

Psoas Major: a case report and review of its anatomy, biomechanics, and clinical implications

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A 25-year-old male professional hockey player with right sided hip pain was diagnosed with myofasciopathy of the right psoas major and rectus femoris. The patient maintained a conservative treatment regimen and was prescribed a four week active strengthening program. The program progressed from resisted concentric exercise to eccentric abduction/adduction exercises along with balance training, core stabilizing and endurance exercises in the first two weeks. In the final two weeks the program progressed to include sport specific exercises. At three weeks the patient was able to participate in non-contact practice and was clear for full contact at five weeks. The anatomy, biomechanics, and function of the psoas major muscle are discussed as is its influence on lumbar spine stability. Evidence-based evaluation and management strategies for psoas dysfunction are presented.
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KEY WORDS: Psoas, case report, exercise, stability, biomechanics

Un joueur de hockey professionnel de 25 ans avec une douleur à la hanche droite a été diagnostiqué avec un syndrome myofascial au muscle grand psoas droit et au muscle droit antérieur. Le patient a maintenu un régime de traitement conservateur et on lui a prescrit un programme de renforcement actif de quatre semaines. Le programme a progressé d'un exercice concentrique contracté à des exercices d'abduction et d'adduction excentriques avec un entraînement lié à l'équilibre, ainsi que des exercices de stabilisation et d'endurance lors des deux premières semaines. Au cours des deux dernières semaines, le programme a progressé afin d'inclure des exercices propres au sport. À trois semaines, le patient était en mesure de participer à une pratique sans contact et a été autorisé au contact sans restriction après cinq semaines. L'anatomie, la biomécanique et la fonction du muscle grand psoas sont discutés, tous comme son influence sur la stabilité de la colonne lombaire. L'évaluation fondée sur les preuves et les stratégies de traitement du dysfonctionnement du psoas sont présentées.
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MOTS CLÉS : psoas, rapport de cas, exercice, stabilité, biomécanique

Introduction

Some researchers and anatomists still refer to the hip flexor muscle complex as one unit or as the iliopsoas.^{1,2} The

psoas muscle differs from the iliacus in that it has a different architecture, innervation and more importantly, a different function. The psoas muscle is comprised of both the

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psoas major and minor, but as the psoas minor is often absent in individuals,³ this paper will focus on the psoas major. A better understanding of the role of the psoas muscle and its impact on lumbopelvic stability may improve the clinical management of individuals suffering from lower back pain. The objective of this paper is to provide a brief case report followed by an evaluation of the literature on the psoas major muscle, specifically its anatomy, biomechanics and function, along with management strategies for psoas major dysfunction. It is hoped that this will enhance the clinician's understanding of this condition and its diagnosis.

Case Presentation

A 25-year-old male professional hockey player presented with right sided hip pain after 5 days of pre-season training camp. The pain was characterized as sharp, had progressively worsened since its insidious onset three days prior, and was aggravated by weight bearing on the right leg and striding out when skating. Rest, ice, athletic taping to minimize hip extension and abduction, and non-steroidal anti-inflammatories decreased the patient's pain somewhat, but striding out when skating continued to exacerbate the condition. The athlete did not recall any particular action or incident that caused the pain but did have history of multiple "groin pulls" throughout his career. No burning, numbness or tingling was present in the hip, groin, thigh or genitals. The patient denied any associated signs and symptoms, previous surgery to the area, or family history of arthritic diseases.

Inspection of the region revealed no ecchymosis or divot deformity. Active, passive and resisted ranges of motion of the lumbar spine and knee were full and pain free bilaterally, while right passive hip extension and resisted hip flexion were limited due to pain. The right psoas major was tender to palpation as was the proximal aspect of the rectus femoris. The strength of the psoas major and rectus femoris were graded as 4/5 using the Grading Motor Strength Scale, while all other hip and groin muscles were graded as 5/5 with manual testing. Muscle testing for rectus femoris was performed with the patient in lateral recumbent position with the hip extended and the knee flexed; whereas the testing for psoas major was performed with the patient supine with the hip flexed approximately 30°, abducted 10° and externally rotated.⁴

