Rehabilitation of the Stability Function of Psoas Major

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Introduction

Psoas major is the largest muscle in cross section at the lower levels of the lumbar spine (McGill et al, 1988). A review of the literature reveals it has been a poorly investigated muscle and there is still controversy concerning its true functional role (Gibbons, 1999). This may be due to several reasons; its location within the body, which does not permit routine access with myolectric electrodes or a clear visual with real-time ultrasound imaging, it's complex anatomy (Bogduk et al, 1992), and finally, it is not always considered separately from iliacus (hence the name 'iliopsoas'). A better understanding of the implications of the function of psoas major on the stability of the lumbo-pelvic region may improve clinical management of related dysfunction. Research was undertaken to gain an understanding of the anatomy, physiology and function of psoas major. This involved a systematic review of the literature, dissection studies of psoas major and the deep myofascial system. From this, a biomechanical model was developed. The purpose of this paper is to briefly highlight this project and discuss specific strategies for training psoas major to contribute to lumbo-pelvic stability.

Summary of Anatomy and Physiology

Psoas major has fibrous attachments to the anterior aspect of all lumbar transverse processes and to the antero-medial aspect of all the lumbar discs and adjoining bodies with the exception of the L5-S1 disc (Bogduk et al, 1992; Gibbons, 1999). For their relative positions on the spine, the attachments on the transverse processes were named posterior and those on the discs and bodies called anterior. These attachments constitute individual fascicles. The fascicles of psoas are about the same length within specimens and have a unipennate fibre orientation. The fibre length within anterior fascicles range from 3 to 8cm and 3 to 5cm in the posterior fascicles. The fascicles run infero-laterally to reach a central tendon where they descend over the pelvic brim and share a common insertion with iliacus to the lesser trochanter (Gibbons, 2001, Gibbons et al, 2001).

Psoas also has significant fascial relations. The medial arcuate ligament is a continuation of the superior psoas fascia. The right and left crus make up the spinal attachment of the diaphragm. They attach to the antero-lateral component of the upper three vertebrae and bodies. The crus and their fascia overlap psoas and appear continuous with psoas until they come more anterior and blend with the anterior longitudinal ligament (Gibbons, 1999). As psoas descends, its infero-medial fascia becomes thick at its lower portion and is continuous with the pelvic floor fascia. This also forms a link with the conjoint tendon, transversus abdominus, and the internal oblique. As psoas passes over the pelvic brim, the fascia of the posterior fascicles attaches firmly to the pelvic brim (McVay and Anson, 1940; Williams et al, 1989; Gibbons, 1999, 2001, Gibbons et al, 2001).).

The nerve supply to psoas is not reported consistently as most anatomical texts list 3 different variations. These are listed under psoas major, the lumbar plexus and the femoral nerve. Dissection has shown that the anterior and posterior fascicles have a separate nerve supply. The posterior fascicles are supplied by the ventral rami of spinal nerves T12 through L4. The anterior fascicles are supplied by branches of the femoral nerve from L2, 3 and 4 (Gibbons, 1999, 2001, Gibbons et al, 2001).

Literature Review Summary

A tool was developed to systematically evaluate literature on muscle function, which consisted of critical methodological criteria and general methodological criteria. It was divided into sections based on the type of research project and the methods used. Each section was given a score based on the criteria within it. Very few studies passed the basic component of the critical methodological criteria. In addition, many studies did not consider psoas separately from iliacus or the method of assessment was very poor (Gibbons, 1999; Gibbons, 2001).

From the literature review, psoas major is thought to function as a stability muscle for the lumbar spine through axial compression and offers little, or no contribution to range of spinal movement. (Bogduk et al, 1992). Andersson et al (1995) state that psoas major controls spinal lateral movement eccentrically and their results indicate that it also contributes to stabilization of the hip joint and assists iliacus with hip flexion.

Evidence of Muscle Dysfunction

Based on motor control studies, Hodges and Richardson (1996, 1997; see Richardson et al, 1999a) concluded transversus abdominus was important for spinal stabilization. They identified an anticipatory reaction in transversus abdominus in response to spinal disturbance produced by limb movements. In subjects without low back pain transversus abdominus was activated prior to limb movements and spinal disturbance, while activation of transversus abdominus was significantly delayed in subjects with low back pain independent of the direction of limb movements and spinal disturbance. The delayed onset of contraction of transversus abdominus indicates a deficit of motor control and as a result of this the authors hypothesize there would be inefficient muscular stabilization of the spine.

