Physical Therapy in Sport 14 (2013) 3–16

Contents lists available at SciVerse ScienceDirect

Physical Therapy in Sport

journal homepage: www.elsevier.com/ptsp

Masterclass

A suggested model for physical examination and conservative treatment of athletic pubalgia

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ARTICLE INFO

Article history:
Received 13 December 2011
Received in revised form
12 March 2012
Accepted 6 April 2012

Keywords:
Athletic pubalgia
Sports hernia
Diagnosis
Treatment
Review

ABSTRACT

Background: Athletic pubalgia (AP) is a chronic debilitating syndrome that affects many athletes. As a syndrome, AP is difficult to diagnose both with clinical examination and imaging. AP is also a challenge for conservative intervention with randomized controlled trials showing mixed success rates. In other syndromes where clinical diagnosis and conservative treatment have been less than clear, a paradigm has been suggested as a framework for clinical decision making.
Objectives: To propose a new clinical diagnostic and treatment paradigm for the conservative management of AP.
Design: Relevant studies were viewed with regard to diagnosis and intervention and where a gap in evidence existed, clinical expertise was used to fill that gap and duly noted.
Results: A new paradigm is proposed to assist with clinical diagnosis and non-surgical intervention in patients suffering with AP. The level of evidence supporting this paradigm, according to the SORT taxonomy, is primarily level 2B.
Conclusions: Further testing is warranted but following the suggested paradigm should lead to a clearer diagnosis of AP and allow more meaningful research into homogeneous patient populations within the AP diagnostic cluster.
Strength-of-Recommendation Taxonomy (SORT): 2B

1. Introduction

Athletic pubalgia (AP), broadly defined as pain in the groin and pubic region, is a relatively common entity in competitive athletes and considered one of the most common injuries in hockey (Agel, Dompier, Dick, & Marshall, 2007), soccer (Arnason, Sigurdsson, Gudmundsson, Holme, Engebretsen, & Bahr, 2004), and Australian rules football (Orchard & Seward, 2002). For such a common entity, relatively little is known about this syndrome. Similar to other syndromes, AP is a collection of signs and symptoms arising from multiple pathologies that are difficult to distinguish from one another (Nam & Brody, 2008). Evidence of this fact are the multiple labels associated with AP (Table 1) and that as many as 90% of athletes with chronic groin pain have multiple pathologies (Caudill, Nyland, Smith, Yerasimides, & Lach, 2008). Names using the term "hernia" appear to be losing favor since often, a hernia is not distinguishable (Davies, Clarke, Gilmore, Wotherspoon, & Connell, 2010; Zoga et al., 2008). Further, imaging including bone scintigraphy, radiographs, and magnetic resonance (MR) are prone to false positive reports (Davies et al., 2010; Silvis et al., 2011). One recent author referred to this region of the body as, "the Bermuda triangle of sports medicine"(Bizzini, 2011). The implication of this statement is that navigating through diagnosis and intervention is challenging, with a great probability of misdiagnosis driving inefficient treatment. One reason for this difficulty may be the reliance on a pathology-based diagnosis to drive intervention.

Two randomized controlled trials (RCTs), using the same active intervention protocol on heterogeneous patient populations, report conflicting levels of success with conservative intervention in patients with AP (Holmich et al., 1999; Paajanen, Brinck, Hermunen, & Airo, 2011). Similar diagnostic and treatment issues have been reported relative to low back pain syndrome (LBPS). New classification schemes have been proposed to help improve the diagnostic process and create smaller, homogeneous patient groups where the effectiveness of treatment can better be examined in patients with

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doi:10.1016/j.ptsp.2012.04.002

Table 1
Synonyms for athletic pubalgia.

Athletic pubalgia
Sports hernia
Sportsmen hernia
Sportsmen's groin
Pubic inguinal syndrome
Osteitis (Os) pubis
Chronic groin pain
Gilmore groin
Adductor-related groin pain
Prehernia complex
Symphysis syndrome
Gracilis syndrome
Groin disruption

LBPS (Delitto, Erhard, & Bowling, 1995; Hall, McIntosh, & Boyle, 2009). These classification schemes have shown promise in the form of improved patient outcomes (Brennan, Fritz, Hunter, Thackeray, Delitto, & Erhard, 2006; Hall et al., 2009). The purpose of this review is to propose a new paradigm which will serve as a skeletal framework for clinical diagnosis and conservative management of AP. The review may assist in guiding future research and improving patient outcomes with conservative treatment for patients with AP.

2. Operational definition and brief anatomy review

Because of the complexity of AP, the operational definition in any clinical review of the topic is important to establish. For this paper, we will define athletic pubalgia as pain in the groin region, medial thigh, lower abdomen, or pubic region that presents in athletes and may encompass the following pathologies: damage to the tendons, fascia, or sheaths in our defined region exempting inguinal hernia and inflammation of the pubic bone from systemic disease or fracture.

Captured by our operational definition of athletic pubalgia are tendinopathies (Kalebo, Karlsson, Sward, & Peterson, 1992; Schilders, Talbot, Robinson, Dimitrakopoulou, Gibbon, & Bismil, 2009), osteitis pubis (Smodlaka, 1980), posterior inguinal wall insufficiency (Hackney, 1993; Orchard, Read, Neophyton, & Garlick, 1998), and nerve entrapments in the inguinal region (Ekberg, Persson, Abrahamsson, Westlin, & Lilja, 1988). A brief review of the anatomy of this region will further elucidate our operational definition of AP. For a more thorough review of the anatomy of this region, the reader is referred to Falvey, Franklyn-Miller, and McCrory (2009). From the pubic symphysis medially to the anterior-superior iliac spine (ASIS) laterally, there are many structures with the potential to cause pain associated with athletic pubalgia: 1) From above, the rectus abdominus, internal oblique, external oblique, and transverse abdominus muscles/tendons/sheaths as well as the inguinal ligament (the fold of the external oblique); 2) From below, the adductor group of muscles, the gracilis, the pectineus, and the iliopsoas. The inguinal canal is formed by contributions from the external oblique (anterior wall and base), internal oblique, and the transverse abdominus (posterior wall and ceiling). Innervation of the area varies but generally speaking, the pubic symphysis is innervated by the genitofemoral and pudendal nerves; the adductor group and gracilis by the obturator nerve; the pectineus and iliacus by the femoral nerve; the psoas directly from the lumbar plexus (L1-3); the rectus abdominus by the thoracoabdominal nerve (originating partially from L1-2); and the internal oblique, external oblique, and transverse abdominus muscles receive innervations from the distal thoracic/upper lumbar spine (Akita, Niga, Yamato, Muneta, & Sato, 1999; Rab, Ebmer, & Dellon, 2001).

3. Theories of pain and dysfunction in AP

Because of the complex innervation of this region, one theory is that nerve entrapment is a potential source of pain in AP (Falvey et al., 2009). Theoretically, the most frequent nerve entrapment in this region is that the cutaneous branches of the ilioinguinal or the genitofemoral (genital branch) nerves become entrapped secondary to weakness in the posterior wall of the inguinal canal (Akita et al., 1999; Bradshaw & McCrory, 1997).

The second and most prevalent theory is more biomechanical in nature and may also explain the weakness in the posterior wall of the inguinal canal. This biomechanical theory stated simply is that an imbalance between normal anatomic structures can change the ability of those structures to dissipate load (Biedert, Warnke, & Meyer, 2003; Holmich et al., 1999; Meyers, Foley, Garrett, Lohnes, & Mandlebaum, 2000). This inability to transmit load is key since the pelvic bone and pubic symphysis are vital links in transferring forces from the lumbosacral region to the hip joint (Dalstra & Huiskes, 1995). Altered load tolerance in this region may cause pelvic instability (Garvey, Read, & Turner, 2010; Mens, Inklaar, Koes, & Stam, 2006; Williams, Thomas, & Downes, 2000) as well as damage to tendons and other soft tissues and their bony interface (Cook & Purdam, 2009; Cunningham, Brennan, O'Connell, MacMahon, O'Neill, & Eustace, 2007; Schilders et al., 2009). The resultant pain my further compromise the motor control of this region (Cowan, Schache, Brukner, Bennell, Hodges, Coburn, 2004).

4. Proposed paradigm for clinical examination and treatment

In the presence of such uncertainty with regard to a complex, painful, and recalcitrant entity like AP, we would like to propose a paradigm that, we hope, will aide in arriving at a diagnosis that will drive efficient and effective conservative intervention. We present this paradigm in Fig. 1 and describe the paradigm in greater detail hereafter. This paradigm will serve as the framework upon which to lay the evidence about diagnosis and treatment of AP. The paradigm can be sub-divided, for simplicity, into 2 halves: 1. examination leading to diagnosis; 2. intervention leading to return to function. The examination component begins with a focus primarily, but not exclusively, on ruling out more common diagnoses that refer pain to this region, eventually focusing on AP as the "only diagnosis left standing". This process, called diagnosis by exclusion, has been advocated in other difficult-to-diagnose syndromes (Spiegel, Farid, Esrailian, Talley, & Chang, 2010), especially in the absence of definitive diagnostic criteria, as is the case with AP. As more is discovered about a syndrome, the diagnostic process often changes from diagnosis by exclusion to criteria-based diagnosis. Criteria-based diagnosis is a list of items that are clinically useful in diagnosis of a syndrome. In addition to helping the clinician to rule out competing diagnoses, the proposed paradigm presents evidence-based criteria to help isolate the diagnosis of AP.

The second part of the paradigm, intervention, presents a linear (stage-based) sequence which starts with addressing local impairments like pain, motion loss, and strength loss then progresses to a regional approach and finally to a whole body approach. Again, for simplicity, the sequence is presented in a linear fashion from impairment-based to multi-modal treatment but the clinical reality is that these intervention approaches are often parallel, and not linear. This paradigm is not the invention of the authors but rather, is based on original work by Delitto et al. (1995), Childs, Fritz, Piva, & Whitman (2004), and a refinement of thoughts compiled over the years and obtained from interaction with professional colleagues and students.

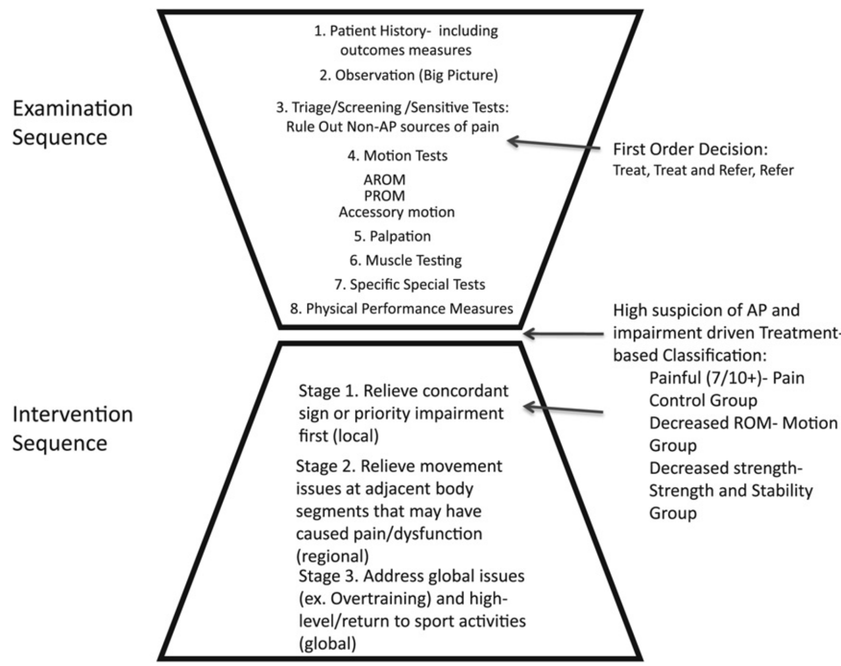

Fig. 1. A proposed paradigm for examination and treatment of patients with athletic pubalgia (AP).

5. Examination sequence

5.1. *Patient history and self-report outcomes measures*

The patient with AP will most often report insidious or non-contact related unilateral pain in the adductor region and/or lower abdominals (Ekstrand & Gillquist, 1983; Verrall, Slavotinek, Fon, & Barnes, 2007). Further questioning is likely to reveal multiple pain episodes and/or chronic pain (Arnason et al., 2004; Emery & Meeuwisse, 2001; Gabbe et al., 2010). As the condition worsens, symptoms may present bilaterally and refer into the testicular region (in males)(Meyers et al., 2000; Schilders et al., 2009). The patient is likely to report that they are not only an athlete, but a highly competitive athlete (Meyers et al., 2000; Zoga et al., 2008). The sport in which the athlete participates is likely to be soccer, American or Australian Rules football, rugby, or hockey (Arnason et al., 2004; Bradshaw & McCrory, 1997; Ekstrand & Gillquist, 1983; Meyers et al., 2000; Verrall, Slavotinek, Fon, et al., 2007; Weir, de Vos, Moen, Holmich, & Tol, 2011; Zoga et al., 2008). Interestingly, 3 studies (Bradshaw & McCrory, 1997; Holmich, 2007; Zoga et al., 2008) demonstrated that runners were a likely group to suffer from AP, although 2 of those studies suggested that other sources of pain from the hip joint were contributory (Bradshaw & McCrory, 1997; Holmich, 2007).

