Analysis of Patient Outcomes Using the MyoKinesthetic™ System in a Treatment-Based Classification System for Low Back Pain: 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 Kari Brody, submitted for the degree of Doctor of Athletic Training with a Major in Athletic Training and titled "Analysis of Patient Outcomes Using the MyoKinesthetic™ System in a Treatment-Based Classification System for Low Back Pain: 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 culminating project in the Doctor of Athletic Training program is a Dissertation of Clinical Practice Improvement (DoCPI). The DoCPI is intended to highlight an athletic trainer's transition into a scholarly practitioner. Included in this comprehensive document is a Plan of Advanced Practice, which contains an insightful analysis of current clinical practice, professional goals, strengths and weaknesses, and a plan for goal attainment. Reflective practice is illustrated through narrative blog excerpts and a description of clinical residency impact. Clinical growth and understanding of the principles of action research and practice-based evidence are provided through a summary of patient outcomes, an analysis of data, and the creation of several manuscripts. Evidence of scholarly practice would not be complete without the inclusion of an original applied clinical research project. Structured to improve patient care, this *a priori* investigation analyzes patient outcomes with the use of the MyoKinesthetic™ System for patients with low back pain. Combined with a thorough literature review on the topics of low back pain treatment and Treatment-Based Classification systems, this action research project demonstrates a clinician's path toward scholarly advanced practice.

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DEDICATION

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CHAPTER 1

NARRATIVE SUMMARY

First recognized as a healthcare profession in 1990, athletic training (AT) continues to evolve, working to match the growing educational and clinical demands of healthcare. The shift from a professional AT degree at the baccalaureate level to one at the master's level demonstrates this continual evolution toward clinical growth. While AT programs continue to produce professional-level clinicians at both the baccalaureate and master's levels, the Doctor of Athletic Training (DAT) degree was developed to create an advanced clinical doctorate in AT. The DAT degree is similar, conceptually, to other academic doctoral programs, but the products differ. Through a multidisciplinary approach, the goal of the DAT program is to produce clinicians who demonstrate advanced knowledge, scholarly practice, and improved clinical-reasoning skills. Currently, the DAT program is the only AT post-professional degree that is structured to facilitate the development of expertise in AT practice by providing students with the resources necessary to pursue their individualized area of advanced practice (Nasypany, Seegmiller, & Baker, 2013).

A professional practice dissertation (PPD) is often a component of doctoral programs whose focus is on relevant field experiences that serve to prepare students for advanced clinical practice (Willis, Inman, & Valenti, 2010). The purpose of a PPD is to develop solutions to "real world" clinical problems using theoretical knowledge (Willis et al., 2010). Similarly, DAT students develop a PPD that is referred to as the Dissertation of Clinical Practice Improvement (DoCPI). The DoCPI is an evidence-based capstone project that serves to highlight students' progress toward advanced practice through an in-depth analysis of patient care experiences and clinical decision-making. Advanced practice is defined as "the attainment of a specialized focal area through increased knowledge, development of skills, and reflection of patient care outcomes" (Nasypany et al., 2013). Advanced practice AT clinicians must also become scholarly practitioners who are successful in analyzing data, discovering new theories, and sharing what they have learned (Knight & Ingersoll, 1998). In the DoCPI, DAT students also demonstrate their understanding and application of evidence-based practice (EBP) and practice-based evidence (PBE) through the completion of an applied clinical research project and manuscript.

The concept of EBP was developed from evidence-based medicine as a means to place more emphasis on using the best evidence to guide decisions about patient care. Patient-centered care values the comprehensive health status of each patient and incorporates patient-rated outcome measures as a means to identify and address all aspects of the patient's disability (Valier, Jennings, Parsons, & Vela, 2014). The process of EBP includes: (1) an acquisition of the best evidence, (2) the use of clinical expertise, and (3) a focus on the specific needs of the patient (Hurley, Denegar, & Hertel, 2011). Rather than ignore clinical judgment, EBP allows clinicians to combine the best of scientific research with professional experience. The end result is a synthesis of information and a method for improving patient care.

Initially, evidence-based medicine was not welcomed by athletic trainers due to perceived barriers, such as time, lack of resources, and knowledge of EBP concepts (Valier et al., 2014; Welch et al., 2014). Although athletic trainers recognized the value in incorporating EBP into AT, they were hesitant to facilitate this change in their clinical practice (Welch et al., 2014). In an effort to provide more EBP resources and mentorship, the National Athletic Trainers' Association (NATA) developed Web-based modules, which were made available to athletic trainers as a means by which to transform knowledge into action (Welch et al., 2014). Unfortunately, an increase in knowledge does not always guarantee a shift in clinical practice, and EBP continues to be absent from most athletic training settings (Valier et al., 2014).

The DAT faculty address concerns surrounding EBP during the first semester in the program while providing the curricular foundation and the guidance necessary to initiate change in various clinical settings. In these clinical settings, which are otherwise known as clinical residency sites, DAT students utilize new knowledge and skills, under structured supervision, while providing patient care. Through the residency experience, students learn how to produce PBE in their clinical setting by collecting global outcomes on their patient care (Nasypany et al., 2013). Practicing within the guides of PBE, DAT students analyze the results obtained from their patient outcomes and incorporate this information with the best available evidence in order to improve patient care.

Bench research is conducted in a controlled laboratory setting under strict conditions. Randomized controlled trials (RCT), a form of bench research, are defined to identify cause-and-effect relationships while limiting selection bias and confounding factors (Wilkerson & Denegar, 2014). A disadvantage of RCTs is that they often do not mimic the athletic training clinical environment; therefore, the results may not be applicable to all patient populations (Wilkerson & Denegar, 2014). In contrast, bedside (or field) research usually occurs in a natural setting. A combination of bench and bedside research is termed translational research, or “bench-to-bedside” research, because it combines the basic science in bench research with investigations on patient care in a natural setting (Hurley et al., 2011). At the heart of translational research is PBE, which is conducted in real world clinical settings to solve real world clinical problems. Clinicians generating PBE are able to draw upon their knowledge of the latest evidence and answer clinically relevant research questions. Through clinical residency, DAT students use real world patient outcomes to develop theories to support the effectiveness of assessment and treatment techniques. In addition to the raw data obtained from patients through PBE, DAT students also augment their existing knowledge by exploring the available research on their chosen topics. The combination of in-depth foundational knowledge and hands-on research experience allows clinicians to overcome the previously mentioned barriers to integrating PBE and EBP into clinical practice.

The terms, *EBP* and *PBE*, cannot be discussed without mentioning action research. The purpose of action research in healthcare is to bring about a specific change in patient outcomes by utilizing methods to improve clinical practice (Koshy, Koshy, & Waterman, 2011). Action research is a continuous cycle involving action, assessment, critical reflection, and implementation of changes (Koshy et al., 2011). Action research has been described as an ideal method for creating professional development because it provides a link between theory and practice (Farrell, 2015). In the DAT, students learn how to apply an action research model to solve local clinical problems (e.g. treatment for ankle sprains), rather than to generate global theories. Initially, students are asked to identify a problem or condition that requires further investigation in order for it to be thoroughly understood. Through detailed analysis of the current published literature that addresses their chosen topics, students gain comprehensive knowledge about their subject matter and develop solutions to the problems that initially intrigued them. The solutions, in turn, benefit the patients and clinical practice. The flexibility and informal nature of action research designs have been fostered in healthcare, social work, and education (Koshy et al., 2011).

Greater understanding through action research is not possible without continuous and purposeful reflection. The importance of reflective learning, which is a vital component of the DAT, cannot be understated. Although I was initially uncomfortable with this form of learning, I grew to appreciate its benefits. *Thinking-in-action* occurs when reflective practice combines experience, skill, knowledge, and intuition to solve a problem (Farrell, 2015). Reflective practice that allows the clinician to systematically review the outcomes and process of problem solving in order to improve professional practice is termed *thinking-on-action* (Farrell, 2015). In the DAT program, students utilize both thinking-in-action and thinking-on-action to analyze their clinical decision-making processes and improve their clinical practice. While collecting global patient outcomes, DAT students are taught to reflect on their evaluation methods, treatment selections, and the results of each of their interventions. Reflections are recorded frequently in weekly journals and patient care documentation. The dissemination of information in the weekly journals facilitates ongoing discussions between students and faculty about clinical practice and patient care. The discussions allow DAT students to view each topic that they and their classmates have written about from many different perspectives. The reflection on patient outcomes also provides further evidence of students' progress toward advanced practice and the ability to demonstrate scholarship.