There is evidence of lumbar multifidus muscle wasting ipsilateral to symptoms in patients with acute / subacute low back pain (Hides et al, 1994; Kader et al, 2001). Hides et al (1994) used real-time ultrasound to assess the multifidus muscle. The paraspinal muscles were scanned in normal subjects and in patients with acute unilateral low back pain. Significant asymmetry of multifidus cross sectional area (CSA) was noted in subjects with low back pain.

This decrease in size of multifidus was seen on the side of the symptoms with the reduced CSA observed at a single vertebral level suggesting pain inhibition (now considered a decrease in normal low threshold recruitment). However, while the pain may resolve the dysfunction may persist. Hides et al (1996) found that recovery of multifidus symmetry was not spontaneous after painful symptoms resolved. They observed that recovery of symmetry was more rapid and more complete in patients who received specific, localized multifidus retraining (Hides et al, 1996). Correction of this asymmetry resulted in a decreased incidence of recurrence after a three-year follow up (Hides et al, 2001)

Inamura et al (1983) examined psoas and sacrospinalis muscle CSA in relation to sex and age. The results suggest there is a decrease in psoas CSA in increasing age for men and women. Cooper et al (1992) studied sacrospinalis and psoas CSA in subjects with recent and chronic low back pain. They found psoas atrophy in both groups of subjects with a greater decrease in CSA in the chronic group. This was of a similar degree to that of the paraspinal muscle wasting.

Dangaria and Naesh (1998) assessed the CSA of psoas major in unilateral sciatica caused by disc herniation. There was significant reduction in the CSA of psoas major at the level and the site of disc herniation on the ipsilateral side. In a single case study, the width was decreased in the posterior fascicles at the level and ipsilateral to the site of symptoms in acute low back pain (Whelan and Gibbons, submitted). More research is currently in progress in this area.

This is a similar pattern of inefficient normal low threshold recruitment (previously referred to as inhibition) as seen in the deep segmental fibres of lumbar multifidus (Hides et al, 1994). This implicates psoas as having a local stabilizing role in the lumbar spine (Gibbons, 1999; Gibbons et al, 2001; Comerford and Mottram, 2000). Further motor control studies are in progress to investigate a possible anticipatory timing pattern of psoas as seen in other local stability muscles.

Model of Psoas Major Function

From dissection studies and a review of the literature, Gibbons (1999) has presented a model of psoas major. A common model of lumbar stability shows the musculature forming a cylinder. The top of the cylinder is the diaphragm, the bottom is the pelvic floor and the wall is formed by the segmentally attaching abdominal and posterior spinal musculature, specifically transversus abdominus and the segmental fibres of lumbar multifidus (Morris, 1961; Bartlink, 1957; Richardson et al, 1999a). Psoas major has intimate anatomical attachments to the diaphragm and the pelvic floor. This unique anatomical disposition allows psoas to act as a link between the diaphragm and the pelvic floor that may help maintain stability of the lumbar cylinder mechanism. This can be conceptually visualized as a rod in the middle of a cylinder.

During inspiration, the diaphragm increases tension making the cylinder relatively more stable. During expiration, the diaphragm relaxes making the cylinder relatively less stable. The anticipatory timing pattern seen in transversus abdominus is earlier in expiration (Hodges et al, 1997), presumably to compensate for this decrease in stability (Richardson et al, 1999a). Richardson et al (1999a) feel that the motor control of the stabilising action of transversus abdominus may be superimposed and summated to the respiratory action of the diaphragm. This may occur, however psoas is ideally located to assist in a stability role here. Through its segmental attachments, axial compression and links to the diaphragm and pelvic floor, psoas may play a role in spinal stability and should now be considered as an important stabilizer of the lumbar spine.

Two previous classification systems of muscle function were combined to develop a new model (Mottram and Comerford, 1998; Comerford and Mottram, 2000; 2001). This divides muscles into local stabilizers, global stabilizers and global mobilizers. Psoas major should be classified as a local and global stabilizer. The posterior fascicles are ideally suited to perform a local stabilizer role while the anterior fascicles are better suited to have a global stabilizer role.

Action:

The local stability role of psoas is to produce axial compression along its line of pull. This has the effect of compressing the vertebral bodies to fix the spine in neutral alignment while longitudinally pulling the head of the femur into the acetabulum. This 'pulling in' or 'shortening the leg' action should be localized to the hip and pelvis. There should not be any lateral tilt ('hitching'), anterior or posterior tilt, or rotation of the pelvis. Likewise, any spinal rotation, flexion or extension should be discouraged.

