Beyond the Basics of Athletic Hip Evaluation

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Abstract: There is a growing trend in the world of orthopedics and sports medicine revolving around the nonarthritic hip. The incidence of hip arthroscopy has exponentially grown in the past decade and despite the importance of the recognition of these hip pathologies as contributors to pain and dysfunction, there is an ever-increasing rate of "failed" procedures emerging in the literature. The etiology of femoroacetabular impingement (FAI) syndrome and associated pathologies of the hip are now better understood. With this understanding there appears a tendency to point a finger at the hip joint without consideration for the involvement of the surrounding joints or extraarticular structures. Because of the nature of the morphological condition of FAI and the high incidence of a gradual progression of pain and impairments over time, as opposed to an acute injury, there is a need for a more robust assessment of the hip. The purpose of this commentary is to discuss the importance of a combined traditional orthopedic exam, imaging, and movement assessment in diagnosis and treatment recommendations in those with nonarthritic hip pain. It is our belief that this combined model can assist in identifying movement dysfunction that may lead to poor surgical outcomes and developing improved nonoperative or preoperative care pathways. **Level of evidence:** Level V.

Introduction

Background and Argument for a Comprehensive Movement Approach

In the past two decades there has been an overwhelming progression in the knowledge and treatment of nonarthritic hip pain. A better understanding of femoroacetabular impingement (FAI) and acetabular hip dysplasia and their roles in labral pathology and hip pain in the adolescent and young adult population has evolved. With more identification of these morphologies, there has come a rise in the surgical treatments. In a recent study by Zusmanovich et al., the authors identified an 85% increase in the incidence of hip arthroscopy for those with FAI Syndrome (FAIS) and labral pathology, treating more than twice as many females than male patients.[1] Similarly, Cevallos et al. noted a twofold increase in the incidence of hip arthroscopy from 2010 to 2014, with no significant change from 2014 to 2017 and a 70% female patient population, in greater than 50,000 cases. In this study, they also identified an almost 20% revision rate with 15.1% of patients having revision arthroscopy within the first 2 years postoperatively and 3.9% of patients converting to a total hip arthroplasty.[2]

With greater recognition of FAI morphology, acetabular dysplasia, and other sources of nonarthritic hip pathology comes the responsibility to take a multifactorial approach to clinical and surgical decision making. The incidence of asymptomatic FAI morphology or labral injury is high in the active population. In a systematic review of asymptomatic volunteers by Frank et al., the presence of cam deformity was identified at a ratio of 3:1 compared to nonathletes. In this same review, labral injury was identified on noncontrasted magnetic resonance imaging (MRI) in 68% of total subjects.[3] If these deformities are seemingly more commonplace, it begs the question as to why some individuals demonstrate increased resilience and compensate with no intervention, while others are debilitated by the same findings? It is our belief that taking a multifactorial approach to evaluation of these patients is the key in successful outcomes both operatively and nonoperatively. The Warwick Agreement on FAIS published in 2016, established that FAIS "is a

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Table 1. Pelvic/Core Control Assessment and Treatment Suggestions

Assessment	Criteria	Common Findings	Suggested Treatment
Multisegmental flexion	Touches toes with uniform spinal curve, posterior pelvic tilt/posterior weight shift, knees straight, and returns to standing without pain.	Flat lumbar spine/no reversal of lordosis into flexion; no weight shift/hinge at hips vs. allowance of pelvis and spine flexion	Assess hip and spine mobility in unloaded postures; if normal mobility is present, treat for stability impairments.
Standing pelvic tilt	Can create anterior and posterior tilt volitionally in weight bearing	Shaking or juttering movement; unable to reverse lordosis into a posterior tilt	If unable to create movement, assess in supine for available mobility; if motion is adequate, unloaded treatment progression for stability and motor control. If no motion, assess lumbar spine mobility.
Standing active hip flexion	Patient elevates the knee toward the chest in standing and should be able to reach >100° of hip flexion with the trunk remaining vertical, no hip flexion on the standing leg, and no shifting of the pelvis throughout the movement.	Collapse of trunk or opposite hip; trunk extension to produce lift; hip/pelvis hike or rotation	Assess unloaded hip flexion actively to passively for adequate mobility. If full motion available, progress through stability and motor control for hip flexion with proximal/trunk stability.
Prone rocking	In quadruped, patient rocks back onto heels and reaches for feet creating full unloaded spine flexion—lumbar spine should round/reversal of lordosis occurs.	Lumbar spine remains flat/extended	Assess and treat for lumbar spine joint mobility restrictions; treat tightness in posterior chain tissues, including thoracolumbar fascia restrictions.
Supine straight leg raise	Patient actively lifts the leg into flexion with knee fully extended to 70° or greater; no extension or rotation of the lumbar spine or shift of the pelvis	Hyperextension and/or rotation at the lumbar spine; shift of pelvis; limited motion due to pain or weakness	Assess passively and observe if movement normalizes/compensations abolish. If they do, treat with stability/motor control progression. If assessment is normal, give slight resistance at the ankle to assess for any of the noted compensations.