While I quickly embraced the DAT program's message of developing scholarly practice, I did not realize how profound an impact it would have on my clinical skills. Prior to the DAT program, I knew that integrating new knowledge with existing clinical expertise was essential to becoming a better clinician, but I did not know how or where to obtain this new information. I was one of the many athletic trainers to resist the adoption of EBP because I did not see clinical applicability in the journal articles I read or the symposia I attended. I failed to see the importance of bench research when it could not be conducted in my clinical practice, and the results did not translate to improved patient care in my local environment. Although my clinical practice was focused on patient-centered care, I lacked the tools necessary to make a change. The DAT became that vessel for change.

In the DAT program, I uncovered methods of integrating new information and skills with my previous clinical experience in order to produce PBE. Through DAT coursework, I learned how to locate and appraise the latest evidence to find meaning that applied to my patient care. I also successfully conducted action research in my clinical setting and produced results that were disseminated through publications and presentations. Further evidence of my clinical growth throughout my professional journey is illustrated in my DoCPI.

The DoCPI is a critical appraisal of my path toward advanced practice as supported by detailed reflection and analysis of my evolution as an AT clinician. Achievement of advanced scholarly practice begins with a plan and the development of specific, measureable goals. My plan of advanced practice (PoAP) is described in Chapter 2 of the DoCPI and chronicles my reflective journey as a DAT student. My PoAP also includes a description of the quantifiable goals associated with becoming an advanced practice clinician. The PoAP begins with an analysis of how my professional knowledge and experience led me to seek a terminal degree in AT. Following the description of my previous experiences, I provide critical insight on my current professional knowledge, strengths and weaknesses, and development of clinical philosophies. My primary area of focus within the PoAP is manual therapy techniques for acute and chronic injuries. My goal to improve expertise and competence within the manual therapy arena led me to make the achievements that are outlined within Chapter 2.

Additionally, future goals are listed to provide further evidence that I will continue on the path toward advanced practice beyond the DAT program.

Collecting and analyzing global patient outcomes is another necessary step in my progression toward becoming an advanced practice clinician. In Chapter 3, I summarize the findings I accumulated over three semesters of clinical residency experience. Throughout this chapter, I include excerpts of my patient care reflections as accompaniment to my written discussion to demonstrate growth in my clinical and decision-making skills. The journal entries also highlight my reflective thoughts as my understanding of new intervention theories increases and I encounter challenges and successes while exploring how to collect PBE. Improvement in my data analysis is apparent from semester to semester as I transition from learning how to administer outcome measures to successfully developing a case series.

In Chapters 4 and 5, I offer evidence of increased knowledge about my chosen action research topic of low back pain (LBP) treatment through a literature review and corresponding *a priori* investigation. The literature review (Chapter 4) focuses on the prevalence of LBP, the efficacy of interventions used within the Treatment-Based Classification (TBC) system, and my selected intervention for LBP: the MyoKinesthetic™ (MYK) System. The *a priori* investigation and use of an action research philosophy to determine the effectiveness of the MYK System on LBP illustrates my ability to incorporate PBE and EBP into my clinical practice. The patient outcomes from this *a priori* investigation are described in further detail in Chapter 5 in an original applied research manuscript, which offers evidence of scholarship in my quest toward advanced practice. The results of my applied research study subsequently provide clinicians with new data regarding treatment of

LBP. Ultimately, the DoCPI highlights the impact of the DAT program on my clinical philosophies, patient care, and development into an advanced practice AT clinician.

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CHAPTER 2

PLAN OF ADVANCED PRACTICE: FINALIZED MARCH 6, 2015

Advanced practice requires a combination of clinical experience, solid foundational knowledge, and a desire to build expertise in a focused area. An advanced practitioner is skilled at reflecting on patient outcomes while building new clinical philosophies and theories. Through constant reflection and critical self-evaluation, an advanced practitioner is able to change his or her clinical practice and influence the athletic training profession by disseminating new concepts and practice-based evidence. Every goal or destination in life requires a path or plan, and advanced practice is no exception. The decision to be more reflective or to develop action research does not happen overnight. Expertise takes time and dedication and requires a focused, organized plan. The following Plan of Advanced Practice (PoAP) describes my progression toward becoming an advanced athletic training practitioner. Included in my PoAP is an analysis of my previous professional experiences and a rationale for pursuing a Doctor of Athletic Training (DAT) degree. In addition to a description of my professional experiences, my PoAP contains defined, measureable goals and methods for achieving these goals.

Reflection on Prior Clinical Competence

Professional Experience and Development

My path to the athletic training (AT) profession was unconventional, but it was formed through much reflection and through an evolution of my career goals. I graduated with a Bachelor of Science in education and intended to spend the remainder of my working life as a teacher. Initially unsatisfied with this choice, I pursued other careers before stumbling upon AT. While taking an anatomy class at a community college, I decided to volunteer in the AT clinic to determine if I was interested in the profession. Within a couple months I knew I had found my calling. The ability to make a difference in the lives of so many individuals was the central motivating factor for me in pursuing a career in the AT profession. My caring nature and athletic background made it easy to form connections with my patients. More importantly, I found a profession that I was passionate about and could imagine working in for the rest of my professional life.

I decided to pursue the internship route toward AT certification, since I had completed my Bachelor of Science degree. The internship program guidelines required me to complete 7 core AT classes along with 1500 hours of internship experience under the direction of a supervising athletic trainer. I placed tremendous value in the practical experience gained in the AT clinic, because I did not feel that the core classes provided all of the information I needed to become a successful athletic trainer. My belief was that if I spent more time in the clinic, I would gain the most important skills needed to identify and treat my intended patient population. At the time, it was commonly held among athletic trainers that the best athletic trainers were the ones with the most experience and the highest authority. I was determined to catch up to them.

Due to my age, maturity, and willingness to work, I was given many responsibilities as an athletic training student (ATS) intern. Many times, I was treated as an assistant athletic trainer, which affected coaches', patients', and administrators' perceptions of me. The supervising athletic trainer left me in charge of many practices and games, and I was allowed to travel with teams without his direct supervision. As a result, I viewed these clinical experiences as a critical component in my education, because they created feelings of clinical confidence as I entered the AT profession.

As an ATS intern, I believed that my clinical skills were progressing faster than those of ATSs from accredited AT programs. In my opinion, the didactic environment was inferior to my abundant, hands-on clinical experiences. Yet, while I valued my practical experiences, I lacked confidence because of my limited foundational AT knowledge. In an effort to increase my knowledge while still maintaining focus on developing my clinical skills, I made the decision to become an independent learner. One example of how I did this is my pursuit of an emergency medical technician (EMT) certification. Since I did not feel that the traditional AT classes prepared me to handle emergency situations with confidence, I took classes to become an EMT, and I have maintained that certification for 12 years.

After completing my internship requirements and passing the national board of certification, I accepted a graduate assistantship to best position myself for a career within an intercollegiate setting. Once again, I placed more value on obtaining independent clinical experience than formal AT education; therefore, I did not seek a graduate degree in AT. My post-professional Master of Arts degree was in health and physical education, and a majority of the coursework did not pertained to AT. I did, however, gain more experience working with a variety of sports. At the time, I considered this far more valuable than what was missing from my foundational knowledge.

Upon completion of my Master of Arts degree, I held one short-term job as an assistant athletic trainer before moving on to a head AT position at the same community college where I completed my internship. I was fortunate to return to a familiar and comfortable setting, which served to foster my growth as an administrator and clinician. The athletic director, who was also my supervising athletic trainer under the internship program, provided the mentorship I needed to successfully navigate my new supervisory role. As a result, I successfully navigated many of the administrative tasks associated with the position, such as conducting pre-participation physical exams, meeting with coaches, hiring AT staff, ordering supplies, monitoring the budget, and serving on committees. In addition to my administrative responsibilities, I was also asked to serve as a preceptor for several accredited AT programs. Due to my positive experiences as an intern ATS, I was eager to work as a preceptor, because it allowed me to incorporate teaching into my clinical setting and stay current in AT knowledge. Another advantage being the head athletic trainer, which was a role I held for seven years, was having the autonomy to work with a variety of inspiring individuals from various medical professions. As a result of these experiences, my motivation to excel in this profession has never waned.

