PASIG MONTHLY CITATION BLAST: No.15 **October 2006**

Dear PASIG members:

This month's Citation BLAST continues our special topic series: *assessing and training core control*, contributed by former PASIG President, Jennifer Gamboa DPT, OCS, MTC. The format is an annotated bibliography of articles on the selected topic from 1996 – 2006. Special topics are targeted periodically throughout the year. If you'd like to suggest a topic or create one, please let me know.

As a reminder, each month's citations will be added to specific EndNote libraries: 1) Ice Skating, 2) Gymnastics, 3) Music, and 4) Dance. This particular topic will be kept in a separate library, as it applies to all of our performing arts populations. The updated libraries are posted on the PASIG webpage for our members to access and download. (Information about EndNote referencing software can be found at http://www.endnote.com, including a 30-day free trial).

Don't forget, the PASIG sponsors an annual student research scholarship. There's still time for students to apply: our deadline is November 15th. This award is to recognize students, who have had an abstract accepted to CSM, for their contribution to performing arts research. For more information on the research award please check our webpage (www.orthopt.org/sig_pa.php).

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

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SPECIAL TOPIC: ASSESSING AND TRAINING CORE CONTROL

Core trunk control is considered a critical element in the prevention and rehabilitation of low back pain as well as many other injuries. Certainly, many performing artist-related injuries are associated with impaired core control or stability. Despite the prominence of core control in our discussions of the risk for, and the rehabilitation and prevention of injuries, there is no common language for defining or measuring core control/stability. Furthermore, there are many different philosophies pertaining to re-establishing core control with limited evidence beyond expert opinion to help us discern the most effective intervention strategies. The following articles have been collected with those difficulties in mind. While none of these articles are seminal, they lay critical groundwork needed to begin building the evidence to support or refute many intuitive practices of performing arts physical therapists. I hope you find them as interesting as I did.

Jennifer M. Gamboa DPT, OCS, MTC

I. Defining Core Stability

Leetun DT, Ireland ML, Willson JD, Ballantyne BT, Davis IM, (2004). Core stability measures as risk factors for lower extremity injury in athletes. Med Sci Sports Exerc 36(6):926-934.

Decreased lumbo-pelvic stability has been suggested to contribute to the etiology of lower extremity injuries, particularly in females. This prospective, non-randomized cohort study compares core stability measures between genders, as well as, between athletes reporting lower extremity injuries and those reporting no injuries. In addition, this study attempts to identify the combination of strength measures that could be used to predict those athletes at risk for lower extremity injuries. Data were collected from 140 subjects over a two year period at six universities. Eighty female and sixty male athletes (mean age = 19) participating in varsity intercollegiate baseball or cross-country were assessed within the first two weeks of the start of their season. Five measures of core stability were collected, including the strength or endurance of hip abductors, hip external rotators, side bridging, trunk extension, and anterior trunk flexors. Injuries were then tracked for one athletic season, and defined as an event that occurred during participation in the sport which required treatment of a care provider and one full day of missed practice or sports participation. Male athletes had greater core stability than the females, with significance found in hip abduction, hip external rotation, and side bridging. Injured athletes had lower core stability than non-injured with significance found in hip abduction and external rotation. A backward logistical regression identified poor hip external rotation strength as a significant predictor of injury. This study provides a specific and reproducible definition of core stability that is based on tests and measures already found to be reliable in the literature. This study could easily be reproduced using performing artist athletes. Such a study would provide an excellent baseline against which to assess and re-assess core stability, and further define the risk relationship between core stability and injury.

II. Effectiveness of Interventions

Escamilla RF Babb E, DeWitt R, Jew P, Kelleher P, Burnham T, et al. (2006). Electromyographic analysis of traditional and non-traditional abdominal exercises: Implications for rehabilitation and training. Phys Ther 86(5):656-671.

