Dynamic Sonographic Evaluation of Lower Limb Musculoskeletal Disorders

Essay

Submitted for Partial Fulfillment of Master Degree in Radio diagnosis

Faculty of Medicine - Cairo University

By

Hani Refaat Kamel Abdel Malek, M.B.,B.CH.

Supervisors

Dr. Omar Moawayh Osman

Assistant Professor of Radio diagnosis
Faculty of Medicine - Cairo University

Dr. Manar Hussein Abdel Sattar

Assistant Professor of Radio diagnosis
Faculty of Medicine - Cairo University

Faculty of Medicine
Cairo University
2009

Acknowledgments

First and foremost, I would like to express my deepest gratitude and thankfulness to GOD for giving me the will and strength to fulfill this work and then to my family for their continuous encouragement and great helps.

My gratitude and thanks to prof. Dr. Ahmed Sami head of Diagnostic Radiology Department Cairo University for his great support.

My sincere gratitude and unlimited thanks are addressed to Dr. Omar Moawayh, assistant professor of Radiodiagnosis, Cairo University for his constant advice, encouragement and sincere remarks. It has been a great honor and extreme pleasure for me to proceed with this work under his supervision.

Words cannot express my appreciation to Dr. Manar Hussein, assistant professor of Radiodiagnosis Cairo University, for her utmost help, kind indispensable guidance, cooperative attitude and encouragement in performing this work.

Last but not least, thanks extended to all staff members and colleagues of the Radiology Department, for their help and co-operation.

CONTENTS

INTRODUCTION

Sonography is a useful technique for the investigation of a number of musculoskeletal disorders. Advances in sonographic technology, including higher resolution probes, power Doppler sonography, extended field-of-view imaging, and compound imaging, have contributed to expand its clinical applications. Sonography has the well-known advantages of low cost, accessibility, portability, non-invasiveness, and multiplanar imaging. But perhaps one of its most important diagnostic advantages over other techniques is its real-time imaging capability, allowing for dynamic evaluation. The real-time imaging feature of sonography is of particular interest because some disorders of muscles, tendons, nerves, and joints are better— or in some cases, only—seen dynamically, that is, during motion of the extremity, muscle contraction, probe compression, or position change of the patient **(Khoury et al, 2007).**

When performing musculoskeletal sonography, the proper equipment is essential to facilitate optimal image quality and diagnostic examinations. In general, the structures examined will be superficial; therefore, high-frequency (≥7-12 MHz) linear array transducers are usually the most appropriate choice. The high resolution attainable allows detailed anatomic depiction of pertinent structures. Proper positioning of the patient is of paramount importance in obtaining high-quality studies. Different sonographic techniques have been described, with the universal goal of optimizing the visualization of structures of interest **(Lin et al, 2000).**

Anisotropy is an important artifact that can affect the image and should be considered when examining any musculoskeletal soft-tissue structure. This finding is most obvious with tendons and ligaments, caused by the highly ordered, parallel pattern of collagen fibers that shows the greatest degree of reflectivity when examined perpendicular to the ultrasound beam. Anisotropy occurs when the ultrasound beam is not perpendicular to the fibrillar structure of the tendon, resulting in the absence of specular reflectors and an artifactual hypoechoic to anechoic appearance. The sonographer should be aware of proper transducer position and may need to manipulate the heel-toe and fore-aft angulation of the probe to avoid this artifact. When a tendon has a curving course, the effects of anisotropy cannot be entirely eliminated. Each separate portion of the tendon must be examined individually, and the evaluation of tendon integrity should be primarily determined during real-time scanning **(Lin et al, 2000).**

Dynamic sonography is helpful in the diagnosis of external snapping hip syndrome; it shows real-time images of sudden abnormal displacement of the iliotibial band or the gluteus maximus muscle overlying the greater trochanter as a painful snap during hip motion **(Choi et al, 2002).**

