# An Examination of Manual Therapies and Patient-Centered Care in Athletic Training:

# A Dissertation of Clinical Practice Improvement

A Dissertation

Presented in Partial Fulfillment of the Requirements for the

Degree of Doctor of Athletic Training

with a

Major in Athletic Training

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by

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## AUTHORIZATION TO SUBMIT DISSERTATION

This dissertation of Belinda Joan Sanchez, submitted for the degree of Doctor of Athletic Training with a Major in Athletic Training and titled "An Examination of Manual Therapies and Patient-Centered Care in Athletic Training: A Dissertation of Clinical Practice Improvement," has been reviewed in final form. Permission, as indicated by the signatures and dates below, is now granted to submit final copies to the College of Graduate Studies for approval.

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## ABSTRACT

The Doctor of Athletic Training program is designed to help athletic trainers transform into scholarly clinicians. Direct evidence of the transformation into a scholarly clinician is provided by a culminating product, the Dissertation of Clinical Practice Improvement (DoCPI). Included in this dissertation is a Plan of Advanced Practice (PoAP), an objective plan uniquely designed to guide the athletic trainer towards advanced practice. The PoAP is fluid in nature and includes a reflection on current clinical knowledge, a description of strengths and weaknesses, current philosophies on patient care, and future professional goals. The present DoCPI contains further evidence of my advancement as a scholarly clinician in the analysis of clinician and patient-centered outcomes and a presentation of residency findings. Included in the residency findings is a summary of key clinical learning experiences, an analysis of selected patient outcomes associated with these learning experiences, a reflection on the findings, and a revised plan for each subsequent semester of clinical residency. The cyclical nature of the residency findings presentation reflects the action research (AR) philosophy used by the scholarly clinician to study and transform their clinical practice. As scholarly clinicians, students of the DAT choose an area of focus in patient care and create practice-based evidence (PBE) through clinical research studies. A review of literature is included in this dissertation detailing the topic of meniscal tears and a potential alternative manual therapy treatment option using the Mulligan Concept. The final component of this dissertation is the presentation of a multi-site research study involving the treatment of meniscal tears using the Mulligan Concept “Squeeze” technique. Together, all components of this dissertation exemplifies the complete development of the scholarly clinician.

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# DEDICATION

To my God.
Thank You for every individual you have placed in my path to help me along the way.

To my family.
Thank you for allowing me to dream.
I love you all.

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# CHAPTER 1: NARRATIVE SUMMARY

The Doctor of Athletic Training (DAT) program at the University of Idaho is a professional practice degree (PPD) program designed to advance the practice of clinicians and educators in the profession of athletic training (AT). Through the DAT curriculum, students are provided the opportunities to learn about innovative treatment techniques, conduct their own clinical research, and develop reflective clinical practice philosophies. Under the program faculty's guidance, students become scholarly clinicians who, ultimately, are on the path to becoming advanced practice athletic trainers (APATs) with developed areas of focus in patient care and research (Nasypany, Seegmiller, & Baker, 2013). Direct evidence of an athletic trainer's transformation into a scholarly clinician is provided by the culminating product of the DAT program: the Dissertation of Clinical Practice Improvement (DoCPI). The DoCPI is a detailed manuscript in which the student highlights the application of reflective clinical practice, analysis of residency experiences, and development of original research. The contents of the DoCPI are an outward expression of the various transformative experiences which have had an impact on the athletic trainer as a result of the DAT program.

Traditionally, doctoral degree programs have been focused on training students to become researchers who test and develop theories within a controlled environment (Willis, Inman, & Valenti, 2010). In contrast, PPD programs allow practicing professionals to take an applied approach to doctoral work. Generally, students who are enrolled in these programs are already involved in their chosen field, but they wish to improve as practicing professionals and seek to solve problems in their field of study (Willis et al., 2010). Because its students attain an advanced level of professional practice and become scholarly practitioners who are competent as clinicians, researchers, and scholars, The University of Idaho's (UI) DAT program fits the PPD program model. The program curriculum challenges practicing athletic trainers to examine their clinical practice, uncover local problems, and create plans for improvement. Students are encouraged to explore practical approaches to the application of research into their clinical practices (e.g., *a priori* case series, case-control trials, cohort studies). By designing research to address their local problems, students can analyze the outcomes of their research, reflect on the results, and draw conclusions to improve patient care. Through the production of quality clinical research, scholarly clinicians can contribute a greater depth and breadth of evidence to the existing body of knowledge in AT.

Research and scholarship are central components of the UI DAT program. A particular emphasis is action research (AR), which is a research philosophy designed to address practical problems from a hands-on and holistic perspective (Koshy, Koshy, & Waterman, 2011). The AR process involves setting up a plan to solve a local problem, implementing the plan, observing its impact, reflecting on the outcomes with key stakeholders, revising the plan as a team, and beginning the process again by implementing the newly revised plan (Koshy et al., 2011).

The DAT student learns to implement an AR philosophy into his or her clinical practice through *a priori* clinical investigations and reflective clinical practice. *A priori* clinical research plans are created prior to the data collection phase and are used for consistent evaluation, treatment, and collection of patient outcomes. Outcomes measures are a valuable tool used to collect patient data in clinical research. Patient outcomes may take the form of disease-oriented evidence (DOE), such as range-of-motion and girth measurements, or patient-oriented evidence (POE), such as the Disablement in the Physical Active (DPA) Scale or the Lower Extremity Functional Scale (LEFS) (Hurley, Denegar, & Hertel, 2011). While disease-oriented outcomes measures are important to the clinician, patient-oriented outcomes capture what is important to the patient, such as perceived disability, societal limitations, and health-related quality of life (HRQOL) (Valovich McLeod et al., 2008). Patient-oriented outcomes can be categorized into multidimensional scales that are designed to measure well-being from physical, cognitive, emotional, and social perspectives (e.g., DPA Scale) and specific scales that are focused on a particular anatomical region, population, injury, or dimension (e.g., LEFS) (Valovich McLeod et al., 2008). The collection of both DOE and POE provides the researcher/clinician with information on the effectiveness of treatment applications and patient progress over time, while still focusing on what is important to the patient.

Not only is collecting patient outcomes valuable in assessing the effectiveness of treatments, the practice also contributes to the application of evidence into clinical practice. Evidence-based medicine (EBM) involves the integration of the best available evidence, clinical expertise, and patient-centered care into clinical decisions (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996). Even though the best available evidence and clinical expertise may dictate the use of a particular treatment, the patient's needs and values should also be considered. By collecting and analyzing POE, the clinician can assess whether their treatment intervention, selected based on the combination of research evidence, clinical expertise, and patient needs is affecting the patient positively or negatively.

The careful application of EBM serves the scholarly clinician well in the development of practice-based evidence. Practice-based evidence is the development of new evidence through a process of meaningful and reflective examination of DOE and POE collected from one's own clinical practice (Nasypany, Seegmiller, & Baker, 2013). While the best available evidence may include published randomized control trials (RCT) and meta-analyses, the value of PBE should not be overlooked because it is clinically relevant and directly applicable to the improvement of patient care. Through the application of PBE, clinicians can become effective producers and consumers of clinically relevant research. Students in the UI DAT program learn to combine their clinical and research skills to effectively produce translational research projects.

Translational research is research which produces an end result ready to be applied to patients in a clinical setting, effectively bridging the gap between a controlled laboratory ("bench research") and clinical practice (the "bedside") (Keramaris, Kanakaris, Tzioupis, Kontakis, & Giannoudis, 2008). Recently, leaders in the AT profession have called for an increase in the production of clinical research and PBE in AT (Sauers et al., 2012; Wilkerson & Denegar, 2014). The call mirrors previous concerns for the lack of growth in relevant research in AT (Knight & Ingersoll, 1998). Through their use of collaborative research networks and a translational research approach, the scholarly clinicians produced by the University of Idaho's DAT program can fill the need for quality clinical research in AT. The practice of being actively involvement in scholarship (i.e., the advancement of knowledge) allows the scholarly clinician to not only advance his or her own clinical practice, but to contribute to the advancement of the AT profession as a whole.

Involvement in scholarship is just one component of becoming a scholarly clinician. Another is the development of clinical expertise in select focus areas. As a scholarly clinician, I have focused on attaining a complex understanding of manual therapy and psychosocial treatment interventions. I plan to gain further expertise in these areas after I complete the DAT program and have created a Plan of Advanced Practice (PoAP) to guide me in my endeavors post-graduation. In general, the PoAP is a "roadmap" that is intended to create an objective plan for the development of particular focus areas in patient care—a key characteristic of an scholarly clinician on a path towards advanced practice (Nasypany, Seegmiller, & Baker, 2013). My PoAP, which is found in Chapter 2 of this dissertation, includes a reflection on my clinical knowledge prior to my enrollment in the DAT program; my current clinical knowledge; a description of my strengths and weaknesses; an explanation of my current patient care, teaching, and leadership philosophies; a list of my future professional goals and the methods by which I will achieve these goals; and my plan to advance my clinical practice and career. I will regularly assess the contents of my PoAP and will develop new objectives and outcomes to fit my personal and professional needs.

Further evidence of my advancement as a scholarly clinician is found in Chapter 3 of this dissertation, in which I reflectively examine the progress of my clinical practice by presenting DOE and POE data that I collected and analyzed across two years of clinical residency. As a scholarly clinician, I began each semester with an *a priori* patient care plan (a plan created prior to initiating patient care) that was intended to guide and assess my patient care practices. I used patient outcomes to evaluate the effectiveness of my treatment interventions, and I reflected on these outcomes to detect patterns. Through careful clinical reflection, I began to develop my clinical philosophies with each passing semester. I was also able to identify the need for psychosocial treatment interventions as a local problem in my clinic. Thus, Chapter 3 includes a reflection on what I have learned about the biopsychosocial-spiritual model of illness and an explanation of how I have begun to incorporate this model into my patient care. The cyclical nature of my analysis of my clinical practice progress reflects the AR philosophy that I have used to study and transform my clinical practice.

Along with developing clinical focus areas and applying EBP and PBE, the scholarly clinician is also expected to attain a breadth and depth of knowledge beyond what is required for entry into the profession. To obtain an increased depth and breath of knowledge in the treatment of meniscal tears with manual therapy, I conducted a review of literature on meniscal tears, clinical diagnosis, surgical treatment interventions, and a potential alternative manual therapy treatment option that uses the Mulligan Concept. The complete literature review can be found in Chapter 4 of this dissertation. The results of this literature review led me to participate in a multi-site research project that involved the treatment of meniscal tears using the Mulligan Concept. The manuscript presented in Chapter 5 of this dissertation is the result of this clinical research and is an example of the type of translational research that can be produced through the collection and application of EBP and PBE.

Together, the content contained in the chapters of this dissertation reflects the growth I have experienced while in the UI DAT program. In developing my PoAP, I have reflected on my current strengths and weaknesses, and defined my philosophies on patient care, teaching, and leadership. The process of collecting POE and DOE outcomes and application of reflective clinical practice have allowed me to assess the effectiveness of my treatment interventions and develop my clinical philosophies with each passing semester of my clinical residency. The composition of a detailed review of literature demonstrates my ability to gather and analyze the best available evidence prior to clinical practice application. Finally, the manuscripts in Chapter 5 and Appendix A show evidence of my abilities to develop scholarly works directly from my clinical practice. Overall, my completed DoCPI demonstrates my transformation from a regular athletic trainer with six years of clinical experience into a scholarly clinician.

**References**

Hurley, W.L., Denegar, C.R., Hertel, J. (2011). *Research Methods: A framework for the evidence-based clinical practice.* Baltimore, MD: Lippincott Williams & Wilkins.

Keramaris, N. C., Kanakaris, N. K., Tzioupis, C., Kontakis, G., & Giannoudis, P. V. (2008). Translational research: From benchside to bedside. *Injury International Journal of the Care of the Injured*, *39*(6), 643–650. http://doi.org/10.1016/j.injury.2008.01.051

Koshy, E., Koshy, V., & Waterman, H. (2011). *Action research in healthcare*. Thousand Oaks, CA: SAGE Publications Inc.

Nasypany, A. M., Seegmiller, J. G., & Baker, R. T. (January, 2013). *A model for developing scholarly advanced practice athletic trainers in post-professional education programs*. Poster presented at the 2013 Athletic Trainers' Educator Conference, Dallas, TX.

Sackett, D. L., Rosenberg, W. M. C., Gray, J. a M., Haynes, R. B., & Richardson, W. S. (1996). Evidence based medicine: What it is and what it isn't. *British Medical Journal*, *312*(7023), 71–72. http://doi.org/10.1136/bmj.312.7023.71

Valovich McLeod, T. C., Snyder, A. R., Parsons, J. T., Curtis Bay, R., Michener, L. a, & Sauers, E. L. (2008). Using disablement models and clinical outcomes assessment to enable evidence-based athletic training practice, part II: Clinical outcomes assessment. *Journal of Athletic Training*, *43*(4), 437–45. http://doi.org/10.4085/1062-6050-43.4.437

Willis, J., Inman, D., & Valenti, R. (2010). *Completing a professional practice dissertation: A guide for doctoral students and faculty*. Charlotte, NC: Information Age Publishing, Inc.

# CHAPTER 2: PLAN OF ADVANCED PRACTICE – MARCH, 2016

## Introduction

The Plan of Advanced Practice (PoAP) is a well-defined "blue-print" used to guide a clinician's progress toward advancing their practice in a particular focus area or areas. The plan is unique and tailored to the personal and professional goals and aspirations of the individual clinician. The PoAP is based on the concept of taking particular and intentional steps towards becoming an advanced practice athletic trainer, which involves careful planning and self-reflection. Clinicians must first reflect on previous clinical experiences and identify a trajectory for clinical growth before developing a plan for gaining expertise in a desired area(s) of focus. Although the PoAP is a detailed roadmap, it is meant to adapt as my professional aspirations and work settings change in the future. Through regular reflection on my goals and aspirations, I plan to adjust my PoAP so it can continue to serve as a helpful roadmap to guide my path towards professional advancements.

My journey toward advanced practice as an athletic trainer and scholarly practitioner has been one of self-discovery. I have come to understand that my interests in patient-care and education lie in serving others and not in serving myself. I seek to improve my clinical skills mainly to teach students to be better clinicians. When I first developed my PoAP in the fall of 2014, I was focused on improving my evaluation skills, understanding of treatment-based classification, and knowledge of treatment techniques. My updated version reflects a broader approach to professional improvement. While it still contains my objectives for advancing my practice, it now includes a plan for instructional development and objectives for personal growth.

## Reflection on Professional Experience and Development

My professional career has been a path of self-discovery. I initially chose a career in athletic training because it combined the two settings I enjoyed most: healthcare and athletics. My first experience in athletic training (AT) was a semester-long tenure as an athletic training student at a community college. I was fascinated with the clinicians' ability to assess injuries, and I admired their confidence in creating plans for their patients' return to play. The unique, interactive, and fast-paced environment suited me well. When I enrolled in an AT program, I was convinced that I would soon be as competent as my supervising athletic trainers.

The best word I can use to describe my education in the AT program is disconnected. I tried to be a "good student" by earning high grades, and a "hard worker" in the clinic by assisting my preceptors in managing the AT clinic. However, my learning techniques were highly inefficient and, as a result, I was unable to make the connection between class content and clinical application. I memorized rehabilitation protocols and applied concepts exactly as they were presented in class or in the textbook. I became a well-trained "knobologist,"— a term often used in the DAT program to refer to clinicians who work on "auto-pilot," or without much reference to clinical reasoning and critical thinking.

My faults became increasingly apparent to me in my first position as a certified athletic trainer, which was when I worked as the only athletic trainer at a community college. Although I made vast improvements in the administration and organization of the athletic training clinic, I was confronted with my clinical deficiencies on a daily basis. I felt that I needed to return to a learning environment that was rich with motivated clinicians. After completing my contract at the community college, I accepted a graduate assistantship at

California Baptist University, where I worked with the swimming, diving, and cross-country teams. I also served as a preceptor for the AT program.

My graduate assistant experience served as a "second chance" to absorb the lessons I should have learned in my professional program. I had full autonomy over my practice; yet I was encouraged to ask questions, regardless of how simplistic they seemed. As a young clinician, this was a pivotal point for me, because I realized I was not meant to know everything. Before this time, I had equated my lack of knowledge in rehabilitation protocols or my inability to arrive at the correct diagnosis with not being "good enough;" but the clinicians who mentored my graduate work taught me that not knowing something was simply an opportunity for growth and improvement. It was the first time I had seen experienced practitioners refer to a textbook or medical journal for guidance. My supervising clinicians had their own limits, in regards to their clinical skills; yet they were able to acknowledge their limitations and work together to seek adequate treatments and referrals, if necessary.

I continued to grow as a clinician in my first job after graduate school, in which I worked as an assistant athletic trainer and adjunct professor at Point Loma Nazarene University (PLNU). Here, I was once again in a supportive environment with clinicians who shared a common mission. This mission, in addition to providing quality healthcare to athletes, was to provide an interactive and challenging learning environment for AT students. Clinicians took the time to conduct thorough evaluations, and students were challenged to think critically and to solve problems alongside the certified ATs. Students were expected to be involved in every aspect of patient care, and the vocalization of their opinions and perspectives was encouraged. While I never gave my students complete autonomy, I was expected to treat them as colleagues and to hold them accountable to the knowledge required of a newly certified athletic trainer.

I admit that my expectations of the AT program at PLNU were low, due to the small size of the school and its limited reputation. However, the vision and level of competence exemplified by the program's leaders caused my expectations to be greatly surpassed. The program served as a tremendous example of clinicians who utilized their individual strengths as they worked together. It was in this setting that I came to realize two things: firstly, a career as a healthcare provider does not match my natural strengths; and secondly, I am much more interested in encouraging students to develop their skills as clinicians than improving my own clinical skills.

After two years of working at PLNU, and with the support of my colleagues, I decided to accept a faculty position at Concordia University Irvine, which in many ways, was similar to PLNU. The faculty at Concordia were encouraged to build relationships with students as mentors, and like PLNU, the AT program at Concordia was small and highly supported by the institution. My new position came with many administrative responsibilities. I was one of only two full-time educators in the AT program, and I was given the task of regaining accreditation of our undergraduate program. I had greater responsibility and worked longer hours than at my previous job, but I enjoyed the time I spent at work and was motivated to improve the program. I was now working within my strengths and no longer doubted my competence. I immediately took ownership of the overwhelming responsibilities that I had been given and worked diligently to understand my new environment and the constructs upon which it was founded.

After a successful site-visit by the Commission on Accreditation of Athletic Training Education (CAATE), I attended the Athletic Training Educator's Conference, where, for the first time in my professional career, I felt as if I belonged. I saw the value in capturing the educational process and improving on it for the benefit of the AT profession and its patients. I was far more interested in the topics of conversation, such as creating quality clinical preceptorships and introducing clinical reasoning in the classroom, than I had ever been in any other professional setting. I returned from the conference with a feeling of empowerment. I was convinced that our program at Concordia needed to transform, but I did not know where to start. I wanted the students in the AT program to conduct research, but I did not know how to guide them through this process. I wanted our preceptors to deliver a higher quality of educational experiences, but I was not sure how to help them do this. Once I acknowledged my limits in this new professional setting, I decided to do something about it.

**Rationale for Pursuing a Doctoral Degree in Athletic Training**

My purpose for pursuing a doctoral degree was two-fold: to become a better clinical educator and to improve the quality of the healthcare services I provide to those in need. Four years into my clinical practice, I noticed that I was continually struggling with the same challenges as a clinician. Despite my struggles in the clinic, I was praised by my colleagues for my administrative accomplishments and my desire to invest in the development of AT students. I enjoyed developing program policies and looked forward to helping students create plans to reach their goals in the clinic and as they advanced toward graduation. During my time at PLNU, I was exposed to two books that significantly influenced my perception of my career goals and professional responsibilities: *StrengthsFinder 2.0* by Tom Rath, and *Cure for the Common Life* by Max Lucado. Reading these books helped me to pay attention to the subtleties of my strengths. I decided that instead of focusing on improving my weaknesses, I needed to shift my outlook and start functioning within my strengths. As I grew sensitive to trends in my workplace and to the impact I had on those around me, I realized that my AT students frequently came to me with questions, knowing that I could explain concepts to them in a manner that they could understand. I also noticed the praise I received from my colleagues for my patience in educating student-athletes in the clinic on their injury and course of treatment. This led me to a shift in my career goals in which I began to move away from patient care toward education.

I had been searching for doctoral programs since my first year of work at PLNU. I was so impressed with the faculty there, that I decided I wanted to invest in a similar career path. My desire to focus on clinical education led me to the DAT program at the University of Idaho. It offered clinical advancement, research experience in an area relevant to the AT profession, and teaching opportunities. I feel that I have come full-circle from student, to clinician, to educator, to student again; although this time around as a student, I have a different perspective and purpose. I am trying to learn for the sake of self-discovery and personal growth. Through my experiences in the DAT program I have gained a greater understanding of myself and I have developed my professional philosophies to a deeper and more meaningful extent than before.

## Current Clinical Competence

### Reflection on Current Professional Knowledge

My previous educational experiences prepared me to approach injury assessment from a biomedical model and with the kinetic chain in mind. I was trained to collect objective information that would result in an accurate diagnosis; therefore, proper diagnosis was important to my decision of how to treat a patient. I relied on the mechanism of injury, the location of pain, and the patient's symptoms to create a differential diagnosis. I then used orthopedic special tests to confirm the pathology. I connected pathologies and dysfunctions directly to treatment protocols, each of which had an expected and widely accepted timeframe for recovery. When injuries fit into my classification system well (e.g., when treating patients with acute injuries caused by an isolated mechanism), the biomedical model allowed me to treat those injuries successfully. However, I was ill equipped to treat injuries outside of my classification system. Despite my methodical process, I continually struggled to diagnose and treat injuries that did not fit neatly into my pathoanatomical classification system.

The DAT program has challenged me to apply a more global approach (i.e., one that considered more body segments and systems than the isolated chief complaint) to patient care. The regional interdependent (RI) approach of evaluating musculoskeletal injuries calls for the consideration of a dysfunction in an altogether unrelated segment of the body, away from the site of injury (Wainner, Whitman, Cleland, & Flynn, 2007). Prior to my enrollment in the DAT program, I would evaluate and treat my patients from a pseudo regional interdependent approach in which I only considered the joints above and below the site of injury. Even then, I would only move away form evaluating the involved body segment when my initial attempts at treatment had failed. However, I now know that good patient care goes beyond assessing joints above or below the injury; it calls for the integration of the organism as a whole. Another global approach that I have been exposed to is the biopsychosocial model, which takes into account the patient's physical, psychological, and social state during assessment and treatment selection (Engel, 1980). As an educator prior to the DAT, I taught both the RI approach and the biopsychosocial model in athletic training courses; however, I failed to make an effort to apply them in my clinical practice. And because I was not applying them to my patient care, I was only teaching these concepts to my students on a superficial level.

I have drastically changed my approach to patient care since I started the DAT program, and I now work within the biopsychosocial-spiritual model on a daily basis when evaluating patients. The biopsychosocial-spiritual model expands the biopsychosocial model to include the patient's spiritual concerns and beliefs (Sulmasy, 2002). Although my patients primarily seek help for musculoskeletal injuries, I have learned that chronic injuries do not exist in isolation. The root cause of a patient's symptoms may be a dysfunction in a system other than the musculoskeletal, such as the nervous system or the immune system. In fact, their issue may even be rooted in a dysfunctional relationship or a traumatic social experience. Therefore, I typically include measurements of stress, anxiety, and well-being, such as the Disablement in the Physically Active Scale or the Yellow Flags Questionnaire to assess psychosocial factors which could be related to the patient's symptoms. I also include stress-reduction and trauma-releasing techniques into my usual treatment protocols with patients.

Patient care goes beyond the ability to evaluate the pathology; it even goes beyond the ability to deliver a treatment. Patient care is about addressing a patient's needs and understanding when to apply which treatment; this is a lesson I am learning in my own clinical practice. As a student in the DAT program, I have evolved from a low-level clinician, a "knobologist" in many respects, to a scholarly clinician seeking to develop my area of advanced practice.

On a scale of zero to ten, where zero is considered to be an "entry-level clinician" and ten, an "advanced practitioner," I would currently rank myself at a seven. I am capable of assessing patients appropriately within the biomedical model, I can classify my patients into proper treatment paradigms, and my manual therapy skills are far better than they were before I entered into the DAT program. But, I could still stand to grow in critical thinking and in the analytical application of the various movement assessment paradigms to which I have recently been exposed. I believe that my breadth of clinical skill is that of an advanced practice athletic trainer. With continued analysis of my patient outcomes and with regular reflection on my practice, I will continue to progress toward a greater level of skill in critical reasoning and a greater depth of knowledge in the paradigms that are new to me.

**Reflection on Strengths**

I believe that a person can be more productive when they focus their time and energy on developing their strengths rather than on attempting to improve their weaknesses, only. I do not think we should ignore our weaknesses; but to fight our own natures may prove to be more frustrating than fruitful. Rather than continue to point out my deficiencies as a clinician, I chose, during the Spring 2015 semester, to begin focusing my energy on identifying my strengths. Since making this change, I have experienced increased enjoyment in the work that I do and decreased frustration when things do not go according to plan. I continue to strive to improve on my weaknesses, but I now seek opportunities to work within my strengths more often than before.

I have taken two approaches to identify my strengths, the first being the use of the Clifton StrengthsFinder (Rath, 2007), an objective tool that was designed to identify a person's top-five natural talents, and the second being observation and reflection on my own professional experiences. The StrengthsFinder is the result of a 40-year study of human traits and strengths which resulted in 34 themes, or strength categories, most common among people. The StrengthsFinder is an online survey used to identify which 5 of the 34 themes occur most often in a person's life; these top five themes are then identified as the person's strengths. The results of my StrengthsFinder assessment, in order from strongest to weakest, follow:

- *Restorative.* In its simplest form, restorative can be defined as problem solving, fixing things, or bringing things back to life (Rath, 2007). When I apply this strength to patient care, it is not the evaluation and assessment process that I enjoy; rather, it is restoring a patient's function back to "normal." I believe that this is why I am driven to decrease pain and to increase function in the clinic, rather than to seek the underlying cause for pain.
- *Achiever.* I am driven by accomplishing tasks and achieving tangible goals. The opportunity to achieve keeps me motivated and provides me with the endurance to complete my longer-term goals.
- *Responsibility.* This strength helps me to take ownership of my commitments. I like things to be done well, with no short-cuts, especially when my name is attached to the final product.
- *Focus.* I like to have clear and defined goals. I have the capacity to work long hours and do not let emotions distract me nor deter my pace.
- *Harmony.* I seek common ground. If a difference in opinion does not conflict with my basic values or take away from the larger purpose, then I see no need to focus on points of disagreement. I prefer to focus on the greater mission and on the similarities among people and groups. I view debate for the sake of debate as impractical and unnecessary. Issues arise when I fail to identify situations where debate and/or interjections (such as brainstorming) are necessary.

The second method by which I have identified my strengths is that of observing and reflecting on my own professional experiences. Those strengths follow:

- *I can work well with anyone.* I am able to work with anyone, even individuals whose opinions and personalities differ form my own. I have experienced the benefits of this strength while working with a diverse population of patients in the UI AT clinic, especially with those requiring greater patience.
- *Administration.* I find it easy to stay organized and to develop necessary policies and procedures for the improvement of organizational administration. "Identifying the details" is something I am good at and I can easily break down someone's vision or problem into smaller, manageable components. I enjoy employing the discipline needed to function within this area.
- *Educating and mentoring students.* I enjoy helping students to develop and accomplish their goals. I also like to simply learn about my students, their backgrounds, and their perspectives.
- *Keeping a calm demeanor under stress.* I find that I have been able to think critically and rationally when the clinic becomes overwhelmed with patients or when an unexpected acute injury case arises. I am also able to efficiently managing a hectic environment.

**Reflection on Areas for Improvement**

Many of the areas in my practice that require improvement are foundational in nature. Prior to my time in the DAT program, I did not have the courage to admit my weaknesses. As a result, instead of seeing my clinical skills grow with each year of experience, I saw my faults increase in intensity and in number. Through the process of purposeful reflection, in the summer of 2014 I began to uncover key deficiencies that I then planned to slowly improve upon throughout my DAT experience. I am still working on improving in these areas, which follow.

- *Overdoing my strengths.* Although I listed achiever and responsibility as strengths, when taken to the extreme, these strengths can become weaknesses. My desire to achieve helps me to stay motivated; but if I do not remain focused on my mission, I can easily drift toward attempting to achieve a goal that was not my own, simply to meet the challenge. Responsibility can also easily become a fault when my need to take responsibility leads me to overcommit myself.
- *Foundational sciences*. I find myself struggling to recall foundational concepts, such as healing timeframes, neurological pain pathways, and biomechanics. I began working to improve this weakness by reviewing foundational concepts such as therapeutic modality parameters and healing timeframes in the summer of 2014, and beginning coursework in human anatomy in the fall of 2014.
- *Assessment and Treatment-Based Classification.* It is difficult for me to pick up on the nuances of abnormal postures and body movements, therefore I have relied heavily on special tests in the past, in place of functional movement screens. Now that I understand that many injuries are due to dysfunctions and not true pathology, I find it necessary to improve on my ability to perform movement assessments and functional movement screens (i.e. Selective Functional Movement Assessment [SFMA], The Myokinesthetic System [MYK], and Total Motion Release [TMR]). By learning paradigms which incorporate both a assessment and treatment component, I feel I can improve in my assessment skills and learn to better classify my patients into the appropriate treatment.

- *Being an evidence-based clinician*. I find myself wanting to apply the new clinical concepts I have learned from a "knobologist" approach. It is not in my nature to take a systematic or analytic approach as I apply various assessment and treatment paradigms. I need to take care to be systematic and evidence-based rather than eminence-based, especially as I study my clinical outcomes and as the line between clinician, researcher, and educator becomes less clearly defined.
- *Over-investing*. In the fall of 2014, I discovered that I measure my self-worth by my successes and failures in patient care. I am an empathetic person, so my challenge has been to care about my work without letting the set-backs of one patient carry over to the next patient and the rest of the patients that I see throughout the remainder of my day.

## Path to Advanced Clinical Practice

### Future Professional Goals

My goal after completing the DAT program is to return to a position where I can serve as an educator and provide guidance and mentorship to students who seek a career in healthcare. Ultimately, I plan to find an educational program with a mission I can support – one that equally values excellence in academics, service to the community, and whole-person development. I want to find a program to invest in, and, by so doing, foster a supportive and sustainable community among all those who are involved, from faculty and support staff to preceptors and students. Because educators demand so much from professional students, it is important, too, that educators provide students with a positive and supportive environment that not only encourages them to excel, but is also a program in which community is intentionally fostered. I plan to offer my perspectives and strengths, as well as the knowledge

I gained at the University of Idaho, as assets to any professional program I may be a part of in the future.

Aside from education, service and social responsibility are two areas in which I plan to increase my involvement as a professional. I already possess experience with being involved in regional professional committees; however, I think it is more important that I interact with individuals within my community and immediate circle of influence, regardless professional affiliation. Education programs are in a prime position to connect with surrounding communities; therefore, I plan to find ways to improve the AT profession on a local, community level. My goals are to connect with leaders in my area and to ensure that the AT profession is well represented through advocacy for patient needs and employment for clinicians.

**Leadership Philosophy**

My philosophy on leadership is that it is a natural responsibility that comes with experience. I believe those who are more experienced have the responsibility to serve their community by taking on leadership roles. As my understanding of my community and profession increases, my attention to civic duties increase as well, which means I will likely take on positions of leadership in the future. Therefore, I need to continue to develop as a leader. I am not a natural leader; while I take initiative in my own life, I do not feel the need to lead others unless I have been assigned the role. Servant leadership is a style of leadership in which the leader is, by nature, a servant first. Only later is that person given the role of leader (Greenleaf, 1977). The servant leader is a "natural born servant," who does not possess any ulterior motives. He or she serves because of a sense of responsibility to take care of subordinates. A servant leader puts the needs of the individuals within the organization as top priority - even above the needs of the organization (Sendjaya & Sarros, 2002). I believe that this describes my leadership style well.

When I am placed in leadership positions, I feel that it is my responsibility to model best practices and to set high standards for myself and those around me. I also believe it is important to invest fully in those whom I am leading and to be present with them when needed. I have been told on several occasions that my ability to connect and be present with others is one of my greatest strengths. I do not yet understand the extent of this gift, nor do I know, exactly, what to do with it. But I believe that it speaks to what I try to do in any setting I find myself in, which is to be "a light" to others. The Bible often refers to God as *light*; and His followers are encouraged to be a light to those around them. My goal in leadership is simple: to be a positive influence on others. Modeling, encouragement, and teaching are all ways in which I hope to influence those around me for the good. I hope to continue to motivate students to reach their potential, to encourage those around me, and to leave things better than they were when I found them.

**Teaching Philosophy**

My philosophy as an educator is to understand that every individual person matters. It is often the case that the students who are the most difficult to work with are the same ones who thirst for guidance. When I find myself struggling with a "difficult student," I realize that it is because I am not present, mentally, with that student, nor am I listening to what he or she is trying to say. Regardless of the chosen teaching methods, I believe that to be an effective teacher, one must have compassion for and truly care about one's students. As an educator, I should take on the responsibility to challenge my students every day, because I feel that my students and my institution have entrusted me to do so. By becoming an educator, I take on the responsibility of developing students and assisting them in reaching their potential. Additionally, I must also allow myself to be challenged and continue to be educated my entire career. Allowing myself to remain stagnant would lead to stagnant teaching methods and decrease my ability to challenge my students.

Just as I strive as a healthcare provider to treat the patient and not the injury, I feel it is important to commit myself to developing students who are well equipped from all perspectives and not just according to accreditation guidelines. As an AT educator, I am helping to develop quality clinicians for this profession. As a mentor, I am challenging students in all aspects outside of didactic education and clinical skill. If I can remember the importance of developing *the whole person* without getting lost in *the standards and outcomes*, then I will consider myself a successful educator.