These authors attempt to address the suggestion that non-traditional abdominal exercises are equally or more effective than traditional crunches and bent-knee sit-ups at activating abdominal muscles and other trunk stabilizers. The authors defined ten non-traditional abdominal exercises using devices such as abdominal straps (for free hanging knee-ups), the Power Wheel (comparable to many reformer exercises), and the Ab Revolutionizer, as well as, reverse crunches on level and incline surfaces. Using EMG surface electromyography, the authors

assessed the muscle activity of the upper and lower rectus abdominis, external and internal obliques, rectus femoris, latissimus dorsi, and lumbar paraspinals of 21 male and female subjects while performing the ten non-traditional and the two traditional abdominal exercises. EMG data were normalized to maximum voluntary muscle contractions. Of all the exercises, the Power Wheel (pike to plank, leg kick backs to plank, and kneeling roll-out to plank), the hanging knee-ups with body weight suspended from straps, and the reverse crunch on a 30° incline were most effective at activating abdominal musculature as well as other trunk stabilizers. The Power Wheel kneeling roll-out was most effective at recruiting abdominal and latissimus activity, while minimizing lumbar paraspinal and rectus femoris activity (in contrast to the other "effective" exercises which had relatively high levels of rectus femoris activity). While these authors did not directly measure Pilates-specific exercises, many of the movements and outside resistance used in the non-traditional exercises emulate Pilates execises on the reformer. This small cohort study begins to lay a foundation for measuring the effectiveness of non-traditional approaches to core control/stability re-education. Once again, this study could easily be reproduced to assess the effectiveness of pilates-based exercises.

Kofotolis N, Kellis E (2006). Effects of two 4-week proprioceptive neuromuscular facilitation programs on muscle endurance, flexibility, and functional performance in women with chronic low back pain. Phys Ther 86(7):1001-1012.

These authors also attempt to quantify the effectiveness of non-traditional trunk control exercises. In this case, the authors use static and dynamic trunk muscle endurance, lumbar mobility, disability, and back pain intensity to assess the improvement in functional performance following two 4-week proprioceptive neuromuscular facilitation programs. Eighty-six women with complaints of chronic low back pain where randomly placed into one of three groups: rhythmic stabilization (static PNF), combined isotonic exercises (dynamic PNF), and a control group (no structured exercise). A multivariate analysis of variance indicated that both training groups demonstrated significant improvements in lumbar mobility, static and dynamic endurance, and Oswestry Index measurements. The importance of this paper is not so much in its significant findings, as one would hope that intervention versus no intervention produces a significant outcome. Rather, the importance is in this study's presentation of a clearly reproducible methodology for assessing functional outcomes that are relevant to a performing arts population. The authors' outcome measures could easily be applied to assess the effectiveness of multiple non-traditional and traditional approaches to core control.

Vera-Garcia FJ, Grenier S, McGill SM (2000). Abdominal muscle response during curl-ups on both stable and labile surfaces. Phys Ther 80(6):564-569.

The purpose of this study was to establish the degree of influence the type of surface (stable or labile) has on the muscle activation of the abdominals. Eight male volunteers were asked to perform four differenct curl-up exercises – 1 on a stable surface and the other 3 on varying labile surfaces. Surface EMG data were recorded from four different abdominal sites on the right and left sides of the body, and normalized for maximum voluntary muscle contraction amplitudes. Performing the curl-ups on a labile surface increased rectus abdominus activity two-fold, while specifically performing the curl up over a gym ball with the feet on the floor, increased external oblique activity four-fold. For all exercises, the rectus was more active than the obliques. Although this is a small, sample of convenience cohort, this study does support the use of proprioceptively-challenging devices to re-acquire core control.

Koumantakis GA Watson PJ, Oldham JA (2005). Trunk muscle stabilzation training plus general exercise versus general exercise only: Randomized controlled trial of patients with recurrent low back pain. Phys Ther 85(3):209-225.

This is an interesting study that, at first glance, seems to negate specific patient education regarding the lumbar protective mechanism, the importance of early integration of functional tasks, and the role that verbal and tactile cuing may play in treating patients with low back pain.

