PERFORMING ARTS
SPECIAL INTEREST GROUP
ORTHOPAEDIC SECTION
AMERICAN PHYSICAL THERAPY ASSOCIATION
APTA
American Physical Therapy Association
The Science of Healing. The Art of Caring.

PASIG MONTHLY CITATION BLAST: No.57 **January 2011**

Dear PASIG members:

Happy New Year to everyone! Congratulations to our newly elected PASIG President: Julie O'Connell and to Nominating Committee Member: Amanda Blackmon.

I've just received our second glossary, Artistic Gymnastics Terminology. Many thanks to the group who worked on this: Gina Pongetti Angeletti, Julie Guthrie. Amy Kuczera, Kim MacLean, Anthony J. Russo, and organizer and cheer leader, Mark D. Sleeper. I'm contributing a third glossary: Hip Hop Terminology. This is short and in need of flushing out in the future. Both are posted on our PASIG webpage. Please check them out.

Hopefully we'll see many of you soon at Combined Sections Meeting in New Orleans, February 9 –12, 2011. Don't forget, PASIG programming is Saturday, Feb. 12th, 2011. Please attend our business meeting directly before the programming! The meeting is open to all - members and non-members and breakfast will be provided.

COMBINED SECTIONS MEETING

Saturday, 2/12/11

7:00 – 8:00 PASIG Business Meeting
8:00 – 11:00 PASIG PROGRAMMING: **Movement Impairment Issues in Performing Artists: Considerations for Evaluation and Treatment of Upper and Lower Quarter Injuries**
8:00 – 8:45 Movement Impairments in the Upper Quarter. Speaker: Lynette Khoo-Summers, PT, Washington University, St. Louis, MO.
8:45 – 9:05 Case Study - Instrumental Musician. Speaker: Jan Dommerholt, PT, Bethesday, MD.
9:05 – 9:25 Case Study - Vocal Musician. Speaker: Alison DeLeo, PT, George Washington University, DC.
9:25 – 10:10 Movement Impairments in the Lower Quarter. Speaker: Lynette Khoo-Summers
10:10 – 10:30 Case Study – Dancer. Julie O'Connell, PT, ATC, AthletiCo, Chicago, IL.
10:30 – 10:50 Case Study – Skater. Jennifer Flug, PT, DPT, OCS, Premier Physical Therapy & Sports Performance, Middletown, DE.

Our PASIG student scholarship winner is Kari Oki from the University of Southern California for her poster presentation entitled "Achilles and patellar tendon morphology in young dancers with and without tenalgia".
PA platforms and posters that you won't want to miss at CSM:

POSTERS

OP02122 AN IMPAIRMENT-BASED MANUAL PHYSICAL THERAPY APPROACH IN THE TREATMENT OF DYSPHONIA IN A PROFESSIONAL SINGER: A CASE REPORT. Garvey C, KORT, Louisville, KY

OP02123 EFFECT OF SPRUNG (SUSPENDED) FLOOR ON LEG STIFFNESS DURING GRAND JETÉ LANDINGS IN BALLET. Hackney JM, Jungblut K, Knoderer C, Brummel S, Physical Therapy, Missouri State University; Theatre and Dance, Missouri State University, Springfield, MO

OP02124 DIFFERENCES IN HIP AND KNEE KINEMATICS DURING PARALLEL AND TURNED-OUT POSITIONAL JUMP-LANDINGS IN PROFESSIONAL BALLET DANCERS. Hong J, Schwass C, Zelenka J, Ziegler M, Sleeper MD, Janowski J, Physical Therapy and Human Movement Sciences, Northwestern University, Chicago, IL; AthletiCo, Chicago, IL

OP02125 ACHILLES AND PATELLAR TENDON MORPHOLOGY IN YOUNG DANCERS WITH AND WITHOUT TENALGIA. Oki KC, Chang Y, Lim A, Kulig K, Heredia-Jimenez JM, Mills J, Bashford G, Biokinesiology and Physical Therapy, University of Southern California, Los Angeles, CA; University of Granada, Granada, Spain; Biological Systems Engineering, University of Nebraska-Lincoln, Lincoln, NE