The patient was diagnosed with myofasciopathy of the right psoas major and rectus femoris. Myofasciopathy can be distinguished from a contusion or muscle strain in that the involved trauma is due to excessive tensile force that overstrains the myofibers and deep fascial layers surrounding the muscles and typically occurs near the myotendinous junction. The patient continued with the ice, taping and non-steroidal anti-inflammatories and was prescribed a four week active strengthening program. The program progressed from resisted concentric to eccentric abduction/adduction exercises, balance training, core stabilizing and endurance exercises in the first two weeks as denoted in Table 1. In the remaining two weeks of the rehabilitation program, the patient continued the previously prescribed exercises, while hockey specific exercises were cautiously introduced (initially under supervision) including sumo squats, side lunges and use of a skating slide board. The patient was able to participate in non-contact practices after three weeks and was cleared for full contact at five weeks.

Discussion

Psoas Major Anatomy

The psoas major is the largest muscle in cross section at the lower levels of the lumbar spine.⁵ It has fibrous attachments to the anterior aspect of all lumbar transverse processes and to the anteromedial aspect of all the lumbar discs and adjoining bodies with the exception of the L5/S1 disc.⁶ For their relative positions on the spine, the attachments on the transverse processes are named the posterior attachments and those on the disc and bodies are called the anterior attachments. These attachments constitute the individual fascicles. The fascicles of the psoas major are approximately similar in length throughout the lumbar spine and have a unipennate fiber orientation. Muscle fiber length within the anterior fascicles ranges from 3 to 8 cm and 3 to 5 cm in the posterior fascicles.⁷ The fascicles are oriented inferolaterally and come together as a common tendon which descends over the pelvic brim and shares a common insertion with the iliacus muscle on the lesser trochanter of the femur.

The fascial relations of the psoas major to the surrounding tissues warrant special attention as these links influence the biomechanics of these interlaced structures. The medial arcuate ligament is a continuation of the su-

Table 1 *Active strengthening program*

Exercise	Timeframe (weeks)	Comment
Isometric exercises	0–2	
Concentric exercises	1–4	
Eccentric abduction/adduction exercises	2–4	
Balance training	0–4	
Core stabilizing and endurance exercises	0–4	
Sumo squats	3–4	Sport specific exercise, introduced under supervision at first
Side lunges	3–4	Sport specific exercise, introduced under supervision at first
Skating slide board	3–4	Sport specific exercise, introduced under supervision at first

terior psoas fascia that continues superiorly to the diaphragm. The right and left crus constitute the spinal attachment of the diaphragm. They attach to the anterolateral component of the upper three lumbar vertebral bodies. The crus and their fascia overlap the psoas major and appear to be continuous with this muscle until they come more anterior and blend with the anterior longitudinal ligament.⁸ As the psoas descends, its inferomedial fascia becomes thick at its inferior portion and is continuous with the pelvic floor fascia.⁹ This forms a link with the conjoint tendon, transverse abdominus, and the internal oblique.¹⁰ As the psoas major courses over the pelvic brim, the fascia of the posterior fascicles attach firmly to the pelvic brim.

Psoas Major Biomechanics and Function

The function of the psoas major is another area of controversy and uncertainty in the literature. It is well established that the psoas functions as a primary flexor of the hip joint^{6,10–14} but it is the other actions that are not well understood. There are several hypotheses that have been put forward that are worthy of consideration.

The electromyographic work of Basmajian¹¹ was the first to investigate the role of the iliopsoas. He concluded that the psoas major could not be separated from the iliacus with regards to their collective action of a hip joint flexor. Keagy et al.¹⁵ performed electromyographic studies on the psoas major in five patients with wire elec-

trodes placed directly into the muscle. Recordings made during various activities indicated that psoas played a significant role in advancing the limb while walking and in controlling deviation of the trunk when sitting. The action of the psoas in rotation, abduction, and adduction of the hip was slight and variable.