The purpose of this randomized controlled trial was to examine the usefulness of the addition of specific stabilization exercises to a general back and abdominal muscle exercise approach for patients with subacute or chronic non-specific low back pain. Patients with previous spine surgery, serious spine pathology or nerve root pain, or signs and symptoms of instability were excluded from the study. Otherwise, 55 patients with recurrent, nonspecific low back pain were recruited and randomly assigned to one of two 8 week treatment groups. Both groups received exercise intervention and written advice. The general exercise only group received progressive therapeutic exercise for trunk flexion and extension, hip abduction and extension, and side bridges that progressed from stable to labile surfaces. Patients were progressed to next level of exercise based on correct and symptom-free performance of previous stage (according to an experienced therapists judgment). The stabilization-enhanced group received additional patient education regarding local stabilizing muscles, early integration of functional kneeling, sitting, and standing tasks, and specific auditory and tactile cuing for correct activation of stabilizing musculature. Patients were progressed to the next stage based on successful co-contraction of transverse abdominus and opposite lumbar multifidus as determined by tactile cuing from treating therapist. Outcomes were based on self-reported pain, disability, and cognitive status measured immediately before and after intervention, and 3 months after the end of the intervention period. The authors found that the outcome measures improved in both groups, the self-reported disability was better immediately following intervention with the general exercise only group, but that no difference existed at the 3 month mark, and that no other differences could be discerned between the two groups. The authors concluded that stabilization-enhanced exercises do not appear to provide additional benefit to patients with subacute or chronic low back pain who have no clinical signs or symptoms suggesting the presence of spinal instability. This study is important because of its problems, and the potential for its use to refute the importance of specific neuromuscular re-education. Among the major issues with this study is the lack of functional or performance-based outcome measures. Subjective changes in patients with chronic low back pain are very difficult to discern, and self-reported measures may not be sensitive enough to identify significant between group differences. Second, the stabilization-enhanced group's exercises were not progressed to the same level of difficulty as the general exercise-only group. Both groups received 8 weeks of training, two times per week. While there was more time spent on education, neuromuscular re-education, and cuing in the stabilization-enhanced group, the physiological demands placed on this group were less than the general exercise-only group. This study raises an interesting question as to the importance of specific neuromuscular and functional re-education, but to thoroughly test the question, the muscular strength and endurance demands must be the same for both groups, and functional/performance-based outcome measures must be included in a between group analysis

Karst GM, Willet GM (2004). Effects of specific exercise instructions on abdominal muscle activity during trunk curl exercises. J Orthop Sports Phys Ther 34(1):4-12.

In contrast with the previous study, these authors found that auditory cuing in the form of specific exercise instruction did have a significant positive effect. In this case, a convenience sample of 25 subjects performed truck curl exercises in accordance with 3 different sets of instructions: non-specific, instructions that emphasized rectur abdominis, and instructions that emphasized obliques. Surface EMG activity was recorded from the upper and lower rectus and the internal and external obliques. Following a single, brief instruction session, subjects demonstrated significantly greater normalized oblique:rectus EMG ratios when following the oblique instructions. Retesting one week later indicated that subjects had retained this skill. While this study does not have the same scientific rigor as a randomized controlled trial, the measurement of abdominal activation patterns may be more sensitive to "stabilization-enhanced" program than self-reported measures. However, this study also needs to be carried further to investigate whether specific auditory cuing translates into better functional/performance-based outcomes as well as better muscle activation patterns.

Hides J, Wilson S, Stanton W, McMahon S, Keto H, McMahon E, Bryant M, Richardson C (2006). An MRI investigation into the function of the tranversus abdominis muscle during "drawing-in" of the abdominal wall. Spine 31(6):E175-178.

The purpose of this study was to investigate the function of the transversus abdominis muscle during an abdominal drawing in maneuver, and to validate the use of real-time ultrasound imaging as a measure of the transversesus abdominis during the same maneuver. Thirteen healthy asymptomatic male elite cricket players aged 21.3 (+/- 2.1) years were imaged using MRI and ultrasound imaging as they performed an abdominal drawing-in maneuver. Measurement of the whole abdominal cross-sectional area was conducted using MRI. The results demonstrated that there was a significant increase in the thickness of the transversus abdominis and the internal oblique muscles, and a significant decrease in the cross-sectional area of the abdominal wall suggesting that the transverses abdominiss contracts bilaterally to form a musculofascial band that appears to tighten (like a corset). Real-time ultrasound imaging of the muscle thickness of both the transversus abdominis and the internal obliques as well as fascial slide correlated with measures obtained using MRI (interclass correlations from .78 to .95). This study is relevant to the performing arts population because of our tendency to emphasize the neuromuscular re-education of the transversus abdominis. Futhermore, real-time ultrasound may ultimately prove to be a viable clinical biofeedback/training tool to successfully enhance trunk stabilization and core control re-education.