02126 DANCERS VALUE PHYSICAL THERAPY FOR TREATMENT OF DANCERELATED INJURIES. Addis K, Engesser-Cesar C, Physical Therapy, Chapman, Chino Hills, CA

OP02127 SUCCESSFUL TREATMENT OF A GUITARIST WITH A FINGER JOINT SPRAIN USING INSTRUMENT-ASSISTED SOFT TISSUE MOBILIZATION: A CASE STUDY. Loghmani MT, Gundeck E, Clayton G, Bayliss AJ, Department of Physical Therapy, Indiana University, Indianapolis, IN

PLATFORM Friday 8am

THE EFFECTS OF FLOOR INCLINE ON LOWER EXTREMITY BIOMECHANICS DURING UNILATERAL LANDING FROM A JUMP IN DANCERS . Pappas E, Hagins M, Orishimo KF, Kremenic I, Liederbach M, Physical Therapy, Long Island University, Brooklyn, NY; Nicholas Sports Medicine Institute, Lenox Hill Hospital, NY, NY; Harkness Center for Dance Injuries, NYU Hospital for Joint Diseases, NY, NY

If you haven't already done so, please contact Kendra Gage (kmhgage@gmail.com) if you have a PA student clinical affiliation. She will need to know the following:

- Name of Practice
- Address
- Clinical coordinator
- Phone
- Fax
- E-mail
- % PA treated and type of artist
- Student requirements

PERFORMING ARTS CONTINUING EDUCATION OPPORTUNITIES

****NEW Performing Arts Independent Study NOW AVAILABLE****
20.3 Physical Therapy for the Performing Artist.

Monographs are available for:
- Figure Skating (J. Flug, J. Schneider, E. Greenberg),
- Artistic Gymnastics (A. Hunter-Giordano, Pongetti-Angeletti, S. Voelker, TJ Manal), and
- Instrumentalist Musicians (J. Dommerholt, B. Collier).

Contact: Orthopaedic Section at: http://www.orthopt.org

Also available:
Orthopaedic Section Independent Study Course. *Dance Medicine: Strategies for the Prevention and Care of Injuries to Dancers*.
This is a 6-monograph course and includes many PASIG members as authors.
- Epidemiology of Dance Injuries: Biopsychosocial Considerations in the Management of Dancer Health (MJ Liederbach),
- Nutrition, Hydration, Metabolism, and Thinness (B Glace),
- The Dancer's Hip: Anatomic, Biomechanical, and Rehabilitation Considerations (G. Grossman),
- Common Knee Injuries in Dance (MJ Liederbach),
- Foot and Ankle Injuries in the Dancer: Examination and Treatment Strategies (M. Molnar, R. Bernstein, M. Hartog, L. Henry, M. Rodriguez, J. Smith, A. Zujko),
- Developing Expert Physical Therapy Practice in Dance Medicine – (J. Gamboa, S. Bronner, TJ Manal).

Contact: Orthopaedic Section at: http://www.orthopt.org

Please send information about other courses of interest to our membership to: Amy Humphrey PT, DPT, OCS, MTC; ahumphrey@Bodydynamicsinc.com

The PASIG is developing a Resource Page, which will be posted on our website. It will have links to articles and citation blasts, by topic. For example, it will have links to help you find injury information regarding figure skating, dancing, gymnastics, musicians, and other aspects of performing arts. This information is being developed right now and will be LIVE on the PASIG website by CSM 2011.

If you haven't perused the PASIG Website lately, you might be missing some vital information. There is a wealth of information located there including:

- Archived monthly citation blasts, by date and topic
- Listing of officers
- Member Directory with an advanced search
- Meeting minutes from our annual meetings at CSM
- Member profile update to provide detailed information about your PA experience, relationships, practice information
- A list of clinical affiliations
- A list of Entry-level PT Programs With a Strong Performing Arts Curriculum
- Performing Arts Glossaries (Ballet and Figure skating)
- Information regarding the PASIG Student Scholarship
- Technical report from the PASIG practice analysis
- A bulletin board to ask questions
- COMING SOON - Resource Page

For this January Citation BLAST, Justin Zelenka and Michelle Ziegler have selected the topic "*Psoas Major Function.*" The format is an annotated bibliography of articles from 2000 – 2010. The PASIG Research Committee initiated this monthly Citation BLAST on performing arts-related topics in June 2005 in the hopes of encouraging our members to stay current in the literature and, perhaps, consider conducting research themselves. Each month we send a new list of performing arts (PA) citations to members of the PASIG to further the pursuit of PA-related scholarship. (Information about EndNote referencing software can be found at http://www.endnote.com, including a 30-day free trial).