**Patient Care Philosophy**

My philosophy on patient care is to expect immediate positive outcomes from therapeutic interventions. My goal is to produce significantly improved outcomes (e.g., decreased pain, increased function) during each visit and to minimize the amount of follow-up visits before complete discharge. I believe that the key to accomplishing this is to classify injuries appropriately. After all, I can only expect improved patient outcomes if I am able to match the dysfunction with the appropriate treatment intervention. The decision to continue or alter a plan of care should be based on the combination of PO and DO outcomes.

My approach to patient care is holistic. I acknowledge the need to incorporate psychosocial interventions into my clinical practice, and I understand the importance of educating my patients. I believe in empowering my patients to take ownership of their health.

I think it is critical to provide my patients with knowledge, to prevent re-injury, and with self-treatments which they can continue to use independently for future aches and pains.

## Plan of Advanced Practice

### Areas of Focus in Advanced Practice

Upon returning to clinical practice in the fall of 2014, I decided to adopt treatment-based classification and manual therapies as my areas of focus for advanced practice. While the pathoanatomical assessment is a critical component of the education and development of new clinicians, proper patient classification is key to improved patient care. A thorough evaluation should guide me towards the most appropriate manual therapy treatment application. As I began to focus more attention on treatment-based classification, I noticed that a subset of patients who met the "classic signs" for a particular treatment were not responding as favorably as others. I found that this same subset benefitted greatly from psychosocial intervention strategies. I discuss such observations in greater detail in Chapter 3.

Through reflective clinical practice, I have developed a secondary focus area that has become meaningful to my clinical practice, which is the application of psychosocial treatment interventions for the treatment of chronic musculoskeletal injuries. I currently use the "Well-Being" subsection within the Disablement in the Physically Active (DPA) Scale to flag patients who are susceptible to chronicity and/or high stress states. Prior to beginning a physical approach to treatment, I treat these patients using autonomic nervous system regulating techniques, such as Primary Reflex Release Technique (PRRT), Trauma Releasing Exercises (TREs), Sensory Flow, or Reflexercise. I have expanded my use of treatment interventions beyond those which primarily focus on physical dysfunction (e.g., mobilization with movement [MWM], MYK, Positional Release Therapy [PRT]). I also now incorporate into my initial evaluations a patient-education component that focuses on the effects of stress on health and well-being. If a patient is properly assessed and classified, then I expect the chosen treatment intervention to be successful.

Table 2.1 contains the Plan of Advanced Practice which I developed for my progress through the DAT program and through the summer after graduation. Although it is detailed, the PoAP is fluid in nature. The plan was initially designed to improve my weaknesses (e.g., foundational sciences, manual therapy skills, and movement assessments); however, the plan evolved to include the development of my strengths and general interest areas (e.g., administration and languages). I have also added a section for education as I move towards a career focused on teaching. Progress towards advancement in any discipline requires particular and intentional steps, which involves careful planning and self-reflection. I plan to assess my progress on personal and professional goals in the middle and at the end of each academic year. Through careful reflection, I will continue to develop my PoAP and adjust the objectives with my changing professional needs.

**Justification of the Plan of Advanced Practice**

"From everyone who has been given much, much will be demanded; and from the one who has been entrusted with much, much more will be asked" (Luke 12:48, New International Version). I expect myself to be a good steward of the knowledge I have attained in the DAT program. As I am exposed to advanced techniques, quality research, and novel approaches to clinical practice, it becomes my responsibility to share this information with those who can benefit from it directly. To ensure my clinical teaching remains current, I will continue to seek courses in advanced clinical skills and manual therapies. Knowing that patient care is full of potential translational research opportunities, I will continue to use an *a priori* approach to patient care and outcomes collection in any patients I treat in the future, and require my students to do the same. I do not plan to continue a career in clinical practice; however, using my advanced knowledge, I will impart a higher level of competence to my students and improve the quality of their patient care. In this way, I will have a positive impact on future clinicians and patients, alike.

*Table 2.1 Objective and Subjective Measures for the Plan of Advanced Practice*

| Area of Focus | Plan to Improve | Outcomes and Time Frames | Completed |
|---|---|---|---|
| **Foundational Sciences** | Complete Human Anatomy Course and Dissection Lab | • Trunk Anatomy – Fall 2014<br>• Extremities – Spring 2015<br>• Read *Clinically Oriented Anatomy* Fall 2015-Fall 2016<br>• View online anatomy lectures (Summer 2016) | • Fall 2014<br>• Spring 2014<br>• Completed Chapters<br>• - |
| | Tissue healing | • Review updated textbooks – Summer 2014 | • Summer 2014 |
| **Evaluation and Treatment** | Functional Movement System | • Read *Movement* (Cook, 2010) – Summer 2015<br>• Incorporate SFMA into clinical practice – assess patient outcomes using SFMA | • Summer 2015<br>• Spring 2016 – applying SFMA to all cases not resolved within 4 visits |
| | Mechanical Diagnosis and Therapy | • Review course notes – Spring 2015<br>• Re-take Part A: Lumbar Spine – Fall 2016 | • -<br>• - |
| | The Mulligan Concept | • Complete Mulligan Concept Manual Therapy Course<br>• Complete Mulligan Concept – Lower Quarter Course<br>• Incorporate MWM into clinical practice – asses patient outcomes using MWM | • Summer 2014<br>• Summer 2015<br>• Fall 2014 – Spring 2016 |
| | The Myokinesthetic System | • Complete MYK Upper Body Course<br>• Complete MYK Lower Body Course<br>• Incorporate MYK into clinical practice – assess patient outcomes using MYK | • Summer 2014<br>• Summer 2015<br>• Fall 2014 – Spring 2016 |
| | Positional Release Technique | • Complete PRT – Upper Extremity Course<br>• Incorporate PRT into clinical practice – assess patient outcomes using PRT | • Summer 2014<br>• Fall 2014 – Spring 2016 |
| | Complete Primal Reflex Release Technique Home Study | • Incorporate into clinical practice – assess patient outcomes using PRRT<br>• Watch home study videos – Spring 2015 | • Began each treatment with PRRT Spring 2015 |
| **Psychosocial Interventions** | Sensory Flow | • Instructed on technique in DAT coursework<br>• Incorporate into clinical practice – assess patient outcomes using sensory flow | • Summer 2014<br>• Spring 2015 |
| | Reflexercise | • Instructed on technique in DAT coursework<br>• Incorporate into clinical practice – assess patient outcomes using Reflexercise | • Summer 2014<br>• Fall 2015 |

| | | | |
|---|---|---|---|
| | The Tapping Solution | • Read *The Tapping Solution* (Ortner, 2013)<br>• Incorporate Tapping into clinical practice – assess patient outcomes using Tapping | • Fall 2015<br>• Fall 2015 |
| | Trauma Releasing Exercises | • Read *Trauma Releasing Exercises* (Berceli, 2005)<br>• Assess patient outcomes using TREs | • Fall 2015<br>• Fall 2015 |
| | The Healing Code | • Read *The Healing Code* (Loyd & Johnson, 2011)<br>• Incorporate The Healing Code into personal health/well-being | • Spring 2016<br>• Spring 2016 |
| **Research** | Apply AR Philosophy in Clinical Practice | • Assess clinical practice and patient outcomes – ongoing | • Outcomes Analysis & Reflection Paper Fall 2015, Spring 2015, Fall 2015<br>• 2 case studies currently in progress |
| | Case Studies and Case Series | • Develop case studies and manuscripts – one each semester<br>• Disseminate manuscripts into publication | • 1 Case study Fall 2014; 1 Case-series Spring 2015; 1 Case-study Fall 2015<br>• Case-series in review with IJSPT – Spring 2016 |
| | Psychosocial POs | • Research valid instruments which are designed to capture a patient's current stress/anxiety state | • Begin reviewing the literature Spring 2017 |
| **Education** | Teaching | • Attend ATEC – Winter 2015<br>• Complete courses through UI Education in Curriculum & Instruction program – begin 2016-2017 academic year<br>• Develop mentor-mentee relationship for the purpose of developing as an educator | • Winter 2015<br>• -<br>• Fall 2016 |
| **Administration** | Preceptorship | • Develop an instrument to self-assess personal efficacy and growth in this area –<br>• Begin literature search June 2016<br>• Hold informal work-group meetings on topic during 2016-2017 academic year to help develop the instrument | • - |
| | Program Administration | • Observe and assist in all areas of program administration, as able | • Ongoing site visits |
| **Personal Growth** | Languages | • Learn French – begin Winter 2016 | • - |

**References**

Berceli, D. (2005). *Trauma Releasing Exercises (TRE): A Revolutionary New Method for Stress/trauma Recovery* [Kindle Version]. Retrieved from Amazon.com

Cook, G. (2010). *Movement: functional movement systems: Screening, assessment, and corrective strategies*. Aptos, CA: On Target Publications.

Engel, G. L. (1980). The clinical application of the biopsychosocial model. *American Journal of Psychiatry*, *137*(5), 535–544.

Greenleaf, R. K. (1977). *Servant Leadership*. Paulist Press.

Loyd, A., Johnson, B. (2011). *The Healing Code.* New York, NY: Grand Central Life & Style.

Ortner, N. (2013). *The Tapping Solution: A revolutionary system for stress-free living.* Carslbad, CA: Hay House, Inc.

Sendjaya, S., & Sarros, J. C. (2002). Servant leadership: Its origin, development, and application in organizations. *Journal of Leadership and Organization Studies*, *9*(2), 57–64.

Sulmasy, D. P. (2002). A biopsychosocial-spiritual model for the care of patients at the end of life. *The Gerontologist*, *42*(3), 24–33. http://doi.org/10.1093/geront/42.suppl_3.24

Wainner, R. S., Whitman, J. M., Cleland, J. A., & Flynn, T. W. (2007). Regional interdependence: A musculoskeletal examination model whose time has come. *Journal of Orthopaedic & Sports Physical Therapy*, *37*(11), 658–660. http://doi.org/10.2519/jospt.2007.0110

# CHAPTER 3: OUTCOMES SUMMARY, RESIDENCY FINDINGS, IMPACT, AND ANALYSIS

## Introduction

Reflective clinical practice is a key component of an athletic trainer's development into a scholarly clinician. During the two years of my clinical residency, I have collected disease-oriented (DO) and patient-oriented (PO) outcomes and have made reflecting on these outcomes a regular part of my patient care. The process of collecting PO and DO outcomes has allowed me to assess the effectiveness of my treatment interventions and develop my clinical philosophies with each passing semester of my clinical residency. Additionally, by analyzing my patient outcomes, I have created evidence supporting my advancement as a clinician.

In this chapter, I identify the barriers I faced at the onset of my clinical residency, reflect on the development of my patient care philosophy, and analyze the evolution of my application of patient outcomes measurements. Included in this chapter is a residency findings section that contains an analysis of patient outcomes that are associated with and provide evidence of what I consider to be vital learning experiences. I also reflect on my residency findings and present revised plans for each subsequent semester of my clinical residency while in the DAT program. The cyclical nature of my residency findings presentation reflects the action research (AR) philosophy that I have used to study and transform my clinical practice.

## Overcoming Barriers

The fall of 2014 not only marked my start of clinical residency in the DAT program, it also marked my return to clinical practice after two years of teaching in an AT program. I was nervous to treat patients again, but I was more excited to advance my clinical skills and experience the transformative process offered by the DAT program at UI. The DAT curriculum included various assignments that required me to reflect on my own successes and failures in clinical practice. I realized early on that to successfully improve as a clinician, I would need to admit my failures and examine my mistakes on a regular basis. Many of the challenges I experienced in the clinic during my two years of clinical residency reflect key lessons that I needed to learn in the clinic. However, I was able to apply the lessons I learned in the clinic to various other aspects of my life as well.

My first week in the Memorial Gym Athletic Training (AT) Clinic brought back several weaknesses that I had never before worked to overcome. I was terrified of failure, hesitant to admit to the presence of gaps in my knowledge, and reluctant to let others see me struggle. I believe that the root of my fears lay in my extreme self-reliance. I now know that this was a "heart issue" that God needed to work out of me. By placing all responsibility and credit for my successes and achievements on myself, I was not able to grow beyond my own capacity. Once I learned to let go of my need to succeed, I was free to be myself and comfortable with acknowledging the gaps in my knowledge. After this turning point, I began to view a lack of knowledge as a learning experience, even in front of my students. Because I was no longer pressuring myself to be perfect, I was able to value mistakes and negative outcomes in my patient care just as much as I used to value successes. Patient outcomes simply became data points that I used to mark the development of practice-based evidence (PBE).

Along with the lesson of letting go of my self-reliance and my need to succeed came the need to admit to myself that patient care is not my passion. Admitting this truth was difficult for me, because most of my colleagues and classmates were passionate about and invested in improving their own clinical practice. I, however, embarked on the journey offered by the DAT program as an educator. My goal upon entering the program was to develop advanced clinical skills, knowledge in utilizing patient outcomes, and experience in conducting clinical research. I knew that if I could do this, I would be better prepared to teach professional AT students.

I believe my lack of passion for advancing my own clinical practice was a barrier to implementing reflective practice in my residency. Therefore, I set out to discover which particular paradigms sparked my passion for patient care, and I focused on these throughout my time in clinical residency. My attempts to understand how and when to apply specific clinical skills have helped me to become more reflective and inquisitive in the clinic. Although I still have areas of weaknesses in patient care, I believe I have grown substantially toward removing the greatest barriers that stood in my way at the onset of the program. By critically examining my patient outcomes, I have begun to improve as a clinician. Additionally, through critical reflection on the patient care philosophies presented by DAT faculty, and through the completion of key course assignments, I have developed my own philosophy on patient care – a philosophy that now serves to guide my clinical practice.

**My New Philosophy on Patient Care**

To say that the DAT program has had an impact on my clinical practice would be an understatement. I did not have an established patient care philosophy prior to the DAT. I merely approached my work one day at a time, with patience and persistence, and focused on "doing no harm" as I helped my patients to compete in their chosen sports despite their aches and pains. I relied on a thorough pathoanatomical evaluation process to assess patient complaints, and, when treating injuries, I stubbornly persisted in implementing lengthy rehabilitation protocols that were focused on strengthening and stretching. Despite my efforts, most of my chronically injured patients would either remain stagnant in their recovery or progress at a gradual pace. After four weeks in the DAT program, my perspective on musculoskeletal injuries and the rehabilitation process transformed in such a way that I could no longer justify my previous approach to patient care.

During the Summer 2014 semester, I was exposed to various new manual therapy treatment paradigms, such as Positional Release Therapy (PRT), Mulligan Concept mobilizations with movement (MWM), Primal Reflex Release Technique (PRRT), Total Motion Release (TMR), Reactive Neuromuscular Training (RNT), and the Myokinesthetic System (MYK). I witnessed patients with diagnoses such as tight hamstrings, disc herniation, and rotator cuff tears experience an immediate elimination of symptoms from a single manual therapy treatment—something that should not have been possible if the diagnosed pathologies were the true root causes of the patients' individual dysfunctions. As a result, my patient care philosophy began to evolve. By my second year in the DAT program, my patient care philosophy became the following:

*My philosophy on patient care is to expect immediate positive outcomes from therapeutic interventions. My goal is to produce significantly improved outcomes (e.g., decreased pain, increased function) during each visit and to minimize the amount of follow-up visits before complete discharge. I believe that the key to accomplishing this is to classify injuries appropriately. After all, I can only expect improved patient outcomes if I am able to match the dysfunction with the appropriate treatment intervention. The decision to continue or alter a plan of care should be based on the combination of PO and DO outcomes.*

*My approach to patient care is holistic. I acknowledge the need to incorporate psychosocial interventions into my clinical practice, and I understand the importance of educating my patients. I believe in empowering my patients to take ownership of their health. I think it is critical to provide my patients with knowledge, to prevent re-injury, and with self-treatments which they can continue to use independently for future aches and pains.*

## The Evolution of My *A Priori* Approach to Collecting Patient Outcomes

I began the fall of 2014 equipped with various effective manual therapy techniques and empowered by a bold new patient care philosophy that was focused on producing immediate improvements in my patients' symptoms. Knowing the value of measuring patient progress with outcomes measures, I decided to use a standard outcomes collection protocol for all of my patients. My plan was to collectively analyze my patients' progress on the Disablement in the Physically Active (DPA) Scale, Patient Specific Functional Scale (PSFS), Numeric Rating Scale for pain (NRS), and Global Rating of Change (GRC) scale. In addition to the previous scales, I aimed to use region-specific PO outcomes to address patient-perceived symptoms and function at the particular site of injury. I looked for patients to report a minimal clinically important difference (MCID)—the improvement required to classify the change as meaningful for the patient (Hurley, Denegar, & Hertel, 2011)—on each outcome measure I collected. I used MCIDs in my first semester of residency as the minimum requirement for a successful treatment.

The DPA Scale is a multi-dimensional outcome instrument designed to assess a patient's state over a 24-hour timeframe. When a patient is evaluated using the DPA Scale, that patient is asked to rate his or her symptoms, functional abilities, and overall well-being (i.e., stress, energy, mood and altered relationships) on a scale of 0-4, where 0 indicates no problem and 4 indicates a severe problem (Vela & Denegar, 2010). Although the instrument includes clear instructions, I learned that it is best to provide verbal instructions prior to handing the form to my patients. I also learned to ask patients to identify their chief complaint prior to administering the instrument, and I asked that they continue to focus on the initial chief complaint at each subsequent administration of the form. Otherwise, patients would complete the DPA Scale based on a different chief complaint each visit, leaving me with unequal comparisons. I found the DPA Scale to be valuable in my clinical practice because it captures a wide breadth of disablement in a single instrument. I also noticed that when my patients completed the DPA Scale prior to my evaluation, they were better able to articulate and specify their main issues.

According to the literature, the DPA Scale is most helpful when patients have experienced a substantial change, and when used over a long period of time (e.g., at one and six weeks post injury, versus three days) (Vela & Denegar, 2010). Because I expected substantial results from my patients in a short period of time, I decided to administer the DPA Scale in my clinical practice once each week. When determining if my treatments had made a change, I looked for the reported MCID score of nine points for acute conditions and six points for chronic conditions (Vela & Denegar, 2010). As I drew close to discharging my patients, I based my decisions on the understanding that a score of less than 35 points is considered "healthy," and a 23 or less is associated with being ready to return to physical activity (Vela & Denegar, 2010).

While the DPA Scale captures functional symptoms and limitations, I relied on the PSFS to better isolate and measure functional limitation. Using the PSFS, I would ask my patient to identify up to five functional tasks and to rate their ability to perform these tasks on a scale of 0-10, where 0 indicates the complete inability to perform the activity and 10 indicates their pre-injury ability to perform the activity (Stratford, Westaway, & Binkley, 1995). I learned that the best way to administer the PSFS instrument was to provide verbal instruction to the patient while completing the form myself. Initially, I would attach the PSFS and DPA Scale forms together on a clipboard and expect the patient to complete the forms independently. However, I soon learned that the instructions were often interpreted differently from patient to patient. Some patients would change their reported activities every visit, while others would report activities that they desired to return to yet had no plans of participating in any time soon (e.g., reporting a winter sport as an area of decreased function in September). Data would not be usable in such cases, because I no longer had equivalent activities to compare over time.

I initially used the PSFS to measure the effects of my treatments on patient function in my patients' daily and functional activities over time. Therefore, I would wait until a patient's next visit to assess the impact of my treatments. However, I eventually learned that I could use the PSFS to measure the immediate impact of my treatments: By requiring patients to identify a limiting activity that could be reproduced in the clinic, I could now apply the PSFS immediately after treatment. Using immediate feedback allowed me to explore further options of treatment within the first visit in patients who did not report significant improvement in their functional abilities. I looked for the minimal detectable change (MDC) of two points when assessing two or more activities and three points when assessing a single activity (Chatman et al., 1997).

As is common in most clinical settings, I used the NRS to assess severity of pain. Prior to the DAT, I used the NRS during my evaluations to measure current pain. However, after reading the literature on the NRS, I learned that the scale is actually designed to capture a patient's pain on average over a 24-hour period. Therefore, in addition to asking my patients to rate their current pain on a scale of 0-10 (with 0 indicating no pain and 10 indicating severe pain), I asked them to use the same scale to give me their "best" pain and their "worst" pain in the previous 24-hour period (Salaffi, Stancati, Silvestri, Ciapetti, & Grassi, 2004). At the end of each patient appointment, I would again ask the patient to report his or her current pain on the same NRS scale. I did this to document improvements in pain scores post-treatment. My goal was to surpass the MCID on NRS by the end of each patient visit. The MCID for the NRS is a decrease of 1 point or 15%; however I preferred to rely on a decrease of 2 points or 33%, which indicates that the patient's level of pain is "much better" (Salaffi et al., 2004).

Lastly, because my goal was to discharge patients quickly, I used the GRC scale to get a better idea of a patient's perception of his or her progress or regress as a direct result of my treatments. The GRC scale is an 11-point scale ranging from -5 ("very much worse") to +5 ("completely recovered") (Kamper, Maher, & Mackay, 2009). In my first semester, I applied the GRC inconsistently in my patients, and, as a result, did not collect valuable data. I was not using a consistent and clear reference point for my patients to compare their current condition to pre- and post-treatment conditions. More importantly, I did not understand that patients with mild complaints may report smaller changes in comparison to patients with severe or acute conditions (Kamper et al., 2009). By my third semester of clinical residency, I had learned to vary my administration of the GRC based on patient presentation. In cases where I expected the patient to experience a quick recovery, I would administer the instrument after the first treatment. In cases where I expected slower progress, I would allow four visits between each administration. While an MCID has not been established for the GRC, I looked for progression toward a score of +5 with each subsequent administration of the scale.

Initially, my purpose for collecting patient outcomes was to establish evidence of my ability (or inability) to resolve my patients' chief complaints. As my philosophy on patient care transformed into a more individual and holistic approach, I became less interested in assessing my personal successes and more interested in addressing the needs of my patients. Early on, I was mostly focused on applying the new treatment paradigms correctly; therefore, I would often neglect to follow my outcomes collection protocol. Eventually, I began to care more about patient improvement than my own clinical advancements. When this shift occurred, my need for evidence of patient progress naturally led to an improved consistency in my collection of PO and DO outcomes. Despite the shift in my intentions, I continued to implement the same four PO outcome measures (i.e., DPA Scale, PSFS, NRS, and GRC) in all of my patients throughout the course of my clinical residency. Eventually, I grew to incorporate DO outcomes pre- and post-treatment interventions (specifically range of motion and girth measurements) whenever they were an issue for a patient.

## Residency Findings

### Fall 2014 – Summary and Analysis of Clinical Residency Experiences

My intention for my first fall semester of clinical residency was to dramatically transform my clinical practice. I was eager to begin implementing the various new treatment paradigms into my treatment protocols, and my plan was to use these new techniques to completely resolve my patients' symptoms within four treatments. To achieve my goal, I planned to incorporate a Selective Functional Movement Assessment (SFMA) and an MYK posture assessment into my standard orthopedic examination. The SFMA and MYK are two different systems that can be used to identify and isolate problematic movements and postures that may be related to a patient's cause of injury (Cook, 2010; Brody, 2015; Uriarte, 2014). In using the movement and posture screens, my intent was to increase my chances of uncovering the root cause of injury for each individual patient and to choose the most appropriate treatment for the injury.

My first lesson of the Fall 2014 semester began when I acknowledged the fact that not all paradigms included in the DAT curriculum would fit within my personal and clinical "style." For example, I was challenged by the concept of incorporating the SFMA into my clinical practice. I attempted to apply the SFMA with several patients during the first fall semester because I appreciated the systematic approach offered by the paradigm to identify dysfunction. But, while I understood the purpose of the SFMA, I was not successful in applying the paradigm beyond the initial, top-tier screening process. I found it difficult to pick up on the nuances and details of the individual breakouts required beyond the top tier. After several failed attempts to apply the breakouts on my patients in the Fall 2014 semester, I decided to shift my approach in applying the SFMA the following semester. To keep my interest in patient care high, I decided to discontinue the use of the SFMA breakouts in the Spring 2015 semester and sought to practice the paradigms that aligned well with my strengths as a clinician. I reasoned that other assessment/treatment paradigms, such as TMR and MYK, also incorporated a general whole-body screen prior to identifying the appropriate treatment and were equally effective and comprehensive.

Perhaps the reason I continued to return to SFMA breakouts in the Fall 2014 semester was my inability to properly pair two particular patients with an effective treatment paradigm. While I was not presented with any post-operative cases or major injuries requiring long-term rehabilitation, I was challenged with two patients who reported only small improvements after more than six weeks of care (Table 3.1). In reviewing these two cases, I realized that I had haphazardly applied several different paradigms during each patient visit, mainly because I was unable to properly classify the patients' dysfunctions.

Patients #2 and #5 presented with the classic signs for common pathologies along with minimal dysfunction across all PO outcomes. Upon initial assessment, I suspected that both cases would be quick and effortless to treat; however, both cases resulted in a 10-week course of treatment with unstable progress. Patient #2 was an avid runner and cyclist who presented with a four-year on-and-off history of bilateral iliotibial band (ITB) tightness, the most recent onset starting two weeks prior to my initial assessment of his injury. The patient presented with classic signs (i.e., tender points (TP) at the ITB and a positive Ober's test) in addition to TP within the quadriceps muscle and a dysfunctional, albeit non-painful, overhead deep squat. His outcomes scores were outside of normal ranges, but were not severe: a DPA Scale score of 25, a PSFS score of 7.5 (running = 7, cycling = 8), and a cumulative NRS score of 1.5 (current = 0, best = 0, worst = 4). Patient #5 was a former collegiate runner who presented with a two-year history of bilateral Achilles tendinalgia. The most recent onset started a month prior to my initial assessment of his injury. The patient presented with TP at the distal Achilles tendon, increased girth on the left Achilles, an inability to complete intense workouts due to pain and discomfort, and decreased dorsiflexion (DF) range-of-motion (ROM) on the left ankle. His outcomes scores were also outside of normal ranges, but were not severe: a DPA Scale score of 22, a PSFS score of 8 (running), and a cumulative NRS score of 2 (current = 0, best = 0, worst = 6).

I began the course of treatment in both cases with what I thought to be the most appropriate treatment intervention. I treated Patient #2 with PRT; however, after resolving his TP, he reported only a minimal improvement in the feeling of tightness and returned the following week with no improvements in his workouts and a full return of his chief complaint. For Patient #5, I attempted to begin with an MWM for Achilles pain but could not find an Achilles mobilization that would produce a PILL effect (**p**ain free, **i**mmediate changes, and **l**ong **l**asting effects). A PRT treatment on the local TP also resulted in no change in pain. I decided to increase Patient #5's DF with 3 sets of 10 repetitions of passive MWM with a mobilization belt. Even though I was able to balance his DF, his symptoms remained (I now measure ROM pre- and post-treatment application, when working to improve ROM; however, I had not yet begun to do so at the time of this patient case).

Despite my best attempts to apply thorough evaluations, and although Patient #2 experienced a resolution of TP and Patient #5 experienced increased ROM, I was perplexed by the lack of overall improved PO outcomes among my patients. In an attempt to uncover a greater underlying source of dysfunction, I opted for a comprehensive approach to each patients' second visit. Because Patient #2 presented with a mild internally rotated femoral posture and bilateral pronation, I chose to evaluate and treat him with MYK. I evaluated Patient #5 using the SFMA, because I was unsure of the best treatment option for him. I stayed the course with my treatment plans for several visits and began to notice a pattern of improvement. However, this improvement was followed by a full return of symptoms.

Rather than reflect on my outcomes and attempt to implement a different plan of action, I began to haphazardly move between various paradigms within each visit, often extending the length of my patients' appointments to two hours or longer. Despite my frustrations, I continued to power through with the same goal of reducing symptoms as much as possible within each visit.

The reasons for my struggles in treating patients #2 and #5 finally became clear when I started to "connect the dots" between the discussions of pain in which I participated in the DAT courses and my approach to patient care. During the Fall 2014 semester, I was introduced in class to the pain neuromatrix that was presented by psychologist and researcher Ronald Melzack in 1989. According to Melzack, pain is more than just a simple sensory input from peripheral nociceptors to the central nervous system (CNS) (Melzack, 1999); pain is actually a multifaceted process produced by the various networks of communication within the CNS. Prior to my enrollment in the DAT program, I treated patients under the assumption that tissue damage was the cause of pain. Through the pain neuromatrix theory, however, pain is explained as a multidimensional experience involving sensory, cognitive, and emotional components (Melzack, 1999; Melzack, 2005).

I had spent weeks trying to alleviate the source of pain in patients #2 and #5; but through the pain neuromatrix theory, I learned that the patients' pain may not have been triggered by a physical dysfunction at all. Perhaps their issue began, or was propagated by, a cognitive input such as a memory or an emotional input such as a trauma or a stressful event. It was not until the final weeks of each patient's course of treatment that I finally began to address the possibility of psychosocial factors as the source of pain. As I reflected back on these two patient cases at the end of the fall semester, I clearly saw signs of fear avoidance behavior. When I finally analyzed my patient outcomes at the end of the semester, I noticed that Patient #5 actually did report excellent scores on the DPA Scale (4/64), PSFS (9/10), and cumulative NRS (0/10) by the third week of treatment; but his GRC was only a +2, and I was not satisfied with his continued inability to complete intense runs without feeling that his pain would return. Patient #2's reported scores also justified discharge (i.e., DPA Scale = 1/64, PSFS = 10/10, cumulative NRS = 0/10 on week eight); however, he felt that he still had issues with his ITB, which prevented him from pushing through strenuous workouts.

Fear avoidance behavior occurs when a patient takes steps to avoid activities that they fear might make their pain worse (Waddel, Newton, Henderson, Somerville, & Main, 1993). In such cases, the fear of the pain is a greater issue than the pain itself (Waddel et al., 1993). Both patients #2 and #5 had expressed on several occasions that the reason they were unable to complete their workouts was because they felt that if they pushed themselves further, they would re-injure their ITB/Achilles. Because I was looking for physical and pathoanatomical sources of pain, I did not pick up on these signs of psychosocial factors. While I did eventually attempt to incorporate psychosocial treatment strategies into these patients' treatment routines, I did so quite reluctantly and awkwardly. My attempts at applying Trauma Releasing Exercises (TRE) and Tapping proved to be unsuccessful (Table 3.1). My experiences in treating patients #2 and #5 taught me I needed to become more comfortable with asking my patients about potential cognitive, behavioral, and emotional sources of dysfunction related to their symptoms. I also saw the need to address such sources of pain much sooner than six to eight weeks into the course of treatment.

**Fall 2014 – Reflection and Revised Goals for Clinical Residency**

At the onset of the Fall 2014 semester, I set out to resolve my patients' issues within four treatments. While my goal was reasonable for simple cases, such as positional faults that could be resolved with an MWM, the goal was unrealistic for more difficult cases, such as when dealing with tissue healing and psychosocial issues. Because my goal was to resolve symptoms quickly, I often focused only on eliminating pain without attempting to identify the root cause, as in the cases of patients #2 and #5. While patients such as these were outliers in my previous athlete-only clinical practice, they were commonplace in my current clinical setting, which was open to the general population. The experimental and no-cost nature of our clinic attracted a patient population that was otherwise unable to seek effective treatments from other healthcare providers. Therefore, I began to prepare myself to embark on a long road of treating difficult cases, which would require a more comprehensive approach to assessment than I had previously engaged in.

I learned, from the fall semester, that a haphazard approach to eliminating pain was ineffective. I wanted to maintain my goal of resolving symptoms quickly; but to make achieving this goal possible, I would need to identify dysfunction more quickly and focus on resolving the dysfunction instead of the symptoms. I would also need to consider a more effective approach to matching my patients' needs with an appropriate treatment paradigm. I decided to adopt the treatment-based classification (TBC) approach to patient care. The TBC approach involves a systematic evaluation procedure that aims to classify patients according to which treatments produce positive results (Chevan & Clapis, 2013). At the time, I did not know that a systemic TBC evaluation procedure includes the screening for physical and psychological red flags warranting referral (Chevan & Clapis, 2013). Therefore, while I aimed to follow a TBC approach for the spring of 2015, I now understand that I was applying the philosophy, not the full approach.

By following the TBC philosophy in my next semester of clinical residency, I hoped to mitigate treatment timeframes and successfully discharge my patients quickly. My plan was to work within a single treatment paradigm during each visit, and any combination of treatments would be very specific and intentional. I would measure each patient's progress daily; but I expected every patient, regardless of classification, to experience a significant and measurable improvement with respect to their injury (i.e., MCIDs in patient outcomes) by their next visit. I decided I would implement paradigms that required a comprehensive whole-body assessment in cases of insidious onset or chronic pain. Such paradigms, which included TMR, MYK, and PRRT, require a clinician to administer a comprehensive screen that would then be used to guide the clinician in selecting the appropriate treatment intervention. I believed that this approach would fulfill my desire to assess dysfunction from a regional-interdependence (RI) perspective.

**Spring 2015 – Summary and Analysis of Clinical Residency Experiences**

It was not until the end of the spring semester that I started to see the “big picture” of my progress toward becoming Advanced Practice Athletic Trainer (APAT). The realization that I was making progress came after I treated two patients who presented with isolated tendon pain (Table 3.2). Patient #40 was diagnosed with patellar tendinitis two years prior to seeing me and had received treatment from a physical therapist. Despite treatment, the patient continued to rely on ice and topical ointments on a regular basis and had not been able to return to regular running and biking activities. Patient #42 presented with anterior shoulder pain consistent with shoulder impingement. I decided to classify her injury as tendinalgia, based on the results of her clinical exam, which showed that her symptoms were isolated to the proximal biceps long-head tendon.

Both of these patients represent pivotal moments in the transformation of my clinical practice. My experience with Patient #42 (Table 3.2) was the first time I began treatment using a comprehensive treatment (i.e., TMR) rather than a local treatment. The patient presented with pain above 90° of flexion and abduction. Normally, I would have treated her with MWM, but the combination of an insidious onset of symptoms, her recent increased activity, and a change in training venue (a harder floor with less absorption) led me to think about addressing potential soft-tissue dysfunction or imbalance. When assessed with the "Fab 6" TMR motions, all six motions were close to symmetrical; therefore, various other shoulder motions were assessed further. Internal rotation (IR) in 90° of shoulder abduction with 90° of elbow flexion had the greatest asymmetry, due to 5/10 pain present on the right side.