Drysdale CL, Earl JE, Hertel J (2004). Surface electromyographic activity of the abdominal muscles during pelvic-tilt and abdominal-hollowing exercises. J Athletic Training 39(1):32-36.

This is another study that speaks to traditional versus enhanced trunk stabilization exercises as the authors investigated the differences in muscle activation patterns of the rectus abdominus and external obliques in 26 healthy, active adult females during pelvic tilt and abdominal hollowing exercises. Surface EMG activity was recorded from left and right rectus abdominis and external oblique muscles while the 2 exercises (pelvic tilt and abdominal hallowing) were performed in each of three conditions: hooklying, hips and knees at 90°/90° with support under legs, and hips and knees at 90°/90° without external support. The authors found that abdominal hallowing produced significantly less muscle activity for both the rectus and the external obliques as compared to the pelvic tilt, although the greatest activity for both muscle groups was found in the unsupported 90°/90° position. The authors concluded that abdominal hallowing produced less rectus abdominis and external oblique activity than did pelvic titlting, and thus, may be used to enhance stabilization by minimizing the activiation of large global abdominal muscles. This study is particularly interesting because the authors collected similar EMG data as previous studies, but equated less EMG activity with improved efforts to re-educate trunk control. This study is one of many that highlights the lack of agreement in the literature as to what constitutes appropriate muscle activation patterns for optimal trunk control. Without that agreement, it is difficult to assess the effectiveness of any intervention program, much less distinguish subtleties between interventions.

Stevens VK, Bouche KG, Mahieu NN, Coorevits PL, Vanderstraeten GG, Danneels LA (2006). Trunk muscle activity in heatlhy subjects during bridging stabilization exercises. BMC Musculoskeletal Disorders 7(75):1471-2474.

These authors attempt to address the debate that exists regarding the anatomical classification and function of local and global trunk muscles as related to segmental stabilization, torque production, and general trunk stability. Is the goal of stabilization/trunk control to minimize rectus abdominis activity, or is there some acceptable and necessary interplay between local and global muscle activity? The purposes of this study were to investigate the relative activity levels of local and global muscles (as a percentage of maximal voluntary isometric contraction -- MVIC), as well as, the ratios of local to global muscle activity during bridging stabilization exercises. Thirty healthy university students (15 male, 15 female, mean age 19.6 years)

volunteered to perform 3 bridging exercises (bridging, bridging with a ball under legs, and unilateral bridging). Surface EMG electrodes were attached to local trunk muscles (inferior fibers internal obliques, lumbar multifidus, and lumbar portion of the iliocostalis lumborum, as well as, global trunk muscles (rectus abdominus, external obliques, and the thoracic portion of the iliocostalis lumborum). The methods section of this study clearly articulates the rationale for classifying muscles as either local or global, and is worth reading just to enhance clinical understanding and implications of local vs. global locus of control. The authors found that the relative activity of local and global abdominal muscles and their associated activity ratios changed depending on the stability demands of the exercise. Bridging required relatively little activation of both local and global abdominal muscles. IO activation was about 3% of MVIC, while RA activation was less than 1%. Because RA activity was so low, the IO/RA activation ratio was quite high, but should not be misconstrued as high abdominal demand. Local and global demand of trunk extensors during bridging was similar (about 8% of MVIC), and so the ratio of relative contribution of each was 1. These findings fit well within a larger literature context, which suggests that for most tasks of daily living, modest levels of abdominal wall co-contraction and 1to 3% of MVIC intersegmental activation are sufficient for dynamic stability. Furthermore, during many different tasks, all back muscle contribute in a similar way to control spine position and movement. As bridging progessed to a labile surface (the ball), EO activation was significantly higher than the IO, so that the IO/EO, or local/global, ration was less than 1. These results are in accordance with other literature, and the authors suggest that the global torque of the EO may be necessary to prevent limbs from rolling off the ball. RA activity remained low (1% MVIC), and local/global trunk activation was similar as simple bridging (9 to 10% MVIC with a ratio of relative contribution at about 1). During unilateral bridging, the local/global muscle activation demands were more complex. Ipsilateral local control (IO) and contralateral global control (EO) were necessary to produce segmental stability. Aside from very interesting findings, this study is powerful because it provides a template for investigating our assumptions about many of the non-traditional exercises that we using in performing arts rehabilitation to facilitate improved core control and/or dynamic stability.