As always, your comments, suggestions, and entry contributions to these Citation BLASTs are welcome. Please drop me an e-mail anytime.

Regards,
Shaw

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Psoas Major Function

The function of the psoas major muscle as it relates to the hip and lumbar spine has been a topic of debate. Its primary role as a hip flexor with the iliacus muscle is well established, but its effect on the lumbar spine continues to be investigated. It has been suggested that psoas major is a flexor of the lumbar spine, while others propose that it is a stabilizer and not a mover. In the last decade, concepts of spinal stability have been redefined with greater focus on the role of the musculature surrounding the spine as opposed to stability from the intervertebral discs and spinal ligaments. Understanding fiber type composition within the psoas major may give better insight as to the true function of this muscle. We may also glean a better understanding of psoas major function by looking at studies conducted on athletes who perform similar physical tasks to dancers. Many dancers continue to dance beyond 30 years of age; therefore, better understanding about the physiological changes that occur within the psoas major may improve our treatment. In conclusion, a better understanding of the function of psoas major would be beneficial for treatment of hip and low back pain, but unfortunately, the literature on this topic continues to be limited, with very few peer reviewed publications available from the last decade, and fewer still related specifically to dance.

Justin Zelenka SPT
Michelle Ziegler SPT
Northwestern University

Clinical Addendum:

Many dancers who complain of anterior hip pain often seem to be struggling with this dual function of the psoas muscle: prime mover of the femur and stabilizer of the spine. This can result in overuse tendinosis if they are not activating other core stabilizers to relieve the burden on the psoas.

S. Bronner PhD, PT
ADAM Center
Long Island University

Andersson E, Oddsson L, et al. (1995). The role of the psoas and iliacus muscles for stability and movement of the lumbar spine, pelvis and hip. Scand J Med Sci Sports **5**(1): 10-16.

The activation patterns of the psoas and iliacus muscles were investigated in 7 healthy adult subjects (4 men and 3 women) during a variety of motor tasks in standing, sitting and lying. Myoelectric activity was recorded simultaneously from the 2 muscles using thin wire electrodes inserted under guidance of high-resolution ultrasound. In general, both muscles were coactivated, albeit to different relative levels, particularly when hip flexor torque was required. Selective activation of the iliacus could, however, be seen to stabilize the pelvis in contralateral hip extension during standing. Psoas was found to be selectively involved in sitting with a straight back and in contralateral loading situations requiring stabilization of the spine in the frontal plane. During training exercises from a supine position, such as sit-ups, the contribution of the psoas and iliacus muscles could be varied by changing the range of motion as well as the position and support for the legs. Thus, the 2 anatomically different muscles of the iliopsoas complex were shown to have individual and task-specific activation patterns depending on the particular demands for stability and movement at the lumbar spine, pelvis and hip.

Anloague PA, Huijbregts P (2009). Anatomical variations of the lumbar plexus: a descriptive anatomy study with proposed clinical implications. J Man Manip Ther **17**(4): e107-114.

This study supports the relationship between neural mechano-sensitivity and muscle tension, by looking at variances in the lumbar plexus, which is anatomically related to the psoas major muscle. Dissection of 34 lumbar plexes to look at the prevalence of anatomical variations in the lumbar plexus and the six peripheral branches from the origin at the ventral roots of (T12) L1-L4 to the exit from the pelvic cavity. Prevalence of anatomical variation in the individual nerves ranged from 8.8-47.1% with a mean prevalence of 20.1%. Anatomical variations included absence of the iliohypogastric nerve, an early split of the genitofemoral nerve into genital and femoral branches, an aberrant segmental origin for the lateral femoral cutaneous nerve, bifurcation of the lateral femoral nerve prior to exiting the pelvic cavity, bifurcation of the femoral nerve into two to three slips separated by psoas major muscle fibers, the presence of a single anterior femoral cutaneous nerve rather than the normal presentation of two separate anterior femoral cutaneous branches, and the presence of an accessory obturator nerve. Comparison with relevant research literature showed a wide variation in reported prevalence of the anatomical variations noted in this study. Clinical implications and directions for future research are proposed.