Patient report outcomes measures are widely used in an attempt to capture results from treatment that are meaningful to patients and to address constructs like function and readiness to return to sport. These measures can be region-specific (hip), condition-specific (AP), dimension-specific (pain), generic (health profile), or individualized (patient chooses items of importance)(Garratt, Schmidt, Mackintosh, & Fitzpatrick, 2002). A recent review of region-specific outcomes measures for the hip revealed only one questionnaire for the groin region (Thorborg, Roos, Bartels, Petersen, & Holmich, 2010). This measure was found to be of lower quality and was used only in post-operative patients. More recently, Thorborg, Holmich, Christensen, Petersen, & Roos (2011) developed and validated the Hip and Groin Outcome Score (HAGOS), an outcomes measure which uses 6 subscales to capture not only the patient's disability but also the patient's perception of his or her disability. The authors concluded, based on 101 subjects, that the questionnaire had "adequate" measurement qualities. Independent validation has yet to be performed on the HAGOS, as such, we believe it prudent to recommend the use of dimension-specific, generic, and individualized measures. Because the conceptual frameworks for generic, individualized, and dimension-specific measures differ, all are needed to provide more inclusive and valid understanding of outcomes in patients with AP. An important note is that our level of evidence rating for this category does not reflect the evidence supporting the following outcomes measures, but instead, reflects that the use of these measures in a population with AP is recommended based on our clinical experience rather than the actual validation of these measures in this population.

The chief impairment to capture in patients with AP is pain given that pain is generally what drives the patient to seek care. Pain is a multidimensional construct with affective, sensory, and intensity components (Hegedus et al., 2010). The affective and sensory components can be captured by the Short Form McGill Pain Questionnaire (SFMPQ)(Melzack, 1987) which is a valid (Melzack & Katz, 2001) and reliable (Grafton, Foster, & Wright, 2005) instrument. There are multiple ways to capture a pain intensity rating. The Numeric Pain Rating Scale (NPRS)(Jensen, Karoly, & Braver, 1986) is an 11-point (0 = no pain; 10 = worst possible pain), consistent measure of pain intensity that can be adapted to ask about pain at rest, pain during regular daily activities, and pain during sport (Price, Bush, Long, & Harkins, 1994).

The Lower Extremity Functional Scale (LEFS) is a generic measure of lower extremity function validated in an outpatient setting (Binkley, Stratford, Lott, & Riddle, 1999). The LEFS contains 20 questions about a person's ability to perform everyday tasks and can be used to evaluate the functional impairment of a patient with a disorder of one or both lower extremities. The LEFS can be used by clinicians as a measure of patients' initial function, ongoing progress and outcome, as well as to set functional goals. A higher score toward 80 represents excellent function whereas a lower score toward 0 represents functional losses. Test-retest reliability of the

LEFS has been demonstrated to be excellent ($R = 0.86$) in outpatients with lower-extremity musculoskeletal dysfunction (Binkley et al., 1999) and the LEFS was also found to be valid, responsive and reliable in an inpatient orthopedic setting (Yeung, Wessel, Stratford, & Macdermid, 2009).

Another generic measure is the Single Assessment Numeric Evaluation (SANE)(Williams, Gangel, Arciero, Uhorchak, & Taylor, 1999). The SANE is a patient-based outcome measure used to establish patient perception of overall results. The SANE rating is determined by patient response to the following question: "How would you rate your hip today as a percentage of normal (0–100% scale with 100% being normal)?". The definition of SANE is based on the personal experience of the patient including satisfaction and adaptation to symptoms, focusing on the concept of expected level of performance. Therapeutic success can thus be defined at the individual level (i.e., for each patient) as achieving a state acceptable at the end of the care. The SANE method enables clinicians to further understand the process of recovery within the multiple dimensions that exist. The SANE is time-efficient and correlates well with other established outcomes measure but has not been studied in patients with AP.

The Patient-Specific Functional Scale (PSFS) is an individualized functional outcome scale used to evaluate changes in disability over time (Chatman et al., 1997). The PSFS may assist clinicians in goal setting and targeted treatment interventions to achieve pre-specified goals. The PSFS requires patients to identify three activities that they are having difficulty with or are unable to perform (Chatman et al., 1997; Young, Michener, Cleland, Aguilera, & Snyder, 2009). The patient rates each activity on a 0 ("unable to perform activity") to 10 ("able to perform activity at same level as before injury or problem") scale, with the final score determined by averaging the three activity scores. A higher score toward 10 represents the ability to perform the activity well with lower scores representing a lower level of function. Test-retest reliability of the PSFS has been demonstrated to be excellent ($R = 0.84$) in patients with knee dysfunction (Chatman et al., 1997).

5.2. *Observation*

Observation is defined as the process of looking at the patient as a whole, followed by inspection of the localized area of symptoms.

The stereotypical patient with AP is a young, male athlete. In reality, this picture becomes less clear when the evidence is examined. While the term athlete is an accurate descriptor in the majority, the age, experience, and gender of the athlete are less clear. In one study involving Australian Rules football players, AP was more common in the young (Orchard, Wood, Seward, & Broad, 1998). A second study with a broader sample population confirmed that those with AP are mostly under the age of 40 (Zoga et al., 2008). However, in a study of National Hockey League players, Emery and Meeuwisse (Emery & Meeuwisse, 2001) found groin pain to be more common in older, more experienced players. Finally, a study of professional soccer players reported that those aged 16–21 years were least likely to have a groin injury when compared to 22–30 year olds (most injured), and those over 30 (2nd most injured)(Ekstrand, Hagglund, & Walden, 2011).

With regard to gender, the usual report is that more males than females are prone to AP. While there seems to be good support for this statement (Bradshaw & McCrory, 1997; Holmich, 2007; Meyers et al., 2000; Zoga et al., 2008), the gender difference may be related to sport. Female runners may have a higher incidence of AP (Bradshaw & McCrory, 1997; Holmich, 2007) and in competitive hockey, there may be no gender difference at all (Schick & Meeuwisse, 2003). Because most of the studies we examined consisted of relatively small samples of convenience, there is certainly room for greater understanding of the risk factors associated with AP. There is also reason to suspect that the stereotype of the young male who plays a cutting sport may not be entirely accurate nor all encompassing.

In our clinical experience, there is very little from a local observational perspective that can be considered a hallmark sign of AP. Observed findings like ecchymosis, an obvious inguinal bulge, or an antalgic gait have been inconsistent or non-existent.

5.3. *Triage and screening*

Triage and screening is defined as the process by which the examiner rules out, via clinical examination, more serious pathology, pathology that is outside the practice scope of that practitioner, or pathology that requires imaging or lab testing in order that the following decision can be made: refer, treat independently, or treat and refer. This step is critical in a syndrome like AP.

In order to make the decision to refer, the examiner must reconcile with the fact that any clinical examination is imperfect and that serious pathology or pathology that requires further testing beyond physical examination can mimic the signs and symptoms of AP. Further, since AP is a syndrome, other non-urgent, musculoskeletal causes of groin pain must be ruled out before arriving at a diagnosis of AP. Signs of more serious pathology are referred to as "red flags" and generally, the first step in detecting red flags is a standardized medical questionnaire. A detailed medical questionnaire is beyond the scope of this article, but these questions should broach urological, gynecological, rheumatologic, oncologic, and inflammatory sources of groin pain including testicular seminoma, prostatitis, epididymitis, endometriosis, ankylosing spondylitis, inflammatory bowel disease, appendicitis, and genital herpes. Of note, in one study, 16 of 17 females with groin pain were found to have another source of pain beyond AP further suggesting the need for a detailed screen as part of the clinical examination (Meyers et al., 2000). Other red flags include a history of trauma, fever, unexplained weight loss, burning with urination, night pain, and prolonged corticosteroid use (Gabbe et al., 2010; Leerar, Boissonnault, Domholdt, & Roddey, 2007; Van den Bruel, Haj-Hassan, Thompson, Buntinx, & Mant, 2010). An affirmative response to any of these questions or a report of any of these symptoms would require more in-depth questioning and may result in immediate referral or further medical testing or imaging.

The next step is to attempt to discern among the various neuromusculoskeletal sources of groin pain. These sources of groin pain may include but are not limited to hip osteoarthritis, femoroacetabular impingement, hip labral tear, lumbosacral pathology, pelvic or hip stress fracture, and true inguinal hernia (Caudill et al., 2008; Fon & Spence, 2000; Tibor & Sekiya, 2008). In fact, the hip may be the main source of referred pain to the groin and so hip pathology needs to be ruled out before a diagnosis of AP can be suspected (Bradshaw, Bundy, & Falvey, 2008). An efficient way to begin to differentiate the many potential pain referral sources is through the lower quarter screening examination. Traditionally, the lower quarter screen consists of testing of dermatomes, myotomes, deep tendon reflexes, and possible upper motor involvement. Any screening exam should be composed of tests with high sensitivity (Grimes & Schulz, 2002). Since the traditional neurological "screen" (Table 2) actually is composed of tests that are specific rather than sensitive (Cook, Hegedus, Pietrobon, & Goode, 2007), we suggest a modification of that screen that adds sensitive tests that, when negative, assist in ruling out pathology with similar signs and symptoms to AP: intra-articular hip pathology, hip OA, the lumbosacral spine, and fractures and stress fractures. Suggested sensitive additions to the lower quarter screen can be found in Table 3 and we will discuss the screening examination in greater detail here. We

Table 2
Traditional components of a lower quarter screening examination.

Item	Description	Key metrics (if available)	Interpretation
Dermatome testing	L1 – inguinal L2 – inner thigh L3 – medial knee L4 – Medial malleolus (Peeters, Aufdemkampe, & Oostendorp, 1998) L5 – web space of great and 2nd toe (Kerr, Cadoux-Hudson, & Adams, 1988) S1 – underside of foot (Kerr et al., 1988)	SP 88; LR+ 4.0 SP 86; LR+ 1.14 SP 86; LR+ 2.0	Decreased or loss of sensation in any of these dermatomes should cause suspicion of referred pain from the spine and be combined with myotome, reflex, and upper motor neuron (UMN) testing
Myotome testing	L1-2 Resisted hip flexion (Lauder et al., 2000a) L2-3 Single leg sit to stand (Rainville, Jouve, Finno, & Limke, 2003) L4-5 Heel walking L5-S1 Toe walking	SP 84; LR+ 4.38	Weakness compared to the uninvolved side in any of these myotomes should cause suspicion of spine or upper motor neuron pathology and be combined with dermatome, reflex, and upper motor neuron (UMN) testing
Reflex testing	L2-3 Quadriceps (Lauder et al., 2000b) L4-5 Achilles (Lauder et al., 2000b) L5-S1 Extensor Digitorum Brevis (Marin, Dillingham, Chang, & Belandres, 1995)	SP 96; LR+ 3.0 SP 92; LR+ 1.88 SP 91; LR+ 1.56	Hyper- or hypo- reflexia compared to the uninvolved side in any of these deep tendon reflexes should cause suspicion of spine or upper motor neuron pathology and be combined with dermatome, myotome, and upper motor neuron (UMN) testing
Upper motor neuron (UMN) testing	Babinski (Berger & Fannin, 2002)	SP 90; LR+ 8.0	Great toe extension with flexion of the remaining 4 toes is considered positive for an UMN lesion. The patient should be referred for further testing.

SP = specificity; LR+ = positive likelihood ratio; ROM = range of motion.

encourage clinicians to adapt the order in which we present this screen for the convenience of individual patients and circumstances.

The first steps in the screening examination for suspected AP is to rule out the hip joint and lumbosacral region. If hip range of motion (ROM) is not limited in any plane, OA, regardless of severity can be ruled out (Birrell, Croft, Cooper, Hosie, Macfarlane, & Silman, 2001). Even if ROM is limited in only 1 plane, hip OA is an unlikely contributor (Birrell et al., 2001). Femoroacetabular impingement (FAI) and labral tears often are found together on imaging and both can refer pain that is similar to that experienced with AP. The Flexion Adduction Internal Rotation (FADIR) test has been studied multiple times and according to one comprehensive source (Cook & Hegedus, 2007), the FADIR test has high sensitivity which is helpful in ruling out both impingement and labral tears when negative. We support this use of the FADIR test with some caution since the specificity of the FADIR test has been reported in only one study and in this study, the sensitivity was only 59% (Troelsen, Mechlenburg, Gelineck, Bolvig, Jacobsen, & Soballe, 2009). Fractures and stress fractures, while not necessarily an intra-articular pathology, are still a concern in a relatively young, active population. The Patellar Pubic Percussion (PPP) Test is helpful in ruling out a fracture between the patella and pubic bone when negative (Adams & Yarnold, 1997). If this test is positive, the practitioner should refer for imaging (Adams & Yarnold, 1997). The Fulcrum Test (Johnson, Weiss, & Wheeler, 1994) is used in a like fashion to the PPP Test but for cases of stress fracture of the femur. An important point to

Table 3
Additional sensitive components of the lower quarter screen for patients with AP.

