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Clinical implications of paradoxical muscle function in muscle stretching or strengthening

N. I. Gluck, C. S. Liebenson

Abstract Therapeutic stretching or strengthening exercises are successful if the target muscle is properly isolated. Manual resistance techniques require precise patient positioning to isolate the targeted soft tissue. The piriformis, iliopsoas and sternocleidomastoid muscles often demonstrate a paradoxical function that may alter the positioning needed to treat them most efficiently. In addition, the hip adductors have secondary motions that can alter normal hip ranges of motion. A review of the functional anatomy and appropriate isolating strategies is provided for each muscle.

Natalie Gluck DC
Craig Liebenson DC
10474 Santa Monica Boulevard, Suite 202, Los Angeles, CA 90025, USA

Correspondence to: Craig Liebenson, Tel ++1 310 470 2909; Fax: ++1 310 470 3286

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Introduction

Stretching or strengthening techniques are only as useful as the specificity with which they are applied. Manual resistance techniques (MRTs) can be an excellent method to treat trigger points, to lengthen shortened myofascial tissues, to reprogramme muscle and joint proprioceptors, and re-educate muscle patterns (Chaitow 1996, Liebenson 1996). However, as Chaitow stated, 'unless local muscle tension is produced in the precise region of the soft tissue dysfunction, the method is likely to fail to achieve its objective'.

Strengthening exercises in a health club or rehab setting are most successful when the targeted muscle is isolated. This ensures that the maximum number of a muscle's motor units is activated and the joint load penalty is minimized (McGill 1998).

Certain muscles may alter or even reverse their function (thus the 'paradox'), depending on how the involved joint(s) is/are positioned. To perform any stretch or relaxation exercise correctly, the doctor must position the joint accurately to achieve tension in the desired muscle fibres.

The piriformis, iliopsoas and sternocleidomastoid (SCM) often

Table 1 Functional anatomy of piriformis	
Origin:	Anterior surface of sacrum
Insertion:	Greater trochanter of the femur
Action:	Hip abduction, external rotation and extension

demonstrate a 'paradoxical' function. In addition, the hip adductors have important secondary actions which can alter normal hip ranges of motion (Janda & Schmidt 1982).

Piriformis

The piriformis muscle is an external rotator of the hip until 60 degrees of hip flexion (Fig. 1). With more than 60 degrees of hip flexion, the piriformis becomes an internal rotator of the hip (Lehmkuhl & Smith 1983). Thus there are two techniques for stretching the piriformis depending on the degree of hip flexion. Below 60 degrees of hip flexion, the hip is internally rotated and adducted to stretch the piriformis (Fig. 2). Above 60 degrees of hip flexion (usually positioned at 90 degrees of hip flexion), the hip is externally rotated and then adducted to stretch the piriformis (Travell & Simons 1983) (Fig. 3). In other words, to properly assess piriformis length and to stretch a tight piriformis requires that the clinician be aware of how the piriformis function changes above 60 degrees of hip flexion.

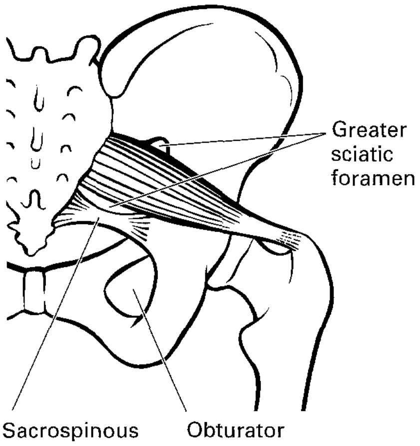

Fig. 1 Anatomy of piriformis muscle

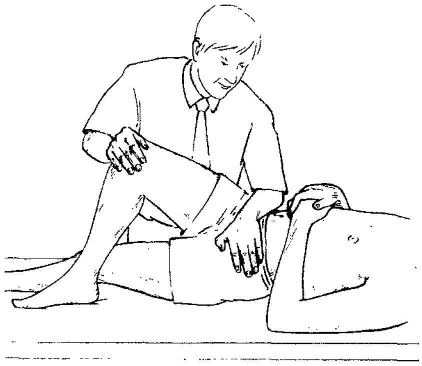

Fig. 2 To stretch the piriformis at less than 60 degrees of hip flexion, the operator must internally rotate the hip, adduct the femur, and apply axial loading along the femoral shaft towards the hip joint to isolate the piriformis muscle (Reproduced from Chaitow 1996.)