Arbanas J, Klasan GS, et al. (2009). Fibre type composition of the human psoas major muscle with regard to the level of its origin. J Anat **215**(6): 636-641.

The aim of this study was to explore the fibre type composition of the human psoas major muscle at different levels of its origin, from the first lumbar to the fourth lumbar vertebra, and to compare the muscle fibre size and distribution of different fibre types between levels with respect to its complex postural and dynamic function. Muscle samples were collected from 15 young males (younger than 35 years). Serial transverse sections (5 microm) of the

samples were cut by cryomicrotome. Type I, IIA and IIX muscle fibres were typed using myosin heavy chain identification. The serial sections were analysed using a light microscope with a magnitude of 100x. The differences between measurements were evaluated using a repeated-measures anova and Scheffe test for post-hoc analysis. This study showed that the human psoas major muscle was composed of type I, IIA and IIX muscle fibres. It had a predominance of type IIA muscle fibres, whereas type I muscle fibres had the largest cross-sectional area. Type IIX muscle fibres were present as a far smaller percentage and had the smallest cross-sectional area. Moreover, the fibre type composition of the psoas major muscle was different between levels of its origin starting from the first lumbar to the fourth lumbar vertebra. They concluded that the fibre type composition of the psoas major muscle indicated its dynamic and postural functions, which supports the fact that it is the main flexor of the hip joint (dynamic function) and stabilizer of the lumbar spine, sacroiliac and hip joints (postural function). The cranial part of the psoas major muscle has a primarily postural role, whereas the caudal part of the muscle has a dynamic role.

Barker KL, Shamley DR, et al. (2004). Changes in the cross-sectional area of multifidus and psoas in patients with unilateral back pain: the relationship to pain and disability. Spine **29**(22): E515-519.

STUDY DESIGN: Prospective, cross-sectional observational study. OBJECTIVES: The aim of this study was to determine if there was an association between wasting of psoas and multifidus as observed on MRI scans and the presenting symptoms, reported pathology, pain, or disability of a cohort of patients presenting with unilateral low back pain. SUMMARY OF BACKGROUND DATA: Current physiotherapy practice is often based on localized spine stabilizing muscle exercises; most attention has been focused on transversus abdominus and multifidus with relatively little on psoas. METHOD: Fifty consecutive patients presenting to a back pain triage clinic with unilateral low back pain lasting more than 12 weeks were recruited. The cross-sectional surface area (CSA) of the muscles was measured. Duration of symptoms, rating of pain, self-reported function, and the presence of neural compression were recorded. RESULTS: Data analysis compared the CSA between the symptomatic and asymptomatic sides. There was a statistically significant difference in CSA between the sides ($P < 0.001$). There was a positive correlation between the percentage decrease in CSA of psoas on the affected side and with the rating of pain ($\rho = 0.608$, $P < 0.01$), reported nerve root compression ($\rho = 0.812$, $P < 0.01$), and the duration of symptoms ($\rho = 0.886$, $P < 0.01$). There was an association between decrease in the CSA of multifidus and duration of symptoms. CONCLUSIONS: Atrophy of multifidus has been used as one of the rationales for spine stabilization exercises. The evidence of coexisting atrophy of psoas and multifidus suggests that a future area for study should be selective exercise training of psoas, which is less commonly used in clinical practice.

Barker PJ, Urquhart DM, et al. (2007). The middle layer of lumbar fascia and attachments to lumbar transverse processes: implications for segmental control and fracture. Eur Spine J **16**(12): 2232-2237.