Internal snapping hip is caused by snapping of the iliopsoas tendon over the iliopectineal eminence. New mechanisms of snapping iliopsoas tendon have been described using dynamic sonography. Sudden iliopsoas tendon flipping over the iliac muscle is the most common cause of internal snapping hip **(Deslandees et al, 2008).**

Ultrasonography is the study of choice to evaluate for DDH in infants younger than six months because it is capable of visualizing the cartilaginous anatomy of the femoral head and acetabulum. It is useful in identifying dysplasia of the cartilaginous portion of the acetabulum, confirming subluxation of the hip, and documenting reducibility and stability of the hip in the infant undergoing treatment for known DDH. Ultrasonography is overly sensitive as a screening tool in the first six weeks of life, and in general should not be ordered until after that **(Storer et al, 2006).**

Snapping knee syndrome refers to a painful snap during knee motion and may be due to a heterogeneous group of disorders. This syndrome may be provoked by abnormal tendon motion around the knee. Snapping knee may also be caused by an intraarticular nodular mass in rheumatoid arthritis. At sonography, the mass can be identified because it appears to jump and slip in and out of the patellofemoral articulation during flexion and extension **(Khoury et al, 2007).**

With static MR imaging, visualization of the presence of a medial plica is possible but the dynamic behavior of the medial plica cannot be examined. Other imaging techniques, including classic arthrography or CT arthrography, are invasive. In 1986, Derks et al described the use of sonography for the diagnosis of medial plica syndrome and verified the accuracy of this method by using arthroscopy. Dynamic sonography, together with sonopalpation (tissue recognition under transducer pressure and pain perception when passing a transducer over the affected part), allows more accurate diagnosis. The presence of the plica is determined during a dynamic examination: The patella is moved, and the behavior of the plica echo is judged by using specific criteria. **(Paczesny et al, 2009).**

Sonography can be helpful in identifying ankle tendon impingement due to osteophytes, fracture fragments, and orthopedic hardware. In such cases, Dynamic sonography, or imaging during joint motion, can aid in the evaluation of tendon tears, transient subluxation, and dislocation of tendons or nerves. Dynamic sonography can also assess tendon impingement, which may occur only with specific movements **(Shetty et al, 2002).**

The use of dynamic ultrasound is effective for determining the presence or absence of a peroneal tendon tear and should be considered a first-line diagnostic tool **(Thomas et al, 2005).**

Peroneal tendon subluxation is a major cause of post traumatic lateral ankle pain. Because peroneal subluxation often occurs only when the foot is dorsiflexed and everted, findings on static imaging studies may appear to be normal **(Neustadter et al, 2004).**

A muscle hernia is a protrusion of muscular tissue through a fascial defect. Hernias mostly occur in the lower leg, usually involving the tibialis anterior muscle. Because of their small size and dynamic features, these lesions can be overlooked at MRI. Although most muscle hernias are treated conservatively, sonography is useful to make the diagnosis and exclude alternative ones such as muscle tear and tumor, the latter being a frequent concern especially of the patient **(Beggs, 2003).**

On sonography, muscle tears may appear as small areas of focal disruption, hyperechoic infiltration, heterogeneous mass (in the presence of a hematoma or hemorrhage), or a combination of these findings. Dynamic sonography is useful when the hematoma is small or has resolved. In such cases, muscle contraction or transducer pressure may better reveal the separation of disrupted frayed ends of the muscle tear **(Khoury et al, 2007).**

THE HIP JOINT

Snapping Hip Syndrome

Snapping hip is described as a painful and audible snap of the hip felt with motion. This syndrome has a wide variety of causes of intra-articular or of extra-articular origin. A significant portion (50%) of snapping hip cases may be asymptomatic **(Pelsser et al, 2001).**

Causes of snapping hip may be extra-articular, including (internal) snapping of the iliopsoas tendon over the iliopectineal eminence, snapping of the iliofemoral ligament over the femoral head and (external) friction of the iliotibial band or gluteus maximus against the greater trochanter **(Khoury et al, 2007).**
Intra-articular snapping hip has been attributed to synovial osteochondromatosis, loose bodies, acetabular labral tears, osteochondral fractures, and transient subluxation of the femoral head **(Pelsser et al, 2001).**