Rationale for Pursuing a Doctor of Athletic Training Degree

My position as a head athletic trainer was extremely rewarding and was framed by many successful patient stories. As I neared the end of my seven-year stint, I realized that many of my previous goals had been attained, and I desired a new challenge. I knew that I had the potential to become a better clinician, and I recognized that I needed to fill in the gaps in my education in order for this to happen. My discovery of the DAT program came at an opportune time to make another career change. The DAT program seemed to be the appropriate avenue in which to pursue my new goals of becoming a better clinician and building my educational foundation. I also realized that these goals, when accomplished, would translate into becoming a better instructor and mentor, because I could share the latest advancements in knowledge and skills with more confidence. Having experienced the role of a head athletic trainer, I was curious about teaching within an AT program. The combination of teaching experience and a doctorate degree was appealing to me, because I thought I might be interested in transitioning into a faculty or administrative role in the future. Although it was difficult to leave a job I enjoyed, I was excited to set new goals for my career and to work to place myself in a position to be more qualified for a variety of jobs in the athletic training profession. I did not need any more motivation than this to pursue an advanced degree.

Reflection on Current Clinical Competence

Professional Knowledge

The DAT program has educated me in many ways, one of which is the importance of a solid didactic foundation. Although clinical experience is important, I have become keenly aware that a framework of foundational knowledge must guide my clinical practice. Prior to the DAT program, the manner in which I made clinical decisions was based on personal experience and observation rather than on foundational AT knowledge and evidence. As a result, many of my clinical choices were habitual and lacked purpose. I did not recognize this limitation in my practice until I began the DAT program. Through curricular coursework, presentations, and an analysis of research, I have learned how to incorporate new information and patient outcomes into my clinical reasoning. When I apply interventions, I analyze the supporting theories to gain a better understanding of when and why the treatments are successful with patients. As I develop justification for my decisions, I also find it easier to explain the reasons and purposes behind my actions. The explanations that have developed as a result of my improved understanding and increased knowledge are demonstrative of my progress toward advanced practice.

The addition of formalized self-reflection to my practice has improved my clinical skills. I utilize self-reflection to dissect my examination process and evaluate my methods of treatment application, which allows me to develop a deeper understanding of my clinical decision-making. The reflections have also been helpful in identifying weaknesses in my clinical skills or gaps in my foundational knowledge. As I incorporate the results of my critical analyses into my practice, I am able to make necessary adjustments to my methods and clinical reasoning. I have welcomed this opportunity to make timely corrections to benefit my patients.

Professional Strengths

Athletic training has been my passion for 12 years, and I have worked diligently to improve my skills and enhance my strengths. The overarching goal of the DAT program is to create a foundation for the improvement of clinical practice. Critically assessing and understanding one's strengths is helpful in constructing this foundation. Ruminations on my thought processes have helped to provide me with deeper analyses of my clinical practice and have helped me to identify positive areas within my practice. The following list highlights my current professional strengths. Each item in the list includes an explanation of how it has shaped my path toward advanced practice.

- <u>Patient rapport</u>: I first recognized this strength in my practice prior to the DAT program, but I have continued to build upon it while working in a new clinical setting. Although I now work with a much different patient population than I did at the community college, I have maintained that same trust and respect with each patient. I consider myself to be compassionate and a natural listener, both of which are qualities that patients appreciate in a clinician. Many times, patients are frustrated by the lack of time devoted to their injury by other healthcare professionals; my caring approach helps to restore their hope. I also believe in sharing my knowledge with each patient and always providing honest feedback. Accordingly, the knowledge I have gained while in the DAT program has helped to improve my communication skills with patients, and it allows me to provide better explanations of their injuries, pain, and reactions to treatment. As I exhibit more confidence in my clinical skills, that confidence carries over to the patient's belief in healing.

- Collection of patient outcomes: I have always been an organized person, but the DAT program has taught me how to apply that skill to my evaluation methods. The development of *a priori* research designs requires following a structured plan and performing each assessment with consistency. Similar to any skill, conducting research requires practice; but the application of an organized approach has allowed me to successfully collect data on several different research studies. In order to efficiently manage the demands of doctorate coursework, teaching, and clinical practice, I have relied on my organizational strengths and my ability to effectively prioritize responsibilities.
- Diversity of intervention options: I am very pleased to add this to my list of strengths, as it was one of the areas that I wanted to improve prior to my enrollment in the DAT program. Over the course of the last two years, I have completed numerous classes on interventions (i.e., Mulligan Concept, Positional Release Therapy, Primal Reflex Release Technique, MyoKinesthetic™ System, Total Motion Release, Thoracic Ring Approach, and Associative Awareness Technique) and have utilized my time in the AT clinic to improve my proficiency in multiple interventions. My approach to patient care has always been predominantly hands-on; I feel that these new interventions have given me more awareness when treating patients and have resulted in better outcomes. A well-rounded patient care approach is much more effective than a limited one, because pain can be caused by numerous factors and is a unique experience for each individual. My ability to

use a variety of interventions has allowed me to treat patients with techniques that are specific to their conditions and are selected based upon their individual responses to the treatments.

- Pelvic girdle assessment and treatment: With my focus on LBP evaluation, and through the mentorship that I have received in the AT clinic, I have improved my skills in this area. Since I was distinctly aware of my inexperience with pelvic girdle (PG) assessment as a first-year DAT student, I took advantage of opportunities to practice in the AT clinic, while also reading material by Richard Jackson and Diane Lee. I now have multiple methods for treating PG dysfunction and can more accurately assess where dysfunction originates. My improvements in this area have not only resulted in positive patient outcomes, but they have also given me confidence to mentor other clinicians and ATSs.
- Evaluation and classification of injuries: Prior to the DAT, I focused primarily on identifying a specific pathoanatomic tissue during each patient evaluation. Once I located the painful structure, I applied a localized treatment. I did not realize how limiting this was until I began the DAT program. As we were introduced to more interventions and assessment methods, such as the SFMA, I had a difficult time attaching a specific diagnosis to my patients because my assessments and treatments were no longer focused on one particular body region. I quickly realized that I needed to shift my approach from local assessments to a global evaluation, which has been more effective in allowing me to identify the true source of dysfunction. The concept of classification has introduced even more clarity into my evaluation process. Classification has allowed me to place each of my patients into specific subgroups based on a global evaluation and the patient's response to treatment. I have eagerly embraced this change, because I no longer see a need

to apply a pathoanatomic diagnosis to most injuries. Applying treatments that quickly resolve conditions that I could not have changed prior to the DAT program also reinforces this concept of classification. For example, when a Mulligan Concept treatment produces an immediate resolution of symptoms, I find it much more logical to identify the injury as a positional fault than a sprain. My justification for this decision is that a positional fault can be corrected instantly, whereas a sprain takes time to heal. The implementation of classification into my practice translates into better patient outcomes, because I am able to apply a treatment that affects the source of pain.

- Mentoring students: Over the years, I have been fortunate to work with many ATSs, and I have enjoyed this responsibility as both a mentor and instructor. I hope that the passion for what I do inspires them and reaffirms their decision to pursue AT. I believe I am a positive role model for the students and that I never display an attitude of complacency. I enjoy learning from my ATSs and helping them assimilate information and translate it into practical application. I foster an environment that is conducive to learning new techniques that are designed to expose ATSs to a variety of assessment and treatment methods. Throughout their clinical experiences, I offer constant constructive feedback and allow ATSs the freedom to learn from their mistakes. I find each mentorship opportunity rewarding and continue to be inspired by the amount of growth and professionalism that is displayed by many ATSs.
- Openness to change: Throughout my professional life, I have experienced several different careers. None of this would have been possible if I were fearful of change. I believe that being open to change promotes growth and development and deters stagnation. I have relied on this strength in the DAT program, because it has enabled me

to embrace each new idea and technique without apprehension caused by previously-formed biases. Learning new skills is always challenging, but I have benefited from my openness to change and my ability to overcome barriers to change.