For treatment, the patient performed 3 sets of 10 repetitions of IR on the left shoulder. The initial treatment produced no improvement in IR on the affected side. The patient then performed a static hold at the end-range shoulder IR for a total of 6 sets of 30 seconds, resting every 2 sets. The second TMR treatment reduced shoulder pain to 3/10 on the right side. Due to fatigue, the patient moved on to horizontal adduction, which she initially reported as "painful," or 4/10 on the NRS. The patient performed static holds of the left shoulder in maximal horizontal adduction for 7 sets of 30 seconds, resting every 2 sets. Pain continued to decrease with TMR until the patient was pain-free during horizontal adduction, shoulder flexion, IR, and ER.

Patient #42 returned for a second visit five days later and was pain-free, did not show signs of impingement, reported a DPA Scale score of 3/64 (down from her previous score of 21), and presented with full range-of-motion and full strength, bilaterally. She did, however, describe the presence of a decrease in strength and stability only during upper extremity closed kinetic chain activities, such as a plank. I applied RNT to address the patient's chief impairment. I asked the patient to perform a plank (her main issue) and noticed scapular winging on the right side. To decrease the scapular winging, I provided perturbations of the right scapula until I found the appropriate direction of perturbation in which the patient reported full strength and a “normal” feeling. The patient performed a plank for 3 sets of 10 perturbations, after which she expressed a return of equal strength and stability bilaterally. I recommended that she return for a full analysis and treatment of her scapular dyskinesia; however, the patient declined further treatment and was, therefore, discharged.

I also treated Patient #40 (Table 3.2) with a comprehensive paradigm, but only after a previous series of MWM tibial IR was found to be unsuccessful. While the initial evaluation appeared accurate, the treatment was not addressing the many underlying emotional issues associated with the patient’s pathology. I had been experimenting with the PRRT nociceptive exam and noticed that Patient #40 presented with many of the same signs as other patients who had responded well to this treatment. I performed the PRRT One-Minute Nociceptive Exam and found substantial jump signs (i.e., tender points which caused the patient to wince or jump) at most of the exam sites. Several of the jump signs were immediately eliminated after applying a simple sequence of commonly prescribed PRRT maneuvers. After the short, two-minute PRRT treatment, the patient reported a relief of pain in her knees.

Because of Patient #40’s history of emotional trauma and because she responded well to PRRT, I classified her as a psychosocial treatment patient. I implemented TREs the next day, and the patient expressed pain-relief and the ability to bike at the gym for long periods of time after the treatment. Although the patient did not reach discharge criteria prior to the clinic closing for the semester, her case reinforced the importance of screening patients for underlying dysfunctions and tailoring treatment programs to patients’ needs. The initial MWM intervention did appear to be the appropriate treatment, based on the patient’s knee pain; however, the patient had underlying trauma and anxiety and may not have experienced improvement in symptoms and function without the application of PRRT and TREs.

Patients #40 and #42 are examples of my improved analytical approach to patient care. By analyzing my outcomes more carefully during the Spring 2015 semester, I was able to pick up on trends in patient outcomes, which led to quicker discharge times and improved patient outcomes. I treated a total of 25 patients in the clinic in Spring 2015 but only collected outcomes on 15. Of those 15 patients, the longest treatment timeframe extended to 9 total visits across 3 weeks, compared to the 19 visits across 10 weeks for my longest case the previous fall. While all cases that extended beyond five visits in the fall and spring were chronic, recurring injuries that were difficult to classify, careful and regular reflection on clinical outcomes led to shorter treatment timeframes in the Spring 2015 semester.

Furthermore, I was able to see evidence of a more organized application of treatment interventions in the spring of 2015. I collected outcomes on a total of 84 treatments that occurred over 51 patient visits. Of these visits, 53% (n = 27) involved the use of a single treatment paradigm, 37% (n = 19) involved the use of 2 paradigms, and only 10% (n = 5) of my patient visits involved the use of 3 different treatment paradigms. In contrast, only 40% (n = 32) of my patient visits in the fall involved the use of a single treatment paradigm; the remaining 60% (n = 49) involved the application of several treatment paradigms within one visit. In fact, 40% (n = 20) of my fall patient visits involved up to three or four treatment paradigms within one visit. Rather than continue to apply my “shotgun approach” in the spring, I followed my plan to use the results of a thorough evaluation to match my patients to the appropriate treatment paradigm. I believe that the application of reflection and clinical reasoning to my clinical practice is what led to my improved patient outcomes.

**Spring 2015 – Reflection and Revised Goals for Clinical Residency**

My major learning experiences in the spring semester were deciding which techniques fit within my patient care philosophy and attempting to be more consistent in implementing these few techniques. I set out to classify patients by their apparent dysfunctions, which would allow me to then implement isolated treatments based on the classification. As a result, I only occasionally combined treatments during a single visit; and when I did, it was intentional.

I think one of the greatest lessons that I learned in the Spring 2015 semester was that I must place my patients' goals ahead of my own and simply start by asking, "How can I help you today?" Another lesson I learned was that I must not take the approach of "unloading" my entire arsenal of treatment paradigms during each patient visit. I had been guilty of this in the past, largely because I had defined my worth as a clinician by my ability to "heal" patients. By the end of the spring semester, however, I had learned the difference between developing my skills as a clinician and defining my worth by my patient outcomes. If a particular intervention failed to produce my desired results during a single visit, I simply adjusted my application and continued to explore options within that technique during that visit.

One of my goals for the spring was to evaluate patients through an RI approach. I found that by incorporating comprehensive paradigms such as PRRT, TMR, and MYK into my clinical practice, I was able to keep an open mind about seeking dysfunction in areas away from the source of pain, as I had done when working with patients #40 and #42. I decided to continue the use of PRRT, TMR and MYK in my clinical practice, considering them paradigms that were compatible with an RI approach.

I continued to struggle throughout the Spring 2015 semester with incorporating psychosocial treatment interventions into my patient care. I lacked confidence in my ability to express to my patients my concerns about the psychosomatic sources of their chronic pain. I decided I needed to learn more the causes of psychosomatic pain. I incorporated *The Healing Code* (Loyd & Johnson, 2011), *Trauma Releasing Exercises* (Berceli, 2005), and *The Tapping Solution* (which I had read in Fall 2014) into my Fall 2015 reading list.

My plan for Fall 2015 was more of a philosophical shift in patient care that involved focusing on patient needs. Rather than going straight into my injury evaluation, I decided to start each patient visit by simply asking the patient how I could help them and what they expected from their appointments with me. Additionally, I made it my goal to incorporate psychosocial treatment paradigms into my clinical practice as well as treatments that target the autonomic nervous system. I began to notice that I had grown to depend on PRRT as a treatment paradigm when patients presented with a myriad of musculoskeletal issues, or when patients appeared frustrated or overwhelmed by their injuries. In these cases, I was able to alleviate several symptoms with PRRT and treat the residual issues more effectively. Throughout the Summer 2015 term, I began to wonder if PRRT was an intervention worth using on intake with all of my patients, regardless of how they presented. I decided to begin implementing this technique on as many patients as I could on Day One of the Fall 2015 semester.

**Fall 2015 – Summary and Analysis of Clinical Residency Experiences**

Stress-management techniques began to play a greater role in my clinical practice in the fall of 2015. My interest in stress-management came about early in the semester, during one of my weekly classes. The conversation, which was led by a faculty member, caused many of my classmates to admit hesitation and incompetence in applying psychosocial treatment interventions. Athletic trainers are not qualified to apply psychological treatment interventions—a fact I do not wish to change. But does this mean that athletic trainers cannot apply psychosocial treatment interventions? *Psychosocial* simply refers to the interactions between the mind and the social environment (Psychosocial, 2016). If a person's environment is stressful, this can have a negative impact on that person's mind and body. I started to wonder, how many psychosocially oriented cases in my clinic were propagated by stress? If a case was caused or amplified by stress, could I help to alleviate the patient's symptoms—or even the root cause of the dysfunction—with simple stress-reduction techniques?

My classmates and I are not alone in our hesitation to help patients with non-physical origins of somatic ailments. In 2003, the Journal of the National Medical Association reported that many healthcare providers have received little training on the topic and do not feel confident in teaching their patients stress-management interventions (Avey, Matheny, Robbins, & Jacobson, 2003). The finding is alarming, particularly when stress continues to be credited for many of the top physical ailments that plague American society (Avey, et al., 2003). While the specific statistics vary, more than 60% of patient visits to a primary healthcare provider are, in some way, stress-related (Boone & Anthony, 2003). There is a direct connection between stress and physical disease; even chronic exposure to mild stressors, such as conflict, anger, and anxiety, can lead to somatic complaints (Davis, Zautra, & Reich, 2001; Eisenberger, Jarcho, Lieberman, & Naliboff, 2006; Kivimäki et al., 2004; Papousek, Schulter, & Premsberger, 2002; Rhudy, Williams, McCabe, Russell, & Maynard, 2008).

Learning about the connection between stress and physical complaints, combined with my knowledge of the pain neuromatrix and my understanding of the complexities of chronic pain, led me to seek out patient-oriented outcomes (POs) focused on screening patients for stress and anxiety. I was excited to find several valid and reliable scales to implement among patients with low-back pain; however, I had difficulty identifying quality questionnaires that could be generalized to a wider population. I "tabled" the search and decided to closely monitor the last four questions of the DPA Scale, which focused on "well-being." I planned to flag any patients who scored high on this section. During the history portion of my patient evaluation, I planned to spend time asking questions that were related to experiences of trauma, stress, and anxiety. I planned to use a stress-reducing technique on all patients who showed signs of psychosocial strain.

I began the fall semester by applying PRRT on all of my patients during their first patient visits. After my initial evaluation and diagnosis/patient classification, I conducted the PRRT One-Minute Nociceptive Exam and treated each of my patients' jump signs. I was able to consistently collect pre- and post-treatment NRS and PSFS in nine patients whom I treated with a full screening and with PRRT on their first visits (Table 3.3). Four patients presented with chronic symptoms that had been present for a minimum of two years, one patient presented with a sub-acute injury two weeks after its onset, and four patients presented with acute injuries within the week of onset. I expected to find an increase in function and decrease in pain in all of these patients; however, that was not the case.

Of particular significance in this *a priori* plan were the learning experiences I had while using a comprehensive treatment that targeted the autonomic nervous system to successfully address the dysfunctions of two patients. Patients #50 and #60 responded with a significant improvement in function after their PRRT treatment—something I had not expected to occur. Patient #60 presented with symptoms of patellar tendinalgia. I never identified the root cause of Patient #60's knee pain; the onset of her symptoms was relatively short, having started only a few days earlier, and she had not experienced this issue before. The patient presented with a PSFS score of 4/10 with single-leg squat as her most affected activity, and a pain of 2/10 on the NRS. Immediately after a single treatment of PRRT, she reported her single-leg squat to be a 9/10 on the PSFS, and her pain had completely diminished (NRS = 0/10). Patient #60 was discharged on her second visit, without the need for follow-up treatment, with a PSFS score of 10 and an NRS score of 0.

Patient #50 was an interesting experience for me. She presented with foot pain of insidious onset two days previous to my initial examination. I had difficulty diagnosing her dysfunction. Even after the patient expressed her struggles with general anxiety, I did not consider psychosocial causes of her pain; I was still looking for a physical source of pain. After ruling out any need for referral, I applied the PRRT treatment. After the treatment, the patient reported an immediate increase in function: collectively, her ability to walk up and down stairs and perform a heel raise went from a 1 to a 7.5 on the PSFS. Although her pain remained a 2/10, she was satisfied with the immediacy of her improvements. On her next appointment, she reported her foot pain as a 0/10 on NRS and expressed the desire to be treated for her symptoms of anxiety. Even though she had not regained full function (she still reported a mild difficulty with stairs and heel raises), she noticed the connection between her foot pain, many previous musculoskeletal injuries, and her anxiety. I continued to treat Patient #50 with Sensory Flow for several visits. Although her anxiety did not completely resolve, she did express a decreased level of anxiety on a daily basis and an increased ability to deal with the daily stressors she faced. Although my patient's outcomes did not meet my criteria for discharge, nor did I see the Sensory Flow treatments as "successful" in fully resolving Patient #50's issue, I learned that meeting the patient's needs and expectations is sometimes a success in itself.

Not all of the patients treated with PRRT experienced the same impressive results as patients #50 and #60. Four patients either reported no change in their symptoms, or mild improvements followed by regression in their condition. Patients #45 and #58 reported no change in their symptoms immediately after treatment or at follow-up, two days later. I moved on to applying MWM in both cases and was eventually able to discharge Patient #45 after two weeks. Patient #58 continued to be treated by a different clinician, due to scheduling conflicts. A third patient (#51) actually reported an increase in hip pain; however, his functional abilities (hip flexion and walking) did improve immediately after the initial PRRT treatment. I applied PRRT again on the patient's next visit, but because there were no improvements and the patient experienced tender points, I moved on to PRT. The fourth patient (#52) did report an immediate improvement in both pain and function; however, his function dropped back to his normal intake score on his follow-up visit even though his knee pain continued to improve. Despite setbacks, I was impressed with the ability to achieve any outcomes in Patient #52, as he had been diagnosed with arthritis in both his knees that was progressively worsening with age.

The three remaining patients reported either an MCID on pain, or function immediately after treatment. I continued to incorporate PRRT into these patients' treatment plans. Treating a group of patients with PRRT gave me a glimpse of the power and limitations of the treatment paradigm. I continue to use PRRT (especially as the initial treatment on the first visit) to treat patients who suffer with a chronic or recurring issue as well as those who present with high levels of stress and anxiety. In the future, I would like to see if a generalized anxiety scale might help me to classify patients into a paradigm such as PRRT and rule out patients who may not benefit, such as patients #45 and #58.

Another important learning experience I had occurred midway through the fall semester while treating Patient #55, who presented with an insidious onset of left shoulder girdle pain (Table 3.4). After four treatments, all of which resulted in minimal improvement, I began to notice that the patient's daily stress from work, school, and family responsibilities was actually more of a factor in his shoulder pain than I had expected. I had initially attributed the patient's symptoms to his scapular dyskinesia and matched him with MYK. When he presented to the clinic on his fifth visit with increased stress and frustration with work and school, I decided to implement TREs. On his first visit, the patient reported a DPA Scale score of 30, PSFS score of 6.5 (left cervical rotation = 7, typing at computer = 6), and a cumulative NRS score of 3 (current = 3, best = 3, worst = 5 in the past 24-hours). On his fifth visit, just prior to TRE treatment, he reported a 5 on PSFS, a cumulative NRS score of 3.5, and a current NRS score of 4. The patient only reported a 1-point decrease in pain after TRE; however, on his next visit, he reported a DPA Scale score of 6, PSFS score of 10, and cumulative NRS score of 0. Patient #55 was my second experience in producing significant results through the use of TREs. The experience was so significant to me that I turned it into a case study manuscript (Appendix X; pending submission) and began to incorporate TREs in as many patients as I could who presented with stress and anxiety.

**Fall 2015 – Reflection and Revised Goals for Clinical Residency**

I began the fall semester with the same hesitation and discomfort toward inquiring about psychosocial factors as I had felt during semesters past. But, because it was my goal to incorporate psychosocial treatment interventions into my clinical practice, I could no longer avoid asking my patients such questions. As I prepared to resume my clinical residency in the fall, I reflected on my patient care philosophy from the previous spring. In my philosophy, I stated my intent to apply a holistic approach to patient care. Yet I had to ask myself, "If I continue to ignore my patients' cognitive, emotional, social, and spiritual health, am I truly treating the whole person?"

I think my previous bias toward psychological intervention was my greatest barrier to addressing these issues myself. Because I am not a mental health professional, I did not feel equipped to help my patients resolve their stress and anxiety as it related to their injuries. But after seeing the dramatic improvements in the psychosocial well-being of patients' #55 and #60 after they were treated with non-psychological treatment interventions, I felt justified in treating such cases myself. I could no longer validate withholding such effective treatments from patients in need of anxiety-reducing interventions. Midway through the Fall 2015 semester, I began to include questions about levels of stress into all of my patient histories. In all cases where the patient did not present with an acute injury and a clear mechanism, I asked the patient to try to identify a stressful event that may have been impacting his or her life at the time of injury. I admit that I had already asked previous patients such questions, but only after all other physical treatment paradigms had failed (e.g., patients #2, #5, #40, and #55).

## Final Reflection and Impact on Clinical Practice

My journey toward advancing my clinical practice has been extremely rewarding; however, it has not been without struggle. In my first year of DAT clinical residency, my primary focus was on improving in my clinical skills and discharging patients quickly. I believed that if I could master the application of manual therapies, my efficacy in patient care would improve, as well. I presented in my PoAP (Chapter 2) a summary of my personality strengths according to the StrengthsFinder assessment, which include: Restorative, Achiever, Responsibility, Focus, and Harmony. I believe that the reason I found myself struggling in clinical residency during my first year of the DAT program was that I was too focused on proving I could restore my patients' issues quickly and independently. I had placed an incredible amount of responsibility on myself in the fall of 2014, and I was unable to achieve my unrealistic goals.

In contrast, during my second year, I shifted my focus away from being successful as a clinician and began to ask how I could use my personality strengths to help my patients. In doing so, I was able to be 100% myself in front of my patients and was able to approach them in a humble, unassuming manner, and ask how I could help them. I no longer feel the responsibility to fully heal my patients, nor do I presume that I can. What I do feel is a responsibility to share the knowledge I have about chronic pain, the role stress plays on injury and illness, and the many effective and non-invasive paradigms which exist to uncover and release the root cause of psychosocial issues.

I think that the biggest impact I have had on my site of clinical residency has been my use of a biopsychosocial-spiritual approach to patient care. I now encourage those around me to consider the possibility of a psychosomatic source of injury. If a colleague or student asks for my advice on treating a patient, I always start by asking if there is a traumatic or stressful event associated with the injury; then we discuss whether or not any types of psychosocial treatment interventions have been applied. I realize that not all clinicians will gravitate toward such treatments, but in as much as these treatments have impacted my clinical practice, I hope to pass the experiences and benefits along to anyone who is willing to listen.

Although I do not plan to pursue a career in AT clinical practice, I do hope to share the lessons I have learned in the DAT and impact future clinicians as an educator. I plan to teach students from a patient-centered care philosophy, and I hope to impress on them the importance of collecting patient outcomes for the benefit of the patient. Because I still hope to treat patients on occasion, I do plan to continue creating *a priori* plans and will produce scholarly papers based on what I learn from patient care. I plan to continue my search for outcome measures that adequately screen patients for psychosocial factors, and I will explore psychosocial treatment interventions. I will also continue to participate in manual therapy continuing education courses, notably Mechanical Diagnosis and Therapy, as I feel it fits well within my TBC treatment philosophy.

As a scholarly clinician, I am only as effective as my ability to critically analyze and reflect on practice-based and published evidence. Therefore, I plan to continue to collect patient outcomes in a way that facilitates regular reflection and analysis. I have witnessed the traditional model of athletic training clinical practice and the more progressive model put forth by the UI DAT program. Although I respect the passion and dedication of the clinicians who work hard to keep the traditional model going, I feel a responsibility to move toward advanced practice athletic training.

*Table 3.1 Patient Outcomes in Long-Term Patient Cases - Fall 2014*

| | | | NRS | | PSFS | | DPA Scale | |
|---|---|---|---|---|---|---|---|---|
| ***Patient #*** | **Total Txs** | **Timeframe** | **Initial** | **Discharge** | **Initial** | **Discharge** | **Initial** | **Discharge** |
| *2* | 19 | 10 weeks | 1.5 | 3.5 | 7.5 | 4.5 | 25 | 23 |
| *5* | 17 | 7 weeks | 2 | 0 | 8 | 9 | 22 | 12 |

Notes: Txs = Treatments; Initial scores taken at time of initial evaluation scores; Discharge scores for Patient #2 taken at last visit and on day of actual discharge for Patient #5; NRS = Numeric Rating Scale (0-10); PSFS = Patient Specific Functional Scale (0 = unable to perform, 10 = able to perform at a normal level; DPA = Disablement in the Physically Active Scale (0-64)
* Denotes minimal clinically important difference

*Table 3.2 Patient Outcomes in Tendinalgia Cases - Spring 2015*

| Patient # | Body Part | Dx | Visit # | Date | Tx | DPA Scale | PSFS | NRS Worst | NRS Best | NRS Current | NRS Avg | a-tx NRS | p-tx NRS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42 | Right shldr | SIS; Biceps tendinalgia | 1 | 2/26 | TMR | 21 | - | 6 | 3 | 3 | 4 | 3 | 0* |
| | | | 2 | 3/13 | RNT | 3* | - | 0 | 0 | 0 | 0* | 0 | 0 |
| | | | Patient Discharged after 2 treatments. | | | | | | | | | | |
| 40 | Left knee | Patellar tendinalgia | 1 | 4/14 | PRRT; TMR | 57 | - | - | - | - | - | - | - |
| | | | 2 | 4/16 | PRRT; TRE | - | 4.33 | 7 | 0 | 0 | 2.33 | 0 | 0 |
| | | | 3 | 4/21 | PRRT; TRE | 41* | 5.67 | 3 | 0 | 0 | 1* | 0 | 4 |
| | | | 4 | 4/23 | PRRT; TRE | - | 6.67* | 7 | 0 | 2 | 3 | 2 | 0* |
| | | | 5 | 4/28 | MYK L3 | 34* | 6.67 | 2 | 0 | 0 | 0.7* | 0 | 0 |

Notes: Dx = Diagnosis; Tx = Treatment(s); a-tx = prior to treatment; p-tx = post treatment; - = no data; shldr = shoulder; DPA = Disablement in the Physically Active Scale (0-64); PSFS = Patient Specific Functional Scale (0 = unable to perform, 10 = able to perform at a normal level); NRS = Numeric Rating Scale (0-10)
*Denotes minimal clinically important difference

Table 3.3 Patient Outcomes in Cases Treated with PRRT - Fall 2015

| ***Patient* #** | **CC** | **Onset** | **Treatment Effect** | **PSFS Pre-Tx** | **PSFS Post-Tx** | **NRS Pre-Tx** | **NRS Post-Tx** | **F/U PSFS** | **F/U NRS** |
|---|---|---|---|---|---|---|---|---|---|
| *45* | Hip Joint Immobility | Acute | None | 4 | 0 | 0 | 0 | 4 | 0 |
| *50* | Anxiety/Foot Pain | Acute | Increase Function | 1 | 7.5* | 2 | 2 | 7.5 | 0 |
| *51* | Hip Immobility & Pain | Chronic | Onset of Pain; Increased Function | 3 | 5 | 0 | 2 | 5 | 0 |
| *52* | Anterior Knee Pain | Chronic | Increase Function | 6 | 8* | 4 | 3 | 6 | 0 |
| *56* | LBP | Acute | Decrease Pain | 7 | 7 | 1 | 0* | 7 | 0 |
| *57* | Hip Pain | Chronic | Decrease Pain | - | - | 5 | 0* | - | - |
| *58* | Knee Pain w/ Activity | Chronic | None | 4 | - | 0 | 0 | 4 | 0 |
| *60* | Anterior Knee Pain | Sub-Acute | Increase Function Decrease Pain | 4 | 9* | 2 | 0* | 10 | 0 |
| *61* | Lateral Knee Pain | Acute | Decrease Pain | 0 | 0 | 6 | 1* | 3 | 5 |

Notes: CC = Chief Complaint; PSFS = Patient Specific Functional Scale (0 = unable to perform, 10 = able to perform at a normal level); Tx = Treatment; NRS = Numeric Rating Scale (0-10); F/U = Follow-up
*Denotes minimal clinically important difference

*Table 3.4 Patient Outcomes in a Single Case Treated with TRE - Fall 2015*

| ***Visit* #** | **Days Between Treatments** | **Tx** | **DPA Scale** | **NRS Current** | **PSFS (Turning Head)** | **PSFS (Typing at Computer)** | **PSFS Average** | **NRS Post-Tx** |
|---|---|---|---|---|---|---|---|---|
| *1* | - | MYK | 30 | 3 | 7 | 6 | 6.5 | 2 |
| *2* | 2 | MYK & TMR | | 3 | 8 | 4 | 6 | 1* |
| *3* | 5 | MYK | | 3 | 7 | 5 | 6 | 1* |
| *4* | 7 | TMR | 30 | 5 | 5 | 5 | 5 | 2* |
| *5* | 2 | TRE | | 4 | 9* | 5 | 7* | 3 |
| *6* | 5 | Discharge | 6* | 0* | 10 | 10* | 10* | 0* |

Notes: DPA = Disablement in the Physically Active Scale (0-64); NRS = Numerical Rating Scale (0-10); PSFS = Patient-Specific Functional Scale (0 = unable to perform, 10 = able to perform at a normal level); MYK = Myokinesthetics; TMR = Total Motion Release
*Denotes minimal clinically important difference

**References**

Avey, H., Matheny, K. B., Robbins, A., & Jacobson, T. A. (2003). Health care providers' training, perceptions, and practices regarding stress and health outcomes. *Journal of the National Medical Association*, 95(9), 833, 836–845. Retrieved from http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2594476&tool=pmcentrez&rendertype=abstract

Berceli, D. (2005). *Trauma Releasing Exercises (TRE): A revolutionary new method for stress/trauma recovery*. North Charleston, S.C.: BookSurge Publishing.

Boone, J. L., & Anthony, J. P. (2003). Evaluating the impact of stress on systemic disease: The MOST protocol in primary care. *Journal of the American Osteopathic Association*, 103(5), 239–246.

Chatman, A. B., Hyams, S. P., Neel, J. M., Binkley, J. M., Stratford, P. W., Schomberg, A., & Stabler, M. (1997). The Patient-Specific Functional Scale: Measurement properties in patients with knee dysfunction. *Physical Therapy*, 77(8), 820–829.

Chevan, J., & Clapis, P. A. ( 2013). *Physical therapy management of low back pain: A case-based approach.* Burlington, MA: Jones & Bartlett Learning.

Davis, M. C., Zautra, A. J., & Reich, J. W. (2001). Vulnerability to stress among women in chronic pain from fibromyaliga and osteoarthritis. *Annals of Behavioral Medicine*, 23(3), 215–226.

Eisenberger, N. I., Jarcho, J. M., Lieberman, M. D., & Naliboff, B. D. (2006). An experimental study of shared sensitivity to physical pain and social rejection. *Pain*, 126(1-3), 132–138. http://doi.org/10.1016/j.pain.2006.06.024

Kamper, S. J., Maher, C. G., & Mackay, G. (2009). Global rating of change scales: A review of strengths and weaknesses and considerations for design. *The Journal of Manual & Manipulative Therapy*, 17(3), 163–170.

Kivimäki, M., Leino-Arjas, P., Virtanen, M., Elovainio, M., Keltikangas-Järvinen, L., Puttonen, S., … Vahtera, J. (2004). Work stress and incidence of newly diagnosed fibromyalgia: Prospective cohort study. *Journal of Psychosomatic Research*, *57*(5), 417–422. http://doi.org/10.1016/j.jpsychores.2003.10.013

Loyd, A., Johnson, B. (2011). *The Healing Code.* New York, NY: Grand Central Life & Style.

Melzack, R. (1999). From the gate to the neuromatrix. *Pain*, *Supplemental* 6(1), S121–S126. http://doi.org/10.1016/S0304-3959(99)00145-1

Melzack, R. (2005). Evolution of the neuromatrix theory of pain. The Prithvi Raj Lecture: Presented at the Third World Congress of World Institute of Pain, Barcelona 2004. *Pain Practice*, 5(2), 85–94. http://doi.org/10.1111/j.1533-2500.2005.05203.x

Papousek, I., Schulter, G., & Premsberger, E. (2002). Dissociated autonomic regulation during stress and physical complaints. *Journal of Psychosomatic Research*, 52(4), 257–266. http://doi.org/10.1016/S0022-3999(02)00298-2

Psychosocial. (2016). *Merriam-Webster.com.* Retrieved May 23, 2016, from http://www.merriam-webster.com/dictionary/psychosocial

Rhudy, J. L., Williams, A. E., McCabe, K. M., Russell, J. L., & Maynard, L. J. (2008). Emotional control of nociceptive reactions (ECON): Do affective valence and arousal play a role? *Pain*, 136, 250–261. http://doi.org/10.1016/j.pain.2007.06.031

Salaffi, F., Stancati, A., Silvestri, C. A., Ciapetti, A., & Grassi, W. (2004). Minimal clinically important changes in chronic musculoskeletal pain intensity measured on a numerical rating scale. *European Journal of Pain*, 8(4), 283–291.

Vela, L. I., & Denegar, C. R. (2010). The Disablement in the Physically Active scale, Part II: The psychometric properties of an outcomes scale for musculoskeletal injuries. *Journal of Athletic Training*, 45(6), 630–641. http://doi.org/10.4085/1062-6050-45.6.630

Waddel, G., Newton, M., Henderson, I., Somerville, D., & Main, C. J. (1993). A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. *Pain*, 52(2), 157–168.

# CHAPTER 4: REVIEW OF LITERATURE

Meniscal lesions are the second most common knee injury in sports (Majewski, Susanne, & Klaus, 2006), and as many as 50% of orthopedic surgeries performed in the United States involve the meniscus (Englund et al., 2010). Tears in the meniscus are more prevalent among males than females, both in adults and adolescents (Drosos & Pozo, 2004; Shieh, Bastrom, Roocroft, Edmonds, & Pennock, 2013), with tears among adolescent populations occurring almost exclusively during sports-related activities (Drosos & Pozo, 2004; Shieh et al., 2013). The current standard of care for treating meniscal tears is surgical intervention. Surgical options for the treatment of meniscal tears include partial meniscectomy, meniscal repair, and meniscus transplant (Brophy & Matava, 2012); when diagnostically indicated (e.g., a tear in the outer vascular zone), arthroscopic surgical repair is generally the first choice due to the salvation of meniscal tissue which is thought to delay the onset of osteoarthritis (OA; Getgood & Robertson, 2010). Osteoarthritis of the knee, however, has been associated with meniscal tears, especially in those treated with surgical meniscectomies (Snoeker, Bakker, Kegel, & Lucas, 2013; Englund, 2008).

Patients who undergo any type of meniscal surgery are at a significant risk for requiring a subsequent surgery (Paxton, Stock, & Brophy, 2011). Failure rates of meniscal surgical interventions range from 9% to 49% (Getgood and Robertson, 2010; Hwang & Kwoh, 2014; Katz et al., 2013; Lyman et al., 2013; Nepple, Dunn, & Wright, 2012; Peters & Wirth, 2003; Pujol Barbier, Boisenroult & Beaufils, 2011; Vundelinckx, Vanlauwe, & Bellmans, 2014). Additionally, there was no difference when comparing the outcomes of meniscectomy to those of sham surgery (Sihvonen et al., 2013) or conservative rehabilitation (Herrlin, Hallander, Wange, Wiendenhielm, & Werner, 2007).

Researchers commonly report a recommendation to exhaust conservative treatment options prior to seeking surgical intervention (Hwang & Kwoh, 2014; Katz et al., 2012; Herrlin et al., 2007; Bin, Kim, & Shin, 2004). Conservative treatment may involve various manual therapy techniques that are effective in resolving symptoms and increasing function (Englund et al., 1992). To improve the treatment of meniscal pathology, it is important to understand the nature of meniscal injuries, treatment options, and the research that must still be conducted to maximize patient outcomes.

**Basic Anatomy and Function of the Meniscus**

The medial "C-shaped" meniscus covers 50% of the medial tibial plateau surface area and is wider at the posterior horn than the anterior (Rath & Richmond, 2000). The periphery of the medial meniscus attaches firmly to the joint capsule and to the medial collateral ligament (MCL) at its midsection via the deep medial collateral ligament fibers (Lee & Fu, 2000). The deep medial collateral ligament restricts the medial meniscus from excessive motion (Masouros, McDermott, Amis, & Bull, 2008). The lateral "O-shaped" meniscus accounts for 70% of the surface area on the lateral tibial plateau (Rath & Richmond, 2000). The lateral meniscus is only loosely attached to the joint capsule and has no attachment to the lateral collateral ligament (LCL), allowing for greater mobility during activity (Rath & Richmond, 2000). Also contributing to the mobility of the lateral meniscus are fibers of the popliteal tendon that insert along the lateral meniscus at the posterolateral corner (Rath & Richmond, 2000).

Tibial attachment sites of the medial and lateral menisci exist anteriorly adjacent to the anterior cruciate ligament (ACL) and posteriorly adjacent to the posterior cruciate ligament (PCL; Greis, Bardana, Holmstrom, & Burks, 2002). The anterior horns of the medial and lateral menisci are connected by the transverse ligament (Fox, Bedi, & Rodeo, 2012). The lateral meniscus is supported by two meniscofemoral ligaments: the ligament of Humphry, or anterior meniscofemoral ligament, and the ligament of Wrisberg, or the posterior meniscofemoral ligament (Greis et al., 2002; Poynton, Javadpour, & Finegan, 1997). The occurrence of these ligaments is highly variable.

**Microstructure**

The meniscus is composed of approximately 70% water and additional dry substance that includes fibrochondryte cells and an extracellular matrix (McDevitt & Webber, 1990; Renstrom & Johnson, 1990). The dry substance is 60-75% collagen (McDevitt & Webber, 1990; Renstrom & Johnson, 1990), 90% of which is type I collagen (McDevitt & Webber, 1990). The concentration of collagen in the meniscus increases from birth until the age of thirty and remains fairly consistent until age of 80, at which point it begins to decline. Elastin and non-collagenous proteins also exist in the meniscus in small quantities (0.6% and 8-13% of the dry substance; McDevitt & Webber, 1990).

The fibers on the surface of the meniscus are organized in a multidirectional mesh-like fashion. The meshed network functions to dissipate shear stress exerted on the surface by the femoral condyles (Greis et al., 2002). Deeper fibers are orientated circumferentially, contributing to the meniscus' ability to withstand weight-bearing loads from the femur. Radial fibers run perpendicular to the circumferential fibers, and both are crimped at rest and elongate under tension (Renstrom & Johnson, 1990). The radial fibers add structural integrity to the meniscus and prevent longitudinal tearing during stress (Renstrom & Johnson, 1990). While the circumferential fibers expand to allow for the dispersal of load, the radial fibers act as ties that prevent excessive expansion.

