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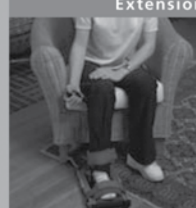

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To serve as an advocate and resource for the practice of Orthopaedic Physical Therapy by fostering quality patient/client care and promoting professional growth.

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Editor's Message

Christopher Hughes, PT, PhD, OCS

Looking Back to Move Forward

Once again summer has come and gone and we now enter into the fall season. Kids go back to school, clinic schedules go back to normal after juggling summer vacation vacancies, and if you are in academia a new group of students enter into PT school.

Sometimes time has a way of slipping by regardless of whether you are involved in research, practice, or education. I think you all know what I mean. In the famous quote of Ferris Bueller: "Life moves pretty fast. If you don't stop and look around once in a while, you could miss it."

How true this is. As clinicians we often we get so busy in treating patients that we rarely have time to really reflect on what we are doing or what comes before us. The importance of reflection is a vital part of the learning process. However I think physical therapists are taught or are so accustomed to be continuously in "action mode" that they rarely are afforded this critical part of the learning process. If we are not careful our work can become too "reflexive" not affording us the time to really step back and look at patient problems in a different way or even apply current evidence into practice. Therapists can be creatures of habit and it is this habit that sometimes can come back to haunt us by limiting opportunities for productive change both from a treatment standpoint and also from a professional development standpoint.

I remember reading a psychology text in the late 70s and I have never forgotten the one message from the author. He stated that every time we act we reinforce the idea or motivation behind that act. What a true statement. In essence it is not the action that leads to habitual behavior but the intent underlying the action that serves as the powerful reinforcer. One needs only to look at the current literature on fear avoidance behavior and low back pain to appreciate the power of such a phenomena in clinical practice.[1,2]

Old habits are hard to break. As we (the profession and the public at large) anxiously await what lies ahead in proposed changes to the health care system, one can only imagine how the cards will fall and where the profession will be in the next 5 to 10 years. Will we be in a better or worse practice environment? How will the profession adapt to change? One thing is for certain change is coming and I think the best defense is a good offense. It is up to each one of us to stay on top of change and be ready to position ourselves for what may be the biggest change in health care since the introduction of managed care.

The late astrophysicist Stephen W. Hawking has been quoted as saying "Intelligence is the ability to adapt to change." I think such a statement is very fitting given today's challenges in health care. If we are to survive and thrive as a profession to meet the needs of the public we have to be willing to reinvent, critically analyze, and reflect on who we are as a profession and how can we fit into any new health care model. As individuals we need to educate our patients, communicate with our legislators, and continually strive to improve the evidence underlying our practice to make sure everyone knows the unique services we provide. There are many fronts from which we can make a difference. We need to "raise the bar" of our educational programs to put out quality therapists, support research that results in improved patient care, provide professional support to fellow clinicians and stand together on important causes. We also need to seek collaborative partnerships that strengthen, not weaken, our most critical causes.

In October the Orthopaedic Section leadership will once again convene for a strategic planning session to determine how on target we have been on previous initiatives and also create new ones. In order to chart a viable future course, it is imperative to take the time to reflect back on previous efforts. Again, reflection can afford the chance to more thoroughly recognize where we have been and where we are going.

As a clinician the fall season can be a good time to take some time to see where you are professionally and compare it to where you would like to be. As a new grad, have you been able to meet your short-term goals? As an experienced clinician, have you been able to continually grow professionally and use your talents in the most beneficial ways? Does the practice of PT still excite you? Are my career goals congruent with the profession's goals? These are important questions to ask; and as Editor of OP myself, the remaining staff and Board members will be looking at ways to meet your needs by putting out the best publication we can. As a member, I encourage you to provide input and also be a contributor to *OP*? We have been very fortunate this past year. Article submissions are up and I believe our quality of publication continues to improve. I am grateful for the efforts of our past authors and also to our advertisers who are willing to support *OP*. I look forward to another productive year as *OP* Editor. I am privileged to serve and will do my best to meet your needs in the areas of practice, education, and research.

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President's Corner

James J. Irrgang, PT, PhD, ATC, FAPTA

Fall 2009

I hope your fall is going well and that your favorite football team has been winning!

For many, 2009 has been a challenging year, but the horizon appears to be brighter. Overall, the Orthopaedic Section has weathered the challenging financial times as well as can be expected. Membership continues to be strong, which is important to advance the mission and vision of the Section. Like many, our reserve and research endowment funds saw decreases in value, but due to the efforts of our Treasurer, Steve Clark, and our financial advisors we were able to minimize our losses and since the lows in March, we have experienced some recovery of those losses. Our reserve fund continues to exceed the recommended levels and our operating income continues to exceed our expenses.

The following is a brief summary of some of the Section's ongoing initiatives:

ICF Based Clinical Practice Guidelines – Under the leadership of Joe Godges, the Section has published clinical practices guidelines related to plantar fasciitis/heel pain, neck pain, and hip osteoarthritis. By the end of 2009, guidelines related to low back pain, knee ligament insufficiency, and Achilles tendinopathy will be completed. Additional guidelines that are under development and scheduled to be completed in 2010 include knee meniscus and articular cartilage, rotator cuff and impingement syndrome, frozen shoulder, and hip labral injuries. Completed guidelines have and will continue to be published in the **Journal of Orthopaedic and Sports Physical Therapy (JOSPT)**. To maximize dissemination of the guidelines, the guidelines are available via open access so that they are available to nonsubscribers of **JOSPT**. Additionally efforts are underway to have the guidelines available through Guidelines.gov. To bring the guidelines to "life," the Section is planning to create narrated presentations that include videos of examination and intervention procedures, which will be available to Section members via the Section Web site.

Promotion and Development of Orthopaedic Residencies – Tara Jo Manal and Jason Tonley have led the Section's efforts to promote the development of orthopaedic residencies. Responses from a survey conducted earlier this year indicate that Section members have a substantial interest in orthopaedic residencies; however, barriers to establishing a residency include curriculum development and understanding viable financial models. To address the issues related to curriculum development, the Section has created "Curriculum in a Can" that consists of Independent Study Courses published by the Section, written examinations, and tools for evaluating resident performance. Independent study courses to support the didactic component of a residency are available at discounted rates for residents that are members of the Section. The Section has also sponsored programming at the 2009 Combined Sections and APTA Annual Meetings to provide those interested in developing residency programs with information that can be used to plan and develop a program and facilitate completion of the application for credentialing by the APTA. Similar programming will be offered as a preconference course at the 2010 Combined Sections Meeting in San Diego.

Clinical Research Grants – The Section continues to provide funding to any Orthopaedic Section member who has the clinical resources to examine a well-defined clinical practice issue, but who needs external funding to facilitate completion of the project. This year, the Section will offer grants for new investigators as well as unrestricted grants. New investigator grants are for individuals who have not received any federal or national competitive grants, excluding grants or scholarships designed only for doctoral students, such as the PODS from the Foundation for Physical Therapy. New investigators can request up to $15,000. These grants are intended to encourage and support new investigators who have not previously received grant funding. Any Section member can submit a proposal for an unrestricted grant for up to $25,000. The deadline for submission of 2010 grants is November 11, 2009. Additional information regarding the Orthopaedic Section Research Grant program can be found at: http://www.orthopt.org/research.php.

Foot and Ankle Clinical Research Grant – In addition to the grants described above, the Foot and Ankle Special Interest Group is sponsoring a grant to support clinical research related to the foot and ankle. Any Orthopaedic Section member can submit an application for the Foot and Ankle Clinical Research Grant. Up to $15,000 over 2 years (maximum $7,500 per year) will be offered. Additional information on the Foot and Ankle Clinical Research Grant can be found at http://www.orthopt.org/research.php.

Orthopaedic Section Strategic Planning – The Orthopaedic Section leadership including the Board of Directors, Committee Chairs, and Special Interest Group Presidents will meet in LaCrosse, WI October 8-10, 2009 to develop a new strategic plan for the Section. The plan will outline the Section's goals, objectives, and strategies over the next 3 to 5 years and will provide direction for use of the Section's human and financial resources. Data from a membership survey conducted earlier this year will be used to guide the strategic planning process.

In closing, I would like to encourage you to participate in the upcoming Orthopaedic Section elections for the office of President and Nominating Committee. Voting will open on November 1 and close on November 30, 2009. Section members in good standing will receive e-mail notification of the voting process. If you wish to cast your vote by regular mail, please contact the Section office to request a mailed ballot.

I hope that you have a successful fall in preparation for the upcoming holiday season.

The CAB Model of Pain-related Activity Avoidance: Description and Implications for Research and Practice in Physical Therapy

Todd E. Davenport, DPT, OCS[1]
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ABSTRACT

Background and Purpose: Pain-related activity avoidance is a phenomenon that causes substantial annual patient morbidity. Therefore, it has been the subject of many recent studies related to physical therapist practice. The purposes of this review are: (1) to provide a rationale for considering cognition and affect in physical therapist practice, and (2) to propose the CAB Model for patient education in physical therapist management of pain-related activity avoidance. **Method:** Narrative review. **Findings:** 'CAB' is an acronym that emphasizes **C**ognition and **A**ffect in designing patient education programs that facilitate change in avoidant **B**ehavior. **Clinical Relevance:** This review synthesizes literature that suggests pain-related cognitions and affect may be important targets for patient education by physical therapists, because they may serve as progenitors of pain-related activity avoidance. This narrative review provides a model for physical therapists to use in considering these features of clinical presentation and to guide future research.

Key Words: pain, cognition, emotion, behavior, physical therapy

INTRODUCTION

Pain is among the most common concerns that lead people to seek physical therapy. It is defined as a somatosensory modality that provides the perception of an unpleasant sensory experience associated with actual or potential tissue damage.[1,2] While most individuals share a common stimulus-specific anatomy and physiological processing that provides for the information-gathering function of pain, a vast body of clinical and scientific evidence indicates there are substantial differences in how patients respond to pain. Many of these differences relate to the affective and cognitive-evaluative functions of pain.[3] The affective function of pain provides emotional unpleasantness to pain sensations. This causes people to avoid additional pain and the tissue damage that pain represents. The cognitive-evaluative function of pain serves for learning and behavioral adaptation. Disorders involving the affective and cognitive-evaluative functions of pain may result in maladaptive behavioral responses to pain, such as a disabling avoidance of work, family, and recreational activities. One such behavior includes activity avoidance, which is associated with a spiraling cycle of decline in pains and function.[4-6]

The *Guide to Physical Therapist Practice*[7] and recent literature[8,9] suggest that physical therapists' ability to effectively address their patients' maladaptive behavioral responses to pain, such as activity avoidance, partly depends on their ability to provide adequate patient education to promote behavior change. Effective patient education by physical therapists appears to depend on the use of effective brief psychoeducational strategies that can address the cognitive and affective processes that motivate pain-related activity avoidance. However, the literature to date that characterizes effective brief psychoeducational strategies in the physical therapy setting is in a nascent stage of development. The purposes of this narrative review are 3-fold. First, we will present the rationale for physical therapist intervention at the level of cognition and affect for purposes of optimal patient education in patients with pain-related activity avoidance. Second, we will describe the CAB Model of theoretical relationships between **C**ognition and **A**ffect in determining motivation for **B**ehavior based on supporting evidence, and discuss the model's relevance to clinical practice and future research related to pain-related activity avoidance.

Cognition and Affect are Important Targets for Management of Pain-Related Activity Avoidance by Physical Therapists

The clinical importance of the affective and cognitive components or pain has made them the subject of numerous studies. In general, psychological factors more strongly predict outcomes for patients with low back pain than demographic characteristics, physical factors, and pain intensity.[10-13] Lethem et al[4] and Slade et al[5] and their colleagues were among the first to describe a potential mechanism relating psychological factors with clinical outcomes related to low back pain in the general population. In their Fear-Avoidance Model, all patients were considered to be at least somewhat fearful of pain because of the typical affective function of pain. Lethem[4] and Slade[5] hypothesized that some patients seek to avoid pains by reducing or avoiding functional behaviors that may provoke pain, while other patients confront pain. The authors described pain confrontation as a strategy that promotes recovery by progressively reducing levels of fear through repeated self-exposure to pain-provoking activities. Avoidance of pain was thought to reinforce additional activity avoidance over time. In turn, pain and activity avoidance was thought to result in deconditioning that reduces the overall capacity for pain-free functional activities. The avoidance of activity and associated

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deconditioning then would result in a spiraling cycle of decline in patient function. Subsequent conceptual work by this group suggested these predictions may generalize well to patients with persistent pain, regardless of pathology.[14] Much research exists to date that documents these so-called fear avoidance beliefs' association with disability and temporal characteristics.[6,15-17]

While construct validity of the Fear-Avoidance Model remains an open question,[12,18-20] it is evident that pain-related activity avoidance is an important issue in physical therapist practice.[21-26] A nascent literature in the field of physical therapy suggests the importance of exercise and educational interventions provided by physical therapists to ameliorate disablement in patients with pain-related activity avoidance. George and colleagues[8] reported on the physical therapy management of a 42-year-old male with low back pain and elevated fear avoidance beliefs. Along with using a treatment-based classification approach and graded exercise, ongoing patient education was provided to the patient in an attempt to improve the patient's specific understanding of his health condition, provide a pain self-management plan, and build a collaborative approach to treatment. The approach used in this case study included an unspecified amount of treatment time spent with individualized instruction, which was supplemented with a pamphlet. Subsequently, in a study of subjects with LBP and elevated activity avoidance beliefs, Godges et al[9] demonstrated that a pragmatic approach to physical therapy combined with patient education guided by review of a pamphlet reduced significantly the number of days to return to work. A component of individualized education was provided by the treating physical therapist which centered on 3 primary questions that were asked of each subject in the education group of this study. These included whether the subject had learned new information from their review of the pamphlet, had questions regarding material presented in the pamphlet, and whether the pamphlet provided them with information that would be helpful to manage their back pain. These examples from the physical therapy literature provide preliminary support for the importance of educational interventions and brief counseling strategies provided by physical therapists in addressing disablement in patients with pain-related activity avoidance. Despite the compelling nature of these studies, no studies have identified the specific components of optimal patient education programs for this patient population.

Successful patient education programs facilitate clinically meaningful changes in patients' and clients' behavior. Motivation to perform behaviors, including functional and self-management activities, is associated with patients' thoughts, beliefs, attitudes, and emotions.[27] Therefore, these cognitive attributes may be important treatment considerations in optimal patient education by physical therapists for patients with pain-related activity avoidance. Correspondingly, studies indicate cognitive-behavior therapy associated with exercise-based treatments positively affects disablement in patients with pain-related activity avoidance.[28] Identification of cognitive and affective factors associated with functioning and disablement appears important to determine the characteristics of effective patient education programs in patients with pain-related activity avoidance. In this manner, cognitive and affective components of behavior change form an important route of intervention for physical therapists to promote successful outcomes in this patient population. Implementation of formal cognitive-behavior therapy programs is within the scope of practice for physical therapists,[7] although it may be outside the usual training and time constraints for many physical therapists at this time. However, this should not prevent the formation of guidelines physical therapists may use to consider cognitive and affective components of pain-related activity avoidance in order to improve the quality of patient education in this population. This will provide a cadre of clinicians who are capable of providing effective patient education programs, an approach that has been promoted in the literature.[29,30]

The CAB Model

The development of the CAB Model has been based on the widely accepted observation that individuals' **C**ognitions and **A**ffect predicate their motivation to complete a **B**ehavior. One's self-assessments of the efficacy to perform a behavior and the behavior's potential outcome appear to be the primary thoughts and beliefs that predict behavior enactment by patients. According to the CAB Model (Figure 1), patients with pain-related activity avoidance are predicted to demonstrate low efficacy and/or outcomes expectations that lead to excessive pain-avoiding behavior in the short-term and subsequently leading to activity-avoiding behavior over time. Also according to the CAB Model, activity-related cognition is hypothesized to be influenced by emotional state through cognitive filtering. Therefore, emotional states serve as a potential amplifying factor to existing pain- and activity-avoidant cognitions, because anxiety and depression appear to cause additional negative appraisal of efficacy and outcomes expectations through the processes of catastrophizing and learned helplessness.

Efficacy Thoughts and Outcome Beliefs Predict Motivation for Activity Performance Despite Pain

Many investigators have applied theories from the field of cognitive psychology in an attempt to explain pain-related activity avoidance. Early experimental work in animal models by Miller and Dollard[31] suggested that new behavior may be learned by imitation in the presence of sufficient motivation. They also suggested the development of new behavior through imitation is shaped by the rewards received for imitating the new behavior. This work is historically important because it is among the first studies to describe the influence of social interaction on developing new behavior. However, this hypothesis did not explain adequately the potential role of internal motivation for acquiring a new behavior through imitation. Bandura[32-34] advanced this early work by proposing a model for learning new behavior that acknowledges reciprocal causation among external factors related to the environment and internal factors related the individual. This contrasted with the behaviorists' view of the time, which recognized the effect of the environment to shape the development of new behaviors externally as preeminently important.

Bandura's Social Cognitive Theory[33] suggests learning is a self-directed and goal-oriented activity that is guided by the motivation of the individual, and learning may or may not change behavior. According to early conceptual work with Social Cognitive Theory, patients' expectations about the activities they might perform, in the presence of adequate incentives and ability, were hypothesized to be important determinants of whether these activities will be performed.[32,35] Expectations are not considered to condition an automatic response, in which favorable expectations always result in performance of an activity. Rather, individuals' expectations are thought to help shape patients' functional behavior by way of motivation to complete functional activities.[32-35] In this context, patients' expecta-

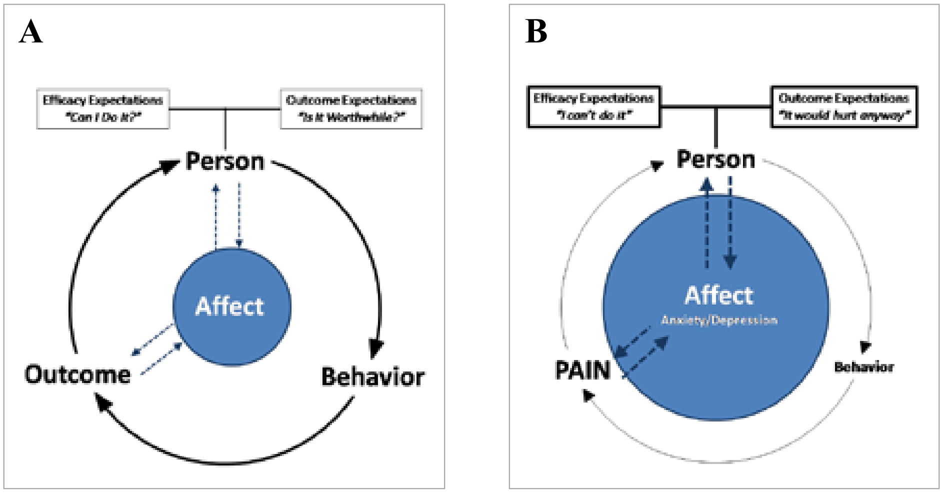

Figure 1. The CAB Model of hypothetical relationships among cognition, affect, and behavior in pain-related activity avoidance. Patient cognitions (efficacy and outcome expectations) combined with emotional state are hypothesized to predict the performance of an activity (A). Cognition and affect reciprocally inform each other, as well as interpretation of activity outcome. In patients with pain-related activity avoidance (B), the behavioral outcome of pain causes increased maladaptive cognitive processes (negative efficacy and outcome expectations). Affective processes (anxiety and depression) further influence negative cognitions by way of catastrophizing and learned helplessness. As behaviors diminish over time, negative cognitive and affective processing becomes the primary source of information regarding potential behavior outcome, rather than direct experience with the behavior itself. This leads to a spiraling cycle of decline in patient function.

tions affect the degree and duration of pain coping necessary to perform health-related and functional behaviors (Figure 1).

According to Social Cognitive Theory, 2 sets of expectations influence a patient's motivation for the performance of a behavior, including outcome expectations. Outcome expectations are defined as a patient's cost to benefit analysis that a certain behavior will result in a certain outcome.[32-34] The major implication for physical therapist practice of patients' outcome expectations is that a behavior may be avoided by a patient if the behavior is considered too costly in terms of anticipated pain relative to a more minor perceived gain. Patients' avoidance behaviors are thought to be reinforced by their outcome expectation of pain reduction through avoiding activities that potentially provoke pain, whether or not the patient actually is successful to reduce their pain in this manner.[36] Cipher and Fernandez[37] also identified that positive outcome expectations regarding a pain-generating cold pressor task significantly predicted whether subjects would volunteer for the experimental treatment, while negative expectations predicted avoidance.

Efficacy expectations are the second set of expectations predicted by Social Cognitive Theory to determine motivation for the performance of a behavior. Bandura[35] broadly describes efficacy expectations as an individual's task- and situation-specific estimate of personal mastery. Bandura[35] also surmised individuals would avoid environments and activities that seemed to exceed one's own estimate for coping. Therefore, self-efficacy influences an individual's choice of environment and activities. In addition, self-efficacy is positively associated with the magnitude and persistence of coping behaviors once they are initiated.[38-40] These ideas appear to explain the significant association between self-efficacy and pain-related activity avoidance, in that patients with low self-efficacy more frequently tended toward increased pain-related activity avoidance beliefs[12,41-43] and poorer functional outcomes.[44] Woby and colleagues[45] found that patients with persistent low back pain who demonstrated high self efficacy beliefs also showed significantly better clinical outcomes regardless of the strength of other beliefs about pain and function than individuals with low self-efficacy beliefs. Self-efficacy expectations regarding work also significantly predict the likelihood of returning to work in injured workers.[46] This suggests self-efficacy may mediate the relationship between pain-related activity avoidance and clinical outcomes in patients with persistent low back pain.

An analysis of the behavior change literature in body weight management and smoking cessation supports the notion that self-efficacy is modifiable, and that high self-efficacy is important to successful health behavior change in patients. Participants in a smoking cessation behavior therapy group aimed at increasing social support and empowerment were 6 times more likely to case smoking than a control group.[47] Teixeira and colleagues[48,49] determined high exercise self-efficacy was among important pretreatment predictors of response to a weight management program in overweight and obese women. High exercise and eating self-efficacy was a significant predictor of favorable response to an 8-week behavior therapy program in a similar sample.[50] However, despite the apparent importance of high self-efficacy to facilitate short-term behavior change, the effect of the program to strengthen self-efficacy beliefs was transient because this trend was not significantly present at 6-month follow-up. These results suggest that high self-efficacy combined with the ability to implement clinician instructions accurately and consistent home exercise program compliance may have positive impacts on short-term patient compliance and short-term clinical outcomes in patients with pain-related activity avoidance, but those intermediate-term effects are variable.