Areas for Improvement

Reflection on my current areas for improvement is equally important in the quest toward advanced practice. I am naturally a reflective practitioner, and I gained a greater appreciation for this skill when I began the DAT program. My reflections are now focused on developing ways to improve my patient care. I have learned how to analyze each choice and decision, which has translated into more purposeful action in my clinical practice. As I increase my knowledge and use reflection to provide logical reasoning behind my decisions, I recognize that these are noticeable changes from my previous practice as a head athletic trainer. In an effort to continue this intellectual and clinical growth, I have identified the following areas of my practice that are in current need of improvement:

- Foundational knowledge: Expanding my clinical practice and intervention strategies to improve patient care has helped me to identify gaps in my foundational knowledge. As such, I have worked to develop a better understanding of functional anatomy, pain theories, and physiology of healing; but I have only scratched the surface. Teaching has been one of the most effective methods through which I have expanded my knowledge, since instruction requires a thorough explanation of concepts at a level that is easily understood by many. I have been able to assess my growth in this area each semester as my explanations improve and I am more proficient at answering student questions. Other methods that I have utilized to gain a deeper understanding of the mechanisms, assessments, and treatments of various injuries are reading research and completing courses.

- Conducting research: Currently, research produced by athletic trainers is limited, and the AT profession is encouraging clinicians to generate practice-based evidence. While in the DAT program, I have developed a strong base for conducting and disseminating research through the creation of four manuscripts, all of which were submitted for publication. In addition, I have also had two presentations accepted at a regional AT conference. I realize that I have just begun to emulate scholarly practice, and I need more experience in the areas of research design, statistics, and scientific writing in order to increase my confidence and become more proficient.
- Gaining confidence and competence in my practical skills: While in the DAT, I have learned a variety of interventions; but two years is not a sufficient amount of time to become competent in every technique. In order to increase my confidence with an intervention, I need time to utilize the technique on a variety of patients while also reflecting on the results through examination of patient outcomes. The combination of practical experience and critical analysis of my methods is essential in building proficiency and ultimately improving patient care.

Path to Advanced Practice

Once I began the DAT program, I realized that I was taking my first steps along my path toward advanced practice. The DAT program not only provides the foundation for clinical growth, but it also requires the creation of a path for the pursuit of advanced practice within the AT profession. The path is guided by individualized philosophies and is defined by the goals that one creates. While I acknowledge that changes will occur over time, the following represents my current clinical philosophies:

Philosophy of Clinical Practice

> *I strive to provide the best patient care by treating the "whole person" and not just an injury or symptom. In order to accomplish this, I utilize proper evaluation and classification methods to better ensure that the interventions result in positive outcomes. My clinical decision-making process continues to change as I develop a greater understanding of different treatment paradigms. Reflecting on my practice and patient outcomes helps guide me in future assessments and allows necessary adjustments to take place in a timely manner. I not only read current research, but I also contribute to new and existing theories to further substantiate my decision-making. Learning new interventions is critical to my practice, but becoming competent and comfortable is mandatory to success. I aspire to be a clinician that improves the quality of life of patients as well as one that inspires athletic training students to find passion in the AT profession.*

Rehabilitation Philosophy

> *As a clinician, I have always placed tremendous value on manual (or hands-on) therapy. In addition to the mechanical and neurophysiological benefits, manual therapy also affects the psychological component of the healing process. To me, there is nothing more satisfying than helping patients by providing the correct treatment based on their injury classification. My focus on patient-oriented evidence (POE) is much stronger than disease-oriented evidence (DOE) because POE is more meaningful to the patient and can subsequently influence DOE. With each patient I treat, I display a caring and confident attitude, because this can be just as important as the application of the intervention.*
>
> *While modalities such as electrotherapy, ultrasound, and laser have their purpose, they often ignore the source of dysfunction. For this reason, I tend to choose interventions that address the cause of injury and not the compensations. In order to identify the source of pain, I utilize the MyoKinesthetic™ (MYK) posture screen and Selective Functional Movement Assessment (SFMA). Both components complement a standard orthopedic clinical evaluation and provide a guide for treatment selection. Many therapies, such as Mulligan Mobilizations with Movement (MWM) and Reactive Neuromuscular Training (RNT), can be attempted at a sub-therapeutic level to determine their efficacy. If indicated, I attempt these therapies because they may provide instant and long-lasting relief. In my clinical experience with the MYK System, I have achieved numerous positive patient outcomes, which makes this my intervention of choice for a variety of injuries and conditions. For any injury, the ideal treatment produces instantaneous results, which improves the patient's physical, emotional, and spiritual state. My goal as a clinician is to be competent in many different forms of manual therapy that enhance various components of healing. Each*

patient is unique; I try to vary my treatment approach to match his or her specific needs.

Low Back Pain Rehabilitation Philosophy

As my area of focus and action research topic, I have provided my LBP philosophy:

Low back pain (LBP) is a prevalent condition regardless of the type of patient population. Additionally, the lack of a gold standard for diagnosis and treatment creates many challenges encountered by clinicians attempting to improve LBP patient outcomes. Education is a key component in many rehabilitation programs, and this is especially true of LBP conditions. An awareness of prevention and maintenance steps can help the patient avoid the frequent recurrences that plague many LBP patients. For this reason, I focus on educating each patient regarding LBP symptoms, posture, breathing, and proper movement patterns.

Each LBP patient may have a completely different symptom and pattern presentation from other patients. I conduct a comprehensive evaluation in an effort to locate the source of pain. The evaluation includes pelvic girdle movement, posture asymmetries, special tests, palpation, range of motion, and neurological function. In most cases, I prefer a global treatment, because LBP can be the result of a variety of compensatory patterns. I attempt to identify these compensations in the MYK posture assessment and SFMA Top Tier. I prefer to apply the MYK treatment on acute and chronic LBP patients before I apply any other intervention, due to my successful outcomes with the MYK System for this condition.

Based on my evaluation, the majority of my patients with LBP are classified into the MYK System or Mulligan treatment groups; occasionally, however, other interventions will be applied. If a patient's chief complaint is a tender or trigger point, then I attempt PRT to relieve the pain. With chronic LBP patients, the psychosocial aspect can directly influence the severity of the condition and the healing process. For these patients, I incorporate other emotionally-based therapies, such as tapping and Associative Awareness Technique. I also use independent treatments, such as Total Motion Release and Mechanical Diagnosis and Therapy, because they provide the patient with a means to control his or her condition while increasing the longevity of the effects of other interventions. Regardless of the intervention chosen, I expect all patients to experience a 50% or better reduction in pain after one visit. Rapid results are especially important with LBP patients, because this debilitating condition can significantly impact quality of life.

Area of Advanced Practice

My current position as an athletic trainer in a university AT clinic has provided numerous opportunities to gain clinical experience with a variety of conditions. Within this environment, I have adopted the use of many new interventions in order to effectively treat my patient population. My goal to become a more proficient and skillful clinician in my current clinical setting and in future clinical roles led to my decision to pursue manual therapy for acute and chronic injuries as my area of focus toward advanced practice. In the pursuit of advanced practice in manual therapy, I have focused on LBP with greater detail and direction, because it is the topic of my action research project. In order to effectively evaluate and treat LBP, I have also developed a better understanding of the Treatment-Based Classification (TBC) system.

The TBC system is used to match patients to specific treatments based on the patients' evaluations and responses to treatment. The addition of a TBC system to my practice and an increased focus on manual therapy interventions has been instrumental in improving my patient outcomes. Measures of clinical proficiency in relation to patient outcomes will be further discussed in Chapter 3.