**Vascular Anatomy**

The meniscus receives its blood supply from the superior and inferior portions of the medial and lateral genicular arteries via premeniscal capillary plexuses (Arnoczky & Warren, 1982). Radial branches from these plexuses extend into the menisci and travel a short distance toward the center of the joint, ending in terminal capillary loops (Arnoczky & Warren, 1982). The well-vascularized periphery is referred to as the *red zone*. The narrow transitional region is the *red-white zone*, or *pink zone*, and the inner most region of the meniscus, which is completely avascular, is the *white zone* (Rodkey, 2000). The depth of vascularity from the periphery ranges from 10-30% in the medial meniscus and 10-25% in the lateral. The lateral meniscus is also avascular at the popliteal hiatus (Arnoczky & Warren, 1982). The zones are useful in describing the location of tears and discussing healing potentials. Tears in the red zone have a potential for healing, while those in the white zone do not (Fox et al., 2012).

Infants are born with an abundance of blood supply throughout the menisci. Newborn vascularity ranges from 50% (Renstrom & Johnson, 1990) to 100% (Greis et al., 2002). By nine months, the inner portion loses most of its vascularity and continues to diminish until it reaches the reported averages at approximately 10 years of age (Greis et al., 2002). Because the avascular portions of the meniscus depend on diffusion from the synovial fluid for nutrition (Fox et al., 2012; Greis et al., 2002; Renstrom & Johnson, 1990), movement at the knee and weight-bearing activities may aid vascular supply due to mechanical pumping and compression of the menisci (Fox et al., 2012).

**Neuroanatomy**

The neural supply of the meniscus follows the same path as the vascular anatomy. Local nerve branches have been reported to stem from the posterior and medial articular nerves (Lee & Fu, 2000; Wilson, Legg, & McNeur, 1969). The premeniscal region of the joint capsule is highly innervated, and branches from these nerves extend into the peripheral third of the meniscus as myelinated and unmyelinated free nerve endings. The nerve fibers are more abundant in the anterior and posterior horns of the menisci than they are in the body (Renstrom & Johnson, 1990). Nerve fibers become less dense in the middle third of the meniscus and are absent in the inner third, insertion sites, and at the meniscofemoral ligaments (Lee & Fu, 2000; Wilson et al., 1969). The majority of nerve fibers at the menisci are reported to be mechanoreceptors, providing proprioceptive feedback during extreme end ranges of motion (Fox, 2007; Greis et al., 2002).

Sensory neuromapping, charting areas of the menisci that detect painful versus pain-free sensation, produced similar findings to those previously reported on neural anatomy of the knee (Dye, Vaupel, & Dye, 1998). Mapping of the internal structures of the knee has been conducted without intraarticular anesthesia. Palpation of the peripheral regions of the menisci via arthroscopic probing produced slight to moderate discomfort, while palpation of the inner rims produced only an awareness of the palpation without pain (Dye et al., 1998). Palpation of the synovium, capsule, and retinacula produced the second highest amounts of pain and discomfort (Dye et al., 1998).

**Function and Biomechanics**

The menisci play a functional role in (a) optimizing articular congruency (Fox et al., 2012; Lee & Fu, 2000; Masouros et al., 2008; Rath & Richmond, 2000; Renstrom & Johnson, 1990), (b) load transmission (Fox et al., 2012; Greis et al., 2002; Lee & Fu, 2000; Rath & Richmond, 2000; Renstrom & Johnson, 1990), (c) shock absorption (Fox et al., 2012; Greis et al., 2002; Lee & Fu, 2000; Masouros et al., 2008), (d) stability (Fox et al., 2012; Lee & Fu, 2000; Masouros et al., 2008; McDermott, Masouros, & Amis, 2008; Rath & Richmond, 2000); (e) proprioception (Fox et al., 2012; Greis et al., 2002), (f) joint lubrication (Fox et al., 2012; Lee & Fu, 2000; Rath & Richmond, 2000; Renstrom & Johnson, 1990), and (g) nutrition (Fox et al., 2012; Lee & Fu, 2000; Rath & Richmond, 2000; Renstrom & Johnson, 1990). Limited evidence exists to support conclusions about the function of the meniscus in joint lubrication and nutrition, but researchers report these functions as a secondary effect at the meniscus during weight-bearing activities (Renstrom & Johnson, 1990). Additionally, the existence of mechanoreceptors within the meniscal horns and attachments sites may suggest that the meniscus plays a functional role in joint proprioception (Lee & Fu, 2000; Renstrom & Johnson, 1990).

The biomechanical role of the meniscus is prevalent during weight-bearing activities. On average, the knee joint transmits three times a person's body weight while weight bearing. The shape of the meniscus allows for better congruency between the articulating surfaces of the flat tibial plateaus and the convex femoral condyles (Masouros et al., 2008). Greater forces are placed on the medial tibial condyles as loads increase (Morrison, 1970), and therefore the meniscus is essential in transmitting and dissipating these forces equally on the tibia. The congruency of the meniscus adds to its role as a secondary stabilizer, especially in resisting anterior translation of the ACL-deficient knee (Renstrom & Johnson, 1990); the meniscus-meniscofemoral ligaments also play a role in the rotational stability of the tibia (Masouros, Bull, & Amis, 2010).

The role of load transmission is critical throughout the entire range of motion at the knee. In full knee extension, the meniscus is centered on the tibial plateau. As the knee flexes, the meniscus moves posteriorly (Masouros et al., 2008; McDermott et al., 2008). The anterior horns have more mobility than do the posterior horns and the lateral meniscus has greater posterior mobility than does the medial meniscus due to its loose peripheral attachment. The greater concavity of the medial tibial condyle may also contribute to the decreased mobility of the medial meniscus (Masouros et al., 2008). Although this posterior translation benefits the load-dispersal capabilities of the meniscus, limited mobility, along with the increased load-bearing responsibility of the medial meniscus, may contribute to the increased prevalence of medial meniscal tears (Fox et al., 2012).

Shock absorption in the meniscus is attributed to its tissue properties. High water content allows for displacement of fluids under pressure, creating a drag force that resists external forces (Masouros et al., 2008; Renstrom & Johnson, 1990). Additionally, the crimped resting state of the circumferential fibers allows for an expansion under hoop stress during weight-bearing activities (Masouros et al., 2008; McDermott et al., 2008).

## Meniscal Tears

Meniscal tears commonly result from the compressive forces on the meniscus by the tibia and femur during flexion and rotation of a weight-bearing knee (McDermott, 2006). A tear in young individuals often occurs from a sudden excessive force, while older adults more commonly experience the gradual onset of degenerative tears (McDermott, 2006). Young patients who sustain pathology will recall a specific mechanism of injury 80-90% of the time (Lento & Akuthota, 2000). Classic signs and symptoms of a meniscal tear include catching, locking, or clicking; joint line pain; and a feeling of “giving out” or instability (Lowery, Farley, Wing, Sterett, & Steadman, 2006). Pain and/or inability to fully squat and a gradual onset of swelling over the first 24 hours following an injury are also commonly reported symptoms (Bower, 2013; McDermott, 2006). Researchers have reported joint line tenderness as the most accurate finding in diagnosing meniscal involvement in adolescent patients (Willis, 2006). Common risk factors for sustaining an acute meniscal tear include participation in sports (Snoeker et al., 2013); chronic tears often occur as a result of persistent kneeling, repetitive squatting, or climbing stairs (Drosos & Pozos, 2003; Snoeker et al., 2013).

**Classification of Meniscal Tears**

Researchers have classified tears based on their appearance and location. Horizontal tears occur in the mid-substance of the meniscus, separating it into superior and inferior segments. Longitudinal tears occur vertically along the circumferential orientation of the collagen fibers (Jee et al., 2003). A radial, or transverse, tear also occurs vertically and perpendicularly across the circumferential fibers; the disruption of the circumferential collagen fibers will affect the dispersal of weight-bearing loads (Harper, Helms, Lambert, & Higgins, 2005). Oblique, or parrot-beak, tears are a combination of radial and longitudinal tears. A tear of this kind will start in a radial direction at the inner rim and change direction longitudinally as it approaches the periphery (Jee et al., 2003). Bucket-handle tears are longitudinal tears in which the mid portion of the tear has flipped over itself (Jee et al., 2003). Complex tears are those that present with two or more of the previously described classification characteristics (Jee et al., 2003).

Longitudinal and oblique tears are the most viable for surgical repair, so long as they occur in the vascularized periphery. A particular prospective study involving 1,485 meniscal tears found 40% of the tears in the vascular peripheral portion (Metcalf & Barrett, 2014). Of those, 28% were complex tears, and 32% horizontal. Complex tears were more prevalent in patients over the age of 40 (found in 35% of patients) than in younger patients (found in 13%;

Metcalf & Barrett, 2004). Tears in the avascular inner rims, as well as radial and complex tears have a lower success rate for surgical repair (Barber-Westin & Noyes, 2014).

## Evaluation and Diagnostics

An experienced practitioner should use a battery of tests to clinically diagnose meniscal lesions, as no single test is pathognomonic for a meniscus tear (Lowery et al., 2006). The tests, palpations, and history components that have been identified (i.e., inclusion criteria) have a high specificity and high sensitivity, and they have been tested in a battery of tests. Many tests have been identified to detect meniscal tears upon clinical diagnosis. These tests include Apley's test, Anderson grind test, McMurray's test, bounce home test, axially loaded pivot shift test, knee compression rotation test, Ege's test, and Thessaly's test (Chivers & Howitt, 2009). In addition to special tests, a detailed history including catching or locking of the knee joint will alert an examiner of a possible meniscal tear (Lowery et al., 2006). The research of Lowery et al., (2006) recommend using the following when assessing patients for suspected meniscal pathology: (a) catching or locking as described by the patient during the history, (b) palpation of joint line tenderness, (c) McMurray's test, (d) pain with hyperextension, and (e) pain with forced flexion.

Additionally, two other tests have been identified and are recommended when assessing meniscal lesions. The first being Thessaly's test at 20 degrees, which is a dynamic weight bearing reproduction of the mechanism of injury. The second is Apley's compression and distraction test, which also reproduces the compressive and rotating force involved in the mechanism of injury. Both tests have been studied in a battery, with one or more of the five tests identified by Lowery et al. (2006). Researchers assessed the accuracy of Thessaly's test with joint line tenderness and McMurray's test, indicating that a battery of tests increases the accuracy of physical diagnosis (Konan et al., 2009). In general, the physical examination is considered essential to the diagnosis of meniscal lesions (Fowler & Lubliner, 1989; Miller, 1998; Kurosaka et al., 1999; Lowery et al., 2006).

## Patient History, Range of Motion, and Palpation

**Patient history.** One of the most important elements to any diagnosis is taking a detailed history. A few key history components will alert an examiner to meniscal pathology outside of the mechanism of injury (Lowery et al., 2006). Losses of flexion greater than 10 degrees, loss of extension greater than five degrees, crepitus, and/or joint line swelling are common history components of meniscal pathology (Magee, 2008). Catching, locking, or the sensation of catching or locking in the knee has been identified throughout literature as symptoms of meniscal pathology (Lowery et al., 2006). Lowery et al. (2006) investigated the mechanical history component further with an intact ACLs, identifying catching, locking, or the sensation of catching to have a sensitivity of 21% and specificity of 92%. The positive predictive value (PPV) associated with the history component was 74%, and the positive likelihood ratio (PLR) was 3.34 in knees treated surgically (Lowery et al., 2006).

**Pain with forced joint movement.** Pain associated with forced knee flexion and pain associated with hyperextension were identified by Lowery et al. (2006) as a part of a clinical composite score used to accurately detecting meniscal pathology. Practitioners perform forced knee flexion by having the patient lie supine with examiner on the involved side (Lowery et al., 2006). The patient then actively moves his or her knee into maximum flexion, and the examiner applies an over pressure if pain is not elicited in active movement (Lowery et al., 2006). A positive test is elicited by pain within the joint line in active movement or forced overpressure (Lowery et al., 2006; Fowler & Lubliner, 1989). Lowery et al. (2006)

investigated forced knee flexion with intact ACLs, identifying a sensitivity of 47% and specificity of 59%, respectively. The PPV associated with the range of motion (ROM) component was 55%, and the PLR was 1.16 in knees treated surgically (Lowery et al., 2006).

Pain with hyperextension (modified bounce home test) is performed by having the patient lie in the supine position with the examiner on the involved side (Lowey et al., 2006). The examiner cups the heel of the patient's foot with one hand and the other hand on the knee guiding the knee from flexion into passive extension (Lowery et al., 2006). A positive test is indicated by pain in the joint line of the knee (Magee, 2008; Lowery et al., 2006; Kurosaka et al., 1999; Fowler & Lubliner, 1989). If extension is not complete or a "springy" block is felt, this is thought to be a block from the torn meniscus (Magee, 2008). Lowery et al. (2006) investigated pain with hyperextension with an intact ACL identifying a sensitivity of 33% and specificity of 88%. The PPV associated with the ROM component was 75% and the PLR was 2.59 in knees treated surgically (Lowery et al., 2006).

**Palpation.** Joint line tenderness is a well-known assessment for meniscal lesions and has a high sensitivity and a low specificity (Malanga et al., 2003; Rose, 2006). Practitioners assess joint line tenderness by having the patient supine with the examiner on the involved side (Malanga et al., 2003). The patient flexes the affected limb to approximately 90 degrees (Malanga et al., 2003). The medial edge of the medial meniscus is palpated by having the patient internally rotate the tibia, and external rotation allows for improved palpation of the lateral meniscus (Malanga et al., 2003). A positive test is indicated by pain over the palpation site in the joint line (Malanga et al., 2003; Rose, 2006). Joint line tenderness has a high sensitivity in both medial (68%-92%) and lateral (87%-95%) meniscal pathology, but best results are in lateral meniscal tears with only 8% variability between the lowest and highest sensitivity percentage reported (Eren, 2003).

Lowery et al. (2006) investigated joint line tenderness on patients with an intact ACL, identifying a sensitivity of 65% and specificity of 62%. The PPV of joint line tenderness associated with the ROM component was 65%, and the positive likelihood ratio was 1.83 in knees treated surgically. Fowler and Lubliner (1989) identified joint line tenderness with a sensitivity of 86% and a specificity of 29%. Karachalios et al., (2005) report a medial meniscus joint line tenderness sensitivity of 87%, a medial meniscus sensitivity of 87%, a lateral meniscus sensitivity of 78%, a lateral meniscus specificity of 90%, a medial meniscus diagnostic accuracy of 71%, and a lateral meniscus diagnostic accuracy of 78%. Konan et al. (2008) identify this test with a medial meniscus sensitivity of 83%, a medial meniscus specificity of 76%, a lateral meniscus sensitivity of 68%, a lateral meniscus specificity of 97%, a medial meniscus diagnostic accuracy of 81%, a lateral meniscus diagnostic accuracy of 90%, a PPV medial meniscus of 91%, and a PPV lateral meniscus of 87%. Kurosaka et al. (1999) report joint line tenderness to have an overall sensitivity of 55%, overall specificity of 67%, and an overall diagnostic accuracy of 57%. Rose et al. (2006) identify this test with a medial meniscus sensitivity of 92%, a medial meniscus specificity of 78%, a lateral meniscus sensitivity of 95%, a lateral meniscus specificity of 93%, a PPV medial meniscus 73%, and a PPV lateral meniscus of 86%.

**ACL assessment.** The clinician should rule out ACL involvement prior to assessing a patient for a meniscal tear, so tests used for identifying meniscal pathology will not lead to false positives due to a concurrent injury (Fowler & Lubliner, 1989; Lowery et al., 2006). Lachman’s test and the pivot shift test serve as accurate diagnoses of ACL-deficient knees preoperatively, effectively ruling out ACL injuries when these tests are negative (Katz et al., 1986). Katz et al. (1986) identified the pivot shift test and Lachman's test as having a sensitivity of 81.8% individually, the Lachman's test as having a specificity of 98%, and the pivot shift test as having a specificity of 98.4% for all ACL tears (acute and chronic). In a 2012 meta-analysis 20 studies were included, where the overall sensitivity and specificity (without anesthesia) of the Lachman test was 81% , positive predictive value (PPV) was 88%, negative predictive value (NPV) of 72%, positive likelihood ratio (PLR) of 4.5 and negative likelihood ratio (NLR) of .22 (Eck et al., 2013). The sensitivity of the pivot shift (without sedation) was 28%, specificity 81%, PPV 94%, NPV 30%, PLR 5.35, and NLR 0.30 (Eck et al., 2013). In 2015, Leblanc et al. reaffirmed high sensitivities in both Lachman's test (89% for complete and partial, 96% for complete tears) and pivot shift (79% for complete and partial, 86% for complete tears) during non-sedation evaluation, by conducting a systematic review of 8 studies. Overall, the Lachman's test has the highest sensitivity (without sedation) for diagnosing complete ACL ruptures in clinic but the pivot shift was the most specific (with sedation) (Eck et al., 2013).

***Lachman's test.*** The Lachman's test is performed in the supine position with patient relaxed, examiner on the involved side (Katz et al., 1986). The examiner holds the knee joint in 10 to 20 degrees of flexion in a slight external rotation by stabilizing the distal femur with one hand (the outside hand, when facing a patient's head) and placing the other hand behind the proximal tibia (Katz et al., 1986). The hand on the tibia applies the anterior tibial translation, and force should be applied from the posteriormedial aspect; a negative test is one in which there is steady restraint and an immediate end point is felt (Katz et al., 1986). A positive sign is indicated by a "soft" end feel and the disappearance of the infrapatellar tendon slope from tibial translation (Makhmalbaf et al., 2013; Katz et al., 1986). The Lachman's test has many modifications based on examiner hand size or patient limb size, but all positive signs are the same (Makhmalbaf et al., 2013; Katz et al., 1986).

***Pivot shift test.*** The pivot shift test is performed in the supine position with patient relaxed and examiner on the involved side (Malanga et al., 2003). The patient's hip is flexed and abducted about 30 degrees (Malanga et al., 2003). The examiner holds the patient's foot with one hand and places the other at the knee, which is placed in 10 to 20 degrees of flexion. Torque is applied to the tibia while rotating it internally (Malanga et al., 2003). A valgus force is applied to the knee joint, while the leg is flexed to 30 to 40 degrees (Malanga et al., 2003). A positive test is indicated by an anterior subluxation of the lateral tibial plateau under the femoral condyle (Katz et al., 1986; Malanga et al., 2006).

**Special Tests for Meniscal Tears**

According to Fowler and Lubliner (1989), McMurray's test, Apley's compression and distraction test, and the joint line tenderness test are the most commonly used tests for identifying meniscal pathology. In a 2003 review of orthopedic special tests of the knee, the 3 stated tests, plus the bounce home test (forced extension), were examined and identified as reliable tests for the clinical diagnosis of meniscal tears (Malanga et al., 2003). Thessaly's test is a more recent addition because it offers a dynamic element to these well-established tests (Karachalios et al., 2005).

**McMurray's test.** Many researchers have studied the McMurray's test, and its specificity is reported at various ranges throughout studies. The varying range could be attributed to specific clinician deviations and/or modifications from McMurray's (1928) original methodology, but a positive sign remained the same across all studies reviewed.

Modern textbooks often deviate from McMurray's original work clarifying hand placement, and varying flexion of the knee joint. McMurray's test is performed with the patient in supine with a flexed hip and flexed knee (heel to buttock, if possible) (McMurray, 1928). The examiner on the side of the involved limb places one hand over the joint line with the thumb and middle fingers centered on the joint line to feel for any "popping." The other hand grasps the sole of the foot, and while the patient is relaxed, the examiner has full control over the limb, externally rotating the foot while slowly extending the knee (McMurray, 1928). The examiner checks the medial meniscus with external rotation of the foot while slowly extending the knee, and the lateral meniscus with internal rotation (Hing et al., 2009). The process is repeated several times. A positive test is indicated by a palpable "click" or "pop" in the joint line; pain may be associated, but pain alone is not a positive test (McMurray, 1928; Evans, Bell, & Frank, 1993; Hing et al., 2009).

Lowery et al. (2006) investigated McMurray's test with an intact ACL, identifying a sensitivity of 21% and specificity of 95%. The PPV of McMurray's test associated with the ROM component was 81% and the positive likelihood ratio was 5.00 in knees treated surgically. Evans et al. (1993) stated that McMurray's "thud" is only significant in medial meniscal tears in a prospective study of 104 patients, all of whom received arthroscopy. Accuracy of medial "thud" had a specificity of 98%, sensitivity of 16%, and PPV of 83%; however, lateral pain elicited in internal rotation had a specificity of 94%, sensitivity of 50, and PPV of 29%, illustrating the "thud" was not significant in the lateral joint line, but that pain was indicative of a meniscal tear (Evans et al., 1993). Kurosaka et al. (1999) identify this test with an overall sensitivity of 37%, overall specificity of 77%, and an overall diagnostic accuracy of 45%. Fowler and Lubliner (1989) identify overall sensitivity as 16% and overall specificity as 95% for McMurray's test. Konan et al. (2008) identify this test with a medial meniscus sensitivity of 50%, a medial meniscus specificity of 77%, a lateral meniscus sensitivity of 65%, a lateral meniscus specificity of 86%, a medial meniscus diagnostic accuracy of 57%, a lateral meniscus diagnostic accuracy of 77%, a PPV medial meniscus of 86%, and a PPV lateral meniscus of 50%. Karachalios et al. (2005) identify this test with a medial meniscus sensitivity of 48%, a medial meniscus specificity of 94%, a lateral meniscus sensitivity of 65%, a lateral meniscus specificity of 86%, a medial meniscus diagnostic accuracy of 78%, and a lateral meniscus diagnostic accuracy of 84%.

**Apley's compression and distraction test.** Apley's compression and distraction test is normally tested in conjunction with the McMurray test and the joint line tenderness test (Scholten et al., 2001; Meserve et al., 2008; Kurosaka, et al., 1999). In Apley's original research in 1947, he described the need to recreate the mechanism of injury through compression and rotation during examination. Apley's test is performed by having the patient lie prone, with the knee flexed to 90 degrees and the examiner on the involved side (Apley, 1947). The patient's thigh is stabilized on the table with the examiner's knee (Apley, 1947). The examiner grasps the foot in both hands medially and laterally rotates the tibia, combined with a distraction force (Aply, 1947). The process is then repeated using compression. A positive test is indicated by pain with the compression force and a relief of pain with the distraction force (Magee, 2008; Malanga, et al., 2003).

Kurosaka et al. (1999) identify Apley's test with a sensitivity of 13%, specificity of 90%, and a diagnostic accuracy of 28%. Fowler and Lubliner (1989) identify the overall sensitivity as 16% and specificity as 80%. Karachalios et al. (2005) identify this test with a medial meniscus sensitivity of 41%, a medial meniscus specificity of 93%, a lateral meniscus sensitivity of 41%, a lateral meniscus specificity of 86%, a medial meniscus diagnostic accuracy of 75%, and a lateral meniscus diagnostic accuracy of 82%. All studies were based on the methodology of Apley's original work.

**Thessaly's test.** Thessaly's test is a dynamic reproduction of load transmission performed at 5 and 20 degrees of flexion. The examiner supports the patient by holding the patient's outstretched arms. The patient stands on a flat surface and flexes the knee to either 5 or 20 degrees and then internally and externally rotates the knee and body three times (Karachalios et al., 2005). A positive test is indicated by discomfort in the medial or lateral joint line (Karachalios et al., 2005). A feeling of locking or catching may be felt during this test as well, which further supports the diagnosis of a meniscal tear (Karachalios et al.; 2005, Harrison et al., 2009). Thessaly's test at 20 degrees has a high specificity (97.7) as well as a high sensitivity (90.3; Harrison et al., 2009.). Thessaly's test has been studied in conjunction with McMurray test, Apley's compression and distraction test, and the joint line tenderness test, and has been identified as superior to all three in a level-one study (Karachalios et al., 2005).

Harrison et al. (2009) identify this test's overall sensitivity as 90%, overall specificity as 98%, overall diagnostic accuracy as 89%, and PPV as 99%. Konan et al. (2008) identify this test with a medial meniscus sensitivity of 59%, a medial meniscus specificity of 67%, a lateral meniscus sensitivity of 31%, a lateral meniscus specificity of 95%, a medial meniscus diagnostic accuracy of 61%, a lateral meniscus diagnostic accuracy of 80%, a PPV medial meniscus of 83%, and a PPV lateral meniscus sensitivity of 66%. Karachalios et al. (2005) identify this test with a medial meniscus sensitivity of 89%, a medial meniscus specificity of 97%, a lateral meniscus sensitivity of 92%, a lateral meniscus specificity of 96%, a medial meniscus diagnostic accuracy of 94%, and a lateral meniscus diagnostic accuracy of 96%. All studies followed the original procedures described by Karachalios in 2005.

**Clinical Composite Tests**

Using a combination of reliable tests may be essential in the clinical diagnosis of a meniscal tear because the use of a valid testing battery could improve the diagnostic accuracy of the clinical exam. Lowery et al. (2006) identified a potential testing battery utilizing the following findings: positive McMurray's test, pain with terminal knee flexion, pain with terminal knee extension, joint line tenderness, and a history of clicking and/or popping. The clinical composite score of the testing battery has a PPV of 92.3%, specificity of 99% and a sensitivity of 11.2% for detecting meniscal tears when all 5 signs are present (Lowery et al., 2006). The PPV and specificity decrease to 81.8% and 96.1% respectively, while sensitivity increases to 17% when only 4 signs are present (Lowery et al., 2006). When 3 of the 5 signs are present, the PPV is 76.7%, specificity is 90.2%, and sensitivity is 30.8% (Lowery et al., 2006); superior or comparable to magnetic resonance imaging (MRI) alone in detecting meniscal pathology (Miller, 1996).

**Imaging**

**Magnetic resonance imaging.** Practitioners routinely recommend magnetic resonance imaging (MRI) after a clinical diagnosis of a meniscal tear prior to any surgery discussions with a patient (Miller, 1996). Four major factors are taken into consideration when using MRIs as the only diagnostic tool, which include (a) image quality affects the recurrence of false positive interpretations, (b) inexperienced scanners, (c) incorrect image parameters yield less than favorable diagnostic accuracy, (d) and interpretation issues (Miller, 1996). Structures such as the transverse meniscal ligament, lateral inferior geniculate artery, and the popliteus tendon may replicate the presence of a meniscal tear (Boden et al., 1992; Nikolaou et al., 2008). Meniscal tears and meniscal degeneration have a similar presence on MRIs, leading to false positives (Nikolaou et al., 2008).

**MRI compared to clinical exam.** Magnetic resonance imaging has been compared to the accuracy of the clinical diagnosis of meniscus tears and has been found to be comparable (Miller, 1996); in some cases, a clinical exam was found to be superior to an MRI (Miller, 1996). The clinical exam using a battery of meniscal specific tests had an accuracy of 80.7%, and MRI had 73.7% accuracy (Miller, 1996). The clinical diagnosis in Miller's study consisted of detailed history, and the assessment of: persistent pain, buckling, locking, effusion, joint line tenderness, and limited function. Muellner et al. (1997) illustrated that clinical diagnoses alone had an accuracy of 89% and 89% in MRI. The clinical diagnostic accuracy in Muellner et al. (1997) study consisted of six tests: joint line tenderness, McMurray's test, Apley's test, Pahyr's test, Steimenn's test and Bohler's test.

In a retrospective analysis of MRI efficacy in detecting internal lesions of the knee, MRI was reported to be slightly better than a clinical exam, but the clinical exam did not include a detailed history and only utilized two special tests (McMurray's and Apley's; Nikolaou et al., 2008). Diagnostic accuracy using clinical exam was reported as 60%, sensitivity as 65%, and specificity as 50%, while the diagnostic accuracy of MRI was reported as 81%, sensitivity as 83%, and specificity as 69% (Nikolaou et al., 2008).

Clinical examination has been determined to have a similar, and in some cases better, diagnostic accuracy than the MRI, concluding that MRI is only necessary in cases lacking a detailed history or one that is confusing (Rose, 2006; Boden et al., 1992; Kurosaka et al., 1999; Lowery et al., 2006; Mohan & Gosal, 2007; Miller, 1996). Surgeons may also advocate for an MRI, so not to appear too aggressive in support of surgery or for financial gains (Muellner et al., 1997). Relying on MRI results in the absence of a proper clinical examination may lead to unnecessary arthroscopic procedures, as it has been well documented that meniscal tears are often found in asymptomatic patients (Troupis et al., 2014).

**Arthroscopy.** Practitioners consider arthroscopy the “gold standard” for the detection of meniscal pathology, allowing a surgeon visual confirmation of an issue through a scope. Arthroscopy is a demanding procedure and dependent on the surgeon’s level of experience, especially in difficult to view areas due to overlapping structures or small spaces (Nikolaou et al., 2008). Arthroscopy, however, may not be a desired diagnostic tool because of the risks involved, such as, infection, reaction to general anesthetics, and/or scarring (Nikolaou et al., 2008).

## Patient Outcomes Scales and Instruments

In addition to the diagnostic assessment of meniscal lesions, practitioners should also assess the patient with reliable patient-oriented and disease-oriented outcomes. Outcome scales help to monitor and assess the patient’s well-being, pain and functionality throughout the course of treatment, allowing the clinician to assess the effectiveness of the chosen treatment. Consideration of the population for which the instrument is intended is an important aspect for the validity of any instrument (Garratt et al., 2004). Accurate outcome measures are the cornerstone in determining effective treatments from noneffective treatments (Roos et al., 1998). An awareness of how patients perceive their injury through a physical, psychological, and social well-being lens plays a large role in the treatment process. A clinician must be able to determine the need for referral based on psychological components exceeding their scope of practice and when the presence of psychological or social components are hindering the physical healing process (Garratt et al., 2004).

Reliability refers to an instrument's’ internal consistency. Validity is whether the instrument measures what it is intended to measure. Responsiveness is whether the instrument is sensitive to changes in health (Garratt, 2004). The following instruments have high reliability, high validity, and high responsiveness.

**Knee Injury and Osteoarthritis Outcome Score**

The Knee injury and Osteoarthritis Outcome Score (KOOS) is a self-administered patient-oriented tool that assesses five dimensions: pain, symptoms, activities of daily living, sport and recreational function, and knee-related quality of life. The KOOS is intended for patients with knee injuries that can result in OA, and has been assessed in men and women from 14 to 79 years of age (Roos & Lohmander, 2003; Roos et al., 1998). The KOOS is a self-explanatory questionnaire that assesses short- and long-term patient relevant outcomes following knee injury, including meniscal pathology. The questionnaire takes about 10 minutes to complete. Each dimension of KOOS is scored separately, and patients answer each item on a 5-point Likert scale of 0 to 4; a total score of 100 indicates no symptoms (Roos et al., 1998). Aggregate scores are not desirable, as the instrument is intended for clinicians to thoroughly assess patients on each component of the KOOS on a regular basis (Roos et al., 1998; Roos & Lohmander, 2003). Each dimension of the KOOS is scored separately, however a composite score (KOOS) from the average of all five subsections has been used for researcher purposes (Roos & Lohmander, 2003). There are currently no published MCID values for the KOOS. A total score for the KOOS has not been assessed for validity or reliability; however, reliability for each subsection is as follows: ICC for pain as 0.85-0.93, symptoms as 0.83-0.95, activities of daily living as 0.75-0.91, sports/recreation as 0.61-0.89, and quality of life as 0.83-0.95 (Roos et al., 1998).

**Patient Specific Functional Scale**

The Patient Specific Functional Scale (PSFS) is a patient-oriented tool that assesses patients' perceptions of their functional ability, and researchers designed the scale to complement generic or condition specific measurement scales (Chatman et al., 1997). The PSFS should be administered during the history intake at the time of initial assessment. The patient is asked to identify up to five activities, deemed important, that they have difficulty with or are incapable of performing due to injury. The activities are rated by the patient on an 11-point scale, where 0 represents *unable to perform* and 10 represents *able to perform at level before injury*. The tool takes approximately four minutes to complete. The clinician's role is to read instructions and record activities with corresponding ratings and remind patients of activities at follow-up appointments.

The PSFS score is calculated using an average of the ratings associated with each activity given by the patient. The minimum important difference (MID) noted by Abbott and Schmitt (2014) in patients with lower limb injuries was an increase of 2.3 points for a small change, 2.7 for a medium change, and greater than 2.7 for a large change. The reported minimal detectable change (MDC) is a change in 2.5 points when using an individual activity in patients with a lower limb injury (Chatman et al., 1997). Researchers found the test-retest reliability for the PSFS to be excellent, with an ICC of 0.84 (Chatman et al., 1997).

**Disablement in the Physically Active Scale**

The Disablement in the Physical Active (DPA) Scale is a patient-oriented scale created to assess disablement across the three interrelated domains of impairment, functional limitation, and disability, as well as health related quality of life (Vela & Denegar, 2010). Responses to the DPA Scale range from 1 to 5, where a score of 1 indicates that the patient does not have a problem with the listen item, and a score of 5 indicates that the patient is severely affected by the problem. During the calculation of the patient's score, 16 points are subtracted from the final score, to make 0 the lowest score and 64 the highest. The 16 points are subtracted because the scale uses a 1-5 interval to rate each item; without the 16-point adjustment a patient with no disablement would score 16 points on the scale rather than 0 (Vela & Deneger, 2010). A normal, healthy range for the DPA Scale is a score of 34 or less, and a score less than or equal to 23 in acute patients indicates that a patient is ready for further functional testing by an athletic trainer or physician (Vela & Denegar, 2010). An MCID is a decrease of 9 points for an acute injury and a decrease of 6 points for a chronic injury (Vela & Denegar, 2010). The DPA Scale was found to have a high test-retest reliability with an ICC of 0.943 and high validity for acute (r = -0.751) and chronic (r = -0.714) patients (Vela & Deneger, 2010).

**Numeric Rating Scale**

The numerical rating scale (NRS) for pain has been widely used throughout the medical field and is accepted as a valid patient-oriented scale to assess levels of pain in many patient populations (Krebs et al., 2007). The NRS is a commonly used rating scale in athletic training. The NRS scale is scored on an 11-point scale, where a score of 0 represents no pain, and a score of 10 represents severe pain (Downie et al., 1978). The MCID for the NRS is a decrease of 2 points, or 33% in patients with chronic musculoskeletal pain (Salaffi et al., 2004). The MID noted by Abbott and Schmitt (2014) was a decrease of 1.5 points for a small change, 3.0 for a medium change, and 3.5 for a large change. The NRS is widely accepted as a valid (r = 0.90 - 0.92, P < 0.5- 0.1; Good et al., 2001) and reliable (ICC of 1.00) scale (Herr et al., 2004).