motion-related clinical disorder of the hip with a triad of symptoms, clinical signs, and imaging findings. It represents symptomatic premature contact between the proximal femur and the acetabulum." In addition, the authors conclude there are three pathways of care for those with FAIS, including conservative management, physiotherapy, and surgical intervention.[4] Unfortunately, there is limited evidence to support any specific physiotherapy program in the treatment of these individuals.[5] It is our belief that the most critical and underutilized aspect for the assessment and treatment of those with FAIS or generally classified nonarthritic hip pain is the component of whole-body movement assessment and neuromotor control. Additionally, we feel that this is also a critical consideration in those with continued hip pain after hip arthroscopy. The purpose of this commentary is to discuss the importance of a combined traditional orthopedic exam, imaging, and movement assessment in diagnosis and treatment recommendations in those with nonarthritic hip pain.

Traditional Examination of the Hip

The traditional orthopedic exam of the hip has been fairly succinct. Range of motion in hip flexion, extension, internal rotation, external rotation, abduction, and adduction can be quickly completed in addition to strength assessment of the same movements. Common special tests include, but are not limited to, the dial test, log rolling, combined flexion, abduction, and external rotation (FABER), combined flexion, adduction, and internal rotation (FADIR), and scour testing. Simple palpation of the anterior, medial, lateral, and posterior hip and the lower abdominals may also be common practice. This exam can be completed rather methodically in a matter of minutes and is often the extent of the orthopedic exam combined with imaging findings on plain film radiographs and potentially MRI. There is evidence to support that imaging findings of FAI or labral pathology may be more common in the general population. It is our hypothesis that those who remain active, but without symptoms, may have better movement patterns and motor control than their peers, who are experiencing hip pain.

Movement Assessment and Common Findings

It is important to consider each individual patient's complaints or pain-inducing activities when selecting movements to assess; however, we have found that the following movement impairments are commonly present in patients with nonarthritic hip pain and, when improved, can have a significant impact on reduction of pain and/or success following hip arthroscopy.