Although there are numerous manual therapy interventions in existence, I was only familiar with a few prior to my enrollment in the DAT program. In my previous clinical practice, I frequently used the MYK System, mobilizations (Maitland), and massage. While these interventions did produce positive outcomes, I was not successful with every patient. As a result, I wanted to incorporate into my clinical practice more interventions that could improve my ability to treat a variety of conditions. I focused on the new interventions that are outlined below in an attempt to become more skillful in my application of manual therapy. In the following list I describe my specific areas of focus in my PoAP and my reasons for their inclusion in my practice:

- The MyoKinesthetic™ System: I chose to focus my action research on the use of this intervention for treatment of LBP. The MYK System has been a constant in my clinical practice for many years, but I was only using the treatment portion of the MYK System, not the assessment component. Once I became a certified MYK practitioner in Fall I, I realized the significance of the MYK System as a TBC system and began to incorporate the MYK posture screen into my evaluations. One of the primary benefits of the MYK System is the combination of a global assessment to identify the source, rather than site, of pain and a matching treatment aimed at clearing dysfunctions within the body. The DAT has reinforced the importance of global assessments, such as the MYK System, because an evaluation focused on determining the cause of pain provides the clinician with information to apply a treatment aimed at correcting the primary dysfunction. As I have correctly applied the MYK System in my clinical practice, I have observed significant improvements in my patient outcomes. I have also used the MYK System to effectively treat migraines, Reflex Sympathetic Dystrophy, PG dysfunction, and neck injuries.
- Additional treatment interventions: The ability to choose from multiple interventions to make significant improvements in pain and function is empowering. In addition to the MYK System, there are many other interventions that I have become clinically competent in that address both the local and global sources of dysfunction and pain. As I have learned more about proper assessment and locating the driver of pain, I have realized that each patient requires a unique approach to treatment. The ability to offer patients a specific treatment that is matched to their individual conditions requires a diversified clinical skill-set. Incorporating more interventions into my practice enables me to treat a variety of conditions. In addition, if one intervention fails to produce positive outcomes, I

can analyze why it did not work and apply an alternate treatment that may be more successful. The primary goal with each of the interventions I have studied is to clear the source of dysfunction causing pain. In my previous setting at the community college, it was rare to completely eliminate pain on the first visit. Not only is this a possibility now, but it is a common occurrence. Successful outcomes are less likely without a thorough understanding of the theory supporting each intervention. For this reason, I chose to focus on the practical application of each technique as well as the reasoning behind its use and its benefits to patient care. The primary interventions studied and incorporated into my clinical practice were:

- Associative Awareness Technique (AAT)
- Primal Reflex Release Technique (PRRT)
- Mulligan Concept
- Reactive Neuromuscular Training (RNT)
- Positional Release Therapy (PRT) or Strain-CounterStrain (SCS)
- Total Motion Release (TMR)
- Emotional Freedom Technique (EFT) or Tapping
- Trauma Releasing Exercises (TREs)
- Thoracic Ring Approach
- Emotion Code
- Energy Medicine

- <u>Self-improvement</u>: Another important step in becoming an advanced practitioner is developing a greater sense of awareness and an appreciation of mindfulness. We are all affected by the energy surrounding us on a daily basis, but we can also control how we react to these effects. I have completed classes in Yi Ren Qigong to understand how to feel and balance the body's energetic fields, which has translated into a greater awareness of my patients' energy levels. I have also read books on mindfulness, and I work to apply the principles of meditation and awareness into my daily life. When combined with tapping and EFT, mindfulness is a very effective tool in dealing with emotional stress and lessening its negative effect on the body. I believe that chronic pain is a result of our emotional, spiritual, and physical states, rather than just a sign indicating tissue damage. Exploring mindfulness and awareness has helped me to understand that pain and injury can be different experiences for each individual, because factors such as memory, environment, and beliefs contribute to each patient's perception of pain. A greater understanding of the causes of pain helps me to individualize each of my patients' treatments and assists me in focusing on my patients' specific needs, both emotionally and physically.

Objective and Subjective Assessment of Accomplishments

The path toward advanced practice is continuous and requires being focused on the voyage rather than the destination. My professional journey is guided by my passion for helping others through education and healing. Analysis of my progress along this path has revealed growth as a clinician as well as the development of goals that extend beyond the DAT program. The following outline represents the specific areas that I have demonstrated proficiency in and my accomplishments within each of these areas.

I. MyoKinesthetic™ System Theory and Application
   a. Examined supporting theory and foundational assessment principles for treatment efficacy
   b. Applied knowledge of pain theories to clinical decision making
   c. Applied technique and analyzed patient outcomes in clinical practice
   d. Became a Certified MYK Practitioner - November, 2013

e. Developed and conducted an action research project focused on analyzing patient outcomes with the use of MYK for LBP

II. Manual Therapy Interventions
  a. Mulligan Concept
    i. Completed lower quarter course - September, 2013
    ii. Completed upper quarter course - July, 2014
    iii. Completed Northeast Seminar (NES) video series – Fall, 2013
    iv. Read *Manual Therapy: NAGs, SNAGs, MWMs etc.* (Mulligan, 2010)
    v. Examined theories for treatment efficacy
    vi. Applied technique and analyzed patient outcomes in clinical practice
    vii. Read published literature related to application of Mulligan MWMs
  b. PRRT
    i. Completed home study course - August, 2013
    ii. Completed introductory course - January, 2014
    iii. Applied technique and analyzed patient outcomes in clinical practice
  c. PRT
    i. Completed spine and pelvis course - July, 2013
    ii. Completed lower body course - April, 2014
    iii. Completed upper body course - July, 2014
    iv. Read *Positional Release Therapy: Assessment and Treatment of Musculoskeletal Dysfunction* (D'Ambrogio & Roth, 1997)
    v. Applied technique and analyzed patient outcomes in clinical practice
  d. Thoracic Ring Approach
    i. Completed online lectures for assessment and treatment - October, 2013
    ii. Applied technique and analyzed patient outcomes in clinical practice
  e. Emotion Code
    i. Completed video seminar series - November, 2013
    ii. Incorporated technique into clinical practice and collected outcomes
  f. TMR
    i. Completed Level 1 course – November, 2014
    ii. Completed Level 2 course – February, 2015
    iii. Applied knowledge of pain theories to clinical decision making
    iv. Applied technique and analyzed patient outcomes in clinical practice
  g. AAT
    i. Incorporated technique into clinical practice and collected outcomes
    ii. Completed online course levels 1 – Fall, 2015

III. Evaluation and Classification of Musculoskeletal Injuries
  a. Completed NES video series on the SFMA - July, 2013
    i. Applied top tier and breakouts to clinical assessment and analyzed patient outcomes
  b. Completed MYK certification course - November, 2013 and 2014
    i. Incorporated MYK posture assessment into clinical practice and analyzed patient outcomes

c. Completed NES video series on Diagnosis and Treatment of Muscle Imbalances by Shirley Sahrmann - October, 2014
    i. Incorporate assessment into clinical practice and analyze patient outcomes

IV. Evaluation, Classification, and Treatment of Acute and Chronic LBP
a. Completed MYK certification course - November, 2013 and 2014
b. Read *Physical Therapy Management of Low Back Pain: A Case-Based Approach* (Chevan & Clapis, 2013) - December, 2013
c. Utilized TBC system algorithm (Stanton et al., 2011) to classify patients into subgroups
d. Utilized MYK System to treat each LBP patient
e. Collected data on clinical application of MYK treatment and recorded patient outcomes
f. Analyzed results to determine effectiveness of MYK for LBP

V. Professional Scholarship and Action Research
a. Read *Action Research in Healthcare* (Koshy, Koshy, & Waterman, 2011) – Fall and Spring, 2013-2014
b. Developed proficiency in statistics
    i. Analyzed action research and reliability data
    ii. Evaluated literature to determine the best use for each statistical test
c. Completed poster presentation at NWATA Annual Meeting and Clinical Symposium - "The Sway Balance Test Is Not Significantly Affected by Exercise" - March, 2014
d. Submitted abstract for NATA Annual Clinical Symposia - "A 5-Minute Injury Predicting Assessment…Too Good To Be True?" - July, 2014; rejected October, 2014
e. Submitted abstract for NWATA Annual Meeting and Clinical Symposium - "Treatment of Chronic LBP Using the MYK System: A Case Report" - November, 2014; accepted
f. Submitted manuscript for publication with IJATT - "Meniscal Lesions: The Evidence for the Physical Examination and Conservative Treatment" - September, 2014; recommended for publication
g. Submitted manuscript for publication with IJATT - "Treatment of Meniscal Lesions Using the Mulligan Squeeze Technique: A Case Series" - September, 2014; awaiting decision
h. Submitted manuscript for publication with IJATT – "The MYK System, Part 1: A Clinical Assessment and Matching Treatment Intervention" - October, 2014; accepted for publication
i. Submitted manuscript for publication with IJATT – "Treatment of Chronic LBP Using the MYK System: Part 2" – October, 2014; recommended for publication
j. Collect outcomes for a priori design on migraines, and create a case series to be submitted for publication – December, 2014
k. Complete DAT dissertation – in progress, anticipated May, 2015