Emotional States Guide Thoughts and Beliefs about Activity Performance Despite Pain

Investigators have examined the role of affect as potential correlates and progenitors of pain-related activity avoidance. Depressed affect is recognized as a significant predictor of increased disability,[51,52] improvement with multidisciplinary rehabilitation programs,[53,54] and increased health care utilization in patients with pain.[55,56] Likewise, anxiety and sensitivity to anxiety have been the focus of many studies in patients both with and without pain. Studies have identified these factors as a similarly significant predictors of a tendency toward potential pain-related activity avoidance in children and adolescents,[57-61] as well as pain frequency,[62] low pain coping,[63] increased disability,[52,54,64] and increased health care utilization[55] in adults. Patients with idiopathic or nonspecific pain were more likely than patients with specific or organic pain to screen positively for a major psychological disorder in one sample[65] and other studies have identified a significantly greater prevalence of nonpain fear and avoidance in patients with nonspecific pain.[66,67] However, it is important to note that most studies to date looking into the role of affect did not report the prevalence of patients who were diagnosed with a major psychological disorder related to anxiety or depression despite liberal use of the psycho-diagnostic labels 'anxiety' and 'depression.' A recent systematic review also documented inconsistent evidence for the predictive ability of measures of anxiety and depression on work outcome.[46] Nevertheless, from the current available evidence to date, affective features of anxiety and depression are important considerations for the clinical management of pain-related activity avoidance by physical therapists.

The inconsistent influence of affect on outcome in patients with pain-related activity avoidance suggests a mechanism involving an indirect effect that may not be observable across studies. One potential explanation of the relationship between outcome and affect involves cognitive bias. Cognitive bias refers to the tendency to make errors in judgment that are based on thoughts and beliefs, particularly those that guide attention. Attentional bias is the tendency to take into account certain stimuli over others. This is thought to be a largely adaptive response to assist individuals in making rapid decisions regarding the most important stimuli upon which to take action. Baumeister and colleagues[68] suggested in their recent review that a great many psychological studies have documented the trend that attention toward negative or potentially dangerous stimuli typically takes priority over attention to positive stimuli. In fact, the observation that negative stimuli outrank positive stimuli in attentional bias is so common that it has been suggested as one of the more pervasive findings in the psychological literature.[68] Attention toward negative stimuli also may be modulated by affect.[69] In patients with pain-related activity avoidance and negative affect (ie, anxiety or depression), attentional bias toward negative stimuli may shape and reinforce existing avoidance behaviors. Therefore, physical therapists' consideration of affective characteristics may be an important component of optimal educational interventions in this population.

Perhaps the use of affective states as a cognitive filter partially explains the phenomenon of pain catastrophizing, which appears to be associated with pain-related activity avoidance. Catastrophizing is a cognitive process in which an individual dwells on the most negative possible result of a behavior.[70,71] Catastrophizing has been characterized as a series of automatic "What if?" questions that patients with anxiety disorders appear to ask themselves.[72] The responses to these questions generated by the individual seem to "betray a rapid-fire sense of impending incompetence,[73(p96)] rather than using data that supports one's own efficacy. Patients who engage in pain catastrophizing thoughts and beliefs may use their perceived incompetence as a cognitive filter that biases them toward attending to additional feedback from the environment that supports their view of incompetence. This cycle is clinically significant, because pain catastrophizing appears to be important in predicting disability[60,61,74-79] and pain intensity[61,74,76,77,80-82] in patients with various forms of persistent pain. The cyclic nature of pain catastrophizing suggests it may be viewed as a cognitive habit that improves with rehearsal. Each time the most negative possible outcome of a behavior is expected, information appears to be selectively perceived to support this notion. This cycle would more effectively reinforce pain-related activity avoidance over time. Pain catastrophizing further buttresses the importance of cognition and affect valuable considerations for physical therapists in designing optimal patient care management plans.

Cognitive filtering according to depressed mood also may be partly responsible for pain-related behavior avoidance through learned helplessness. Seligman[83] first described learned helplessness based on human and animal research, in which an individual perceives injurious stimuli as inevitable and uncontrollable. These perceptions have been hypothesized to reduce the capacity for meaningful response to potentially traumatic stimuli, to limit the ability to learn alternate coping and escape strategies, and to promote emotional distress.[83-85] The nature of individuals' causal explanations for negative stimuli and events have been associated with learned helplessness.[86,87] Specifically, attributions that patients direct to causes that are within the individual (internal), do not change over time (stable), and many different situations (generalizable) seem to predict learned helplessness in depression.[86,87] While the role of learned helplessness in pain-related activity avoidance has been less studied to date, it has been associated with disability in patients with persistent pain.[88] Of therapeutic importance, studies have documented that learned helplessness is reversible and preventable in response to specific exposure to appropriate escape and coping strategies.[89-93] The reversibility of learned helplessness in response to these interventions may partly explain the effectiveness of exposure-based therapeutic programs for patients with pain-related activity avoidance.[8,9,36,94,95] However, the role for specific patient education by physical therapists to address patients' escape strategies, coping skills, and attributional style may be the subject of important future studies.

Implications of the 'CAB' Model for physical therapist management of pain-related activity avoidance

Predictions based on the CAB Model have several implications for research and practice related to optimal physical therapist management of pain-related activity avoidance. Patient education to address pain-related cognition in combination with movement-related interventions appears optimal for patients without significant affective overlay, because efficacy and outcome expectations serve as strong predictors of motivation to perform behaviors (Figure 2). Findings from several studies suggest quota-based exercise programs that facilitate pain confrontation alone may promote improvements in short-term patient outcomes.[94,96-98] However they may run the unintended risk of reinforcing avoidant behaviors in the long term through reinforcing the existing cognitive and affective patterns they are meant to address. This may account for inconclusive findings in clinical trials regarding the clinical effectiveness of graded exposure approaches in the context of multidisciplinary pain management for this patient population.[99] Second, patients with substantial cognitive and affective components also may require specific intervention to address these issues. Movement-related interventions may be limited in their ability to address effectively these components if they are clinically significant. Therefore, guidelines for referral to licensed mental health providers by physical therapists must be created to ensure appropriate interdisciplinary care is provided to patients with needs requiring attention beyond the scope of physical therapist practice.

Intervention at the level of cognition by way of patient education for patients with pain-related activity avoidance necessitates physical therapists measure efficacy and outcomes expectations. Since self-efficacy beliefs are known to be specific to a task or situation, their generalization across health conditions and movement dysfunctions that

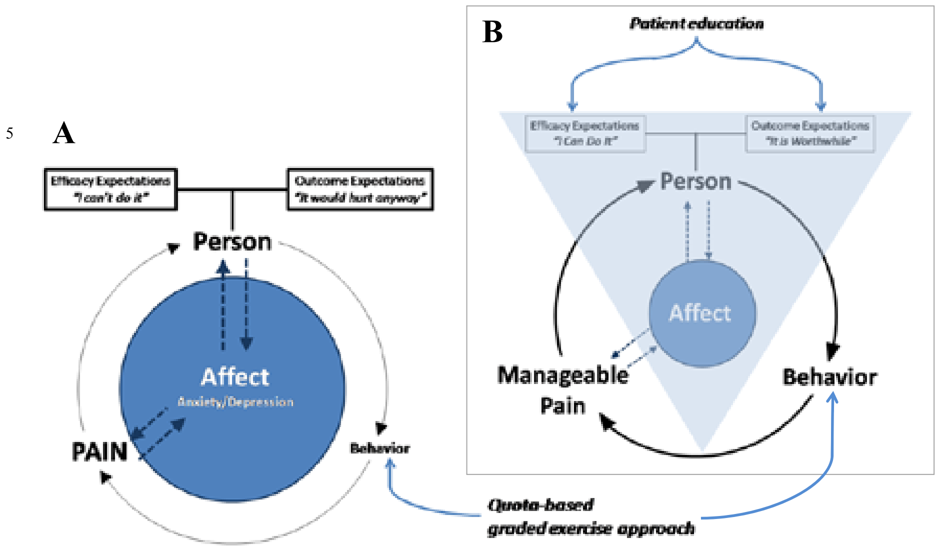

Figure 2. Predicted effects of selected interventions for pain-related activity avoidance according to the CAB Model. Interventions at the level of behavior, such as a quota-based graded exercise programs, may run the risk of reinforcing maladaptive cognitive and affective responses to activity because they are not directly addressed (A). Empirically sound approaches to patient education that addresses maladaptive cognitive and affective responses to activity that occurs simultaneously with behavioral interventions may provide patients the opportunity to practice implementing new cognitive and affective strategies and optimize clinical outcomes (B).

differ in pain-related avoidance behaviors remains unclear. Assessment of self-efficacy is in early stage of development in the rehabilitation literature, so few health condition- and stage-specific scales currently exist.[100-103] Existing questionnaires that were designed to measure pain-related fear, such as the Fear Avoidance Beliefs Questionnaire[104] and Tampa Scale for Kinesiophobia,[105] actually also may be useful measures of outcomes expectations and attributions. The measurement and optimal interventions at the levels of efficacy and outcome expectations appear to be important topics for future research in physical therapy.

The CAB Model also suggests a need for examination and evaluation of patients' emotional states in order for physical therapists to design optimal patient education programs to address pain-related activity avoidance. The global role of affect as a cognitive filter may be measured by the Pain Catastrophizing Scale.[106] Several standardized instruments already exist to assess the extent of specific affective states in cognitive filtering on the basis of affect, including the State-Trait Anxiety Inventory[107] and Beck Depression Inventory.[108] Clinically significant anxiety and depression according to these questionnaires constitute a need for referral to a licensed mental health provider. Subclinical depression and anxiety features may require differential patient education interventions to address pain catastrophizing and learned helplessness, respectively. Evidence of potential adverse pain-related affect also may be gathered by way of the McGill Pain Questionnaire,[109,110] although it may be less specific to determining the emotional state that is most responsible for potential cognitive filtering. Additional research should establish best practices related to physical therapists' measurement and intervention at the level of patients' affect for purposes of considering emotional states in patient education programs and establishing the need for referral to licensed mental health professionals.

CONCLUSION

This review proposed the CAB model for patient education in physical therapist management of pain-related activity avoidance, based on current scientific evidence and emerging literature that suggests an important role for individualized patient education provided by physical therapists in this population. 'CAB' is an acronym that emphasizes the need to consider <u>C</u>ognition and <u>A</u>ffect in designing patient education programs that facilitate change in avoidant <u>B</u>ehavior. Future studies should examine the construct validity of this model, as well as its optimal application to physical therapist practice.

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Comparison of Tissue Heating between Manual and Hands-free Ultrasound Techniques using a 1-MHz Frequency

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ABSTRACT

Study Design: Single-factor repeated-measures design. **Objective:** To examine the effectiveness of tissue heating with a hands-free ultrasound (US) technique compared to a hand-held ultrasound transducer at a frequency of 1-MHz using the Rich-Mar AutoSound™ unit. **Background:** US is a therapeutic modality often used to provide deep tissue heating. Recently, a "hands-free" US unit has been introduced by Rich-Mar Incorporated. This unit allows the clinician to choose the mode of US delivery, using either a hand-held (manual) transducer or a hands-free (HF) device that pulses the US beam through the transducer. However, the Center for Medicare and Medicaid Services has deemed delivery of US via a hands-free unit to be investigational. **Methods and Measures:** This study was completed in 2 phases using a manual transducer (5 cm^2 effective radiating area) and a hands-free transducer (14 cm^2 effective radiating area). In phase 1, muscle temperature was measured with 26-gauge, 4-cm Physiotemp thermistors placed in the triceps surae muscle at 2- and 3-cm deep. In phase 2, thermistors were placed at 4- and 5-cm deep. Tissue temperatures were recorded at baseline and every 30 seconds. **Results:** At the 2-cm depth, the tissue temperature increased 0.73°C using the manual transducer and 0.75°C with the HF device. At the 3-cm depth, the tissue temperature did not show a change with either device (-0.04°C manual; -0.07°C HF). At the 4-cm depth, the tissue temperature did not change with the manual device and a decrease of 0.31° C was observed with the HF device. Finally, at the 5-cm depth, the manual device yielded a 0.72° C increase and the HF device again resulted in a decrease of 0.19° C. **Conclusions:** In this study, neither of the devices on the Rich-Mar Ultrasound unit resulted in the production of a therapeutic heating effect at any depth studied. In fact, the HF device actually resulted in a lowering of tissue temperature. Thus, if the goal is to increase tissue temperature to enhance circulation or the viscoelastic properties of the soft tissue, the 1-MHz component of this device is not effective. Clinicians should be careful about drawing conclusions regarding ultrasound as a modality based on the outcome of a particular parameter.

Key Words: tissue heating, therapeutic ultrasound, thermal modality

INTRODUCTION

As a therapeutic modality, ultrasound (US) is known to have thermal and mechanical effects.[1-5] Clinicians use therapeutic ultrasound to elevate tissue temperatures to decrease joint stiffness,[6] reduce muscle guarding,[2,6] increase soft tissue extensibility,[7] decrease pain,[2,8] and increase blood flow.[7,9] The frequency of therapeutic US is inversely related to the depth of tissue penetration. Thus, 1-MHz US is believed to penetrate 4 to 5 cm deep, while 3-MHz US has been reported to penetrate 2 to 3 cm depth.[10-18]

In the past decade there have been a plethora of US studies in the quest to substantiate the efficacy of this modality. The mitigating factor, however, may not be the physiologic US wave itself but rather the devices used to deliver it. In the past few years, Rich-Mar Incorporated introduced an AutoSound™ unit (Rich-Mar, Inc, Chattanooga, TN) which is capable of delivering US in the traditional method of a manual transducer as well as through a "hands-free" transducer. The "hands-free" device functions by securing a 4-chamber, 14 cm^2 transducer to the skin with Velcro straps. The US wave is sequentially pulsed through the 4-chambers as follows: A, B, C, D, A, B, C, D, etc. Although this could be a tremendous clinical attribute for time efficiency, the effectiveness has only been reported in 3 studies, all using the 3 MHz frequency.[19-21] In fact, the Center for Medicare and Medicaid Services (CMS) and several other insurance companies have deemed delivery of US via a hands-free device to be investigational or experimental.[22] The purpose of this study was to examine the amount of tissue heating with a hands-free AutoSound™ transducer compared to a traditional hand-held transducer using a 1-MHz frequency.

Methods

Subjects

Participants were recruited via flyers. Each participant read and signed the informed consent document approved by the University Institutional Review Board for the Protection of Human Subjects. Participants were screened for lower extremity injuries and medical conditions for which US is contraindicated.[23,24] Phase 1 included 20 volunteers (7 males, 13 females; age 24.05 ± 4.54 yrs; height 1.68 ± 0.11 m; body mass 70.15 ± 16.24 kg). Phase 2 included 25 volunteers (10 males, 15 females; age 25.64 ± 3.29 yrs; height 1.71 ± 0.10 m; body mass 75.57 ± 17.49 kg).

Instrumentation

Muscle temperature was measured with a 26 gauge, 4 cm Thermalert TH-8® monitoring thermister (Physitemp Instruments Inc., Clifton, NJ). The Physitemp Thermalert TH-8® was precalibrated by the manufacturer under the guidelines of the National Institute of Standards and Technology and the device self-calibrated each time it was turned on. The device measures temperature in the range of –10 to 60°C and accurate to ± 0.1° C. The US treatments were provided with a new, factory calibrated Rich-Mar AutoSound™ device. The two US delivery techniques compared were the manual mode with a hammer transducer and the hands-free AutoSound™ transducer.

Beam non-uniformity ratio (BNR) is a measure of the variability of the US intensity across the crystal. The BNR for both devices at the 1-MHz frequency was ≤ 5.5:1. The effective radiating area (ERA) is the surface area of the US transducer that is capable of transmitting an US wave. The ERA for the hammer transducer was less than 5cm^2 and the hands-free AutoSound™ transducer was less than 14cm^2 (3.5cm^2/transducer x 4 chambers = 14cm^2). It should be noted,

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however, that the Rich-Mar Operation Handbook[25] states that the actual ERA for the 5cm^2 and the hands-free AutoSound™ transducers are ± 25% of the reported values. This is within the ERA range reported by Johns, Straub, and Howard[26] for the Rich-Mar transducer.

Procedure

Each participant was comfortably positioned in prone. The skin on the posterior aspect of the lower leg was cleaned with alcohol and allowed to air dry. The order of the treatment techniques of each participant was alternated between the manual technique and the AutoSound™ technique. By performing each technique on the same subject, there were no issues with differences in body composition. The perimeter of the hands-free transducer was outlined on the region of the triceps surae muscle with the greatest muscular girth. This assured that the same treatment area was used for both transducers, allowing a better comparison of the heating effects of the two devices. For phase 1, each technique was performed on a different leg. For phase 2, the two techniques were performed on the same leg. This change in methodology was elected in an attempt to reduce a potential element of error in the placement of the thermistors. By using the same leg for both techniques and allowing the tissue temperature to return to baseline between treatments, a more accurate comparison of the techniques could be assured.

Thermistor Insertion

A T-square with a level attached (Figure 1) was used to horizontally insert the thermistors into the medial aspect of the triceps surae muscle. The thermistors were inserted at a vertical depth of 2 and 3 cm for phase 1 and 4 and 5 cm for phase 2. The placement of the thermistors was based on the depth of penetration of the 1-MHz US frequency. The half-value depth is the distance that the US beam will travel through the tissue before the amplitude/energy is dissipated to 50% of the original value.[18,27,28] The half-value depth for the 1-MHz frequency has been estimated to be 2.3 cm.[18,27] Any estimated value for living tissue, however, has the uncertainty of varying thicknesses of each type tissue.[28] The half-value depth for skin (4 cm), fat (5 cm), and muscle (1-2 cm) have been reported to be notably different.[29,30] Initially, a methodological decision was made to place the thermistors at the depths of 2 and 3 cm (phase 1). However, when data collection revealed that tissue heating was not effective, phase 2 was implemented with thermistors at a depth of 4 and 5 cm.

Figure 1.

The temperature of each thermistor was monitored for at least 3 minutes after insertion. Data collection did not commence until a stable baseline was achieved, ie, temperature measurement was the same for 3 consecutive readings. The US treatment using the manual technique was administered at 1.5 W/cm^2 with a 5 cm^2 transducer. The speed of movement was maintained at 3 to 4 cm per second in circular movements[13] using 5 cc of room temperature AquaSonic gel as a coupling medium[27,31-34] Tissue temperature readings were recorded from each thermistor at baseline and every 30 seconds for the duration of the 10-minute treatment. Both temperature readings were always taken in immediate succession (shallow thermistor then deep thermistor).

For the AutoSound™ technique, the triceps surae muscle of the opposite lower leg (phase 1) or the same lower leg (phase 2) of the same participant was used. The thermistors were carefully inserted in the previously identified manner for phase 1 or left in place allowing the tissue temperature to return to baseline for phase 2. The "hands-free" transducer was secured with 2 Velcro® straps (Figure 2) over the portion of the calf

Figure 2.

muscle with the greatest girth. A room temperature[33] Rich-Mar gel pad was used as the coupling medium as recommended by the manufacturer. The treatment used the same parameters (1.5 W/cm^2 for 10-minutes) as that of the manual technique. The pulsations of the US wave through the transducer chambers were consistent with the 3 to 4 cm per second movement of the manual technique. At the conclusion of each treatment, the coupling medium was removed from the participant's skin and antibiotic ointment was applied to the thermistor sites. The thermistors were soaked in Cidex® for a minimum of 12 minutes, rinsed, and dried with sterile gauze.

Data Analysis

A repeated measures two-way analysis of variance (ANOVA) was performed for treatment (manual and hands-free) and depth of thermistors (2, 3, 4, and 5 cm) repeated over time. Tissue temperatures were assessed at baseline and then every 30 seconds for 10-minutes. Post-hoc analyses were performed when main effects were identified. Statistical significance was set at $p < 0.05$.

RESULTS

Table 1 summarizes the baseline, final, and total change in temperature across thermistor depths. Figures 3 through 6 demonstrate the tissue temperatures for both methods of treatment at each thermistor depth over time. At the 2-cm depth there was a significant difference for treatment method [$F(3.85) = 4.11$: $p = 0.04$] and time [$F(1.58) = 2.57$: $p < 0.00$]. At the 3-cm depth there was no significant difference for treatment method [$F(3.85) = 0.04$: $p = 0.83$] or time [$F(1.58) = 0.32$: $p < 0.99$]. At the 4-cm depth there was a significant difference for treatment method [$F(3.85) = 13.81$: $p < 0.00$] but not for time [$F(1.58) = 0.46$: $p = 0.99$]. At the 5-cm depth there was a significant difference for treatment method [$F(3.85) = 101.46$: $p < 0.00$] and time [$F(1.58) = 2.13$: $p = 0.01$]. A post-hoc power analysis of this study was determined to be 96%.

DISCUSSION

Although it is not typical to begin the discussion of a research study with limitations, this was an important component of the research methodology. Conducting this study in 2 phases helped to trouble-shoot 2 of the limitations: similar tissue composition and identical thermistor location. Despite an attempt to use both legs of each individual as their own control in phase 1, there was no guarantee that the tissue composition of the right calf was identical to that

Table 1. Summary of Baseline, Final, and Total Change in Temperature (mean ± standard deviation) Across all Thermistor Depths

Tissue Depth	Mode of Treatment	Baseline Temperature	Final Temperature	Total Change in Temperature
2 cm	AutoSound	34.85 ± 1.03ºC	35.60 ± 0.86ºC	+ 0.75ºC*
	Manual	34.85 ± 1.20ºC	35.58 ± 1.13ºC	+ 0.73ºC*
3 cm	AutoSound	35.43 ± 0.90ºC	35.36 ± 0.85ºC	- 0.07ºC
	Manual	35.41 ± 1.04ºC	35.37 ± 1.05ºC	- 0.04ºC
4 cm	AutoSound	35.65 ± 0.70ºC	35.34 ± 0.73ºC	- 0.31ºC
	Manual	35.57 ± 0.73ºC	35.56 ± 0.76ºC	- 0.01ºC
5 cm	AutoSound	36.65 ± 0.68ºC	36.46 ± 0.73ºC	- 0.19ºC
	Manual	36.55 ± 0.61ºC	37.27 ± 0.73ºC	+ 0.72ºC*

* indicates a significant difference from baseline to final temperature

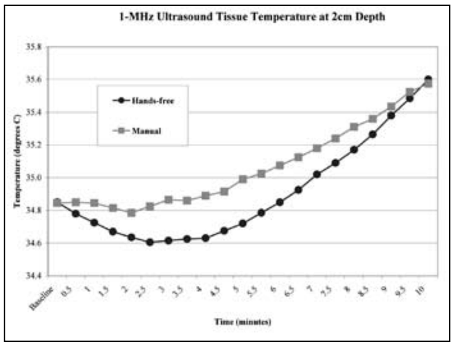

Figure 3.