From a clinical standpoint, snapping hip becomes a diagnostic possibility when the patient reports a click or a snap in the hip with motion. On physical examination, the clinician may either hear the click, feel the snap through his hand, or actually feel a band of tissue passing abruptly under his hand. Classically, when a snapping iliopsoas tendon was suspected, bursography or tenography was performed as preoperative procedures to confirm the diagnosis **(Vaccaro et al, 1995).**
Recently, sonography has been used in the diagnosis of this entity. Sonographic studies are advantageous when compared with bursography and tenography because they allow direct non-invasive real-time visualization of soft tissues surrounding the coxofemoral joint in a single examination. Because sonography cannot allow evaluation of the intra-articular space, radiography, arthrography, CT, or MR imaging may still be required to confirm the diagnosis of an intra-articular cause of snapping hip **(Cardinal et al, 1996).**

Functional Anatomy

The pelvis is the link between the trunk and the lower extremities. The ball-and-socket joint of the hip allows for 3° of freedom, approximately

120° of flexion, 20° of extension, 40° of abduction, 25° of adduction, and 45° each of internal and external rotation. The iliotibial band, or tensor fascia lata, is a ligament that originates from the iliac crest and inserts on the lateral proximal tibia. Crossing 2 joints, this ligament functions to flex and rotate the thigh medially **(Byrd and Jones, 2004).**

The most common cause of a snapping hip is the iliotibial band snapping over the greater trochanter. This may be associated with trochanteric bursitis or with increased varus of the hip. The finding of a tight iliotibial band is common. Sudden loading of the hip (eg, landing after a jump) may reproduce this sensation of the iliotibial band subluxing over the greater trochanter. With sudden loading, the hip typically is flexed, causing the iliotibial band to move anteriorly followed by the tendon snapping backward as the individual recovers and extends the hip **(Dobbs et al, 2002).**

The gluteus maximus is the largest of the gluteal muscles and functions as an extensor and external rotator of the hip. Originating along the posterior ilium, dorsal surface of the sacrum, and gluteal aponeurosis, the gluteus maximus inserts on the iliotibial tract and gluteal tuberosity of the femur. During extension of the hip, the distal border may snap over the greater trochanter of the femur **(Gruen et al, 2002).**

The psoas and iliacus muscles originate from the lumbar spine and pelvis, respectively, and are innervated by the L1, L2, and L3 nerve roots. These muscles converge to form the iliopsoas muscle and insert onto the lesser trochanter of the proximal femur as the iliopsoas tendon. The psoas major tendon exhibits a characteristic rotation through its course, transforming its ventral surface into a medial surface and its dorsal surface into a lateral surface. The iliac portion of this tendon has a more lateral position and the most lateral muscle fibers of the iliacus muscle insert onto the lesser trochanter of the femur without joining the main tendon. The iliopsoas muscle passes anterior to the pelvic brim and hip capsule in a groove between the anterior inferior iliac spine laterally and the iliopectineal eminence medially. The musculotendinous junction is consistently found at the level of this groove. The iliopsoas muscle functions as a hip flexor and external rotator of the thigh. Furthermore, an iliopsoas-infratrochanteric muscular bundle has been described, which likely relates to the iliopsoas tendon. This muscular bundle arises from the anterior inferior iliac spine (above the origin of the rectus femoris muscle), courses along the anterolateral aspect of the iliacus muscle, and inserts without a tendon onto the anterior surface of the lesser trochanter of the femur. The iliopsoas bursa lies between the musculotendinous junction and the pelvic brim. An internal cause of snapping hip has been described as the iliopsoas tendon snapping over the iliopectineal eminence, hip capsule itself, or lesser trochanter (less likely). The motion of extending a flexed, abducted, and externally rotated hip reproduces the snapping phenomenon **(Joseph, 2006).**