**Clinometry**

Researchers have found the Clinometer smartphone application to be both valid and reliable when compared to the gold standard goniometry measurements at the shoulder (Werner et al., 2014). Inter-rater reliability was reported to be 0.8 (ICC 2,1; Werner et al., 2014), and validity was reported to be 0.98 at the shoulder in symptomatic patients (Werner et al., 2014). Currently, no studies exist validating the use of the Clinometer smartphone application in the lower extremity.

**Goniometry**

Researchers have reported the goniometric levels of intra-tester and inter-tester reliability for a universal goniometer when measuring knee joint flexion (ICC of 0.997 and 0.977-0.982) and extension (ICC of 0.972-0.985 and 0.893-0.926). Validity varied from 0.975-0.987 for flexion and 0.390-0.442 for extension (Brosseau et al., 2001).

## Treatment

Accurate diagnosis of meniscal lesions is the first step to producing quality outcomes in patients with meniscal tears. However, accurate diagnosis alone does not solve the patient's problem. Following up an accurate diagnosis with the proper course of treatment should be the primary focus of any experienced practitioner.

Currently, there is no general consensus on the proper treatment of meniscal injuries based on sound foundational research (Howell & Handoll, 1996). Previously, clinicians thought that meniscal surgery was necessary to prevent OA after a patient sustained meniscal lesion (Belzer & Cannon, 1993; O'Donoghue, 1980) because of increased contact forces on the articular surfaces of the joint (Belzer & Cannon, 1993). However, a cadaveric study of meniscal tears found that patients could sustain a tear of up to 90% in either meniscus before significant alteration of joint arthrokinematics as compared to an uninjured knee (Bedi et al., 2010).

There are several surgical treatment options for meniscus injuries, including partial meniscectomy, meniscal repair, and meniscus transplant (Brophy & Matava, 2012). However, a patient's age, activity level, and lifestyle must be considered in addition to the size and location of the meniscal tear (Belzer & Cannon, 1993). Furthermore, Englund et al. (2012) reported that surgery might not be recommended for all meniscal lesions. The researchers found that almost one-third of all meniscal lesions found on an MRI are asymptomatic (Englund et al., 2012). As such, researchers have embraced that surgery is only necessary if the meniscal tear interferes with normal joint motion (Englund et al., 2012). This may be a result of the significant associated risks of surgeries (Brophy & Matava, 2012), a new trend based on the arthrokinematics of the meniscus. Other researchers believe that conservative therapy should be exhausted first (Hwang & Kwoh, 2014; Katz et al., 2012; Herrlin et al., 2007; Bin et al., 2004). Finally, some researchers believe partial meniscectomies should be discontinued all together for certain populations, specifically middle-aged patients with degenerative medial meniscal tears (Sihvonen et al., 2013).

**Partial Meniscectomy**

The most common surgery performed to treat meniscus injury is an arthroscopic partial meniscectomy. Using an arthroscopic procedure, the torn section of the meniscus is removed. The goal is to retain as much intact meniscus as possible to decrease articular forces on the joint. Initially, practitioners presumed partial meniscectomy regardless of the location of the meniscal lesions (O'Donoghue, 1980). Prevalence of partial meniscectomies has increased significantly over the past five years because of the current clinical philosophy surrounding meniscal injuries (Sihvonen et al., 2013).

In 2004, Bin et al. published a case series on 96 patients with radial tears of the medial meniscus who were treated with a partial meniscectomy after pain persisted following three months of conservative therapy. There was a statistically significant improvement in patients who had less than 50% of the meniscus torn, but no change in patients who had greater than 50% torn. The researchers suggested that partial meniscectomy should be used in patients older than 50 years of age where any portion of the meniscus was torn (Bin et al., 2004), however, they did acknowledge that preserving meniscal tissue was necessary to prevent OA, but suggested older patients were more likely to have OA regardless of meniscal pathology (Bin et al., 2004). Removing damaged meniscal tissue to alleviate mechanical symptoms may be the more appropriate option in this scenario because the articular cartilage may already be compromised in the older patient population (Bin et al., 2004).

Several years later, Herrlin et al. (2007) contradicted the results of Bin et al. (2004) in a randomized control trial. Herlin et al. (2007) found that there was no significant difference between partial meniscectomy and conservative therapy at 8 weeks postsurgery and 6 months postsurgery and no significant difference in pre- and post-treatment activity level. The researchers suggested exhaustion of conservative therapy before pursuing surgical options (Herrlin et al., 2007). In 2012, the researchers of another randomized control trial compared the long-term outcomes of conservative therapy to partial meniscectomy, and their results confirmed those of Herrlin et al. (2007): no significant difference in the outcomes existed in 351 patients at 6 or 12 months post treatment (Katz et al., 2013).

The Meniscus Repair in Osteoarthritis Research (METEOR) study (Katz et al., 2013), the first large-scale, longitudinal study on partial meniscectomy outcomes in patients with knee comorbidities, was a randomized control trial conducted over seven sites with 351 participants. As stated previously, the researchers found no clinically significant difference between partial meniscectomy and conservative therapy at 6 and 12 months post treatment. While there was a 30% crossover rate from the physical therapy group to the surgery group, at 6 months there was no clinically significant difference in the outcomes of the crossover group and the surgery group (Hwang & Kwoh, 2014; Katz et al., 2013).

Finally, in an effort to determine if the use of partial meniscectomies should be discontinued in middle-aged patients with degenerative medial meniscal tears all together, Sihvonen et al. (2013) conducted a randomized sham study on 146 patients. The researchers found no significant difference between the outcomes of a partial meniscectomy and sham surgery and no significant difference in the patients' ability to identify which surgery they underwent. The researchers also highlighted the fact that since the publication of results of Katz et al. (2013), the use of partial meniscectomies continued to grow exponentially when they should have decreased significantly (Sihvonen et al., 2013).

Over the last decade, evidence has been mounting that partial meniscectomies may not lead to improved patient outcomes (Hwang & Kwoh, 2014; Katz et al., 2013; Sihvonen et al., 2013; Herrlin et al., 2007) as once believed (Belzer & Cannon, 1993; O'Donoghue, 1980). In addition, patients have a significant risk of developing OA in the long term, the exact outcome the surgical technique intended to prevent (Brophy & Matava, 2012). A Cochrane review of all meniscus surgery studies performed prior to 1996 found an astounding problem. Most of the studies produced only reported surgical outcomes and surgical techniques without control or alternative therapy outcomes, and the ones that did exist were significantly biased and flawed (Howell & Handoll, 1996). While the aforementioned research studies are not without their minor flaws (e.g., small sample sizes, studies conducted on the general population, not controlling for outside treatments (Herrlin et al., 2007; Bin et al., 2004; Hwang & Kwoh, 2014), the results published in these studies account for the level 1 evidence requested by Howell and Handoll (1996).

**Meniscal Repair**

Meniscus repair is a procedure in which the lesion is sutured, and all of the meniscal tissue is retained; however, meniscal repair is not always indicated. Meniscal repair is only successful when the tear occurs in the small vascular portion of the meniscus (Getgood & Robertson, 2010). Tears in the vascular portion of the meniscus occur in 60.7% of ACL comorbidity patients, but only in about 40% of ACL-intact patients (Metcalf & Barrett, 2014). Currently, several studies have been published where the researchers identify the failure rates of meniscal repair procedures (Lyman et al., 2013; Nepple et al., 2012; Pujol Barbier et al., 2011), but published research studies comparing the outcomes of meniscal repair against any other treatment paradigm are limited in quantity.

The statistics on the failure rates of meniscal repair surgery vary greatly. Getgood and Robertson (2010) estimated that meniscal repair surgeries had a 42% failure rate, but only if performed more than three months post-injury. Nepple et al. (2012) concluded that the overall failure rate greater than five years was between 22.3% and 24.3%, and 29% of the failures occurred after two years. In contrast, Pujol et al. (2011) conducted a retrospective cohort study on the failure rates of meniscus repair and subsequent partial meniscectomy; the failure rate was 12.3% overall, of which 53% of patients sustained a subsequent lesion equal to, but not greater than, the initial lesion, and 31.3% sustained a smaller subsequent lesion (Pujol et al., 2011). Finally, in patients under 40 years of age, researchers estimated the failure rate to be 8.9% if the patient sustained a medial meniscal tear and the surgeon performing the procedure participated in more than 24 meniscal repair surgeries per year (Lyman et al., 2013).

While the failure rate is widely disputed, the outcomes of meniscal repair compared to partial meniscectomies are limited in quantity, but clear. Paxton et al. (2011) conducted a systematic review of four studies comparing the outcomes of partial meniscectomies with those of meniscal repair, finding that the latter group had a lower reoperation rate than the former. The meniscal repair groups also had improved disability outcomes compared to the partial meniscectomy group (Paxton et al., 2011). Most researchers are hesitant to refute the efficacy of meniscal repairs, even with a failure rate between 8.9% and 42% (Lyman et al., 2013; Nepple et al., 2012; Pujol et al., 2011) because more research is needed to corroborate not only the failure rates, but the effect and the efficacy of the treatment and its outcomes as compared to conservative therapy.

**Meniscal Transplant**

Meniscus transplant is a relatively new development in the treatment of meniscal lesions developed through an anatomic cadaveric study (Kohn & Moreno, 1995). Practitioners performed meniscal transplant surgeries as early as 1980, but were and continue to be mainly experimental. As of 2010, only 4,000 procedures total had been performed in the United States (Getgood & Robertson, 2010), which is minuscule compared to partial meniscectomies occurring at the rate of 700,000 per year (Sihvonen et al., 2013).

The meniscus does not have an immune response, so replacement or transplant is relatively uncomplicated, and allograft tissue can either be sutured to meniscal remnants or to posterior and anterior attachments (Getgood & Robertson, 2010). Meniscal lesions must be measured extensively in order to ensure the correct size of the allograft. This can be accomplished through X-ray, bone scan, computerized tomography scan, MRI, and arthroscopy. Allografts, however, have a failure rate of 44% (Peters & Wirth, 2003) to 49% (Vundelinckx et al., 2014).

In regards to autografts, practitioners are exploring many possibilities for potential tissue donor sites (Makris, Hadidi, & Athanansiou, 2013). Meniscal autografts through growth of meniscal scaffolds from donor tissue are in development (Getgood & Robertson, 2010). There are no reliability or outcomes studies for meniscal autograft transplant because the autografts currently do not resemble or mimic the original meniscus (Makris et al., 2013).

A more recent theory has begun to develop over the last decade that focuses on the surgical treatment of meniscal tears. This theory argues that surgery may not be the quintessential treatment and that conservative therapy treatment paradigms should be investigated further (Hwang & Kwoh, 2014; Katz et al., 2013; Sihvonen et al., 2013; Herrlin et al., 2007) as once assumed (Belzer & Cannon, 1993; O'Donoghue, 1980). Conservative treatment can involve various manual therapy techniques, which has shown to effectively resolve symptoms and increase function (Englund et al., 1992).

## The Mulligan Concept

### Background

Manual therapy encompasses a wide array of techniques and theories of efficacy (Threlkeld, 1992). The history of these techniques are rooted in the studies and research of well-known scientific scholars and are used for many different musculoskeletal injuries; however, the conservative treatment of symptoms of meniscal tears using the Mulligan Concept (MC) has not been explored. The MC was developed on a mobilization with movement (MWM) theory and principles that involve compression, traction, and/or articulation (joint mobilization) of the restricted or painful joint (Hing, Hall, Rivett, Vicenzino, & Mulligan, 2015; Mulligan, 1993; Mulligan, 2004; Mulligan, 2010; Vicenzino, Hing, Rivett, & Hall, 2011). The MC interventions incorporate a sustained passive joint mobilization during the patient's active movement, which may address and correct pain and discomfort at the knee due to meniscal tears.

**Positional Fault Theory**

The potential efficacy of the MC "Squeeze" technique for alleviating the symptoms of meniscal tears is based primarily in the technique's mechanical correction of a theoretical positional fault of the knee joint (Mulligan, 2010). During a typical mechanism for meniscus tears (i.e., twisting of the knee while weight bearing), the meniscus could become slightly distorted towards the periphery (Mulligan, 2010). Therefore, clinicians should consider the presence of a positional fault when patients present with meniscal tear symptoms.

Mulligan's positional fault theory is based in the foundational knowledge of normal arthrokinematics of the joint and the changes that may with injury. Mulligan theorized that minor positional faults occur secondary to injury and cause joint mal-tracking, which leads to pain, stiffness, and/or weakness (Mulligan, 1993; Mulligan, 2004). The changes that occur within the joint are not just limited to the joint surface itself, but also effects connective tissue and all other associated structures within the joint. For example, after a mechanism of injury for meniscus tears occur, meniscal tissue within the joint could cause the joint to become blocked and lose motion thus leading to pain and dysfunction. Gale et al. (1999) also determined that meniscal subluxation is common in knees with OA and correlated with the severity of joint space narrowing on plain radiographs, thus supporting a faulty mechanical component causing pain and dysfunction. If a meniscus has become dislodged or torn and flaps of the tissue are trapped within the joint, classic meniscus tear symptoms such as knee-joint locking, clicking, pain, and loss of motion could occur, along with other mechanical joint positional dysfunctions.

Although secondary faults due to injury are not typically observed via diagnostic imagining (Mulligan, 1993), evidence of joint positional faults have been reported in both clinical and laboratory settings (Hsieh, Vicenzino, Yang, Hu, & Yang, 2002; Hubbard & Hertal, 2008; Hubbard, Hertal & Sherbondy, 2006; Kavanagh, 1999; Fukuhara, Sakamoto, Nakazawa, & Kato, 2012). However, the positional fault theory is not universally accepted and although more evidence continues to be produced suggesting its plausibility, it remains theoretical.

Hsieh et al. (2002) observed a single case study where MRIs were taken of a thumb over a period of three weeks. Imaging was performed before the application of a MWM treatment, and a positional fault was observed. Follow-up imaging was performed immediately after the treatment, and the positional fault was absent; the patient also reported a resolution of symptoms. A three week follow-up MRI revealed a return of the fault in the joint, but the patient did not report a return of the symptoms. Limiting factors in this study were a lack of statistical analysis and the utilization of one patient. Those factors provide low-level evidence and an inability to make a definitive statement that all injuries lead to positional faults that MWMs are indicated to correct.

Support for the presence of a positional fault in chronic ankle instability and in acute and subacute ankle sprains is also found in the literature (Berkowitz & Kim, 2004; Hubbard & Hertal, 2006; Hubbard et al., 2006; Kavanagh, 1999; Vicenzio, Paungmali, & Teys, 2007). The studies are inconclusive as to whether the positional fault predisposed the participant to injury or if it was caused by the injury, even though significant differences in fibular positioning on the talus was observed in both sub-acute lateral ankle sprain and chronic ankle instability participants as compared to the uninjured ankle and matched controls. Thus, one could argue that the findings likely support the positional fault to be the result of injury, rather than the cause. In either case, the results are promising and suggest that, if these faults exist, treatments such as MWMs would be effective in correcting joint positioning that has been altered due to injury. More research is needed in this area to determine if Mulligan's positional fault theory can be consistently and scientifically accepted.

One possible positional fault mechanism of the menisci within the knee joint could be supported using a physiological rationale similar to the meniscoid in the cervical spine. Hearn and Rivett (2002) explored the biomechanical reasoning for pain relief after a Sustained Natural Apophyseal Glide (SNAG) in the cervical spine. The researchers assessed the role of the meniscoid in zygopohyseal joint dysfunction. The meniscoid in the cervical spine is reminiscent of the menisci in the knee. They both have similar functions and positioning within their respective joints. Hearn and Rivett (2012) discussed the possibility of the meniscoid becoming entrapped between the cervical vertebrae or displaced on the articular surface after the vertebrae returns to the neutral position from an open packed position, much like the meniscus can cause a joint to become mechanically stuck after a patient has been sitting for extended period of time with the knee in an open packed position. The review implicates the possibility that a cervical SNAG could lead to a decrease in pain by separating the facet surfaces and releasing the meniscoid or allowing the trapped segment to return to its normal resting position and normal arthrokinematic function. Researchers also noted a possibility of stretching adhesions that are secondary to positional faulting of the meniscoid or to the joint capsule in the knee joint attached to the meniscus and may have developed adhesions secondary to meniscal pathology.

**Neurophysiological Effects**

The body's ascending and descending pathways for pain perception and modulation occur along the same route to the central nervous system (Ossipov, Dusso, & Porreca, 2010). Researchers also theorize the origin of pain associated with meniscal pathology is the result of compression on the peripheral nerve supply on the outer horn of the structure (Renstrom & Johnson, 1990), where joint impingement on the nerve sends noxious signals to the spinal cord and upward to the supraspinal mechanisms of pain perception. Theoretically, chronic pain will continue to exist as long as the tissue of the meniscus is compressed and signals are continually relayed to the brain.

Multiple theories exist to explain how and why joint mobilizations contribute to pain relief in patients with painful and restrictive movement. Melzack and Wall's (1965) classic gate control theory offers insight to a possibility that passive joint movement initiates segmental inhibitory mechanisms that cause spinal mechanisms of pain control to block the noxious signal's pathway to the brain. The peripheral touch stimulated large A-Beta fibers may transmit non-painful contact stimulus faster to the central nervous system (CNS) than smaller noxious transmitting delta fibers (Vicenzino et al., 2011). Researchers observed initiation of sympathetic nervous system responses after a treatment of MWMs, eliciting similar responses of pain relief to those seen after spinal manipulation (Paungmali, O'Leary, Souvlis, & Vicenzino, 2003). While neurophysiological implications involving CNS hypoalgesia for most MC techniques are accepted, researchers have not concluded the mechanism by which the technique produces the hypoalgesia effect. However, Paungmali et al. (2003) suggest that the hypoalgesic effects of MWMs at the elbow to treat lateral epicondylalgia was not produced by an opioid pain-modulating mechanism and may have resulted from other mechanisms of pain control.

Many studies have been conducted which support the mechanical hypoalgesia component of the MC, but most are case studies or case series with small sample sizes concentrated on the shoulder, elbow, or ankle (Collins, Teys, & Vicenzino, 2004; Paungmali et al., 2003; Slater, Arendt-Nielson, Wright, & Graven, 2006; Teys, Bisset, & Vicenzino, 2008). Studies conducted to explore the hypoalgesic effect in the knee resulting from joint mobilization have typically involved patients with osteoarthritis. While osteoarthritis has been indicated as a secondary joint disease due to meniscal injury (Englund et al., 2009), no studies have measured pain reduction in patients with meniscal pathology exclusively. Despite this, researchers also suspect hypoalgesia mechanisms and a physiological component contribute to positive outcomes of the treatment as well.

**Psychological Implications**

Psychological or psychosocial involvement may also contribute to positive outcomes of the MC Squeeze technique; supporting implications of the mechanisms of efficacy of the MC to provide a placebo effect after treatment is completed (Vicenzino et al., 2011). The mechanisms by which this may occur lay in musculoskeletal interventions that affect a variety of patient components not directly related to the physical injury itself. The history of both the patient and clinician, in addition to a patient's exposure to pain, healing, and fears about treatment, play a role in how effective the treatment will be for the patient (Bialosky, Bishop, Price, Robinson, & George, 2009; 2011; Vicenzino et al., 2011).

Pain relief has physiological mechanisms by which the placebo and psychological effect takes place. Bialosky, Bishop, George, and Robinson (2011) suggested interpreting and classifying the placebo effect of manual therapy as an active ingredient in pain reduction, while Miller and Kaptchuk (2008) suggested interpreting the placebo effect as 'contextual healing' instead of an unexplained positive reaction to an intervention.

The placebo effect is typically used to determine the efficacy of an indicated therapeutic intervention and disregarded as actively contributing to positive patient outcomes. If the therapeutic intervention does not elicit considerable significant positive outcomes compared to the placebo, the treatment is classified as ineffective (Bialosky et al., 2011). As placebo hypoalgesia relates to MWMs and other treatment interventions, studies support the placebo's relationship to the central nervous system's descending pain inhibitory pathways from the supraspinal structures (Bialosky et al., 2011). Whether or not MWM's hypoalgesic effect is based in actual accepted mechanisms of pain control by correcting biomechanical and physiological faults or by way of the placebo effect is of no difference. If patients are reporting positive outcomes for pain reduction and increases in function, the treatment is successful and indicated for the patient's condition.

Teys et al. (2008) determined during a study on shoulder pain and range of motion that patients receiving a sham treatment gained increases in range of motion and decreases in pain as compared to the control group. While the MWM treatment group had the most significant gains, the study lends credit to both the efficacy of MWMs for the treatment of shoulder pain and restriction and also to the consideration of using a placebo effect as a viable and useful component of manual therapy.

Vicenzino et al. (2007) concluded that while there is acceptance of the implications and speculations of neurophysiologic involvement elicited from the MWMs, the actual effect of the technique is much more complex and multifaceted. The implications for other psychological components along with the placebo effect involve diminishing a patient's previous perception that movement at a particular joint is painful. By applying the MWM and instructing the patient to move through the now pain-free range, the previous fearful memory may be eliminated (Vicenzino et al., 2011).

**The Mulligan Concept Squeeze Technique Procedure**

The basic treatment application for all MWMs incorporates Mulligan's rules and principles for the intervention. Mulligan advocates that his techniques be pain free during the patient's full range of motion. If at any point the movement becomes painful while the glide is applied, the clinician is to stop the movement and adjust the glide. For the treatment to be indicated, the clinician must be able to apply the correct glide to provide the patient with a pain-free range of motion. If pain-free motion is not achieved, the patient may fall within the contraindications of the technique or other principals of the treatment may have not been followed (Mulligan, 1993; Mulligan, 2004; Mulligan, 2010; Vicenzino et al., 2011; Vicenzino, 2011; Hing et al., 2015).

The MC uses the acronym "CROCKS" (contraindications, repetitions, overpressure, communication, knowledge, and skills, subtle movement, sustain, and sense) to serve as a reminder of the general principles for all its intervention ns. If practitioners follow all of these principles, Mulligan suggests that a PILL effect (pain free, instant, long-lasting) will occur for the patient (Hing et al., 2015; Mulligan, 1993; Mulligan, 2004; Mulligan, 2010; Vicenzino et al., 2011).

The technique for the MC Squeeze incorporates patient generated open packed positioning of the knee joint, compression of the joint space, and a minor fibio-tibial glide either posterior or anterior dependent upon flexion or extension restrictions. Minimal tibial-femoral rotation may be required if an alteration is needed to provide pain relief (Hing et al., 2015; Mulligan, 1993; Mulligan, 2010). To perform the technique correctly, the patient may be placed in a weight-bearing or supine position. The approach for treating flexion may be done either supine or standing, but treatment for extension can only be done while the patient is supine (Mulligan, 2010; Hing et al., 2015).

The clinician begins the treatment by first testing for restrictive movement and/or local pain during knee flexion or extension, depending on the primary complaint of the patient. If a restriction and/or pain is noted while the patient is supine, the treatment is performed supine; if the restriction and/or pain is noted during a weight-bearing activity, the patient is treated during the weight-bearing activity.

To perform the technique in the supine position, the clinician will begin by palpating the medial and lateral joint line of the knee to locate an area of most tenderness. If tenderness is noted over the postero-medial or medial joint space of the right knee, the clinician will stand at the left side of the patient; however, if tenderness is noted over the lateral joint line, the clinician will stand on the same side as the patient. The clinician will place the medial border of one thumb, reinforced by the other, over the tender joint space and instruct the patient to actively and slowly flex the knee so the joint space will open. When the clinician begins to feel the joint space open beneath the thumbs, a squeeze is applied centrally. While squeezing centrally, the clinician encourages more joint flexion using the ulnar border of the hand that is over the upper end of the tibia. The patient may experience localized discomfort from the overlap grip to tolerance, but the localized discomfort should not be exacerbated with movement. The clinician maintains the squeeze and overpressure for a few seconds, repeat three times, and then reassess motion. This MC Squeeze technique, while effective, is uncomfortable due to the pressure caused underneath the clinician's thumb while the squeeze portion of the treatment is performed, but the movement itself should not be painful (Mulligan, 2011). Other MWMs have a pain-free requirement (Mulligan, 1993).

The same technique and hand placement is used for a weight-bearing patient. The clinician will kneel beside the patient and place his or her thumbs over the joint margin, as indicated for the supine patient. The clinician will then instruct the patient to perform a squat during the movement, at which point the clinician will apply thumb pressure as the joint space is revealed. The patient may feel more comfortable holding on to a table or a chair for support during the weight-bearing alternative. The squeeze is held for a few seconds and then three more repetitions are done before reassessing for pain and motion (Hing et al., 2015; Mulligan, 2010).

The pressure or squeeze from the clinician occurs centrally, from the tender point (as noted in the assessment). The direction of the squeeze is important to mention because of the anatomical movement of the menisci during flexion and extension of the knee, especially if the tender point is located along the lateral joint line. The lateral meniscus is more mobile than the medial meniscus and is pulled anteriorly during knee extension via the patellomensical ligament. During the last few degrees of flexion, the menisofemoral ligament pulls the posterior horn of the lateral meniscus medially and anteriorly (Bedi et al., 1999).

Patients complaining of pain with extension and full flexion may benefit most from the squeeze technique because of the clinician's hand placement and the direction applied in the joint space during active movement.

**Efficacy of Treatment of Mobilization with Movement**

Hing et al. (2007) conducted a review of all relevant MWM studies and reported significant positive results with the treatment application when compared to placebo or controls. The authors found only one study that did not report notable improvements from applications of MWMs, but this study conducted by Slater et al. (2006) pertained to outcomes of lateral epicondylalgia induced by the research team.

Support exists for the mechanical correction of a theoretical positional fault. In regards to the mechanisms of pain control related to a hypoalgesic effect and psychological theories, Bialosky et al. (2009) suggested a combination of both biomechanical (e.g., positional fault) and neurophysiological (e.g., hypoalgesia) mechanisms are responsible for the efficacy of manual therapy techniques, such as MWMs, for treating musculoskeletal injuries. The MC Squeeze technique involves direct pressure on the tender point in the joint space, which may incorporate both a mechanical correction of a displaced meniscus and a hypoalgesic effect. By applying direct pressure into the joint line, the potentially displaced tissue could be placed back into its normal anatomical position. Moreover, correcting a potential position fault could lead to a return to functioning arthrokinematics of the joint. The pressure provided by the clinician during the technique also causes minor discomfort to the patient, which may elicit peripheral mechanisms of pain control such as endogenous opioids thus, contributing to a decrease in pain.

## Conclusion

The MC Squeeze technique is a recommended option for conservative therapy of meniscal tears. The manual therapy intervention is designed to treat limited range of motion and localized joint line pain during movement (Mulligan, 2010), which are symptoms often found in the presence of meniscal tears (Lowery et al., 1996). Despite the theorized benefit of this technique with these patients, the authors of this literature review could not identify formal investigations of the efficacy of this treatment. Therefore, research is to examine the effect of the MC Squeeze technique in physically active patients who present with clinical symptoms of meniscal tears and meet the criteria for a clinical diagnosis of a meniscal tear.

**References**

American Association of Orthopaedic Medicine. (2013). Cyriax System of Orthopaedic Medicine. Retrieved from: http://http://www.aaomed.org/Cyriax-System-of-Orthopaedic-Medicine on November 29, 2014.

Andrews, S., Shrive, N., & Ronsky, J. (2011). The shocking truth about meniscus. *Journal of Biomechanics*, 44(16), 2737–2740. doi:10.1016/j.jbiomech.2011.08.026

Arnoczky, S. P., & Warren, R. F. (1982). Microvasculature of the human meniscus. *The American Journal of Sports Medicine*, 10(2), 90–5. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/7081532

Berthiaume, M.J., Raynauld, J.P., Martel-Pelletier, J., LaBonte, F., Beaudoin, G., Bloch, D.A., Choquette, D., Haraoui, B., Altman, R.D., Hochberg, M., Meyer, J.M., Cline, G.A. & Pelletier, J.P. (2005). Meniscal tear and extrusion are strongly associated with progression of symptomatic knee osteoarthritis as assessed by quantitative magnetic resonance imaging. *Annals of the Rheumatic Diseases*, 64, 556-563. doi: 10.1136/ard.2004.023796.

Bialosky, J.E., Bishop, M.D., Price, D.D., Robinson, M.E., George, S.Z. (2009). The mechanisms of manual therapy in the treatment of musculoskeletal pain: A comprehensive model. *Manual Therapy*, 14(5), 531-538. doi: 10.1016/j.math.2008.09.001.

Bialosky, J.E., Bishop, M.D., George, S.Z., & Robinson, M.E. (2011). Placebo response to manual therapy: Something out of nothing? *Journal of Manual and Manipulative Therapy*, 19(1), 11-19. doi: 10.1179/2042618610Y.0000000001

Belzer, J. P., & Cannon, W. D. (1993). Meniscus tears: Treatment in the stable and unstable knee. *Journal of the American Academy of Orthopaedic Surgeons*, 1(1), 41–47.

Berkowitz, M.J. & Kim, D.H. (2004). Fibular position in relation to lateral ankle instability. *Foot and Ankle International, 25*(5), 318-321.

Bin, S.-I., Kim, J.-M., & Shin, S.-J. (2004). Radial tears of the posterior horn of the medial meniscus. *Arthroscopy: The Journal of Arthroscopic & Related Surgery: Official Publication of the Arthroscopy Association of North America and the International Arthroscopy Association*, 20(4), 373–378. doi:10.1016/j.arthro.2004.01.004

Boden, S. D., Davis, D. O., Dina, T. S., Stoller, D. W., Brown, S. D., Vailas, J. C., & Labropoulos, P. A. (1992). A prospective and blinded investigation of magnetic resonance imaging of the knee. Abnormal findings in asymptomatic subjects. *Clinical Orthopaedics and Related Research*, 282, 177-185.

Brophy, R. H., & Matava, M. J. (2012). Surgical options for meniscal replacement. *The Journal of the American Academy of Orthopaedic Surgeons*, 20(5), 265–272. doi:10.5435/JAAOS-20-05-265

Brosseau, L., Balmer, S., Tousignant, M., O'Sullivan, J. P., Goudreault, C., Goudreault, M., & Gringras, S. (2001). Intra- and intertester reliability and criterion validity of the parallelogram and universal goniometers for measuring maximum active knee flexion and extension of patients with knee restrictions. *Archives of Physical Medicine And Rehabilitation*, 82(3), 396-402.

Chatman, A. B., Hyams, S. P., Neel, J. M., Binkley, J. M., Stratford, P. W., Schomberg, A., & Stabler, M. (1997). The Patient-Specific Functional Scale: measurement properties in patients with knee dysfunction. *Physical Therapy*, 77(8), 820-829.

Chivers, M., & Howitt, S. (2009). Anatomy and physical examination of the knee menisci: A narrative review of the orthopedic literature. *The Journal of the Canadian Chiropractic Association*, 53(4), 319-333.

Collins, N., Teys, P. & Vicenzino, B. (2004). The initial effects of a Mulligan's mobilization with movement technique on dorsiflexion and pain in subacute ankle sprains. *Manual Therapy*, 9(2), 77-82. doi: 10.1016/S1356-689X(03)00101-2

Deyle, G.D., Henderson, N.E., Matekel, R.L., Ryder, M.G., Garber, M.B., & Allison, S.C. (2000). Effectiveness of manual physical therapy and exercise in osteoarthritis of the knee. *Annals of Internal Medicine*, 132(3), 173-181, Retrieved from http://annals.org

Dye, S. F., Vaupel, G. L., & Dye, C. C. (1998). Conscious neurosensory mapping of the internal structures of the human knee without intraarticular anesthesia. *The American Journal of Sports Medicine*, 26(6), 773–777.

Eck, C., Bekerom, M., Fu, F., Poolman, R., & Kerkhoffs, G. (2013). Methods to diagnose acute anterior cruciate ligament rupture: A meta-analysis of physical examinations with and without anaesthesia. *Knee Surgery, Sports Traumatology, Arthroscopy*, 21(8), 1895-1903. doi:10.1007/s00167-012-2250-9

Englund, M., Roemer, F. W., Hayashi, D., Crema, M. D., & Guermazi, A. (2012). Meniscus pathology, osteoarthritis and the treatment controversy. *Nature Reviews Rheumatology*, 8(7), 412–419. doi:10.1038/nrrheum.2012.69

Englund, M., Guermazi, A. & Lohmander, L.S. (2009). The meniscus in knee osteoarthritis. *Rheumatic Disease Clinics of North America,* 35(3), 579-590. doi: 10.1016/j.rdc.2009.08.004

Eren, O. T. (2003). The accuracy of joint line tenderness by physical examination in the diagnosis of meniscal tears. *Arthroscopy: The Journal of Arthroscopic & Related Surgery: Official Publication of the Arthroscopy Association of North America and the International Arthroscopy Association*, 19(8), 850-854.

Evans, P. J., Bell, G. D., & Frank, C. (1993). Prospective evaluation of the McMurray test. *The American Journal of Sports Medicine*, 21(4), 604-608.

Exelby, L. (1996). Peripheral mobilisations with movement. *Manual Therapy,* 1, 118-126: Retrieved from: http://kinex.cl/papers/Rodilla/MWMNUEVO.pdf on November 29, 2014.

Fowler, P. J., & Lubliner, J. A. (1989). The predictive value of five clinical signs in the evaluation of meniscal pathology. *Arthroscopy: The Journal of Arthroscopic & Related Surgery: Official Publication of the Arthroscopy Association of North America and the International Arthroscopy Association*, 5(3), 184-186.