ITEM	Description	Key metrics	INTERPRETATION
Repeated lumbar motion (Donelson et al., 1997)	The patient repeats forward, backward, and side bending	SN 92; LR– 0.12	If repeated motions don't reproduce the pain, the lumbar spine is ruled out
Thigh Thrust Test (Laslett et al., 2005)	The patient is supine and the hip and knee are flexed to 90°. The examiner provides compression along the long axis of the femur using a hand under the patient's sacrum as a wedge to create shearing force at the SIJ.	SN 88; LR– 0.17	If the thigh thrust does not reproduce the patient's pain, the sacroiliac joint is ruled out
Sensitive tests of the hip:			
1. Flexion Adduction Internal Rotation Test (FADIR)(Ito, Leunig, & Ganz, 2004; Sink, Gralla, Ryba, & Dayton, 2008)	The patient is supine. The examiner moves the patient's leg into the combined motions of flexion, adduction, and internal rotation FAI, labrum	SN 96 to 100	If the FADIR does not reproduce the patients pain, then FAI and/or a torn labrum can be ruled out
2. Hip ROM	Lack of limitation in any hip motion (Birrell et al., 2001)	SN 100	With OA of the hip, there is generally a loss of ROM in 2 or more planes. If ROM is limited in 1 or less planes, OA is unlikely.
3. Patellar Pubic Percussion (PPP) Test (Adams & Yarnold, 1997)	A stethoscope is placed on the pubic bone while the examiner either taps or places a tuning fork on the patella.	SN 94; SP 95 LR+ 20; LR– 0.06	If auscultation produces like sounds bilaterally, then femoral neck fracture can be ruled out. Different sounds means refer for imaging.
4. Fulcrum test (Johnson et al., 1994)	The patient is seated at the end of a table with the examiner's forearm placed under the thigh. The examiner pushes the patient's leg down on to the forearm.	SN 100	If the patient's pain is not reproduced, then a femoral stress fracture can be ruled out. A positive test means refer for imaging

SIJ = Sacroiliac Joint; SN = Sensitivity; LR+ = positive likelihood ratio; LR– = negative likelihood ratio; ROM = range of motion; SP = specificity.

reiterate is that the benefit of most of these tests is that they are used early in the examination and that their value is in being negative which helps rule out hip pathologies.

Once the decreased likelihood of referral from the hip joint has been established, the lumbosacral region should be ruled out. According to the literature, lack of symptom reproduction following repeated flexion, extension, and side bending of the lumbar spine can rule out the lumbar spine as a contributor (Donelson, Aprill, Medcalf, & Grant, 1997). The clinician is also encouraged to perform passive accessory intervertebral motion testing of the lumbar spine for symptom reproduction as described by Maitland (Maitland, Hengeveld, & Banks, 2002) to further clear the lumbar spine as a potential contributor. Next, the sensitive Thigh Thrust Test is performed to rule out the sacroiliac joint (SIJ)(Laslett, Aprill, McDonald, & Young, 2005). If the patient does not report reproduction of the chief complaint of pain, then the SIJ has been ruled out. A positive finding with any of these tests is less helpful since all have lower specificities meaning a positive test cannot be used to rule in AP. Also, these tests are imperfect in that their sensitivities are not 100%. This imperfection means that in daily clinical practice, there will be some tests that are falsely negative. Despite their imperfection, screening tests are important since AP is a diagnosis of exclusion.

5.4. Diagnosis of AP

Assuming that the clinician has effectively ruled out the lumbosacral spine, intra-articular hip pathology, fractures, and other sources of referred symptoms to the groin region, the next logical step is to continue with a focused clinical examination involving motion testing, palpation, strength testing, and finally, specific special tests for AP.

5.4.1. Motion testing

Motion testing includes active (AROM), passive (PROM), and accessory motions. For this review, we have combined the evidence on AROM and PROM since, often, authors of the papers included in our review did not specify whether the assessed motion was tested actively or passively. We have captured this combination by using the simplified abbreviation of ROM. The evidence correlating AP and ROM is conflicting. Some have hypothesized that AP is caused by overstretching of the hip into abduction and external rotation which implies a lack of flexibility in these two motions (Merrifield & Cowan, 1973). Lack of flexibility has been found to be correlated with AP in numerous studies (Arnason et al., 2004; Delahaye et al., 2003; Ekstrand & Gillquist, 1983; Ibrahim, Murrell, & Knapman, 2007; Verrall et al., 2005; Verrall, Slavotinek, Barnes, Esterman, Oakeshott, & Spriggins, 2007); still other studies have found flexibility to be no issue (Emery & Meeuwisse, 2001; Tyler, Nicholas, Campbell, & McHugh, 2001; Witvrouw, Danneels, Asselman, D'Have, & Cambier, 2003). The motions most often reported as limited are hip internal rotation, external rotation, and abduction implying that the hip rotators and adductor group exhibit decreased flexibility. No studies were found examining the correlation between accessory motions and AP but one case series did report decreased anterior and posterior glide of the hip in patients with AP (Kachingwe & Grech, 2008). The debate of the importance of ROM as a contributing factor to AP will continue but due to the findings in some studies of limited motion, we suggest that the detailed examination of patients with AP include ROM testing. We also believe that pain reproduction with accessory motions of the pubic symphysis may be an important finding but there is no research to support this statement.

5.4.2. Palpation

Experts have recommended palpation over specific structures such as the adductor longus muscle insertion, pubic symphysis joint, rectus abdominis muscle, and the psoas muscle to further localize the source of pain (Holmich, Holmich, & Bjerg, 2004; Meyers et al., 2000). One study found tenderness over the pubic bone in 75% of Australian Rules Football players with groin pain which was strongly correlated with training restriction during the season (Slavotinek, Verrall, Fon, & Sage, 2005). Another study found superior pubic ramus pain with palpation in 85% of subjects (Verrall, Slavotinek, Fon, et al., 2007). Further, the lack of a palpable hernia was reported in one study (Meyers et al., 2000). Intra-observer agreement for pain provocation over specific structures is generally found to be good ($K > 0.80$)(Holmich et al., 2004). Based on this moderate level research, we recommend a detailed palpation of the pubic region including the pubic ramus and symphysis, the lower abdominals, and the adductor region with the intent of reproducing the patient's complaint of pain.

5.4.3. Strength testing

Strength testing in patients with AP is recommended, although the reliability of testing internal and external rotation of the hip has been questioned (Malliaras, Hogan, Nawrocki, Crossley, & Schache, 2009). One study (Emery & Meeuwisse, 2001) reported no association of strength deficit with AP, but the majority of evidence supports a correlation of strength loss with AP (Crow, Pearce, Veale, VanderWesthuizen, Coburn, & Pizzari, 2010; Delahaye et al., 2003; Hemingway, Herrington, & Blower, 2003). Strength has generally been tested against resistance provided by an examiner with the results classified as pain or loss of strength in a single plane, as a ratio of one muscle group to another, or as a motor control issue. Several studies have correlated hip weakness or pain with resisted hip testing with AP (Crow et al., 2010; Delahaye et al., 2003; Hemingway et al., 2003; Tyler et al., 2001). Crow et al. (2010) reported decreased hip adductor strength both prior to and during an episode of AP suggesting weakness as both a causative and resultant factor. Muscle strength imbalance has been considered a greater risk factor in developing sports related groin pain than the measurement of isolated adductor strength alone. Tyler, Nicholas, Campbell, Donellan, & McHugh (2002) found adductor strength to be 18% less than the abductor strength in injured vs. uninjured ice hockey players. The same study reported an athlete as 17 times more likely to experience an adductor muscle strains if their adductor strength is less than 80% of their abductor strength. Others have correlated oblique or rectus abdominus weakness or pain with resisted testing with AP (Hemingway et al., 2003; Tyler et al., 2001). Cowan et al. (2004) reported delayed contraction of the transversus abdominus in a small sample ($n = 10$) of competitive Australian Rules football players with AP. Hemingway et al. (2003) described the bent knee fallout test with abdominal drawing in and a pressure biofeedback cuff to assess oblique function and recruitment. Eighty-seven percent of the subjects with AP due to posterior abdominal wall deficiency failed the test.

We recommend resisted strength testing of the major muscle groups in the groin and lower abdominal region to include the hip (flexors, extensors, abductors, adductors) and abdominal (obliques, rectus abdominus) musculature. The clinician should take note of decreased strength compared to the uninvolved side, the ratio of abduction to adduction strength regardless of side tested, and perhaps more importantly, the reproduction of the patient's pain with testing (Meyers et al., 2000). While there certainly is no harm in testing for delayed transversus abdominus or oblique contraction, the evidence supporting this testing is limited in patients with AP.

5.4.4. Special tests

As the clinician arrives at the end of the systematic physical examination process, special tests should exhibit the metrics of high specificity and a high positive likelihood ratio (LR+), which will help rule in the diagnosis of AP. The list of specific special tests for patients with AP is short (Table 4) and currently, the bilateral adductor test (Verrall, Slavotinek, Barnes, & Fon, 2005) exhibits the best metrics and is the only specific test for AP we would recommend. The Squeeze (Verrall, Slavotinek, et al., 2005) and Single Adductor (Verrall, Slavotinek, et al., 2005) tests are appropriate but with worse metrics and there is no need to perform redundant tests that increase the patient's pain. The Active Straight Leg Raise (ASLR) Test (Mens, Vleeming, Snijders, Ronchetti, & Stam, 2002) is intriguing especially since one theory of the etiology of AP is that the inability to effectively transfer load from the lumbar spine to the hip causes pain. If pelvic ring instability is one cause of AP, and if this test detects that instability, then the test would have value. However, the sensitivity and specificity of the ASLR test in patients with AP is unknown.

5.4.5. *Physical performance measures*

Physical performance measures (PPMs), defined as activities performed by the patient in order that the examiner is better able to assess function, are assessed in a very standardized, repeatable way. These measures are best performed at the end of the examination process since the clinician has ruled out more serious pathologies, ruled out contribution of other hip pathology, ruled in AP, and has a good idea of the patient's pain level. PPMs are performed as a complement to self-report measures to capture both baseline physical function and to gauge recovery. If the patient is unable to perform the PPM, a less strenuous PPM can be chosen or testing can be deferred until follow-up. There are no PPMs that have been tested in populations exclusively with AP, so the use of the following PPMs is based on our clinical opinion.

The Star-Excursion Balance Test (SEBT) or the modified SEBT (Y balance test) is a useful functional screening tool developed to assess an athlete's dynamic balance and postural control. The SEBT requires lower extremity coordination, flexibility, strength and balance (Filipa, Byrnes, Paterno, Myer, & Hewett, 2010) Researchers have provided evidence that the SEBT is sensitive for screening impairments related to musculoskeletal injuries including chronic ankle instability, decreased quad strength, and patellofemoral pain syndrome (Gribble & Hertel, 2003). The test is performed with the patient standing on one leg at the center of the "star". While maintaining single leg stance, the patient reaches with the free limb in eight different directions (starting anteriorly and progressing clockwise) in relation to the stance foot. The Y Balance Test was developed to standardize performance of the SEBT incorporating those directions with the greatest accuracy in identifying lower extremity dysfunction (anterior, posteromedial, and posterolateral)(Hertel, Braham, Hale, & Olmsted-Kramer, 2006; Plisky, Gorman, Butler, Kiesel, Underwood, & Elkins, 2009). The SEBT has demonstrated good intra-rater reliability with reliability coefficients (ICC 2,1) ranging from 0.67 to 0.96 (Filipa et al., 2010; Kinzey & Armstrong, 1998).