Bogduk (1997) suggests that psoas has minimal ability to produce any significant range of motion at the lumbar spine. It has segmental attachments anteriorly to every lumbar vertebra and disc (except L5/S1). He states that the primary role of psoas on the lumbar spine is generating force along a longitudinal moment to enhance spinal stability via axial compression. Psoas contraction should increase stiffness segmentally in the lumbar spine and should resist motion segmentally rather than produce it (Comerford and Emerson, 1998).

Assessment and Rehabilitation

The assessment and retraining of the stability role of psoas major is outlined in the diagram below.

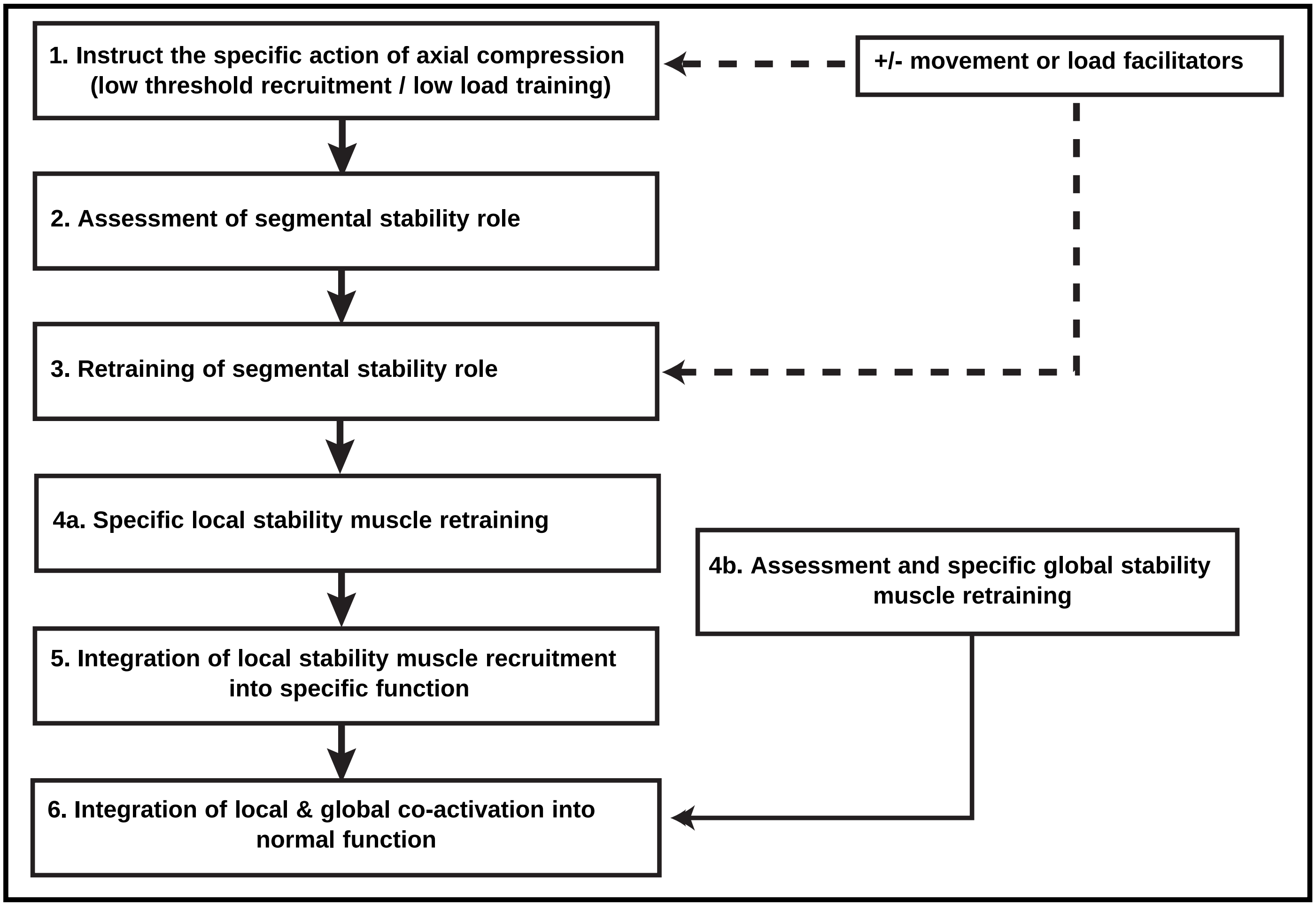

Figure 1: Summary of the six stages of psoas major stability rehabilitation.