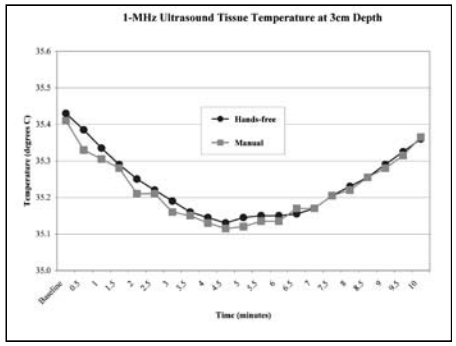

Figure 4.

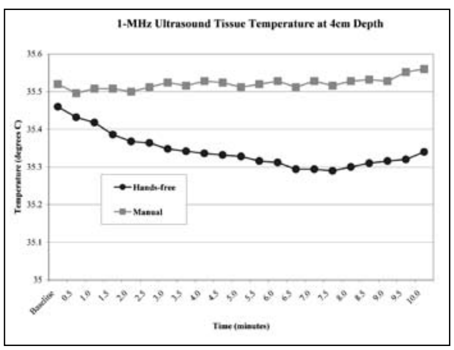

Figure 5.

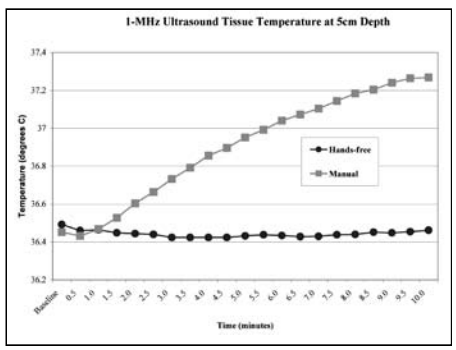

Figure 6.

of the left. Likewise, one cannot guarantee, that despite using a standardized thermistor insertion technique with a T-square and a level, the thermistors were at exactly the same tissue depth. Thus, the methodological change was implemented for phase 2. This change involved allowing the tissue temperature of the calf to return to baseline and administering both techniques in the same treatment session to the same calf.

Any study using US as a therapeutic modality must consider the type of machine employed[10,15,34] and the clinician's technique.[5,13,23,24,36] Generalizations about the effectiveness of US has been haunted by the inconsistencies of the various US units.[10,15,35] Previous studies have identified the importance of the method of transducer movement,[13,23,24] the speed of transducer movement,[5,13] and the size of the treatment area[1,2,13,14,23,24,27,32] on the efficacy of treatment. Furthermore, the optimal speed of transducer movement has been reported to be 3-4cm/sec.[13,27,31] The treatment area of 2 to 3 times the effective radiating area (ERA) of the transducer has also been identified as producing maximal therapeutic effects.[1,2,13,14,23,24,27,32] Appreciation for and implementation of these parameters are not consistently observed in clinical settings, however. All too often, clinicians can be observed treating a larger than appropriate area, rapidly traversing the skin with the transducer, and tilting the transducer side-to-side. Rich-Mar, the manufacturer of the AutoSound™ device, has reported that besides the obvious advantage of not having to physically administer the US treatment, the AutoSound™ device can compensate for poor clinician technique.

The purpose of this study was to examine 2 different techniques within the Rich-Mar AutoSound™ device. To date, there are no other studies that have looked at the use of the 1-MHz frequency of the AutoSound™ device. Only 3 studies have examined the 3-MHz frequency.[19-21] McCutchen, Demchak, and Brucker[21] compared the AutoSound™ technique to that of the manual technique using the Omnisound 3000C device. Treatments were performed with a 3 MHz frequency at 1.0W/cm^2 for 8 minutes. Although the tissue temperature increased by 1.8ºC with the AutoSound™ technique, the tissue treated with the Omnisound (manual technique) increased by 3.2ºC. Gulick[20] also reported significantly lower heating at tissue depths of 1 cm (5.1ºC vs. 6.7ºC) and 2cm (1.5ºC vs. 4.0ºC) with the hands-free technique when compared to the manual technique at 1.5W/cm^2 for 10 minutes. Fincher, Trowbridge, and Ricard[19] also studied the 3-MHz frequency administered at 1.5W/cm^2 for 10 minutes but the thermister depth was 2.5 cm. Again, the AutoSound™ device produced a significantly lower temperature increase (2.05 ± 0.6ºC) then the manual techniques (3.38 ± 1.36ºC and 4.53 ± 1.30ºC).

Based on the results of previous studies,[13,27,32] the expectation was for a 1-MHz treatment at 1.5W/cm^2 for 10 minutes to yield a 2 to 3°C temperature increase. This would have been classified as moderate therapeutic heating.[6] The tissue temperature increase throughout this study, however, never exceeded 1°C at any depth or with either treatment method. There was no difference in the treatment area or ERA of the techniques. Both methods treated an area that was 14 to 15 cm^2 in size and equivalent to a 3:1 ERA. Likewise, the depth of the tissues analyzed clearly covered the half-value depth for the 1-MHz frequency. Perhaps a higher treatment intensity (2.0W/cm^2) could have been used. With a BNR of 5.5:1 in the AutoSound™ device, however, spatial peak intensities as high as 11W/cm^2 is likely to result in patient discomfort.

One factor that may have influenced the tissue heating is the movement of the US transducer. With the AutoSound™ device, there are 4 rectangular transducer chambers arranged consecutively down the length of the transducer. Each of the transducers had an ERA of 3.5cm^2 and was energized sequentially to distribute the US energy to isolated tissue compartments. The pattern of energizing the transducer was: A, B, C, D, A, B, C, D, etc. Whereas, the manual technique used an overlapping, circular method and may have yielded greater heating of the centrally located tissue.

The concept of providing US treatment through a "hands-free" mechanism is clinically attractive. Using the hands-free technique can do exactly that, free your hands to perform manual techniques to impart a soft tissue stretch to maximize the effect of the "stretching window."[13,27,32] The hands-free technique can also compensate for poor clinical application of this modality, ie, too large of a treatment area and too rapid movement of the transducer. If the heating effect never reaches a therapeutic level, however, the ancillary interventions may not be efficacious.

CONCLUSIONS

In summary, this study reveals the importance of testing clinical modalities. The Rich-Mar AutoSound™ unit failed to achieve therapeutic heating at 1.5W/cm^2 over a 10-minute treatment period with a 1-MHz frequency. As clinicians, aside from deciding to use a modality, the choice of which type of US device to use is an important part of an efficacious treatment. Exploring the literature regarding the effectiveness of available units on the market and the appropriate parameters to use are critical aspects of clinical decision-making.

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Excerpt from Interdisciplinary Work and the Scientific Basis for Visceral Manipulation: Soft Tissue Fascial Mobilization

Diane Beach, MS, PT, MOMT

The scientific basis for Visceral Manipulation work by Jean-Pierre Barral, DO, RPT is drawn from research in multiple biological and health care disciplines. The changing nature of the biological sciences and clinical practices in fields such as Physical Therapy has been dramatic in the 30 years I have practiced, with an increasing emphasis on multi-discipline approaches to clinical knowledge and clinical practice. Recent advances in related sciences are now making it necessary to look across disciplines for some of the answers to our questions regarding the manual therapy's mechanisms of action.

Khalsa et al. (2006) in their editorial review state that research and practice need to draw on different areas of science (neuroscience, biomechanics, endocrinology, imaging, and immunology) to answer questions regarding the mechanisms of manual therapy. They point out "the complexities of studying the manual therapies, translating research findings into clinical practice, and that some of the most important questions will come from clinicians themselves". They also state "the value of networks of clinicians and scientists who can work together to explore common areas". They report that "the manual therapies may trigger a cascade of cellular, biomechanical, neural, and/or extracellular events as the body adapts to external stress". Bialosky et al. (2008) state "the mechanical force from manual therapy initiates a cascade of neurophysiological responses from the peripheral and central nervous systems, which are then responsible for the clinical outcomes".

Visceral Manipulation is organ specific soft tissue mobilization. The abdominal and thoracic organs are enveloped in their connective tissue/fascial membranes. As soon as we manually manipulate this visceral soft tissue, we are affecting changes locally and in surrounding areas because of their fascial connections (Schleip, 2003). Langevin (2005) states that unspecialized connective tissue surrounds and permeates not only the

Visceral Manipulation recreates, harmonizes and increases proprioceptive communication in the body to enhance its internal mechanism for better health.

musculoskeletal system in the body but all other tissues and organs. Because of this, unspecialized connective tissue plays a role in "integrating the function of diverse cell types existing within each tissue (e.g. lung, intestine – Swartz et al. in Langevin 2005 pg. 261). Moreover, the connective tissue matrix is a key participant in mechanotransduction, or mechanisms allowing cells to perceive and interpret mechanical forces (Chiquet et al. in Langevin, 2005 p. 261)". Langevin (2005) states these connective tissues influence, and are influenced by, normal and pathological function of a wide variety of organ systems although the exact mechanism by which the connective tissues interpret and integrate mechanical information is not yet known.

Bessou and Laporte (in Langevin, 2001, p. 2280) report "how pressure, stretch, and mechanical stimulation could result in mechanical connective tissue deformation thus influencing the group 3 muscle afferent found in perimuscular fascia and adventitia of muscle blood vessels". Early seminal work by Gerald Cooper (1979) elaborated on the importance of the visceral ligamentous attachments. Leon Page DO (Role of Fascia in the Maintenance of Structural Integrity, ND) emphasizes the interrelationships of connective tissues including the visceral ligaments. Clinical work published by Barral and Mercier (1988) supports this and states that gentle manipulation of a visceral ligament can induce an immediate and palpable release within that ligament. Schleip (2003) hypothesizes that these changes underneath the practitioner's hands may be due to alterations in the ground substance, which can alter physiological organ function in surrounding areas.

The cellular/tensegrity research of Ingeber (2008), connective tissue research of Langevin et al. (2001 and 2002), and the fascial research of Schleip (2003) are critical in our understanding of connective tissue and its applications in the manual therapies. Today, the physical therapist specializing in manual therapy must concern herself with many different systems in the body (musculoskeletal, visceral, lymphatic, neuromuscular, connective tissue/fascial, cranial/dural, neural, vascular, etc.) in order to acquire the skill, experience, and competence for practice.

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Intrarater and Interrater Reliability of R1 During the Straight Leg Raise

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ABSTRACT

Background: Clinicians use R1 (the point of first passive resistance) during tests such as the straight leg raise (SLR), to identify the presence of neural tension. **Purpose:** The purpose of this study was to determine the intra- and interrater reliability of R1 in measuring the SLR of asymptomatic college-age individuals. **Methods:** Thirty asymptomatic subjects ages 18-31 participated in this study. Two experienced examiners performed the SLR while blindfolded. Data were collected on 2 separate days over a 2-week time period. **Findings:** The intrarater reliability was found to be good. Coefficients for examiners A (ICC= 0.71, 0.73) and B (ICC= 0.73, 0.70) for the left and right lower extremities, respectively. The interrater reliability was found to have fair to good ICC. The normative values for asymptomatic individuals in the 18-31 age range were found to be in the range of neural tension (35°-70°). **Clinical Relevance:** The results indicate that R1 of the SLR is a reliable measure in asymptomatic subjects. Further study may lead to its clinical use in symptomatic individuals.

Key Words: interrater reliability, straight leg raise, R1

INTRODUCTION

Physical therapists utilize functional tests and impairment measures to establish baselines, gauge improvement, and measure outcomes in patients. A commonly employed test for the lower quarter is the straight leg raise (SLR) measure. The active SLR may assess hip flexor contractility, lumbopelvic stability[2], or symptom magnification.[3] The passive measure may be used to evaluate hamstring flexibility, restrictions in the hip joint capsule, or neural tension. To be interpreted as a valid measure of neural tension, the SLR findings must be asymmetrical from the concordant sign to the normal side, be the same radicular pain recorded by the patient, and lastly, the pain should have a sensitization quality. In the detection of a suspected pathology, neural tension testing relies on the ability of the tests to differentiate between neural and non-neural tissues.

Limitations in SLR found in the 35-60 degree range of elevation which are accompanied by symptom reproduction may be termed adverse neural tension (ANT). Adverse neural tension is defined as an abnormal physiological or mechanical response from the nervous system that limits the nervous system's range or stretch.[4] Several neural tension tests incorporate sensitizing maneuvers to differentiate between adverse neural tension and other musculoskeletal pathologies. To better assess the clinical effectiveness of adverse neural tension tests, such as, the upper limb tension test or the straight leg raise, the validity and reliability of these tests need to be determined. Knowledge that the test is reliable, along with a range of measurement error, enables clinicians to confidently differentiate between significant changes and measurement error. Several studies have been undertaken in an attempt to establish such measures.

A study by Gabbe et al[5] investigated the reliability of several lower extremity musculoskeletal screening tests, which included passive straight leg raise and active slump test. The passive straight leg raise and the active slump test were used to assess the mobility of pain sensitive neuromeningeal structures.[5] In the active slump test, the subjects were positioned in a sitting position and asked to fully flex the cervical spine, followed by the thoracic and lumbar spine. The subjects were then asked to fully dorsiflex their ankle and extend their knee until a stretch or discomfort was felt. The degree of knee extension was then measured. In the passive straight leg raise, the subjects were placed in the supine position on a plinth table as the examiner lifted their leg until the point of stretch or discomfort. The angle between the leg and the horizontal was then recorded with a bubble inclinometer. The interrater reliability for both tests was qualified as "very good" to "excellent" with high ICC values and measurement of error ranges were determined.[5] A similar study was conducted by Strender et al[6] in which the inter-tester reliability of several clinical tests, including the SLR test, were examined. Results illustrated a "good" intertester reliability of the SLR.[6]

Modifications from the typical straight leg raise testing position have been made in order determine if the lumbar spine position affects the straight leg raise test angle. In order to test this theory, Hall et al[7] attempted to determine the reliability of this modified SLR. The study was completed on asymptomatic individuals and showed intra- and intertester reliability of R1, P1, R2, and P2 during the modified SLR test.[7]

Clinicians use R1, defined as the point in joint range of motion at which passive resistance is first felt. This measure is assessed during tests referred to the upper limb tension, straight leg raise (SLR), and slump tests to identify the presence of neural tension. The nerve biomechanics (neurodynamics) that occur during these tests may explain the reproduction of symptoms seen in patients.

Adverse neural tension is an abnormal response of neural tissue caused by a physiological or mechanical defect in neural structures. Nerve provocation tests, such as the upper limb tension test, the straight leg raise, and the slump test, exert mechanical stresses on the nerve and nerve roots. Mechanical hypersensitivity of these structures can be detected via the patient's report of reproduction of symptoms. Studies have identified sensitizing maneuvers during the nerve provocation tests that allow clinicians to differentiate between neural tension and other non-neural or musculoskeletal pathologies.[8-10]

Cadaver studies have been used to identify the strain, tension, and excursion of the nerves in the upper and lower extremity during neural tension testing.[8-10] Coppieters et

Daemen College, Amherst, NY

al[10] used 8 male embalmed cadavers to measure the strain and excursion in the sciatic, tibial, plantar nerves, and plantar fascia during the different components of the straight leg raise test. The authors hypothesized that ankle dorsiflexion and hip flexion range of motion would significantly increase strain in the 3 nerves mentioned; the other prediction was that no increase in strain would be recorded in the plantar fascia.[10] Plantar fascia is a non-neural tissue and, therefore, would not be affected by maneuvers in tests aimed at increasing tension in neural structures. The results indicated that ankle dorsiflexion significantly increased strain in the tibial and plantar nerves, and hip flexion significantly increased tension in the sciatic and tibial nerves.[10] Excursion of the nerves was found to occur in the direction of the moving joint. There was no increase in strain in the plantar fascia, confirming that these maneuvers do not affect non-neural tissue and may be useful in differentiating between a peripheral nerve pathology and plantar fasciitis.[10] Cadaver studies have shown that the spinal cord is tensioned and slackened with cervical flexion and extension, respectively. Other studies have shown that neural mobilization techniques decreased neural tension in both symptomatic and asymptomatic subjects, which therefore increased R1.[11-17] Several studies have been conducted to identify the validity and reliability of adverse neural tension tests, however, varying results have been found.

The following studies by Coppieters et al,[18,19] were conducted to differentiate between neural and non-neural tissues. The authors injected specific muscles of asymptomatic volunteers with hypertonic saline. Measurements were taken for pain perception and the size of the painful area when performing neural tension tests. Coppieters et al[12] performed the upper limb tension test for the median nerve on subjects with injections into the thenar muscles of the hand. The authors found little variation in pain and the size of the painful area in the different testing positions, and therefore concluded that pain of a non-neural origin will not increase during neurodynamic testing.[18] Consequently, the upper limb tension test for the median nerve is a valuable test to differentiate neurogenic from non-neurogenic disorders.[18] Coppieters et al[13] explored the affect of induced muscle pain in the tibialis anterior musculature during the straight leg raise and induced muscle pain in the soleus musculature during the slump test implicating non-neural tissue. The results indicated that the different stages of the straight leg raise and slump test have no impact on pain perception when the pain is of a non-neural origin.[13] The findings of this study may support the specificity of these tests in detecting adverse neural tension.[19] Consistent with the two studies by Coppieters et al,[18,19] neural tension tests may be specific to detect neural tension, however, stress on non-neural tissues is possible. In determining the presence of neural tension, reproduction of the complaint may be most indicative of a positive test finding.[1]

Limitations in range of motion in the SLR measure may arise from neural tension, adverse neural tension, or shortness of the hamstring muscles. The clinical relevance of R1 may be determined by whether the measure is reproductive of the individual's complaint and whether the reproduction of that complaint is changed by intervention.[1]

The process of assessing the reliability of SLR in symptomatic individuals may begin with establishing the reliability of R1 in asymptomatic subjects. Whereas the P1 measure may be utilized in determining the first point of pain in patients, the focus of this research was to establish normative data in determination of R1 (the point of first resistance) in asymptomatic college-age individuals. This may serve as a preliminary investigation for future research comparing R1 measures in symptomatic individuals prior to and following physical therapy interventions.

PURPOSE

The purpose of this research is to determine the reliability and validity of R1 as measured during the straight leg raise.

METHODS

Subjects and Setting

Thirty asymptomatic subjects (18 females and 12 males) from local colleges in the western New York region participated in this study as noncompensated volunteers. Participants were between the ages of 18 and 31 years and were recruited from the campus of Daemen College in Amherst, NY. Exclusion criteria included the presence of low back pain, prior hamstring or hip injuries, surgeries, or pregnancy.

Design

A randomized controlled trial was conducted to assess the interrater and intrarater reliability of R1, during the straight leg raise (SLR) measure. Upon arrival, the subjects completed a questionnaire regarding their demographics, medical and surgical history, and history of low back pain and/or hamstring injury. The questionnaire was then reviewed to determine whether inclusion criteria were met. If the subjects were eligible to participate in the study, they were given an informed consent form. A second purpose of the study was to determine if the performance of repeated lumbar extension would significantly affect the SLR. The subjects were randomly assigned to a control group or experimental group. This study was reviewed and approved by the Daemen College Human Subjects Research Review Committee.

Examiners

Data were collected by 2 physical therapy professors who are Board Certified Orthopaedic Clinical Specialists active in clinical practice of musculoskeletal injuries. The examiners were assisted by 2 student physical therapists. Examiner A is a fellowship instructor with 25 years experience and credentials that include PhD, OCS, and FAAOMPT. Examiner B is a fellowship student with 15 years experience and credentials that include DSc and OCS.

Instruments

Measurements of the SLR were taken using the Dynatronics Inc (Salt Lake City, UT) Universal Inclinometer. The SLR has been found to be a reliable tool for measuring adverse neural tension[8]but was used in this study to assess range in asymptomatic individuals. The passive SLR measurement using an inclinometer was found to have excellent reliability, with an ICC of 0.93.[5]

Procedures

Upon arrival to Daemen College, the subjects completed a questionnaire. The questionnaire included demographics, history of low back pain, hamstring, and/or hip injuries or surgeries. If the subjects met the inclusion criteria, an informed consent form was completed and an identification number was assigned. The subjects were instructed to lie supine on plinth one and then the examiner completed a passive SLR. The SLR was measured with the subjects in supine on a plinth with the ankle in neutral, the knee fully extended, and both hips in 0° of abduction, adduction, and rotation. The examiner passively flexed the hip by raising the lower extremity off the plinth while maintaining the following positions: the ankle in neutral, the knee fully extended, and both hips in 0° of abduction, adduction, and rotation. These positions were maintained throughout the motion until the examiner first perceived resistance. Examiner A was paired with student researcher A. Prior to the SLR, examiner A palpated and placed the inclinometer on the right tibial tuberosity. The examiner set the inclinometer to 0, and was blindfolded. In order to maintain neutral hip rotation while blindfolded, Examiner A then grasped the right posterior leg firmly just inferior to the bulk of the calf during elevation until resistance was first felt. Examiner A paused briefly as student researcher A read the inclinometer over the examiner's shoulder and recorded the measurements. Measurements were completed on the left leg in the same manner, with the same order followed for each subject, the right limb always being assessed first. The subject was instructed to walk a short distance to plinth 2 and lie supine. The instructions and procedure were repeated by examiner B paired with student researcher B. After examiner B completed the SLR measurements, the subjects were instructed to report to plinth 3. Plinth 3 was located in an area of the same room, however, not in view of the previously discussed procedures. The experimental group performed the interventions in this area. The subjects assigned to the experimental group were instructed to lie in the prone position and complete 3 sets of 10 end range lumbar extension exercises (press-ups). The subjects assigned to the control group remained behind the room divider for the same amount of time as the experimental group, but did not perform the exercises. The subjects were then instructed to return to the first plinth. The SLR measures were then performed on the subjects in the same order as described previously. At the completion of day 1, subjects were asked to return 2 weeks later for follow-up measurements to establish intrarater reliability.