Technique

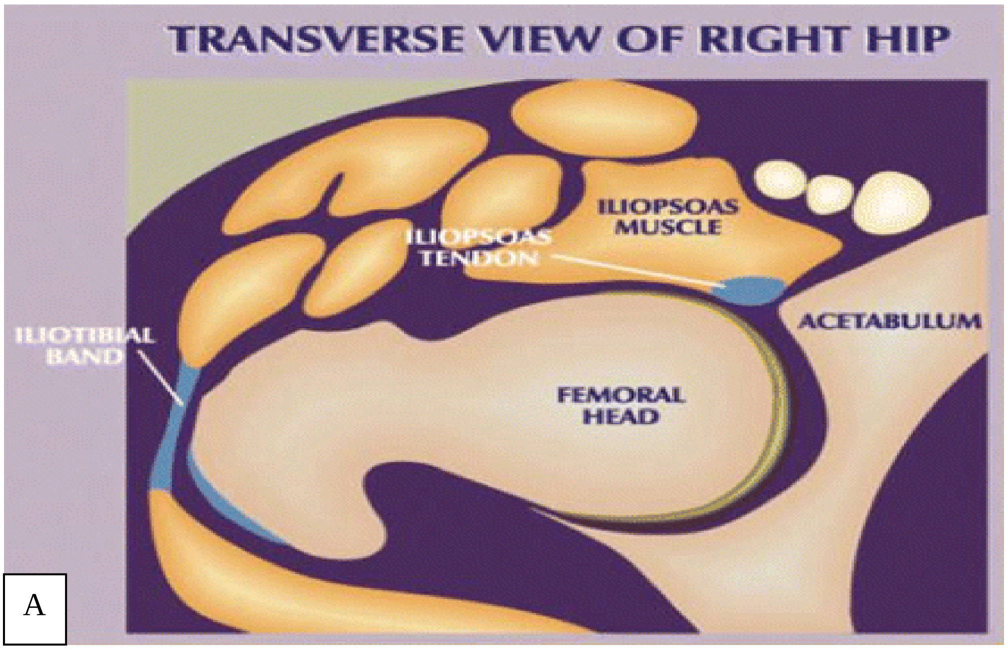
The conventional sonographic study of the hip is an important part of the examination because it can allow identification of structural abnormalities. Sonographic findings of tendinitis, bursitis, synovitis, or local tenderness over the course of a tendon, for example, may orient the clinician toward the appropriate diagnosis. There are no normal thickness values established for the tendons around the hip in the literature. Based on the premise that these structures are symmetric on the left and right sides of a given patient, structural abnormality is suspected when corresponding tissues are asymmetric or when they have an abnormal echogenicity **(Pelsser et al, 2001).**

Using a curved 5.0-MHz or a linear 7.0-MHz transducer, the anterior aspect of the hip is examined first using transverse and sagittal planes as the patient is lying supine with both legs extended. Oblique sagittal images parallel to the femoral neck are also obtained for evaluation of the hip joint capsule. The medial, lateral, and posterior aspects of both hips are also examined using transverse and sagittal scanning. The medial aspect of the hip is examined by asking the patient to flex, abduct, and externally rotate the hip (frog-leg position). The hip is examined laterally by turning the patient on the contralateral side. Then the posterior aspects of both hips are examined with the patient lying prone **(Pelsser et al, 2001).**