Fox, A. J. S., Bedi, A., & Rodeo, S. A. (2012). The basic science of human knee menisci: Structure, composition, and function. *Sports Health*, 4(4), 340–51. doi:10.1177/1941738111429419

Fox, M. G. (2007). MR imaging of the meniscus: Review, current trends, and clinical implications. *Radiologic Clinics of North America*, 45(6), 1033–1053. doi:10.1016/j.rcl.2007.08.009

Fukuhara, T., Sakamoto M., Nakazawa R., & Kato K. (2012) Anterior positional fault of the fibula after sub-acute anterior talofibular ligament injury. *Journal of Physical Therapy Science*, 24(1), 115-117. http://doi.org/10.1589/jpts.24.115

Gale, D.R., Chaisson, C.E., Totterman, S.M.S., Schwartz, R.K., Gale, M.E., Felson, D. (1999). Meniscal subluxation: Association with osteoarthritis joint space narrowing. *Osteoarthritis and Cartilage,* 7(6), 526-532. doi: 10.1053/joca.1999.0256

Garratt, A., Brealey, S., & Gillespie, W. (2004). Patient-assessed health instruments for the knee: A structured review. *Rheumatology*, 43(11), 1414-1423.

Getgood, A., & Robertson, A. (2010). (v) Meniscal tears, repairs and replacement – a current concepts review. *Orthopaedics and Trauma*, 24(2), 121–128. doi:10.1016/j.mporth.2010.03.01

Good, M., Stiller, C., Zauszniewski, J.A., Anderson, G.C., Stanton-Hicks, M., Grass, J.A. (2001). Sensation and distress of pain scales: Reliability, validity, and sensitivity. *Journal of Nursing Measurements*, 9(3), 219-238.

Greis, P. E., Bardana, D. D., Holmstrom, M. C., & Burks, R. T. (2002). Meniscal injury: I. basic science and evaluation. *The Journal of the American Academy of Orthopaedic Surgeons*, 10(3), 168–176. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12041938

Harper, K. W., Helms, C. A., Lambert, H. S., & Higgins, L. D. (2005). Radial meniscal tears: Significance, incidence, and MR appearance. *American Journal of Roentgenology*, 185(6), 1429–34. doi:10.2214/AJR.04.1024

Harrison, B., Abell, B., & Gibson, T. (2009). The Thessaly test for detection of meniscal tears: validation of a new physical examination technique for primary care medicine. *Clinical Journal of Sport Medicine: Official Journal of the Canadian Academy of Sport Medicine*, 19(1), 9-12. doi:10.1097/JSM.0b013e31818f1689

Hearn, A & Rivett, A. (2002). Cervical SNAGs: A biomechanical analysis. *Manual Therapy,* 7(2), 71-79, doi: 10.1054/math.2002.0440.

Herr, K.A., Spratt, K., Mobily, P.R., Richardson, G. (2004). Pain intensity assessment in older adults: Use of experimental pain to compare psychometric properties and usability a selected pain scales with younger adults. *The Clinical Journal of Pain.* 20(4), 207-219).

Herrlin, S., Hållander, M., Wange, P., Weidenhielm, L., & Werner, S. (2007). Arthroscopic or conservative treatment of degenerative medial meniscal tears: A prospective randomized trial. *Knee Surgery, Sports Traumatology, Arthroscopy*, 15(4), 393–401. doi:10.1007/s00167-006-0243-2

Hing, W., Bigelow, R. & Bremner, T. (2007). Mulligan's mobilization with movement: A systematic review. *The Journal of Manual & Manipulative Therapy,* 17(2),39-66

Hing, W., White, S., Reid, D., & Marshall, R. (2009). Validity of the McMurray's test and modified versions of the test: A systematic literature review. *The Journal of Manual & Manipulative Therapy*, 17(1), 22-35.

Hing, W., Hall, T., Rivett, D., Vicenzino, B. & Mulligan, B. (2015). The Mulligan Concept of Manual Therapy Textbook of Techniques. Chatswood, Australia: Elsevier.

Howe, T., Dawson, L., Syme, G., Duncan, L., & Reid, J. (2012). Evaluation of outcome measures for use in clinical practice for adults with musculoskeletal conditions of the knee: A systematic review. *Manual Therapy*, 17(2), 100-118. doi:10.1016/j.math.2011.07.002

Howell, J., & Handoll, H. (1996). Surgical treatment for meniscal injuries of the knee in adults. In *Cochrane Database of Systematic Reviews*. John Wiley & Sons, Ltd. Retrieved from http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD001353/

Hsieh C.Y., Vicenzino, B., Yang, C.H., Hu, M.H., Yang, C. (2002). Mulligan's mobilization with movement for the thumb: A single case report using magnetic resonance imaging to evaluate the positional fault hypothesis. *Manual Therapy*, 7(1), 44-49 doi:10.1054/math.2001.0434

Hubbard, T.J. & Hertel, J. (2008). Anterior positional fault of the fibula after sub-acute lateral ankle sprains. *Manual Therapy,* 13, 63-67. doi: 10.1016/j.math.2006.09.008

Hubbard, T.J., Hertel, J., & Sherbondy, P. (2006). Fibular position in individuals with self-reported chronic ankle instability, *Journal of Orthopaedic and Sports Physical Therapy,* 36(1), 3-10.

Hwang, Y. G., & Kwoh, C. K. (2014). The METEOR trial: No rush to repair a torn meniscus. *Cleveland Clinic Journal of Medicine*, 81(4), 226–232. doi:10.3949/ccjm.81a.13075

Jee, W., Mccauley, T. R., Kim, J., Jun, D., Lee, Y., Choi, B., & Choi, K. (2003). Meniscal tear configurations: Categorization with MR imaging. *American Journal of Roentgenology,* 180(1), 93–97.

Johnson, D. L., Swenson, T. M., Livesay, G. A., Aizawa, H., Fu, F. H., & Herner, C. D. (1995). Insertion-site anatomy of the human menisci: As a basis for meniscal transplantation. *Arthroscopy: The Journal of Arthroscopic and Related Surgery*, 11(4), 386–394.

Karachalios, T., Hantes, M., Zibis, A., Zachos, V., Karantanas, A., & Malizos, K. (2005). Diagnostic accuracy of a new clinical test (the Thessaly test) for early detection of meniscal tears. *The Journal of Bone and Joint Surgery. American Volume*, 87(5), 955-962.

Kavanagh, J. (1999). Is there a positional fault at the inferior tibiofibular joint in patients with acute or chronic ankle sprains compared to normals? *Manual Therapy*, 4(1), 19-24.

Katz, J., & Fingeroth, R. (1986). The diagnostic accuracy of ruptures of the anterior cruciate ligament comparing the Lachman test, the anterior drawer sign, and the pivot shift test in acute and chronic knee injuries. *The American Journal of Sports Medicine*, 14(1), 88-91.

Katz, J. N., Brophy, R. H., Chaisson, C. E., de Chaves, L., Cole, B. J., Dahm, D. L., Losina, E. (2013). Surgery versus physical therapy for a meniscal tear and osteoarthritis. *New England Journal of Medicine*, 368(18), 1675–1684. doi:10.1056/NEJMoa1301408

Kirkley, A., Birmingham, T. B., Litchfield, R. B., Giffin, J. R., Willits, K. R., Wong, C. J., Fowler, P. J. (2008). A randomized trial of arthroscopic surgery for osteoarthritis of the knee. *New England Journal of Medicine*, 359(11), 1097–1107. doi:10.1056/NEJMoa0708333

Kohn, D., & Moreno, B. (1995). Meniscus insertion anatomy as a basis for meniscus replacement: A morphological cadaveric study. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 11(1), 96–103. doi:10.1016/0749-8063(95)90095-0

Kos, J., Hert, J. & Sevcik, P. (2002). Meniscoids of the intervertebral joints. *Acta Chirurgiae Orthopaedicae et Tramatologiae Cechoslovaca,* 69(3), 149-157. Retrieved from http://ncbi.nlm.nih.gov on November 27, 2014.

Krebs, E. E., Carey, T. S., & Weinberger, M. (2007). Accuracy of the pain numeric rating scale as a screening test in primary care. *Journal of General Internal Medicine*, 22(10), 1453-1458.

Kurosaka, M., Yagi, M., Yoshiya, S., Muratsu, H., & Mizuno, K. (1999). Efficacy of the axially loaded pivot shift test for the diagnosis of a meniscal tear. *International Orthopaedics*, 23(5), 271-274.

Larsen, E., Jensen, P., & Jensen, P. (1999). Long-term outcome of knee and ankle injuries in elite football. *Scandinavian Journal of Medicine and Science in Sport*, 9(5), 285–289.

Lee, J. M., & Fu, F. H. (2000). The Meniscus: Basic science and clinical applications. *Operative Techniques in Orthopaedics*, 10(3), 162–168. doi:10.1053/otor.2000.5289

Lento, P. H., & Akuthota, V. (2000). Meniscal injuries: A critical review. *Journal of Back and Musculoskeletal Rehabilitation*, 15(2), 55–62. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/22388443

Lowery, D. J., Farley, T. D., Wing, D. W., Sterett, W. I., & Steadman, R. J. (2006). A clinical composite score accurately detects meniscal pathology. *Arthroscopy: The Journal of Arthroscopic and Related Surgery*, 22(11), 1174-1179.

Lyman, S., Hidaka, C., Valdez, A. S., Hetsroni, I., Pan, T. J., Do, H., Marx, R. G. (2013). Risk factors for meniscectomy after meniscal repair. *The American Journal of Sports Medicine*, 41(12), 2772–2778. doi:10.1177/0363546513503444

Maitland, G. (5th ed). (1986). Vertebral Manipulations. London: Butterworths.

Makhmalbaf, H., Moradi, A., Ganji, S., & Omidi-Kashani, F. (2013). Accuracy of Lachman and anterior drawer tests for anterior cruciate ligament injuries. *Archives of Bone and Joint Surgery*, 1(2), 94-97.

Makris, E. A., Hadidi, P., & Athanasiou, K. A. (2011). The knee meniscus: Structure–function, pathophysiology, current repair techniques, and prospects for regeneration. *Biomaterials*, 32(30), 7411–7431. doi:10.1016/j.biomaterials.2011.06.037

Malanga, G., Andrus, S., Nadler, S., & McLean, J. (2003). Physical examination of the knee: A review of the original test description and scientific validity of common orthopedic tests. *Archives of Physical Medicine and Rehabilitation*, 84(4), 592-603.

Mariani, P., Adriani, E., Maresca, G., & Mazzola, C. (1996). A prospective evaluation of a test for lateral meniscus tears. *Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal of the ESSKA*, 4(1), 22-26.

Mascarenhas, R., Yanke, A., Frank, R., Butty, D., & Cole, B. (2014). Meniscal allograft transplantation: Preoperative assessment, surgical considerations, and clinical outcomes. *Journal of Knee Surgery*, 27(6), 443-457. doi:10.1055/s-0034-1382080

Masouros, S. D., Bull, A. M. J., & Amis, A. A. (2010). (i) Biomechanics of the knee joint. *Orthopaedics and Trauma*, 24(2), 84–91. doi:10.1016/j.mporth.2010.03.005

Masouros, S. D., McDermott, I. D., Amis, A. A., & Bull, A. M. J. (2008). Biomechanics of the meniscus-meniscal ligament construct of the knee. *Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal of the ESSKA*, 16(12), 1121–32. doi:10.1007/s00167-008-0616-9

McDermott, I. D., Masouros, S. D., & Amis, A. A. (2008). Biomechanics of the menisci of the knee. *Current Orthopaedics*, 22(3), 193–201. doi:10.1016/j.cuor.2008.04.005

McDevitt, Cahir A., & Webber, R. J. (1990). The ultrastructure and biochemistry of meniscal cartilage. *Clinical Orthopaedics and Related Research*, (252), 8–18.

McMurray, T.P., (1928). The diagnosis of internal derangements of the knee. In: The Robert Jones birthday volume. Humphrey Milford, London, pp 301-306

Melzack, R. & Wall, P.D. (1965). Pain mechanisms: A new theory. *Science*, 150(3699), 971-979. doi: 10.1126/science.150.3699

Meserve, B., Cleland, J., & Boucher, T. (2008). A meta-analysis examining clinical test utilities for assessing meniscal injury. *Clinical Rehabilitation*, 22(2), 143-161. doi:10.1177/0269215507080130

Metcalf, M. H., & Barrett, G. R. (2004). Prospective evaluation of 1485 meniscal tear patterns in patients with stable knees. *The American Journal of Sports Medicine*, 32(3), 675–680. doi:10.1177/0095399703258743

Miller, F.G. & Kaptchuk, T.J. (2008). The power of context: Reconceptualizing the placebo effect. *Journal of the Royal Society of Medicine,* 101(5), 222-225. doi: 10.1258/jrsm.2008.070466

Miller, G. K. (1996). A prospective study comparing the accuracy of the clinical diagnosis of meniscus tear with magnetic resonance imaging and its effect on clinical outcome. *Arthroscopy: The Journal of Arthroscopic & Related Surgery: Official Publication Of The Arthroscopy Association Of North America And The International Arthroscopy Association*, 12(4), 406-413.

Mohan, B., & Gosal, H. (2007). Reliability of clinical diagnosis in meniscal tears. *International Orthopaedics*, 31(1), 57-60.

Morrison, J. B. (1970). The mechanics of the knee joint in relation to normal walking. *Journal of Biomechanics*, 3(1), 51–61.

Moss, P., Sluka, K., & Wright, A. (2007). The initial effects of knee joint mobilization on osteoarthritic hyperalgesia. *Manual Therapy,* 12(2), 109-118. doi: 10.1016/j.math.2006.02.009

Muellner, T., Weinstabl, R., Schabus, R., Vécsei, V., & Kainberger, F. (1997). The diagnosis of meniscal tears in athletes. A comparison of clinical and magnetic resonance imaging investigations. *The American Journal of Sports Medicine*, 25(1), 7-12.

Mulligan, B. (1993). Manual therapy rounds: Mobilisations with movement (MWM's). *The Journal of Manual & Manipulative Therapy*, 1(4), 154-156.

Mulligan, B. (5 Ed.). (2004). Manual Therapy 'NAGS', 'SNAGS', 'MWMS'. Wellington, New Zealand: Plane View Services Ltd

Mulligan, B. (6 Ed.). (2010). Manual Therapy NAGS, SNAGS, MWMS etc. Wellington, New Zealand: Plane View Services Ltd

Nikolaou, V., Chronopoulos, E., Savvidou, C., Plessas, S., Giannoudis, P., Efstathopoulos, N., & Papachristou, G. (2008). MRI efficacy in diagnosing internal lesions of the knee: A retrospective analysis. *Journal of Trauma Management & Outcomes*, 2(1), 4. doi:10.1186/1752-2897-2-4

Nepple, J. J., Dunn, W. R., & Wright, R. W. (2012). Meniscal repair outcomes at greater than five years. *The Journal of Bone and Joint Surgery. American Volume*, 94(24), 2222–2227. doi:10.2106/JBJS.K.01584

O'Donoghue, D. H. (1980). Meniscectomy indications and management. *Physical Therapy*, 60(12), 1617–1623.

Ossipov, M.H., Dussor, G.O. & Porreca, F. (2010). Central modulation of pain. *Clinical Journal of Investigation*, 120(11), 3779-3787. doi: 10.1172/JC143766

Paungmali, A., O'Leary, S., Souvlis, T. & Vicenzino, B. (2003). Hypoalgesic and sympathoexcitatory effects of mobilization with movement for lateral epicondylalgia.

*Physical Therapy,* 83, 374-383. Retrived from: http://ptjournal.apta.org on Novemenber 27, 2014.

Paungmali, A., O'Leary, S., Souvlis, T., & Vicenzino, B. (2004). Naloxone fails to antagonize initial hypoalgesic effect of manual therapy treatment for lateral epicondylalgia. *Journal of Manipulative and Physiological Therapeutics,* 27(3), 180-185.

Paungmali, A., Vicenzino, B. & Smith, M. (2003). Hypoalgesia induced by elbow manipulation in lateral epicondylalgia does not exhibit tolerance. *The Journal of Pain,* 4(8), 448-454. doi: 10.1067/S1526-5900(03)00731-4

Paxton, E. S., Stock, M. V., & Brophy, R. H. (2011). Meniscal repair versus partial meniscectomy: A systematic review comparing reoperation rates and clinical outcomes. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 27(9), 1275–1288. doi:10.1016/j.arthro.2011.03.088

Peters, G., & Wirth, C. J. (2003). The current state of meniscal allograft transplantation and replacement. *The Knee*, 10(1), 19–31. doi:10.1016/S0968-0160(02)00139-4

Pettman, E. (2007). A history of manipulative therapy. *The Journal of Manual of Manipulative Therapy,* 15(3), 165-174. Retrieved From: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2565620/pdf/jmmt0015-0165.pdf

Poynton, A. R., Javadpour, S. M., & Finegan, P. J. (1997). The meniscofemoral ligaments of the knee. *The Journal of Bone and Joint Surgery*, 79(2), 14–17.

Prasad, V., Vandross, A., Toomey, C., Cheung, M., Rho, J., Quinn, S., Cifu, A. (2013). A decade of reversal: An analysis of 146 contradicted medical practices. *Mayo Clinic Proceedings*, 88(8), 790–798. doi:10.1016/j.mayocp.2013.05.012

Pujol, N., Barbier, O., Boisrenoult, P., & Beaufils, P. (2011). Amount of meniscal resection after failed meniscal repair. *The American Journal of Sports Medicine*, 39(8), 1648–1652. doi:10.1177/0363546511402661

Rath, E., & Richmond, J. C. (2000). The menisci: Basic science and advances in treatment. *British Journal of Sports Medicine*, 34(4), 252–257. Retrieved from http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1724227&tool=pmcentrez&rendertype=abstract

Renstrom, P., Johnson, R. J. (1990). Anatomy and biomechanics of the menisci. *Clinics in Sports Medicine*, 9(3), 523–538.

Rodkey, W. G. (2000). Basic biology of the meniscus and response to injury. *Instructional Course Lectures*, 49, 189–193.

Roos, E. M., Roos, H. P., Ekdahl, C., & Lohmander, L. S. (1998). Knee injury and Osteoarthritis Outcome Score (KOOS)--validation of a Swedish version. *Scandinavian Journal of Medicine & Science In Sports*, 8(6), 439-448.

Rose, R. C. (2006). The accuracy of joint line tenderness in the diagnosis of meniscal tears. *The West Indian Medical Journal*, 55(5), 323-326.

Scholten, R., Devillé, W., Opstelten, W., Bijl, D., van der Plas, C., & Bouter, L. (2001). The accuracy of physical diagnostic tests for assessing meniscal lesions of the knee: A meta-analysis. *The Journal of Family Practice*, 50(11), 938-944.

Shultz, S., Nguyen, A.D., Windley, T.C., Kulas, A.S., Botic, T.L. & Bruce, D. (2006). Intratester and intertester reliability of clinical measures of lower extremity anatomic characteristics: Implication for multicenter studies. *Clinical Journal of Sport Medicine,* 16(2), 155-161.

Sihvonen, R., Paavola, M., Malmivaara, A., Itälä, A., Joukainen, A., Nurmi, H., Järvinen, T. L. N. (2013). Arthroscopic partial meniscectomy versus sham surgery for a degenerative meniscal tear. *New England Journal of Medicine*, 369(26), 2515–2524. doi:10.1056/NEJMoa1305189

Slater, H., Arendt-Nielson, L., Wright, A., & Graven, N. (2006). Effects of a manual therapy technique in experimental lateral epicondylalgia. *Manual Therapy,* 11(2). 107-117. http://dx.doi.org/10.1016/j.math.2005.04.005:

Takasaki, H., Hall, T., & Jull, G. (2013). Immediate and short-term effects of Mulligan's mobilization with movement on knee pain and disability associated with knee osteoarthritis: A prospective case series. *Physiotherapy Theory and Practice,* 29(2), 87-95. doi: 10.3109/09592985.2012.702854

Teys, P., Bisset, L., & Vicenzino, B. (2008). The initial effects of a Mulligan's mobilization with movement technique on range of movement and pressure pain threshold in pain-limiting shoulders. *Manual Therapy,* 13(1), 37-42. http://dx.doi.org/10.1016/j. math. 2006.07.0 11

Threlkeld, J.A. (1992). The effects of manual therapy on connective tissue. *Physical Therapy,* 72 (12), 893-902, Retrieved from: http://ptjournal.apta.org/content/72/12/893.full.pdf

Timotijevic, S., Vukasinovic, Z., & Bascarevic, Z. (2014). Correlation of clinical examination, ultrasound sonography, and magnetic resonance imaging findings with arthroscopic findings in relation to acute and chronic lateral meniscus injuries. *Journal of Orthopaedic Science: Official Journal of the Japanese Orthopaedic Association*, 19(1), 71-76. doi:10.1007/s00776-013-0480-4

Troupis, J. M., Batt, M. J., Pasricha, S. S., & Saddik, D. (2015). Magnetic resonance imaging in knee synovitis: Clinical utility in differentiating asymptomatic and symptomatic meniscal tears. *Journal of Medical Imaging & Radiation Oncology*, 59(1), 1-6. doi:10.1111/1754-9485.12240

Vedi, V., Spouse, E., Williams, A., Tennant, S.J., Hunt, D.M., & Gedroyc, M.W. (1999). Meniscal movement an in-vivo study using dynamic MRI. *Journal of Bone & Joint Surgery*, 81(1), 37-41.

Vela, L. I., & Denegar, C. R. (2010). The Disablement in the Physically Active Scale, part II: The psychometric properties of an outcomes scale for musculoskeletal injuries. *Journal of Athletic Training*, *45*(6), 630-641. doi:10.4085/1062-6050-45.6.630

Vicenzino, B. (2011, June). Mulligan's mobilisation with movement: The science, the evidence and the art. PowerPoint Presentation presented at the 2nd International Mulligan Concept Conference, Porto, Portugal.

Vicenzino, B., Hing, W., Rivett, D. & Hall, T (2011). Mobilisation with Movement The art and the science. Australia: Elsevier Australia.

Vicenzino, B., Paungmali, A., & Teys, P. (2007). Mulligan's mobilization-with-movement, positional faults and pain relief: Current concepts from critical review of literature. *Manual Therapy*, 12(2), 98-108, doi: 10.1016/j.math.2006.07.012

Voloshin, A. S., & Wosk, J. (1983). Shock absorption of meniscectomized and painful knees: A comparative in vivo study. *Journal of Biomedical Engineering*, 5(2), 157–161.

Vundelinckx, B., Vanlauwe, J., & Bellemans, J. (2014). Long-term subjective, clinical, and radiographic outcome evaluation of meniscal allograft transplantation in the knee. *The*

*American Journal of Sports Medicine*, 42(7), 1592–1599. doi:10.1177/0363546514530092

Wareluk, P., & Szopinski, K. (2012). Value of modern sonography in the assessment of meniscal lesions. *European Journal of Radiology*, 81(9), 2366-2369. doi:10.1016/j.ejrad.2011.09.013

Werner, B. C., Holzgrefe, R. E., Griffin, J. W., Lyons, M. L., Cosgrove, C. T., Hart, J. M., & Brockmeier, S. F. (2014). Validation of an innovative method of shoulder range-of-motion measurement using a smartphone clinometer application. *Journal of Shoulder and Elbow Surgery*, 23(11), e275–282. http://doi.org/10.1016/j.jse.2014.02.030

Willis, R. B. (2006). Meniscal injuries in children and adolescents. *Operative Techniques in Sports Medicine*, 14(3), 197–202. doi:10.1053/j.otsm.2006.06.003

Wilson, A. S., Legg, P. G., & McNeur, J. C. (1969). Studies on the innervation of the medial meniscus in the human knee joint. *The Anatomical Record*, 165(4), 485–491.

# CHAPTER 5: CLINICAL RESEARCH

## Innovative Treatment of Clinically Diagnosed Meniscal Tears: A Randomized Sham-Controlled Trial of the Mulligan Concept "Squeeze" Technique

**Pending Submission to The American Journal of Sports Medicine**

### Abstract

**Background:** Meniscal tears are a common injury, often leading to surgery or lengthy conservative treatment. Arthroscopic surgery is currently the gold standard for treatment; however, this option may lead to subsequent surgeries and osteoarthritis prompting a need for alternative treatment options for meniscal tears.

**Purpose:** To assess the effects of the Mulligan Concept (MC) "Squeeze" technique compared to a sham technique in participants presenting with a clinically diagnosed meniscal tear.

**Study Design:** A multi-site randomized sham-controlled trial.

**Methods:** Participants (n = 23) were recruited as a sample of convenience in a physically active and sedentary population, ranging from 14-62 (age = 24.91 ± 12.09) years of age, who reported common symptoms of a meniscal tear. Randomization ensured equal distribution of participants into either the MC "Squeeze" technique treatment group or the sham group. A maximum of 6 treatments were applied within a 14-day period for each treatment. Patients were assessed using the Numeric Pain Rating Scale (NRS), Patient Specific Functional Scale (PSFS), the Disablement in the Physically Active (DPA) scale and the Knee Injury Osteoarthritis Outcome Score (KOOS).

**Results:** All participants in the MC "Squeeze" group met the discharge criteria of ≤ 2 points on the cumulative NRS, ≥ 9 points on the PSFS, and ≤ 34 points on the DPA Scale for chronic and ≤ 23 for acute injuries at the end of the treatment intervention. A significant difference

was found on the changes in PSFS scores ($F_{(1, 21)} = 4.40$, $p = .048$, partial eta squared = .17, observed power = .52) and DPA Scale scores at discharge ($F_{(1, 21)} = 7.46$, $p = .013$, partial eta squared = .27, observed power = .74) between the two groups.

**Conclusion:** The results indicate the MC "Squeeze" technique had a positive effect on patient function and health-related quality of life over a period of 14 days that was clinically and statistically superior to the sham treatment.

**Clinical Relevance:** The MC "Squeeze" technique is an effective treatment for reducing symptoms associated with meniscal tears in a patient population meeting the criteria for a clinical diagnosis.

**Key Terms:** Meniscal Tears, Manual Therapy, Knee Pain, Rehabilitation

## Introduction and Background

The incidence of lower body injury, especially knee injuries, has grown[45,59] due to increased participation in recreational sports[24,53] and intercollegiate athletic competition.[27] Meniscal tears commonly occur as a result of sport participation[45] and, in a 10 year epidemiologic study on the occurrence of knee injuries, researchers found meniscus tears were the second most common knee injury.[45] Meniscal injuries are not only common in the young, athletic population; 35% of adults over the age of 50 experience degenerative tears.[34]

Injuries to the meniscus are often the result of compressive forces placed on the meniscus by the tibia and femur during flexion and rotation during weight bearing.[46] A meniscal tear can affect critical functions of the meniscus, such as joint congruency, load transmission, and shock absorption[22,38] leading to the classic signs and symptoms of a meniscal tear: catching, locking, or clicking; joint line pain; and a feeling of “giving out” or instability.[39] Despite the importance of the meniscus tissue for function, incidental findings of asymptomatic tears on magnetic resonance imaging (MRI) are relatively common,[40,62,73,70] suggesting the presence of a meniscal tear does not directly correlate to knee disability. In theory, patients with meniscal tears may not seek medical treatment if physical symptoms that would indicate injury or pathology are not being experienced. Therefore, the presence of meniscal lesions on MRI findings may not equate to the pathology being the root cause of dysfunction.[62,73]

When a meniscus tear is diagnosed, treatment options are typically categorized as surgical, involving partial meniscectomy or meniscal repair, or non-surgical, which is defined as conservative therapy.[47] Arthroscopic surgery currently remains the proposed gold standard for treatment of meniscal tears. Arthroscopic partial meniscectomy (APM) is often a more attractive surgical option for patients due to shorter post-surgery rehabilitation time-lines.[20] An APM occurs in as many as 61 per 100,000 meniscal tears[23] and approximately one-third of patients who exhaust conservative care will go on to have a meniscectomy to decrease pain and increase function.[47] Although patients elect to have APM more often, the APM procedure has inconsistent results for alleviating the symptoms of meniscal tears[54,50,41,34,63] and 50% of patients who undergo APM develop knee OA symptoms confirmed by radiographic images years after surgery.[16,17,19,20] Furthermore, the severity of symptoms and the extent of cartilage damage seen on imaging in patients who underwent APM is worse than the damage observed in cases of degenerative meniscus tears.[16,17,19,20]

Preservation of the meniscus through arthroscopic surgical repair is considered the most ideal option;[20] however, failure rates have been reported as high as 42% following those procedures[23] and the risk for subsequent surgeries is as high as 20%.[52] Consequently, patients who undergo any type of meniscal surgery are at risk for requiring subsequent surgeries,[52] which suggests clinicians should exhaust conservative care options for meniscus tears before pursuing surgical options.[26]

Recommendations for conservative therapy for meniscus tears commonly includes active exercises focused on increasing range of motion (ROM) and muscle strength while improving balance and flexibility.[26,47] Although conservative therapy protocols are recommended as an alternative to surgery,[26,34,30] lengthy timelines[47] and poor outcomes[26,34,30] may make those protocols less appealing to patients. Time commitment for conservative care has been reported to be between 8 and 10 weeks with patients performing therapeutic exercises 3 times a week or more[47] and no significant difference was found between the immediate and long-term outcomes of partial meniscectomy and conservative therapy in middle aged patients with degenerative medial meniscal tears.[26,34,30] Because reported outcomes of surgery and conservative care are similar and have inconsistent results,[26,34,30] there is a need for research into non-operative alternative treatment methods for treating the symptoms of meniscal tears.

The Mulligan Concept (MC) is a manual therapy paradigm with specific techniques theorized to address the symptoms associated with meniscal tears.[49] One of those techniques, the MC "Squeeze" technique, is designed to treat range of motion deficits and pain localized to the joint line of the knee during movement.[49] Such symptoms are often reported in the presence of meniscal tears due to altered joint mechanics and function caused secondarily by the disruption of meniscal tissue.[4] If meniscal tissue is dislodged or subluxed from its normal anatomical position after a tear, the disrupted tissue may cause increased pressure on the highly innervated periphery of the meniscus tissue and result in the commonly reported symptoms.[55,38,71,15] Conceivably, to alleviate the pain and dysfunction resulting from the tissue disruption, the abnormal pressure on the periphery of the meniscus and the pain-sensitive anterior capsular structures need to be resolved. Within the MC, it has been proposed that relocating the tissue towards the midline of the joint would reduce pain because the periphery of the menisci would no longer send pain signals.[49] The MC "Squeeze" technique may produce this benefit through the application of a therapeutic pressure to the meniscus.[49] Pressure is applied through a "squeezing" force on the meniscus at the most tender/swollen point along the joint line while the patient actively flexes and extends their knee to mobilize the tissue back to its normal anatomical position.[49]

The MC "Squeeze" technique has produced favorable patient outcomes for clinically classified meniscal tears in anecdotal reports and published a priori case studies.[5,29] In these reports, patients reported positive changes in pain, function, disability, and psychosocial well-being on patient reported outcome measures; however, the small sample size and lack of comparison groups necessitates the need for further investigation to determine the effectiveness of the MC "Squeeze" technique. Therefore, the purpose of this study was to assess the effects of the MC Squeeze technique compared to a sham technique in participants presenting with a clinically diagnosed meniscal tear.

## Methods

### Study Design

The present study was a multi-site randomized sham-controlled trial, designed to be conducted across four clinics with four clinician-researchers providing treatment. Clinical experience among the clinician-researchers ranged from 3-10 years (mean = 6.5 ± 2.89 years), but each had equal experience and training in the MC. Prior to beginning this study, the clinicians all completed two accredited MC courses together and had one year of experience in applying the MC in patient care. Additionally, a training session was conducted in-person with the four clinician-researchers to review methods prior to commencing the study. The training involved the review of all inclusion/exclusion orthopedic tests and dependent variables, and the verification of MC "Squeeze" technique application by a certified MC teacher with over 20 years of experience within the MC.

The Institutional Review Boards at the four clinical sites approved the application of treatment and collection of medical information from the participants in this study. Participant recruitment took place between October 2015 and March 2016. Participants signed written informed consent acknowledging possible publication of de-identified outcomes, and consent/assent forms were collected from all minors participating in this study.

**Participant Selection**

Participants were recruited as a sample of convenience of physically active and sedentary participants, ranging from 14-62 years of age. Any participant who reported any of the common symptoms of a meniscal tear with various mechanisms of injury or onset of symptoms (i.e., acute and chronic) was considered for participation in this study at each clinical site. Participants were screened by the clinician-researchers using an extensive medical history, common knee orthopedic tests, muscle/strength integrity, and range of motion (ROM) assessments.

Inclusion criterion were a positive finding in a minimum of three of the following: McMurray's test, pain with maximal knee flexion, pain with maximal knee extension, joint line tenderness, and a history of clicking and/or popping.[39] The preceding inclusion criteria ware formed according to the clinical composite score (CCS) developed by Lowery et al.[39] (Table 5.1). When three of the signs were present, the CCS had a specificity of 90.2% and a positive prediction value (PPV) of 76.7%;[39] in comparison, an MRI has a specificity of 69-93.3%[10,51] and a PPV of 80.4-83.2%[10] for meniscal tears. Participants were also required to present with a positive finding in a minimum of one of the following orthopedic tests: Apley's compression and distraction (specificity = 90%);[31] and Thessaly's performed at 20 degrees of knee flexion (specificity = 96-97%).[37] Exclusion criteria were the presence of knee comorbidities, such as anterior cruciate ligament (ACL) tears, knee contusion, fracture, knee dislocation, other knee ligament instability, and non-mechanical causes of pain (e.g., hyperalgesia).

## Randomization

An a priori randomization was designed to ensure equal distribution of participants into either the MC "Squeeze" technique treatment group or the sham group. Participant numbers were randomly generated prior to the commencement of the study and assigned prior to clinical exam. Each clinician-researcher was assigned a set of participant numbers consisting of an equal distribution of participants to treatment groups. If a participant was disqualified based on the results of their clinical exam, the participant number was assigned to the next eligible participant.

## Outcome Measures

Patient outcome measures were collected to track participant progress and treatment effects. Patient outcomes included the Numeric Pain Rating Scale (NRS), the Patient Specific Functional Scale (PSFS), the Disability in the Physically Active (DPA) Scale, and the Knee injury and Osteoarthritis Outcome Score (KOOS). Cumulative NRS and PSFS were collected at intake, daily pretreatment, and 24-hours after the final treatment. Current NRS and PSFS scores were also collected daily after each treatment intervention. The DPA Scale and KOOS were only collected at intake and 24-hours after the final treatment.