VI. Self-Improvement
  a. Completed Qigong Level 1 course - September, 2013
  b. Completed Qigong Level 2A course - October, 2013

Goals for Professional Future

The DAT program represents a model for the future of AT, where clinicians become scholarly practitioners who incorporate evidence and outcomes into daily practice. Change begins with AT students, but it is the educators and preceptors that must ensure this change occurs. Athletic trainers must model the behavior they wish to see reflected in their students; therefore, they must demonstrate proper use of practice-based evidence and provide reasoning for their clinical decisions. As we develop more clinicians who are capable of and willing to become scholarly practitioners, the AT profession will gradually transform into the exemplary model displayed by the DAT program. I feel confident that I have transitioned from a DAT student into a clinician who embodies the future direction of the AT profession and who exhibits that change in my daily practice.

As I embark upon another change in my employment setting, I am hopeful that my patient care philosophy and diverse skill-set will be desired commodities. Prior to enrolling in the DAT program, I enjoyed my role as a head athletic trainer; however, I feel that I would be more successful in this role now, as a result of my improved clinical abilities in patient care and my greater understanding of pain and injury. My primary goal in obtaining my doctorate degree was to better serve my patients, and I feel that I have achieved that goal. The addition of multiple interventions and a more thorough assessment method has fueled my desire to continue to improve my clinical skills and has intensified my passion for healing. I also believe the AT profession needs preceptors and educators who can successfully combine patient outcomes with evidence and experience to improve patient care. Athletic training students need preceptors who can conduct and guide research and produce results that are disseminated through publications and presentations. The DAT program has prepared me to take on these roles while continuing my quest toward advanced practice.

I also believe that my knowledge and skills make me a distinctive educator with a unique perspective. Over the past two years, I have enjoyed serving as an educator in a professional Master of Science athletic training program. I also have 13 years of clinical experience which, combined with a new patient care philosophy and advanced skill-set, allows me to offer my students a wealth of information and a successful method for achieving positive outcomes. An ideal role for me, following the completion of the DAT degree, would be a combination of clinical and instructional responsibilities. At some point in my professional future, I may find administrative roles such as clinical coordinator or program director appealing. Currently, however, I prefer to focus on further exploration of my clinical skill-set and practice.

Regardless of the setting, it is my job to be a leader for change and to promote the DAT program's vision for this profession. Included in this vision is an overall focus on the improvement of patient care, which is supported by the collection of patient outcomes, the examination of current research, the move from critical self-reflection to direct decision-making, and the dissemination of scholarly products. As such, I have developed a number of goals that I plan to pursue upon completion of the DAT degree. The timeline for these goals will be ongoing and will be dependent upon my future employment setting.

I. Interventions
    a. Continue to incorporate each technique into clinical practice and collect data on patient outcomes to determine efficacy of treatment
        i. MYK System
        ii. Mulligan Concept
        iii. PRRT

        iv. PRT
        v. TMR
        vi. AAT
        vii. Thoracic Ring Approach
    b. Energy Medicine (Eden & Feinstein, 2008) – Summer, 2015
        i. Complete video courses
        ii. Incorporate into clinical practice and collect data on effectiveness
    c. Complete one or two new classes each year

II. Evaluation and Classification of Musculoskeletal Injuries
    a. Read *Anatomy Trains: Myofascial Meridians for Manual and Movement Therapists* (Myers, 2009) – Fall, 2015

III. Professional Scholarship and Action Research
    a. Submit manuscript for publication with JMMT – "Analysis of Patient Outcomes Using the MyoKinesthetic™ System in a Treatment-Based Classification System for Low Back Pain" – April, 2015
    b. Complete manuscript on the MYK System reliability data
    c. Conduct a follow-up study on the MYK posture screen and injury prediction – Fall, 2015 and Spring, 2016
    d. Develop *a priori* research designs for shoulder and knee pathologies
    e. Disseminate future action research results through manuscripts and conference presentations

IV. Self-Improvement
    a. Intuition
        i. Read *The Science of Medical Intuition* (Myss & Shealy, 2002) - Summer, 2015
        ii. Practice enhancing intuition skills when making clinical decisions
    b. Practice mindfulness daily
        i. Meditation
        ii. Qigong
        iii. Yoga
    c. Audible library
        i. Finish books already purchased
        ii. Add to collection

Justification for Plan of Advanced Practice

The PoAP is not just a two-year plan; it is the beginning of a longer path for my professional future. The PoAP has been instrumental in shaping my understanding of advanced scholarly practice. While in the DAT program, I have worked toward advanced practice by staying current on the latest evidence, incorporating new information into evaluation and treatment strategies, and collecting data on patient outcomes. Additionally, I have analyzed and disseminated my results in the form of scholarly products, the creation of which provides further evidence of my progress along the path toward advanced practice. As I transition into a DAT graduate, I will continue to add to my PoAP and provide parameters for advanced practice beyond the DAT program. In order to establish our own individuality in the healthcare industry, AT, as a profession, is in need of the type of clinical advancement achieved through the PoAP. The end result is not only more skillful clinicians, but also better educators and preceptors for ATSs.

On a personal level, the PoAP has provided the structure I needed to accomplish many goals, including some that I did not originally think possible. As a result of my achievements in the DAT program, I believe that my most important contributions to AT will be successful patient care and serving as a mentor for ATSs. Continuation of my PoAP is focused on further development of my clinical skills and foundational knowledge, and the dissemination of results. As the AT profession continues to evolve, I will make changes to my PoAP as dictated by my progress and the needs of the profession. The path toward advanced practice must remain fluid and open, because rigidness will only serve to hinder my growth and ability. The DAT program has provided the foundation for the type of clinical practice I always aspired to be a part of, and the exposure to different philosophies has opened the door to limitless possibilities for my future in the profession. Seeing our profession in a new light is exciting and motivating, and I am eager to be a part of the change to advance the AT profession.

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CHAPTER 3

OUTCOMES SUMMARY, RESIDENCY FINDINGS, AND IMPACT

The Doctor of Athletic Training (DAT) program facilitates an evolution toward scholarly practice through appropriate coursework and critical reflection. The knowledge and skills gained in the DAT program are demonstrated through changes in patient care and are evaluated through the collection of patient outcomes. The examination of patient outcomes provides athletic trainers with a means with which to measure their success as clinicians and their progress toward advanced practice. In this chapter, I will discuss the processes of collecting patient outcomes, reflecting on the results, and attaining predetermined goals while following a model of action research in the clinical setting. I will demonstrate my philosophical growth through detailed self-reflection and meaningful analyses of my clinical decision making. The examinations of my patient outcomes and residency findings that follow will provide the reader with a thorough understanding of my DAT clinical residency experience and its impact on my patient care philosophy.

Development of Patient Care Philosophy

My primary reason for entering the DAT program was that I desired to improve my patient care skills; therefore, the development of an inclusive philosophy was essential to my clinical practice. Before I entered the DAT program, my greatest challenge as a clinician was to select an appropriate intervention based on the identified diagnosis. Two primary pitfalls of my practice were a lack of experience with a variety of interventions, and a focus on the pathoanatomic diagnosis as the true source of pain. The DAT program not only provided me with the guidance I needed to identify these pitfalls, but it also offered me the direction I needed in order to create a more effective patient care philosophy.

