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DIAGNOSTIC METHODS: Case Report

Principles of diagnostic sonography in iliopsoas tendon pathology: A case report

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ABSTRACT

This article describes the diagnostic value of musculoskeletal sonography in the management of tendon pathology and outlines a clinical example of its scope of utilization. Herein we describe the case of a 65-year-old man who sought rehabilitation services for left groin pain following a period of intense trekking and uphill walking. He presented with left hip flexor weakness and local tenderness over the left iliopsoas tendon with negative findings on neurological evaluation. Additionally, he presented with left hip capsule and hip flexor tightness with left gluteus maximus and gluteus medius weakness. The left hip capsule tightness was predominantly in the posterior fibres, with restriction of hip internal rotation. The clinical picture overall was suggestive of the presence of risk parameters for iliopsoas tendinopathy. Plain radiographs of the hip revealed mild degenerative changes with a mild pincer impingement. While his clinical and radiological picture was suggestive of degenerative and soft tissue pathology of the hip, a real-time sonographic study was useful in the quantitative confirmation of a partial tear of the left iliopsoas tendon. Additionally, a repeat sonographic study performed four weeks later, revealed a healing iliopsoas tendon seen as a decrease in the width of the hypoechoic presentation of the tear. To summarize, the value of musculoskeletal sonography as a diagnostic tool as well as the assessment of the progression of tendon healing is discussed. Sonography is safe, noninvasive, and does not use ionizing radiation. It is steadily gaining popularity in the diagnosis of tendon lesions.

1. Introduction

Musculoskeletal sonography (MSKUS) is steadily gaining popularity in the practice of musculoskeletal medicine. Musculoskeletal sonographic imaging uses sound waves to produce pictures of muscles, tendons, ligaments, and joints throughout the body. It is used to diagnose sprains, strains, tears, and other soft tissue conditions. It is considered safe, noninvasive, and does not use ionizing radiation (Taheri et al., 2016).

While magnetic resonance imaging (MRI) is now a norm in imaging practice, MSKUS, with its rapid technological improvements, has evolved into a complementary tool for musculoskeletal imaging. In musculoskeletal practice, the literature documenting the effectiveness of MSKUS is promising, especially with the diagnosis of soft tissue pathologies of the shoulder (Hougs Kjær et al., 2017).

The advantages of MSKUS (Nazarian, 2008) include:

1. Contra-indications for its application are rare with the ability for safe application over areas with surgical implants and hardware. Hence, hypothetically, almost every patient can undergo MSKUS;
2. While standard soft tissue imaging procedures show static images, MSKUS has the ability to visualize real-time dynamic imaging;
3. MSKUS facilitates the easy administration of repeat examinations to visualize and quantify the degree of healing of soft tissues.
4. MSKUS is very effective in guiding therapeutic interventions because of its real-time capacity giving it a clear advantage over MRI in guiding a wide range of musculoskeletal interventions, especially needling and injections.

The perceived disadvantages of MSKUS (Nazarian, 2008) include:

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1. MSKUS is skill-dependent and is therefore occasionally perceived as a difficult-to-learn procedure, with few programs teaching the technique. Clinicians who are motivated to learn often end up teaching themselves;
2. Concurrently, clinicians are not always very confident of their probe handling skills and have to train sonographers involving added training in anatomy and probe placing skills; and
3. Although MSKUS is considered more reliable, sensitive, and specific for certain conditions, professional and technical reimbursements for MRIs are much higher, making MSKUS less preferable.

1.1. Basic physics

Ultrasound utilizes the piezoelectric effect to produce sound waves. This is accomplished by a lead zirconate crystal situated in the probe. A gel-coupling medium sends the sound waves to the tissues and upon interaction, they are reflected back to the transducer. This reflection is converted into an electric current that is used to produce an ultrasound image. The impedance encountered by the soft tissue interfaces determines the brightness of the echo and the subsequent image. The direction of the sound wave to the object being imaged also influences the quality of the image. A sound wave that is perpendicular to the surface of an object being imaged will be reflected to a greater extent than one that is not perpendicular (Kumbhare et al., 2016; Serafin-Król and Maliborski, 2017).