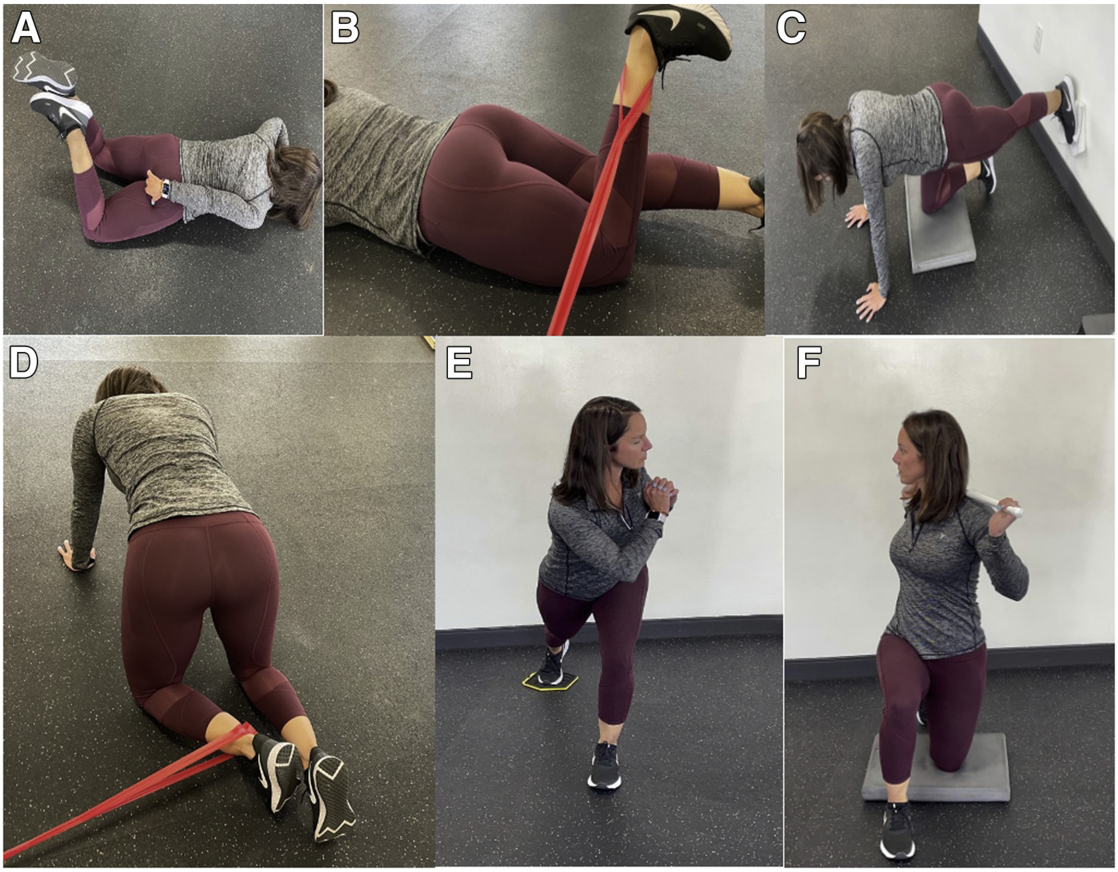

Fig 1. Deep rotator series. (A) Isometric activation of the deep rotators of the hip with palpation at the region of the quadratus femoris. The patient palpates the ischial tuberosity and drops off laterally into the musculature. The active foot is placed on the medial ankle of the contralateral side and is used to press in to for isometric external rotation. The patient is cued to use submaximal pressure and focus on the lower hip musculature without cocontraction of the larger (gluteal) muscles. (B) Prone resisted external rotation. The patient has a resistance band around the ankle, anchored directly lateral to the active side. With a stable pelvis, the patient pulls against the resistance into external hip rotation and controls the return to neutral starting position. (C) Quadruped, hip extended, IR/ER (joint centration) with neutral pelvis. Using a towel on the foot to cue extension through the hip, the patient maintains a neutral pelvis and lumbar spine while creating pure internal and external rotation of the femur. (D) Quadruped-resisted external rotation. With the resistance band anchored laterally and around the ankle of the active side, the patient maintains a stable pelvis and spine while pulling into external rotation and controlling the return to neutral. (E) Reverse lunge with slider and rotation. Maintaining stability in the lead leg, the patient slides into a reverse lunge and rotates the torso toward the front leg. The focus should be on loading the front hip and controlling the weight-bearing rotation. (F) Half kneeling torso rotation. While maintaining pelvic stability, the patient rotates toward the up leg and back to neutral.

Pelvic/Core Control

The presence of an anterior pelvic tilt is a common finding in those with nonarthritic hip pain.[6] Impairment findings with an excessive anteriorly tilted pelvis include an increased lumbar lordosis, limited lumbar flexion/tight paraspinals, and weakness in the abdominals. These impairments may create an increased demand on the hip flexors, which also can be tight and tender to palpation. Influenced by the Janda approach, Key et al. described the systemic local muscle system (SLMS) and systemic global muscle system (SGMS), which describe the musculature that functions in more local/postural control versus global/prime mover functions respectively.[7]

Observation of the pelvis, as well as the lumbar spine, while performing multisegmental flexion, standing active hip flexion, pelvic tilting, active supine straight leg raise, and prone rocking can expose patterns of weakness and compensations that may be putting excessive stress on the articular surfaces and/or labral tissue of the hip. Patients often struggle to create and maintain a more neutral pelvic position, especially when performing more dynamic movements. Multiple studies have demonstrated increased hip ROM with a more neutral to posteriorly tilted pelvic position versus a more anterior position.[6,8-10] A more anterior positioned pelvis creates decreased space between the rim of the acetabulum and the femur in the flexed and