Upon arrival on the second test session, subjects checked in and received his or her identification number. The subjects were instructed to lie supine on plinth 1 and relax as the examiner passively performed the SLR measurement. Examiner A was paired with student researcher B and examiner B was paired with student researcher A. Examiner A palpated and placed the inclinometer on the right tibial tuberosity and then set the inclinometer to 0. The examiner was then was blindfolded and performed the SLR on the right leg to the first point at which resistance was felt. Examiner A then

paused while student researcher B read and recorded the measurement. As in the order performed earlier, measurements were then taken on the left leg. The subject was then instructed to lie supine on plinth 2 as examiner B performed the same procedure with student researcher A. Lumbar extension exercises were not performed by the subjects on day 2.

Treatment variables

Fifteen out of the 30 subjects were assigned to the experimental group and 15 were assigned to the control group. The experimental group performed 3 sets of 10 end range press-ups in the prone position. The control group did not receive an intervention.

Statistical analysis

To assess the effect of repeated lumbar extension on the SLR, data were analyzed using 4 paired t-tests. Level of significance for each test was set at $p < .05$. In all 4 t-tests, control subjects' right and left SLR measurements were compared to experimental subjects' right and left SLR measurements. Although 62% of the subjects demonstrated an improvement in the SLR at R1, these changes were not found to be statistically significant at $p > 0.05$. To assess reliability, a statistical analysis was performed with SPSS 6.0. Intra and interrater reliability were calculated using Intra-Class Correlation Coefficient (ICC). For the purposes of this study, fair reliability was represented by an ICC between 0.40 and 0.70.[20] Good reliability was represented by an ICC between 0.70 and 0.90.[20]

RESULTS

Thirty subjects participated in the study. The ages of subjects ranged from 18 to 31 and the mean age was 22.9 years. The intrarrater reliability was analyzed from the examiners' SLR measurements prior to lumbar extension exercise (pretest) on day 1 and corresponding day 2 measurements. Table 1 summarizes the results of intrarater reliability. The intrarater reliability for the onset of R1 was found to have good ICC for examiner A and B. ICC for examiner A

Table 1. Intrarater Reliability of R1 during the Straight Leg Raise (SLR)

	Intrarater Reliability Examiner A[*]	Intrarater Reliability Examiner B[*]
Passive SLR (Left)	0.71	0.73
Passive SLR (Right)	0.73	0.70

[*]Intraclass Correlation Coefficient

was 0.71 and 0.73 for the left and right SLR measures, respectively. Intraclass coeffient for examiner B was 0.73 and 0.70 for the left and right SLR measures, respectively. Table 2 summarizes the mean of the SLR measurements from day 1 pretest and day 2. The mean of the SLR measurements for Examiner A were 60° with a standard deviation (SD) of 7 on the right leg and 62° with an SD of 7 on the left leg. The mean of the SLR measurements for Examiner B were 61° with a SD of 8 on the right lower extremity and 62° with a SD of 10 on the left lower extremity.

Table 2. Mean (SD) of the SLR measurements from Day One Pretest and Day Two

	Examiner	Mean (SD)
Right Leg	A	60° (7)
	B	61° (8)
Left Leg	A	62° (7)
	B	62° (10)

Table 3 summarizes the results of interrater reliability. The interrater reliability was analyzed using pretest day 1 SLR measurements between examiner A and B, and was found to have fair ICC of 0.67 for the left lower extremity and 0.63 for the right lower extremity.

Interrater reliability between examiners' SLR measurements following lumbar extension exercises (posttest) was also analyzed. The interrater reliability between examiners for posttest day 1 was found to have fair ICC on the left SLR measure and good ICC on the right SLR measure. The interrater reliability posttest day 1 was 0.65 on the left and 0.71 on the right. A third inter-

Table 3. Interrater Reliability of R1 during the Straight Leg Raise (SLR)

	Interrater Reliability Day 1 Pre-Test*	Interrater Reliability Day 1 Post Test*	Interrater Reliability Day 2 (no lumbar extension exercises)*
Passive SLR (Left)	0.67	0.65	0.81
Passive SLR (Right)	0.63	0.71	0.78

*Intraclass Correlation Coefficient

rater reliability analysis was completed for the SLR measurements between examiners on day 2 when no lumbar extension exercise were performed. The interrater reliability on day 2 was found to have good ICC for both SLR measures. The interrater reliability was 0.81 and 0.78 for the left and right SLR measures, respectively. Table 4 summarizes the mean of the SLR measurements from examiners A and B. The mean of all measurements from day 1 pretest and day 2 was 61° with a SD of 8 on the right lower extremity and 62° with a SD of 9 on the left lower extremity.

Table 4. Mean (SD) of the SLR Measurements from Day One Pre-test and Day Two- Examiner A & B Together

	Mean (SD)
Right Leg	61° (8)
Left Leg	62° (9)

DISCUSSION

The results of this study indicated good intrarater reliability among 2 trained examiners in detecting R1 during a SLR measure in asymptomatic college students. The establishment of good intrarater reliability allowed for analysis of interrater reliability. The interrater reliability of detecting R1 during the SLR measure ranged from fair to good.

On day 1 of the experiment, 3 out of the 4 interrater reliability measurements (left and right lower extremity pretest and left lower extremity posttest) were found to have fair reliability ICC= 0.67, 0.63, and 0.65 respectively, while on day 2 of the experiment, the interrater reliability measurements (left and right lower extremities) were found to have good reliability ICC= 0.81, 0.78 respectively. The difference between interrater reliability on both days may be attributed to learning curve by the examiners. The intra- and interrater reliability can be associated with similar training of both examiners. In a study by Anson et al,[21] postgraduate training was a factor in the reliability of detecting R1. Both of the examiners in the present study are physical therapy professors and Board Certified Orthopaedic Clinical Specialists, who are active in clinical practice.

Physical therapy clinicians often assess P1, the point at which pain is first felt, rather than R1 when examining patients. For the purpose of this study, R1 was used to assess asymptomatic subjects who would not likely to experience pain (P1) during the straight leg raise. Previous studies have established excellent reliability of the SLR (ICC= .93) in detecting P1;[5]however, there is limited evidence on the reliability of the SLR using R1.

Neural tension is typically associated with SLR measurements between 35° and 70°. From 0° to 35°, there is slack in the nerve roots and no dural movement.[22] Fahrni[22] found that above 70° of SLR, there is no longer any movement of the nerve root and tension may be related primarily to joint pain or muscle tightness.

There is limited research pertaining to normative values for R1 in asymptomatic college-age individuals. R1 for the subjects in this study ranged between 44° and 90° for both examiners. The average R1 by both examiners for the right and the left legs were between 60° and 62°. In this study, the majority of asymptomatic individuals were in the range indicative of neural tension, but not symptom reproduction. Patients with SLR measurements in the range of neural tension (35-70°) may be at risk for low back or leg pain without experiencing symptoms.[22] Thus, R1 may be used in a clinic to identify asymptomatic patients in order to prevent signs and symptoms associated with ANT. Sensitizing maneuvers can be performed to distinguish ANT from other musculoskeletal pathologies;[23] however, this study did not include sensitizing maneuvers.

One limitation of this study was the inclinometer. Although research has concluded that the inclinometer is a reliable tool for measuring joint range of motion,[24] it was difficult to read during this study. The inclinometer was small, making it challenging for the student researchers to read the inclinometer precisely over the examiner's shoulder. While both student researchers were trained to read the inclinometer, differences in interpretation of the measurements may have negatively impacted the reliability.

Future studies should investigate the presence of ANT in asymptomatic individuals by incorporating treatment at R1 to prevent potential ANT related symptoms. Long-term studies should be conducted to determine the possible prevention of low leg and back pain.

CONCLUSION

This study found fair to good intra- and interrater reliability of R1 during the SLR with experienced clinicians. The normative values for asymptomatic individuals in the 18 to 31 age range were found to be in the range of adverse neural tension. Thus, the SLR may be used in the clinic to find R1 in asymptomatic individuals in order to prevent signs and symptoms associated with ANT. When 2 clinicians are treating the same patient, the clinicians should have similar backgrounds in order to accurately identify R1. The accurate identification of R1 would allow physical therapists to prevent symptoms of ANT at the appropriate degree of SLR based on the patient.

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Single Inclinometer vs. Double Inclinometer Measures of Lumbar Spine Range of Motion: A Validity Study

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ABSTRACT

Background: Previous studies have shown that the double inclinometer (DI) method of lumbar ROM measurement is reliable and valid when compared to the "gold standard" of radiography. The purpose of this study is to compare a novel SI method with the established DI technique in measurement of lumbar ROM. **Methods:** Participants underwent both the SI and DI lumbar ROM measurements in a randomized fashion. Using the DI measurements as the reference standard, the validity of the SI measurements was determined using simple linear regression. **Results:** Lumbar flexion averaged 37.3° (10.3°) using the DI method and 40.5° (10.4°) using the SI method. Lumbar extension averaged 14.9° (11.0°) using the DI method and 14.9° (8.8°) using the SI method. The SI closely predicted the DI measurement outcome, establishing validity for the novel technique. **Clinical Relevance:** The validity of the SI method was established for both flexion and extension movements. These results support the use of the single inclinometer method.

Key Words: inclinometer, validity, lumbar range of motion

INTRODUCTION

Low back pain (LBP) and its associated dysfunction is a major health concern in the United States. A recent cross-sectional study over a 14-year period showed a dramatic increase of people identified as having chronic (>3 months), impairing low back pain. The incidence rate of LBP in the non-institutionalized population sample (5357 households) demonstrated an increase from 3.9% in 1992 to 10.2% in 2006, across all age strata with 84% of those LBP subjects seeking care from a health care provider.[1]

Precise range of motion (ROM) measurements are helpful for determining disability, guiding overall treatment, and restoring function in patients with LBP. Several measurement techniques in determining ROM and spinal dysfunction have been assessed in the past. Inclinometer measurement has been shown to be both reliable and valid when compared to other devices for measuring lumbar spine ROM in LBP populations.[2-4] In particular, the double inclinometer (DI) method of assessing spinal dysfunction and frequently associated LBP has demonstrated to have both high intra- and inter-rater reliabilities when compared to the "gold standard" radiography.[3-6] No study to date has investigated the validity of the single inclinometer (SI) technique in assessing spinal dysfunction in LBP populations. The clinical use of a single inclinometer in spinal ROM measurement, if valid, would be less expensive and easier to manipulate than DI. The purpose of this study is to compare a novel SI method with the established DI technique in measurement of lumbar ROM.

METHODS

Participants

A convenience sample of 20 healthy volunteers (female = 14, mean age =25.3) without current complaint of low back pain participated. The Institutional Review Board for Human Subjects at Western Carolina University approved the study. Criteria for inclusion were 18 years of age and older, written consent to participate, and proficiency with the English language. Exclusion criteria were current episode of low back pain (< 6 months), previous lumbar surgery, and past medical history of spondyloarthropathy.

Experimental Procedure

Randomization of tester assignment to either SI or DI technique was determined by a coin flip. The tester assigned to perform DI also performed skin marking for the instruments.

Placement of instruments

For both flexion and extension measurement, testers took position opposite of each other on the right and left side of the subject. Instruments were placed by each tester simultaneously in order to both measure the same event. Total lumbar ROM is the difference between the inclinometer measurements at the T_{12} and S_1 locations. The angle on the upper inclinometer (T_{12}) indicates gross lumbopelvic and hip motion and the lower inclinometer (S_1) indicates pelvic and hip motion only. For the DI measurement, one inclinometer was placed just lateral to S_1 and the second inclinometer was placed just lateral to T_{12}. Both inclinometers were zeroed prior to the initiation of movement. For the SI measurement, the inclinometer was placed at just lateral to S_1 and zeroed.

Flexion measurement

Subjects were asked to stand with their feet together and knees straight in a relaxed stance then and bend forward as far as comfortable. Each subject was allowed 3 practice trials for warm-up. Instruments were placed as outlined above and the subject was asked to perform lumbar flexion and momentarily hold their position at the end of their comfortable range. The DI-S_1 and DI-T_{12} angles were read and recorded. The SI-S_1 angle was read and the inclinometer was then moved superiorly just lateral to the T_{12} marking, re-zeroed, and held in place. The subject was then asked to return to their

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*This study was conducted for partial fulfillment of the requirements of the WCU MPT degree.

original relaxed starting position, and the SI-T_{12} angle was read.

Extension measurement

For extension, subjects were asked to stand relaxed with feet together and arms crossed in front of their body and bend backwards as far as comfortable. Measurement values during extension movement for DI and SI, respectively, were determined in the manner previously described for flexion.

Statistical Analysis

The measurements taken by each method for the two motions were analyzed using SPSS software. Using the DI measurements as the reference standard, the validity of the SI measurements was determined using simple linear regression, where the SI value was the independent (predictor) variable used to estimate the value measured using the DI technique (dependent variable). We also determined the median, range, and 95% confidence interval of the paired differences between the SI and predicted DI value.

RESULTS

Lumbar flexion averaged 37.3° (10.3°) using the DI method and 40.5° (10.4°) using the SI method. Lumbar extension averaged 14.9° (11.0°) using the DI method and 14.9° (8.8°) using the SI method. With y and x representing the DI and SI values, respectively, the following equations were found to be significant using simple linear regression:

Flexion: $y = x * 0.86 + 2.4$ ($p < 0.001$ [slope: β] and $p = 0.64$ [constant: b])
Extension: $y = x * 0.86 – 1.004$ ($p < 0.001$ [slope: β] and $p = 0.70$ [constant: b])

The median of paired differences between the DI flexion and predicted value was 0.3° (range: -6.4-9.1°; 95% CI: -4.9 – 5.5°). The median paired differences between the DI extension and predicted value was -1.8° (range: -18.0-7.9°; 95% CI: -4.1 – 7.7°). Values obtained during the DI measurements are plotted against the values predicted from the SI measurements in Figures 1 and 2.

DISCUSSION

Reliable methods for measuring lumbar ROM are important in assessing spinal function in individuals with LBP.[8] Clinical measurements must be valid and reliable to be of value.[2] Previous investigators have

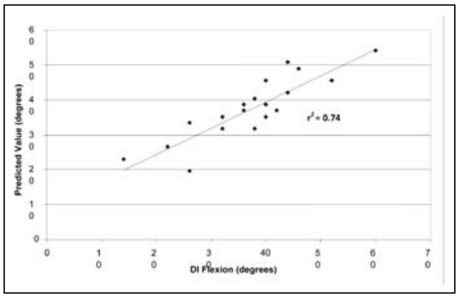

Figure 1. Plot of DI flexion vs. the predicted value of DI flexion from the SI flexion using the equation y = x * 0.86 + 2.4 where y and x are DI flexion and SI flexion, respectively.

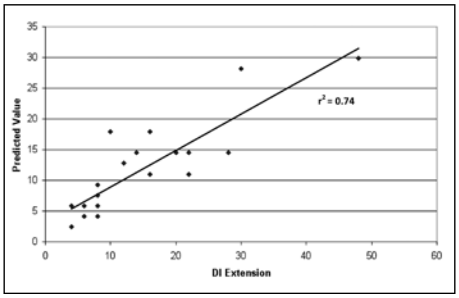

Figure 2. Plot of DI extension vs. the predicted value of DI extension from the SI flexion using the equation y = x * 0.86 – 1.0 where y and x are DI extension and SI extension, respectively.

shown the double inclinometer method to be reliable for the measurement of lumbar ROM.[3-4] Furthermore, Saur demonstrated that manually determining (palpating) the reference points for the double inclinometer method is reliable when compared to a fluoroscopically identified landmark; and that total lumbar ROM as measured by DI was highly correlated (r = 0.97) with radiographic measured ROM, thus establishing validity for the DI technique.[9]

The current study investigated a novel measurement method, single inclinometer lumbar ROM assessment, and its validity compared to the previously established valid double inclinometer method. The single inclinometer method represents an alternative for the clinician, which is less expensive and possibly less cumbersome and easier to administer. The results of the current study suggest that the SI method is valid when compared to the DI method in a population of healthy, asymptomatic young adults.

Simple linear regression analysis is a useful statistical method for determining validity. The following describes linear regression analysis and its role in the interpretation of the study findings. Regression analysis is used to study relationship(s) between a dependent variable and one (simple regression) or more (multiple regression) independent or predictor variables. In our study using simple regression the dependent variable DI was the "gold standard" measurement used to validate the use of the SI measurement (independent or predictor variable). Regression analysis produces an equation that uses the independent variable to estimate or predict the dependent variable. This prediction equation is the equation for a straight line:

$$y = mx + b$$

where,

- y: dependent variable (in our study this was the DI measurement)
- m: slope of the regression line
- x: independent variable (in our study this was the SI measurement)
- b: offset from the origin when the line equation is plotted on the x y graph.

In linear regression, m (slope) is represented by β (Greek symbol beta). When there is only one independent variable (simple regression), β is equivalent to the more familiar r-value calculated with Pearson's correlation indicating the strength of the relationship (or prediction) between the dependent and independent variables. In our study β was 0.86 ($p < 0.001$) for both flexion and extension. The offset value (b) accounts for any consistent (systematic) difference between the independent and dependent variables. If b equals 0, the raw value of independent variable can be used in place of the dependent variable. We found offsets that were different from 0, but the differences were not significant. Generally speaking the more significantly different b is from 0 the more important it is to apply the regression equation when using the independent variable to predict the dependent variable. When the independent variable is entered into the regression equation to predict the dependent variable, there will usually be a difference between the values. These difference values have clinical importance. The median value of the paired differences, which is less sensitive to outliers than the mean, gives a sense of how close the predicted value is to the actual value. One must also consider the range and 95% confidence interval (CI) of the paired differences. The range includes any outliers (if present) and allows the reader to determine if they are acceptable. The 95% CI is a range that is less influenced by outliers and gives a sense of how close the predicted value will be in 95% of the measurements.

Limitations

There are several limitations of the current study. First the sample size was small (N=20) and relatively homogenous, healthy (20-30 yr old healthy young adults). Finally, testing was performed only one time per participant. Thus, test-retest reliability was not established. Future research could be directed toward large, symptomatic subjects with test-retest reliability as part of the design. For utility, comparison of the single inclinometer technique with other methods, such as the modified-modified Schöber and radiography, could be considered as well.

CONCLUSION

The current study described a novel method of measuring lumbar ROM using a single inclinometer and its validity with the commonly accepted double inclinometer method. The validity of the SI method was found to be good for both flexion and extension movements. These results support the use of the single inclinometer method as a quicker and less expensive measurement tool when compared to the double inclinometer (DI) method. However, as the subjects were healthy young adults, this method needs further investigation with a more diverse population including symptomatic patients. Based on the promising results of the current study, the SI technique should be considered as a clinical measurement method by practicing physical therapists.

ACKNOWLEDGEMENTS

The authors would like to thank Sue McPherson, PhD for her assistance with this project.

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2010 Elections

The 2010 Orthopaedic Section election is fast approaching. Don't forget to vote in November! The slate includes:

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Roy Bechtel, PT, PhD
James J. Irrgang, PT, PhD, ATC, FAPTA

NOMINATING COMMITTEE MEMBER:
Robert DuVall, PT, DHSc, MMSc, OCS, SCS, ATC, FAAOMPT, MTC, PCC, CSCS
Deborah L. Givens, PT, PhD, DPT, OCS
Rob Roy Martin, PT
Dr. Todd Allen Telemeco, DPT, PT, PhD

And for the Special Interest Groups (SIGs), the slate includes:

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Get involved! Cast your Vote!!

Book Reviews

Michael J. Wooden, PT, MS, OCS
Book Review Editor

Singh K, Ed. ***Curbside Consultation of the Spine: 49 Clinical Questions.*** Thorofare, NJ: SLACK Incorporated; 2008, 170 pp., illus.

The intent of this book is to provide concise, practical answers to questions about the care of patients with spinal disorders that are often left unanswered by traditional spine references. There are 8 contributing authors to this book, all of whom are physicians. While the intended audience for this book is orthopedic spine surgeons and neurosurgeons, other health care providers can benefit from the brief discussions regarding the medical and surgical care of patients with spinal disorders.

The book contains 49 scenarios that are organized into the following 15 sections: Anatomy, Diagnostic Imaging, Surgical Approach, Spinal Instrumentation, Tumor, Infection, Trauma, Degenerative Disease, Pediatrics, Bone Grafts, Intraoperative Technique, Postoperative Patients, Sports Medicine, Deformity, and Rehabilitation.

Each section is presented in a standardized question and answer format. Some of the questions that may interest physical therapists are:

- "I have a 34-year-old male with recurrent leg pain 4 weeks after a discectomy - what imaging study should I order?"
- "What risk factors will increase the likelihood of postoperative infection?"
- "What screening radiographs should a spinal trauma patient get?"
- "I have a 12-year-old male with a 3-month history of back pain that does not appear to be resolving - how should I work up back pain in an adolescent?"
- "I have a 62-year-old female with rheumatoid arthritis who has become myelopathic - does she need an operation?"

The answers provided are brief (typically 2 to 3 pages in length), well-written, and easy to follow. Additionally, the answers are written in a straightforward, somewhat conversational tone, similar to what might be expected in a dialog between colleagues.

The unique format of this book allows the authors to offer evidence-based advice, as well as preferences and opinions, on a wide range of practical topics relating to the care of patients with spinal disorders. Images, line drawings, and diagrams are routinely used to supplement the text. Pertinent reference lists follow each answer, which invite more in-depth review of the literature for a given scenario.

Unfortunately for physical therapists, there are only 3 scenarios that deal with the rehabilitation of patients with spinal disorders. Therefore, this book would not be recommended for the physical therapist looking for specific information on the rehabilitation of patients with spinal disorders. However, it would serve as a valuable primer for the physical therapist who would like to gain a basic understanding of the medical and surgical care of patients with spinal disorders ranging from those that are more common (ie, disc degeneration, radiculopathies) to those that are less common and more complex (ie, infections, tumors, spinal cord injuries). This book would also be a useful addition to a hospital or university library, where it could be accessed by several different disciplines.