1.2. Probes

The transducer, or probe is one of the primary physical components of an ultrasound machine. It is directly connected to the other components. This includes the image screen, or monitor, and the computer processing unit. The probe is the component that is placed on the skin surface of the structure being imaged. It facilitates the to and fro transmission of ultrasound waves and is hence one of the key components of image production. There are two basic types of probes used in MSKUS: linear and curvilinear. The linear probe has a higher frequency (5–15 MHZ) and generates a rectangular image field. These are better for imaging superficial structures (muscles, tendon, and fascia) and blood vessels and are also called vascular probes. Curvilinear probes are of a lower frequency (3–5 MHZ) and generate sector or 'pie-shaped' images which are narrower in the near field and wider in the far field (Fig. 1). These are used for deeper endo-cavity imaging as in the abdomen and are used to image structures around the hip and pelvis. The linear probe can be utilized virtually anywhere over the musculoskeletal system (Serafin-Król and Maliborski, 2017).

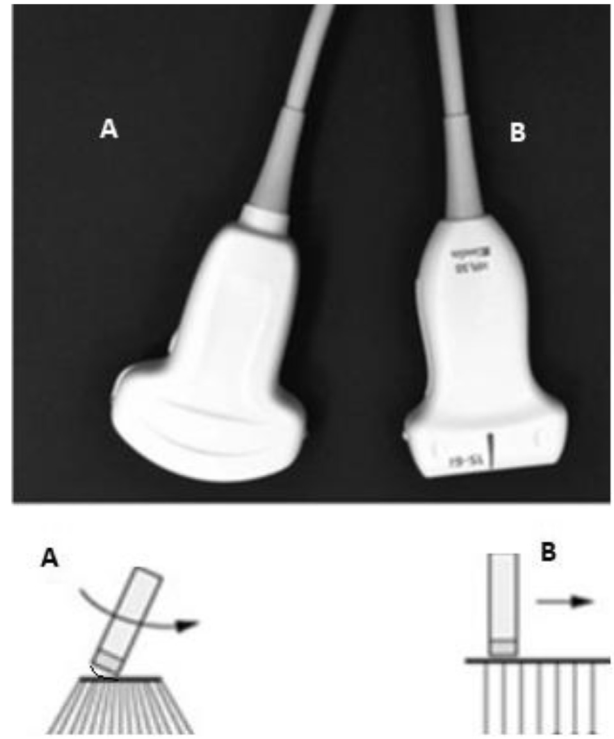

Fig. 1. Probe types.

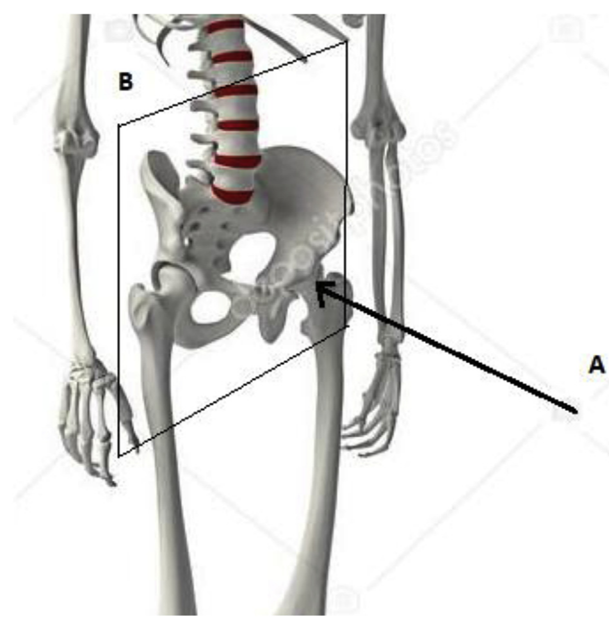

Fig. 2. Radiographic imaging of the left hip.

1.3. The 3-dimensional plane vs. surface view

The novice MSKUS clinician, having prior experience with radiological imaging, must undergo a paradigm shift in observing musculoskeletal anatomy on the screen. In a typical x-ray, the central beam passes perpendicularly over the area being investigated; however, depending on the surface plane targeted (e.g. frontal) an actual frontal plane image is projected making interpretation more easily decipherable (Figs. 2 and 3).