Stage 1: Instruct Specific Action of Axial Compression

Psoas should have the ability to activate in any position of the trunk and under any load situation. The first stage must be viewed as only instruction in the longitudinal action of psoas. This is so the subject understands and is aware of the contraction required. It is not part of the segmental assessment or rehabilitation, although information regarding sensation of effort, proprioception and substitution strategies is gained.

Monitoring technique

When assessment is performed in supine or inclined sitting, it is possible for the therapist to monitor these with a simple palpation technique. The therapist uses the second and third digits ('peace sign') to palpate the anterior superior iliac spine (ASIS) and the soft tissue below in the antero-lateral groin (5cm below the ASIS)(Figure 3b).

The upper finger assesses for control of movement of the pelvis and maintenance of the lumbo-pelvic neutral position while the lower finger checks for excessive activity in rectus femoris and sartorius. As the client attempts to activate psoas, there should be no movement of the pelvis (assessed by monitoring the ASIS). Any pelvic movement (monitored at the ASIS) is discouraged. This is considered a loss of the neutral lumbo-pelvic position and is thought to be associated with excessive activity of quadratus lumborum or iliocostalis.

It is important that the client is aware of the sensation of shortening the leg. The therapist should not be able to palpate radial expansion of sartorius or rectus femoris under the lower finger. It is possible for sartorius and the tensor fascia latae (TFL)/ilio-tibial band (ITB) to co-contract to produce shortening of the hip. This would be associated with noticeable muscle contraction and significant resistance to passive rotation of the femur. Rectus femoris and the hamstrings may also co-contract to shorten the hip. This would be associated with noticeable contraction and significant resistance to passive movement of the pelvis.

Step 1

Describe the position of psoas major on the lumbar spine and hip to the client. The action is vertical shortening so that the hip moves closer to the spine or it 'shortens the hip into the acetabulum'. The description that different individuals relate to will vary so it is useful to become familiar with different verbal cues for this action. When in the starting position, it may be useful to passively distract the femur and push it into the acetabulum several times to give the sensation of the action required.

Step 2

Starting position: Supine with the lumbar spine in a neutral position. A common substitution strategy is to hitch the hip using quadratus lumborum or iliocostalis. In this situation, long sitting would be preferred instead of supine. Alternatively, in long sitting a common substitution strategy is to rotate the pelvis. In this situation supine would be preferred. The hip should be in neutral rotation (a guide is to position the toes vertically) (Figure 3b). If the hip is externally rotated at rest, it should be placed in its mid position and actively controlled there.

Step 3

Gently distract the femur and then give an appropriate instruction. The most common are "pull (or suck) your hip into the socket" or "shorten your hip without moving your back". Maintain the distraction during the activation to provide a sensory or afferent stimulus for the longitudinal action of psoas. This is the action that Stage 2 will assess the segmental efficiency of.

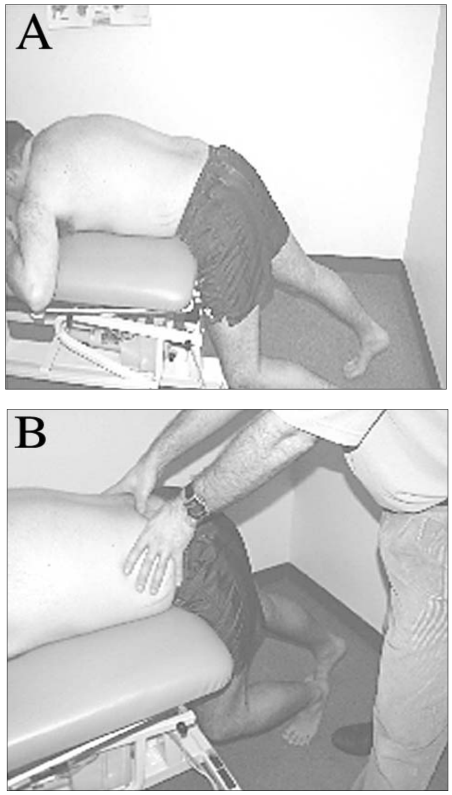

Figure 2: A: Starting position for the assessment of the local stability role for psoas major. B: Manual palpation of the spine in the assessment position.

