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CME ARTICLE

The Hip-Spine Connection: Understanding Its Importance in the Treatment of Hip Pathology

JOHN M. REDMOND, MD; ASHEESH GUPTA, MD; RIMA NASSER, MD; BENJAMIN G. DOMB, MD

educational objectives

As a result of reading this article, physicians should be able to:

1. Discuss the kinematic relationship between the hip and lumbar spine.

2. Explain the innervation of the hip and lumbar spine and how they relate to one another.

3. Recognize the effect of hip disease on the lumbar spine in an athletic population, prior to the onset of degenerative changes.

4. Describe an algorithm for diagnosis and treatment of patients who present with concomitant hip and lumbar spine pain.

ABSTRACT

The hip and lumbar spine are closely related and can create similar patterns of pain and dysfunction. Diagnosis and treatment of hip and spine–related conditions can be challenging due to symptom overlap. Successful evaluation and treatment of hip and lumbar spine conditions requires a thorough understanding the hip-spine connection. Historically the hip-spine connection has been considered in the context of arthrosis; however, the hip-spine connection also needs to be considered in a younger athletic popula-

The authors are from the Department of Orthopedic Surgery (JMR), Mayo Clinic Florida, Jacksonville, Florida; NOVA Orthopedic & Spine Care (AG), Woodbridge, Virginia; and the American Hip Institute (RN, BGD), Hinsdale Orthopedics, Loyola University Stritch School of Medicine, Westmont, Illinois.

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Correspondence should be addressed to: Benjamin G. Domb, MD, American Hip Institute, Hinsdale Orthopedics, Loyola University Stritch School of Medicine, 1010 Executive Ct, Ste 250, Westmont, IL 60559 (drdomb@americanhipinstitute.org).

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tion. The purpose of this review is to describe the hip-spine connection, discuss the clinical implications of this connection, and offer an approach to diagnosis and treatment. [*Orthopedics.* 2015; 38(1):49-55.]

Clinicians are often faced with the diagnostic dilemma of a patient who presents with pain that is vague or doesn't follow a familiar pattern. Often the answer can be found in a thorough history and physical examination. However, frequently there is more than one problem contributing to the pain, particularly in the hip, pelvic girdle, and spine—areas that are intimately related in function and anatomy. Disorders of these structures have overlapping presentations and symptomatology, which can create confusion as to the source of pain. This confusion can lead to a delay in diagnosis and treatment. It is imperative to understand this connection when treating patients who may be candidates for hip procedures.

The current authors introduce the hip-spine connection, a term used to describe the relationship between the hip and spine that exists prior to the appearance of degenerative changes. Most descriptions of the hip-spine connection are limited to coexisting hip and spine dysfunction in the setting of arthritis. Symptoms can and do occur prior to the onset of degenerative changes, especially in the high-demand athletic population.

The purpose of this review is to describe the hip-spine connection, discuss the clinical implications of this connection, and offer an approach to diagnosis and treatment. The first section of this article describes the connection between the hip and spine. The second section reviews the clinical implications of pathology affecting the hip-spine connection. The third section offers an algorithmic approach to evaluating hip and spine pain with a brief review of various conditions that can affect one, the other, or both, as well as how to differentiate them.

The Hip-Spine Connection

The hip and spine have coordinated movement, and limitations of one area will affect the other. This may manifest itself as pain. The etiology of the pathology may be difficult to discern due to the overlap of innervation in certain areas of the spine, pelvic girdle, and hip.

Hip-Spine Kinematics in Asymptomatic Adults

The kinematics of motion involving the lumbar spine, pelvic girdle, and hip are highly interrelated. Farfan[1] described the relationship, and advantage, of lumbar lordosis and hip extension for upright activity. He noted that lumbar muscle activity increased as the lumbar spine flexed to 45° and that further flexion thereafter required pelvic rotation. The rigidity of spinal column ligamentous structures determined the endpoint of flexion, at which point the muscles involving the pelvic girdle—including the iliopsoas and abdominals—activated to allow for further flexion. The hamstrings, posterior hip muscles, and lumbar paraspinals activated to counteract these flexion forces. At terminal flexion, the paraspinals were inactive and resisted further spine bending in their fully elongated position.