The sonographic view of the same joint, however, varies in its screen representation. While the probe and the beam are still directed perpendicular to the joint, a surface image in layers, as opposed to a perpendicular frontal plane image, is obtained (Figs. 4 and 5). The clinician must hence improve the necessary cognitive skills to interpret surface anatomy in layers in both the long and short axes of the tissue being investigated.

1.4. Diagnostic principles in MSKUS

This section describes the principles underlying MSKUS diagnoses assuming the obtained image is accurate and free of 'artifacts'. An artifact in MSKUS jargon is an error in imaging. On the screen, these are images of structures that are misinterpreted, not real or present, or are situated in an incorrect location. They can

Fig. 3. Frontal plane AP view of the L hip.

Fig. 4. A sonographic beam of the right (R) hip in a frontal plane.

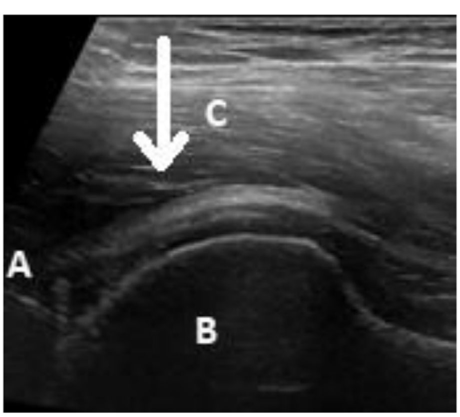

Fig. 5. Frontal plane 'layer' view of the R hip. A - acetabulum; B - femoral head; C - direction of probe placement.

occur for the following reasons:

1. Operator skill and improper use of the MSKUS equipment;
2. Incorrect MSKUS system assumptions;
3. The physics of MSKUS; and
4. Viewer error.

1.5. *Echogenicity and the 'normal' logic*

As with most other imaging techniques, the clinician is encouraged to comprehend and practice to perfection the interpretation of 'normal' MSKUS images. The logic is that while the comprehension of 'normal' is perfected, any deviation from normal may not be missed by the eye. MSK structures have a characteristic image presentation based on tissue type. In MSKUS jargon, the words hyperechoic, hypoechoic, and anechoic are encountered.

The reflection of the ultrasound waves results in the formation of an image and the reflection is termed an 'echo'. The strength of this 'echo' determines how that tissue will appear on the image. When a large proportion of the ultrasound waves striking a structure are reflected back to the probe, the structure is described as being 'hyperechoic' or with 'increased echogenicity', and will appear bright on the image. When a structure reflects relatively few ultrasound waves, it is 'hypoechoic' or with 'decreased echogenicity', and appears relatively dark or grey. Fluid-containing structures reflect few if any of the ultrasound waves and are described as being 'anechoic', appearing completely black on the image.

Typical synovial joints, cortical bone, capsules, muscles, and ligaments are usually hyperechoic and cartilage, synovium, and cancellous bone are anechoic. Applying basic logic, when soft tissues such as tendons, muscles, or ligaments are disrupted, and depending on the extent of the disruption, they can range from being hypoechoic to patches of anechoic. The image is typically anechoic when there is a buildup of fluid (Ihnatsenka and Boezaart, 2010).

2. Case report

2.1. *History and clinical findings*

A 65-year-old male who experienced symptoms of hip and groin pain with pain radiating into the left medial thigh is described. The pain was reported to have started following a bout of intense trekking and uphill walking. He reported trekking as his recreational activity which occurred several times during the year. The pain, although gradual and mild, on and off, had intensified 3 months prior to consultation. The pain was sharp and was aggravated by ascending stairs. Less pain on standing and walking was reported. He also reported pain while turning in bed and while performing yoga. His pain seemed considerably less at rest, although certain physically demanding days at work caused pain at rest. His job involved standing, walking, and traveling, as he was a sales professional. The job also involved a lot of driving, plane travel, long hours of desk work, and meetings. He denied tingling or numbness in the involved extremity. He rated this pain as an 8 on a scale of 10 using the *Numerical Pain Rating Scale (NPRS)* (Chapman et al., 2011). His medical history was unremarkable, and he was not taking any medications. He denied any recent or past trauma.