In addition to the Y Balance Test, we would recommend a hop test battery (Gustavsson et al., 2006). Single leg hop tests have been studied mostly in an ACL-injured population. Gustavsson et al. (2006) found that if 1 of 3 hop tests (vertical hop, single hop for distance, timed side hop) showed a deficient limb symmetry index (LSI) (involved score ÷ uninvolved score × 100), the sensitivity for detecting an ACL reconstructed knee was 91%. The single hop for distance is a useful tool to identify persistent deficits in lower limb performance including functional power, force attenuation, and postural stability in athletes post ACL reconstruction compared to controls ($P < 0.001$)(Myer et al., 2011; Reid, Birmingham, Stratford, Alcock, & Giffin, 2007). The authors recommend a minimum LSI value of >90% prior to reintegration into sport. Normal values for recreational athletes have been reported in the range of 173.5–195.0 cm with an ICC (2,k) of 0.96 (Ageberg, Zatterstrom, & Moritz, 1998; Bolgla & Keskula, 1997; Brosky, Nitz, Malone, Caborn, & Rayens, 1999; Petschnig, Baron, & Albrecht, 1998). One final addition to the Gustavsson et al. (2006) battery is the triple hop for distance which has been reported to have a large effect size (Myer et al., 2011).

The modified agility *T*-test (MAT) is used to evaluate side to side differences in lower extremity agility performance specific to cutting and running maneuvers (Myer et al., 2011). The MAT is a timed performance test utilized for sports that require quick starts, dynamic changes in direction, and efficient movement. The test is

Table 4
Specific Physical Examination Tests (Special Tests) for Patients with Athletic Pubalgia (AP).

Test	Description	Key metrics	Interpretation
Squeeze test (Verrall, Slavotinek, et al., 2005)	Athlete lays supine, hips flexed to 45° and knees flexed to 90°. The examiner places his or her fist between the patient's knees and instructs the patient to squeeze maximally.	SN 49; SP 88; LR+ 4.08	Reproduction of the patient's pain is a positive test for AP. The probability of detecting AP with a positive test is increased 4×
Single Adductor (Verrall, Slavotinek, et al., 2005)	The patient is supine and flexes the test leg to 30°. The examiner places their hand on the medial aspect of the patient's heel and instructs the patient to resist the examiner's attempt to abduct the patient's hips. The process is completed on the contralateral side also.	SN 32; SP 88; LR+ 2.67	Reproduction of the patient's pain regardless of the lower extremity tested is a positive test for AP. The probability of detecting AP with a positive test is increased 2.7×
Bilateral adductor (Verrall, Slavotinek, et al., 2005)	The patient is supine with both hips flexed to 30°, slightly abducted, and slightly internally rotated. The examiner places their forearms on the patient's medial foot arches and instructs the patient to resist the examiner's attempt to abduct the patient's hips.	SN 65; SP 92; LR+ 8.13	Reproduction of the patient's pain is a positive test for AP. The probability of detecting AP with a positive test is increased 8×
Active Straight Leg Raise (Mens et al., 2002)	The patient is supine with legs 20 cm apart and asked to raise one leg while rating the difficulty of the lift. The process is repeated on the opposite leg. A belt is placed securely around the pelvis and each leg lift is repeated and the patient is asked whether the lift was more difficult, as difficult, or easier than the lifts without the belt	[a]SN 87; SP 94; LR+ 14.5	If the patient has less pain or can produce greater force in the leg lift with a stabilizing pelvic belt in place, then the patient with AP has impaired load transfer through the pelvis due to instability in the pelvic ring.
Valsalva	The patient bears down forcefully as in a difficult bowel movement	In patients with AP, this test is positive in less than: 10% (Meyers et al., 2000) 30% (Weir et al., 2011)	Reproduction of the patient's pain is a positive test for a hernia. The use of this test in patients with AP is dubious.

SN = Sensitivity; SP = specificity; LR+ = positive likelihood ratio; LR− = negative likelihood ratio.
[a] These statistics come from a study by Mens et al. (2002) on pelvic pain in pregnancy and not AP.

designed to incorporate four, 90-degree cuts isolated to a single direction during the trial to evaluate a potential unilateral deficit. The goal of the athlete is to attain a symmetry within 10% in the time taken to complete the task (Myer, Paterno, Ford, Quatman, & Hewett, 2006). The MAT test has shown excellent reliability at ICC (3,1) of 0.825 (Hickey, Quatman, Myer, Ford, Brosky, & Hewett, 2009).

5.5. *Clinical examination summary*

When diagnosing AP, the clinician should rule out hip and pelvis fractures and other red flags, especially of the urologic and gynecologic systems. After eliminating red flag sources of pain, referred sources of pain from the hip and lumbosacral region should be ruled out. After these two steps have excluded competing diagnoses, systematic physical examination should be undertaken to compile criteria associated with AP with a focus on the diagnosis of AP. Criteria of note are highly competitive male athletes who play a cutting sport with the exception of female runners and hockey players. The athlete is likely to report a slow onset of pain in a defined area from the groin to the pubic symphysis, sometimes with radiation into the testes or lower abdominal region. Hip motion may be limited but the clinician is more likely to find weakness of the adductor group (when compared to the abductor group) and pain with either the squeeze or bilateral adductor test.

We encourage the reader to remember that while many of these tests have been assessed for reliability and validity, the individual tests have not been studied in a patient population with AP nor has the battery of tests that we have recommended been tested as a group on any population. Therefore, the level of evidence is 3C based on our collective clinical opinion.

6. Intervention sequence

Multiple interventions have been described for the treatment of AP; most of which are surgical and mention specific conservative treatments only in passing. With rare exception, studies investigating conservative treatment of AP are of limited quality, lacking evidence from high quality randomized, controlled trials. This lack of conservative intervention evidence was the driving force behind the development of our new paradigm. We understand that this is only the initial step of a process that should include controlled trials to examine the effect of treatment on subgroups and replication of those findings in further studies (Kamper, Maher, Hancock, Koes, Croft, & Hay, 2010). We believe that individuals suffering from symptoms consistent with our operational definition of AP can initially be classified into subgroups based on clinical features. For patients who fit our definition of AP, Fig. 2 is designed to assist in the allocation of patients to a specific treatment category and to allow treatment providers to address the impairments of a more homogenous subgroup of patients.

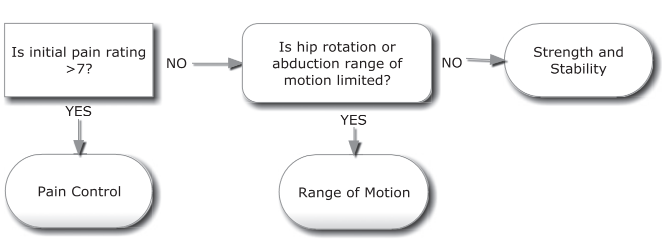

Fig. 2. Subgroup classification (Stage 1). If, over the course of 6–8 weeks, conservative treatment does not result in improvement, particularly if the patient is an elite athlete, other treatment options should be discussed (Anderson, Strickland, & Warren, 2001). If progress is noted, then conservative treatment should be continued following Stages 2 and 3 of our proposed intervention sequence.

Specific interventions paired with these priority impairments comprise an initial list that may be worth investigating as potential treatment effect mediators in patients with AP. These categories have been selected based on a combination of earlier research, biological rationale, and clinical experience and are also limited in number to reduce the likelihood of Type I error (chance findings due to multiple comparisons) in follow-up studies examining treatment effect (Childs et al., 2008; Delitto et al., 1995; Farber & Wilckens, 2007; Holmich et al., 1999; Kamper et al., 2010; Larson & Lohnes, 2002; Lynch & Renstrom, 1999; Verrall, Slavotinek, Fon, et al., 2007). Further research will determine whether additional classification categories should be added. Also, as with previous authors (Childs et al., 2004; Delitto et al., 1995), these categories are not meant to be mutually exclusive and therefore, some patients may fall into more than 1 treatment group (Stanton et al., 2011). These treatment groups are to facilitate the initiation of an efficient treatment program based on impairment (pain, motion loss, strength deficit). We recognize that pre-injury norms (range of motion, strength) have not been established in this patient population and further development of such norms would be useful in determining who is at greater or less risk for injury as well as more focused management of impairments. The intervention sequence then progresses to a multi-modal intervention addressing regional and whole-body issues. The sequence is presented in a linear fashion from impairment-based to multi-modal treatment but the clinical reality is that these intervention approaches are often parallel, and not linear.

6.1. *Stage 1 – local intervention*

6.1.1. *Pain Control Group*

As pain is generally what drives patients with AP to seek care, the first category, which we classify as the Pain Control Group, includes a subgroup of patients who rate their pain >7/10 and have higher levels of disability (Childs et al., 2004; Delitto et al., 1995). We made the decision not to categorize this subgroup based on duration of symptoms since there is little known about AP in the acute stages. Therefore, this group includes populations who are acute, subacute, chronic recurring, and chronic overuse patients (Knight, 2008). Treatment in this group consists of manual interventions to decrease pain and modification of activity to decrease loading through the lumbopelvic-hip complex (Fricker, 1997; Verrall, Slavotinek, Fon, et al., 2007). Manual interventions include joint mobilization, manipulation, passive range of motion (ROM) and soft tissue techniques. We included manual interventions in this phase citing evidence of improved perception of symptoms after their use in other regions of the body (Childs et al., 2008; Hoeksma et al., 2004; Lewis, Khan, Souvlis, & Sterling, 2010; Nielsen, Mortensen, Sorensen, Simonsen, & Graven-Nielsen, 2009; Toro-Velasco, Arroyo-Morales, Fernandez-de-Las-Penas, Cleland, & Barrero-Hernandez, 2009). Bialosky, Bishop, Price, Robinson, and George (2009) cited several studies suggesting a potential mechanism of action of manual therapy on musculoskeletal pain mediated by both the peripheral and central nervous system. An intriguing intervention for AP that has been studied in other tendinopathies is the glyceryl trinitrate patch. Recall that within our definition of AP falls tendinopathy of the adductor group or the abdominal group. Although no research exists to support the use of dermally applied glyceryl trinitrate in patients with AP, there is evidence of an analgesic effect in tendinopathies of the rotator cuff (Berrazueta et al., 1996; Paoloni, Appleyard, Nelson, & Murrell, 2005) and common elbow extensors (Paoloni, Appleyard, Nelson, & Murrell, 2003) with mixed findings in the Achilles tendon (Kane, Ismail, & Calder, 2008; Paoloni, Appleyard, Nelson, & Murrell, 2004). Conversely, there is great doubt about the effectiveness of modalities on pain and so we cannot recommend their use (French, Cameron, Walker, Reggars, & Esterman, 2006; Kroeling et al., 2009; Rutjes et al., 2009; Yousefi-Nooraie et al., 2008). The goals of this stage are to decrease pain and disability as quickly as possible so that the patient can move into one of the other classifications (Motion, Strength and Stability) and expediently, into the second (regional) stage of treatment.

6.2. Stage 1 – local intervention

6.2.1. Motion group

The motion or mobility classification includes patients who have limited joint mobility, limited range-of-motion (ROM), or a combination of both. The ROM category includes interventions designed to restore full, pain-free motion of the hip complex and to ensure the patient's ability to perform low to moderate intensity activities without discomfort (Fritz & George, 2000). Evidence supports that in patients with AP, decreased hip motions include primarily hip internal rotation, external rotation, and/or abduction range of motion. Restoration of ROM is important since athletes with limited hip ROM may be at a greater risk for AP (Verrall, Hamilton, et al., 2005; Verrall, Slavotinek, Barnes, et al., 2007). In addition, several authors suggest a relationship between limited hip ROM and long-standing groin pain (Fricker, 1997; Wollin & Lovell, 2006).

With the obvious impairment of limited hip ROM, the natural thought would be passive ROM or stretching to improve ROM. Both passive ROM and stretching as an early portion of a recovery program and as part of an injury prevention program have been suggested in patients with AP (Fricker, 1997; Nicholas & Tyler, 2002; Tyler et al., 2002). However, more robust evidence from a randomized controlled trial suggests that an active exercise program may improve abduction range of motion without specifically stretching the adductors (Holmich et al., 1999). There is not enough evidence to discount passive stretching and ROM completely since they appear to improve ROM in the lower extremity (Moller, Oberg, & Gillquist, 1985; Wiktorsson-Moller, Oberg, Ekstrand, & Gillquist, 1983) but active stretching appears to have greater benefit (Holmich et al., 1999). Keeping these facts in mind, we have recommended a group of exercises, which may restore hip ROM (Table 5) with the understanding that the specific exercises are a mixture of SORT evidence levels 1, 2, and 3.

6.3. Stage 1 – local intervention

6.3.1. Strength and stability group

The third category, Strength and Stability is designed to safely improve strength in the muscles surrounding the hip and pelvis without increasing pain. The rationale for the Strength and Stability classification is based on evidence derived from studies that have successfully incorporated strength-based treatments in populations of individuals suffering from impairments related to the pathologies captured by our definition of AP (Holmich et al., 1999; Tyler et al., 2002; Weir et al., 2011). The reason for incorporation of a stability program is the theory that the pelvic ring is instrumental in transferring load from the lumbosacral region to the hip and dysfunction here may create discomfort (Mens et al., 2006). Further, magnetic resonance imaging has demonstrated pubic instability in a small subgroup of athletes with osteitis pubis (Zoga et al., 2008). Instability in this study was defined in the sense of muscle disruption/defect/detachment from the pubic bone. Strength and Stability is a combined group since there is not currently enough evidence to support instability alone as a major cause or effect of AP.