Using an electromagnetic tracking device, Lee and Wong[2] measured movements of the hip and spine in forward, backward, lateral, and twisting motions in 20 healthy participants. They confirmed what previous studies have shown using video techniques: the contributions of the spine and hip in forward and backward bending are similar, with the spine having a greater contribution in the early stage of the movement, and less so toward the end. Lateral flexion of the lumbar spine was accompanied by abduction of the ipsilateral hip and adduction of the contralateral hip; however, the hip joint contribution was small. On the other hand, during twisting of the trunk, the hips contributed most of the motion.

Table 1

Distribution of Hip Pain

Location	%
Groin	55-92
Lateral hip	59-67
Thigh	35-52
Knee and below	22-47
Foot	2

Hip Distribution of Symptoms

Classically, intra-articular hip symptoms localize to the groin; however, the distribution is known to be variable (**Table 1**). Byrd[3] described hip labral tears presenting with a classic "C" sign where the patient places the index finger over the anterior aspect of the hip and thumb over the posterior trochanteric region to indicate the location of the pain. When evaluating labral tears, Burnett et al[4] noted that 92% of patients had groin pain, 59% had lateral hip pain, 52% had anterior thigh/knee pain, and 38% had buttock pain. Clohisy et al[5] reported that 88% of patients presenting with femoroacetabular impingement requiring surgical intervention had groin pain, 67% had lateral hip pain, 35% had anterior thigh pain, 29% had buttock pain, 27% had knee pain, and 23% had low back pain.

Hip pain that travels distal to the knee has been thought to be related to lumbar spine pathology; however, in one study of patients with osteoarthritis scheduled to undergo primary total hip arthroplasty (THA), 47% of patients had pain radiating below the knee.[6] The authors felt this may stem from referral along the saphenous branch of the femoral nerve, which innervates the hip joint. Lesher et al[7] described 12 pain distributions after obtaining pain diagrams of patients with degenerative hip disease. Traditional groin pain and buttock pain was seen in 55% and 71% of patients, respectively. Pain distal to the knee was seen in 22% of patients, and 2% of patients described pain occurring as distal as the foot.

Extra-articular hip pain sources have traditionally been characterized as follows: iliopsoas tendonitis produces anterior groin pain, trochanteric bursitis causes lateral pain, adductor strains create medial thigh pain, and piriformis syndrome evokes posterior pain. However, it is important to realize that intra- and extra-articular hip pain cannot always be determined based on pain patterns, and in many patients they coexist.

Spine and Sacroiliac Joint Distribution of Symptoms

Within the spectrum of spine disorders, there is considerable overlap in the distribution of symptoms. An evaluation of the dermatomal distribution of radiculopathies showed that 64.1% of lumbar radiculopathies did not correspond to a specific dermatome.[8] Lumbar provocation diskography showed radiation of pain into the groin, buttock, hip, and lower extremities.[9] Noxious stimulation of the interspinous ligament and paravertebral muscles has also been shown to refer pain into the lower extremities.[10] Facet syndrome was described by Mooney and Robertson[11] after detailing the distribution of pain reported after provocative intra-articular facet injections. The distribution was indistinguishable from other back pain complaints frequently associated with diskogenic pain. A subsequent study found no consistent segmental or sclerotomal pattern for facet-mediated pain in patients undergoing diagnostic medial branch blocks.[12] The investigators also found pain radiating to the buttock and trochanteric region was relieved by blocking the L4 and L5 level medial branches, whereas groin pain seemed to stem from L2 to L5 medial branches (**Table 2**).

Pelvic pain related to the sacroiliac joint may present in various locations. Gluteal pain near the posterior superior iliac spine is the most common complaint, although symptoms can include groin and lower extremity pain. This distribution can be explained by the communication of the sacroiliac joint with nerves in the area: Fortin et al[13] found 61% of 76 sacroiliac joint injections showed 5 patterns of contrast extravasations from the joint. Three of these communicated with the dorsal sacral foramen, the L5 epiradicular sheath, and the lumbosacral plexus.