2.2. *Testing*

Observation revealed the patient to be in moderate distress on functional movement and transfers, especially when changing from sitting to standing. Observation of walking revealed a mild decrease of stance time on the left lower extremity in comparison to the right, with a mild lurch to the left. The patient was then asked to sit in an erect posture to assess the range of motion in the lumbar region, and was asked to bend forward with his hands between the knees, directed down towards the floor. Lumbar flexion revealed a reversal of lordosis with minimal discomfort in the left groin during terminal flexion. He was then asked to stand in an erect posture and bend forward toward the floor. This reproduced minimal discomfort in the groin region in the terminal range of flexion. Lumbar extension, side bending, and rotation were full and painless with no reproduction of symptoms. Additionally, lumbar and sacral dermatomes, myotomes, deep tendon reflexes, and the Babinski reflex were normal. He denied bladder and bowel disturbances.

In the supine lying position, the groin and inguinal area were palpated. He reported pain and tenderness over the anterior and medial femoral-acetabular rim. The iliopsoas tendon was palpated over the mid-inguinal area, which reproduced comparable pain and tenderness. The tensor fascia lata was palpated just below the anterior superior iliac spine to reproduce pain and tenderness. Movement testing done over the left hip joint revealed restriction of internal rotation at 15°. Hip flexion range was near normal; however, reproduced discomfort terminally. External rotation was full and free. A straight leg raise (SLR) reproduced comparable discomfort and a resisted SLR was weak and painful with a grade of 3+/5. Resisted flexion of the left hip in the seated position was also weak and painful. A plain anteroposterior (AP) radiograph of the left hip revealed mild osteoarthritis (OA) with medial compartment narrowing and a pincer impingement (Fig. 6).

While the radiograph was indicative of mild OA and pincer impingement, the more suspicious findings were the weakness of hip flexion, and tenderness over the iliopsoas tendon, suggesting a tendon pathology. A sonographic examination was performed over the anterior aspect of the left hip utilizing a long axis technique (Moore, 2016) (Fig. 7). It revealed a hypoechoic fissure over the left iliopsoas tendon, indicating a tear. This finding correlated with the clinical picture, especially weakness during resisted hip flexion (Nigel et al., 2005) (Fig. 8).

The patient had undergone a detailed medical evaluation prior to being referred for physical therapy. This included a visceral screen and x-rays to rule out anything obviously wrong. He was assured that the findings were negative for visceral involvement including other ailments and was told by the examining clinician that the presentation pertained to the musculoskeletal system, requiring the expertise of a musculoskeletal practitioner.

The clinical findings met the 'Set A' criteria for hip OA by the American College of Rheumatology, (level of evidence 2A) which include: age, 50+; hip pain, hip internal rotation less than 15°; pain

Fig. 7. Long axis sonographic technique over the acetabular rim and femoral head.

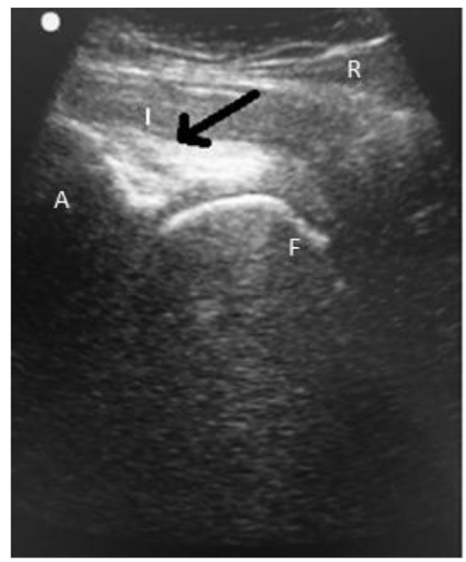

Fig. 8. Sonographic image of the L hip depicting an iliopsoas tendon tear with anechoic fluid over the femoral head.