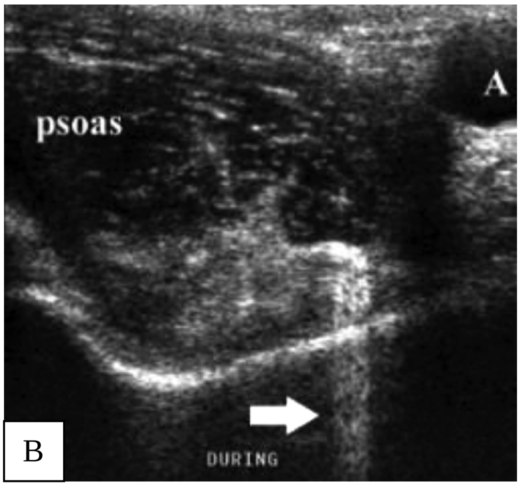
For dynamic sonography of iliopsoas tendon snapping, the transducer is placed anteriorly in a transverse or oblique transverse plane just above the hip joint while the patient performs the motion that produces the snap. This usually involves passage of a flexed, abducted, and externally rotated hip back to full extension, with the snap occurring about half-way during motion **(Fig. 1 A &B)**. Straight hip flexion and extension or internal-to-external rotation may occasionally produce the snap. With snapping, there is an abrupt mediolateral or rotatory motion of the iliopsoas tendon during the dynamic maneuver. Rarely, an underlying synovial cyst may be associated with a snapping iliopsoas tendon **(Fig. 1C).** For dynamic sonography of iliotibial band snapping, the patient lies on the opposite side while the abnormal hip is being scanned transversely during flexion and extension to reproduce the snapping of the iliotibial band. The normal iliotibial band (coursing laterally to the trochanter and distal gluteus medius tendon) will glide smoothly over the greater trochanter during hip motion. With snapping, there is abnormal jerking movement of the iliotibial band as it abruptly snaps over the greater trochanter **(Fig. 2) (Khoury et al, 2007).**

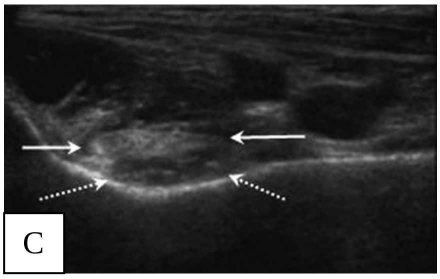
Dynamic examinations of external hip snapping may be performed with the patient standing on the contra-lateral leg, because this more effectively reproduced the snap that would occur while standing or running. This suggests that weight bearing and contraction of the gluteus maximus muscle are important for generating the external snapping hip **(Choi et al, 2002).**

With the use of tissue harmonic imaging, a streak artifact may be seen behind a rapidly moving soft-tissue structure such as a snapping tendon **(Kamaya et al, 2004).** This streak artifact is a linear, hyperechoic striated band oriented supero-inferiorly **(Fig. 1B).** This is a useful artifact during dynamic sonography because it may help locate and identify the quickly or abruptly moving tendon (or other soft-tissue structure). The artifact, however, may be machine dependent **(Khoury et al, 2007).**



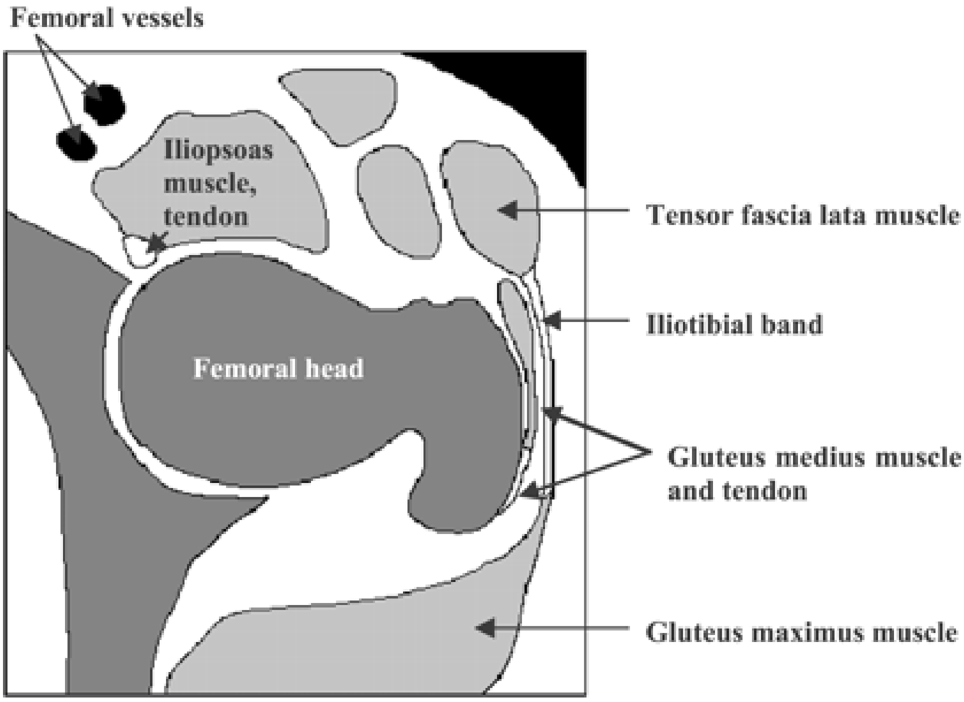
(Fig. 1A) **Diagram of transverse section of right hip shows relationship of iliopsoas Tendon, hip joint, and surrounding structures** *(Khoury et al, 2007).*