Michael D. Ross, PT, DHSc, OCS

David TS, Andrews JR, eds. ***Arthroscopic Techniques of the Shoulder: A Visual Guide.*** Thorofare, NJ: Slack, Inc.; 2009, 175 pp., illus.

This book is comprised of 14 chapters, written by different surgeons who are experts in the field of orthopaedic surgery of the shoulder. The main purpose of the book according to the editors is to provide "useful pointers organized in a manner that could be accessed or referenced quickly and is visually rich in photos, high in content, and low in verbiage."

In the first chapter, positions used for the arthroscopic surgical procedures are described. Both the lateral decubitus position and the beach chair position are discussed, with advantages and disadvantages for each. Tips for successful positioning, surgical tips and pearls, as well as pitfalls are addressed.

Chapter 2 outlines shoulder surgical portals. Various portal entries are covered, including 5 posterior portals, 2 anterior portals, 2 low anterior portals, 5 lateral portals, and 3 other portal entries. Each portal description includes landmarks, indications for the portal site, and risks associated with using the portal.

Chapters 3-14 cover various procedures performed with shoulder arthroscopy. The topics include diagnostic arthroscopy, subacromial decompression, distal clavicle excision, rotator cuff repair: bridging suture techniques, arthroscopic subscapularis repair, massive rotator cuff repairs, superior labral repairs, Bankart repairs, capsular imbrications, arthroscopic capsular release, coracoplasty, and arthroscopic biceps tenodesis.

Each chapter describes the goals, operative technique, tips and clinical pearls, and pitfalls. The latter two topics assist the surgeon in obtaining the best surgical technique to maximize the outcomes, while minimizing potential complications.

The editors' main objective was undoubtedly achieved. The book is very well organized and easy to follow. The book is written in bullet-style format, allowing the reader to quickly look for necessary information. All of the pictures are in color, and are clearly labeled. The pictures include not just the surgical procedure itself, but also the set-up in the operating room and of the specific equipment used. For a reader who is less familiar with the specifics of the surgical procedures this book offers a great insight as to what occurs. This book is a great reference for anyone who is involved with the surgical care of patients, from physicians to therapists, of any level. For therapists, this book is also a great tool to use in education of their patients about the procedure they have just gone through or about to go through. I would highly recommend this book to anyone in the health care industry for the reasons stated above.

Michelle Finnegan, DPT, OCS, MTC, FAAOMPT

Antaya G. ***The Princess and the Pea: A Holistic Approach to Orthopedic Manual Physical Therapy.*** Minneapolis, MN: Langdon Street Press; 2009, 121 pp.

This book describes a holistic approach to orthopaedic manual therapy. The author describes herself as a holistic physical therapist with over 20 years of experience. The purpose of the book is to describe complexities of the human body and, is written for manual therapists who look beyond "conventional" assessment and treatment. It is based on a holistic approach, to orthopaedic manual therapy including evaluation and treatment and how the clinician can use alternative manual therapy techniques to influence their patients and restore the body to eliminate symptoms. Many of the concepts here are influenced by Cyriax, Upledger, and Barral.

The book is comprised of 12 chapters, describing conventional and alternative manual therapy techniques, a holistic approach to assessment and treatment, craniosacral therapy, visceral release, heightened palpation, and energy treatment.

Chapter 1 defines the difference between conventional and alternative manual therapy treatments. The author believes that in orthopaedic manual physical therapy, there should be a paradigm shift from a symptom-oriented, localized view of pain and dysfunction to a holistic, whole -body mind view of pain and dysfunction. The author's belief is that difficult cases can be solved with this shift in paradigm.

Chapters 2 and 3 describe a holistic approach to both assessment and treatment. The author uses the Cyriax assessment tool with biomechanical evaluation and treatment, and uses alternative techniques such as craniosacral rhythm, energy scan, arcing, diaphragm releasing, and unwinding to add to the assessment and treatment.

Chapter 4 discusses the important role that craniosacral therapy has in orthopaedic manual therapy. An in-depth discussion on what is craniosacral therapy was written along with key components of craniosacral therapy including Head-on-Neck (HON) posture, the dural tube, and how emotional aspects are affected from using craniosacral therapy. The author has tried to simplify this work, which is taught in a series of continuing education courses.

Chapter 5 describes the role of the visceral system in this holistic approach. This short chapter defines visceral mobilization, its importance to the body, and the most common areas of restriction including the craniosacral and visceral systems.

Chapters 6 and 7 describe the use of heightened palpation skills and its importance in feeling for dysfunction with the hands. It also begins in-depth discussion on energy medicine, the use of vision and sixth sense and how it is incorporated in today's alternative manual therapy treatment. Discussion on how to improve the therapists hand/body awareness is discussed with examples and case studies.

Chapter 8 describes how body imaging can be incorporated into treatment in orthopaedic manual physical therapy. The author feels that having a positive body image is associated with a healthy, positive outlook on life that helps not only our emotional state but biomechanical state as well. The author uses numerous examples to discuss how body imaging should be incorporated into practice.

Chapters 9, 10, and 11 are the final chapters of the book discussing how holistic physical therapy fits into the big picture of orthopaedic manual physical therapy. The author points out that science in this area is lacking. In Chapter 11, case studies are presented within the context of the previous chapters. Subjective and objective findings were described and treatment progression is described over a period of a few weeks. Conclusions were made to each of these patients how a holistic approach helped them relieve their pain over conventional treatment.

Overall, I found the book interesting, but difficult to read because of lack of flow. I am not sure where it fits in the overall orthopaedic manual physical therapy paradigm. As a manual physical therapist, I am always looking for advances to treatment that may be considered "alternative.' This book describes some of those treatment methods but was biased toward craniosacral therapy. From a scientific point of view, there is no evidence; therefore, none of this approach is evidence-based. That said, the orthopaedic manual physical therapist might use this book as a guide in choosing other continuing education courses.

David M. Nissenbaum, MPT, MA, LAT

IMAGING EDUCATIONAL INTEREST GROUP

The Imaging Educational Interest Group (IEIG) was established by the Section with the goal of being a valued resource for physical therapists involved with imaging. The chair is Douglas M. White, DPT, OCS. Our activities to date include:

- Provided well attended programming at CSM 2009.
- Established a Google Group for APTA members with an interest in imaging. This is the place to be for updates, resources, to ask questions of your peers, mentorship, and networking. For an invitation send an email with your APTA membership number to Dr.DMWhite@gmail.com.
- Dr. White is scheduled to present Sonography to the APTA State Government Affairs forum.
- As this issue of OP arrives in your mail box, the International Summit on Direct Access and Advanced Scope of Practice will soon be taking place in Washington, DC. Dr. White will be attending and he hopes to see many other physical therapists with an interest in imaging as this will be a major topic. Go to www.directaccesssummit.com for more information and to register.
- The IEIG is sponsoring 2 preconference programs for CSM 2010 in San Diego.
  - Sonography for Common Upper Extremity Orthopaedic Conditions: This course will present the physical therapy application of musculoskeletal sonography for common shoulder, elbow, wrist, and hand conditions. The course will provide an overview of the physics of sonography and application. Techniques of imaging the upper extremity will be presented. Identification of normal anatomy and abnormal morphology will be presented. The indications for, and limitations of, sonography in musculoskeletal conditions will be discussed. Participants will apply techniques learned using hands-on sessions with live demonstrations and practice sessions. The practical aspects of incorporating sonography into PT practice will be presented.
  - Imaging for the Physical Therapist: From Basics to Application: This workshop will focus on the application of imaging in physical therapy practice. The imaging characteristics of Conventional Radiography, CT, MRI, and Diagnostic Ultrasound will be presented, as well as their value in the examination of various dysfunctions and diseases. Furthermore, there will be opportunities to review radiographic anatomy. This workshop will help the therapist employ imaging in clinical work: 1) Identify clinical presentations that indicate further imaging studies. 2) Use imaging studies to assess contra-indications to treatment. 3) Modify treatment based on imaging studies.
- During CSM 2010 the EIG is sponsoring:
  - Evidence Based Practice and Integration of Musculoskeletal Imaging in Physical Therapy Practice: A Case Based Approach for the Shoulder and Knee: This case based course of the shoulder and knee complexes reviews a wide spectrum of imaging principles including the rationale for certain imaging modalities. This course will address plain radiographs (x-rays), magnetic resonance imaging (MRI), computed tomography (CT), MRI & CT arthrogram, rehabilitative ultrasound imaging and the role and limitations of specific image sequences. Actual patient cases will be used and full sequences of images will be viewed to learn strategies on how to identify normal anatomy as well as commonly seen musculoskeletal pathologies including tendon dysfunction, fractures, ligamentous tears, and muscular dysfunction. Participants will also be taught how to integrate and apply imaging findings into their overall musculoskeletal clinical practice.

Topics in Geriatrics: Volume 5

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APTA American Physical Therapy Association *The Science of Healing. The Art of Caring.*

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Topics in Geriatrics: Volume 5 offers the course participant an increased depth of knowledge on multiple topics: amputee rehabilitation for patients with diabetes; the integumentary system; health promotion; orthopedic considerations in the lower quarter; and osteoarthritis in the upper quarter. The participant will gain clinically-applicable knowledge across a variety of practice areas, making this course ideal for the generalist in geriatric physical therapy who is committed to lifelong learning and providing top-quality, evidence-based care to his or her patients.

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- Differential Diagnosis in the Management of the Integumentary System—*Paula Simon, PT, DPT, GCS*
- The Role of the Physical Therapist in Health Promotion for Older Adults—*Jason Hardage, PT, DScPT, NCS*
- The Aging Skeleton: Lower Quarter—*Holly Lookabaugh-Deur, PT, DSc, GCS*
- Osteoarthritis in the Upper Quarter—*Leon F. Bradway, PT, MS, CMT*

Editor

Jason Hardage, PT, DScPT, NCS
Sue Wenker, PT, MS, GCS

Additional Questions

Phone toll free 877/766-3452 • Fax 608/788-3965
Section on Geriatrics, APTA, 2920 East Avenue South, Suite 200
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- Topics in Geriatrics: Volume 4–*30 contact hours* (topics include electrically-powered mobility devices and seating systems; reimbursement issues; breast cancer; issues in the Veterans Health Care System; end-of-life issues; and pharmacokinetics, pharmacodynamics, and disease management)
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- FOCUS: Geriatric Physical Therapy–*30 contact hours* (topics include the musculoskeletal system; the neuromuscular system; the pulmonary system; the integumentary system; the cardiovascular system; and multisystem involvement)
- Topics in Geriatrics: Volume 2 (formerly named Topics in Geriatrics 2005)–*30 contact hours* (topics include therapeutic exercise; chronic obstructive pulmonary disease; post-polio syndrome; aquatic exercise; management of physical and chemical restraints; and ethics)
- Topics in Geriatrics: Volume 1 (formerly named Topics in Geriatrics 2004)–*20 contact hours* (topics include issues in home care; Alzheimer disease; and diabetes)
- Focus on Physical Therapist Assistants in Geriatrics–*10 contact hours* (topics include wound care and red flags in acute care)

Fees for Current Home Study Courses

	Section on Geriatrics Member	APTA Member	Non-APTA Member
Topics in Geriatrics: Volume 5 (available thru Dec 2014)	$200	$300	$400
Topics in Geriatrics: Volume 4 (available thru Dec 2013)	$200	$300	$400
Topics in Geriatrics: Volume 3 (available thru Dec 2012)	$200	$300	$400
FOCUS: Geriatric Physical Therapy (available thru Dec 2011)	$200	$300	$400
Topics in Geriatrics: Volume 2 (available thru Dec 2010)	$200	$300	$400
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(Note: must already be a member of APTA.) ☐ I wish to become a PTA Member ($35).
☐ I wish to become a PT Member ($45).

Fax registration and Visa, MasterCard, American Express, or Discover number to: (608) 788-3965

Visa/MC/AmEx/Discover (circle one) # ______________________________

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Registration Fee	________
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Please make checks payable to: Section on Geriatrics
Mail check and registration form to: Section on Geriatrics, APTA, 2920 East Avenue South, Suite 200, La Crosse, WI 54601. 877-766-3452

Orthopaedic Section, APTA, Inc.

Pre-conference Courses & Conference Information

2010 Combined Sections Meeting

2-Day Pre-conference Courses
Tuesday & Wednesday, February 16 – 17, 2010

Imaging for the Physical Therapist: From Basics to Application

Description: This workshop will focus on the application of imaging in physical therapy practice. The imaging characteristics of Conventional Radiography, CT, MRI, and Diagnostic Ultrasound will be presented, as well as their value in the examination of various dysfunctions and diseases. Furthermore, there will be opportunities to review radiographic anatomy. This workshop will help the therapist employ imaging in clinical work: 1) Identify clinical presentations that indicate further imaging studies. 2) Use imaging studies to assess contra-indications to treatment. 3) Modify treatment based on imaging studies.
Speakers: *Lynn McKinnis, PT, BS; Hilmir Agustsson, DPT, MHSc, MTC, CFC*

Mobilization of the Nervous System

Description: This pre-conference course, with course notes written by David Butler and the faculty of NOI, is intimately related to orthopedic physical therapists as the content of the presentation integrates current pain sciences, neurodynamics, manual therapy and clinical reasoning. It consists of evidence-based strategies and management of the physical dysfunction of the nervous system. Neurodynamics is a new science. This course offers a fresh understanding and management strategies for common syndromes such as plantar fasciitis, tennis elbow, nerve root disorders, carpal tunnel syndromes and spinal pain. Innovative management tools involve conservative decompression of nerves, various neural mobilizing techniques and the new patient education techniques which emerge from neurodynamics and pain sciences.
Speakers: *Robert Johnson, PT, MS, OCS; Steve Schmidt, PT; Emilio Puentedura, PT, DPT, OCS, FAAOMPT; John Tomberlin, PT, OCS; Adriaan Louw, MPT*

Selected Manual Therapy Interventions and Functional Exercises for the Lower Extremities

Description: The purpose of this two day pre-conference course is to enhance the physical therapist's knowledge of the manual interventions and functional exercise prescription for lower extremity pathology. A unique feature of this course is the integration of exercises designed not only to enhance the therapeutic effects of the manual therapy interventions, but also to progress toward full function. Each day will include extensive hands-on mobilization and exercise labs, culminating on the second day with two case studies. The attendees will have the basic skill set to correctly diagnose and provide the appropriate manual intervention and progressive exercise program for this patient group. Strong emphasis on intervention with both thrust and non-thrust techniques as well as exercise prescription.
Speakers: *Robert Boyles, PT, DSc, OCS, FAAOMPT; Danny McMillian, DScPT*

1-Day Pre-conference Courses
Wednesday, February 17, 2010

Sonography for Common Upper Extremity Orthopaedic Conditions

Description: Sonography is fast becoming an adjunct to physical therapist management of orthopaedic conditions. This course will present the physical therapy application of musculoskeletal sonography for common shoulder, elbow, wrist and hand conditions. The course will provide an overview of the physics of sonography and application. Techniques of imaging the upper extremity will be presented. Identification of normal anatomy and abnormal morphology will be presented. The indications for, and limitations of, sonography in musculoskeletal conditions will be discussed. Participants will apply techniques learned using hands-on sessions with live demonstrations and practice sessions. The practical aspects of incorporating sonography into PT practice will be presented.
Speakers: *Douglas M. White, PT, DPT, OCS; Wayne Smith, DPT; Reg B. Wilcox, III, DPT, MS*

Comprehensive Cervical Spine Management: What am I missing?

Description: Recent literature suggests that treating acute neck pain, whether of insidious or traumatic onset, by addressing the impairments of pain, decreased mobility, and weakness is not sufficient to prevent some patients from progressing to a chronic condition. Findings of older studies, *some over 15 years old*, have yet to make it into mainstream management of cervical conditions. The purpose of this course is to discuss, demonstrate and practice the evaluation and treatment of proprioceptive, oculomotor, muscle endurance, and postural control impairments that are associated with neck pain. The participant will leave with an understanding of the additional components necessary for a truly comprehensive management program for patients with cervical pain.
Speaker: *Rob Landel, DPT, OCS*

Knee & Patellofemoral Dysfunction; Examination, Diagnosis, Surgical Considerations & Treatment Methods

Description: Advanced examination, diagnosis and treatment methods for knee pathology with emphasis on patellofemoral dysfunction. Specific patellofemoral examination, patella malalignments identified, static and active PF structures assessed and lower extremity muscle function defined. Information regarding specific knee exam, research, surgery and post-op protocols will be discussed. Practical exam and treatment methods will be performed. Understanding and recognition of abnormal MRI and x-ray studies. New manual and exercise techniques will be described. Learn how to discuss PT treatment options with physicians.
Speaker: *Kate Grace, PT*

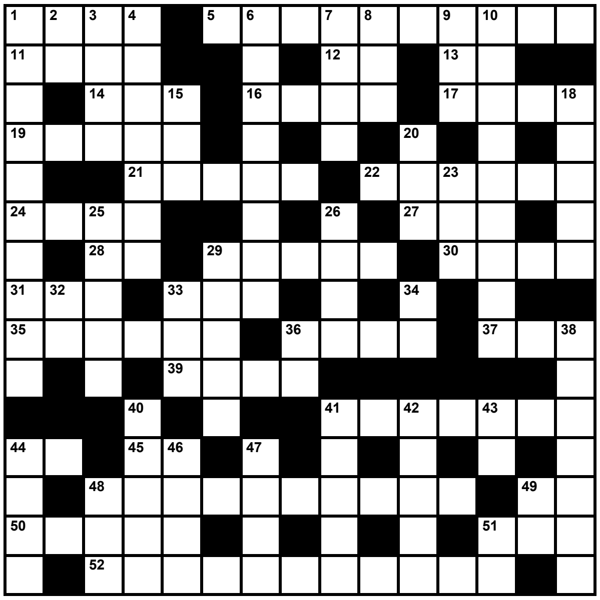
The How-to-Guide to Develop and Manage an Orthopedic Residency Program

Description: The Orthopedic Section of the APTA has adopted an initiative to promote the expansion of residency training programs in Orthopedic Physical Therapy. Outpatient orthopedic physical therapy clinics are encouraged to explore the value added benefit of residency training on site. Training the next generation of clinical specialists in the area of orthopedics is a way to contribute to the profession and raise the level and profile of your practice. This pre-conference course will review all the necessary components to the successful development of Residency Training in your clinic. This includes a review of curricular components of orthopedic knowledge, skills, and abilities required of residency programs. The program will explore sample curriculum and unique methods to provide the necessary lecture and lab training to the residents. The breadth and depth of material covered will apply equally to those contemplating the idea and to those fine tuning their application for credentialed status. Bring your laptop!
Speakers: *Tara Jo Manal, PT, DPT, OCS, SCS; Jason Tonley, PT, DPT, OCS*

Clinical Pilates: The Bridge between the Pilates System and Physical Therapy

Description: Lecture, review of evidence, instruction and guided lab practice is designed to enhance the participants experiential understanding of the classic Pilates Method, and breakdown of the of the Pilates' core fundamentals for a unique application and integration throughout the continuum of care. Small groups and limited enrollment ensure individualized instruction and attention for mat practice. Participants should bring a mat for lab portion.
Speakers: *Aija Paegle, MPT; Sarah Faller, BFA, CPI*

LOOKING FOR MORE DETAILS? Complete information the Orthopaedic Section's eight pre-conferences, conference programming and platform presentations can be found online: www.orthopt.org ***We'll see you in San Diego!***



Hip Bits and Pieces

Crossword by Myles Mellor
www.thecrosswords.com

Answers can be found at Orthopaedic Section Web site: www.orthopt.org

Across

1 Gray's subject (for short)
5 Bony structure of the hip (2 words)
11 Hip joint
12 ___crum
13 Internet address
14 Treatment for swelling
16 Way of walking that can be affected by hip bones and their placement
17 One of the prominent palpable bony structures of the hip, for short
19 Lab examinations
21 Articles
22 Bowed
24 Hip motion is ___ in socket motion
27 Window type
28 Mystery TV channel letters
29 A joining at the hip?
30 One the prominent bony structures of the hip, for short
31 Midback muscle, for short
33 Relevant
35 Of service
36 One side of the hip
37 Hang loosely
39 Going in an opposite direction
41 Lower portion of either innominate bone
44 "The hip bone's connected __ the thigh bone...."
45 Stumbling expression
48 The ilium, pubis and ischium are all separated by the ______ cartilage
49 Student loan, for short
50 Repeated
51 Have a medical problem
52 One of the extracapsular ligaments

Down

1 Socket in the hipbone
2 Disapproval word
3 Line of rotation
4 Relating to the sense of touch
6 Pubofemoral _____
7 One of the prominent bony structures of the pelvis, for short
8 Kind of scan
9 Tear
10 Slipped ___ can occur with hip bones
15 Approx.
18 Lateral halves of the body
20 Circular object
23 Upper limit
25 Tensor fascia ____
26 Femur, for one
29 Overturn
32 Top grades
33 In the manner of (2 words)
34 Length measurement, for short
36 Roman 51
38 The inferior and superior ____ may be termed triceps coxae together with the obturator internus
40 Relating to a membrane covering the brain and the spinal cord
41 Upper hipbone portion
42 More attractive
43 Placed inside
44 Lacerated
46 Small version
47 Back of the leg muscle
48 Prefix with angle
49 ___ joint
51 Aluminum symbol

Occupational Health

SPECIAL INTEREST GROUP

AUGUST 2009 OHSIG BOARD STRATEGIC PLANNING MEETING

Greetings OHSIG members! We wanted to update you on activities taking place on your behalf. The OHSIG Board met in Chicago for 2 days of strategic planning. Those who attended included:

- Dee Daley, VP/Ed Chair
- Drew Bossen, Practice Chair
- Rick Wickstrom, Membership Chair and Advisor
- Kathy Rockefeller, Research Chair
- John Lowe, Nominating Committee Chair
- Margot Miller, Immediate Past President/Advisor

Topic areas included the following:

1) Updated OHSIG Mission, Vision, and 3-year Strategic Plan. Once approved, the Strategic Plan will be posted on OHSIG/Ortho Web site for members to view.
2) Reviewed the working draft of the Work Rehab Guidelines and made final edits. Once approved, these will be posted on APTA's Web site, under Occupational Health Guidelines. A timeline for revising the remaining guidelines is as follows: Ergonomic and Legal guidelines 2010; Acute Care and Role of the PT in Occ Health 2010/2011.
3) Discussed establishing liaison relationships with key contacts at the State level for payment policy and practice issues. This will assist dissemination of current information to OHSIG members. Our goal is to establish liaisons by November 2009.
4) Promote evidence-based practice in occupational health by disseminating peer reviewed literature to OHSIG members via citation email blast. Our goal is to do this quarterly.
5) Discussed improved capability for "Finding a PT" who is working in the area of Occupational Health and an OHSIG member.
6) Discussed establishing liaison relationships with external stake holder groups for exchange of information.
7) Identify "special projects" where OHSIG members have an opportunity to participate in areas of their expertise and where a finite timeline is identified. This will promote member involvement without long duration commitment.
8) Discussed options for moving forward with specialty/certification designation in occupational health physical therapy.