Fig. 6. Radiographic image of the left hip showing mild osteoarthritis with pincer impingement.

with hip internal rotation; morning stiffness of the hip less than 60 min (Bennell, 2013); plain AP radiograph of the L hip which revealed mild OA; medial compartment narrowing; and pincer impingement. Additionally, sonographic examination confirmed the presence of an iliopsoas tendon tear, which correlated to the clinical finding of the weakness of hip flexion in the absence of nerve root pathology and comparable pain and tenderness over the iliopsoas tendon. The patient was assured that with targeted intervention, combined with activity modification, and given the right time frame, the condition may respond well to conservative treatment.

2.3. Intervention

The intervention was based on addressing the biomechanical parameters that posed a risk for the iliopsoas tendon. Based on a literature review combined with anecdotal clinical experience, the term 'hip at risk' (Jackson et al., 2015) including the vulnerability of the iliopsoas tendon was present when the following were seen:

i iliopsoas tightness;
ii posterior capsule tightness causing restricted internal rotation; and
iii gluteus maximus and gluteus medius weakness.

Treatment targeted functional mobility of the hip capsule, adequate length of the iliopsoas, and functional strength of the gluteus maximus and medius. The patient was seen twice a week for four weeks. Methods incorporated included manual therapy in the form of soft tissue and joint mobilization addressing the iliopsoas and hip posterior capsule, corrective exercise to self-stretch the iliopsoas and strengthen the gluteus maximus and medius, and pain reduction modalities (Romeo et al., 2013; Witvrouw et al., 2007; Dwyer et al., 2013; Joseph et al., 2012).

2.4. Outcomes

At the end of the fourth week, on completion of two treatment sessions per week for four weeks, there was decreased discomfort on terminal hip flexion, sit to stand transfers, and stair climbing (pain rating 0–1 on the NPRS scale) with decreased symptom reproduction on local pressure over the left iliopsoas tendon. Passive hip extension was 20° and passive hip internal rotation was 30°. His Global Rating of Change Questionnaire (GROCQ) score was 5+, indicating 'feeling a good deal better'. The GROCQ is considered a reliable self-reporting measure for pain and function (Kamper et al., 2009). Resisted hip flexion in the SLR and the sitting position was stronger, (grade 4); however, slightly weaker compared to the right side. While the clinical picture was indicative of tendon healing, a method of visual quantification was lacking. Therefore, a repeat sonographic study was performed after four weeks of treatment. It revealed a healing iliopsoas tendon seen as a decrease in the width of the hypoechoic presentation of the tear with a decrease in anechoic fluid over the femoral head (Fig. 9).

He was discharged from rehabilitation and advised regarding the risk of relapse secondary to overuse. He was further warned that considering the moderate OA of the hip and a healing tendon, a relapse was possible if he continued to participate in intense climbing and trekking endeavors.

3. Discussion

The psoas major and minor muscles originate over the anterior surfaces of the transverse processes of T12-L5 vertebrae, the upper two-thirds of the iliacus, and the bodies and intervening intervertebral discs of T12 and L1. They insert as a conjoint tendon over the lesser trochanter. Prior to insertion, they pass over the iliopectineal eminence, the anterior aspect of the femoral head, and the overlying iliopsoas bursa (Figs. 10 and 11). Literature suggests this location to be a potential site for irritation of the tendon leading to pathologies (Anderson, 2016).

The rationale for intervention was based on minimizing the vulnerability of the iliopsoas tendon as the biomechanical profile combined with the activity involved (uphill climbing) were causing increased demands on the tendon. The cycle of events that potentially created this scenario is explained below.

Hip flexor tightness, perhaps a lifestyle issue, can occur since most people spend a considerable amount of time during the day in a seated position. When the femur is fixed in a position of relative flexion, the iliopsoas, being a postural muscle, is in a shortened position and predisposed to tightness (Hammoud et al., 2014; Grgić, 2009) (Fig. 12).