Nachemson^{16,17} showed that the psoas major was active during upright standing, forward bending, and lifting. These observations prompted the inference that the psoas major may function as a lumbar spine stabilizer. Others have since proposed and found evidence for various roles that the psoas major may play with respect to lumbar spine stability and movement. These roles include psoas major being a flexor of the lumbar spine on the pelvis,¹⁸ a lateral flexor of the lumbar spine,¹⁹ a stabilizer of the lumbar spine,^{10,13,14,20} stabilizer of the hip,^{3,6,21} power source for bipedal walking and running,²² and controller of the lumbar lordosis when supporting difficult lumbar loads.²³

Yoshio et al.²⁴ used cadavers to analyze the psoas major in its dynamic phase (as a flexor of the hip joint) as well as in its static phase (involving fixation of the hip joint to maintain a sitting or standing position against gravity). Their results suggest that the psoas major works phasically: (1) as an erector of the lumbar vertebral column, as well as a stabilizer of the femoral head onto the acetabulum (from 0°–15°); (2) exerting decreased stabilizing action, in contrast to maintaining the erector action

(from 15°–45°); and (3) as an effective flexor of the lower extremity at the hip joint (from 45°–60°). They further concluded that the function of the psoas major as a hip stabilizer is overshadowed by its action of stabilizing/erecting the lumbar vertebral column.

Over the last decade, new insights into muscle function and the role of muscles in providing dynamic stability have emerged. Some muscles may have stabilization of the lumbosacral spine as their primary role, while others appear to have multiple roles and these multiple roles may be dependent upon spinal position and the loads being transmitted to the spine (i.e. low load vs. high load).^{25–27}

Recent research on lumbar musculature and how it relates to individuals suffering from lower back pain has progressed through the use of advanced imaging techniques. Dangeria and Naesh²⁸ conducted a clinical prospective cohort study examining the cross-sectional area of the psoas major in healthy volunteers and subjects with unilateral sciatica caused by a disc herniation. These authors demonstrated that in most patients with a lumbar disc herniation there was a significant reduction in the cross-sectional area of the psoas major on the affected side only and most prominently at the level of the disc herniation. They suggested that a correlation exists between the reduction in the cross-sectional area of the psoas major (Spearman's $\rho = 0.8$; $P = 0.05$) and the duration of continuous sciatica of the affected side but that no correlation exists between the amount of disc herniation and reduction in psoas major cross-sectional area. Similarly, Danneels et al.²⁹ examined the trunk muscles (paraspinal, psoas and multifidus) in chronic low back pain patients and healthy control subjects employing computerized tomography at three different lumbar levels. These authors found no significant differences in the cross-sectional area of the psoas major or paraspinals but they did find significant differences existed in the cross-sectional area of the multifidus at the L4 spinal level. Barker et al.³⁰ investigated the cross-sectional of the psoas major in the presence of unilateral low back pain through the utilization of magnetic resonance imaging (MRI). These authors found that there were statistically significant differences in cross-sectional area of the psoas major between sides (median reduction was 12.3%) at the levels of L1–L5 and that there was a positive correlation between a decreased cross-sectional area of the psoas major and the duration of symptoms. In another MRI study, Hides et al.³¹ assessed the effects of prolonged

bed rest on the trunk muscles. This study showed that the cross-sectional area of certain muscles decreased or were unaffected by bed rest as one would imagine but surprisingly found that the psoas major and rectus abdominis actually increased in cross-sectional area. The authors attributed this increase or hypertrophy to increases in muscle tone and to the possibility that the subjects maintained a flexed trunk position during bed rest, resulting in a psoas muscle shortening.

More recently Dickx et al.³² used muscle functional magnetic resonance imaging (mfMRI) to evaluate changes in lumbar muscle activity with induced muscle pain. This study was one of the first to examine patients with acute low back pain and how it affects activity of the trunk musculature. mfMRI was obtained under three different conditions: a resting MRI was obtained after the subjects laid supine for 30 minutes; an MRI was obtained after trunk extension at 40% of one-repetition maximum without pain; and an MRI was obtained after the subjects were injected with hypertonic salt into the right longissimus muscle to induce pain and then subjects were required to again perform the back extension exercise while experiencing low back muscle pain. There were no significant changes in the psoas major muscle recruitment between resting and exercise leading the authors to conclude that the psoas major was not significantly recruited during trunk extension exercises. During the trunk extension exercises with pain induced, the authors reported that there was a statistically significant reduction in the psoas major activity bilaterally and at multiple levels whereas previous studies found it to be ipsilateral and on the symptomatic side.^{28,30}