Stage 2: Assessment of Segmental Stability Role

When the action of psoas has been correctly been taught the assessment of the segmental stabilizing role (local stability) of psoas can start.

The client is prone on the plinth with one leg firmly extended to help maintain balance, and the other leg hanging freely over the edge with the foot on the floor (Figure 2a). The side with the leg hanging freely is the side to be assessed. Gravity will provide a slight distraction force. The pelvis and spine are positioned in neutral with the trunk muscles relaxed. Each lumbar vertebral level is manually palpated to assess the relaxed joint play displacement in the transverse and anterior directions (Figure 2b).

Psoas is facilitated by instructing the patient to "pull the hip back into the socket", against the minimal distraction force of gravity, without moving the spine or pelvis. This gentle contraction is sustained. Here, the therapist should check for observable or palpable co-contraction of the erector spinae. If present, the therapist should instruct the client to decrease the effort until this is eliminated. Each lumbar vertebral level is re-palpated to assess the contracted joint play in the transverse and anterior directions. Ideally, there should be a significant palpable increase in resistance to manual displacement (stiffness) at each level with psoas activation. The client should be able to maintain the contraction (and increased stiffness) for fifteen seconds with normal relaxed breathing and without fatigue or substitution. This response should be noted at all lumbar segmental levels.

Segmental psoas dysfunction is identified at the vertebral level in which there is no increased resistance to manual displacement during psoas activation when compared to adjacent levels (which do increase resistance to translation when psoas is activated). This lack of resistance to manual displacement indicates a probable loss of segmental control of the local stability role of psoas (Comerford and Emerson, 1998; Comerford and Mottram, 2000). This assessment may also be performed in other positions (prone or side lying) so long as distraction of the hip is controlled and there is no over activation of the paraspinal muscles.

Note: If the client is using facilitation techniques during the assessment to activate psoas, the palpation should be performed with and without the facilitators for comparison. It is possible to facilitate other local stability muscles, which may affect the palpation component of the assessment.

Stage 3: Retraining of the Segmental (Local) Stability Role

There are a variety of facilitation strategies to aid in the rehabilitation of the segmental stability role of psoas.

Facilitation Strategies:

From the current research evidence to date, the local stability muscles have a motor control deficit in the presence of low back pain that is not related to weakness or length change. These deficits are better retrained with specific low effort exercises (Hides et al, 1996; Richardson et al, 1999a; O'Sullivan, 1997). As with other local stability muscles, subjects respond differently to various facilitation strategies. The goal is to achieve consistent low threshold activation of psoas major to provide segmental stiffness when the assessment (Stage 2) is re-tested. When this can be achieved, the facilitation techniques should be discarded and retraining should be progressed to a more efficient specific contraction and integration into function.

The following techniques can help facilitate psoas:

1 - Active hip external rotation

This should be a slow, low effort, small range movement. When the client's hip is normally positioned in external rotation, it is useful to apply a small amount of resistance to the external rotation so the movement is not passive (Figure 3). This facilitator serves three purposes. First, the external rotation may disadvantage or inhibit the TFL/ITB, which is a femoral internal rotator. Second, the external rotation may recruit the deep hip intrinsic muscles. These fit the classification of local stabilizers as outlined by Comerford and Mottram (2001). Local stability muscles should functionally co-activate together (Richardson et al, 1999a), so activating the deep hip intrinsic muscles may facilitate the local stability role of psoas major. Thirdly, psoas and iliacus share a common tendon as they insert into the lesser trochanter and they may contribute to lateral rotation. In normal function the local and global muscles recruit synergistically. Low threshold activation of the global role of iliacus and the anterior fascicles of psoas through lateral rotation may facilitate the local function in the posterior fascicles of psoas.

2 - Normal (unforced) end range expiration

During expiration the diaphragm ascends and because of the anatomical relationship that exists between the diaphragm and psoas, expiration may create a mechanical pull on psoas via fascial connections. However, it is possible that this relationship may be more neurophysiological rather than biomechanical. Abdominal breathing in supine / crook lying provides the best excursion of the diaphragm and will have the best leverage for any fascial pull on psoas (Williams et al, 1989).