Successful completion of Stage 1 is indicated by the patient achieving pain-free adductor strength of at least 80% that of the abductors (Tyler et al., 2002). While strength testing of the non-dominant leg may be less strong than the dominant, some research suggests adductor-to-abductor strength ratios should not differ much between legs (Thorborg, Serner, Petersen, Madsen, Magnusson, & Holmich, 2011).

Regarding strengthening, Holmich et al. (1999), in a randomized controlled trial, demonstrated that young, active individuals with hip adductor pain who were not able to participate in sport, benefited from supervised active training. Training frequency was three times per week for 90 min and included groups of two to four patients who were supervised by one physical therapist. The exercises were divided into two modules, one set of exercises for the first two weeks and the second to be performed from week three until discharge. Exercises targeted the hip adductors, hip abductors, abdominal muscles, back extensors, balance and coordination. Seventy-nine percent of the participants returned to sport in an average of 18.5 weeks. Others have utilized this original program as a framework for their successful exercise intervention (Holmich, Larsen, Krogsgaard, & Gluud, 2010; Larson & Lohnes, 2002; Tyler et al., 2002). Exercises targeting the adductors of athletes with adductor-to-abductor strength ratios of less than 80% may be an effective means of decreasing incidence of groin strains (Maffey & Emery, 2007; Tyler et al., 2002).

Although pelvic instability has been a described and treated condition (Depledge, McNair, Keal-Smith, & Williams, 2005; Hungerford, Gilleard, & Lee, 2004; Richardson, Snijders, Hides, Damen, Pas, & Storm, 2002; Williams et al., 2000), we were unable to find any direct conservative interventions focused on stability in athletes having AP. Delayed firing of the transverse abdominus and obliques is a common issue in patients with instability or pelvic injuries and is generally addressed by a program promoting pelvic strengthening and core stability (Cowan et al., 2004; Hodges & Richardson, 1997; Jansen, Mens, Backx, Kolfschoten, & Stam, 2008; Stevens, Vleeming, Bouche, Mahieu, Vanderstraeten, & Danneels, 2007). Further, some authors have proposed training for the transverse abdominus and obliques as well as other muscles acting to stabilize the pelvis may improve hip strength and decrease discomfort (Cowan et al., 2004; Mens et al., 2006). Therefore, we recommend a program (Table 6), which consists of strengthening of the hip adductors, rectus abdominus, abdominal obliques, and transverse abdominus since each of these muscle groups has been implicated in AP.

As the patient shows signs of improvement in strength and stability, generally by comparing strength ratios of the involved to the uninvolved side and of ipsilateral hip abductors to adductors, the patient should be progressed to a more regional program, Stage 2 of our paradigm.

Table 5
Suggested program to restore hip ROM in patients with AP.

Exercises
Side-lying abduction and adduction*
One-leg Coordination Exercise Flexing and Extending Knee and Swinging Arms in Same Rhythm (mimic cross country skiing on one leg)*, **
Skating on slide board*
Sitting adduction and abduction**
Iliopsoas stretching**
Unilateral lunges+
Sumo squat+
Side lunge+
Kneeling pelvic tilt+
Passive internal and external ROM
Supine, feet together, butterfly wings (active ROM)

*Holmich et al. (1999), **Holmich et al. (2010), +Tyler et al. (2002).

Table 6
Suggested program to restore local motion, strength, and stability in patients with AP.

Exercises
Demonstration of appropriate stabilization in supine with bent knee fallout
Active hip internal/external rotation in sit
Active Straight Leg Raise with abdominal bracing
Side plank hip adduction
Curl up
Crunch
Reverse curl up
Standing cable hip flexion
Standing cable hip adduction
Full sit-up
Pike position on theraball
Kneeling reach out with sliders

The above exercises are recommended based on our clinical experience and work by Escamilla, Babb, et al. (2006), Escamilla, McTaggart, et al. (2006).

6.4. *Stage 2 – regional interventions*

After addressing the chief complaints in the primary local region of the groin and pelvis, we advocate a more regional approach to intervention. There is ample evidence of the intricate relationship between motions of the lumbar region, sacrum, pelvis and hip and that the ratio of these motions is changed in the presence of pain (Esola, McClure, Fitzgerald, & Siegler, 1996; Shum, Crosbie, & Lee, 2005, 2007). Perhaps most important to this paper is that this altered ratio was also found with limb movements in athletes who played sports that involve cutting along with hip and trunk rotation (Scholtes, Gombatto, & Van Dillen, 2009). Further, there is evidence that forces applied distally in the kinetic chain while running can cause proximal pain (Schache, Bennell, Blanch, & Wrigley, 1999). This view of the body as interconnected regions, perhaps held by holistic practitioners for decades, was recently labeled "regional interdependence"(Wainner, Whitman, Cleland, & Flynn, 2007). While there have been no studies that have examined regional intervention specifically in patients with AP, we believe that an integral part of the rehabilitation of patients with AP is the progression from local treatment to regional interventions. A point worth reiterating is that although we have outlined the progression from local to regional interventions, clinically, these interventions operate in parallel. Regional interventions in patients with AP can be directed at the remaining muscle groups of the hip not already addressed with local intervention (abductors and extensors), the lumbar spine, and the lower extremities. A sample of suggested exercises can be found in Table 7.

Table 7
Suggested program to restore regional strength and stability in patients with AP.

Exercises
Bracing or drawing in of abdominals wit hip extension in quadruped
Resisted hip internal/external rotation in sit
Body-weight squats with band resistance around knees
Single leg deadlift
Single leg squat
Single leg chest press
Single leg row
Standing cable hip extension
Standing cable hip abduction
Sliding board
Cable diagonal chops and lifts
Front squat
Roman chair lumbar extensions
2 Legged plyometrics
1 Legged plyometrics

The above exercises are recommended based on our clinical experience and work by Distefano, Blackburn, Marshall, & Padua (2009).

6.5. *Stage 3 – global interventions*

The clinician should carefully consider several variables when rehabilitating the athlete with AP in Stage 3, where the focus is not only on return to sport but also on attainment of prior level of performance. Variables to consider include the patient's re-examination findings, their tolerance of progression, the sport in which the athlete participates, and the position requirements within that sport. Recall that most athletes who suffer with symptoms of AP are likely to play sports that primarily involve sprinting and cutting. Proper assurance of readiness to return to their sport is not an exact science. The PPMs previously described, the MAT, Y balance test, and hop battery, can provide the clinician with some means of objectivity but also a method of training. There are various normative values for these tests published elsewhere (Reiman & Manske, 2009).

Further, lower extremity and total body anaerobic power (Arnold, Brown, Micheli, & Coker, 1980; Baker & Newton, 2008; Davis, Barnette, Kiger, Mirasola, & Young, 2004; Farlinger, Kruisselbrink, & Fowles, 2007; Montgomery, 1988; Sawyer, Ostarello, Suess, & Dempsey, 2002), multiple changes of direction (Baker & Newton, 2008), and proper work to rest ratio integration (Iosia & Bishop, 2008; Rhea, Hunter, & Hunter, 2006; Stolen, Chamari, Castagna, & Wisloff, 2005) are all components of a properly designed program for the athlete with AP attempting to return to their sport. Table 8 provides a sample of exercises and tests that will provide the necessary components. One area that requires some greater discussion is work to rest ratio since tendinopathy is a major contributor to AP. Designing a proper work to rest ratio for the rehabilitating athlete with AP is important not only to most closely replicate the demands of the particular sport (Rhea et al., 2006; Stolen et al., 2005), but also to avoid excessive loading of the involved tissue. Load has been shown to be both anabolic and catabolic for tendons (Benjamin, 2002). Repetitive energy storage and release, as well as excessive compression appear to be key factors in the onset of tendinopathy. The amount of load (volume, intensity, frequency) necessary to induce pathology is not clear; however, providing sufficient time between loadings to allow for tendon response is important (Cook & Purdam, 2009). Therefore volume (hours) and frequency (sessions per day or week) of intense load may be critical in the capacity of both normal and pathological tendons to tolerate load (Langberg, Skovgaard, Asp, & Kjaer, 2000).

Table 8
Suggested program to restore sport related function in patients with AP.

Exercises
Total body anaerobic power drills
• Medicine ball throws (overhead forward and back; side-throws)
• Repetitive box drill plyometrics
Anaerobic capacity drills
• Yo–yo/beep test
• Running/skating line drills
Sport specific drills with emphasis on total body anaerobic power
• Acceleration/deceleration running drills with ball (soccer/rugby/football)
• Acceleration/deceleration skating drills with puck (hockey)
Sport specific drills with emphasis on speed and quickness
• Progression from form drills (A and B walks/skips) to sprints of sport related distances
Sport specific drills with emphasis on changes-of-direction/agility
• Cone drills with sport related object (soccer ball, hockey puck, football)
• Slalom pole drills with sport related object
• Visual cueing change of direction drills with sport related object
• Audible cueing change of direction drills with sport related object
Sport specific drills with emphasis on anaerobic capacity
• Position specific drills performed at appropriate work: rest ratios

The above exercises are recommended based on our clinical experience.

7. Summary

Athletic pubalgia is a syndrome composed of multiple pathologies and is currently a diagnosis of exclusion. As with other syndromes, the diagnostic process must involve, first, a ruling out of related areas as contributors. The first group of pathologies to rule out in patients with AP includes those pathologies of a non-musculoskeletal nature. These pathologies are generally in the practice patterns of obstetrics, gynecology, and urology, and necessitate referral to a specialist in those areas. Next, musculoskeletal pathologies that masquerade as AP should be ruled out and those pathologies include intrarticular lesions of the hip, stress fractures of the femur and pelvis, and contribution from the lumbosacral region. Once AP becomes the working diagnosis, intervention should focus on local impairments, regional dysfunctions, and global issues that would facilitate return to sport. We hope that the introduction of this paradigm will allow clearer study of patients with AP who will be placed in smaller, more homogeneous groups. We further hope that, as with other heterogeneous pathology-based groups (for example, low back pain and neck pain), research of conservative care in patients with AP will identify which subgroups benefit from surgery versus conservative care so that the treatment of patients with AP is both more efficient and effective.

Clinical recommendation	SORT evidence rating
Examination	
Patient interview	2B
Self-report outcomes measures	3C
Observation	2B
Triage and screening	2B
Motion testing – range of motion	2B
Accessory motion	3C
Palpation	2B
Strength testing	2B
Special testing	2B
Physical performance measures	3C
Intervention	
Pain Control Group	3C
Motion group	2B
Strength and stability group	2B
Regional interventions	3C
Global interventions	3C

Conflict of interest

The authors deny any conflict of interest.

Ethical approval

N/A.

Funding

This is a non-funded study.

References

Adams, S. L., & Yarnold, P. R. (1997). Clinical use of the patellar-pubic percussion sign in hip trauma. *American Journal of Emergency Medicine, 15*(2), 173–175.

Ageberg, E., Zatterstrom, R., & Moritz, U. (1998). Stabilometry and one-leg hop test have high test-retest reliability. *Scandinavian Journal of Medicine & Science in Sports, 8*(4), 198–202.

Agel, J., Dompier, T. P., Dick, R., & Marshall, S. W. (2007). Descriptive epidemiology of collegiate men's ice hockey injuries: National Collegiate Athletic Association Injury Surveillance System, 1988–1989 through 2003–2004. *Journal of Athletic Training, 42*(2), 241–248.

Akita, K., Niga, S., Yamato, Y., Muneta, T., & Sato, T. (1999). Anatomic basis of chronic groin pain with special reference to sports hernia. *Surgical and Radiological Anatomy, 21*(1), 1–5.

Anderson, K., Strickland, S. M., & Warren, R. (2001). Hip and groin injuries in athletes. *American Journal of Sports Medicine, 29*(4), 521–533.

Arnason, A., Sigurdsson, S. B., Gudmundsson, A., Holme, I., Engebretsen, L., & Bahr, R. (2004). Risk factors for injuries in football. *American Journal of Sports Medicine, 32*(1 Suppl.), 5S–16S.

Arnold, J. A., Brown, B., Micheli, R. P., & Coker, T. P. (1980). Anatomical and physiologic characteristics to predict football ability. Report of study methods and correlations, University of Arkansas, 1976. *American Journal of Sports Medicine, 8*(2), 119–122.

Baker, D. G., & Newton, R. U. (2008). Comparison of lower body strength, power, acceleration, speed, agility, and sprint momentum to describe and compare playing rank among professional rugby league players. *Journal of Strength & Conditioning Research, 22*(1), 153–158.