Psoas Major and Lumbar Spine Stability

A common model of lumbar stability shows the musculature surrounding the spinal vertebrae forming a cylinder. The top of the cylinder is the diaphragm, the bottom is the pelvic floor, and the wall is formed by segmentally attaching abdominal and posterior spinal musculature, specifically the transversus abdominus and the segmental fibers of lumbar multifidus.³³ There is growing evidence that demonstrates how these muscles coordinate their activity to stabilize the spine. For example, transversus abdominis has been shown to co-contract with: the diaphragm;³⁴ the pelvic floor;³⁵ and the deep fibres of lumbar multifidus.³⁶ According to this model, the psoas major is ideally located

to assist in a stabilizing role. Psoas major has intimate anatomical attachments to the diaphragm and the pelvic floor. This unique anatomical location allows the psoas major to act as a link between these structures and may help in maintaining the stability of the lumbar cylinder mechanism. This can be thought of conceptually as a supporting rod in the middle of the cylinder. Early biomechanical literature suggested that the psoas major might aid in the stabilization of the lumbar spine through its large potential to generate compressive forces, which would result in increased spinal stiffness.³⁰

McGill³⁷ conceptualizes lumbar spine stability as a fishing rod placed upright and vertical with tensioned guy wires attached at different levels along its length and those guy wires being attached to the ground in a circular pattern. Here the rod represents the lumbar vertebrae and the guy wires are the various muscles attaching to the lumbar spine. Reducing the tension on one of the muscles (wires) will allow the spinal segment (rod) to buckle and allow spinal injury to occur. Jucker et al.¹² showed that the psoas major counteracts the action of iliopsoas during hip flexion. They believe that the iliopsoas would torque the pelvis into anterior pelvic tilt and that the psoas major works against these forces, adding to the stiffness within the pelvis and the lumbar spine. An activated and stiffened psoas major will contribute some shear stiffness to the lumbar motion segment.^{38,39}

Psoas Major Clinical Presentation and Management

Myofascial pain from or myofasciopathy of the psoas major muscle will often present as anterior hip and/or lower back pain. Referral areas include the anterior thigh.⁴⁰ The psoas major muscle can be considered as a pain source in athletes, office workers or anyone who spends much of their day sitting. Psoas major myofascial pain is thought to be prevalent in certain sports including soccer, dance, and hockey (as in the case presented above).⁴⁰ Myofascial psoas major pain is different from that of psoas tendinitis, psoas bursitis or coxa saltans and these are among the strongest differential diagnoses, along with tears of the hip labrum. Table 2 provides a list of possible differential diagnoses for psoas major myofascial pain. It should be noted that the snapping or popping of coxa saltans produces pain at the anterior aspect of the groin, and patients can often reproduce the snap or pop themselves.

In the physical examination, postural analysis may in-

Table 2 *Differential diagnoses for psoas major myofascial pain*

Psoas bursitis	Osteoarthritis
Psoas tendinitis	Labral tear
Psoas strain (major and/or minor)	Intra-articular bodies
Psoas abscess	Joint infection
Coxa saltans	Inflammatory arthritides/ Gout
Iliacus	Femoral stress fracture
Iliotibial band	Avascular necrosis of femoral head
Rectus femoris	Femoral bone tumour
Adductor muscles	Hernia
Lumbar spine or sacroiliac joint referral	Obturator nerve entrapment

dicate an increased lumbar lordosis and posterior pelvic tilt. Gait analysis may reveal a shortened stride on the affected side and conducting a functional squat test may cause pain or indicate hip flexor weakness.^{40,41} Strength testing of psoas major can be conducted in numerous ways (generally supine) as long as the patient resists the examiner's attempt to extend the hip.^{4,42-44} Assessment of active and passive hip ranges of motion is important, particularly active flexion and extension and passive extension (generally performed with the patient prone).⁴⁵ Palpation can be conducted with the patient either supine or side-lying^{44,45} but should likely involve the examiner flexing the hip to 30° and palpating the psoas major muscle medial to the anterior superior iliac spine and deeper into the abdomen. When the examiner feels they are palpating the psoas major muscle, having the patient flex their hip against resistance should allow the examiner to feel the psoas major contract. The examiner must consider patient comfort when palpating the psoas major as it may be extremely tender, ticklish, or more invasive than the patient's comfort level allows. Still, reproduction of the patient's pain on palpation of the psoas major muscle belly with tightness and tenderness are strong indicators of psoas major myofasciopathy.⁴⁰ The psoas major mus-