3 - Pelvic floor contraction

There is a strong anatomical relationship between the pelvic floor fascia and the inferior psoas fascia. The pelvic floor contraction should be a low effort (less than 25% maximum voluntary contraction) contraction. If a proprioceptive / sensation of effort deficit exists, a higher perceived effort is permissible (Comerford and Mottram, 2001; Gibbons and Comerford, 2001) providing the oblique abdominal muscles do not dominate the contraction. The oblique dominance is monitored via palpation of the antero-lateral abdominal wall (Figure 4). With a slow, low effort pelvic floor contraction, a 'tensioning' (transversus abdominus recruitment) should be felt and not a 'bulge' in the antero-lateral abdominal wall (Richardson et al, 1999b). It is understood that local stability muscles should co-activate (Richardson et al, 1999a). When a 'bulge' is palpated, it is non-specific for transverses abdominus and may not be specific for posterior psoas major facilitation.

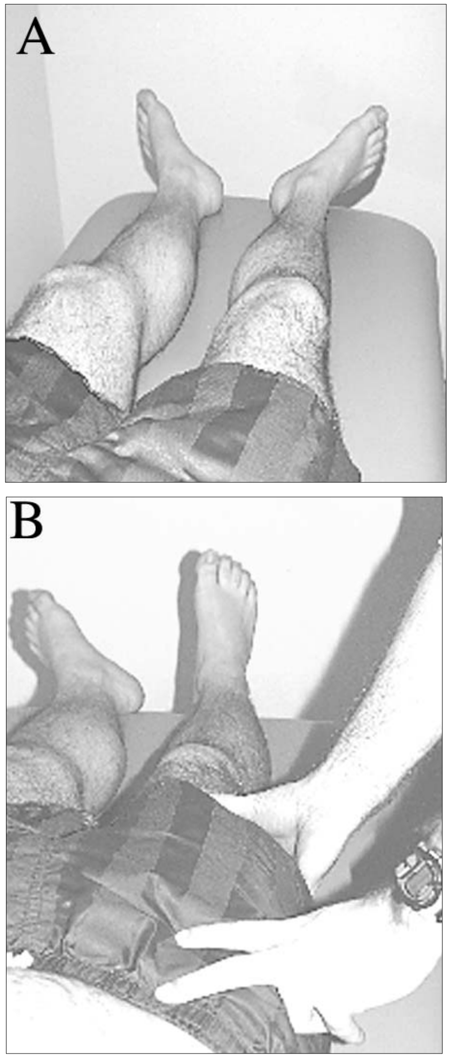

Figure 3: A: Client positioned in hip external rotation at rest. B: Low effort resistance to active hip external rotation during psoas major facilitation with the hip in neutral rotation.

4 - Resistance to passive anterior rotation of the innominate

Psoas passes over the pelvic brim where it becomes tendinous and continues to the lesser trochanter. While it does, the fascia of the posterior fascicles attaches to the pelvic brim. As psoas generates force, this orientation creates a posterior rotation moment on the innominate relative to the sacrum that can resist an anterior rotation action. The client is instructed to use minimal effort to maintain a neutral spine and hold the pelvis steady during isometric resistance to passive anterior rotation of the innominate.

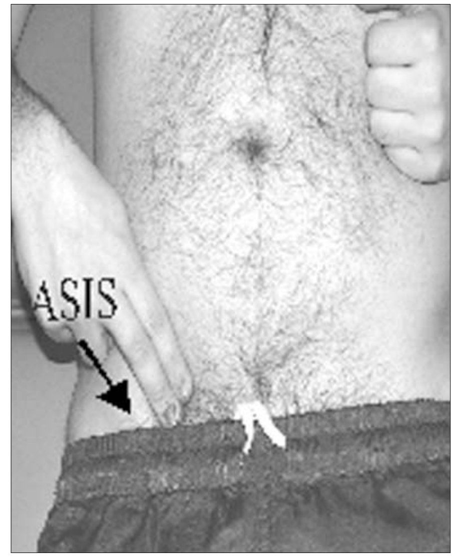

Figure 4: Palpation of the lower abdominal wall to monitor abdominal activation during a pelvic floor contraction. (from the ASIS, palpate 2cm down along the inguinal ligament then 1cm medial).

5 - Side-lying segmental lumbar facilitation

The client is positioned in side lying with the dysfunctional psoas uppermost. The bottom leg is straight and the top leg bent with the spine and pelvis in neutral alignment in terms of tilt and rotation. The top leg is supported horizontally with the spine, pelvis and upper trunk all neutral. Psoas is facilitated by gently distracting the top leg longitudinally and the patient is instructed to pull the hip back into the socket without moving the spine or pelvis. Facilitation may be localized to the segmental level of dysfunction by manually palpating the dysfunctional spinal level (as identified in Stage 2 testing). The therapist or client gently grips the spinous process and manually oscillates that vertebrae with a side to side, back and forth motion, while the psoas activation is sustained. This provides afferent mechanical proprioception and feedback. As function improves with retraining, there should be reassessment of symmetry and segmental control with the assessment (Stage 2).