As my knowledge base grew, I became less reliant on the biomechanical-pathological model and more focused on the patient-response model. In the biomechanical-pathological model, the clinician incorporates principles of biomechanics and arthrokinematics into evaluation and treatment (Chevan & Clapis, 2013). While these principles are important components of a musculoskeletal evaluation, I prefer an approach that is concentrated on adapting to the response of each patient. The patient-response model complements evidence-based practice (EBP) in that it places more emphasis on the patient's response to individual treatments than on a specific structural abnormality (Chevan & Clapis, 2013). The patient-response model also values the totality of the healing process and incorporates other bodily systems, such as energetic- and emotionally-based systems. I found the use of this model to be liberating, because it eliminated the need for a specific biomechanical diagnosis, which often complicated my clinical decision making. Instead, I began to focus on paradigms that included global assessments to identify the source, and not the site, of pain.

The research that I read on pain theories during the Fall I (first residency) semester in the DAT program also contributed to my understanding of the philosophies behind different treatment interventions. Researchers have been unable to identify one single pain center in the brain, which demonstrates the complexity of this sensation and the extent to which different body systems are involved. The *pain neuromatrix*, which is a term that is used to describe the various brain mechanisms that define the pain experience (Melzack, 2001), can also be used to explain the many causes of chronic pain. The research done on pain theories has improved my communication with patients concerning their condition and response to treatment. A major part of patient-clinician communication is patient education, which has also been demonstrated to be a valuable component in the healing process (Shacklock, 1999). The clinician must be able to produce a comprehensible explanation of the injury and the reasons for pain to his or her patients. As my knowledge base continues to grow, I will continue to share new information and theories with my patients in the hopes of improving their understanding of their pain, which will, in turn, facilitate their healing.

One practice that has helped me to attain greater scholarship is that of critical, formal self-reflection. *Experiential learning* is a term that is used to describe the combining of analytical reflection with experience, all for the purpose of increasing one's learning potential (Kolb & Kolb, 2009). While I believe in the power of learning by doing, I feel that it was the reflection part of this learning style that solidified my understanding of the different theories with which I was presented in my various classes.

Through continuous reflection, scholarly research, and insightful discussions, I have evolved as a clinician and have developed a patient care philosophy centered on the patient-response model of evaluation and treatment. The experiences I had over the course of my residency have helped to shape my philosophy as I continue along the path toward advanced practice. Each clinical decision that I now make is based on a wealth of reliable scientific information and the culmination of patient outcomes. I believe that this method is the foundation for solid practice-based evidence (PBE).

Overcoming Challenges

When it came to patient care, the DAT residency experience was not without its share of challenges. The combination of new information and unfamiliar skills caused me to work outside of my comfort zone during much of my clinical residency. Looking back, I believe that the successes I had and the struggles I met with were critical to my learning process.

One of the biggest challenges I encountered in the first couple of semesters in the DAT program was dealing with failure after having applied new interventions. Prior to the DAT program, I attributed a patient's lack of improvement to their decreased motivation or the presence of true tissue pathology. As a result of the material I studied and the skills I learned in the DAT program, however, the blame shifted entirely to myself as a clinician. I knew that the new interventions we learned were effective when used by other clinicians, so the failures I experienced had to be a result of clinician error rather than technique error. When a patient did not achieve positive outcomes following treatment, I was unsure if this was a result of selecting an inappropriate technique or of my inexperience with the technique. As I learned more about the theories behind each intervention and practiced my application of each technique, I began to see improvements in my patient outcomes. Additionally, I believe that the failures in outcomes were more pronounced to me because my expectations had changed. The possibility of eliminating pain with one treatment meant that I was no longer willing to allow a patient to leave the clinic without being completely pain-free.

Another noticeable challenge for me as a clinician was the change in settings. My previous position was in a collegiate environment, where I was responsible for treating patient-athletes. Currently, I am employed in a free clinic that serves the general population. The change in clinical settings provided me with contrasting experiences with patients. In the traditional athletic setting, I usually had to dissuade patients from returning to activity before they were completely healed. In the free clinic, however, I have seen a trend of fear-avoidance behaviors among patients, when it comes to the normal activities of daily living. The shift in behaviors between the two populations forced me to improve my communication skills with patients in order to better educate them about pain and injury. Additionally, I was exposed to psychosocial and energetic forms of treatment as another means to target the source of a patient's condition. The addition of these components to my practice has allowed me to successfully treat a more heterogeneous population.

Outcomes Collection

Fall I, 2013

When I began the DAT program in 2013, I had been a practicing athletic trainer for 11 years, and I believed I was competent in obtaining and documenting all necessary information about my patients. After just a short time in the DAT program, I realized that the primary weakness in this part of my practice, however, was the lack of inclusion of outcome measures that provided consistent and comparable information about pain, disability, and function. Prior to the DAT program, the Numeric Rating Scale (NRS) (Farrar, Young, LaMoreaux, Werth, & Poole, 2001) was the only form of patient-oriented evidence that I collected pre- and post-treatment. The NRS allowed me to determine decreases in pain following treatment, thereby establishing treatment success.

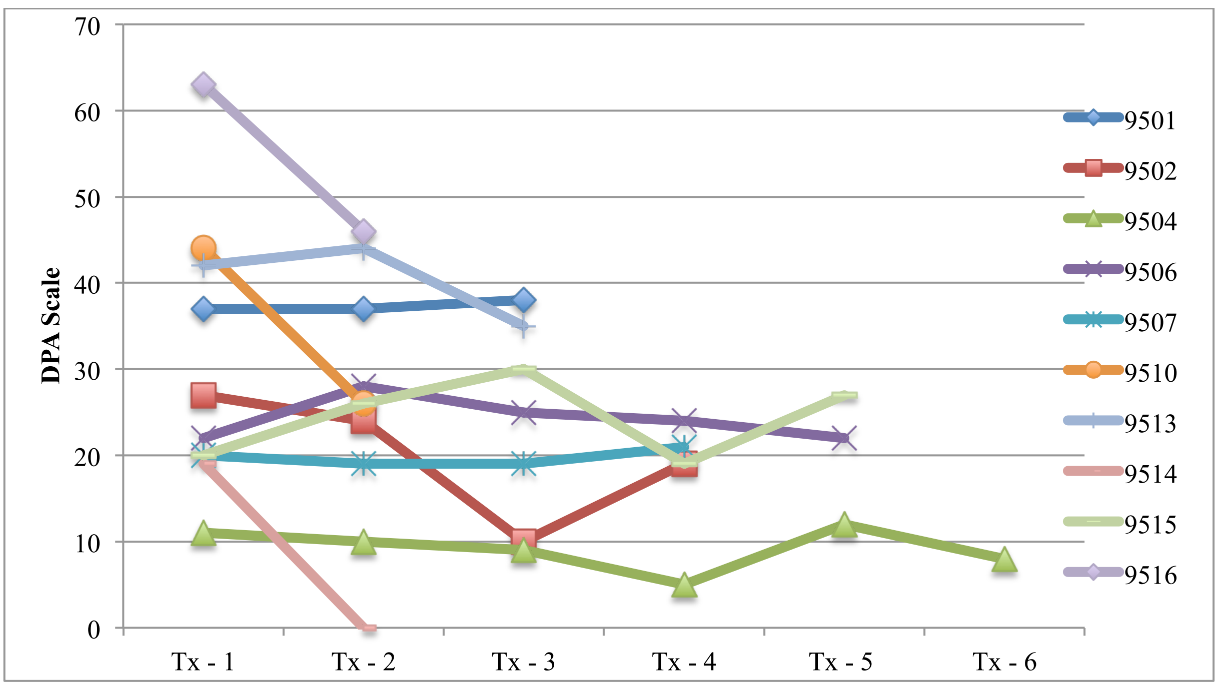
Following the first summer semester, which focused on EBP and PBE, I became determined to develop an efficient way to collect patient outcomes and incorporate the Disablement in the Physically Active (DPA) Scale—a multidimensional instrument designed to measure a patient's disablement and health-related quality of life (Vela & Denegar, 2010a, 2010b) —into my practice. I did not, however, discover the complexity of outcomes collection until I attempted it for the first time in the Fall I semester.