cle is intimately linked with the iliacus, psoas minor (if present), adductor group, and quadriceps muscles (rectus femoris in particular as it also aids with hip flexion), thus evaluation of these muscles for strength, flexibility, and palpating for tonicity and tenderness is necessary to aid management decisions.

It is important to evaluate lumbar ranges of motion when assessing patients with suspected psoas major myofasciopathy, particularly as active and passive extension may be limited by a tight psoas major.⁴⁵ The flexibility of the psoas major muscle can be further assessed with orthopaedic testing using the Thomas test, Yeoman's test or Gaenslen's test.^{40,43,44} The Thomas test is traditionally thought to help differentiate tight hip flexors (including primarily psoas major) from tight quadriceps femoris muscles.^{43,44} Both Yeoman's test⁴⁴ and Gaenslen's tests^{43,44} are generally acknowledged as sacroiliac joint provocation maneuvers, however these tests do involve passive hip extension and observation of hip extension restriction and pain during these maneuvers could implicate psoas major, particularly if pain is elicited anteriorly.⁴⁵

A final examination procedure of interest for ruling out coxa saltans is the Snapping Hip Test.^{40,41} This involves the examiner attempting to reproduce the snapping of the hip with the patient supine with a flexed and abducted hip that is brought into extension and adduction by moving the hip into neutral position while palpating and listening for a snap or click.^{40,46} A modification of this maneuver involves adding external hip rotation to the initially flexed and abducted position and in returning the patient to neutral position adding in internal rotation to the adduction and extension required.⁴⁰

The conservative treatment of a psoas major myofasciopathy has not been previously reported in the literature. Like many other myofasciopathies, most of the literature surrounding them is anecdotal at best. Initial treatment should focus on immobilizing the injured muscle for approximately three to five days to prevent further retraction of the strained muscle while attempting to reduce pain by using various modalities.

After the acute treatment phase, the clinician may add soft tissue mobilization and light resistance training (isometric muscle contraction/activation exercises) and progress towards weight-bearing exercises to facilitate more rapid and intensive capillary in-growth to the damaged area, as well as improved myofiber regeneration. It is

important to maintain the ranges of motion of the lumbosacral spine and hip joints and prevent arthrogenic muscle inhibition through proprioceptive exercises and joint manipulation/mobilizations, as these joints may have been coincidentally injured. During the rehabilitation program, a gradual progression of exercises should be implemented beginning with isometric training followed by concentric training. Once these exercises are tolerated the patient should begin eccentric dynamic training.

The decision to initiate sport-specific training should be based upon the following criteria: whether the patient can perform basic movements that utilize the injured muscle without pain; whether the patient has similar strength levels between the injured muscle and its contralateral counterpart; and whether the patient is able to stretch the injured muscle to approximately the same length as the contralateral muscle. This phase of rehabilitation should be supervised and a gradual progression of sport-specific activities should be employed.

Conclusion

The critical elements of correctly diagnosing a psoas major myofasciopathy include the absence of bruising and significant swelling, with the presence of restricted ranges of motion and muscular pain on palpation and resisted specific muscle testing. Clinicians should be aware of the anatomy and biomechanical influence that this muscle has on lumbar spine biomechanics and stability when assessing and treating patients. It is thought that a stable spine along with increased muscle endurance is protective and therefore may help to reduce the incidence of low back pain. It is difficult to draw conclusions from a case report but based on the literature it is the authors' contention that psoas major myofasciopathy should be considered among the differential diagnoses for low back pain. Increased knowledge of this condition should aid clinicians in selecting the most appropriate methods for its treatment and rehabilitation.

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