The anatomy of the middle layer of lumbar fascia (MLF) is of biomechanical interest and potential clinical relevance, yet it has been inconsistently described. Avulsion fractures of the lumbar transverse processes (LxTP's) are traditionally attributed to traction from psoas major or quadratus lumborum (QL), rather than transversus abdominis (TrA) acting via the MLF. This attachment is also absent from many biomechanical models of segmental control. The aims of this study were to document: (1) the morphology and attachments of the MLF and (2) the attachments of psoas and QL to the LxTP's. Eighteen embalmed cadavers were dissected, measuring the thickness, fibre angle and width of the MLF and documenting the attachments of MLF, psoas and QL. The MLF was thicker at the level of the LxTP's than between them (mean 0.62: 0.40 mm). Psoas attached to the anteromedial surface of each process and QL and TrA to its lateral border; QL at its upper and lower corners and TrA (via

the MLF) to its tip. In three cadavers, tension applied to the MLF fractured a transverse process. The MLF has a substantial and thickened attachment to the tips of the LxTP's which supports the involvement of TrA in lumbar segmental control and/ or avulsion fracture of the LxTP's.

Delp SL, Hess WE, et al. (1999). Variation of rotation moment arms with hip flexion. J Biomech **32**(5): 493-501.

Dancers often perform movements where the hip is flexed yet they still must maintain an externally rotated lower extremity, for example; movements such as landing a jump with the working leg extended into arabesque, or performing a developpe devant. The purpose of this study was to examine the influence of hip flexion on the rotational moment arms of the hip muscles. They hypothesized that flexion of the hip would increase internal rotation moment arms and decrease external rotation moment arms of the primary hip rotators. To test this hypothesis they measured rotational moment arms of the gluteus maximus (six compartments), gluteus medius (four compartments), gluteus minimus (three compartments) iliopsoas, piriformis, quadratus femoris, obturator internus, and obturator externus. Moment arms were measured at hip flexion angles of 0, 20, 45, 60, and 90 degrees in four cadavers. A three-dimensional computer model of the hip muscles was developed and compared to the experimental measurements. The experimental results and the computer model showed that the internal rotation moment arms of some muscles increase with flexion; the external rotation moment arms of other muscles decrease, and some muscles switch from external rotation to internal rotation as the hip is flexed. This trend toward internal rotation with hip flexion was apparent in 15 of the 18 muscle compartments they examined, suggesting that excessive hip flexion may exacerbate internal rotation of the hip. The gluteus maximus was found to have a large capacity for external rotation. Enhancing the activation of the gluteus maximus, superior and inferior gemeli, and quadratus femoris may help better control external rotation in a dancer when increasing hip flexion angle.

Edelstein, J. (2009). "Rehabilitating psoas tendonitis: a case report." HSS J **5**(1): 78-82.

This case report describes the examination and physical therapy intervention for a woman with anterior hip pain whose medical diagnosis following magnetic resonance imaging (MRI) was bilateral labral tears and psoas tendinitis. Her physical therapy evaluation revealed findings consistent with psoas tendonitis. Utilizing theories of neuromuscular patterning and knowledge of normal muscle function, the patient was successfully treated in physical therapy following six physical therapy sessions, once a week for 6 weeks. The patient was found to have an overactive psoas muscle, as indicated by hip flexion being the primary mover in her movement patterns, and dysfunctional abdominal and pelvic floor muscles. Functionally based therapeutic exercise and electrical stimulation were used to reeducate the muscles of the abdomen, pelvic floor, and hips in order to create muscular balance and correct muscle dysfunction.

Hoshikawa Y, Muramatsu M, et al. (2006). Influence of the psoas major and thigh muscularity on 100-m times in junior sprinters. Med Sci Sports Exerc **38**(12): 2138-2143.