MacDonald DA, Moseley GL, Hodges PW (2006). The lumbar multifidus: Does the evidence support clinical beliefs. Manual Therapy In press.

This paper reviews the biomechanical, electromyographic, histochemical and morphological evidence behind five clinical assumptions the role of the multifidus in spinal stability. The assumptions addressed are: 1) the deep fibers of the mutlifidus stabilize the spine while the superficial fibers and the erector spinae extend and rotate the spine; 2) the deep fibers have a greater percentage of slow twitch fibers than the superficial fibers and the erector spinae; 3) the deep fibers are tonically active during movements of the trunk and gait, whereas the superficial fibers and the erector spinae are phasically active; 4) the deep fibers and the transverse abdominis co-contract during function; and 5) the changes in lumbar paraspinals that occur with low back pain affect the deep fibers more than the superficial fibers or the erector spinae. The authors conclude the following. One, the preponderance of anatomical and biomechanical evidence indicates that the deep and superficial fibers of the multifidus as well as the erector spinae control segmental motion (which dovetails nicely with the previous study in this bibliography). Two, EMG studies refute the belief that the deep fibers are tonically active during static postures, trunk movements, and gait. Therefore, training tonic activity of the multifidus is unlikely to restore function. Three, the deep fibers and the transverse abdominis do not maintain tonic co-contraction. Thus, training co-contraction of deep fibers and the transverse abdominis is unlikely to restore typical function, but may be required to compensate for an underlying osseoligamentous deficit to restore intervertebral control. Four, deep and superficial fibers of the multifidus and the erector spinae all have a preponderance of slow twitch (type I) muscle fibers, although more data needs to be collected from health subjects as opposed to cadavers or surgical patients. Thus, the clinical implications of variable muscle fiber characteristics cannot be determined. Five, although the histochemical and morphological evidence is incomplete at this time, there is good evidence to support that exercises which target the deep fibers of the

multifidus are effective at reducing the recurrence rate of LBP following the first acute episode, and as part of the multi-modal management of moderately disabled patients with chronic LBP.

III. Tests and Measures

Ladeira CE, Hess LW, Galin BM, Fradera S, Harkness MA (2005). Validation of an abdominal muscle strength test with dynamometry. J Strength Conditioning Research 19(4):925-930.

This article is relevant because it speaks to a test that is commonly used in screening environments to quickly assess abdominal strength. These authors looked at the reliability and validity of the double leg lowering maneuver (DLLM) as described by Kendall. Four evaluators examined 28 subjects. The validity of the DLLM was evaluated with the Nicholas Hand-Held Dynamometer (NHHD) as the gold standard. The DLLM scores were compared to themselves for reliability and to the NHHD scores for validity. The reliability for the DLLM was very high (r=0.932), but the validity was very low (r=-0.338 to -0.446). These authors conclude that the DLLM should not be used to assess muscle strength, but may have utility in assessing pelvic tilt motor control.

IV. Miscellaneous

Gill NW, Teyhen DS, Lee IE (2006). Improved contraction of the transversus addominis immediately following spinal manipulation: A case study using real-time ultrasound imaging. Manual Therapy In press.

This case study was undertaken when the authors encountered a clinical dilemma while attempting to apply to clinical prediction rule for manipulation to a patient with a history and physical examination consistent with clinical lumbar instability. The patient in this case was a 43-year-old male with a 30-day history of right low back pain and diffuse, posterior right thigh pain to the knee. During exam, he was found to have four of five criteria that predict short term success with spinal manipulation, but was also found to have signs suggestive of clinical instability. Pre-manipulation, the patient underwent transverse abdominis training using the abdominal drawing-in maneuver and ultrasound images were obtained to measure the TrA muscle thickness. The regional lumbo-pelvic manipulaton used to develop the above-mentioned clinical prediction rule was then performed and was followed by another series of ultrasound images to determine TrA thickness. The results document a dramatic change in the patient's ability to perform preferential TrA contraction during an abdominal drawing in maneuver immediately following spinal manipulation. While manipulating a patient with signs of clinical instability appears to be counterintuitive, it may, indeed, be a reasonable treatment option in order to facilitate stabilization exercises.