**Numeric Rating Scale (NRS).** Participant reported level of pain was measured using the NRS. The NRS is a patient-oriented scale used among various patient populations.[35] The NRS is scored on an 11-point scale, with 0 representing no pain and 10 representing severe pain.[11] Cumulative NRS is calculated as an average of the current, best, and worst pain scores over the past 24 hours. The reported minimal clinically important difference (MCID) for the NRS is a decrease of 2 points or 33%.[61]

**Patient Specific Functional Scale (PSFS).** Participant function was measured using the PSFS. The PSFS is a patient-oriented tool that assesses the patient's perception of their current functional ability.[64] The participant is asked to list up to three activities which are affected by their injury and rate their perceived ability to perform each activity on a scale from 0 (unable to perform the activity) to 10 (able to perform the activity at the same level as before the injury occurred). For this study, each participant was asked to identify the single activity most affected by his or her knee injury and rate it using the PSFS 11-point scale. The same activity was used to assess PSFS throughout the duration of the study. The reported minimal detectable change (MDC) is a change in 2.5 points when using an individual activity in participants with a lower limb injury.[8]

**Disablement in the Physically Active (DPA) Scale**. Participant physical impairment, functional limitation, disability, and health-related quality of life[68] were measured using the DPA Scale. The DPA Scale is a questionnaire in which responses are based on a scale ranging from 1 (no problem) to 5 (severe problem) across 16 items; 16 points are subtracted from the total to create a total possible score range from 0 to 64 points.[68] A normal, healthy range has been observed to be a score of less than 35, and a score of 23 or less has been observed in participants deemed ready to return to full participation after injury by an athletic trainer or physician.[68] The MCID is a decrease of 9 points for an acute injury and 6 points for a chronic injury.[68]

**Knee Injury Osteoarthritis and Outcome Score (KOOS).** The KOOS is a questionnaire designed for patients suffering from a knee pathology often associated with osteoarthritis, including ACL tears, meniscal tears, and chondral lesions. The tool includes questions regarding pain, symptoms, and functional limitations in activities of daily living and sport/recreation, as well as quality of life. Responses within each dimension are based on a scale ranging from 0 to 4; a total score of 100 would indicate no symptoms.[58] The MCID for each subsection is a change of 8-10 points.[58] However, an MCID value has not been established for KOOS$_5$,[58] which is a composite score of all five subsection scores.

**Treatment Interventions**

Treatment and participant position began in the same position that elicited knee symptoms during assessment, which was either supine/non-weight bearing (NWB), partial weight bearing (PWB), or full weight bearing (FWB)[49] for both treatment options.

**Mulligan Concept "Squeeze" Intervention.** The clinicians placed themselves in a position of biomechanical advantage based on each participant's individual treatment position. The participant actively placed the involved knee in approximately 90 degrees of flexion (allowing access to the joint line) or to the participant's pain-free limit of flexion in NWB. The clinician then placed the medial border of one thumb (i.e., the contact thumb) on the site of maximum pain and/or joint line edema (i.e., joint line tenderness), while the other thumb (i.e., the mobilizing thumb) was used to apply a force through the first thumb in an overlapping manner (Figure 5.1). Next, the participant extended their knee through their pain-free range, while the clinician maintained contact force with thumbs, releasing the force as the joint space closed in maximal knee extension (Figure 5.2). The participant then performed active knee flexion as the clinician continued to apply a "squeezing" force towards the center of the joint until maximal knee flexion was reached (Figure 5.3). The clinician held the pressure at the joint line for two seconds as the participant applied overpressure by pulling their tibia with both hands to their end range of knee flexion (Figure 5.3). If a participant could not grasp their tibia, they were given a strap to assist them into flexion (Figure 5.4). The participants returned to their end-range of knee extension, while the clinician released the force as the joint space closed. The participants were allowed to experience localized discomfort from the overlap grip, but the localized discomfort was not exacerbated with movement.

When participants were restricted in flexion, they were asked to perform active knee flexion only (Figure 5.3). Participants, who were restricted in extension, were asked to perform active knee extension only (Figure 5.2). Participants, who were restricted in both flexion and extension, were asked to perform knee flexion first, followed by knee extension. The treatment consisted of three sets of 10 repetitions with a minimum of 30 seconds of rest between each set. As the participants progressed towards full weight bearing, the participant position during treatment application also progressed from supine to partial weight bearing (Figure 5.5) to full weight bearing (Figure 5.6). Each participant was monitored for any increase in pain throughout the technique in accordance with MC treatment principles.

**Sham Intervention.** The “sham” treatment followed the same protocol as the MC “Squeeze” group (i.e., flexion/extension movement pattern was consistent) with the exception of the hand placement and the force. The hand placement for the sham treatment consisted of the same overlap grip of the thumbs, but the clinician applied the “squeeze” a ½ inch below the point of maximal joint line tenderness (Figure 5.7, 5.8). To provide consistent force using the sham treatment across treatment applications and participants, the clinician used only enough force to blanch the nail bed of the reinforcing thumb when applying the “sham” treatment.

**Treatment Application Protocol**

The protocol consisted of a maximum of 6 treatments within a 14-day period. Treatment applications were separated by a minimum of 24 hours and a maximum of 72 hours between each treatment session. If participants reached discharge criteria prior to the sixth treatment, they could be discharged successfully from the study prior to completing all 6 treatments; a minimum of 24 hours was required after the last treatment to assess a participant for discharge. Participants were not restricted from any activities of daily living and were allowed to participate as tolerated (based on clinical presentation and clinician assessment) in any specific sport activities throughout the duration of this study.

**Discharge Criteria.** The discharge criteria for both treatment groups included: a PSFS score of nine or higher for the reported patient-specific activity, a cumulative NRS score of two or less (with no greater than a one on current pain), and a DPA Scale score of 34 or less for persistent/chronic injuries and 23 or less for acute injuries. Participants were discharged from the study once they reached the predetermined criteria and maintained the outcomes a minimum of 24 hours post treatment.

**Data Analysis**

Descriptive statistics (mean ± SD) were calculated for all participant demographics. Using NRS, PSFS, DPA, and KOOS scores from a pilot study, an a priori power analysis using G power determined a minimum of 16 participants would be required for this study. A series of one-way analyses of variance (ANOVAs) was performed on the NRS and PSFS scores due to the variance in baseline scores between each group (i.e., linearity and homogeneity of regression did not exist). A series of one-way analyses of covariance (ANCOVAs), with baseline scores as the covariate, was performed on DPA Scale and $KOOS_5$

scores. Patient outcomes on NRS and PSFS were used to assess the effect of each intervention after a single treatment, and NRS, PSFS, DPA, and $KOOS_5$ were used to assess the effect of each treatment intervention after final treatment. Mean differences, ± standard deviation (SD), were calculated with statistical significance set at $p \leq 0.05$, confidence intervals (CI) at 95%, and partial eta squared values: small = 0.02, medium = 0.13, and large = 0.26.[9] All data analyses were performed using Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) version 23.0.

## Results

### Participant Demographics

Twenty-eight participants (males = 14, females = 14) qualified for this study. Five participants elected to withdraw prior to reaching discharge criteria in the allotted 14-day period. Two participants withdrew due to the time constraints of the study (MC "Squeeze" group = 1, sham group = 1), two sustained additional injuries (sham = 2), and the last did not offer a reason (sham = 1). The remaining 23 participants (age = 24.91 ± 12.09, males = 11, females = 12) were included in the final data analysis. The MC "Squeeze" group was composed of 12 participants (acute = 6, chronic = 6) and the sham group was composed of 11 participants (acute = 3, chronic = 8). Participants were generally healthy (i.e., no general medical or orthopedic comorbidities) with a mean BMI of 28.48 ± 5.35, from both athletic and general populations (MC "Squeeze" BMI = 25.98 ± 5.62, Sham BMI = 26.35 ± 5.17; Table 5.2). The results of each participant's clinical exam are presented in Table 5.3.

### Numeric Rating Scale Outcomes

A univariate ANOVA was used to assess the change in current pain between the MC "Squeeze" and sham groups immediately after the first treatment. No significant difference was found ($F_{(1, 21)} = .006$, $p = .938$, partial eta squared = .000, observed power = .051) between the two groups. The MC “Squeeze” group reported a mean reduction on current NRS of 1.56 ± 1.01 after a single treatment, while the sham group reported a mean reduction of 1.30 ± 1.51.

A univariate ANOVA revealed no significant difference in cumulative pain scores between the MC “Squeeze” and sham groups after the final treatment ($F_{(1,21)} = 1.70$, $p = .21$, partial eta squared = .075, observed power = .24) (Table 5.1). However, the MC “Squeeze” group reported a mean reduction on cumulative NRS of 2.19 ± 1.00 effectively meeting the MCID of 2 points for NRS,[61] while the sham group only reported a mean reduction of 1.24 ± 2.31 (Table 5.4). All 12 (100%) participants in the MC “Squeeze” group met the discharge criteria of ≤ cumulative 2 points on NRS at the end of the treatment intervention, while only 4 (36%) of the 11 sham participants met the discharge criteria for NRS.

**Patient Specific Functional Scale Outcomes**

A univariate ANOVA was used to assess the change in PSFS scores between the MC “Squeeze” and the sham groups immediately after the first treatment. A significant difference was found ($F_{(1, 21)} = 4.40$, $p = .048$, partial eta squared = .17, observed power = .52) between the two groups. The MC “Squeeze” group reported a mean improvement of function on PSFS of 1.58 ± 2.69 after a single treatment application, while the sham group reported a mean reduction of .46 ± 1.86. Four (33%) participants in the MC “Squeeze” group reported an MDC on the PSFS after the first treatment while no participants in the sham group reported clinically meaningful improvements in function.

A univariate ANOVA revealed a significant difference in the change in PSFS scores between the MC “Squeeze” and the sham groups after the final treatment ($F_{(1, 21)} = 41.92$, $p$

$< .001$, partial eta squared = .67, observed power = .10) (Table 5.4). After the final treatment, the MC "Squeeze" group reported a mean change on PSFS of 5.83 ± 1.85, twice the MDC of 2.5 for PSFS,[8] while the sham group only reported a mean change of .55 ± 2.07 (Table 5.4). All 12 (100%) participants in the MC "Squeeze" group reported a PSFS score equal or greater than 9 points after final treatment, while only 4 (36%) of the 11 sham participants reported equivalent PSFS scores, and produced a moderate effect size.[9]

**Disablement in the Physically Active Scale Outcomes**

A univariate ANCOVA, with baseline scores set as the covariate ($p < .001$), revealed a significant difference in DPA Scale scores between the MC "Squeeze" and sham groups after the final treatment ($F_{(1, 21)} = 7.46$, $p = .013$, partial eta squared = .27, observed power = .74) (Table 5.4). The mean difference in DPA Scale scores between the two groups was 8.78 ($p$ = .013, 95% CI: -15.48, -2.08). After the final treatment, the MC "Squeeze" group reported a mean DPA Scale score of 9.00 ± 8.12, 14 points below the accepted "return to play" score of 23,[68] while the sham group reported a mean score of 18.55 ± 14.05 (Table 5.4). The mean change for the MC "Squeeze" group was 14.92 ± 7.68, more than twice the mean change of the sham group (mean change = 6.36 ± 8.15) (Table 5.4).

**Knee Injury Osteoarthritis and Outcome Scores**

A univariate ANCOVA, with baseline scores set as the covariate ($p < .001$), did not reveal a significant difference in $KOOS_5$ scores between the MC "Squeeze" and sham groups after the final treatment ($F_{(1, 21)} = 2.11$, $p = .16$, partial eta squared = .095, observed power = .28) (Table 5.4). The mean difference in $KOOS_5$ scores between the two groups was 6.23 ($p$ = .16, 95% CI: -2.73, 15.19). However, after final treatment, the MC "Squeeze" group reported a mean $KOOS_5$ score of 79.32 ± 15.23, while the sham group only reported a mean score of

69.84 ± 13.69 (Table 5.4). The mean change for the MC "Squeeze" group was 13.82 ± 10.94, more than the mean change of the sham group (mean change = 9.07 ± 11.13) (Table 5.4). Five (42%) of the 12 participants in the MC "Squeeze" group reported $KOOS_5$ scores of ≥ 80/100 points by the end of the treatment intervention, while only 2 (18%) of the 11 sham participants reported equivalent scores.

## Discussion

Participants among both treatment groups in this randomized sham-controlled study experienced positive effects, but the results suggest the improvements reported by the MC "Squeeze" group were superior overall. All 12 participants in the MC group met discharge criteria within the 14-day, 6 treatment restriction; whereas only 4 sham participants (n = 11) met discharge criteria within the research timeframe. Additionally, 42% (n = 5) of the MC "Squeeze" participants displayed a full resolution of positive findings on a clinical exam; 58% (n = 7) continued to display up to two positive findings, despite self-reporting as asymptomatic (Table 5.3). In comparison, none of the sham participants displayed a full resolution of positive findings on a clinical exam (Table 5.3).

A significant difference was not found between groups on the NRS; both groups reported a decrease in pain immediately after the first treatment and over the course of treatment. However, there is a possibility of a type II error occurring in the interpretation of this analysis. The analysis of change in pain scores yielded a low power (0.051) immediately after the first treatment and a low power (0.24) from intake to discharge. The lack of significant difference between the groups on the NRS at any point during the study may be attributed to higher intake scores and more variability in pain for the sham group. Lower mean NRS scores at intake for the MC "Squeeze" group afforded less room for improvement compared to the sham group during the course of treatment; thus, a “floor/ceiling” effect for the MC group may have limited the ability to detect a statistically significant difference between groups. A notable clinical difference, however was found between groups; after the first treatment, 50% of participants in the MC “Squeeze” group reported an MCID on the NRS, while only 36% of participants in the sham group reported equivalent results. Furthermore, 100% of the MC “Squeeze” group reported NRS scores of 1 or less at the completion of the study, as opposed to only 36% of the sham group.

Analysis of the PSFS scores revealed a statistically significant difference between the two groups, immediately after the first treatment and over the course of treatment, in favor of the MC “Squeeze” group. In addition, the MC “Squeeze” group experienced clinically significant improvements (i.e., MDC) immediately after the first treatment and over the course of treatment on the PSFS. It is possible the sham group experienced a “floor/ceiling” effect due to a smaller window for improvement with mean PSFS scores at baseline of 6.45 ± 1.57 as compared to the MC “Squeeze” group’s mean baseline scores of 3.67 ± 1.72; however, further consideration of the outcomes suggests the MC group experienced superior outcomes to the sham group. For example, none of the sham patients reported an MDC on the PSFS after the first treatment, whereas 33% of the MC “Squeeze” group did. Moreover, 100% of the participants in the MC “Squeeze” group reported a PSFS score of 9 or better over the course of treatment as compared to just 36% of the sham. Thus, the differences between the MC “Squeeze” group and the sham group suggest the MC “Squeeze” technique may have had advantageous effects in alleviating the functional activity symptoms associated with clinically diagnosed meniscal tears compared to the sham intervention. In addition to improving functional activity, the MC “Squeeze” treatment also improved the group’s perception of their disability as reported in their DPA Scale scores. A statistically significant difference was found between the MC "Squeeze" group and the sham group over the course of treatment. The MC "Squeeze" group reported lower scores on the DPA Scale, with 100% of participants reporting scores of less than 23 points by the end of the treatment intervention. In contrast, only 55% of the sham participants reported scores of less than 23 points. A score below 23 is clinically relevant for the participants in this study because it is indicative of normative values reported after discharge from treatment for an acute injury and would also fall within the published normal, healthy range (0-34 points) for uninjured people.[68]

A statistically significant difference between groups was not found on the $KOOS_5$. The lack of significant difference between the MC "Squeeze" and sham groups could be due to the $KOOS_5$ inquiring about symptoms within the past week. The timeframe of this study was two weeks and the $KOOS_5$ was administered within 24 to 72 hours of the participants reporting being symptom-free or completing the 6 treatment sessions. Although a number of participants were asymptomatic (e.g., pain resolved, etc.) at the time of $KOOS_5$ administration, it is a possible that participants may have still been symptomatic within the week the final KOOS questionnaire was completed, which may have led to depressed scores. It is also worth noting that there was a moderate effect size and a low power for the $KOOS_5$ analysis; thus, it is possible a Type II error is being committed by accepting that there is no difference between groups.

One potential reason for the positive effects experienced by the MC "Squeeze" group is the treatment's theorized effect on the meniscal tissue.[48,49] After meniscal injury, meniscal tissue can become dislodged from its normal anatomical position,[55,38,71,15] defined as meniscal derangement.[60] Tissue derangement has been theorized to contribute to approximately 42% of all knee pain.[43] In the presence of tissue derangement at the knee, pressure may be placed on the highly innervated joint line structures.[55,38,71,15] Hypothetically, the MC "Squeeze" technique repositions the deranged meniscal tissue into its normal anatomical position and therefore alleviates the symptoms commonly associated with meniscal tears.[48,49] However, these ideas remain purely theoretical, as there is a paucity of research available on the tissue derangement model in the extremities.[60]

The positive effects experienced by the sham group also cannot be ignored. Approximately 36% of the sham group experienced symptom improvement that qualified those patients for discharge from the study. Additionally, the majority of the sham group experienced some positive effects on most outcome instruments. The positive effects in the sham group could be attributed to the resemblance of our sham treatment to the repeated directional preference movements in the Mechanical Diagnosis and Therapy (MDT) paradigm. The MDT paradigm involves the classification of patients according to how their symptoms respond to repetitive or sustained unidirectional movements, the most common of which is a "derangement syndrome."[25,44,14,43,60,2] Derangement is defined as an anatomical disturbance in the normal resting position of a joint.[3,25,44,43,60] Patients with a reducible derangement will present a directional preference during the MDT evaluation.[3,25,44,43,60] While the MDT evaluation method was not followed in this study, it was possible that sham participants experienced improvements, or even complete abolishment of symptoms, due to the "sham" treatment resulting in applied repeated motion in a directional preference. Patients classified with a knee derangement have experienced significantly better outcomes in pain and function when compared to a control group.[60]

The positive effects achieved by the sham group could also be attributed to the psychological mechanisms of the placebo effect. The magnitude of the placebo effect depends largely on patient expectation.[21,33,67] The participants in this case series were blinded to the intervention that they received. As a result, patient outcomes may have improved based on the participant's expectation of being randomized into the treatment group. The positive effects reported by our sham participants are comparable to other placebo-controlled studies in which participants are told they will either receive a treatment or a placebo and results in small, but significant improvements in pain with small effects sizes.[28] Additionally, the sham participants that reached discharge criteria is not a new phenomenon; the placebo effect has been attributed to up to 50% of patients reaching discharge criteria, particularly in manual therapy.[6] While placebos may not alter the pathophysiology, they can alleviate symptoms (e.g. patient-reported pain).[33] Different types of manual therapies or therapeutic touch elicit various mechanisms of pain control associated with Central Nervous System (CNS) descending pain modulation including, but not limited to, an increase in ß-endorphins, serotonin meditation, increases in dopamine production and oxytocin mediation.[69] Therefore, the placebo effect could explain why some participants experienced improvements in symptoms but most participants did not experience the significant improvements in functional activity and disability reported by the MC "Squeeze" group.

One limitation of this study was the inclusion of a relatively small sample size for generalization across all patient populations suffering from meniscal tears. Power was calculated based on pilot data of a 5-participant sample and, although the minimum sample size (n = 16) was surpassed in this study, a larger sample size including a more diverse patient population would allow for greater generalization to clinical practice. A larger sample size is also likely necessary in this study due to the number of scales used and is evident in the low power, but moderate effect size noted on certain outcomes measures (e.g., $KOOS_5$). Specifically regarding the KOOS, there was a limitation in study design because the final data collection was 24 hours post symptom resolution and/or sixth treatment intervention and the scale requires patients to analyze symptoms over the past week when symptoms may have still been present. Therefore, a true analysis of improvement on the KOOS may not have occurred with the study design.

Other limitations included difficulty determining a true sham/placebo (i.e., sham was similar to MDT) treatment in manual therapy, a lack of clinician blinding, a lack of arthroscopy for the confirmation of meniscal tears, and not controlling for each participants' activity during the course of treatment. Additionally, in participant recruitment of an injured population within the confines of the researcher's individual clinics, equal numbers of acute and chronic patients could not be obtained or equally distributed with the a priori randomization (Table 5.2). Lastly, the MC guidelines recommend applying an internal rotation accessory glide of the tibia when treating patients with general knee pain, and to then progress to medial/lateral glides of the tibia, to provide the greatest reduction in symptoms.[49] Thus, results reported in this study may have been further improved by determining which MC technique was best for each individual participant or through utilizing multiple interventions within the MC.

Future research on the effects of the MC "Squeeze" technique should include sub-classification of participants (e.g., acute versus chronic mechanism, etc.) prior to randomization. Because most of the participants included in this study were younger athletic patients with BMIs below the obesity level, additional research assessing older, sedentary individuals with higher BMIs would be advantageous because chronic degenerative meniscus tears are typically observed in populations who are older, sedentary, and overweight.[23,72] Additionally, the MC paradigm includes various other treatments for knee pain in addition to the “Squeeze” technique and contains recommendations to attempt multiple treatment interventions to match the patient to an intervention that abolishes pain during treatment as opposed to limiting rehabilitation to one technique for all patients.[47,48] Therefore, future research on the effects of the MC in the treatment of meniscal tears should be conducted by following the complete MC treatment guidelines and utilizing the full treatment paradigm; it will also be useful to compare the MC to traditional conservative rehabilitation protocols as opposed to a sham intervention. Researchers should also wait a week after the final treatment to collect the KOOS outcomes measure, as it is designed to capture patient symptoms over the course of a week. Finally, future research should include follow-up data (short-term and long term), identifying the time frames improvements are maintained following a return to sport or activities of daily living.

## Conclusion

The results in this study indicate the MC “Squeeze” technique had a positive effect on patient function over a period of 14 days that was, in general, clinically and statistically superior to the sham treatment. While participants in both groups experienced a decrease in pain, only the MC “Squeeze” group reported a significant increase in functional activity and decrease in disability. The results in this study indicate that the MC “Squeeze” technique is an effective treatment for reducing symptoms associated with meniscal tears in a patient population meeting the criteria for a clinical diagnosis.

*Table 5.1 Positive Findings for the Clinical Composite Score Proposed by Lowery et al., (2006) for the Detection of Meniscal Tears*

| | **5 Positive Findings** | **4 Positive Findings** | **3 Positive Findings** |
|---|---|---|---|
| **Sensitivity (%)** | 11.2% | 16.86% | 30.8% |
| **Specificity (%)** | 99% | 96.1% | 90.2% |
| **PLR** | 11.45% | 4.29% | 3.15% |
| **PPV** | 92.3% | 81.8% | 76.7% |

Note: PLR = Positive Likelihood Ratio; PPV = Positive Predictive Value

*Table 5.2 Participant Demographic Data for the MC "Squeeze" and Sham Group*

| Participant ID # | Gender | Age | Sport/Activity | BMI | Onset (Duration of Symptoms) | Joint Line Point of Treatment |
|---|---|---|---|---|---|---|
| **101** | Male | 45 | Football Coach | 35.6 BMI | Chronic | Medial |
| **102** | Male | 23 | Football | 32.8 BMI | Chronic | Medial |
| **103** | Female | 53 | General Population | 24.0 BMI | Chronic | Lateral |
| **104** | Male | 22 | Soccer | 24.3BMI | Chronic | Medial |
| **105** | Male | 20 | Baseball | 32.5 BMI | Acute | Medial |
| **106** | Male | 21 | Track & Field | 23.6 BMI | Acute | Lateral |
| **107** | Male | 14 | Basketball | 18.5 BMI | Acute | Medial |
| **108** | Female | 18 | Dance | 29.9 BMI | Chronic | Lateral |
| **109** | Female | 21 | ROTC | 24.0 BMI | Acute | Medial |
| **110** | Female | 25 | Swim Coach | 26.8 BMI | Acute | Medial |
| **111** | Female | 20 | Basketball | 21.30BMI | Chronic | Medial |
| **112** | Male | 16 | Soccer | 18.5 BMI | Acute | Lateral |
| **113*** | Male | 33 | Football/Track Coach | 23.0 BMI | Chronic | Lateral |
| **114*** | Male | 19 | Baseball | 25.7 BMI | Chronic | Lateral |
| **115*** | Female | 20 | Soccer | 24.4 BMI | Chronic | Medial |
| **116*** | Female | 19 | Cross Country | 20.4 BMI | Acute | Medial |
| **117*** | Male | 23 | Football | 31.0 BMI | Acute | Medial |
| **118*** | Female | 19 | ROTC | 24.1 BMI | Acute | Lateral |
| **119*** | Female | 18 | Recreational Basketball | 21.3 BMI | Chronic | Medial |
| **120*** | Female | 21 | General Population | 35.2 BMI | Chronic | Medial |
| **121*** | Female | 62 | General Population | 30.4 BMI | Chronic | Posterior Lateral |
| **122*** | Male | 23 | General Population | 33 BMI | Chronic | Lateral |
| **123*** | Female | 18 | Recreational Basketball | 21.3 BMI | Chronic | Medial |

*= Sham Treatment Group

*Table 5.3 Signs and Symptoms Present Among all Participants at Intake and Discharge/After the 6 Treatments*

| **Sign/Symptoms** | **MC 'Squeeze" Group (n = 12)** | | **Sham Group (n = 11)** | |
|---|---|---|---|---|
| | *Intake* | *Final Treatment* | *Intake* | *Final Treatment* |
| | n (%) | n (%) | n (%) | n (%) |
| **History of Popping/Clicking** | 10 (83.33) | 2 (16.67) | 9 (81.82) | 9 (81.81) |
| **JLT** | 12 (100) | 4 (33.33) | 11 (100) | 8 (72.73) |
| **Pain in TKE** | 6 (50) | 0 (0) | 6 (54.55) | 6 (54.55) |
| **Pain in TKF** | 11 (91.17) | 0 (0) | 10 (90.90) | 6 (54.55) |
| **Positive McMurray's Test** | 11 (91.17) | 2 (16.67) | 10 (90.90) | 8 (72.73) |
| **Positive Thessaly's Test** | 10 (83.33) | 0 (0) | 11 (100) | 6 (54.55) |
| **Positive Apley's Test** | 5 (41.67) | 0 (0) | 2 (18.18) | 2 (18.18) |
| **Edema** | 0 (0) | 0 (0) | 1 (9.09) | 1 (9.09) |
| **NWB/PWB** | 3 (25) | 0 (0) | 1 (9.09) | 0 (0) |

Note: MC = Mulligan Concept; JLT = joint line tenderness; TKE = terminal knee extension; NWB = non weight-bearing; PWB = partial weight-bearing

*Table 5.4 Analysis of Variance (ANOVA) in Outcome Measures from Intake to Final Treatment Between Groups*

| **Outcomes** | **MC 'Squeeze" Group M (± SD)** | | **Sham Group M (± SD)** | | **p** | **Effect Size** | **Power** |
|---|---|---|---|---|---|---|---|
| | *Intake* | *Final Treatment* | *Intake* | *Final Treatment* | | | |
| **NRS (Avg)** | 2.64 (± .89) | 0.44 (± .44) | 3.67 (± 2.50) | 2.42 (± 1.96) | .206 | .075 | .238 |
| **PSFS** | 3.67 (± 1.72) | 9.50 (± 1.85) | 6.45 (± 1.57) | 7.00 (± 2.07) | .000* | .666* | 1.00* |
| **‡DPA Scale** | 23.92 (± 10.05) | 9.00 (± 8.12) | 24.91 (± 11.96) | 18.55 (± 14.05) | .013* | .272* | .739 |
| **‡$KOOS_5$** | 65.50 (± 12.26) | 79.32 (± 15.22) | 60.76 ± 18.32) | 69.84 (± 13.69) | .162 | .095 | .282 |

Note: MC = Mulligan Concept; NRS = Numeric Rating Scale for pain; Avg = average; PSFS = Patient Specific Functional Scale; DPA = Disablement in the Physically Active Scale; $KOOS_5$ = Knee injury and Osteoarthritis Outcome Score (composite score)
‡ANCOVA with baseline scores extracted as covariates
*Notes statistical significance, large effect size, and high power

*Figure 1 MC "Squeeze" Hand Placement in Flexion*

Starting hand placement showing the overlap thumb grip**.** “Squeeze” force is directed toward the center of the joint.

*Figure 2 MC "Squeeze" Hand Placement in Extension*

Clinician hand placement in NWB (supine) for the MC “Squeeze” technique treatment in full knee extension. Clinician alleviates pressure on joint line.

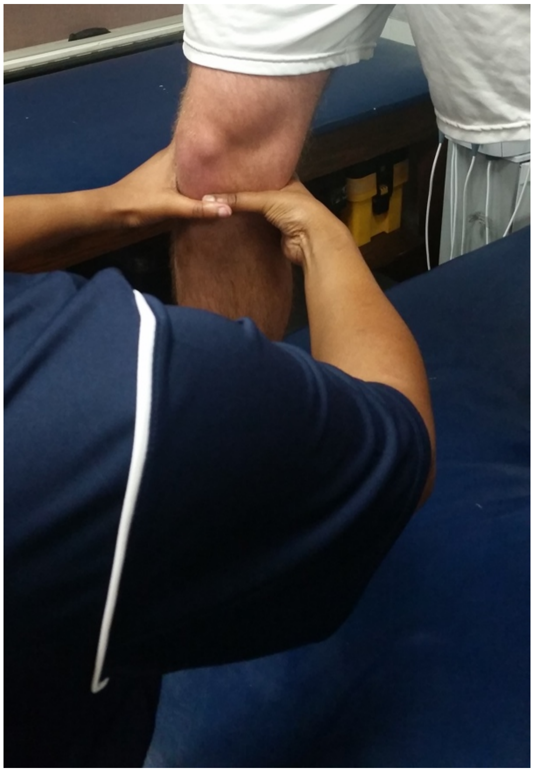
*Figure 3 MC "Squeeze" with Over-Pressure*

Clinician hand placement in NWB (supine) for the MC “Squeeze” technique treatment in full knee flexion. Over-pressure is provided by the participant.

*Figure 4 MC "Squeeze" Over-Pressure with Strap*


Clinician hand placement in NWB (supine) for the MC “Squeeze” technique treatment in full knee flexion. Participant uses a strap to assist in providing over-pressure.

*Figure 5 MC "Squeeze" in PWB*

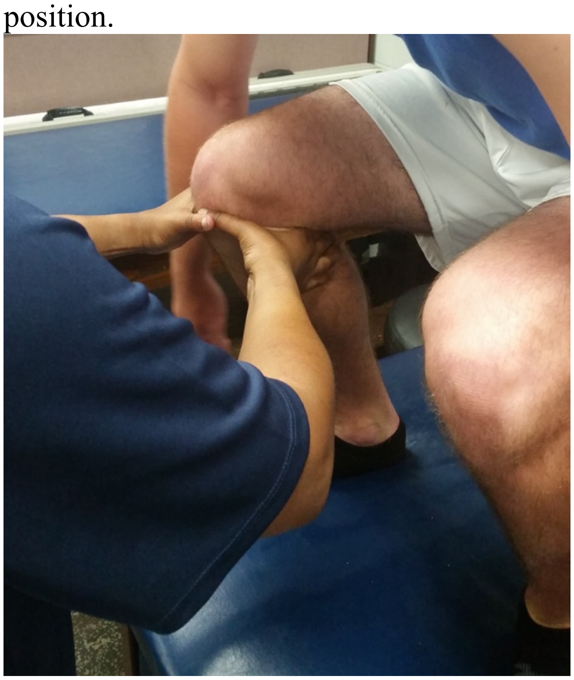


A. Clinician hand placement in PWB (lunge) for the MC "Squeeze" technique – starting position.

B. Clinician hand placement in PWB (lunge) for the MC "Squeeze" technique – ending position.

Figure 6 MC "Squeeze" in FWB

A. Clinician hand placement in FWB (squat) for the MC “Squeeze” technique – starting position.



B. Clinician hand placement in FWB (squat) for the MC “Squeeze” technique – ending position.

*Figure 7 Sham Hand Placement in Flexion*

Clinician hand placement in NWB (supine) for the sham treatment in full knee flexion. Clinician applies overlap thumb grip ½ inch inferior to the reported joint-line tenderness. Note: Blue line indicates joint line. Arrow indicates ½ inferior to joint line

*Figure 8 Sham Hand Placement in Extension*

Clinician hand placement in NWB (supine) for the sham treatment in full knee extension. Clinician applies overlap thumb grip ½ inch inferior to the reported joint-line tenderness. Notes: Blue line indicates joint line. Arrow indicates ½ inferior to joint line

**References**

1. Acebes C, Romero F, Contreras M, Mahillo, Herrero-Beaumont G. Dynamic ultrasound assessment of medial meniscal subluxation in knee osteoarthritis. *Rheumatol*. 2013;52(8): 1443-1447. http://dx.doi.org/10.1093/rheumatology/ket110

2. Apeldoorn AT, Helvoirt H, Meihuizen H, Tempelman H, Vandeput D, Knol DL, … Ostelo RW. The influence of centralization and directional preference on spinal control in patients with nonspecific low back pain. *J Ortho Sports Phys Ther*. 2016;46(4): 258–269. http://doi.org/10.2519/jospt.2016.6158

3. Aytona MC, Dudley K. Rapid resolution of chronic shoulder pain classified as derangement using the McKenzie method: A case series. *J Man Manip Ther*. 2013;21(4): 207–212. http://doi.org/10.1179/2042618613Y.0000000034

4. Bedi A, Kelly NH, Baad M, Fox AJS, Brophy RH, Warren RF, Maher SA. Dynamic contact mechanics of the medial meniscus as a function of radial tear, repair, and partial meniscectomy. *J Bone Joint Surg Br.* 2010;92(6): 1398-1408. http://doi.org/10.2106/JBJS.I.00539

5. Brody K, Baker R, Nasypany A, Seegmiller J. Meniscal lesions: The physical examination and evidence for conservative treatment. *Int J Athl Ther Train.* 2015;20(5): 35-38.

6. Chaibi A, Benth JS, Russell MB. Validation of placebo in a manual therapy randomized controlled trial. *Sci Rep*. 2015;5(11774): 1-8. http://dx.doi.org/10.1038/srep11774

7. Chakravarty E, Hubert H, Lingala V, Zatarain E, Fries J. Long distance running and knee osteoarthritis. *Am J Prev Med*. 2008;35(2): 133-138. doi:10.1016/j.amepre.2008.03.032.