PURPOSE: This study aimed to investigate how the cross-sectional areas (CSA) of the quadriceps femoris (QF)3, hamstrings (Ham), and psoas major (PM) in junior sprinters are related to mean running velocity (MV100m) calculated from official records of 100-m races. METHODS: In 44 sprinters (22 boys and 22 girls) aged 14-17 yr, cross-sectional images were taken at the upper thigh and midthigh and midway between the fourth and fifth lumbar vertebrae using magnetic resonance imaging. CSA of the three muscles located in both sides were analyzed. For each muscle, the mean values of the CSA of the right and left sides were calculated and used for regression analyses of the relationships between CSA variables and MV100m. RESULTS: Stepwise multiple-regression analyses produced prediction equations of MV100m with independent variables of QF CSA at the midthigh and

PM-to-QF CSA ratio at the upper thigh for boys (R = 0.38) and PM-to-QF CSA ratio at the midthigh for girls (R = 0.33). In the regression model for boys, QF CSA at the midthigh had a negative regression coefficient. CONCLUSION: For junior sprinters of both genders, the higher development of PM relative to QF, rather than absolute muscle size, is a factor in achieving a better performance in 100-m race performance.

Hu H, Meijer OG, et al. (2010). Is the psoas a hip flexor in the active straight leg raise? Eur Spine J.

Psoas function is a topic of considerable relevance in sports and clinical science. However, the literature on psoas function is not sufficiently consistent. Questions are, amongst others, if during hip flexion the psoas always has the same function as the iliacus, and if the psoas affects the hip more than the lumbar spine. In the present study, 17 healthy women, 20-40 years, performed the active straight leg raise (ASLR), with the right or the left leg ("Side"), and without or with weight added above the ankle ("Condition"). Electromyographic (EMG) activity of psoas and iliacus were recorded with fine-wire electrodes, and of rectus femoris and adductor longus with surface electrodes, all on the right side. Movements of the leg were recorded with active markers and a camera system. During ASLR, the iliacus, rectus femoris, adductor longus and psoas were active ipsilaterally, but psoas was also active contralaterally. All muscles started to contract before movement onset, the iliacus, rectus femoris, and adductor longus largely at the same time, before the psoas. There was no significant difference between the amplitude or time of onset of ipsilateral and contralateral psoas EMG activity, nor was there a significant interaction between Side and Condition for the psoas. Although ipsilateral psoas activity is consistent with the psoas being a hip flexor, contralateral activity is not. The most simplest explanation of the pattern found is that the psoas is bilaterally recruited to stabilize the lumbar spine, probably in the frontal plane.

Jemmett RS, Macdonald DA, et al. (2004). Anatomical relationships between selected segmental muscles of the lumbar spine in the context of multi-planar segmental motion: a preliminary investigation. Man Ther **9**(4): 203-210.

In the last decade, concepts regarding spinal stability have been redefined. Whereas traditional stability models considered only the integrity of the intervertebral disc and spinal ligaments, mechanisms contributing to spinal stability are now thought to include neural and muscular elements. Lumbar muscles capable of generating intersegmental stiffness are considered necessary for the control of multi-planar segmental spinal motion. The transversus abdominis, psoas, quadratus lumborum and multifidus have each been described functionally as contributing to segmental motion control in the lumbar spine. However, the fundamental anatomy of these muscles has not been fully established nor have their architectural characteristics as a functional group been explored. A dissection of the lumbar spine was undertaken to document the attachments of the deep vertebral muscles and illustrate their group architectural characteristics in the context of multi-planar segmental motion. The transversus abdominis, psoas, quadratus lumborum and multifidus were each noted to have segmental attachment patterns in the lumbar spine. As a group, they surround the lumbar motion segments from the anterolateral aspect of a vertebral body to the spinous process. A hypothetical role for this muscle group in maintaining lumbar spine stability is discussed as are suggestions for future research.

Kirchmair L, Lirk P, et al. (2008). Lumbar plexus and psoas major muscle: not always as expected. Reg Anesth Pain Med **33**(2): 109-114.

Background and Objectives: Conflicting definitions concerning the exact location of the lumbar plexus have been proposed. The present study was carried out to detect anatomical variants regarding the topographical relation between the lumbar plexus and the psoas major muscle as well as lumbar plexus anatomy at the L4-L5 level. Methods: Sixty-three lumbar plexuses from 32 embalmed cadavers were dissected to determine the topographical relation between lumbar plexus and psoas major muscle. At the L4-L5 levels variability in the course of the femoral as well as obturator nerve were described. Results: The lumbar plexus was situated within the psoas major muscle in 61 of 63 cases. In 2 of 63 cases the entire plexus was localized posterior to the psoas major muscle. In the 61 of 63 cases in which the lumbar plexus was situated within the psoas major muscle, emergence of the individual nerves most often occurred on the posterior or posterolateral surface. Conclusions: The results synthesize contrasting assumptions in previous literature, by demonstrating that both locations of the lumbar plexus may be encountered in clinical practice: within and posterior to the psoas major muscle. However, the latter situation represents a minor variant. At the level of L4-L5 the femoral nerve, showing a remarkable degree of branching, as well as the obturator nerve, were found within the psoas major muscle in the vast majority of specimens.