The likely explanation for overlap in pain diagrams between the hip and lumbopelvic region is the overlap in innervation. Innervation of the lumbar facet joints is likely the medial branches of the dorsal rami of L1 through L5.[14] Intervertebral disks are innervated by multiple nerves, including the sinuvertebral nerves, adjacent ventral primary rami, and grey rami communicans.[15] The sacroiliac joints are innervated by dorsal rami of L2-S2.[16] The hip shares this innervation pattern with the anterior joint capsule being innervated by the obturator and femoral nerve (L2-L4) and the posterior capsule innervated by the sciatic and superior gluteal nerve (L4-S1).[17]

Clinical Implications of the Hip-Spine Connection

Several studies have evaluated the relationship of low back pain associated with degenerative conditions of the hip.[18,19] Reference to such coexistence of hip and spine disorders was first published by Bohl and Steffee,[19] who described the course of 6 patients with continued pain after total hip arthroplasty (THA) that was relieved with lumbar laminectomy.

The term *hip-spine syndrome* was first coined by Offierski and MacNab[20] in 1983 and was used to describe patients with coexisting hip and spine degenerative changes. In 2007, Ben-Galim et al[21] studied 25 patients with hip-spine syndrome before, 2 months after, and 2 years after THA. All outcome measures improved after THA. The authors concluded that THA improved lumbar spine pain in this setting. Conversely, a study of arthrodesed hips converted to THA found that patients with low back pain had moderate relief of their back pain after THA.[22]

Table 2

Lumbar Spine Pain Patterns

Location	Pain
L4-L5 medial branches	Buttock and trochanter
L2-L5 medial branches	Groin

Movement Relationships in the Setting of Hip Disorders

Hip pathology can have an effect on lumbopelvic motion, and several studies have investigated this connection.[23,24] Multiple authors have noted increased lumbar lordosis and sacral slope in patients with hip pathology (**Table 3**).[25,26] Offierski and MacNab[20] showed that a fixed flexion contracture of the hip leads to pelvic rotation, increasing lumbar lordosis, which may in turn result in increased loading of the lumbar facets and ligaments. Thurston[27] measured angular displacement of the spine and pelvis during unassisted ambulation in patients with unilateral hip degenerative joint disease. He found that lumbar side bending was increased in patients with hip degenerative joint disease. There was also a significant increase in sagittal plane movement and a significant decrease in coronal plane movements of the pelvis when compared with asymptomatic volunteers. During swing phase, there was little motion at the hip joint and the entire pelvis/leg complex.

The Hip-Spine Connection as It Relates to Sports

The majority of reports on coexisting hip and spine disorders relate to patients with degenerative conditions of the hip and spine. It stands to reason that these disorders are a part of a continuum and

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Table 3

Differential Diagnosis

Intra-articular hip
Femoroacetabular impingement
Dysplasia
Instability
Labral tear
Ligamentum teres tear
Synovitis
Capsulitis
Loose body
Degenerative joint disease
Osteonecrosis
Extra-articular hip
Muscle/tendon/bursa
Adductor strain
Iliotibial band syndrome
Iliopsoas complex
Piriformis/hip external rotators
Trochanteric bursitis
Hamstring complex
Bone
Stress fracture
Epiphysitis
Transient osteoporosis
Nerve
Meralgia paresthetica
Genitofemoral
Ilioinguinal
Sciatic
Other
Sports hernia
Pelvic visceral pain
Spine
Axial
Disk
Facet
Lumbar strain
Vertebral fracture
Radicular
Spinal stenosis
Radiculopathy
Spondylolisthesis

exist prior to the development of degenerative changes. Because of the complexity of the biomechanics and interrelationships of movement in the spine, pelvic girdle and hip, an asymptomatic disorder in one region may go unrecognized as contributing to the symptomatic condition in the other. As an example, limited hip motion, related to shortened muscles, stiff capsule, or cartilage or bony deformity, leads to an increased compensatory motion in the lumbopelvic region. In the setting of a golf swing or tennis stroke, the lack of hip motion forces a compensatory lumbar motion to occur to perform the task of rotation. Eventually this may lead to overload followed by pain.

A few studies directly suggest the hip-spine connection in an athletic population. Nadler et al[28] reported college athletes with lower extremity ligamentous laxity and/or an overuse injury were at increased risk for the development of low back pain requiring treatment the following year. Another study of Division I college athletes revealed that patients who had asymmetric hip extension strength also had reports of lower extremity injury or low back pain during the previous year.[29]

Van Dillen et al[23] evaluated hip rotation changes in athletes with and without low back pain. Individuals with low back pain who regularly participated in recreational sports had decreased total passive hip rotation and asymmetry of hip rotation. Asymmetry in hip rotation leads to abnormal forces in the lumbopelvic region and is a risk factor for the development of low back pain.[30] The authors concluded that specific directional demands on the hip may contribute to low back pain in athletes.[23] This suggests the need for specific training methods and rehabilitation for athletes at risk for developing low back pain.