The literature adequately supports that a tight muscle is predisposed to increased tendon tensile stress and subsequent

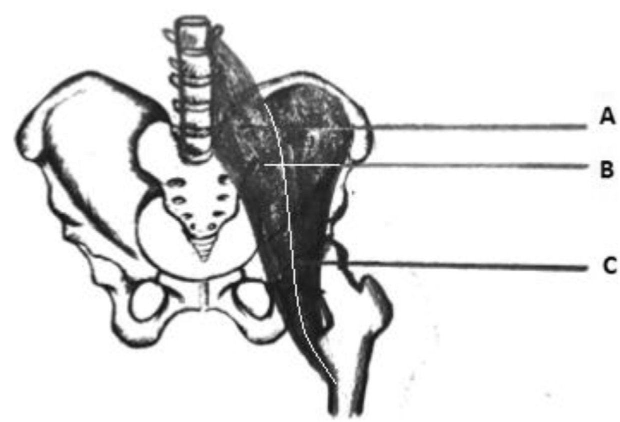

Fig. 10. Anterior view of the iliopsoas.

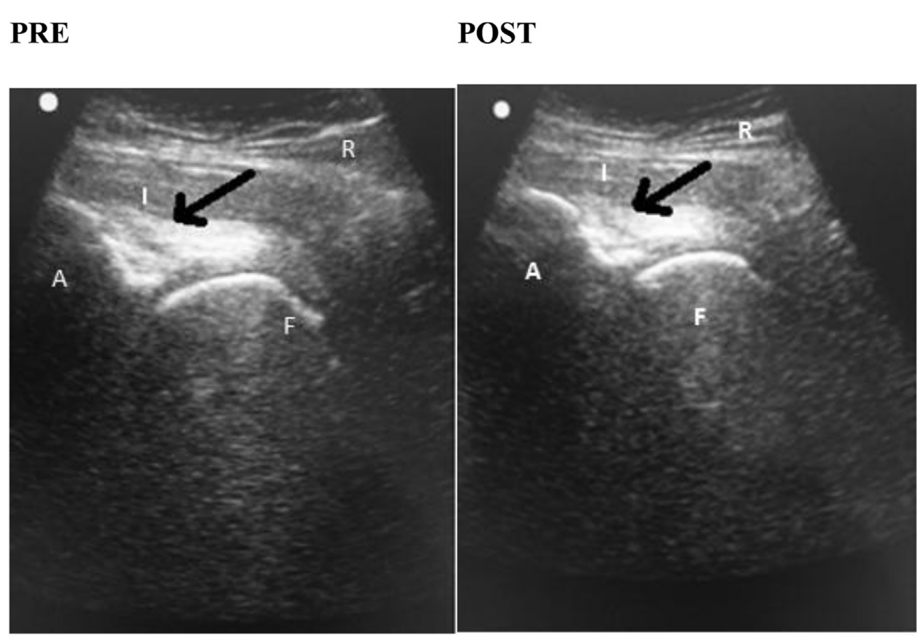

Fig. 9. Repeat sonographic image taken after 4 weeks showing healing of the iliopsoas tear with a decrease in anechoic fluid over the femoral head (adjacent comparison image).

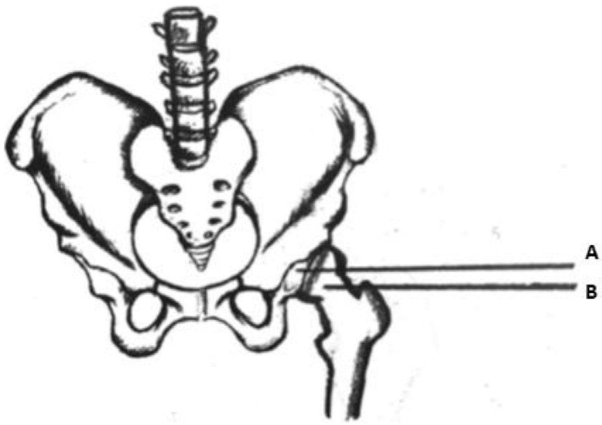

Fig. 11. Diagrammatic representation of iliopsoas irritation sites.