Kubo T, Muramatsu M, et al. (2010). Profiles of trunk and thigh muscularity in youth and professional soccer players. J Strength Cond Res **24**(6): 1472-1479.

Soccer is similar to dance in the sense that performance requires strength in the lower extremities and the trunk. Differences seen in muscle cross sectional area in youth verse professional soccer players may also be seen in youth verse professional dancers. The present study aimed to examine the influence of lateral dominance for ball kicking on the cross-sectional areas (CSAs) of thigh and trunk muscles in Japanese elite youth and professional soccer players, and to clarify the difference between the 2 groups in the muscle CSAs of the 2 body segments in relation to that in lean body mass (LBM). The CSAs of 4 (rectus abdominis, oblique, psoas major, and erector spinae) and 3 (quadriceps femoris, hamstrings, and adductors) muscle groups located in the trunk and thigh, respectively, were determined in 18 youth players (16.8+/-0.6 years) and 17 professional players (23.7+/-3.1 years) using magnetic resonance imaging. In youth and professional players, no significant effect of lateral dominance was found in the CSA of any muscle group. In all muscle groups except for the erector spinae, the CSAs were significantly greater in the professional players than in the youth players. The CSA of every muscle group was significantly correlated to the two-thirds power of LBM (LBM). In terms of the ratio of CSA to LBM, only the psoas major was significantly greater in the professionals. In conclusion, Japanese youth and professional soccer players did not exhibit bilateral asymmetry in the CSAs of thigh and trunk muscles, and the professional players had more developed psoas major muscle as compared with youth players even when matched for whole-body lean tissue mass. The current results suggest that for soccer players with bilateral asymmetry in the muscularity of the thighs and trunk, personalized strength programs for developing symmetry are recommended, and exercises involving hip flexion should be incorporated progressively into individual strength and conditioning programs.

Penning L (2000). Psoas muscle and lumbar spine stability: a concept uniting existing controversies. Critical review and hypothesis. Eur Spine J **9**(6): 577-585.

Psoas muscle (PM) function with regard to the lumbar spine (LS) is disputed. Electromyographic studies attribute to the PM a possible role as stabilizer. Anatomical textbooks describe the PM as an LS flexor, but not a stabilizer. According to more recent anatomical studies, the PM does not act on the LS, because it tends to pull the LS into more lordosis by simultaneously flexing the lower and extending the upper region, but due to the short moment arms of its fascicles, this would require maximal muscular effort and would expose the LS motion segments to dangerous compression and shear. The findings of the present study indicate that the described opposite action of the PM on upper and lower LS regions, performed passively and requiring minimal muscular effort, may serve to stabilize the LS in an upright stance. It was demonstrated that a vertically placed elastic metal strip, modelled into a lordotic configuration to imitate the LS, will be brought into more lordosis,

with maintenance of vertical position, if a string fastened at its upper end is pulled downward in a very specific direction. Conversely, any increase of lordosis of the strip brought about by vertical downward pushing of its top, will be stabilized by tightening the pulling string in the same specific direction. As this direction corresponded with the psoas orientation, the experiments show that the PM probably functions as a stabilizer of the lordotic LS in an upright stance by adapting the state of contraction of each of its fascicles to the momentary degree of lordosis imposed by factors outside the LS, such as general posture, general muscle activity and weight bearing. The presence of multiple PM fascicles, all of about equal length, and attaching to all LS levels, facilitates this function.

Sajko, S. and K. Stuber (2009). "Psoas Major: a case report and review of its anatomy, biomechanics, and clinical implications." J Can Chiropr Assoc **53**(4): 311-318.