(Fig. 1C) **Snapping iliopsoas tendon.Snapping iliopsoas tendon over cyst. In this case, iliopsoas tendon (solid arrows) was seen to snap over synovial cyst (dashed arrows)** *(Khoury et al, 2007).*

(Fig. 1B) **Snapping iliopsoas tendon. Streak artifact, manifested by linear, hyperechoic striated band oriented superoinferiorly (arrow), in this case of iliopsoas tendon snapping** *(Khoury et al, 2007).*



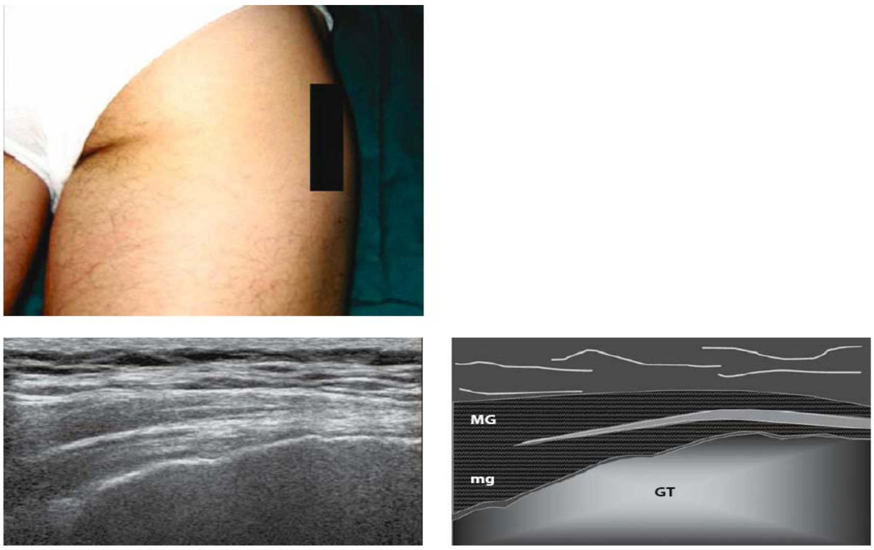
(Fig. 2) **Diagram showing a transverse section of the left hip. Note the relationships between the iliotibial band, the gluteus maximus muscle, and the surrounding structures** *(Khoury et al, 2007).*