Rotational sports are thought to place an increased repetitive demand on both the hip and spine, possibly leading to early dysfunction. Harris-Hayes et al[31] looked at patients with and without low back pain who participated in rotation-related sports. They found that the low back pain group demonstrated less hip rotation, greater knee flexion, and less lumbopelvic rotation. Other studies have demonstrated that a statistically significant reduction in hip internal rotation is associated with low back pain in professional tennis players and golfers. Vad et al[32] evaluated professional male tennis players and reported a 40% prevalence of low back pain. There was a significant correlation between low back pain and decreased hip internal rotation. Their hypothesis was that repetitive pivoting of the lead hip causes microtrauma and scar formation, leading to capsular contracture and subsequent reduction in internal range of motion. More recently, Murray et al[33] studied amateur golfers and found a statistically significant correlation between low back pain and decreased hip internal rotation.

Hip Evaluation, Spine Evaluation, and Diagnostic Algorithm

The complexity of hip and lumbopelvic symptoms, and the fact that they often coexist, presents a host of questions that need to be answered to provide the best treatment for patients. Is the problem in the hip, spine, or both? If it is in both, then which to treat first? The initial step is to take a good history, perform a thorough physical examination, and correlate symptoms with the appropriate radiography. The history should include information about onset, type of pain, location, and exacerbating factors. While each area is being examined, a differential diagnosis is formulated (**Table 3**), and conditions are included or excluded based on findings.

Evaluating the Hip

A careful and detailed hip examination includes multiple maneuvers to reproduce the patient's symptoms. Current research indicates that physical examination findings do not have sufficient specificity to rule in an intra-articular hip disorder, but a negative finding for a combination of several hip tests may rule out intra-articular pain.[34] Pain relief from an intra-articular anesthetic injection is reported to be a 90% accurate for detecting intra-articular pathology.[35] Pateder and Hungerford[36] found that hip injections help predict hip vs spine disorders with 100% sensitivity, 81% specificity, 97% positive predictive value, and 100% negative predictive value. Further imaging of the hip or spine can be guided by the results of diagnostic injections.

Extra-articular hip problems, such as iliopsoas tendinitis, are common in sports and cause anterior pelvic pain. Pain with palpation of the tendon and relief from a local diagnostic injection can confirm the diagnosis. Lateral hip pain may be intra- or extra-articular. Tenderness to palpation on the trochanter is often related to trochanteric bursitis. A trochanteric injection will often confirm extra-articular pathology.