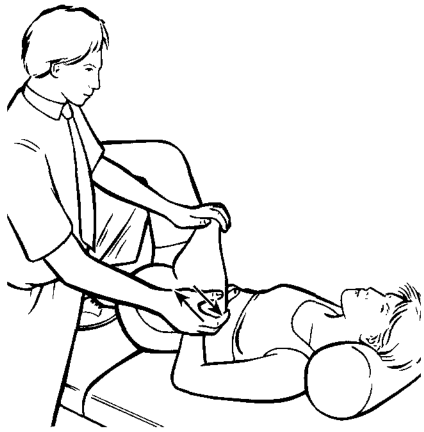

Fig. 3 To stretch the piriformis at more than 60 degrees of hip flexion, the operator must externally rotate the hip, adduct the femur, and again apply axial loading along the femoral shaft towards the hip joint to isolate the piriformis muscle

The patient can comfortably self-stretch the piriformis in the supine position, by flexing the involved hip, externally rotating the femur and resting the involved leg over the uninvolved knee. This position is often called the 'figure 4' stretch. By placing the uninvolved foot against a wall, the patient can comfortably perform this stretch without using the arms to add tension. The patient should keep the sacrum on the ground to increase tension on the piriformis (Fig. 4).

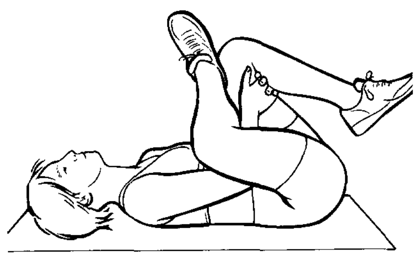

Fig. 4 Self-stretch of piriformis muscle

Iliopsoas

The primary function of the iliopsoas is hip flexion (Fig. 5). The iliopsoas also functions synergistically with the rectus abdominus during trunk flexion. Unfortunately, because of poor posture, overactivity in the iliopsoas can often limit isolation of the abdominals during trunk flexion, resulting in increased lumbar strain (Johnson & Reid 1991, McGill 1995). According to Janda, the psoas paradox occurs when either the erector spinae

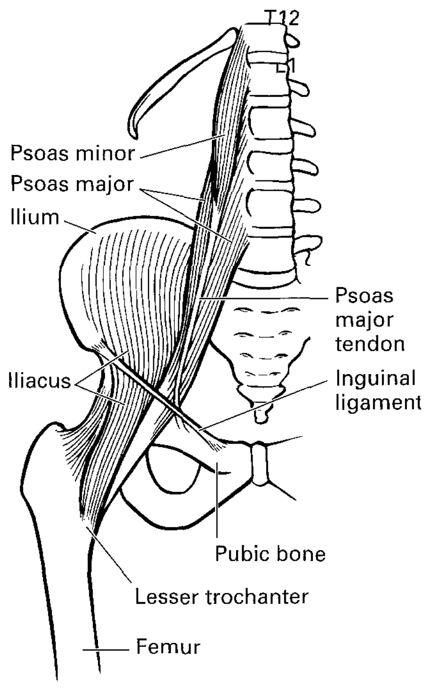

Fig. 5 Anatomy of the iliopsoas

or the iliopsoas is shortened, resulting in the iliopsoas causing an increased lumbar lordosis during trunk flexion activities (Fig. 6).

An overactive iliopsoas can substitute for the abdominals and cause a poor movement pattern during trunk flexion. When this occurs, as the patient flexes the trunk forward, the lumbar spine will be prevented from kyphosing because of the overactivity of the shortened iliopsoas (Fig. 6).

This situation is worsened by the common training technique of holding the feet down by a strap or pad or manually while the individual performs sit-ups or other trunk flexion exercises. A simple solution to this problem is to deactivate the hip flexors by having the patient press the soles of the feet into the ground while performing sit-ups. Thus the key to isolating abdominals during trunk flexion exercises is to prevent the back from lordosing and deactivate the iliopsoas (Fig. 6).

Sternocleidomastoid

The primary function of the SCM when only one side is contracted is to rotate the neck contralaterally and flex it ipsilaterally (Travell & Simons 1983) (Fig. 7). However, when both SCMs are contracted in unison, they flex the lower cervical spine and extend the upper cervical spine.