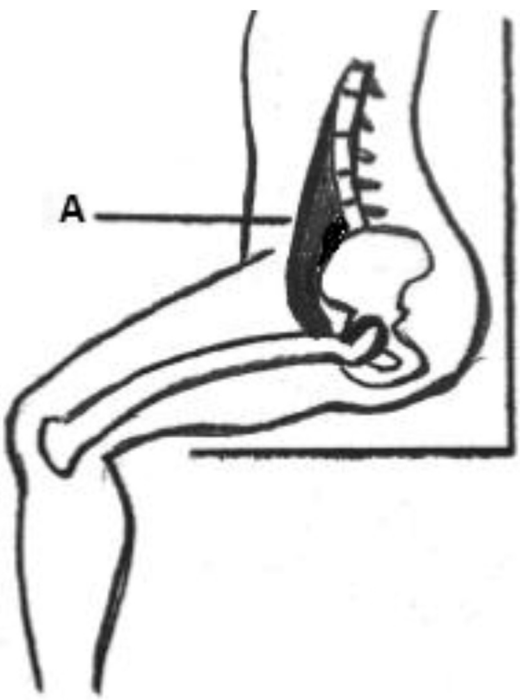

Fig. 12. The shortened position of the hip iliopsoas during sitting.

tendinitis (Witvrouw et al., 2007). While it is clearly understood that a major contributing factor to tendinitis is increased tensile stresses combined with overuse, the vulnerability of a tendon can be further augmented by the presence of muscle tightness and associated alterations in biomechanical or anthropometric parameters (Maganaris et al., 2004). Additional demands of hip flexion in the open kinetic chain as would be required for uphill climbing (Yokozawa et al., 2007) pose an additional risk and added vulnerability for the tendon.

In the presence of hip flexor tightness, the femur is fixed in a position of relative flexion with the iliopsoas in a shortened position. While standing, this creates an anterior pelvic tilt with increased lumbar lordosis (Sajko and Stuber, 2009). This creates an added excursion of the iliopsoas tendon over the femoral head and iliopectineal eminence (especially with hip extension), predisposing to friction. (Hammoud et al., 2014) (Fig. 13).

In the presence of concurrent hip posterior capsule tightness

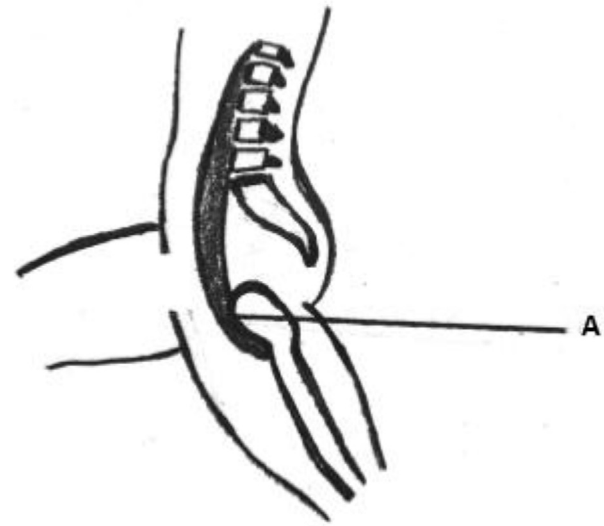

Fig. 13. Hip extension in a terminal stance in preparation for ascending uphill while the opposite side contracts concentrically.

causing restricted hip internal rotation, the femoral head is in a position of relative external rotation in the acetabulum which may create an added prominence (Cibulka et al., 2009). When there are demands for hip extension during the terminal stance phase of gait, there is potential for the iliopsoas to be susceptible to friction over the underlying iliopectineal eminence and prominent femoral head, secondary to the added excursion of the tight tendon. This can result in wear and tear. The terminal stance position would resemble the leg in an extended position in preparation for uphill climbing (Fig. 13); a position for potential friction. This is followed by the leg proceeding towards hip flexion during the actual climbing motion (Yokozawa et al., 2007), making the tight tendon contract concentrically and repetitively creating a vicious cycle of repetitive wear and tear.

4. Conclusion

This case report describes the value of sonographic imaging in detecting tendon pathologies in the hip. The nature of the activity, clinical presentation, and examination methods described in this case report highlight the ability of experienced practitioners to make a clinical diagnosis of tendon pathology. However, we practice in an era where quantification of diagnosis (for validity and diagnostic utility) is mandatory. Hence, the value of an easily administered and visually quantifiable diagnostic tool like MSKUS cannot be overlooked. While tendon pathology is easily identified using MSKUS, its added ability to visually quantify tendon healing, similar to the ability of radiograph assessments to quantify bone healing, is highlighted.

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