A 25-year-old male professional hockey player with right-sided hip pain was diagnosed with myofascopathy 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.

Skyrme AD, Cahill DJ, et al. (1999). Psoas major and its controversial rotational action. Clin Anat **12**(4): 264-265.

The action of psoas major muscle as a primary flexor of the hip joint is undisputed. However it is also variably reported as being a medial and a lateral rotator of the femur at the hip joint. The psoas and iliacus muscles, along with their common insertion, were isolated by dissection in six adult cadaveric specimens. The action of psoas muscle was assessed by pulling the muscle along its long axis and then observing the effects on rotation of the femur, with a visual estimation of the rotation in degrees. The experiment was repeated with the hip joint capsule removed. In the anatomical position, applied traction along the long axis of the muscle produced hip flexion with no rotational component. With the hip in the abducted position, traction produced flexion, adduction, and lateral rotation of the femur at the hip joint. In adduction of the hip, traction on psoas produced only flexion at the hip joint, with no rotation. In maximal flexion, traction also produced adduction. The results were unaffected by the removal of the joint capsule.

Takahashi K, Takahashi HE, et al. (2006). Different changes of quantity due to aging in the psoas major and quadriceps femoris muscles in women. J Musculoskelet Neuronal Interact **6**(2): 201-205.

Understanding how the psoas major's cross sectional area changes with age can help us better understand the physiological changes occuring in the adult dancer population. The study examined changes due to aging in the size of the psoas major compared with changes in the quadriceps femoris. The participants (n=210) were exclusively women ranging in age from 20 to 79 and divided into 6 age groups (n=35 each) in 10-year increments. Cross-sectional areas of the two muscles were measured by an MR scanner for a comparative estimation of muscle size. The psoas major showed the greatest quantity in subjects in their 20s, after which it declined steadily until the 60s and dramatically in the 70s, while the area of the quadriceps femoris was preserved until the 40s and showed no dramatic later decline. Exercise beyond regular daily activities is recommended to prevent the psoas major from decreasing in volume. It was also recommended to develop a method of maintaining psoas major's muscle volume which would target women younger than 40 and older than 60.

Yoshio M, Murakami G, et al. (2002). The function of the psoas major muscle: passive kinetics and morphological studies using donated cadavers. J Orthop Sci **7**(2): 199-207.

This study was carried out to analyze the phasic heterogeneity in the function of the psoas major muscle (PMM) depending on the flexion angle at the hip joint. The study design was a passive kinetic experiment using 25 osteoligamentous specimens with the PMM tendon. We measured the flexion angle of the hip joint where the PMM tendon loses contact with the femoral head and pelvic surface. Ten osteoligamentous specimens were used for additional measurements of the tensile force and pressure exerted on the PMM and/or at the bone-tendon interface when the PMM tendon was gently pulled in line with the PMM origin in the supine position. The tension loading the PMM tendon was measured at seven different angled positions of hip joint flexion (0 degrees, 15 degrees, 30 degrees, 45 degrees, 60 degrees, 75 degrees, and 90 degrees), using a load cell attached to a traction appliance. The pressure was measured at each of eight sites along the long axis of the PMM, using a pressure sensor. The PMM tendon lost contact with the femoral head at angled positions of 14 degrees (average) hip flexion, and lost contact with the iliopectineal eminence at positions of 54 degrees (average). The tension was stronger at angled positions of 0 degrees -30 degrees at the hip joint. The pressure on the femoral head and pelvic surface were stronger at positions of 0 degrees -30 degrees at the hip joint. The pressure on the femoral head was strongest at a hip flexion of 0 degrees. The tensile force markedly decreased at 45 degrees -60 degrees flexion at the hip joint, while the pressure on the femoral head gradually reduced to zero in the same phases. We concluded that the PMM works phasically: (1) as an erector of the lumbar vertebral column, as well as a stabilizer of the femoral head in the acetabulum at 0 degrees -15 degrees flexion at the hip joint; (2) less as a stabilizer, in contrast to maintaining its erector action, at 15 degrees -45 degrees; and (3) as an effective flexor of the lower extremity, at 45 degrees -60 degrees.