Benjamin, M. (2002). Tendons are dynamic structures that respond to changes in exercise levels. *Scandinavian Journal of Medicine & Science in Sports, 12*(2), 63–64.

Berger, J. R., & Fannin, M. (2002). The "bedsheet" Babinski. *Southern Medical Journal, 95*(10), 1178–1179.

Berrazueta, J. R., Losada, A., Poveda, J., Ochoteco, A., Riestra, A., Salas, E., et al. (1996). Successful treatment of shoulder pain syndrome due to supraspinatus tendinitis with transdermal nitroglycerin. A double blind study. *Pain, 66*(1), 63–67.

Bialosky, J. E., Bishop, M. D., Price, D. D., Robinson, M. E., & George, S. Z. (2009). The mechanisms of manual therapy in the treatment of musculoskeletal pain: a comprehensive model. *Manual Therapy, 14*(5), 531–538.

Biedert, R. M., Warnke, K., & Meyer, S. (2003). Symphysis syndrome in athletes: surgical treatment for chronic lower abdominal, groin, and adductor pain in athletes. *Clinical Journal of Sport Medicine, 13*(5), 278–284.

Binkley, J. M., Stratford, P. W., Lott, S. A., & Riddle, D. L. (1999). The Lower Extremity Functional Scale (LEFS): scale development, measurement properties, and clinical application. North American Orthopaedic Rehabilitation Research Network. *Physical Therapy, 79*(4), 371–383.

Birrell, F., Croft, P., Cooper, C., Hosie, G., Macfarlane, G., & Silman, A. (2001). Predicting radiographic hip osteoarthritis from range of movement. *Rheumatology (Oxford), 40*(5), 506–512.

Bizzini, M. (2011). The groin area: the Bermuda triangle of sports medicine? *British Journal of Sports Medicine, 45*(1), 1.

Bolgla, L. A., & Keskula, D. R. (1997). Reliability of lower extremity functional performance tests. *Journal of Orthopaedic & Sports Physical Therapy, 26*(3), 138–142.

Bradshaw, C. J., Bundy, M., & Falvey, E. (2008). The diagnosis of longstanding groin pain: a prospective clinical cohort study. *British Journal of Sports Medicine, 42*(10), 851–854.

Bradshaw, C., & McCrory, P. (1997). Obturator nerve entrapment. *Clinical Journal of Sport Medicine, 7*(3), 217–219.

Brennan, G. P., Fritz, J. M., Hunter, S. J., Thackeray, A., Delitto, A., & Erhard, R. E. (2006). Identifying subgroups of patients with acute/subacute "nonspecific" low back pain: results of a randomized clinical trial. *Spine (Phila Pa 1976), 31*(6), 623–631.

Brosky, J. A., Jr., Nitz, A. J., Malone, T. R., Caborn, D. N., & Rayens, M. K. (1999). Intrarater reliability of selected clinical outcome measures following anterior cruciate ligament reconstruction. *Journal of Orthopaedic & Sports Physical Therapy, 29*(1), 39–48.

Caudill, P., Nyland, J., Smith, C., Yerasimides, J., & Lach, J. (2008). Sports hernias: a systematic literature review. *British Journal of Sports Medicine, 42*(12), 954–964.

Chatman, A. B., Hyams, S. P., Neel, J. M., Binkley, J. M., Stratford, P. W., Schomberg, A., et al. (1997). The Patient-Specific Functional Scale: measurement properties in patients with knee dysfunction. *Physical Therapy, 77*(8), 820–829.

Childs, J. D., Cleland, J. A., Elliott, J. M., Teyhen, D. S., Wainner, R. S., Whitman, J. M., et al. (2008). Neck pain: clinical practice guidelines linked to the International Classification of Functioning, Disability, and Health from the Orthopedic Section of the American Physical Therapy Association. *Journal of Orthopaedic & Sports Physical Therapy, 38*(9), A1–A34.

Childs, J. D., Fritz, J. M., Piva, S. R., & Whitman, J. M. (2004). Proposal of a classification system for patients with neck pain. *Journal of Orthopaedic & Sports Physical Therapy, 34*(11), 686–696, discussion 697–700.

Cook, C., & Hegedus, E. (2007). *Orthopedic physical examination tests: An evidence-based approach*. Upper Saddle River: Prentice Hall.

Cook, C. E., Hegedus, E., Pietrobon, R., & Goode, A. (2007). A pragmatic neurological screen for patients with suspected cord compressive myelopathy. *Physical Therapy, 87*(9), 1233–1242.

Cook, J. L., & Purdam, C. R. (2009). Is tendon pathology a continuum? A pathology model to explain the clinical presentation of load-induced tendinopathy. *British Journal of Sports Medicine, 43*(6), 409–416.

Cowan, S. M., Schache, A. G., Brukner, P., Bennell, K. L., Hodges, P. W., Coburn, P., et al. (2004). Delayed onset of transversus abdominus in long-standing groin pain. *Medicine & Science in Sports & Exercise, 36*(12), 2040–2045.

Crow, J. F., Pearce, A. J., Veale, J. P., VanderWesthuizen, D., Coburn, P. T., & Pizzari, T. (2010). Hip adductor muscle strength is reduced preceding and during the onset of groin pain in elite junior Australian football players. *Journal of Science and Medicine in Sport, 13*(2), 202–204.

Cunningham, P. M., Brennan, D., O'Connell, M., MacMahon, P., O'Neill, P., & Eustace, S. (2007). Patterns of bone and soft-tissue injury at the symphysis

pubis in soccer players: observations at MRI. *American Journal Roentgenology, 188*(3), W291–W296.
Dalstra, M., & Huiskes, R. (1995). Load transfer across the pelvic bone. *Journal of Biomechanics, 28*(6), 715–724.
Davies, A. G., Clarke, A. W., Gilmore, J., Wotherspoon, M., & Connell, D. A. (2010). Review: imaging of groin pain in the athlete. *Skeletal Radiology, 39*(7), 629–644.
Davis, D. S., Barnette, B. J., Kiger, J. T., Mirasola, J. J., & Young, S. M. (2004). Physical characteristics that predict functional performance in Division I college football players. *Journal of Strength & Conditioning Research, 18*(1), 115–120.
Delahaye, H., Laffargue, P., Voisin, P., Weissland, T., Letombe, A., Dupont, L., et al. (2003). Evaluation of athletes with longstanding groin pain. *Isokinetics and Exercise Science, 11*, 45–47.
Delitto, A., Erhard, R. E., & Bowling, R. W. (1995). A treatment-based classification approach to low back syndrome: identifying and staging patients for conservative treatment. *Physical Therapy, 75*(6), 470–485, discussion 485–479.
Depledge, J., McNair, P. J., Keal-Smith, C., & Williams, M. (2005). Management of symphysis pubis dysfunction during pregnancy using exercise and pelvic support belts. *Physical Therapy, 85*(12), 1290–1300.
Distefano, L. J., Blackburn, J. T., Marshall, S. W., & Padua, D. A. (2009). Gluteal muscle activation during common therapeutic exercises. *Journal of Orthopaedic & Sports Physical Therapy, 39*(7), 532–540.
Donelson, R., Aprill, C., Medcalf, R., & Grant, W. (1997). A prospective study of centralization of lumbar and referred pain. A predictor of symptomatic discs and anular competence. *Spine (Phila Pa 1976), 22*(10), 1115–1122.
Ekberg, O., Persson, N. H., Abrahamsson, P. A., Westlin, N. E., & Lilja, B. (1988). Longstanding groin pain in athletes. A multidisciplinary approach. *Sports Medicine, 6*(1), 56–61.
Ekstrand, J., & Gillquist, J. (1983). The avoidability of soccer injuries. *International Journal of Sports Medicine, 4*(2), 124–128.
Ekstrand, J., Hagglund, M., & Walden, M. (2011). Epidemiology of muscle injuries in professional football (soccer). *American Journal of Sports Medicine*, (Epub ahead of print).
Emery, C. A., & Meeuwisse, W. H. (2001). Risk factors for groin injuries in hockey. *Medicine & Science in Sports & Exercise, 33*(9), 1423–1433.
Escamilla, R. F., Babb, E., DeWitt, R., Jew, P., Kelleher, P., Burnham, T., et al. (2006). Electromyographic analysis of traditional and nontraditional abdominal exercises: implications for rehabilitation and training. *Physical Therapy, 86*(5), 656–671.
Escamilla, R. F., McTaggart, M. S., Fricklas, E. J., DeWitt, R., Kelleher, P., Taylor, M. K., et al. (2006). An electromyographic analysis of commercial and common abdominal exercises: implications for rehabilitation and training. *Journal of Orthopaedic & Sports Physical Therapy, 36*(2), 45–57.
Esola, M. A., McClure, P. W., Fitzgerald, G. K., & Siegler, S. (1996). Analysis of lumbar spine and hip motion during forward bending in subjects with and without a history of low back pain. *Spine (Phila Pa 1976), 21*(1), 71–78.
Falvey, E. C., Franklyn-Miller, A., & McCrory, P. R. (2009). The groin triangle: a pathoanatomical approach to the diagnosis of chronic groin pain in athletes. *British Journal of Sports Medicine, 43*(3), 213–220.
Farber, A. J., & Wilckens, J. H. (2007). Sports hernia: diagnosis and therapeutic approach. *Journal of the American Acadcademy of Orthopaedic Surgeons, 15*(8), 507–514.
Farlinger, C. M., Kruisselbrink, L. D., & Fowles, J. R. (2007). Relationships to skating performance in competitive hockey players. *Journal of Strength & Conditioning Research, 21*(3), 915–922.
Filipa, A., Byrnes, R., Paterno, M. V., Myer, G. D., & Hewett, T. E. (2010). Neuromuscular training improves performance on the star excursion balance test in young female athletes. *Journal of Orthopaedic & Sports Physical Therapy, 40*(9), 551–558.
Fon, L. J., & Spence, R. A. (2000). Sportsman's hernia. *British Journal of Surgery, 87*(5), 545–552.
French, S. D., Cameron, M., Walker, B. F., Reggars, J. W., & Esterman, A. J. (2006). Superficial heat or cold for low back pain. *Cochrane Database of Systematic Reviews, 1*, CD004750.
Fricker, P. A. (1997). Management of groin pain in athletes. *British Journal of Sports Medicine, 31*(2), 97–101.
Fritz, J. M., & George, S. (2000). The use of a classification approach to identify subgroups of patients with acute low back pain. Interrater reliability and short-term treatment outcomes. *Spine (Phila Pa 1976), 25*(1), 106–114.
Gabbe, B. J., Bailey, M., Cook, J. L., Makdissi, M., Scase, E., Ames, N., et al. (2010). The association between hip and groin injuries in the elite junior football years and injuries sustained during elite senior competition. *British Journal of Sports Medicine, 44*(11), 799–802.
Garratt, A., Schmidt, L., Mackintosh, A., & Fitzpatrick, R. (2002). Quality of life measurement: bibliographic study of patient assessed health outcome measures. *British Medical Journal, 324*(7351), 1417.
Garvey, J. F., Read, J. W., & Turner, A. (2010). Sportsman hernia: what can we do? *Hernia, 14*(1), 17–25.
Grafton, K. V., Foster, N. E., & Wright, C. C. (2005). Test-retest reliability of the Short-Form McGill Pain Questionnaire: assessment of intraclass correlation coefficients and limits of agreement in patients with osteoarthritis. *Clinical Journal of Pain, 21*(1), 73–82.
Gribble, P. A., & Hertel, J. (2003). Considerations for normalizing measures of the star excursion balance test. *Measurement in Physical Education and Exercise Science, 7*(2), 89–100.
Grimes, D. A., & Schulz, K. F. (2002). Uses and abuses of screening tests. *Lancet, 359*(9309), 881–884.
Gustavsson, A., Neeter, C., Thomee, P., Silbernagel, K. G., Augustsson, J., Thomee, R., et al. (2006). A test battery for evaluating hop performance in patients with an ACL injury and patients who have undergone ACL reconstruction. *Knee Surgery, Sports Traumatology, Arthroscopy, 14*(8), 778–788.
Hackney, R. G. (1993). The sports hernia: a cause of chronic groin pain. *British Journal of Sports Medicine, 27*(1), 58–62.
Hall, H., McIntosh, G., & Boyle, C. (2009). Effectiveness of a low back pain classification system. *Spine Journal, 9*(8), 648–657.
Hegedus, E. J., Zavala, J., Kissenberth, M., Cook, C., Cassas, K., Hawkins, R., et al. (2010). Positive outcomes with intra-articular glenohumeral injections are independent of accuracy. *Journal of Shoulder and Elbow Surgery, 19*(6), 795–801.
Hemingway, A. E., Herrington, L., & Blower, A. L. (2003). Changes in muscle strength and pain in response to surgical repair of posterior abdominal wall disruption followed by rehabilitation. *British Journal of Sports Medicine, 37*(1), 54–58.
Hertel, J., Braham, R. A., Hale, S. A., & Olmsted-Kramer, L. C. (2006). Simplifying the star excursion balance test: analyses of subjects with and without chronic ankle instability. *Journal of Orthopaedic & Sports Physical Therapy, 36*(3), 131–137.
Hickey, K. C., Quatman, C. E., Myer, G. D., Ford, K. R., Brosky, J. A., & Hewett, T. E. (2009). Methodological report: dynamic field tests used in an NFL combine setting to identify lower-extremity functional asymmetries. *Journal of Strength & Conditioning Research, 23*(9), 2500–2506.
Hodges, P. W., & Richardson, C. A. (1997). Contraction of the abdominal muscles associated with movement of the lower limb. *Physical Therapy, 77*(2), 132–142, discussion 142–134.
Hoeksma, H. L., Dekker, J., Ronday, H. K., Heering, A., van der Lubbe, N., Vel, C., et al. (2004). Comparison of manual therapy and exercise therapy in osteoarthritis of the hip: a randomized clinical trial. *Arthritis Rheumatism, 51*(5), 722–729.
Holmich, P. (2007). Long-standing groin pain in sportspeople falls into three primary patterns, a "clinical entity" approach: a prospective study of 207 patients. *British Journal of Sports Medicine, 41*(4), 247–252, discussion 252.
Holmich, P., Holmich, L. R., & Bjerg, A. M. (2004). Clinical examination of athletes with groin pain: an intraobserver and interobserver reliability study. *British Journal of Sports Medicine, 38*(4), 446–451.
Holmich, P., Larsen, K., Krogsgaard, K., & Gluud, C. (2010). Exercise program for prevention of groin pain in football players: a cluster-randomized trial. *Scandinavian Journal of Medicine & Science in Sports, 20*(6), 814–821.
Holmich, P., Uhrskou, P., Ulnits, L., Kanstrup, I. L., Nielsen, M. B., Bjerg, A. M., et al. (1999). Effectiveness of active physical training as treatment for long-standing adductor-related groin pain in athletes: randomised trial. *Lancet, 353*(9151), 439–443.
Hungerford, B., Gilleard, W., & Lee, D. (2004). Altered patterns of pelvic bone motion determined in subjects with posterior pelvic pain using skin markers. *Clinical Biomechanics (Bristol, Avon), 19*(5), 456–464.
Ibrahim, A., Murrell, G. A., & Knapman, P. (2007). Adductor strain and hip range of movement in male professional soccer players. *Journal of Orthopaedic Surgery (Hong Kong), 15*(1), 46–49.
Iosia, M. F., & Bishop, P. A. (2008). Analysis of exercise-to-rest ratios during division IA televised football competition. *Journal of Strength & Conditioning Research, 22*(2), 332–340.
Ito, K., Leunig, M., & Ganz, R. (2004). Histopathologic features of the acetabular labrum in femoroacetabular impingement. *Clinical Orthopaedics and Related Research, 429*, 262–271.
Jansen, J. A., Mens, J. M., Backx, F. J., Kolfschoten, N., & Stam, H. J. (2008). Treatment of longstanding groin pain in athletes: a systematic review. *Scandinavian Journal of Medicine & Science in Sports, 18*(3), 263–274.
Jensen, M. P., Karoly, P., & Braver, S. (1986). The measurement of clinical pain intensity: a comparison of six methods. *Pain, 27*(1), 117–126.
Johnson, A. W., Weiss, C. B., Jr., & Wheeler, D. L. (1994). Stress fractures of the femoral shaft in athletes—more common than expected. A new clinical test. *American Journal of Sports Medicine, 22*(2), 248–256.
Kachingwe, A. F., & Grech, S. (2008). Proposed algorithm for the management of athletes with athletic pubalgia (sports hernia): a case series. *Journal of Orthopaedic & Sports Physical Therapy, 38*(12), 768–781.
Kalebo, P., Karlsson, J., Sward, L., & Peterson, L. (1992). Ultrasonography of chronic tendon injuries in the groin. *American Journal of Sports Medicine, 20*(6), 634–639.
Kamper, S. J., Maher, C. G., Hancock, M. J., Koes, B. W., Croft, P. R., & Hay, E. (2010). Treatment-based subgroups of low back pain: a guide to appraisal of research studies and a summary of current evidence. *Best Practice & Research Clinical Rheumatology, 24*(2), 181–191.
Kane, T. P., Ismail, M., & Calder, J. D. (2008). Topical glyceryl trinitrate and non-insertional Achilles tendinopathy: a clinical and cellular investigation. *American Journal of Sports Medicine, 36*(6), 1160–1163.
Kerr, R. S., Cadoux-Hudson, T. A., & Adams, C. B. (1988). The value of accurate clinical assessment in the surgical management of the lumbar disc protrusion. *Journal of Neurology, Neurosurgery and Psychiatry, 51*(2), 169–173.
Kinzey, S. J., & Armstrong, C. W. (1998). The reliability of the star-excursion test in assessing dynamic balance. *Journal of Orthopaedic & Sports Physical Therapy, 27*(5), 356–360.
Knight, K. L. (2008). More precise classification of orthopaedic injury types and treatment will improve patient care. *Journal of Athletic Training, 43*(2), 117–118.
Kroeling, P., Gross, A., Goldsmith, C. H., Burnie, S. J., Haines, T., Graham, N., et al. (2009). Electrotherapy for neck pain. *Cochrane Database of Systematic Reviews, 4*, CD004251.
Langberg, H., Skovgaard, D., Asp, S., & Kjaer, M. (2000). Time pattern of exercise-induced changes in type I collagen turnover after prolonged endurance exercise in humans. *Calcified Tissue International, 67*(1), 41–44.