Fig 2. Adductor series. (A) Hook lying hip adduction isometrics. Patient creates a neutral pelvic position and performs isometric squeeze on the ball between the knees. Emphasis can be placed on unilateral work as desired. (B) 90/90 hip adduction isometrics. Patient maintains a neutral pelvic position with the feet elevated in a 90/90 "tabletop" position and performs isometric squeeze on a ball between the knees. (C) Short-lever Copenhagen adductor plank. With the body lined up perpendicular to a bench and one knee on top of the bench, the patient performs a side plank then elevates the lower leg to meet the bottom of the bench. The patient should maintain a straight hip and spine alignment throughout. (D) Long lever Copenhagen adductor plank. With the body lined up perpendicular to a bench and one foot/ankle on top of the bench, the patient performs a side plank then elevates the lower leg to meet the bottom of the bench. The patient should maintain a straight hip and spine alignment throughout. (E) Half kneel adductor pulls. With a glider under one knee and foot, the patient extends the opposite leg laterally and pulls inward, using the adductors to glide across the floor. They can then eccentrically control the push movement going the opposite direction. (F) Lateral lunge with glider. With one foot on a disc or furniture mover, the patient performs a lateral lunge, controlling the range of motion eccentrically with the adductors and then pulls into the starting position.

rotated positions. This can create a functional impingement that may be modified with core stabilization and a more neutral pelvic position. Pelvic positioning and neuromuscular control become especially critical in those with increased mobility or generalized laxity. This becomes even more important for those who participate in activities that require end range stability, such as dance or gymnastics. Therefore, it is important to determine whether there is a true mobility restriction present about the hip or if there is a lack of motor control or overall stability. This will aid in creating better efficiency and efficacy of treatments used for those with hip pain. Our suggested assessments and potential treatment strategies for pelvis and core control are outlined in Table 1.

Deep Rotator Function

The six deep rotators of the hip comprise the piriformis, gemellus superior, obturator internus, gemellus inferior, obturator externus, and quadratus femoris. For many years now, the hip abductors and extensors have stolen the show when it comes to discussions related to hip strength in those with lower quarter pain or dysfunction. Although these larger muscles, which predominantly comprise the gluteus maximus, medius, and mimimus, are critical to hip function, they are often the only focus of treatment in patients presenting with hip pain. A comparison would be to treat all shoulder pain patients with exercises for the latissimus and deltoid, and to ignore the rotator cuff completely. Active stability of the hip is primarily modulated by the deep

Table 2. Thorax Rotation Assessment and Treatment Suggestions

Assessment	Criteria	Common Findings	Suggested Treatment
Multisegmental rotation	Standing tall with feet together, patient rotates to the right and left 100° or more with at least 50° from pelvis down and 50° from the thorax; no deviation/loss of height; feet remain flat on the floor; no use of momentum	Limited range of motion to one or both sides; limited motion at the pelvis and excessive motion in the thorax (hypermobility); forward flexion of the trunk; compensations at the foot/ankle	If limited motion, assess with lumbar locked test (below); if excessive motion in the thorax, assess segmental rolling patterns (below)
Lumbar locked extension/rotation test	In quadruped, patient rocks back onto heels in full flexion and rotates around center axis with goal of >45° of rotation, measuring the angle of the AC-to-AC joint line in reference to the horizontal.	Limited/<45° to one or both sides; side bending vs. rotation; compensations with upper body	If limited, assess the same movement passively. If still limited, assess and treat the thorax for mobility limitations; if normal and >45°, assess segmental rolling patterns and treat with stabilization progression.
Segmental rolling patterns	Without the use of the lower body, the patient uses the upper extremity and movement of the head to create a segmental roll from supine to prone and prone to supine. The reverse of this can be performed, leading with the lower extremity and keeping the upper body relaxed.	Use of the leg when leading with the arm to assist or use of the arms when leading with the leg; use of momentum; inability to roll in a direction or gets stuck in the movement and unable to complete the pattern.	Retrain the pattern with various forms of assistance to facilitate proper motor control. Once patterns are restored progress to higher-level stability training for rotational movements.

rotators. Activation of these muscles along with the iliocapsularis provides dynamic stabilization of the femoral head in the acetabulum, while at the same time decreasing the shearing forces on the hip joint.[11] Of the six muscles, the quadratus femoris, which takes its origin off the lateral border of the ischial tuberosity and inserts below the intertrochanteric crest of the femur can generally be palpated in the prone position to assess the ability to contract when creating external rotation force. When the deep rotators are inhibited or weak, there is a tendency for the gluteus maximus or other prime mover muscles to attempt to create the local stability. This, in turn, produces an increased posterior to anterior directed force of the femur on the acetabulum, causing poor joint centration with resultant irritability of the anterior hip structures. A proposed deep rotator series is outlined in Figure 1, A—F.

