was performed in nine sessions over a twenty-five day period. A training protocol was developed and modified to address the client’s physical limitations.

1. Strategies to improve hip extension were employed as follows: side lying passive range of motion, proprioceptive neuromuscular facilitation (PNF) hold relax stretch and active assist during hip extension stretch emphasizing gluteus maximus activation (Figure 5). A neutral pelvis and abdominal bracing was held throughout the stretch. Pillows
were placed between legs and care taken not to allow internal rotation of hip or break THA posterior precautions.

2. Increasing hip internal rotation without breaking total hip precautions of posterior movement presented a challenge. This physical fault was not directly addressed in training, however it eliminated itself with the application of weight bearing rotational exercises and the patient’s continued swinging of the golf club as approved by the physician. These exercises occurred within 2 weeks of initial testing which was a total of 9 weeks post op (Figures 6-11)

3. The patient’s inability to assume and maintain a stable core was another concern addressed in training. This training was addressed through exercises in supine, quadruped, standing, and in golf stance positions. Neuromuscular re-education was performed for proper pelvic tilt in the sagittal plane. This exercise was executed both in-clinic training and in his home exercise program. Abdominal hollowing and bracing, bridges, single leg bridging, and front planks were employed as part of training and home exercise program (Figures 12-17)

4. Testing also revealed that balance was deficient. The patient was given several weight bearing exercises aimed at challenging tri-planar balance in single limb stance as well as weight shifting activities. Balance exercises also focused on maintenance of spine angle throughout performance. (Figures 6, 8-11)

5. Correction of the swing fault was addressed by the patient’s PGA teaching professional as training progressed.

Reassessment
The client was reassessed following 9 training sessions over a period of 25 days. While this is perhaps not an optimal length of training period the reader will find that positive changes had occurred.

Review of Problem List
1 and 2. Overall hip function was improved. Not only was hip range of motion improved, but gluteal muscle activation was improved as well. Hip flexion was increased to equal the right side. Hip internal rotation as measured prone was increased bilaterally with the left side improving almost 10 degrees and the right 15 degrees. The patient was also able to perform the bridge with leg extension without hamstring cramping, indicating improved gluteal muscle activation.
3. The patient also displayed increased core stability. Neuromuscular control was enhanced as evidenced by improved control with weight bearing sagittal plane pelvic motion. The patient was also able to maintain pelvic stability when performing the leg lowering test. He demonstrated improved stability and control when performing a modified 1/3 squat test.

4. Significant improvements in balance were demonstrated as the patient was now able to maintain single limb
stance for 8 seconds. The patient subjectively scored each
direction of the wobble board balance test as “easy.”

5. The patient was able to eliminate his swing fault. He no
longer exhibited hanging back at impact. In addition, 3D
kinematic sequence analysis revealed that the client’s
sequence returned to the pre-injury normal pelvis-torso-
arms-club head sequence.

6. Reassessment of function with the Modified Harris Hip
score produced a score of 100 out of the possible 100 points
available.

DISCUSSION
The THA procedure is becoming more prevalent and
occurring in younger individuals. As these trends contin-
ue, therapists, golf professionals, and fitness professionals,
will be presented with the challenge of designing treatment
protocols to most effectively and efficiently return the
patient to normal function, as well as leisure activities such
as golf.

The goal of this article was to present a case study that
exhibited many of the physical faults and swing faults that
are typically encountered when treating a patient with a
left lead leg THA who wishes to return to golf. Several
physical faults were identified including decreased hip
extension and internal rotation, inhibition of hip extensor
musculature, decreased core stability, and diminished bal-
ance. One significant swing fault, hanging back, was also
identified. By initially addressing the clients specific
physical faults the authors aimed to eliminate the injury
potential that can be caused by training for strength, power,
and speed on top of those faults.

SUMMARY
The author’s rationale for the treatment approach, as well
as specific treatment modalities, were detailed. Post-treat-
ment results were given showing improvements in all five
of the faults detailed in the problem list. The client was able
to eliminate the vast majority of his physical faults and was
able to eliminate his swing fault. The key to this success
was multifactorial. Improvement in hip mobility, proper
activation of hip extensors, improved lumbopelvic stability
and control, improved weight bearing balance and stability,
and technical weight bearing exercises to improve weight
shift and rotation onto the lead side were all important
components in eliminating the most significant swing fault—hanging back. Restoration of proper swing mechanics followed without incident.

REFERENCES