Larson, C. M., & Lohnes, J. H. (2002). Surgical management of athletic pubalgia. *Operative Techniques in Sports Medicine, 10*(4), 228–232.
Laslett, M., Aprill, C. N., McDonald, B., & Young, S. B. (2005). Diagnosis of sacroiliac joint pain: validity of individual provocation tests and composites of tests. *Manual Therapy, 10*(3), 207–218.
Lauder, T. D., Dillingham, T. R., Andary, M., Kumar, S., Pezzin, L. E., Stephens, R. T., et al. (2000a). Effect of history and exam in predicting electrodiagnostic outcome among patients with suspected lumbosacral radiculopathy. *American Journal of Physical Medicine & Rehabilitation, 79*(1), 60–68, quiz 75–66.
Lauder, T. D., Dillingham, T. R., Andary, M., Kumar, S., Pezzin, L. E., Stephens, R. T., et al. (2000b). Predicting electrodiagnostic outcome in patients with upper limb symptoms: are the history and physical examination helpful? *Archives of Physical Medicine and Rehabilitation, 81*(4), 436–441.
Leerar, P. J., Boissonnault, W., Domholdt, E., & Roddey, T. (2007). Documentation of red flags by physical therapists for patients with low back pain. *Journal of Manual & Manipulative Therapy, 15*(1), 42–49.
Lewis, C., Khan, A., Souvlis, T., & Sterling, M. (2010). A randomised controlled study examining the short-term effects of Strain-Counterstrain treatment on quantitative sensory measures at digitally tender points in the low back. *Manual Therapy, 15*(6), 536–541.
Lynch, S. A., & Renstrom, P. A. (1999). Groin injuries in sport: treatment strategies. *Sports Medicine, 28*(2), 137–144.
Maffey, L., & Emery, C. (2007). What are the risk factors for groin strain injury in sport? A systematic review of the literature. *Sports Medicine, 37*(10), 881–894.
Maitland, G., Hengeveld, E., & Banks, K. (2002). *Maitland's vertebral manipulation*. Oxford, United Kingdom: Butterworth-Heinemann.
Malliaras, P., Hogan, A., Nawrocki, A., Crossley, K., & Schache, A. (2009). Hip flexibility and strength measures: reliability and association with athletic groin pain. *British Journal of Sports Medicine, 43*(10), 739–744.
Marin, R., Dillingham, T. R., Chang, A., & Belandres, P. V. (1995). Extensor digitorum brevis reflex in normals and patients with radiculopathies. *Muscle & Nerve, 18*(1), 52–59.
Melzack, R. (1987). The short-form McGill Pain Questionnaire. *Pain, 30*(2), 191–197.
Melzack, R., & Katz, J. (2001). *The McGill Pain Questionnaire: Appraisal and current status*. New York: Guilford Press.
Mens, J., Inklaar, H., Koes, B. W., & Stam, H. J. (2006). A new view on adduction-related groin pain. *Clinical Journal of Sport Medicine, 16*(1), 15–19.
Mens, J. M., Vleeming, A., Snijders, C. J., Ronchetti, I., & Stam, H. J. (2002). Reliability and validity of hip adduction strength to measure disease severity in posterior pelvic pain since pregnancy. *Spine (Phila Pa 1976), 27*(15), 1674–1679.
Merrifield, H. H., & Cowan, R. F. (1973). Groin strain injuries in ice hockey. *J Sports Medicine, 1*(2), 41–42.
Meyers, W. C., Foley, D. P., Garrett, W. E., Lohnes, J. H., & Mandlebaum, B. R. (2000). Management of severe lower abdominal or inguinal pain in high-performance athletes. PAIN (Performing Athletes with Abdominal or Inguinal Neuromuscular Pain Study Group). *American Journal of Sports Medicine, 28*(1), 2–8.
Moller, M. H., Oberg, B. E., & Gillquist, J. (1985). Stretching exercise and soccer: effect of stretching on range of motion in the lower extremity in connection with soccer training. *International Journal of Sports Medicine, 6*(1), 50–52.
Montgomery, D. L. (1988). Physiology of ice hockey. *Sports Medicine, 5*(2), 99–126.
Myer, G. D., Paterno, M. V., Ford, K. R., Quatman, C. E., & Hewett, T. E. (2006). Rehabilitation after anterior cruciate ligament reconstruction: criteria-based progression through the return-to-sport phase. *Journal of Orthopaedic & Sports Physical Therapy, 36*(6), 385–402.
Myer, G. D., Schmitt, L. C., Brent, J. L., Ford, K. R., Barber Foss, K. D., Scherer, B. J., et al. (2011). Utilization of modified NFL combine testing to identify functional deficits in athletes following ACL reconstruction. *Journal of Orthopaedic & Sports Physical Therapy*, .
Nam, A., & Brody, F. (2008). Management and therapy for sports hernia. *Journal of American College of Surgeons, 206*(1), 154–164.
Nicholas, S. J., & Tyler, T. F. (2002). Adductor muscle strains in sport. *Sports Medicine, 32*(5), 339–344.
Nielsen, M. M., Mortensen, A., Sorensen, J. K., Simonsen, O., & Graven-Nielsen, T. (2009). Reduction of experimental muscle pain by passive physiological movements. *Manual Therapy, 14*(1), 101–109.
Orchard, J. W., Read, J. W., Neophyton, J., & Garlick, D. (1998). Groin pain associated with ultrasound finding of inguinal canal posterior wall deficiency in Australian Rules footballers. *British Journal of Sports Medicine, 32*(2), 134–139.
Orchard, J., & Seward, H. (2002). Epidemiology of injuries in the Australian Football League, seasons 1997–2000. *British Journal of Sports Medicine, 36*(1), 39–44.
Orchard, J., Wood, T., Seward, H., & Broad, A. (1998). Comparison of injuries in elite senior and junior Australian football. *Journal of Science and Medicine in Sport, 1*(2), 83–88.
Paajanen, H., Brinck, T., Hermunen, H., & Airo, I. (2011). Laparoscopic surgery for chronic groin pain in athletes is more effective than nonoperative treatment: a randomized clinical trial with magnetic resonance imaging of 60 patients with sportsman's hernia (athletic pubalgia). *Surgery*, .
Paoloni, J. A., Appleyard, R. C., Nelson, J., & Murrell, G. A. (2003). Topical nitric oxide application in the treatment of chronic extensor tendinosis at the elbow: a randomized, double-blinded, placebo-controlled clinical trial. *American Journal of Sports Medicine, 31*(6), 915–920.
Paoloni, J. A., Appleyard, R. C., Nelson, J., & Murrell, G. A. (2004). Topical glyceryl trinitrate treatment of chronic noninsertional Achilles tendinopathy. A randomized, double-blind, placebo-controlled trial. *The Journal of Bone and Joint Surgery.* American volume, *86-A*(5), 916–922.
Paoloni, J. A., Appleyard, R. C., Nelson, J., & Murrell, G. A. (2005). Topical glyceryl trinitrate application in the treatment of chronic supraspinatus tendinopathy: a randomized, double-blinded, placebo-controlled clinical trial. *American Journal of Sports Medicine, 33*(6), 806–813.
Peeters, G. G., Aufdemkampe, G., & Oostendorp, R. A. (1998). Sensibility testing in patients with a lumbosacral radicular syndrome. *Journal of Manipulative and Physiological Therapeutics, 21*(2), 81–88.
Petschnig, R., Baron, R., & Albrecht, M. (1998). The relationship between isokinetic quadriceps strength test and hop tests for distance and one-legged vertical jump test following anterior cruciate ligament reconstruction. *Journal of Orthopaedic & Sports Physical Therapy, 28*(1), 23–31.
Plisky, P. J., Gorman, P. P., Butler, R. J., Kiesel, K. B., Underwood, F. B., & Elkins, B. (2009). The reliability of an instrumented device for measuring components of the star excursion balance test. *North American Journal of Sports Physical Therapy, 4*(2), 92–99.
Price, D. D., Bush, F. M., Long, S., & Harkins, S. W. (1994). A comparison of pain measurement characteristics of mechanical visual analogue and simple numerical rating scales. *Pain, 56*(2), 217–226.
Rab, M., Ebmer, & Dellon, A. L. (2001). Anatomic variability of the ilioinguinal and genitofemoral nerve: implications for the treatment of groin pain. *Plastics and Reconstructive Surgery, 108*(6), 1618–1623.
Rainville, J., Jouve, C., Finno, M., & Limke, J. (2003). Comparison of four tests of quadriceps strength in L3 or L4 radiculopathies. *Spine (Phila Pa 1976), 28*(21), 2466–2471.
Reid, A., Birmingham, T. B., Stratford, P. W., Alcock, G. K., & Giffin, J. R. (2007). Hop testing provides a reliable and valid outcome measure during rehabilitation after anterior cruciate ligament reconstruction. *Physical Therapy, 87*(3), 337–349.
Reiman, M. P., & Manske, R. C. (2009). *Functional testing in human performance*. Champaign, IL: Human Kinetics.
Rhea, M. R., Hunter, R. L., & Hunter, T. J. (2006). Competition modeling of American football: observational data and implications for high school, collegiate, and professional player conditioning. *Journal of Strength & Conditioning Research, 20*(1), 58–61.
Richardson, C. A., Snijders, C. J., Hides, J. A., Damen, L., Pas, M. S., & Storm, J. (2002). The relation between the transversus abdominis muscles, sacroiliac joint mechanics, and low back pain. *Spine (Phila Pa 1976), 27*(4), 399–405.
Rutjes, A. W., Nuesch, E., Sterchi, R., Kalichman, L., Hendriks, E., Osiri, M., et al. (2009). Transcutaneous electrostimulation for osteoarthritis of the knee. *Cochrane Database of Systematic Reviews, 4*, CD002823.
Sawyer, D. T., Ostarello, J. Z., Suess, E. A., & Dempsey, M. (2002). Relationship between football playing ability and selected performance measures. *Journal of Strength & Conditioning Research, 16*(4), 611–616.
Schache, A. G., Bennell, K. L., Blanch, P. D., & Wrigley, T. V. (1999). The coordinated movement of the lumbo-pelvic-hip complex during running: a literature review. *Gait & Posture, 10*(1), 30–47.
Schick, D. M., & Meeuwisse, W. H. (2003). Injury rates and profiles in female ice hockey players. *American Journal of Sports Medicine, 31*(1), 47–52.
Schilders, E., Talbot, J. C., Robinson, P., Dimitrakopoulou, A., Gibbon, W. W., & Bismil, Q. (2009). Adductor-related groin pain in recreational athletes: role of the adductor enthesis, magnetic resonance imaging, and entheseal pubic cleft injections. *The Journal of Bone and Joint Surgery.* American volume, *91*(10), 2455–2460.
Scholtes, S. A., Gombatto, S. P., & Van Dillen, L. R. (2009). Differences in lumbopelvic motion between people with and people without low back pain during two lower limb movement tests. *Clinical Biomechanics (Bristol, Avon), 24*(1), 7–12.
Shum, G. L., Crosbie, J., & Lee, R. Y. (2005). Symptomatic and asymptomatic movement coordination of the lumbar spine and hip during an everyday activity. *Spine (Phila Pa 1976), 30*(23), E697–E702.
Shum, G. L., Crosbie, J., & Lee, R. Y. (2007). Movement coordination of the lumbar spine and hip during a picking up activity in low back pain subjects. *European Spine Journal, 16*(6), 749–758.
Silvis, M. L., Mosher, T. J., Smetana, B. S., Chinchilli, V. M., Flemming, D. J., Walker, E. A., et al. (2011). High Prevalence of pelvic and hip magnetic resonance imaging findings in asymptomatic collegiate and professional hockey players. *American Journal of Sports Medicine*, .
Sink, E. L., Gralla, J., Ryba, A., & Dayton, M. (2008). Clinical presentation of femoroacetabular impingement in adolescents. *Journal of Pediatric Orthopaedics, 28*(8), 806–811.
Slavotinek, J. P., Verrall, G. M., Fon, G. T., & Sage, M. R. (2005). Groin pain in footballers: the association between preseason clinical and pubic bone magnetic resonance imaging findings and athlete outcome. *American Journal of Sports Medicine, 33*(6), 894–899.
Smodlaka, V. N. (1980). Physiatrists and sports medicine. *Archives of Physical Medicine and Rehabilitation, 61*(3), 148.
Spiegel, B., Farid, M., Esrailian, E., Talley, J., & Chang, L. (2010). Is irritable bowel syndrome a diagnosis of exclusion?: a survey of primary care providers, gastroenterologists, and IBS experts. *American Journal of Gastroenterology, 105*(4), 848–858.
Stanton, T. R., Fritz, J. M., Hancock, M. J., Latimer, J., Maher, C. G., Wand, B. M., et al. (2011). Evaluation of a treatment-based classification algorithm for low back pain: a cross-sectional study. *Physical Therapy, 91*(4), 496–509.
Stevens, V. K., Vleeming, A., Bouche, K. G., Mahieu, N. N., Vanderstraeten, G. G., & Danneels, L. A. (2007). Electromyographic activity of trunk and hip muscles