Adductor to Abductor Ratio

When it comes to the hip, most rehabilitation programs focus upon the gluteal muscles in terms of both function and training. The somewhat “forgotten muscles” of the adductor complex are underemphasized or mislabeled as tight based on patient complaints. In our observations, patients with hip pain often have weakness in the adductors associated with pain and palpable tenderness. This can often present as having high tone rather than a true shortening of the musculature. In addition, because of the attachment in the proximal groin, pain in the adductors can often be lumped in with joint pain due to the overlapping area of pain referral and similar nature of pain. Proper differential diagnosis can be very helpful in treatment planning for these individuals. Neuromuscular reeducation and gradual activation and strengthening of the adductors can improve mobility and decrease pain by creating a better agonist/antagonist relationship with the abductors. Tyler et al. found that ice hockey players who suffered groin injuries had lower adduction to abduction ratios, as compared to their uninjured peers at 78% versus 95%. Additionally, in the players who sustained a groin strain, preseason adduction to abduction strength ratio was lower on the side that subsequently sustained a groin strain when compared with the uninjured side at 70% versus 86%. A player was 17 times more likely to sustain an adductor muscle strain if his adductor strength was less than 80% of his abductor strength.[12,13] Although these studies were specifically done in ice hockey players, based on the best available evidence and clinical experience, we recommend aiming for an adductor to abductor ratio between .8 to 1.0. This can be assessed with hand-held dynamometry and easily managed and progressed in the clinic. Monitoring abduction fatigue and its role in the function of the adductors can also be beneficial in treatment progressions. As the abductors fatigue, the adductors may attempt to compensate, resulting in irritability or increased tone and creating more medial/groin pain. The clinician must keep a close eye on the patient’s exercise form and general fatigue level throughout the exercise progression. This can help prevent the patient from falling back into compensatory habits, while at the same time, it is helpful in determining recommendations for activity limits during rehabilitation. An example adductor progression is outlined in Fig 2, A-F.

Thorax Mobility and Stability

Traditionally, those with nonarthritic hip pain tend to do relatively well with sagittal plane activity. Transverse plane, rotational movement is typically more limited and painful. On the basis of the stability-mobility model, both the hip and thorax are generally areas of increased mobility, especially in rotational movement. In keeping with region interdependence, if one area is painful or limited, it may also place undue stress on the adjacent region due to avoidance or gross limitations. Improvement in thorax mobility may assist in taking some stress off the hip joint. In the presence of adequate mobility, efficient segmental stability can also help in creating a more controlled movement in the transverse plane. We suggest the use of a simple weightbearing multisegmental rotation assessment to look at combined spine and lower body rotation. When limited, using a lumbar locked thorax extension/rotation assessment can determine the presence of limited mobility versus stability or motor control dysfunction. This test, along with seated and half-kneeling rotation have been previously determined to be reliable assessments of torsos rotation.[14] Table 2 outlines our recommended assessment and potential treatment strategies for the thorax.

Discussion

Clinical Pathways and General Recommendations

This commentary is not an exhaustive list of all possible movement impairments affecting those with nonarthritic hip pain; however, it provides a starting point to on which to build. Although many patients will have dysfunction in the above areas, not all patients will be successful with conservative management and may proceed with surgical interventions. We have found in our clinical practice that by addressing the movement impairments, the patients are better prepared for surgery and have better postoperative outcomes. In similar fashion, we have also found that in many patients who have had previous arthroscopy and have not recovered or have been considered a "failed" procedure, these movement impairments are commonly present and have not been previously identified or treated. It is our belief that in many of these cases, the persistent joint irritability is a matter of abnormal stress on the joint due to poor movement rather than the presence of abnormal bony anatomy or labral damage. Movement dysfunctions in the presence of significant joint irritability are common. In these patients, a combined treatment approach using ultrasound guided intra-articular injection with physical therapy to address impairments can have a more successful outcome compared to those with traditional physical therapy alone. Assessment of the movement dysfunction both before and immediately following an injection with an anesthetic included can provide powerful insight into the role of pain in the patient's function.

Conclusion

There remains a gap in knowledge both generally, as it relates to the rehabilitation of nonarthritic hip pain, as well as the specific investigations of local muscular function around the hip. Most research on the spine, knee, and shoulder utilize fine wire electromyography (EMG) to assess the function of the stabilizers, as related to the prime movers. The location of the deeper stabilizing muscles about the hip makes EMG a much more difficult strategy; however, we are hopeful that the advances in assessment with the use of real-time ultrasound and dynamic MRI may lead to more research to back these proposed ideas. As we continue to learn through mutual experiences both in true investigative fashion and through anecdotal clinical experience, it is crucial to the success of our professions both as rehab providers and physicians to share these ideas and experiences to better serve this somewhat complex patient population. It is our belief that this combined model can help identify movement dysfunction that may lead to poor surgical outcomes and develop improved nonoperative or preoperative care pathways.