Seeking Authors for OPTP
We are seeking authors for OPTP. If you would like to submit an article on behalf of Occupational Health, please let us know. Case studies would be an excellent way to share your expertise/experience with others.

A Sneak Peak at Occupational Health CSM Programming in San Diego CA, Feb 17-20, 2010

Course Title: **Functional Testing Update: Work Injury Management and Prevention**

Functional testing for work injury management and prevention in clinical and employer based situations has continued to grow and gain acceptance as a standard practice in many physical therapy clinics. This program will look at best practices and legal considerations related to functional tests such as functional capacity evaluations, fit for duty tests, and post offer prework screens. Whether you consult with companies or see employee clients in your PT practice, you will need to understand the importance of keeping up to date on the latest standards of practice and legal developments which can impact your services.

Although there are a range of terms and philosophies related to functional capacity evaluations (FCEs), one of the most used documents by internal and external stakeholders in occupational health has been the APTA Occupational Health Physical Therapy Guideline on Functional Capacity Evaluation. New guidelines reflect updated practice expectations, definitions, recommended test components, guidelines for administration, and evaluative/ outcome expectations of therapist performance. This program will also review the results of an international Delphi study on consensus language related to functional capacity evaluation and potential impact on physical therapist practice, including ICF terminology.

This program will also discuss issues therapists should be aware of when marketing, designing, testing, and implementing functional testing programs (including "prework screens"). Legal risks and challenges for therapists can be costly and you should know how to minimize risks. Case studies will demonstrate the importance understanding legal risks, illustrating real world positive outcomes and consequences of various functional testing programs.

Look for this educational program and the OHSIG Business Meeting in CSM programming announcements. Our business meeting will include updates on occupational health guidelines, strategic planning, updates on Occupational Information Development Advisory Panel for Social Security/plans to replace the Dictionary of Occupational Titles and other "Hot Topics."

Submitted by Bill O'Grady, OHSIG Interim President
Dee Daley, VP/Ed Chair
Margot Miller, Advisor

GUIDELINES: OCCUPATIONAL HEALTH PHYSICAL THERAPY: EVALUATING FUNCTIONAL CAPACITY BOD 10-08-01-01 [Retitled: Occupational Health Guidelines: Evaluating Functional Capacity, Amended BOD G11-01-07-11; BOD 03-01-16-54; BOD 03-00-25-60; BOD 11-97-16-53] [Guideline]

1.0 Introduction

A Functional Capacity Evaluation (FCE) is a comprehensive battery of performance based tests that is used commonly to determine ability for work, activities of daily living, or leisure activities.[1]

The need for functional evaluation was identified in the 1980s by workers' compensation systems that required specific information about worker functional capacities and limitations to expedite the return-to-work process. Historically, return-to-work decisions were based upon diagnoses and prognoses of physicians, but did not include objective measurements of worker functional abilities and job match demands. Physical therapists, whose core competencies include functional evaluation, began to develop functional capacity tests for comparison to the physical demands of jobs and occupations. These functional tests initially examined and evaluated the ability of a worker to perform physical job match conditions as described by the US Department of Labor in *Selected Characteristics of Occupations as Defined in the Revised Dictionary of Occupational Titles*[2] and *The Revised Handbook for Analyzing Jobs.*[3] Functional examination/evaluation, combined with diagnoses and prognoses by physical therapists has emerged as a valid and effective tool to support safe return to work, activities of daily living or leisure activities after an injury or illness.

The Functional Capacity Evaluation today quantifies safe functional abilities, and is a pivotal resource for:

1.1 Return-to-work and job-placement decisions
1.2 Disability evaluation
1.3 Determination of how non-work-related illness and injuries impact work performance
1.4 Determination of function in non-occupational setting
1.5 Intervention and treatment planning
1.6 Case management and case closure

2.0 Purpose of Document

The purpose of this document is to establish guidelines for performance of Functional Capacity Evaluations (FCEs) in a manner that promotes excellence, accountability and consistency. The use of the term guidelines is consistent with the current APTA definition, Guideline: A statement of advice (APTA Bylaws, Standing Rule #16). This document is to be used in context with the APTA *Standards of Practice for Physical Therapy* and the Accompanying Criteria,[4] the APTA *Guide to Physical Therapist Practice, Second Edition,*[5] and the standard language and framework for health and health-related states that is described in *The International Classification of Functioning, Disability and Health,* known more commonly as ICF[6]. The 2008 APTA House of Delegates voted unanimously to endorse the ICF Model, which uses a broad view of health-related states from biological, personal, and social perspectives. The ICF includes a "robust and rich taxonomy that describes, rather than classifies individuals according to their functioning and provides a standard language that includes positive and negative aspects of functioning."

These guidelines for evaluating functional capacity are intended for use by:

2.1 *Physical therapists* to design and perform functional evaluations
2.2 *Referral sources* to facilitate appropriate referral for FCE and to integrate the findings into case management
2.3 *Insurance companies, managed care organizations, and claims review organizations*, that authorize, monitor, and remunerate for FCEs
2.4 *State Workers' Compensation regulatory agencies* as definitions and guidelines for evaluees on workers' compensation
2.5 *Disability management systems and regulators,* including the Social Security Disability Administration and disability insurance companies, as a resource document
2.6 *Employers, employees, organized labor, educators, students, researchers, and others* as a resource document

3.0 Definitions

3.1 Ability7. A present competence to perform an observable behavior or a behavior which results in an observable product.
3.2 *Activity*6. An activity is the execution of a task or action by an individual.
3.3 *Activity limitation*[6]. Activity limitations are difficulties an individual may have in executing activities.
3.4 *Capacity*[6].The highest probable level of functioning of an individual in a given domain at a point in time.
3.5 Content validity[7]. Demonstrated by data showing that the content of a selection procedure is representative of important aspects of performance on the job.
3.6 *Environmental factors*[6]. Environmental factors make up the physical, social and attitudinal environment in which people live and conduct their lives.
3.7 *Evaluation.*[5] A dynamic process in which the physical therapist makes clinical judgments based on data gathered during the examination.
3.8 *Examination.*[5] A comprehensive screening and specific testing process leading to diagnostic classification or, as appropriate, to a referral to another practitioner. Examination has three components: history, systems review, and tests/measures.
3.9 *Functional capacity activity*. Any examination activity that generically or specifically simulates a work or practical lifestyle task.
3.10 *Functional Capacity Evaluation* (FCE). An FCE is a detailed examination and evaluation that objectively measures the evaluee's current level of function, primarily within the context of the demands of competitive employment, activities of daily living or leisure activities. Measurements of function from an FCE are used to make return-to-work/activity decisions, disability determinations, or to design rehabilitation plans. An FCE measures the ability of an individual to perform functional or work-related tasks and predicts the potential to sustain these tasks over, a defined time frame. This supports tertiary prevention by preventing needless disability or activity restrictions.

There are two types of functional capacity evaluations:

3.10.1 *General Purpose FCE*. The evaluation protocol consists of standardized tests and measures that are applied to all evaluees. This type is appropriate when a targeted job does not exist, or functional job requirements have not yet been determined. The results from this type of FCE may be used to evaluate an evaluee's compatibility with specific job or occupational demands when more information or options become available for consideration.
3.10.2 *Job-specific FCE.* The evaluation protocol is designed with emphasis on content validity to measure an evaluee's

ability to perform the physical demands of a specific, identified job. This type of FCE may include participation in representative work samples in a clinic or monitoring the evaluee while performing critical job tasks at the work-site to determine the evaluee's ability to safely perform the required work tasks and to determine whether there are participation restrictions.

3.11 Functional Capacity Evaluation Examiner. A physical therapist licensed in the jurisdiction in which the services are performed, who is able to demonstrate evidence of education, training, and competencies specific to the delivery of FCEs.

3.12 *Impairments*[6]. Impairments are problems in body function or structure such as a significant deviation or loss.

3.13 *Job analysis*. The process of analyzing job duties and responsibilities to quantify functional job demands or performance expectations.

3.14 *Job description*. A general statement of job duties and responsibilities.

3.15 *Participation*[6]. Participation is involvement in a life situation.

3.16 *Participation Restrictions6*. Participation restrictions are problems an individual may experience during involvement in life situations.

3.17 *Performance*. What an individual does in his or her current environment. Performance is affected by a number of factors including behavioral attitudes, injury, pain and environmental and social stressors.

3.18 *Job Match Condition.* A type of functional capacity that may be used to systematically match and classify worker functional capacities and job demands in a worker job match taxonomy. Examples of physical job match conditions defined by the Department of Labor[2,3] that are commonly referenced by occupational health professionals include, but are not limited to:

3.18.1 *Balancing*. Maintaining body equilibrium to prevent falling when, walking, standing, crouching or running on narrow, slippery, uneven or erratically moving surfaces; or maintaining body equilibrium when performing gymnastics feats.

3.18.2 *Carrying.* Transporting an object, usually holding it in the hands or arms or on the shoulder.

3.18.3 *Climbing.* Ascending or descending ladders, stairs, scaffolding, ramps, poles, and the like, using feet and legs or hands and arms. Body agility is emphasized.

3.18.4 *Crawling.* Moving about on hands and knees or hands and feet.

3.18.5 *Crouching.* Bending body downward and forward by bending legs and spine.

3.18.6 *Far Vision.* Clarity of vision at 20 feet or more.

3.18.7 *Feeling*. Perceiving the attributes of objects, such as size, shape, temperature, or texture.

3.18.8 *Finger dexterity.* Ability to move the fingers and manipulate small objects with the fingers rapidly or accurately.

3.18.9 *Fingering.* Picking, pinching, or otherwise working primarily with fingers rather than with the whole hand or arm as in handling.

3.18.10 *Handling.* Seizing, holding, grasping, turning, or otherwise working with hand or hands. Fingers are involved only to the extent that they are an extension of the hand, such as to turn a switch or shift automobile gears.

3.18.11 *Hearing.* Perceiving the nature of sounds by ear.

3.18.12 *Kneeling.* Bending legs at knees to come to rest on knee or knees.

3.18.13 *Lifting.* Raising or lowering an object from one level to another (includes upward pulling).

3.18.14 *Manual dexterity.* Ability to move the hands easily and skillfully. To work with the hands in placing and turning motions.

3.18.15 *Motor coordination.* Ability to coordinate eyes and hands or fingers rapidly and accurately in making precise movements with speed. Ability to make a movement response accurately and quickly.

3.18.16 *Near acuity.* Clarity of vision at 20 inches or less.

3.18.17 *Pulling.* Exerting force upon an object so that the object moves toward the force (includes jerking).

3.18.18 *Pushing.* Exerting force upon an object so that the object moves away from the force (includes slapping, striking, kicking, and treadle actions).

3.18.19 *Reaching.* Extending hand(s) and arm(s) in any direction.

3.18.20 *Sitting.* Remaining in a seated position.

3.18.21 *Standing*. Remaining on one's feet in an upright position at a work station without moving about.

3.18.22 *Stooping.* Bending body downward and forward by bending spine at the waist, requiring full use of the lower extremities and back muscles.

3.18.23 *Talking.* Expressing or exchanging ideas by means of the spoken word to impart oral information to clients or to the public and to convey detailed spoken instructions to other workers accurately, loudly, or quickly.

3.18.24 *Walking.* Moving about on foot. It is acknowledged that not all physical job match conditions have well established, objective tests and measures for testing evaluees. This may limit the usefulness of including some factors during a functional capacity evaluation or job analysis process.

3.19 *Job Modification.* Change in a task to allow the demands of the job to match the abilities of the evaluee.

3.20 *Medically stable.*5 Medical stability is defined as that state in which primary healing is complete, or the progression of primary healing is not compromised. Clinically, medical stability refers to the consistent presence of a set of signs and symptoms. Consistent means that the location of the symptoms and the presence of the signs have reached a plateau. The intensity of the symptoms may vary with activity or intervention/treatment, but the location or pattern of change of symptoms remains consistent.5

3.21 *Physical Demand Characteristic Levels* for physical job match conditions of occupations listed in the Revised Dictionary of Occupational Titles include:2

3.21.1 Categories of Strength physical demand levels:

3.21.1.1 *Sedentary.* Exerting up to 10 pounds of force occasionally or a negligible amount of force frequently to lift, carry, push, pull, or otherwise move objects, including the human body. Sedentary work involves sitting most of the time, but may involve walking or standing for brief periods of time. Jobs are Sedentary if walking and standing are required only occasionally and all other Sedentary criteria are met.

3.21.1.2 *Light.* Exerting up to 20 pounds of force occasionally, or up to 10 pounds of force frequently, or a negligible amount of force constantly to move objects. Even though the weight lifted may be only a negligible amount, a job should be rated Light Work: (1) when it requires walking or standing to a significant degree; or (2) when it requires sitting most of the time but entails pushing or pulling of arm or leg controls; or (3) when the job requires working at production rates pace entailing the constant pushing or pulling of materials even though the weight of those materials is negligible.

3.21.1.3 *Medium.* Exerting 20 to 50 pounds of force occasionally, or 10 to 25 pounds of force frequently, or greater than negligible up to 10 pounds of force constantly to move objects.

3.21.1.4 *Heavy.* Exerting 50 to 100 pounds of force occasionally, or 25 to 50 pounds of force frequently, or 10 to 20 pounds of force constantly to move objects.

3.21.1.5 *Very Heavy.* Exerting in excess of 100 pounds of force occasionally, or in excess of 50 pounds of force frequently, or in excess of 20 pounds of force constantly to move objects.

Job match conditions that may be interpreted using strength physical demand levels include lifting, carrying, pushing and pulling.

3.21.2 Categories of *Aptitude levels*2 relevant to some physical job match conditions are:

3.21.2.1 *Markedly Low.* The lowest 10 percent of the population. This segment of the population possesses a negligible degree of the aptitude.

3.21.2.2 *Lower.* The lowest third exclusive of the bottom 10 percent of the population. This segment of the population possesses a below average or low degree of the aptitude.

3.21.2.3 *Medium.* The middle third of the population. This segment of the population possesses a medium degree of the aptitude ranging from slightly below to slightly above average.

3.21.2.4 *High.* The highest third exclusive of the top 10 percent of the population. This segment of the population possesses an above average or high degree of the aptitude.

3.21.2.5 *Extremely High*. The top 10 percent of the population. This segment of the population possesses an extremely high degree of the aptitude (exceptional). Examples of functional capacity conditions that may be interpreted using the aptitude work demand levels include finger dexterity, manual dexterity, balancing and motor coordination.

3.21.3 Categories of work tolerance levels2,3 during an 8-hour day as defined by the US Department of Labor2,3 are:

3.21.3.1 *Not Present (Never).* Activity or condition does not exist

3.21.3.2 *Occasionally.* Activity of condition exists up to 1/3 of time

3.21.3.3 *Frequently.* Activity or condition exists from 1/3 to 2/3 of time

3.21.3.4 *Constantly*. Activity of condition exists 2/3 or more of time.

Examples of functional capacity conditions that are appropriate to evaluate by work tolerance levels include sitting, standing, bending.

Additionally, given that some jobs require exposure that is more than an 8-hour work-shift, the functional capacity examiner may need to assess an evaluee's work tolerances for such work situations that involve *extra time or exposure* above an eight-hour shift. For example, an over-the road truck driver may sit and drive for up to 12 hours during a given day. A higher level of sitting tolerance representing extra time above an 8-hour shift would be required for truck drivers exposed to whole body vibration, compared to SEDENTARY office workers that may sit for up to 8 hours per day.

3.22 *Physical Demands of the Job.* Those physical abilities required to perform work tasks successfully. Physical demands as used in this document include work postures positions), body movements, forces the worker applies to job tasks, repetition of the work tasks, and other work stressors.

3.23 Skill[7]. A present, observable competence to perform a learned psychomotor act.

3.24 Work behavior[7]. An activity or function performed to achieve the objectives of the job. Work behaviors involve observable (physical) components and unobservable (mental) components. A work behavior consists of the performance of one or more tasks.

4.0 Knowledge Base

For safe FCE administration and useful interpretation, the FCE examiner should meet competency criteria to ensure a high standard of service provision through adequate knowledge and skills in the following areas:

4.1 Examination (includes history, systems review, and tests and measures) of the following systems:

4.1.1 Cardiovascular/pulmonary[8]

4.1.2 Integumentary

4.1.3 Musculoskeletal

4.1.4 Neuromuscular

4.2 Administration of FCEs and interpretation of tests results.

4.3 Evaluation of physical demands of the job.

4.4 Identification of evaluee behaviors that interfere with physical performance.

4.5 Biomechanical components of safe work practices.

4.6 Impact of relevant laws and regulations on FCE administration, including, but not limited to:

4.6.1 Americans with Disabilities Act

4.6.2 Code of Uniform Guidelines for Employment Selection7

4.6.3 Occupational Safety and Health Administration

4.6.4 Social Security Disability Administration

4.6.5 Workers' Compensation
4.6.6 Health Insurance Portability and Accountability Act (HIPAA)

5.0 Admission Criteria

5.1 The purpose(s) for performing an FCE should be defined.
5.2 Admission criteria require that both of the following be present.
5.2.1 The evaluee must be medically stable5 or the FCE test protocol should be administered within the safe confines of the evaluee's health condition.
5.2.2 The evaluee must consent to participate.
5.3 A decision-making process should be used to determine whether a functional capacity evaluation is appropriate. Indications for an FCE may include, but are not limited to, situations in which objective functional information is required:
5.3.1 Evaluee reaches a point where he/she is not making functional gains with intervention/treatment.
5.3.2 Evaluee has not returned to full or modified duty.
5.3.3 Evaluee is working, but having difficulty maintaining job/activity function is reported or demonstrated. 5.3.4 Healthcare examiner's report that evaluee displays discrepancy between subjective complaints and objective findings.
5.3.6 Supporting documentation is required for disability determination, determination of loss of earning capacity, litigation settlement or case resolution.
5.3.7 Supporting documentation is requested to assist with future rehabilitation or vocational planning.
5.3.8 Supporting documentation is requested to help render a job-placement decision.
5.3.9 Evaluee requires an opportunity to demonstrate safe performance of functional tasks.
5.4 Contraindications for an FCE include any one or more of the following:
5.4.1 Performance of the test would compromise the evaluee's safety or medical condition8.
5.4.2 Communication barriers preclude understanding instructions, communicating concerns, and interpreting the evaluee's responses during the FCE.
5.4.3 Evaluee does not give consent to participate in an FCE.

6.0 Test Components

Components of an FCE should include but are not limited to appropriate administration and documentation of:
6.1 Intake Information/Referral Issues
6.1.1 Referral source and relationship to the Evaluee
6.1.2 Reason for the referral
6.1.3 Underlying medical conditions that may impact work abilities.
6.1.4 Medical restrictions for safety during the FCE
6.1.5 Documentation of Job demands when a job match is being requested.
6.1.6 Review of records, especially objective diagnostics.
6.2 Informed consent
6.2.1 Review reason(s) and objective(s) of the functional capacity evaluation, for example:
6.2.1.1 Support return to work planning
6.2.1.2 Improve communications between all parties.
6.2.1.3 Structured process to explore worker abilities or limitations.
6.2.4.4 Confirm suitability of a specific job option.
6.2.2 Explain what is involved during the FCE, what the worker can expect, including that if any inconsistencies in performance occur, they will be discussed with the worker as they arise and are documented.
6.2.3 Address the risks for injury, aggravation of symptoms, or possibility of soreness in response to testing and explain exam procedures that will help reduce such risks.
6.2.4 Obtain release of information for involved parties and explain how the evaluee will receive the FCE information, when appropriate or required.
6.2.5 Address any evaluee's concerns before proceeding with evaluation.
6.3 Job duties and related physical demands.

Review evaluee's most recent job duties and related physical demands to ensure agreement by the evaluee with information provided by employer (if available).

6.4 History
6.4.1 Mechanism of injury
6.4.2 Treatment to date
6.4.3 Objective diagnostic tests
6.4.4 Surgeries
6.4.5 Other relevant claims/medical history
6.4.6 Evaluee's report of current symptoms and work/leisure limitations.
6.4.7 Current medications
6.5 Systems Review
6.5.1 Cardiovascular/pulmonary
6.5.2 Integumentary
6.5.3 Musculoskeletal
6.5.4 Neuromuscular
6.5.5 Communication, Affect, Cognition, Language and Learning Styles
6.6 Physical examination appropriate for health condition(s) and referral questions.
6.7 Conduct functional capacity tests as appropriate to address the referral questions
6.7.1 Static strength tests to evaluate consistency of effort (e.g. grip, pinch, pull)
6.7.2 Dynamic balance/agility
6.7.3 Finger dexterity tests
6.7.4 Manual dexterity tests
6.7.5 Cardiorespiratory endurance tests[8]
6.7.6 Postural tolerance tasks
6.7.7 Lift/carry strength and endurance tests
6.7.8 Simulated or actual work tasks
6.8 Observation of evaluee
6.8.1 Cooperation during participation.
6.8.2 Consistency and level of effort.
6.8.3 Behaviors that interfere with physical performance.
6.8.4 Body mechanics/safety.
6.8.5 Physiological responses and clinical findings.
6.9 Evaluation of history, records, and test results to recommend safe work abilities.
6.10 Comparison of evaluee's safe work abilities with job or

task demands (if known and requested by the referral source).