Sonographic anatomy of hip joint

Anterior scanning

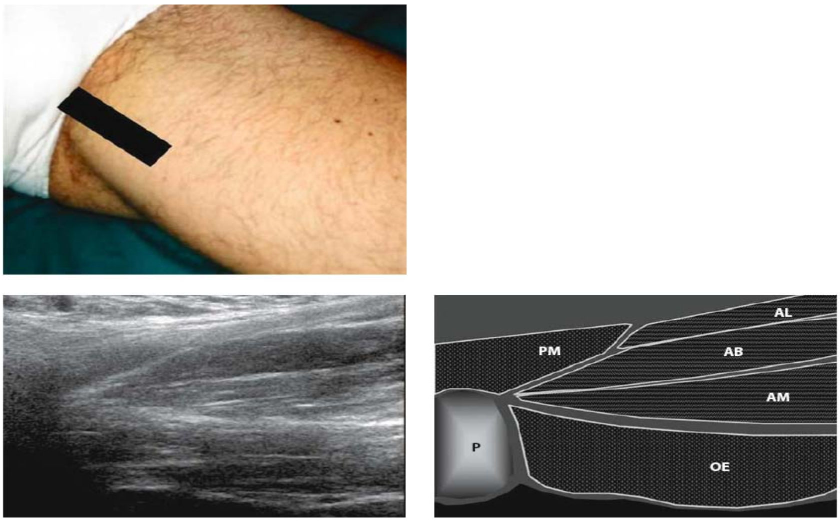
(Fig. 3) **Longitudinal view of the hip joint anteriorly showing the femoral head (FH), acetabulum (A), anterior glenoid labrum (AGL), overlying capsule (C), iliopsoas muscle (IM)** *(Martino et al, 2007).*

Postero-lateral scanning



(Fig. 4) **Longitudinal view of the hip joint postero-laterally showing the greater trochanter (GT), gluteus medius (MG), gluteus minimus (mg)** *(Martino et al, 2007).*

Medial scanning



(Fig. 5) **Medial view of the hip joint showing the symphisis pubis (P), obturator externus (OE), adductor magnus (AM), adductor brevis (AB), adductor longus (AL) and pectineus muscle (PM)** *(Martino et al, 2007).*

Pathology

Snapping hip syndrome is a well-recognized symptom complex that often comes to the attention of a clinician because the patient has pain with motion, and it can be classified as external, internal, or intra-articular according to the causes. An understanding of the precise cause increases the potential for successful treatment **(Choi et al, 2002).**

External snapping may occur when the thickened area at the posterior border of the iliotibial band or the anterior edge of the gluteus maximus muscle snaps forward over the greater trochanter with hip flexion. It may also be elicited by passive movement from an adducted and internal rotation of the hip into flexion and external rotation; at some stage during this movement, the hip clicks abruptly and with pain. This entity may be painless in some patients. Friction of the iliotibial band or the gluteus maximus muscle over the greater trochanter may cause inflammation of the bursa. The pain may be due to trochanteric bursitis or tendonitis **(Faraj et al, 2001).**

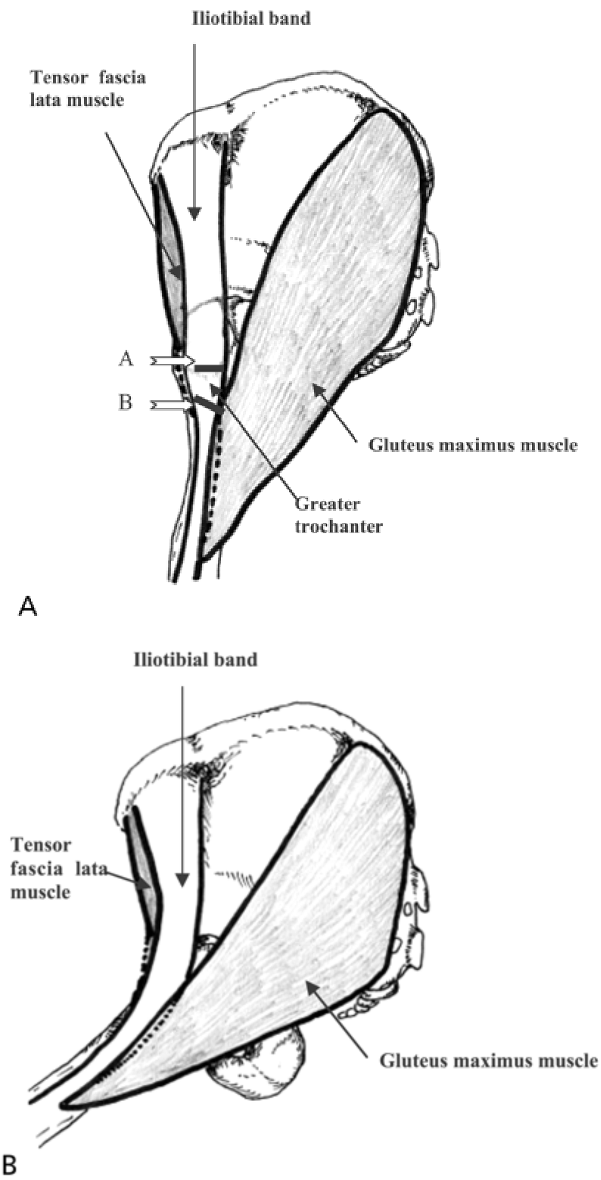
The treatment of external snapping hip syndrome includes conservative treatments such as rest, moist heat, stretching exercises, and anti-inflammatory drugs. Local anesthetics and steroids may also be injected into the trochanteric bursa. Surgical procedures can be performed in cases refractory to conservative treatment **(Pelsser et al, 2001).**