References

1. Zusmanovich M, Haselman W, Serrano B, Banffy M. The incidence of hip arthroscopy in patients with femoroacetabular impingement syndrome and labral pathology increased by 85% between 2011 and 2018 in the United States. *Arthroscopy* In press. https://doi.org/10.1016/j.arthro.2021.04.049.
2. Cevallos N, Soriano KKJ, Flores SE, Wong SE, Lansdown DA, Zhang AL. Hip arthroscopy volume and reoperations in a large cross-sectional population: High rate of subsequent revision hip arthroscopy in young patients and total hip arthroplasty in older patients. *Arthroscopy* 2021;37:3445-3454.e1. doi:10.1016/j.arthro.2021.04.017.
3. Frank JM, Harris JD, Erickson BJ, et al. Prevalence of femoroacetabular impingement imaging findings in asymptomatic volunteers: A systematic review. *Arthroscopy* 2015;31:1199-1204. doi:10.1016/j.arthro.2014.11.042.
4. Griffin DR, Dickenson EJ, O'Donnell J, et al. The Warwick Agreement on femoroacetabular impingement syndrome (FAI syndrome): An international consensus statement. *Br J Sports Med* 2016;50:1169-1176. doi:10.1136/bjsports-2016-096743. PMID: 27629403.

5. Wall PD, Fernandez M, Griffin DR, et al. Nonoperative treatment for femoroacetabular impingement: A systematic review of the literature. *PM R* 2013;5:418-426. doi:10.1016/j.pmrj.2013.02.005.
6. Patel RV, Han S, Lenherr C, Harris JD, Noble PC. Pelvic tilt and range of motion in hips with femoroacetabular impingement syndrome. *J Am Acad Orthop Surg* 2020;28:e427-e432. doi:10.5435/JAAOS-D-19-00155.
7. Key J, Clift A, Condie F, Harley C. A model of movement dysfunction provides a classification system guiding diagnosis and therapeutic care in spinal pain and related musculoskeletal syndromes: a paradigm shift—Part 1. *J Bodyw Mov Ther* 2008;12:7-21. doi:10.1016/j.jbmt.2007.04.005.
8. Ross JR, Nepple JJ, Philippon MJ, Kelly BT, Larson CM, Bedi A. Effect of changes in pelvic tilt on range of motion to impingement and radiographic parameters of acetabular morphologic characteristics. *Am J Sports Med* 2014;42:2402-2409. doi:10.1177/0363546514541229.
9. Swärd Aminoff A, Agnvall C, Todd C, et al. The effect of pelvic tilt and cam on hip range of motion in young elite skiers and nonathletes. *J Sports Med* 2018;9:147-156. doi:10.2147/OAJSM.S162675.
10. Kobayashi N, Higashihira S, Kitayama H, et al. Effect of decreasing the anterior pelvic tilt on range of motion in femoroacetabular impingement: A computer-simulation study. *Orthop J Sports Med* 2021;9:2325967121999464. doi:10.1177/2325967121999464.
11. Retchford TH, Crossley KM, Grimaldi A, Kemp JL, Cowan SM. Can local muscles augment stability in the hip? A narrative literature review. *J Musculoskelet Neuronal Interact* 2013;13:1-12.
12. Tyler TF, Nicholas SJ, Campbell RJ, McHugh MP. The association of hip strength and flexibility with the incidence of adductor muscle strains in professional ice hockey players. *Am J Sports Med* 2001;29:124-128. doi:10.1177/03635465010290020301.
13. Tyler TF, Nicholas SJ, Campbell RJ, Donellan S, McHugh MP. The effectiveness of a preseason exercise program to prevent adductor muscle strains in professional ice hockey players. *Am J Sports Med* 2002;30:680-683. doi:10.1177/03635465020300050801.
14. Johnson KD, Kim KM, Yu BK, Saliba SA, Grindstaff TL. Reliability of thoracic spine rotation range-of-motion measurements in healthy adults. *J Athl Train* 2012;47:52-60. doi:10.4085/1062-6050-47.1.52.