7.0 Test Administration

The physical therapist providing an FCE has the responsibility to ensure that an FCE is appropriate for the evaluee, that the tasks of FCE can be performed safely, that any conflicts of interest with parties involved in the FCE process are identified and managed to ensure objectivity. Important characteristics of test administration include:

7.1 Ensuring that evaluees are screened for underlying medical conditions that prohibit or limit participation in functional testing.
7.2 An FCE includes musculoskeletal screening and kinesiological assessment of the manner that tests are performed to analyze root causes of an evaluee's dysfunction; therefore, an FCE should be performed by the physical therapist and should not be delegated to support staff that cannot perform PT examination/evaluation procedures within their scope of work.
7.3 Identifying, quantifying and analyzing the functional abilities/limitations includes:
7.3.1 Designing and implementing tests of basic functional abilities;
7.3.2 Designing and implementing tests to simulate job-specific tasks.
7.4 Identifying evaluee behaviors that might interfere with physical performance during the:
7.4.1 Interview process.
7.4.2 Examination process.
7.4.3 Functional testing process.
7.5 Comparing the physical demands of work with the results of functional testing, reported lifestyle activities and medical records reviewed (when relevant).
7.6 Documenting results of a completed evaluation process.
7.7 When appropriate, identifying:
7.7.1 Job modifications that would make a job compatible with the physical abilities of the evaluee.
7.7.2 Interventions that would improve the physical abilities of the evaluee.
7.7.3 Need for referral to other professionals.
7.8 Selection of the examination location – The location should be accessible to the evaluee and appropriate to address the referral issues (e.g. work-site, clinic).
7.8.1 A general purpose FCE may be conducted in a clinic or work-site location.
7.8.2 The work-site location may be important if the examiner needs to verify job demands and/or confer with the employer about accommodation options.
7.9 Duration
7.9.1 Because case complexity is quite variable, the amount of professional time to administer a general purpose or job-specific FCE may range from 3-6 hours for a single day exam, to 5-8 hours for a two-day exam.
7.9.2 Certain conditions may warrant administration of the examination activities over more than one day.
7.9.3 Quality assurance and defensibility necessitates adequate professional time to answer the legal and referral questions.
7.9.4 Additional testing may be warranted when the evaluee demonstrates inappropriate illness symptoms and behaviors
7.9.5 Additional time may be necessary for work simulation or job task demonstrations to evaluate pacing and body mechanics.
7.9.6 A full standardized FCE is not always needed. For example, only limited functional capacity testing may be warranted at the conclusion of a work hardening or conditioning program.

8.0 Evaluation Summary

The evaluation summary is an impartial, independent, evidence-based statement and opinion that should:

8.1 Address the purpose(s) of performing the FCE and specific referral questions.
8.2 Quantify the recommended safe work abilities and leisure activity limitations of the evaluee. For example, lifting abilities should be defined based on the zone of lifting and frequency of repetitions over a given duration.
8.3 Identify limiting factors to FCE performance and whether recommended functional capacities are temporary or permanent (when appropriate).
8.4 Compare the physical abilities of the evaluee to the physical demands of the job/activity (when appropriate).
8.5 Document the level of evaluee participation and consistency during in the FCE.
8.6 Identify appropriate recommendations to promote return-to-work; including modification of the environment, tasks or tools to permit the evaluee's return to the job or activity; and further interventions or referrals needed (if requested).

9.0 Data Generation for Outcome Measures

The following are examples of FCE data that may be important to measure outcomes:

9.1 Sociodemographic data
9.1.1 Age
9.1.2 Gender
9.1.3 Race
9.1.4 Ethnicity
9.1.5 Socioeconomic level
9.1.6 Educational level
9.1.7 Referral source
9.1.8 Purpose of the FCE
9.1.8.1 Quantification of safe functional abilities
9.1.8.2 Return-to-work and job-placement decisions
9.1.8.3 Disability evaluation
9.1.8.4 Determination of impact of non-work-related illness and injuries on work performance
9.1.8.5 Determination of function in non-occupational settings
9.1.8.6 Intervention and plan of care
9.1.8.7 Case management and case closure
9.1.8.8 Guidance for intervention/treatment
9.1.9 Administrative
9.1.9.1 Test duration in hours
9.1.9.2 Number of test days
9.1.9.3 Contact time per test by FCE provider
9.1.10 Previous work-related injury

9.1.11 Attorney involved/not involved
9.2 Previous and concurrent treatment
9.2.1 Type of provider
9.2.2 Type of treatment
9.3 Occupational and injury data
9.3.1 Diagnoses by physicians
9.3.2 Diagnoses by physical therapists
9.3.3 Most Recent Employment Status
9.3.3.1 Full-time.
9.3.3.2 Part-time/PRN
9.3.3.3 Retired
9.3.3.4 Laid off
9.3.3.5 Terminated
9.3.4 Return to work goal
9.3.4.1 Same job/same employer
9.3.4.2 Modified job/same employer
9.3.4.3 Different job/same employer
9.3.4.4 Similar job/different employer
9.3.4.5 Different job/different employer
9.3.4.6 None
9.3.5 Work activity status
9.3.5.1 Full duty
9.3.5.2 Limited duty
9.3.5.3 Disability leave
9.3.5.4 Personal leave
9.3.5.5 Unemployed
9.3.6 Date of injury/onset
9.3.7 Date(s) of FCE
9.3.8 Time between date of injury/onset and date of FCE
9.3.9 Previous injury/New injury
9.3.10 Total work time lost
9.3.11 Target job

9.4 FCE findings
9.4.1 Physical demands characteristics1 strength and aerobic level
9.4.2 If a target job exists, the functional abilities of the evaluee and physical work demands of job match/don't match
9.4.3 Functional Progress (if relevant)
9.4.3.1 Unspecified
9.4.3.2 Appropriate
9.4.3.3 Slow
9.4.3.4 Not responding
9.4.3.5 Maximum benefit achieved
9.4.4 Intervention or treatment/No intervention or treatment (if requested)

9.5 Follow-up
9.5.1 Purpose(s) of the FCE met/not met
9.5.2 Continued medical or rehabilitation services engaged/not engaged
9.5.3 Continued, successful job placement 90 days after return to work. Note: Job placement success is affected by other factors, including the evaluee's motivations and employer commitment to job accommodation.

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FOOT & ANKLE

SPECIAL INTEREST GROUP

President's Report

One of the objectives of the FASIG is to keep our members abreast of current reimbursement and political issues that affect us as physical therapists who treat foot and ankle conditions. Reimbursement by third party payors for procedures and supplies such as foot orthoses and taping varies largely across the country. In California where I practice, insurance companies are taking longer than ever to reimburse for our services. Often payment is delayed until seemingly endless support documentation is submitted; an initial denial is given which requires follow-up letters and phone calls until ultimately we are paid for only a portion of our services. It is unfair that we have to jump through flaming hoops and navigate treacherous obstacles in order to be paid by the health insurance companies for our services. Patients who have been adversely affected by the economy and the current insurance fiasco are attending physical therapy less often, attempt to delay making their co-payments and deductibles, and often can't afford to complete a therapeutically grounded PT treatment regimen. Our practice has all but given up on trying to deal with third party payors in terms of billing for foot orthoses or taping supplies and/or procedures.

I would be very interested to hear from our SIG members just how they are being reimbursed for these services. Which CPT or other codes have been effective reimbursed in your state? Let me suggest that we communicate our findings on the Orthopt.org bulletin board for the FASIG. We can also use this mechanism to discuss problematic patient conditions, new techniques, and treatment pearls.

The FASIG has been busy distributing the foot and ankle content survey to many of our entry-level physical therapy programs. Once compiled and analyzed, this information will help us establish a standard base curriculum of the foot and ankle for entry-level PT schools. It will also be used to establish a scope of practice of the foot and ankle that can be incorporated into initiating a fellowship in this specialty area of orthopaedics.

Each year that the FASIG offers a preconference course or similar educational endeavor, a portion of the money earned is placed into our encumbered funds account. During last years' CSM Business Meeting, it was voted to apportion from this fund, $7500 for 2 years to the Orthopaedic Section for research that is focused on the foot and ankle. The research committee will decide on a worthy study to receive this grant. It is open to all Orthopaedic Section members of the APTA, including our Foot & Ankle SIG. Our SIG needs to substantiate the techniques and procedures that we employ to treat our patients, through sound clinical and biomechanical evidence, so that third party payors will reimburse for our services and supplies.

I hope that each of you had a wonderful summer and that the new school year has brought a new enthusiasm and energy to you and your family. The current economic trends have had a profound effect upon our profession and who knows what the federal Healthcare reform holds for us?! Despite all of this, I am confident there will always be a demand for our multidimensional services.

Respectfully submitted,
Stephen Paulseth, PT, MS, DPT, SCS, ATC

LET'S COMMUNICATE

Go to the Bulletin Board for the FASIG at www.orthopt.org

PERFORMING ARTS

SPECIAL INTEREST GROUP

President's Letter

This winter the 2010 Winter Olympics will be held in Vancouver, Canada. One of the highlights of the winter Olympics will be the Figure Skating competition. Figure skating includes ladies, mens, pairs, and ice dance. The governing body for figure skating in the US is the US Figure Skating Association (USFSA). You can find a wealth of information on their Web site at http://www.usfsa.org/. In this issue, look for an ice skating case study about getting the artist back to the ice. The PASIG will be bringing you more information about figure skating this fall and winter.

Programming for CSM 2010 in San Diego is, "Physical Therapy Management in Gymnastics- Spine, Shoulder, Wrist, and Hand Injuries coupled with Stress and Eating Disorders - A Performing Arts PT Challenge." We are hopeful many of you will join us in San Diego for programming and our business meeting.

This fall, the PASIG will be electing a new Vice President and two nominating committee members. Please look for the ballots and VOTE for the PASIG board members during the Orthopaedic Section elections.

As a PASIG member, you should be receiving a monthly citation blast of PA annotated bibliographies. If you DO NOT receive this free benefit, please contact Tara Frederickson (tfred@orthopt.org) to be added to the list.

The deadline for the PASIG Student Research Scholarship is approaching. The scholarship is a $400 award to defray the cost of presenting your performing arts research at CSM. Your abstract should have already been accepted to CSM 2010. Submit your abstracts by November 15, to Amy Humphrey: AHumphrey@bodydynamicsinc.com. More details can be found on our website: http://www.orthopt.org/sig_pa.php.

If you have an interesting PA case study or project that you would like to have published, please let us know. The PASIG is striving to contribute to the PA evidence based body of knowledge, and we have members who can help you through the process. As the late Steve Rose, PT, PhD, FAPTA was quoted as saying at the Orthopaedic Awards Ceremony at CSM 2009 "if it isn't published, it didn't happen."

Yours in the arts,
Leigh A. Roberts, PT, DPT, OCS

Using Evidence to Treat a Figure Skater Limited by Low Back Pain Prior to a National Competition

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Significant figure skating injuries result from traumatic falls; however, overuse injuries due to the physical demands placed on the athlete in combination with a rigorous on and off ice training regimen are common.[1] Low back injuries may account for upwards of 15% of figure skating injuries[2] and treating a figure skater requires basic knowledge of the sport and the skater's specific on and off ice demands and goals for rehabilitation. With the rise in popularity of the sport of figure skating within the last 15 years and the increased focus on bigger jumps and other high point value skills, skaters seeking treatment for injury are predicted to become more common.[1]

This case is about a 19-year-old female collegiate figure skater referred from a sports medicine physician to physical therapy for "lumbar dysfunction" and spondylolysis with complaints of six weeks of low back pain aggravated by sitting, figure skating and sleeping. Self report measures were performed to capture her level of disability and corresponding fear level of performing skating activities. The modified Oswestry Low Back Pain Disability Questionnaire consists of ten questions that allow a patient to self rate pain and the impact their back pain has on everyday life. She scored a 40% on the modified Oswestry which classified this patient as having severe disability with elevated scores on all ten questions.[3] Lifting and pain intensity questions were rated highest. The Fear Avoidance Beliefs Questionnaire (FABQ) was administered in order to determine whether this patient exhibits fear avoidant behaviors related to activity.[4] It is believed that fear of returning to activity can contribute to a delay in progress and that when addressed as its own impairment, it can be treated as a component of the physical therapy program.[5] This information is useful in designing an effective treatment program. For an orthopedic population, a FABQ physical activity score of >15 is considered to be high[6] and her subscale score was a 20/24 indicating she may exhibit apprehension for returning to activity. In order to combat the problem, principles of fear avoidance management were included in her treatment and exercise progression. These included reducing her focus on pain and replacing it with a focus on activity level increases and progressively increasing her activity with positive reinforcement for successful performance of activity.

The patient had a history of low back pain beginning with a fall three years earlier that resulted in temporary lower extremity weakness and difficulty walking that fully resolved. Recent x-rays were unremarkable other than a mild left convex scoliosis. At initial evaluation she reported right low back pain greater than left averaging 7/10 (on a 0-10 point scale) with 10/10 at worst and 2/10 at best. Layback spins, spirals and ice dancing were particularly aggravating to the patient's pain. These irritating skating positions require spinal extension; therefore, extension or lumbar spine closing was identified as a pain provoking activity. She had a major national competition in one month and her goal was to compete pain free or at the highest level possible. Her current training schedule includes skating at least one hour per day and she was not participating in off ice training due to pain.

On evaluation, she demonstrated typical lumbar range of motion with pain provoked on return from flexion and limited end range extension. The required lumbar range of motion for figure skating is increased over expected ranges compared to athletes in sports not requiring hyperextension so the lack of pain free hyperextension is considered a deficit in this patient and restoration of this range is necessary for her to perform her competition choreography. To improve reliability segmental mobility testing is graded as hypermobile, hypomobile or normal.[7] Joint play was performed in the prone position and hypomobile segments were identified throughout the mid-thoracic region and hypermobile segments were found from T12-S1. Decreased posterior hip mobility was found on the right and both hips were tight in internal rotation, iliotibial band flexibility and hip flexor range. Aberrant movements, defined as an observation of trunk active range of motion that includes a painful arc in flexion, a painful arc in returning from flexion, Gower sign, an instability catch or reversal of lumbopelvic rhythm[7] were also evaluated. She demonstrated a painful arc in returning from flexion. A prone instability test is a provocative test performed with the patient prone leaning over the treatment table. A posterior to anterior (PA) glide is performed to a spinal segment. If the level is painful with a PA glide, the patient is asked to slightly lift his/her legs from the ground, activating the muscles of the spine. The PA glide is repeated and if the patient's pain level is decreased, the test is considered positive. She had a positive test at L3. Following the clinical prediction rule developed by Hicks et al, she met all four predictive criteria with a positive LR of 4.0 to benefit from core stabilization exercise.[8] See Table 1 for complete information on the clinical prediction rule. This cluster of tests is used to identify patients who respond positively to a lumbar exercise program. She had no radicular complaints and straight leg raise was >90º bilaterally.

Table 1. Clinical Prediction Rule for Success with Stabilization

Variables	Variables met by this patient	Number of variables present	Positive likelihood ratio
Age <40	X	At least 1 (+) finding	1.3
Aberrant movements	X	At least 2 (+) findings	1.9
Average SLR >91º	X	At least 3 (+) findings	4.0
Positive prone instability test	X		

Based on the following evaluation findings the patient has lumbar hypermobility combined with hip and thoracic hypomobility. Since the joints above and below (thoracic and hip) were stiff it is unlikely they could assist the patient in achieving her lumbar hyperextension needed for her skating positions. As a result of her tightness coupled with her skating demands, we hypothesized that the patient was placing undue stresses on the hypermobile lumbar spine. This repetitive strain increased by the build- up in practice time and more intense practice sessions prior to competition aggravated the lumbar region causing this patient constant low back pain. The plan was to increase hip and thoracic mobility and increase the muscle strength/control of her lumbar stabilizers.

Since her score on the FABQ was slightly elevated, we incorporated a graded exercise program and healthy back approach to her program.[5] She was educated that the typical course of back pain improves over time and movement will not cause her further harm. She was allowed to discuss pain levels one day weekly, while the other discussions were focused only on increasing activity performance each day. A graded exercise program includes taking the emphasis away from pain the majority of treatments and redirecting the focus towards the amount of activity, skating and sitting in class, the patient was able to complete each day. The graded exercise program consisted of a series of stabilization exercises tailored to challenge the patient while maintaining proper form. The exercises began just below the level of patient fatigue and were gradually increased in repetitions by 10% per week, establishing a set quota each week. Positive reinforcement is used to strengthen a behavior while negative reinforcement is used to eliminate a behavior. The patient was continually given positive reinforcement for reaching each quota both in and outside of physical therapy and never required negative reinforcement due to her high level of compliance with activities.[9]

Physical therapy treatment was an impairment based approach. Initial treatment focused on increasing thoracic mobility through thoracic mobilizations/manipulations, increasing hip joint mobility and flexibility with mobilizations and stretching, and increasing the muscle strength/control of her core stabilizers through a graded stabilization program. Lumbar neuromuscular electrical stimulation (NMES) targeting her lumbar extensor muscles was used as an adjunct to her exercise program.

NMES is an effective method of strengthening and increasing muscle activation[10] and was used to improve the performance of the lumbar extensors. Lumbar NMES was performed with the patient prone over pillows and belted to the table with the pelvis in a posterior tilt. The parameters were: 400µsec pulse width, 75 pps frequency, and 12 seconds on/50 seconds off for 15 minutes duration. The intensity (mA) was increased to patient tolerance for the maximal visible and palpable muscle contraction.

Focus to perform a transversus abdominus contraction (TAC) was the objective behind the stabilization program. Stabilization exercises were initiated with performing a TAC in supine and progressing toward performing a TAC while landing jumps and walking through her competition program off the ice; to then be translated to her on ice training. The goal was to integrate sport specific postures into her exercises. Table 2 describes stabilization program details.

Table 2. Stabilization Program

Beginning	Intermediate	Advanced
Supine with knees bent	Supine with bridge	Off ice walk through of skating routine
Supine with leg lifts	Side bridge, knees bent	Mini-trampoline with attitude position
Curl-up	Physioball with alternating hip flexion	Physioball with alternating UE/LE with forward attitude position
Side lying with hip ER	Landing position	
Side lying leg lifts	Spiral position	
(Note: all exercises began with performing a TAC and holding throughout the exercise)		

Postural corrections were incorporated into on and off ice activities as they were considered low level stressors aggravating her low back, particularly with sitting in class all day. Maintaining lumbar neutral while sitting in class was encouraged and later incorporated into seated postures during the long flight to the national competition. Strengthening activities targeting the middle and lower trapezius muscles were included to reduce this patient's tendency to sit with rounded shoulders.

After 15 treatments, her modified Oswestry score decreased to 4% (minimal disability) and her pain was a 3/10 at worst and 0/10 at best. Her spinal hyperextension was available and pain free and she no longer had pain with return from a flexed position. Although still hypomobile, her thoracic segmental motion appeared to be increased corresponding to her reports of pain free range of motion with free skating and ice dancing and the ability to sit for prolonged periods without pain. She was independent in an advanced home exercise program of lumbar stabilization exercises, postural exercises and self stretching on a foam roller that she purchased. By discharge, this patient had improved in all objective measures and was able to fly on a plane for four hours each direction using her postural exercises and compete at nationals pain free.

Combining evidence on fear avoidance activities, applying evidence on clinical prediction rule for lumbar stabilization/control and incorporating sport specific postures into exercises (see figures 1-4 for visual aid) allowed this patient to complete her competition season and successfully manage her pain without taking time off from her sport. A comprehensive home program was incorporated to assist with prolonged pain relief and allow her to self manage further symptoms.

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Figure 1. Transversus abdominus contraction (TAC) performed while holding a jump landing position.

Figure 2. TAC performed while performing a skating spiral.

Figure 3. TAC while balancing on a mini-trampoline and performing an attitude position (leg position for a layback spin).

Figure 4. TAC performed while balancing on a physioball and performing a forward attitude position with the opposite arm raised.

PAIN MANAGEMENT

SPECIAL INTEREST GROUP

Do Opioids Alone Explain Exercise-Induced Hypoalgesia?

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Exercise-induced hypoalgesia (EIH) is a decrease in pain in response to exercise and is used clinically in the treatment of pain. Exercise-induced hypoalgesia occurs with all modes of exercise including aerobic[1] and resistance exercise.[2] The exercise parameters required to produce hypoalgesia in healthy young adults differ with the type of exercise performed. For example, hypoalgesia occurs following aerobic exercise of high intensity (75% VO_{2max}) and prolonged duration (30 minutes) but not with exercise of low intensity (50% VO_{2max}) or shorter duration (10 minutes).[1] In contrast, both high [80% maximal voluntary contraction (MVC)] and low intensity (25% MVC) isometric contractions produce hypoalgesia; though lower intensity contractions must be held for a longer duration for hypoalgesia to occur.[2] Consequently, EIH is dependent upon both the intensity and duration of the specific task.

While EIH is well documented in healthy young adults, significantly less is known regarding EIH in older adults or in individuals with pain disorders. Clinically, exercise is used for pain management in a variety of conditions including chronic neck disorders, fibromyalgia, low back pain, osteoarthritis, rheumatoid arthritis, and myofascial pain. While the benefits of exercise in these conditions has received support in the literature, exercise prescription remains difficult because the optimal exercise parameters, including type and dosage, have yet to be determined. Part of the problem is the difficulty in translating the research of young healthy adults to older adults or those in pain. For example, the majority of individuals with pain cannot tolerate the same exercise parameters (ie, high intensity aerobic exercise) to produce EIH.

To better prescribe exercise, it is important to understand the mechanisms responsible for EIH and how these mechanisms may change within different populations. Both opioid and non-opioid systems (eg, activation of descending inhibitory pathways) have been theorized to be involved. This article will specifically focus on activation of the opioid system as a possible means of EIH.

The discovery in the 1970s of opioid peptides with both analgesic and mood elevating properties has led to significant interest in the role of these peptides in EIH. Much of the opioid research has focused on plasma β-endorphin, an opioid peptide acting both as a neurotransmitter in the central nervous system and as a hormone after release into the bloodstream by the anterior pituitary gland. The majority of research has been conducted using aerobic exercise in healthy young subjects. Results indicate that exercise must be of sufficient intensity and duration to produce an increase in plasma β-endorphin levels. Increases have been demonstrated following aerobic exercise of moderate to high intensity (> 60%VO_{2max}), as well as with lower intensity exercise of a prolonged duration, such as running a marathon (reviewed in Goldfarb & Jamurtas, 1997).[3] Thus, the dose-response relationship for the release of β-endorphins is similar to that of EIH.