during stabilization exercises in four-point kneeling in healthy volunteers. *European Spine Journal, 16*(5), 711–718.
Stolen, T., Chamari, K., Castagna, C., & Wisloff, U. (2005). Physiology of soccer: an update. *Sports Medicine, 35*(6), 501–536.
Thorborg, K., Holmich, P., Christensen, R., Petersen, J., & Roos, E. M. (2011). The Copenhagen Hip and Groin Outcome Score (HAGOS): development and validation according to the COSMIN checklist. *British Journal of Sports Medicine, 45*(6), 478–491.
Thorborg, K., Roos, E. M., Bartels, E. M., Petersen, J., & Holmich, P. (2010). Validity, reliability and responsiveness of patient-reported outcome questionnaires when assessing hip and groin disability: a systematic review. *British Journal of Sports Medicine, 44*(16), 1186–1196.
Thorborg, K., Serner, A., Petersen, J., Madsen, T. M., Magnusson, P., & Holmich, P. (2011). Hip adduction and abduction strength profiles in elite soccer players: implications for clinical evaluation of hip adductor muscle recovery after injury. *American Journal of Sports Medicine, 39*(1), 121–126.
Tibor, L. M., & Sekiya, J. K. (2008). Differential diagnosis of pain around the hip joint. *Arthroscopy, 24*(12), 1407–1421.
Toro-Velasco, C., Arroyo-Morales, M., Fernandez-de-Las-Penas, C., Cleland, J. A., & Barrero-Hernandez, F. J. (2009). Short-term effects of manual therapy on heart rate variability, mood state, and pressure pain sensitivity in patients with chronic tension-type headache: a pilot study. *Journal of Manipulative and Physiological Therapeutics, 32*(7), 527–535.
Troelsen, A., Mechlenburg, I., Gelineck, J., Bolvig, L., Jacobsen, S., & Soballe, K. (2009). What is the role of clinical tests and ultrasound in acetabular labral tear diagnostics? *Acta Orthopaedica, 80*(3), 314–318.
Tyler, T. F., Nicholas, S. J., Campbell, R. J., Donellan, S., & McHugh, M. P. (2002). The effectiveness of a preseason exercise program to prevent adductor muscle strains in professional ice hockey players. *American Journal of Sports Medicine, 30*(5), 680–683.
Tyler, T. F., Nicholas, S. J., Campbell, R. J., & McHugh, M. P. (2001). The association of hip strength and flexibility with the incidence of adductor muscle strains in professional ice hockey players. *American Journal of Sports Medicine, 29*(2), 124–128.
Van den Bruel, A., Haj-Hassan, T., Thompson, M., Buntinx, F., & Mant, D. (2010). Diagnostic value of clinical features at presentation to identify serious infection in children in developed countries: a systematic review. *Lancet, 375*(9717), 834–845.
Verrall, G. M., Hamilton, I. A., Slavotinek, J. P., Oakeshott, R. D., Spriggins, A. J., Barnes, P. G., et al. (2005). Hip joint range of motion reduction in sports-related chronic groin injury diagnosed as pubic bone stress injury. *J Sci Med Sport, 8*(1), 77–84.
Verrall, G. M., Slavotinek, J. P., Barnes, P. G., Esterman, A., Oakeshott, R. D., & Spriggins, A. J. (2007). Hip joint range of motion restriction precedes athletic chronic groin injury. *Journal of Science and Medicine in Sport, 10*(6), 463–466.
Verrall, G. M., Slavotinek, J. P., Barnes, P. G., & Fon, G. T. (2005). Description of pain provocation tests used for the diagnosis of sports-related chronic groin pain: relationship of tests to defined clinical (pain and tenderness) and MRI (pubic bone marrow oedema) criteria. *Scandinavian Journal of Medicine & Science in Sports, 15*(1), 36–42.
Verrall, G. M., Slavotinek, J. P., Fon, G. T., & Barnes, P. G. (2007). Outcome of conservative management of athletic chronic groin injury diagnosed as pubic bone stress injury. *American Journal of Sports Medicine, 35*(3), 467–474.
Wainner, R. S., Whitman, J. M., Cleland, J. A., & Flynn, T. W. (2007). Regional interdependence: a musculoskeletal examination model whose time has come. *Journal of Orthopaedic & Sports Physical Therapy, 37*(11), 658–660.
Weir, A., de Vos, R. J., Moen, M., Holmich, P., & Tol, J. L. (2011). Prevalence of radiological signs of femoroacetabular impingement in patients presenting with long-standing adductor-related groin pain. *British Journal of Sports Medicine, 45*(1), 6–9.
Wiktorsson-Moller, M., Oberg, B., Ekstrand, J., & Gillquist, J. (1983). Effects of warming up, massage, and stretching on range of motion and muscle strength in the lower extremity. *American Journal of Sports Medicine, 11*(4), 249–252.
Williams, G. N., Gangel, T. J., Arciero, R. A., Uhorchak, J. M., & Taylor, D. C. (1999). Comparison of the Single Assessment Numeric Evaluation method and two shoulder rating scales. Outcomes measures after shoulder surgery. *American Journal of Sports Medicine, 27*(2), 214–221.
Williams, P. R., Thomas, D. P., & Downes, E. M. (2000). Osteitis pubis and instability of the pubic symphysis. When nonoperative measures fail. *American Journal of Sports Medicine, 28*(3), 350–355.
Witvrouw, E., Danneels, L., Asselman, P., D'Have, T., & Cambier, D. (2003). Muscle flexibility as a risk factor for developing muscle injuries in male professional soccer players. A prospective study. *American Journal of Sports Medicine, 31*(1), 41–46.
Wollin, M., & Lovell, G. (2006). Osteitis pubis in 4 young football players: a case series demonstrating successful rehabilitation. *Physical Therapy in Sport, 7*, 153–160.
Yeung, T. S., Wessel, J., Stratford, P., & Macdermid, J. (2009). Reliability, validity, and responsiveness of the lower extremity functional scale for inpatients of an orthopaedic rehabilitation ward. *Journal of Orthopaedic & Sports Physical Therapy, 39*(6), 468–477.
Young, I. A., Michener, L. A., Cleland, J. A., Aguilera, A. J., & Snyder, A. R. (2009). Manual therapy, exercise, and traction for patients with cervical radiculopathy: a randomized clinical trial. *Physical Therapy, 89*(7), 632–642.
Yousefi-Nooraie, R., Schonstein, E., Heidari, K., Rashidian, A., Pennick, V., Akbari-Kamrani, M., et al. (2008). Low level laser therapy for nonspecific low-back pain. *Cochrane Database of Systematic Reviews, 2*, CD005107.
Zoga, A. C., Kavanagh, E. C., Omar, I. M., Morrison, W. B., Koulouris, G., Lopez, H., et al. (2008). Athletic pubalgia and the "sports hernia": MR imaging findings. *Radiology, 247*(3), 797–807.