Problem solving tips - watch for and eliminate substitution:

1 - Dominant or excessive activation of rectus femoris

Use less effort and a slower contraction. A pillow may be used to put the knee in slight flexion to disadvantage rectus femoris

2 - Dominant or excessive activation of TFL/ITB

Use less effort and a slower contraction. Ensure the hip external rotation is active rather than passive and slightly more effort may be used during the external rotation contraction. The hip may be placed in slight abduction to disadvantage TFL/ITB.

3 - Dominant or excessive of quadratus lumborum

Ensure the spine is in neutral. Use less effort and a slower contraction. Change position to long sitting.

4 - Dominant or excessive activation of iliocostalis

There is excessive anterior tilt and spinal extension. Ensure the spine is in neutral. Use less effort and a slower contraction.

5 - *Dominant or excessive activation of proximal trunk muscles*

Significant resistance to passive rotation of the pelvis identifies this. Use less effort and a slower contraction. Ensure low effort activity by the facilitators.

6 - Loss of neutral spine

Ensure the spine is in neutral actively rather than passively after it is achieved. Use less effort and a slower contraction.

Movement and load facilitators

In situations where psoas is dysfunctional or there is a lack of proprioception by the client, it can be useful to use movement and load facilitators. A dysfunction identified in psoas is a decrease in normal low threshold recruitment. Under higher load situations psoas will be activated. These can be used to facilitate psoas and then the client can return to the normal low load facilitators.

Some techniques are listed below:

1 - Side-lying rotation to neutral (psoas co-activation with multifidus)

(Adapted Grieve)

The client is positioned in side lying with the dysfunctional side of psoas uppermost. The bottom leg is straight and the top leg bent with the spine and pelvis in neutral alignment in terms of tilt and rotation. The uppermost leg is allowed to drop towards the plinth causing the trunk and pelvis to rotate forwards. Psoas is facilitated by gently distracting the top leg longitudinally and the patient is instructed to pull the hip back into the socket until the trunk and pelvis rotates back to the neutral position. The segmental or oblique fibres of multifidus are co-activated by the direct rotational movement. The technique can be segmentally localized by manual fixation at the level above the dysfunction. The same facilitators as before may be used here. Hip external rotation is achieved when the client gently pushes the top heel downwards. The breathing, pelvic floor contraction or resistance anterior rotation of the innominate can follow.

2 - Sitting - leaning back (eccentric hip flexors)

The client sits with the spine and pelvis in neutral and the feet on the floor. Keeping the spine and pelvis neutral the patient is instructed to slowly lean backwards by only moving at the hips (rock from the ischium). This requires that the deep hip flexors eccentrically lower the trunk backwards. Ensure that the lumbo-pelvic neutral alignment is maintained. There should be no substitution dominance from the hip flexor mobilisers (anterior tilt of the pelvis) or the abdominals (palpable bulge in the antero-lateral abdominal wall; trunk flexion and posterior pelvic tilt), and there should be no fatigue. The client can lean backwards as far as can be controlled and then leans forward to return to neutral (if the forward lean continues beyond 90° hip flexion the bias shifts to multifidus and gluteals to eccentrically control the movement).

3 - Hand - knee diagonal push

Lie in crook lying with the spine supported in neutral. Slowly lift one knee towards the opposite hand and push them isometrically against each other on a diagonal line (watch for substitution e.g. do not stabilise with the opposite foot or allow posterior pelvic tilt). Ensure that the neutral spine position is maintained. Psoas strongly co-activates multifidus in this procedure. This technique uses significant more global stabilizer co-contraction than many of the others. This may be appropriate when significant inhibition is present (e.g. post surgery or inflammatory trauma).

Progression of Psoas Retraining

Once the correct activation can be accomplished, psoas recruitment retraining is performed in a variety of different positions. Clinically, it may be best to start in a position where the client is confident they can achieve a correct activation, rather than what the therapist feels is the best activation. For the majority of patients, recumbent postures, such as supine lying, incline sitting or side lying, are the positions where it is easiest to facilitate and teach the correct activation of psoas. From this, other positions are trained. As a general guide, the psoas contraction should be maintained for ten seconds and for ten repetitions, during relaxed breathing. Two or three sets a day are reasonable, depending on the client. The segmental stability of psoas should be reassessed (Stage 2) regularly to ensure appropriate progression.