A reasonable assumption would be that the release of β-endorphin is responsible for the reduction in pain following exercise. This assumption is supported by the finding that EIH is not limited to the exercising limb. If the response was mediated purely by a local mechanism, a change in pain perception would be expected only at the site of exercise. Yet several studies, regardless of the exercise type, have demonstrated a reduction in pain perception at sites contralateral or distant to the exercising limb(s).[1,2,4] While a greater EIH response is demonstrated in the exercising limb,[4] decreased pain perception found distant to the exercising limb is consistent with a systemic (ie, circulating hormones such as β-endorphin) or central (ie, changes in spinal and supraspinal processing) mechanism of action.

Before activation of the opioid system can be regarded as the main mechanism responsible for EIH, several issues need to be addressed. For example, even though the majority of research in healthy adults has been supportive of elevated levels of plasma β-endorphin following high intensity aerobic exercise, the results have been much more equivocal when assessing the response to resistance exercise. Based upon the high degree of variability of the findings, the mechanism of EIH may change with the type of exercise, providing support for an interaction between opioid and non-opioid systems.

While we know that aerobic exercise of sufficient intensity and duration elicits both an increase in plasma β-endorphin and EIH, surprisingly little research has measured both pain perception and β-endorphin levels in response to exercise.[5,6,7] All three of these studies demonstrated a parallel increase in plasma β-endorphins and hypoalgesia; although no correlation was found between these two variables in any of the studies. Therefore, greater levels of β-endorphins were not associated with greater hypoalgesia. This lack of correlation does not preclude activation of the opioid system from explaining EIH because there may be a threshold effect for the amount of β-endorphins needed to produce EIH. Furthermore, because β-endorphins are unable to cross the blood-brain barrier, changes in plasma levels of β-endorphins are indicative only of a peripheral (outside of the central nervous system) response to exercise. β-endorphins or other opioids may be acting in the central nervous system in producing the hypoalgesic effects, which cannot be measured via plasma levels.

Another issue with the opioid and EIH theory is the asynchronous time courses between peak plasma β-endorphin levels and hypoalgesia. Following a high intensity cycling program to exhaustion, hypoalgesia peaked at or near maximal exercise then began to decline; whereas β-endorphin levels continued to rise for an additional 10 minutes.[5] Therefore, whether plasma β-endorphins are directly responsible for the increase in hypoalgesia is not clear for it would be expected that hypoalgesia would remain stable or increase as β-endorphin levels continued to rise.

Another way to assess the interaction between activation of the opioid system and EIH is through the use of opioid antagonists such as naloxone. If EIH is mediated by the opioid system, then naloxone administration should prevent or attenuate the hypoalgesic effect. Although naloxone-induced decreases in hypoalgesia have been found, the results have not been consistent across studies.[5,6,8] Interestingly, Droste et al found *greater* hypoalgesia when naloxone was administered.[5] The differing effects of naloxone on the EIH response provides further evidence that both opioid and non-opioid mechanisms are involved.

It is important to note that all of the above studies were conducted using aerobic exercise and only male subjects, most of who were trained athletes. Consequently, these results are limited to this population and cannot be translated to other forms of exercise, older or sedentary subjects, female participants, or clinical pain populations.

Very few studies have examined the β-endorphin response to exercise in the older adult or in the clinical pain population. Some evidence suggests that the magnitude of the increase in plasma β-endorphins after aerobic exercise is less in older than younger adults.[9] The few studies that have been done in the clinical population are inconclusive. For individuals with osteoarthritis, there were no consistent changes in either pain or of β-endorphin levels following 30 to 45 minutes of "therapeutic exercise."[10] In individuals with migraines, there was an increase in β-endorphin levels following treadmill exercise, which were not correlated with the changes in headache parameters.[11] Thus, future research must first establish if exercise differentially activates the opioid system in older adults or individuals with pain conditions, including the required parameters. Once activation of the opioid system has been established, additional research is needed to determine if this system is responsible for EIH in these populations.

In addition to human research, animal studies have evaluated activation of the opioid system in relation to EIH. In an animal model of chronic muscle pain, naloxone partially prevented the EIH response to low intensity exercise of shorter duration,[12] thus supporting the opioid hypothesis. However, recall that in healthy individuals low intensity aerobic exercise must be of prolonged duration to activate the opioid system. Therefore, these results provide interesting insight into how the mechanisms may differ when pain is present. Furthermore, animal research shows a cross-tolerance between endogenous (exercise-induced) and exogenous (pharmacologically-induced) activation of the opioid system. For example, animals that chronically exercised experienced less pain relief with the administration of exogenous opioids.[13] This decreased response to opioid medications was correlated with the amount of exercise and readily reversible, returning to pre-exercise levels following exercise cessation.[14]

There are several potential clinical implications to the above findings. While the animal research has yet to be replicated in humans, it suggests that individuals who regularly exercise may be less sensitive to opioid medications (eg, codeine or oxycodone) than sedentary individuals. Specifically, trained individuals in need of opioid medication may find it more difficult to achieve successful pain control. Hypothetically, reducing or ceasing exercise may restore medication efficacy, as demonstrated in the animal research. Likewise, individuals with a chronic pain condition who are experiencing tolerance to morphine or other opioid medications may not experience the same level of EIH due to cross-tolerance of the opioid system. A regular exerciser may require an individualized program that differs from that of a non-exerciser, such as altered exercise parameters or the use of exercise targeting non-opioid systems. Furthermore, altered response of the opioid system may also impact those individuals not taking opioid medications. Trained individuals who regularly exercise may experience tolerance to EIH as they do with opioid medication, which has important implications for exercise progression to maintain or increase pain relief. Clearly, continued research into the interaction of the opioid system and EIH in humans is needed.

In conclusion, the mechanisms behind EIH are quite complex and likely involve activation of both opioid and non-opioid systems. Future research must address the primary mechanism(s) responsible for EIH in different client populations. Understanding the mechanisms of EIH will allow practitioners to gain insight into the most effective type and dosage of exercise to reduce pain, thereby impacting clinical decisions designed to improve the lives of individuals with pain conditions.

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ANIMAL PHYISCAL THERAPIST

SPECIAL INTEREST GROUP

President's Message

Where did the summer go? It's been an eventful one on the animal rehabilitation/physical therapy front and I'm certain we'll have more "excitement" to come.

New Hampshire and Nebraska have passed legislation regarding physical therapy treatment of animals. Rules and regulations have yet to be outlined.

The Veterinary Board of New Jersey has suggested a rule change regarding the practice of complementary medicine on animals by unlicensed persons. The AR-SIG submitted comments to the Board regarding this rule change and is awaiting word on this proposed change.

I attended a preconference course on residencies and fellowships in physical therapy at the APTA Annual Conference. I'd love to hear feedback from our membership regarding the SIG's direction, but, this workshop, sponsored by the Orthopaedic Section, was eye-opening and exciting, to say the least. As many of you know, we've been working on a Practice Analysis for quite a while now. The results of this analysis will be an outline of a curriculum for a residency program in animal rehabilitation/physical therapy. There are many questions:

-Should the ARSIG sponsor the residency?

-Should the ARSIG outline criteria and offer the residency at a private clinical or educational facility?

-Can the ARSIG offer continuing education (by independent study, online study, or in-person/hands-on courses) to prepare physical therapists for the proposed residency?

-Can completion of these residencies eventually lead to specialist-designation for physical therapists in animal rehabilitation/physical therapy?

There are so many more questions than answers at this point! If there is anyone with experience in residency training/education who would like to take on this project or work with us on it, please contact me at your convenience. We hope to have an informal discussion at CSM 2010 regarding this possibility.

The next VetPT Symposium will be at Auburn University in August 2010. Watch for more details coming soon.

I'm very excited that we will be having a Legislative Luncheon at CSM 2010. Those of you who are/were/will be involved in animal rehabilitation in states in which legislation has/will/was established for physical therapists in animal rehabilitation should plan to attend. A goal is to outline a model practice act that is acceptable to the APTA and ARSIG. Justin Elliott of the APTA State Government Affairs Office will be participating in our discussion. I plan to send out a survey to members in the near future regarding our agenda/position on these hot topics but definitely want to get your input in person. This could be a groundbreaking meeting for physical therapists in animal rehabilitation. Be there or be square!!!

Thanks to Kirk Peck, our ARSIG liaison from Nebraska, who will be presenting at September's State Government Affairs Forum. Great to see animal rehabilitation/physical therapy back on the agenda at that meeting!

Have a great fall and see you in SanDiego in February!

Amie Hesbach (forpawsrehab@comcast.net)

CASE STUDY: BORDER COLLIE WITH SCIATICA

SIGNALMENT

"Hank" Ferguson is a 5-year old neutered male Border collie who presented in physical therapy for an evaluation on 4-21-09 with a diagnosis of Bridging Spondylosis at L7-S1. Hank's normal activity level was competitive herding, along with herding sheep and cattle two times a week. On days he was not herding, he usually ran loose in an open space for one to two hours as his owner walked. His owner reported progressive lameness in the right hind limb over a 6-week period; additionally reporting that he was always non-weight bearing on his Right Hind Limb (RHL) after resting/sleeping. He had seen two DVMs and both had recommended an MRI and possibly a Dorsal Laminectomy. The owners preferred to try physical therapy. Radiograph results were normal for bilateral stifle and hip joints. His owner refused NSAIDs for Hank because of his previous GI upset with medications. Hank's prior medical history included bilateral shoulder OCD surgery performed 10-19-04 and probable L-S IVDD diagnosed on 11-28-06. At that time he was treated with rest and acupuncture for several weeks.

EVALUATION AND TREATMENT

On initial evaluation, Hank presented in standing with Toe Touch Weight Bearing (TTWB) to Partial Weight Bearing (PWB) of the RHL. At a walk and a trot, he presented with shortened strides bilaterally in the hind limbs, TTWB to PWB of the RHL, and a lameness score of 3/5. Moderate atrophy was palpable and observed in the right gluteals, quads, and hamstrings. Moderate muscle spasms were palpable bilaterally in the epaxial musculature T9 to the pelvis. Moderately decreased vertebral mobility was palpable, especially into extension, from L1 to S1. Hank would not allow hip extension in side lying or standing. Neurological tests were normal. When L7 nerve root mobility was assessed, stifle extension passive range of motion was approximately 50% on the left and 25% of full extension on the right. Cervical and thoracic limb passive range of motion was normal and painless. Bilateral stifle and tarsus mobility was normal and painless.

On the initial visit, Hank was treated with manual segmental traction from T13-S1. His owner was instructed to limit his exercise activities to one hour per day, including herding activities; and to massage the epaxial musculature qd to bid for ten to fifteen minutes. Hanks owner observed and demonstrated correctly a "tail pull," also to be done bid. for two to five minutes. The plan of care was to see Hank for physical therapy BIW, gradually working towards core strengthening as tolerated and decreasing to once a week visits.

Hank returned for his second physical therapy visit on 4-24-09. His owner reported that Hank loved his massages and that she had begun his "tail pull." She stated that the first time she pulled his tail; Hank turned around and started biting at his right leg and the base of his tail. She continued his "tail pull" with increased tolerance from Hank. She reported he had not been "three legged" since the first time she pulled his tail. The second treatment session included *Functional Integration™ (FI) to improve RHL weight bearing. Segmental traction was performed from T13-pelvis; bilateral L7 nerve root mobilization was also performed. Hank still did not allow any hip extension during treatment.

Hank's third visit on 4-28-09 consisted of soft tissue release techniques in the right abdominal oblique, hip flexors, and epaxials. FI was performed to further integrate spinal motion to RHL weight bearing and extension. L7 nerve mobilization was performed, along with segmental manual traction from T11-pelvis. During L7 nerve mobilizations, stifle extension had improved to 100% with no pain response.

Hank returned on 4-30-09 for a fourth visit. His owner reported that she had taken him for an hour and a half romp in the open space the previous day, and, for the first time since his injury, Hank did not limp after taking a nap. Treatment consisted of manual segmental traction from T11-pelvis. FI was done in sitting and left side lying, with focus on integrating the four limbs with the thoracic spine with weight shifting.

Hank was re-evaluated on his fifth visit on 5-04-09. His lameness score had improved to 1/5 with partial weight bearing and full strides on the RHL. He was allowing 120 degrees of bilateral hip extension passively during treatment. L7 nerve mobilizations were with full stifle extension and without pain response bilaterally, as were L5 and L6 nerve mobilizations. His owner reported that he was running faster and able to run for longer periods of time without rest. She was noticing a limp that was off and on, depending upon Hanks activity level. Treatment continued to be manual therapy, including FI to integrate weight shifting through the four limbs during all gait activities. Soft tissue release techniques were also being used in the epaxial and the oblique musculature.

Hank participated in a herding competition the weekend before his sixth visit on 05-07-09. His owner did not notice any limping during or after the competition. She also reported he was limping three to five minutes after a short rest or after sleeping overnight. She was not noticing any gate abnormalities during the day. Visits six and seven (05-12-09) were similar to visit five above, with the focus being FI for more efficient and pain-free gait.

Hank returned to his eighth visit on 05-14-09. His owner had reported that he had been about the same that week; however, she had noticed that Hank was beginning to stand with his right leg behind the left. On evaluation, his right ilium was caudally displaced. Muscle Energy Technique was performed in standing position to correct the displacement. FI was performed to integrate weight bearing with spine and pelvic extension. Hank's owner was instructed to decrease his runs in the open space to 30 minutes and begin swimming for 15 minutes, TIW. Swimming was added primarily for core strengthening and energy release. His owner was given precautions and told to watch for increased pain possibly due to increased spinal extension during swimming. She was also instructed to begin gym ball core exercises BIW to TIW. Physical therapy appointments where decreased to once a week.

Hank returned for his ninth visit on 05-19-09. His owner reported that she had not had any adverse side affects from swimming. He had also won a herding competition over the weekend. She reported that he still had a mild limp upon rising from sleeping; but estimated that the limp only continued for 30 to 60 seconds after rising. Treatment on that visit included FI for weight shifting and hip extension. Segmental traction T11-pelvis was also performed; and L5, 6 and 7 nerve mobilizations continued to be normal and painless. His owner was instructed to increase Hank's swimming time from 15 minutes to 20 minutes.

Upon presentation of his tenth visit on 05-26-09, Hank's owner reported that she had not seen Hank limping at all since his previous visit on 05-19-09. She had increased the swimming time from 15 minutes to 20 minutes three times a week; she had increased his running time to two hours since his last visit. On evaluation, Hank's gate was normal at a walk and a trot. Hip extension had increased to 145 degrees bilaterally in side lying. Spinal and pelvic extensions were still mildly decreased. Treatment included FI for spinal, pelvic and hind limb extension.

On 06-02-09, Hank returned for his eleventh visit. On evaluation, his gait was normal at a walk and trot; range of motion through the spine and hind limbs was normal; and nerve mobility was normal. Treatment consisted of FI to integrate the entire body in running and trotting gates.

Hank was seen for his final re-check appointment on 06-16-09. His owner reported that he had been working hard and more frequently and was not noticing any limping or stiffness. He had returned to full activity and was continuing to swim two to three times a week. She was continuing to do massage and core strengthening with the gym ball two to three times a week. Evaluation was normal. Hank was discharged with all goals met.

DISCUSSION

It is probable that Hank would have reached his goals in fewer than 12 treatments if his total activity level would have been limited further from the beginning of treatment. However, it was of utmost importance to his owners that he continued working and exercising as much as possible throughout the course of treatment. In addition, swimming may have been beneficial to add earlier in his home program for energy release and core strengthening. Hank's limited hip and spinal extension was the determining factor in waiting until the eighth visit to begin swimming. Infrared or laser may have been beneficial in decreasing pain and inflammation early on in the rehabilitation process. However, the client's financial limitations were a restraining factor throughout treatment, so treatment techniques were kept to a minimum for cost reasons. If Hank had not been improving consistently, the treatment program would have been adjusted and included more modalities for that purpose.

*Functional Integration is a technique included in the Feldenkrais Method. It is a gentle manual technique used to communicate kinesthetically to the student (canine, feline, equine, human, etc.) how to expand functional motor patterns. The student learns how to reorganize their body in new, more effective and efficient ways. To learn more about the Feldenkrais Method, go to www.feldenkrais.com

Is core stabilization really effective for back pain? **By Steve Hoffman**

If you prescribe core stabilization exercises to your back patients (i.e. tummy tucks, abdominal bracing, abdominal hollowing, dead bug, planks, wobble boards, balls, etc., etc.), you probably have noticed that they do not yield the outcomes many researchers and clinicians had hoped that they would.

This article explains why this is the case, and proposes an alternative to these commonly taught and prescribed core stabilization exercises.

First a little background on core training. Although core training has become very popular since the late 1990's, no standard has yet emerged. In the mid 1990's, Richardson and Jull noted some anecdotal success with core training. [1] Some subsequent small studies showed promising results too. [2,3] However, since then, there have been a limited number of larger controlled studies comparing core training with other forms of exercise. Some of the recent studies have shown results that are not as favorable. [4-7]

- In a 2006 review of evidence regarding the use of core stabilization exercises, Rackwitz et al concluded that "segmental stabilizing exercises are more effective than treatment by GP, but they are not more effective than other physiotherapy interventions." [8]
- Later, Cairns et al concluded after a well designed multi center random controlled trials with 97 patients that "There was no additional benefit of adding specific spinal stabilization exercises to a conventional physiotherapy package for patients with recurrent LBP (low back pain)."[4]

This evidence could either mean that (1) core stability as we know it, *is just a myth,*[9] or that (2) the specific core stability exercises studied are not optimized to achieve the desired core stabilization.

Not surprisingly, it appears that the stability model, as is widely known, may already be in decline.[10,11]

All the above listed core stabilization exercises (tummy tucks, abdominal bracing…) are inconsistent with some of the most important principles in motor learning and training. The most important are the similarity and specificity principles.[12] Basically they state that we become better at repeating what we do (good or bad).[13,14] Another way to say it: "practice does not make perfect, rather, practice makes permanent." Practice a bad movement and it will become a bad habit. Alternatively, practice a good movement and it will become a good habit.

With regard to core stabilization exercises, one needs to first recognize the fact that core stability is very movement specific. It is a three-dimensional concept and function. A person may lack core stability in one movement, and have no deficiency in core stability for other movements. Thus, prior to embarking on core stabilization exercises, one needs to first identify which specific movement has deficiency in core stability. One method to test for lack of core stabilization is to manually apply external stabilization to the specific area, and evaluate if this alone will immediately relieve symptoms such as pain or limited range of motion.[15]

If I lack core stability in bending forward while in an upright weight bearing position, then would it help me to exercise any other movement? (i.e. tummy tucks while lying on my back, abdominal bracing while lying on my tummy, ball exercises on my back or tummy, etc., etc.)

Obviously, a skilled pianist that is deficient in playing a particular song would not consider practicing other songs that he or she has already mastered as a technique to becoming good at playing the particular deficient song.

Similarly, once a movement with deficient core stability is identified, it would be inefficient to exercise other movements that are unrelated.

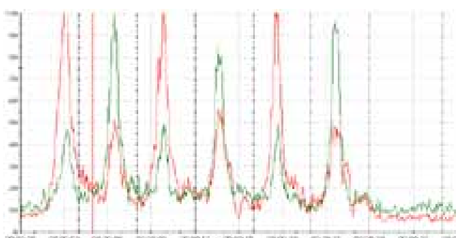
Now that we have established the importance of exercising the particular movement that is deficient, the next question is how to exercise it.

Before the skilled pianist starts to practice a new song in full earnest, she first has to make sure that she is playing it correctly, otherwise, it does not matter how much she practices, as she will never know how to play the song correctly.

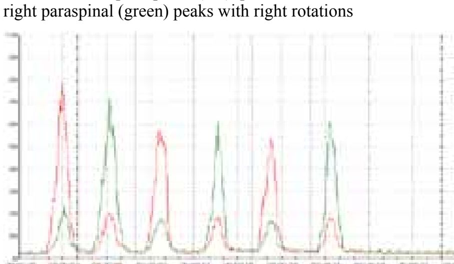
Similarly, before we embark on core stability exercises, we need to first be sure that the movement is correct. In other words, pain-free and with correct muscle activation patterns.

Therefore, in order for core stabilization exercises to even have a chance at achieving the desired outcomes, they must first of all be done (1) in the exact position and direction in which the patient has a problem (i.e. upright and weight bearing when applicable), and equally importantly, (2) the CNS must be firing the muscles correctly while in movement, prior to embarking on exercises. This ensures that during these core stabilization exercises, the CNS learns to fire the muscles correctly rather than incorrectly.

The following graphs show sEMG data for left and right paraspinal muscles while a subject is performing spinal rotations to the left and right (3 times in each direction) before and during an ATM®2 session.



<u>Baseline</u> – Paraspinal Muscle Activation during spinal rotations. Left paraspinal (red) peaks with left rotations and right paraspinal (green) peaks with right rotations



<u>On ATM2</u> – Paraspinal Muscle Activation during spinal rotations. Left paraspinal (red) peaks with left rotations and right paraspinal (green) peaks with right rotations.

Based on the above data, when using the ATM2, the following changes in CNS muscle activation patterns are apparent:

1. Paraspinal muscle activity at rest is reduced from about 10 micro volts to about 2-3 micro volts (70-80% reduction).
2. Jittering (signal noise) in the paraspinal muscles is significantly reduced.
3. Percentage difference between left and right (red & green) at peek rotations is increased from under 60% to almost exactly 70%.
4. Percentage difference between left and right at rest is close to zero (normal) compared to about 30% prior to ATM2.

As can be seen in the above sEMG data, using the ATM Concept and an ATM2 system you can immediately and effectively alter the CNS muscle activation patterns in the position and direction in which the patient has a deficient movement. With sEMG, you have undisputable, specific, objective, and documentable real-time evidence that the ATM2 is normalizing muscle activation patterns. This is at the root of core stabilization exercises, and this explains the immediate pain relief and increases in range of motion you can achieve with the ATM2 for almost all back, neck, pelvis, hip, knee and shoulder patients.

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