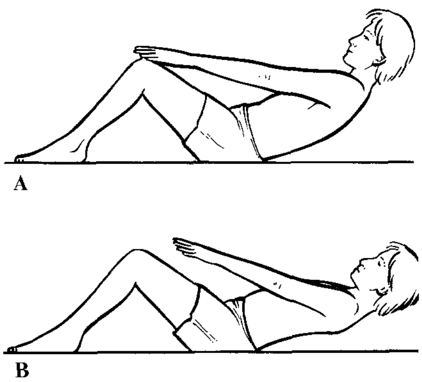

Fig. 6 In normal forward bending of the trunk (A), the patient is able to reverse the lumbar lordosis. In abnormal forward bending of the trunk (B), because of tight erector spinae and overactive iliopsoas, the patient is unable to lose the lumbar lordosis (White & Anderson 1991). This places excess stress upon the lumbar spine and can lead to facet imbrication (Alter 1996)

Table 2 Functional anatomy of iliopsoas (combined psoas major iliacus)

Psoas origin: Anterior surfaces of TPs and vertebral bodies and IVDs of L1–L5
Iliacus origin: Superior two-thirds of iliac fossa, internal lip of iliac crest, iliolumbar and ventral sacroiliac ligaments, and sacral ala
Iliacus and psoas insertion: Lesser trochanter of femur
Action with the origin fixed: Hip flexion, hip abduction, and hip external rotation
Action with the insertion fixed: Flexion of the hip joint, by flexing the trunk on the femur, while increasing the lumbar lordosis; unilaterally, assists in ipsilateral trunk flexion

Table 3 SCM

Origin:	Mastoid process and lateral superior nuchal line of occiput
Insertion:	Manubrium and medial clavicle
Action:	Unilateral action includes ipsilateral lateral flexion and contralateral rotation; bilateral action includes lower cervical flexion and upper cervical extension

Table 4 Adductors

Origin:	Symphysis pubis and obturator foramen
Insertion:	Linea aspera of femur
Action:	Hip adduction, flexion and extension

The supine neck flexion test demonstrates what happens to the cervical spine when the deep neck flexors are weak. Normally, neck flexion occurs without extension of the upper cervicals (and chin poking). In the abnormal situation, neck flexion occurs with extension of the head and upper cervicals because of overactive SCM and suboccipitals (Fig. 8). The clinical implication is that training requires relaxation of the overactive SCM and suboccipitals, followed by activation of the deep neck flexors.

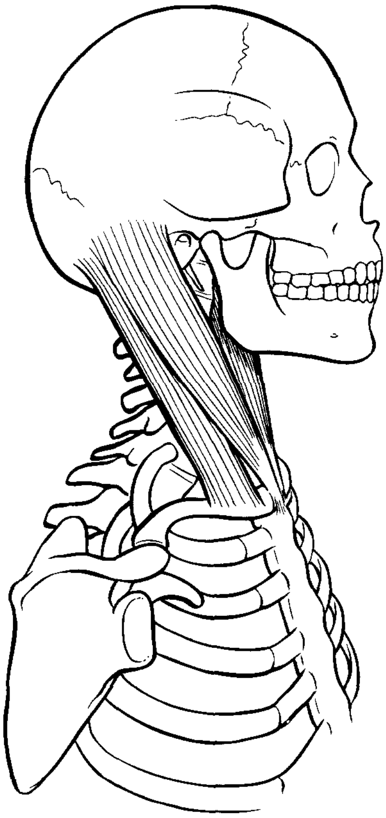

Fig. 7 Anatomy of SCM

Adductors

The anatomy of the hip adductors permits the posterior portion of the adductors to function as hip extensors (in conjunction with the hamstrings), while the anterior portion of the adductors function as hip flexors (in conjunction with iliopsoas and rectus femoris) (Fig. 9). When performing a straight leg raise (SLR) on a patient, if restricted hip flexion is noted, stretch the adductors and then reassess the SLR; stretching the adductors may be all that is needed to restore normal hip flexion (Kendall & McCreary 1983). If the SLR is still limited, then hamstring stretching may also be required.

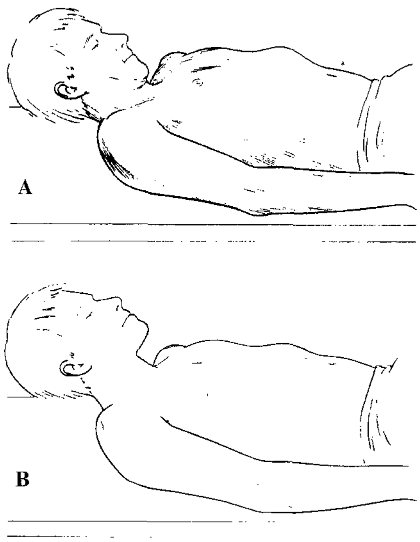

Fig. 8 Normal (A) versus abnormal (B) neck flexion as demonstrated in the supine neck flexion test. (Reproduced from Chaitow 1996.)