8. Chatman AB, Hyams SP, Neel JM, Binkley JM, Stratford PW, Schomberg A, Stabler M. The patient-specific functional scale: Measurement properties in patients with knee dysfunction. *Phys Ther.* 1999;77(8): 820-829.

9. Cohen J. Statistical power analysis and research results. *Am Educ Res J.* 1973;10(3): 225. http://dx.doi.org/10.2307/1161884

10. Crawford R, Walley G, Bridgman S, Maffulli N. Magnetic resonance imaging versus arthroscopy in the diagnosis of knee pathology, concentrating on meniscal lesions and ACL tears: A systematic review. *Brit Med J*. 2007;84(1): 5–23. http://doi.org/10.1093/bmb/ldm022

11. Downie WW, Leatham PA, Rhind VM, Wright V, Branco JA, Anderson JA. Studies with pain rating scales. *Ann Rheum Dis.* 1978;37(4): 378-381.

12. Drawer S. Propensity for osteoarthritis and lower limb joint pain in retired professional soccer players. *Brit J Sports Med.* 2001;35(6): 402-408. doi:10.1136/bjsm.35.6.402.

13. Drosos GI, Pozo JL. The causes and mechanisms of meniscal injuries in the sporting and non-sporting environment in an unselected population. *Knee*. 2004;11(2): 143-149. http://doi.org/10.1016/S0968-0160

14. Dunsford A, Kumar S, Clarke S. Integrating evidence into practice: Use of Mckenzie-based treatment for mechanical low back pain. *J Multidisc Healthc*. 2011;4: 393–402. http://doi.org/10.2147/JMDH.S24733

15. Dye SF, Vaupel G, Dye CC. Conscious neurosensory mapping of the internal structures of the human knee without intraarticular anesthesia. *Am J Sports Med*. 1998;26(6): 773-777.

16. Englund M, Roos EM, Roos, HP, Lohmander LS. Patient-relevant outcomes fourteen years after meniscetomy. Influnce of type of meniscal tear and size of resection. *Rheumatology*. 2001;40: 631-639.

17. Englund M, Roos EM, Lohmander LS. Impact of type of meniscal tear on radiographic and symptomatic knee osteoarthritis: A 16-year follow-up of meniscetomy with matched controls. *Arthritis Rheum*. 2003;48: 2178-2187.

18. Englund M, Lohmander LS. Risk factors for symptomatic knee osteoarthritis fifteen to twenty-two years after meniscectomy. *Arthritis Rheum*. 2004;50(9): 2811-2819. http://doi.org/10.1002/art.20489

19. Englund M, Paradowski, P, Lohmander LS. Radiographic hand osteoarthritis is associated with radiographic knee osteoarthis after meniscetomy. *Arthritis Rheum.* 2004;50: 469-475.

20. Englund M, Guermazi A, Lohmander LS. The Meniscus in knee osteoarthritis. *Rheum Dis Clin North Am*. 2009;35(3): 579-590. doi: 10.1016/j.rdc.2009.08.004

21. Ernst E. Does spinal manipulation have specific treatment effects? *J Fam Pract.* 2000;17: 554-556.

22. Fox AJS, Bedi A, Rodeo SA. The basic science of human knee menisci: Structure, composition, and function. *Sports Health*. 2012;4(4): 340-351. http://doi.org/10.1177/1941738111429419

23. Getgood A, Robertson A. (v) Meniscal tears, repairs and replacement – A current concepts review. *Orthop Trauma*. 2010;24(2): 121-128. doi:10.1016/j.mporth.2010.03.01

24. Hanney WJ, Kolber MJ, Pabian P, Cheatham SW, Schoenfeld BJ, Salamh PA. Endurance times of the thoracolumbar musculature: Reference values for female recreational resistance training participants. *J Strength Cond Res.* 2015;30(2): 588-594.
25. Hefford, C. McKenize classification of mechanical spinal pain: Profile of syndromes and directions of preference. *Man Ther*. 2008;13: 75–81. http://doi.org/10.1016/j.math.2006.08.005
26. Herrlin S, Hållander M, Wange P, Weidenhielm L, Werner S. Arthroscopic or conservative treatment of degenerative medial meniscal tears: a prospective randomised trial. *Knee Surg Sports Traumatol Arthrosc*. 2007;15(4): 393–401. doi:10.1007/s00167-006-0243-2
27. Hootman JM, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: Summary and recommendations for injury prevention initiatives. *J Athl Train*. 2007;42(2): 311-319.)
28. Hrobjartsson A, Gotzsche PC. Is the placebo powerless? An analysis of clinical trials comparing placebo with no treatment. *N Engl J Med*. 2001;44: 1594-1602.
29. Hudson R, Richmond A, Sanchez B, Stevenson V, Baker R, May J, ...Reordan D. An alternative approach to the treatment of meniscal pathologies: A case report analysis of the Mulligan Concept "Squeeze" technique. *Int J Sports Phys.* 2016; 11 (4). 1-11.
30. Hwang YG, Kwoh CK. The METEOR trial: No rush to repair a torn meniscus. *Cleve Clin J Med*. 2014;81(4): 226-232. doi:10.3949/ccjm.81a.13075
31. Karachalios T, Hantes M, Zibis A, Zachos V, Karantanas A, Malizos K. Diagnostic accuracy of a new clinical test (the Thessaly test) for early detection of meniscal tears. *J Bone Joint Surg Am.* 2005;87(5): 955-962.

32. Kaptchuk TJ. The placebo effect in alternative medicine: can the performance of a healing ritual have clinical significance? *Ann Intern Med.* 2002;136: 817-825.
33. Kaptchuk T, Miller F. Placebo effects in medicine. *N Engl J Med*. 2015;373(1): 8-9. http://dx.doi.org/10.1056/nejmp1504023
34. Katz JN, Brophy RH, Chaisson CE, de Chaves L, Cole BJ, Dahm DL, Losina E. Surgery versus physical therapy for a meniscal tear and osteoarthritis. *N Engl J Med*. 2013;368(18): 1675-1684. doi:10.1056/NEJMoa1301408
35. Krebs EE, Carey TS, Weinberger M. Accuracy of the pain numeric rating scale as a screening test in primary care. *J Gen Intern Med.* 2007;22(10): 1453-1458.
36. Kujala UM, Kettunen J, Paananen H, Aalto T, Battie MC, Impivaara O, . . . Sarna S. Knee osteoarthritis in former runners, soccer players, weight lifters, and shooters. *Arthritis Rheum.* 1995; 38(4): 539-546. doi:10.1002/art.1780380413.
37. Kurosaka M, Yagi M, Yoshiya S, Muratsu H, Mizuno K. Efficacy of the axially loaded pivot shift test for the diagnosis of a meniscal tear. *Int Orthop*. 1999; 23(5): 271-274.
38. Lee JM, Fu FH. The Meniscus: Basic science and clincal applications. *Oper Tech Orthop.* 2000; 10(3): 162-168. http://doi.org/10.1053/otor.2000.5289
39. Lowery DJ, Farley TD, Wing DW, Sterett WI, Steadman RJ. A clinical composite score accurately detects meniscal pathology. *Arthroscopy*. 2006; 22(11): 1174-1179. http://doi.org/10.1016/j.arthro.2006.06.014
40. Ludman CN, Hough DO, Cooper TG, Gottschalk A. Silent meniscal abnormalities in athletes: magnetic resonance imaging of asymptomatic competitive gymnasts. *Br J Sports Med.* 1999; *33*(6): 414-416.

41. Lyman S, Hidaka C, Valdez AS, Hetsroni I, Pan TJ, Do H, … Marx RG. Risk factors for meniscectomy after meniscal repair. *Am J Sports Med. 2013;* 41(12): 2772–2778. http://doi.org/10.1177/0363546513503444

42. May S, Aina A. Centralization and directional preference: A systematic review. *Man Ther*. 2012; 17(6): 497–506. http://doi.org/10.1016/j.math.2012.05.003

43. May S, Rosedale R. A survey of the McKenzie classification system in the extremities: Prevalence of mechanical syndromes and preferred loading strategies. *Phys Ther*. 2012; 92(9): 1175-1186. http://dx.doi.org/10.2522/ptj.20110371

44. May S, Ross J. The McKenzie classification system in the extremities: A reliability study using Mckenzie assessment forms and experienced clinicians. *J Manipulative and Physiol Ther. 2009;* 32(7): 556–563. http://doi.org/10.1016/j.jmpt.2009.08.007

45. Majewski M, Susanne H, Klaus S. Epidemiology of athletic knee injuries: A 10-year study. *Knee, 2006;* 13(3): 184-188.

46. McDermott ID. (ii) Meniscal tears. *Current Orthop*. 2006; 20(2): 85-94. http://doi.org/10.1016/j.cuor.2006.02.010

47. Mordecai SC, Al-Hadithy N, Ware HE, Gupte CM. Treatment of meniscal tears: An evidence based approach. *World J Orthop*. 2014; 5(3): 233-241. doi:10.5312/wjo.v5.i3.233.

48. Mulligan, B. Manual therapy rounds: Mobilisations with movement (MWM's). *J Man Manip Ther. 1*993; 1(4): 154-156.

49. Mulligan BR. *Manual therapy NAGS, SNAGS, MWMs etc.* (6th ed.). Wellington, New Zealand: Plan View Services Ltd; 2010.

50. Nepple JJ, Dunn WR, Wright RW. Meniscal repair outcomes at greater than five years. *J Bone Joint Surg Am. 2012;* 94(24): 2222–2227. http://doi.org/10.2106/JBJS.K.01584

51. Nikolaou V, Chronopoulos E, Savvidou C, Plessas S, Giannoudis P, Efstathopoulos N, Papachristou G. MRI efficacy in diagnosing internal lesions of the knee: A retrospective analysis. *J Trauma Manag Outcomes*. 2008; *2*(1): 4. doi:10.1186/1752-2897-2-4

52. Paxton ES, Stock MV, Brophy RH. Meniscal repair versus partial meniscectomy: A systematic review comparing reoperation rates and clinical outcomes. *Arthroscopy.* 2011; 27(9): 1275-1288.

53. *Physical Activity Council.* The Physical Activity Council's annual study tracking sports, fitness, and sports recreation participation in the US: http://www.physicalactivitycouncil.com/pdfs/current.pdf. Published 2016. Accessed May 1, 2016.

54. Pujol N, Barbier O, Boisrenoult P, Beaufils P. Amount of meniscal resection after failed meniscal repair. *Am J Sports Med*. 2011; 39(8): 1648–1652. http://doi.org/10.1177/0363546511402661

55. Renstrom P, Johnson RJ. Anatomy and biomechanics of the menisci. *Clin SPorts Med.* 1990; 9(3): 523-538.

56. Roemer F, Jarraya M, Niu J, Silva J, Frobell R, Guermazi A. Increased risk for radiographic osteoarthritis features in young active athletes: A cross-sectional matched case control study. *Osteoarthr and Cartil.* 2015; 23(2): 239-243. doi:10.1016/j.joca.2014.11.011.

57. Roos H, Lindberg H, Gardsell P, Lohmander L, Wingstrand H. The prevalence of gonarthrosis and its relation to meniscectomy in former soccer players. *Am J Sports Med*. 1994; 22(2): 219-222. doi:10.1177/036354659402200211.

58. Roos EM, Roos HP, Ekdahl C, Lohmander LS. Knee injury and osteoarthritis outcome score (KOOS) - Validation of a Swedish version. *Scand J Med Sci Sports;* 1998; 8(6): 439-448.

59. Roos KG, Marshall SW, Kerr ZY, Golightly YM, Kucera KL, Myers JB, ... Comstock RD. Epidemiology of overuse injuries in collegiate and high school athletics in the United States. *Am J Sports Med*. 2015; 42(7): 1790-1797. 0363546515580790.

60. Rosedale R, Rastogi R, May S, Chesworth BM, Filice F, Willis S, … Robbins SM. Efficacy of exercise intervention as determined by the McKenzie System of Mechanical Diagnosis and Therapy for knee osteoarthritis: A randomized controlled trial. *J Orthop and Sports Phys Ther*. 2014; 44(3): 173–181. http://doi.org/10.2519/jospt.2014.4791

61. Salaffi F, Stancati A, Silvestri CA, Ciapetti A, Grassi W. Minimal clinically important changes in chronic musculoskeletal pain intensity measured on a numerical rating scale. *Eur J Pain.* 2004; 8(4): 283–291.

62. Shellock FG, Hiller WDB, Ainge GR, Brown DW, Dierenfield L. Knees of Ironman triathletes: Magnetic resonance imaging assessment of older (> 35 years old) competitors. *J Magn Reson Imaging*. 2003; 17(1): 122-130.

63. Sihvonen R, Paavola M, Malmivaara A, Itälä A, Joukainen A, Nurmi H, . . . Järvinen TL. Arthroscopic partial meniscectomy versus sham surgery for a degenerative meniscal tear. *N Engl J Med.* 2013; 369(26): 2515-2524.

64. Stratford P, Gill C, Westaway M, Binkley J. Assessing disability and change on individual patients: A report of a patient specific measure. *Physiother Can.* 1995; 47(4): 258-263.

65. Takeda H, Nakagawa T, Nakamura K, Engebretsen L. Prevention and management of knee osteoarthritis and knee cartilage injury in sports. *Br. J. Sports Med.* 2011; 45(4): 304-309. doi:10.1136/bjsm.2010.082321.

66. Turner A. Long term health impact of playing professional football in the United Kingdom. *Br. J. Sports Med*. 2000; 34(5): 332-336. doi:10.1136/bjsm.34.5.332.

67. Vase L, Petersen GL, Riley JL 3rd, Price DD. Factors contributing to large analgesic effects in placebo mechanism studies conducted between 2002 and 2007. *Pain.* 2009; 145: 36-44.

68. Vela LI, Denegar CR. The disablement in the physically active scale, part II: The psychometric properties of an outcomes scale for musculoskeletal injuries. *J Athl Train*. 2010; 45(6): 630-641. doi:10.4085/1062-6050-45.6.630.

69. Vigotsky AD, Bruhns RP. The role of descending modulation in manual therapy and its analgesic implications: a narrative review. *Pain Res Treat*. 2015;2015:292805. doi:10.1155/2015/292805.

70. Walczak BE, McCulloch PC, Kang RW, Zelazny A, Tedeschi F, Cole BJ. Abnormal findings on knee magnetic resonance imaging in a asymptomatic NBA players. *Am J Knee Surg.* 2008; 21(1): 27-33.

71. Wilson AS, Legg PG, McNeur JC. Studies on the innervation of the medial meniscus in the human knee joint. *Anat Rec*. 1969; 165(4): 485-491.

72. Yeh PC, Starkey C, Lombardo S, Vitti G, Kharrazi FD. Epidemiology of isolated meniscal injury and its effect on performance in athletes from the National Basketball

Association. *Am J Sports Med.* 2012; 40(3): 589-594 http://doi.org/10.1177/03635465114286.

73. Zanetti M, Pfirmann CWA, Schmid MR, Romero J, Seifert B, Hodler J. Patients with suspected meniscus tears: Prevalence of abnormalities seen on MRI of 100 symptomatic and contralateral asymptomatic knees. *Am J Roentgenol*. 2003;181: 635-64.1

# APPENDIX A:

# A CASE FOR INCORPORATING TRAUMA RELEASING EXERCISES FOR THE TREATMENT OF MUSCULOSKELETAL INJURIES

**Pending Submission to the International Journal of Athletic Therapy and Training**

Key Points:

1. Stress and anxiety is directly associated with somatic dysfunction and disease
2. Clinicians should be encouraged to screen patients suffering from musculoskeletal injuries for evidence of stress-related contributing factors
3. Trauma-releasing exercises offer a psychosocial intervention plan that fits well into clinical settings focused on treating a motivated, physically active population

## Introduction

The connection between stress and somatic diseases and disorders has been well established (Sobel, 1995). In 1999, the American Institute of Stress reported that 75-90% of patient visits to a primary care physician were stress related. These findings surpassed those of a previous landmark 20-year study conducted at Kaiser Permanente, which reported that 60% of all physician visits involved "worried-well" patients – symptomatic patients without a diagnosable disorder (Cummings & VandenBos, 1981). Despite the apparent need for psychosocial interventions, many healthcare providers have received little training on the topic and do not feel confident in teaching their patients stress-management interventions (Avey, Matheny, Robbins, & Jacobson, 2003).

The autonomic nervous system (ANS) is composed of the sympathetic nervous system (SNS) and parasympathetic nervous system (PNS) and involuntarily functions to control internal body functions and regulate homeostasis. In the presence of danger or trauma, a healthy SNS will release neurotransmitters and hormones to effectively fight or flee for protection. During this time, pain is suppressed until the body is safe from danger (Berceli, 2005). Chronic exposure to stress, conflict, social rejection, anger, anxiety, depression, and other similar psychosocial factors are associated with various somatic complaints and disorders (Davis, Zautra, & Reich, 2001; Eisenberger, Jarcho, Lieberman, & Naliboff, 2006; Kivimäki et al., 2004; Papousek, Schulter, & Premsberger, 2002; Rhudy, Williams, McCabe, Russell, & Maynard, 2008). Chronic psychological stress and chronic pain can result in neuroplasticity changing how the brain interprets pain (Schlereth & Birklein, 2008). As a result, the ANS will create an overreaction to pain and amplify the inflammatory response

(Howarth, Burstal, Hayes, Lan, & Lantry, 1997; Rhudy & Meagher, 2000; Papousek et al., 2002).

Trauma-releasing exercises (TRE) are a sequence of exercises developed by David Berceli from his experiences in observing people exposed to traumas in war-torn countries (Berceli, 2005). When the SNS is activated by trauma, the muscles involved in postures of defense, namely the psoas muscle group, are instinctively activated to either run from danger or flex into a fetal position for protection (Berceli & Napoli, 2006). Animals recover from trauma naturally by shaking vigorously once the dangerous stimulus has been removed (Berceli & Napoli, 2006). In humans however, neurogenic tremors are associated with pathology (Berceli & Napoli, 2006). In fact, fighting the urge to shake when nervous or frightened is quite common across various cultures. During his observations, Berceli noted that after being exposed to life-threatening situations children would often respond by trembling freely while adults would stay frozen to not show fear (Berceli & Napoli, 2006). Trauma-releasing exercises are designed to replicate this shaking response, allowing the body to overcome the side-effects of trauma, anxiety, and stress (Berceli, 2005). The purpose of this case study is to present a case in which a patient with a common musculoskeletal pain was treated with trauma-releasing exercises.

## Case Description

### Physical Exam

A 39-year-old male patient presented with an insidious onset of left shoulder girdle pain. The patient manages an industrial manufacturing company which involves office work and manual labor and is also completing a college degree requiring extended sessions seated in front of a computer. He rated his pain as a 3/10 on the 0-10 Numeric Rating Scale (NRS) and reported an average NRS score for the past 24-hours of 4/10 (current: 3, best: 3, worst: 5). The patient reported a Disablement in the Physically Active (DPA) Scale score of 30 and a Patient Specific Functional Scale (PSFS) score of 6.5/10 – left cervical rotation was a 7 and typing at computer a 6. The patient reported no history of shoulder or thorax injuries.

The patient described a constant pain adjacent to the medial scapular border (3/10 NRS) which would get worse after extended periods of being stationary, such as sitting at a computer. A palpable spasm was present with palpable tenderness. Cervical motions which exacerbated the pain were: left rotation, cervical flexion, and right lateral flexion. Left trunk rotation and left side lying also caused an increase in pain. Shoulder flexion and internal were limited on the left side however measurements were not collected. On postural analysis, the left scapular was observed to be depressed, protracted, and upward rotated compared to the right.

**Treatment History**

Initially, it was suspected the apparent muscle spasm could be causing the patient's symptoms. Therefore, a brief application of Positional Release Therapy (PRT) to reduce the tender point was attempted to test this theory. Two 90-second treatment applications did not have an effect on the muscle spasm, therefore it was suspected that the altered postures, scapular dyskinesia, along with poor posture while typing were the root cause. The patient was assessed and treated through the Myokinesthetics System (MYK) (Brody, Baker, Nasypany, & May, 2014b) with the goal of restoring proper posture and effectively resolving symptoms. Total Motion Release (TMR) (Gamma, Baker, Iorio, Nasypany, & Seegmiller, 2014) was later incorporated to into his treatment protocol to resolve the unilateral movement imbalances.

The application of each treatment did produce short-lasting decreases in pain and slight increases in function, however, the patient would return with equal or increased pain. On the 4th visit, 14-days post initial evaluation, the patient reported no change on the DPA Scale, increased pain, and decrease in function compared to intake - current NRS of 5/10, PSFS of 5 for head rotation and ability to sit at his computer for a long time (Table 1). Myokinesthetics was discontinued at this time and TMR was continued with the goal of providing better patient education and improving patient compliance with TMR home exercises. The patient returned on the 5th visit, two days later, with an increased ability to rotate his head, PSFS of 9, however no significant change in DPA Scale score or level of pain (Table 1). He reported continued non-compliance with TMR exercises due to increased stress from work and school. The patient also expressed feelings of exhaustion due to his current work-load and frustration with his shoulder pain. At this point, the clinician decided to change the course of treatment to a psychosocial treatment intervention. It should be noted that although MYK and TMR are both novel treatments with only limited evidence, they have proven to be extremely effective at producing positive and immediate patient outcomes (Baker, Hansberger, Warren, & Nasypany, 2015; Brody, Baker, Nasypany, & May, 2014a).

**Implementing Trauma Releasing Exercises**

The patient was asked if he would like to try an exercise program designed to alleviate stress and anxiety. The patient was willing to try anything that would help decrease his stress and pain. A quiet room was chosen for the treatment, to limit distractions, and the patient was instructed on the purpose of the treatment paradigm as well as what to expect during the treatment. The clinician proceeded to walked the patient through the exercises and performed them alongside the patient. The total time for TRE session from start to finish was approximately 30 minutes. Immediately after treatment, the patient reported feeling relaxed, less stressed, and slightly sedated. The treatment produced a decrease in shoulder pain, from a 4/10 pre-treatment to a 3/10 post-treatment; no immediate improvement was produced in PSFS scores. The patient returned for his 1st visit post TRE intervention application five days later (6th visit over-all), feeling completely recovered; DPA Scale score was 6, NRS 0/10 within the past 24-hours, and PSFS of 10 for all activities (Table 1). Despite being asymptomatic, the patient was taken through one more session of TREs to help him learn the technique. The patient was discharged at this time and encouraged to continue using TREs on a regular basis as a prevention program.

**Results of Outcome Measures**

Various patient-oriented outcomes were administered throughout this patient case. Course of treatment was guided by the regular assessment of patient-oriented evidence. The DPA Scale, PSFS, and NRS were all administered regularly throughout the patient's course of care. On visit one the patient reported a DPA Scale score of 30, PSFS score of 6.5 – 7 for left cervical rotation and 6 for typing at computer, and an average NRS score of 3 – 3 current, 3 at best, 5 at worst in the past 24-hours. Minimal clinically important differences (MCID) were achieved in NRS scores immediately after treatment on visits 2, 3, and 4; however, pain returned or increased on all follow-up visits (Table 1). A large increase in PSFS for cervical rotation was reported on visit 5, enough to produce an MCID on PSFS, however the score for typing at a computer remained unchanged. Trauma Releasing Exercises were implemented on visit 5 and on visit 6, two days later, an MCID was reported on DPA Scale, PSFS, and NRS. The DPA Scale score dropped 24-points, resulting in a normal score for discharge (Vela &

Denegar, 2010); PSFS and NRS scores were reported to be 10 (able to perform activities at normal pre-injury level) and 0 (no pain) respectively.

**Discussion**

Like most practitioners (Sobel, 1995), the clinician in this case began treating the patient's shoulder girdle pain solely with physical treatment interventions. However, after four consecutive treatments with minimal effects, the patient's high-stress lifestyle and current frustrated state (at the time of visit 5) were taken into account. Upon closer examination of the patient's initial DPA Scale scores, it was found that 40% of the total score (DPA Scale score of 30) was attributed to disabilities in his general "well-being"; i.e. stress, pressure, anxiety, altered relationships, and mood. Although this area was still reported as the main issue after the initial TRE treatment, it was only reported as "slightly" problematic or "does not affect me". The patient could have potentially been discharged in fewer visits, had the clinician addressed his stress and well-being prior to applying physical interventions.

It is important for athletic trainers to be equipped with the techniques needed to prevent future re-injury; this includes techniques of stress-management and psychosocial intervention. In a study conducted on mice in which one group was allowed to shake after being exposed to trauma while the other was impeded from shaking, the group allowed to shake was more resilient to subsequent induced traumas (Porges, 1995). Trauma-releasing exercises are easy to learn and easy to apply. Furthermore, because the treatment is delivered through a sequence of stretches and exercises, TRE treatment the patient without the stigma that other psychosocial treatments might carry. The technique has been used on individuals and in large group settings, and has shown positive therapeutic results in many patients suffering from post-traumatic stress disorder (Berceli, 2005). While the patient in this case did experience complete resolution of his pain, he does not plan to alter his stressful environment. Therefore, trauma-releasing exercises may be an effective way for the patient to manage his constant exposure to stress and anxiety, and prevent future injury.

## Conclusion

The patient in this case experienced a full resolution of symptoms after a single application of trauma-releasing exercises. The results of this case provide clinicians evidence for the use of TREs to help treat musculoskeletal injuries in patients also experiencing stress and anxiety. While the results are favorable, the outcomes are based on a single case-study. Evidence for the efficacy of TREs in populations suffering from PTSD exists, as well as support for the use of TREs in high-stress work environments. However, future research on the treatment of musculoskeletal injuries in a larger sample of patients experiencing stress and anxiety is encouraged.

## Appendices

**Table 1.** Summary of outcomes collected over the course of treatment.

| *Visit* # | Days Since Previous Visit | Treatment | DPA Scale | PSFS (Turning Head) | PSFS (Typing at Computer) | PSFS Average | NRS (Current) | Post Treatment NRS |
|---|---|---|---|---|---|---|---|---|
| *1* | - | MYK | 30 | 7 | 6 | 6.5 | 3 | 2 |
| *2* | 2 | MYK & TMR | | 8 | 4 | 6 | 3 | 1* |
| *3* | 5 | MYK | | 7 | 5 | 6 | 3 | 1* |
| *4* | 7 | TMR | 30 | 5 | 5 | 5 | 5 | 2* |
| *5* | 2 | TRE | | 9* | 5 | 7* | 4 | 3 |
| *6* | 5 | Discharge | 6* | 10 | 10* | 10* | 0* | 0* |

Abbreviations: DPA = Disablement in the Physically Active (0-64); NRS = numerical rating scale (0-10); PSFS = Patient-Specific Functional Scale (0 = unable to perform, 10 = able to perform at a normal level); MYK = Myokinesthetics; TMR = Total Motion Release

*Denotes minimal clinically-important difference (MCID).

**References**

Avey, H., Matheny, K. B., Robbins, A., & Jacobson, T. A. (2003). Health care providers' training, perceptions, and practices regarding stress and health outcomes. *Journal of the National Medical Association*, *95*(9), 833, 836–45. Retrieved from http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2594476&tool=pmcentrez&rendertype=abstract

Baker, R. T., Hansberger, B. L., Warren, L., & Nasypany, A. (2015). A novel approach for the revearsal of chronic apparent hamstring tightness: A case report. *International Journal of Sports Physical Therapy*, 10(5), 723–733.

Berceli, D., & Napoli, M. (2006). A proposal for a mindfulness-based trauma prevention program for social work professionals. *Complementary Health Practice Review*, 11(3), 153–165. http://doi.org/10.1177/1533210106297989

Brody, K., Baker, R. T., Nasypany, A. M., & May, J. (2014a). Treatment of chronic low back pain using the MyoKinesthetic system: Part 2. *International Journal of Athletic Therapy & Training*, 20(5), 22–28.

Brody, K., Baker, R. T., Nasypany, A., & May, J. (2014b). The MyoKinesthetic™ system, part 1: A clinical assessment and matching treatment intervention. *International Journal of Athletic Therapy & Training*, 20(4), 1–9.

Davis, M. C., Zautra, A. J., & Reich, J. W. (2001). Vulnerability to stress among women in chronic pain from fibromyaliga and osteoarthritis. *Annals of Behavioral Medicine*, 23(3), 215–226.

Eisenberger, N. I., Jarcho, J. M., Lieberman, M. D., & Naliboff, B. D. (2006). An experimental study of shared sensitivity to physical pain and social rejection. *Pain*, 126(1-3), 132–138. http://doi.org/10.1016/j.pain.2006.06.024

Gamma, S. C., Baker, R. T., Iorio, S., Nasypany, A., & Seegmiller, J. G. (2014). A total motion release warm-up improves dominant arm shoulder internal and external rotation in baseball players. *International Journal of Sports Physical Therapy*, 9(4), 509–17. Retrieved from http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4127513&tool=pmcentrez&rendertype=abstract

Kivimäki, M., Leino-Arjas, P., Virtanen, M., Elovainio, M., Keltikangas-Järvinen, L., Puttonen, S., … Vahtera, J. (2004). Work stress and incidence of newly diagnosed fibromyalgia: Prospective cohort study. *Journal of Psychosomatic Research*, 57(5), 417–22. http://doi.org/10.1016/j.jpsychores.2003.10.013

Papousek, I., Schulter, G., & Premsberger, E. (2002). Dissociated autonomic regulation during stress and physical complaints. *Journal of Psychosomatic Research*, 52(4), 257–66. http://doi.org/10.1016/S0022-3999(02)00298-2

Porges, S. W. (1995). Orienting in a defensive world: Mammalian modifications of our evolutionary heritage. A polyvagal theory. *Psychophysiology*, 32, 301–318.

Rhudy, J. L., & Meagher, M. W. (2000). Fear and anxiety: Divergent effects on human pain thresholds. *Pain*, 84(1), 65–75. http://doi.org/10.1016/S0304-3959(99)00183-9

Rhudy, J. L., Williams, A. E., McCabe, K. M., Russell, J. L., & Maynard, L. J. (2008). Emotional control of nociceptive reactions (ECON): Do affective valence and arousal play a role? *Pain*, 136, 250–261. http://doi.org/10.1016/j.pain.2007.06.031

Schlereth, T., & Birklein, F. (2008). The sympathetic nervous system and pain. *NeuroMolecular Medicine*, 10(3), 141–147. http://doi.org/10.1007/s12017-007-8018-6

Sobel, D. S. (1995). Rethinking medicine: Improving health outcomes with cost-effective psychosocial interventions. *Psychosomatic Medicine*, 57, 234–244.

Vela, L. I., & Denegar, C. R. (2010). The Disablement in the Physically Active Scale, part II: The psychometric properties of an outcomes scale for musculoskeletal injuries. *Journal of Athletic Training*, 45(6), 630–641. http://doi.org/10.4085/1062-6050-45.6.630

# APPENDIX B: EXTENSION OF PROTOCOL APPROVAL FROM INSTITUTIONAL REVIEW BOARD FROM THE UNIVERSITY OF IDAHO

University of Idaho

January 22, 2016

**Office of Research Assurances**

**Institutional Review Board**

875 Perimeter Drive, MS 3010
Moscow ID 83844-3010
Phone: 208-885-6162
Fax: 208-885-5752
irb@uidaho.edu

To: James May

From: Sharon Stoll
Chair, University of Idaho Institutional Review Board
University Research Office
Moscow, ID 83844-3010

Title: 'Doctor of Athletic Training Clinical Outcomes Database'
Project: 15-586
Approved: 02/02/16
Expires: 02/01/17

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On behalf of the Institutional Review Board at the University of Idaho, I am pleased to inform you that the **first-year extension** of your proposal is approved as offering no significant risk to human subjects as no changes in protocol have been made on this project.

This extension of approval is valid until the date stated above at which time a second extension will need to be requested if you are still working on this project. If not, please advise the IRB committee when the project is completed.

Thank you for submitting your extension request.

Sharon Kay Stoll

Sharon Stoll

University of Idaho Institutional Review Board: IRB00000843, FWA00005639

# APPENDIX C: PROTOCOL APPROVAL FROM INSTITUTIONAL REVIEW BOARD FROM THE UNIVERSITY OF IDAHO

**University *of* Idaho**
**Office of Research Assurances**
**Institutional Review Board**

| | |
|---|---|
| To: | James May |
| From: | Jennifer Walker<br>Chair, University of Idaho Institutional Review Board<br>University Research Office<br>Moscow, ID 83844-3010 |
| Date: | 2/2/2015 12:40:43 PM |
| Title | Doctor of Athletic Training Clinical Outcomes Database |
| Project: | 15-586 |
| Approved: | February 02, 2015 |
| Renewal: | February 01, 2016 |

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On behalf of the Institutional Review Board at the University of Idaho, I am pleased to inform you that the protocol for the above-named research project is approved as offering no significant risk to human subjects.

This study may be conducted according to the protocol described in the application without further review by the IRB. As specific instruments are developed, each should be forwarded to the ORA, in order to allow the IRB to maintain current records. Every effort should be made to ensure that the project is conducted in a manner consistent with the three fundamental principles identified in the Belmont Report: respect for persons; beneficence; and justice.

This IRB approval is not to be construed as authorization to recruit participants or conduct research in schools or other institutions, including on Native Reserved lands or within Native Institutions, which have their own policies that require approvals before Human Participants Research Projects can begin. This authorization must be obtained from the appropriate Tribal Government (or equivalent) and/or Institutional Administration. This may include independent review by a tribal or institutional IRB or equivalent. It is the investigator's responsibility to obtain all such necessary approvals and provide copies of these approvals to ORA, in order to allow the IRB to maintain current records.

As Principal Investigator, you are responsible for ensuring compliance with all applicable FERPA regulations, University of Idaho policies, state and federal regulations.

This approval is valid until February 01, 2016.

Should there be significant changes in the protocol for this project, it will be necessary for you to submit an amendment to this protocol for review by the Committee using the Portal. If you have any additional questions about this process, please contact me through the portal's messaging system by clicking the 'Reply' button at the top of this message.

Jennifer Walker

University of Idaho Institutional Review Board: IRB00000843, FWA00005639

University of Idaho - Office of Research Assurances, IRB. 875 Perimeter Drive, MS 3010, Moscow ID 83844-3010
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