Stage 4 A and B

Assessment of Global Stability

The global stability role of psoas (anterior fascicles) is functionally combined with iliacus. This may be considered efficient when the stabilizer can move the limb through the available passive range of 120° hip flexion. In sitting with the lumbar spine in neutral, the hip is actively flexed through the full range of motion (ideally 120°). There should be no loss of lumbo-pelvic neutral or co-contraction of TFL / ITB and sartorius, or the hamstrings. This can be identified as significant resistance to passive rotation of the hip when it is flexed. In optimum function, this position should be maintained for ten seconds and ten repetitions (it is recognized that there may be other reasons why there is a loss of a neutral spine during this test).

Specific Retraining of the Local and Global Muscle Role Through Range

Global Supported Hip Flexion

The global role is best started in supine or inclined sitting. Here, the local role of psoas is combined with the global role. 'Shortening the hip' activates psoas, and then while maintaining this action, slow heel slides are started. The heel actively slides up beside the opposite leg towards the buttock (as far as the contralateral knee). The heel should slide only as far as the client confidently feels that the hip is still 'shortened'. This position is held for ten seconds. The eccentric return (straightening of the leg) should be controlled and performed at the same slow pace as the concentric component. The client should be taught to monitor tibial external rotation, hip internal rotation and hip adduction (signs of TFL / ITB dominating hip flexion) and lateral hip rotation (a sign of sartorius dominating hip flexion). The therapist should also check for co - contraction rigidity at the point the hip is held. Once the heel slide can be coordinated and reach the opposite knee, the foot can be lifted 2cm and held. The exercises can then be progressed to standing, and sitting unsupported control exercises.

Global Unsupported Hip Flexion

Because the client often experiences difficulty performing this without substitution, the global retraining may start without the local role. This can start in standing with some individuals. Others will have to start in supine or long sitting. In standing, hip flexion can start at 70°, and progresses to 80° and 90°. This can start supported on the wall with a neutral spine and then unsupported standing. This is progressed to sitting hip flexion from 90° to 120°.

Global Spinal Stability Role - Eccentric Control

Psoas also has an eccentric role in spinal stability. This can be started in sitting during a lean backwards and then in standing. Standing and side bending of the trunk is also controlled by psoas and is best started supported at a wall with the spine in neutral and then progressed to unsupported standing.

Rothstein has suggested that to integrate an activity or skill into normal, automatic or unconscious function, many repetitions must be performed under diverse functional situations. To do this, some form of reminder is needed. He has proposed that small 'red dots' are placed so that they are frequently seen and will act as a visual reminder (e.g. on wristwatch, clock, telephone, mirror etc.) for the subject to perform a specific task each time they are observed. This process lends itself well to training of the local stability system.

Stage 5: Integration of Local Stability Muscle Recruitment into Specific Function

When the psoas becomes efficient and is easily activated it can be readily integrated into functional activities. It is easier to start with static activities such as standing or sitting. When this becomes easier, it can be incorporated into dynamic movements such as bending and walking.

Stage 6: Integration of Local and Global Co-Activation into Normal Function

Since the local role of psoas is usually rehabilitated before the global role, integration of the local retraining into function starts earlier. As the global role becomes more efficient, it can also be incorporated into function. This can include the hip flexion component of the stairs, moving while sitting or driving, and standing.

It is important the client continue their functional activity when retraining psoas into function, and not 'stop' and then activate. This may hinder incorporation of psoas into function. The retraining is progressed into activities of daily living, and then work or sport related activities.

Conclusion

A review of the literature to date reveals that psoas major has been a poorly investigated muscle. It functions as a lumbar and hip stabilizer through axial compression and vertical shortening, respectively. Research suggests psoas may have a local stability role in the lumbar spine. A model has been proposed in which the posterior fascicles play a local stability role while the anterior fascicles are a global stability role. Specific exercises and facilitation strategies have been developed for the rehabilitation of psoas major. Although not discussed here, this model has implications for retraining of pelvic floor dysfunction. As well, psoas may be considered a local stabilizer for the hip and components of the above regime may be used in hip rehabilitation. Current research includes validation of the exercises and monitoring technique with real-time ultrasound, and deep needle electromyography. This will aid in the further understanding of psoas, which may lead to improved assessment and rehabilitation strategies.

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