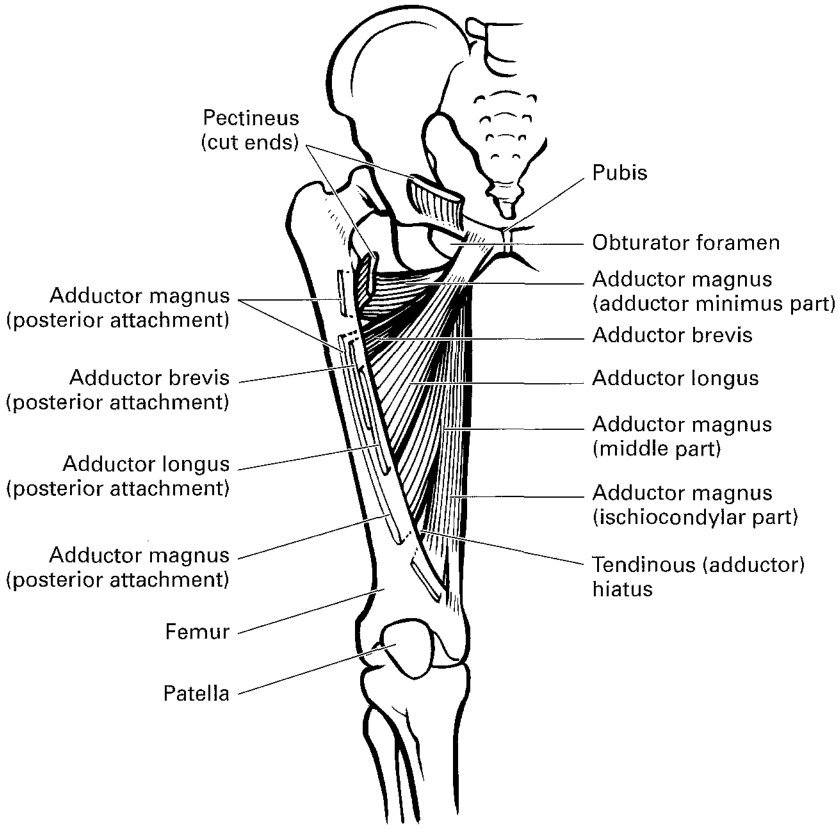

Fig. 9 Anatomy of the hip adductors

Similarly, if a patient has decreased hip extension, try stretching the adductors and then re-evaluate hip extension. If it is still reduced, the iliopsoas, tensor fascia lata, and/or rectus femoris may also be limiting hip extension.

REFERENCES

Alter M 1996 Science of Flexibility, 2nd edn. Human Kinetics, Champaign, IL

Chaitow L 1996 Muscle Energy Techniques. Churchill Livingstone, New York, NY

Janda V, Schmidt HJA 1982 Muscles as a Pathogenic Factor in Back Pain. International Federation of Manipulative Physical Therapists Proceedings, Christchurch, New Zealand

Johnson C, Reid JG 1991 Lumbar compressive and shear forces during various trunk curl-up exercises. Clin Biomech 6: 97–104.

Kendall FP, McCreary EK 1983 Muscles: Testing and function, 3rd edn. Williams & Wilkins, Baltimore, MD

Lehmkuhl LD, Smith LK 1983 Brunnstrom's Clinical Kinesiology, 4th edn. F. A. Davis Co., Philadelphia, PA

Liebenson CS (ed) Rehabilitation of the Spine: A Practitioner's Manual. Williams & Wilkins, Media, PA

McGill S 1995 The mechanics of torso flexion: situps and standing dynamic flexion manoeuvres. Clin Biomech 10: 184–192

McGill S (1998) Low back exercises: Prescription for the healthy back and when recovering from injury. ACSM Resource Manual, 3rd edn. Williams & Wilkins, Baltimore, MD

Travell J, Simons D 1983 Myofascial Pain & Dysfunction, 2nd edn. Williams & Wilkins, Baltimore, MD

White AH, Anderson R 1991 Conservative Care of Low Back Pain. Williams & Wilkins, Baltimore, MD