External snapping hip syndrome may be familiar to orthopedic surgeons, because it is more easily diagnosed clinically than a snapping iliopsoas tendon. Once the external snapping hip has been shown in the appropriate clinical setting, no additional imaging study may be required before treatment. Recently, sonography has been used as a dynamic imaging modality, in which its real-time imaging capability enables the examiner to investigate the soft tissue as the patient moves a hip joint or contracts a muscle to show a pathologic characteristic. It is also possible that an examiner can sense the click through a transducer caused by the snapping movement of the iliotibial band or gluteus maximus during sonographic examination. External snapping hip syndrome is a kinematic disorder, which can be shown better during joint motion or muscle contraction, whereas MRI is a static technique. However, sonography has some limitations in terms of evaluating joint space. Magnetic resonance imaging or computed tomography and arthrography may be performed to exclude other causes such as a labrum tear, loose bodies in the hip joint, or bursitis **(Choi et al, 2002).**

Internal snapping hip syndrome is most commonly caused by a snapping of the iliopsoas tendon over the iliopectineal eminence. As an overuse phenomenon, this condition may occur in any activity resulting in repeated hip flexion or external rotation of the femur. Activities that may predispose to iliopsoas tendinitis include dancing, ballet, resistance training (eg, squats), rowing, running (particularly uphill), track and field, soccer, and gymnastics **(Joseph, 2006).**

Internal snapping hip syndrome occurs by one of several mechanisms. The most common cause is the iliopsoas tendon sliding over the iliopectineal eminence, resulting in a snap or pop. This typically occurs while the hip suddenly moves into extension from a flexed and externally rotated position. The iliopsoas tendon also may produce snapping with sudden movement over the anterior inferior iliac spine or possibly the bony ridge on the lesser trochanter. Less common causes of internal snapping hip syndrome include movement of the iliofemoral ligaments over the femoral head or anterior capsule of the hip **(Joseph, 2006).**

In conclusion, sonography should be the first imaging modality used to evaluate snapping hip. Conventional sonographic evaluations can reveal signs of tendinitis, bursitis, or synovitis. Dynamic sonographic studies can help to identify the structure involved in extra-articular snapping hip by showing the abnormal displacement of this structure with hip motion. Snapping hips can be painless, which emphasizes the need to establish a temporal correlation with sonography between the abnormal motion of the structure and the presence or absence of pain **(Pelsser et al, 2001).**



(Fig. 6) **Diagram showing the pathomechanics of a snapping iliotibial band and gluteus maximus muscle. A, When the hip is extended, the posterior border of the iliotibial band and the anterior border of the gluteus maximus muscle lie posterior to the greater trochanter. The transducer may be placed either transversely over the greater trochanter (open arrow A) or obliquely transverse over the greater trochanter, according to the hip movement (open arrow B). B, During flexion of the hip, the iliotibial band is tense and creates friction over the greater trochanter. As flexion increases, at some stage the iliotibial band is released, moving abruptly anteriorly with pain** *(Choi et al, 2002).*