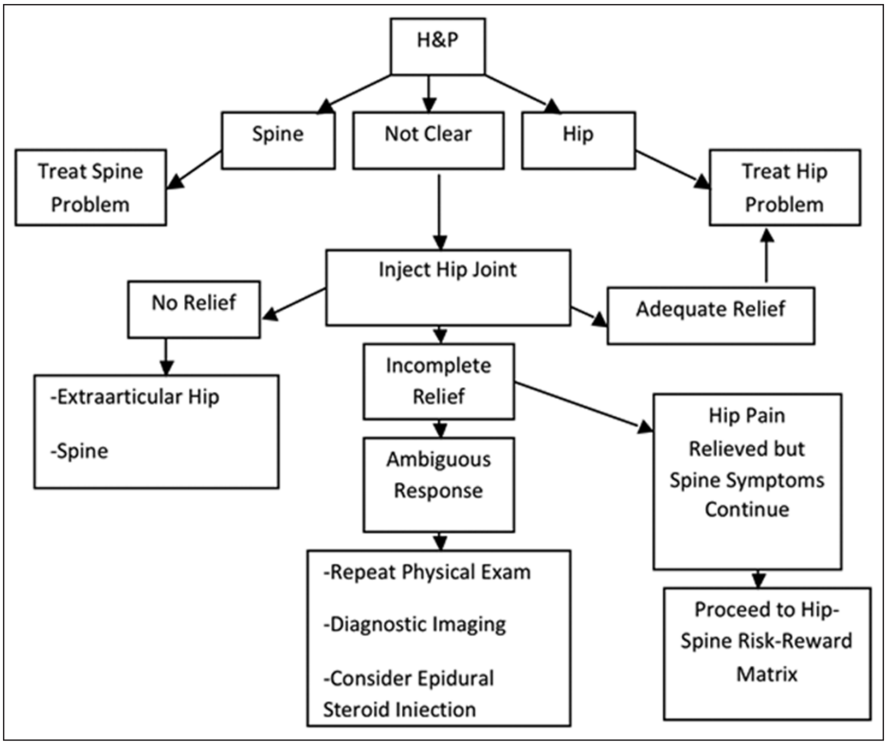

Figure: Hip-spine algorithm. Abbreviation: H&P, history and physical examination.

Evaluating the Lumbar Spine

It is useful to categorize back pain by whether it radiates into the lower extremities (radicular) or not (axial). The etiology of back pain is often difficult to discern, but in general the intervertebral disk is thought to be involved in 26% to 49% of cases, facet pain in 9% to 40% of cases, sacroiliac joint in 2% of cases, and nerve roots in 13% of cases.[37]

Potential causes of axial back pain after acute overload include lumbar strain, acute diskogenic pain from annular tear, and acute spondylolysis related to trauma. Patients usually report pain located in the midline with radiation around the waist and occasionally radicular features.[38] The pain is worse with sitting, coughing, or sneezing, all of which increase stress on the intervertebral disks. The quantification of diskogenic pain is difficult because diskography, the only diagnostic tool for such disorders, has a best-case positive predictive value as low as 50% to 60%. As with other joints, arthritic change visualized on radiographs do not equate to pain.

Spondylolysis and spondylolisthesis have been associated with sports that involve repetitive back extension. Spondylolysis is a relatively common clinical finding, with a prevalence of 3% to 7%, of which 10% are symptomatic.[39] Pars defects may be from a lytic fracture or an elongated pars interarticularis. Spondylolisthesis can develop if the pars defect is bilateral. The spondylolisthesis may lead to nerve root irritation, particularly if there is repetitive lumbar flexion and extension. Gymnastics, ballet, and weight lifting are all associated with spondylolysis and sometimes listhesis in the lower lumbar spine.[40]

Treatment Algorithm

The current authors have often encountered patients who have been treated unsuccessfully for a diagnosis related to the back while the hip was the true source of their pain. The authors' goal is to present an algorithm that can avoid this type of problem and help physicians evaluate the patient in a systematic fashion (**Figure**). One of the main points to take away from this concept of the hip-spine connection is that both the hip and spine can be sources of pain. In medicine, based on Occam's razor, the authors often strive to find one diagnosis that unifies a patient's symptoms. In patients with hip and spine pathology, one should attempt to discern if one source is primary and driving the other. Most current literature describes hip arthritis or restricted range of motion leading to spinal degeneration, yet the reverse is theoretically possible. In any event, all causes of pain and dysfunction should be understood and addressed to offer patients the best chance for a good outcome.

The judicious use of diagnostic injections can be helpful in determining not only the main source of the pain but also the degree of contribution of one area vs the other. This can be a guide as to which

Table 4

Risk-Reward of Potential Interventions
Low risk/high reward
Hip arthroscopy
Hip replacement
Microdiskectomy
Low risk/low reward
Hip injection
Epidural steroid injection
Diagnostic hip arthroscopy
High risk/high reward
Spinal decompression and fusion
Surgery on patients with multiple comorbidities
High risk/low reward
Spinal surgery without a definite diagnosis

treatment options should be considered first. A treatment algorithm for patients who present with both spine and hip pathology must also weigh the risks and benefits of any intervention. Surgery comes with the possibility of complications; however, some procedures are more dangerous than others and some require more healing time than others. For example, an outpatient hip arthroscopy can provide pain relief with little risk, whereas a spinal fusion may carry a larger risk (**Table 4**).

Conclusion

The hip and spine are closely related in function and symptom distribution. Pathology of the hip joint may influence the spine to create further dysfunction and vice versa. Understanding the hip-spine connection and following the algorithm presented can help overcome the limitations of the physical examination and diagnostic methods. It can also provide more timely and accurate treatment for this subgroup of patients who have historically either been referred to several physicians and therapists without success or undergone unnecessary procedures that did not ease their pain.

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