My initial step in the data collection process during the Fall I semester was the development of an Excel spreadsheet that contained information I perceived as important, such as injury diagnoses or classifications, pre- and post-treatment DPA Scale and NRS scores, types of interventions that were applied, numbers of treatments, and information about my clinical decision-making processes. Although I created this method of data collection during the Fall I semester, I did not make any *a priori* identification of which patients would be included in my collection. Since it was not possible to collect data on every patient I treated, I decided to track outcomes on patients who required more than one visit. The result was that I documented information on 16 different patients out of a total of 40 during the Fall I semester (Table 3.1).

By focusing on patients who required multiple treatments, I was unable to capture the positive outcomes that occurred in patients who only required one visit. Initially, I did not see the value in the data collected from one brief treatment, but I later realized that omitting this data was a mistake, because the ability to eliminate pain following one treatment provided valuable supporting evidence for the applied intervention. Although I only treated some patients once, I should have had them return for a follow-up appointment so I could ensure that their treatments held over time and conduct assessments that could then be compared to their initial evaluations. From this experience, I learned that in order to add validity to my data, I needed to collect consistent information at regular intervals, conduct follow-up appointments to ensure the longevity of the treatment I selected for each patient, and inspect patient data for common trends.

Another challenge I faced during the Fall I semester was learning how to properly administer and analyze the DPA Scale. Only 10 out of the 16 patients with documented outcomes received multiple DPA Scales. Initially, I had each patient complete the DPA Scale pre- and post-treatment. As I reviewed the scores between visits, I wondered how the patient could really assess the changes being made when he or she did not have time to perform many of the tasks that caused pain. The DPA Scale requires patients to evaluate their symptoms over a 24-hour period (Vela & Denegar, 2010a), but I was not allowing my patients to do this, because they were completing the form twice within a couple of hours. The scores during this semester were reflective of improper administration and my lack of understanding of outcome measures (Chart 3.1). As a second-semester DAT student, I was still learning how to interpret the responses on the DPA Scale, and working to derive more meaning from the results. I also believe that my frequent dispensing of the DPA Scale diminished the sensitivity of the assessment, because patients did not take the time to read everything thoroughly.

Chart 3.1. Fall I, 2013 DPA Scale Scores – Minimal Changes in Scores Across Time Due to Clinician Error in Administration



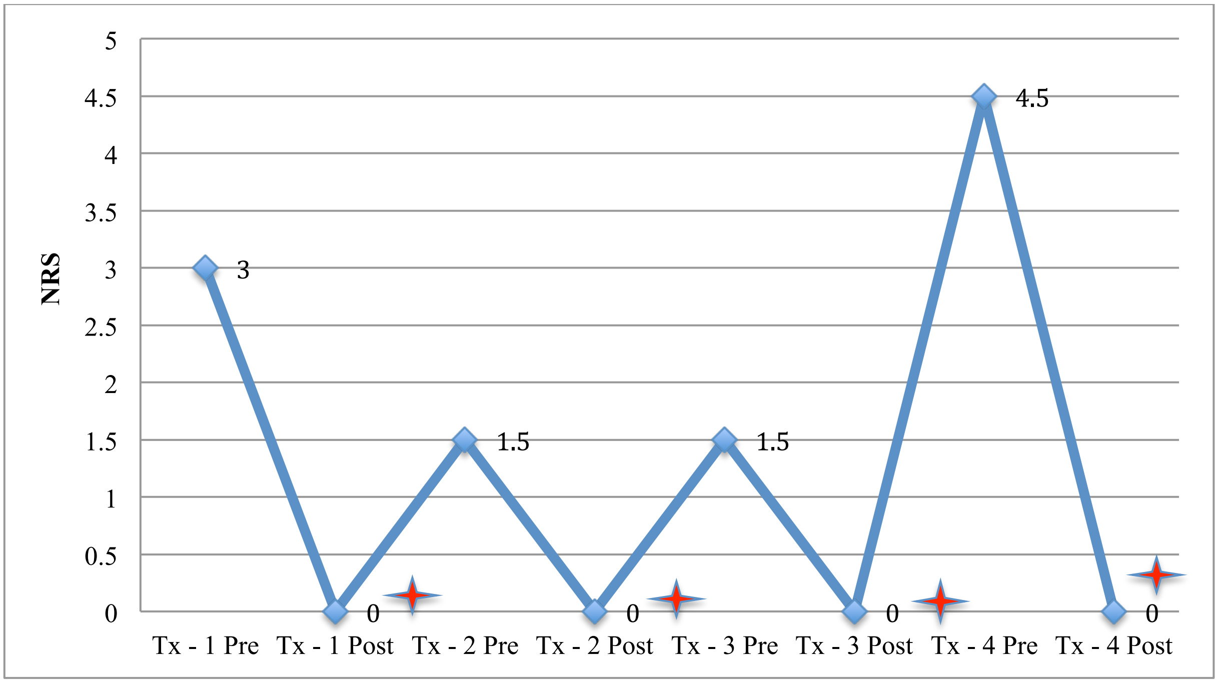
In addition to developing a system for the collection of outcomes during the Fall I semester, I also wanted to focus on my hands-on incorporation of the variety of interventions I had been introduced to during my initial summer semester. My eagerness to improve my clinical skills motivated me to take my first Mulligan Concept (MC) course at the beginning of the Fall I semester. I chose this course over many others based on what I had learned during the initial summer semester and because of the rapid results described by other DAT students and faculty. The MC course that I completed covered all of the mobilizations with movement (MWMs) for the lower extremity and lumbar spine. I was most impressed with the ease of application and short time required to complete treatment. Additionally, the MC could be applied in the initial evaluation to determine if it would be effective in resolving the patient's issue. When I returned to the clinic with my newly acquired knowledge and skill-set, it seemed as if most of my patients were ideal candidates for MC treatment.

My first legitimate attempt at collecting patient outcomes and utilizing the MC occurred with Patient #9501. Patient #9501, an apparently healthy college female, sought treatment in our clinic for chronic Achilles tendon pain, lasting approximately three months. The patient was a dancer and was experiencing pain and weakness with ankle plantarflexion. During the initial evaluation, she reported a 37 on the DPA Scale (range 0 – 64, with 64 indicating severe disability), and a 3 on the NRS (range 0 – 10, with 10 indicating extreme pain) (Farrar et al., 2001; Vela & Denegar, 2010b). The patient had palpable tenderness and a noticeable nodule over the distal, lateral border of the Achilles tendon. Her active range of motion (AROM), passive range of motion (PROM), and strength were within normal limits, and there were no signs of inflammation. The Selective Functional Movement Assessment (SFMA) top tier revealed dysfunctional patterns in cervical flexion and rotation, in multi-segmental extension and rotation, and in the single-leg-stance.

I began treatment with Positional Release Therapy (PRT) in order to relieve the tender points in her Achilles tendon. Since this did not change her pain levels in plantarflexion, I attempted a Mulligan MWM for plantarflexion. Following 1 set of 10 repetitions, the patient reported decreased pain (from a 3 to a 1 on the NRS) with weight-bearing plantarflexion. Since this first set of MWMs was successful according to the principles of the Mulligan Concept, which state that all treatments should follow the PILL (**P**ain-free, **I**mmediate results, and **L**ong **L**asting) effect (Mulligan, 2010), I continued with two more sets. I completed the treatment with the MC tape application for the Achilles tendon to ensure the treatment held when the patient returned to dancing. As a result of just one treatment, I reduced the patient's pain from a 3 to a 0 on the NRS (Chart 3.2). Mulligan MWMs have been shown to be effective in reducing pain and increasing range of motion in a variety of musculoskeletal injuries (Hing, Bigelow, & Bremner, 2009), but I was very impressed by my rapid results as a novice practitioner.

The patient received two more treatments in one week, each time reporting her pain at a 1.5 on the NRS before treatment and a 0 following treatment. The series of treatments held for two weeks until the patient returned again, this time with a pain level of 4.5 on the NRS before treatment (Chart 3.2). Following the same protocol as the previous three treatments, I once again eliminated the patient's pain after applying the MC.

Chart 3.2. Patient #9501 Pre- and Post-Treatment NRS Scores – MC Treatment of Achilles Tendon



 **Denotes MCID in NRS score**

When I reflect back on this specific patient case, I noticed several important learning moments. At that point in time in my first clinical residency, I was extremely impressed with my ability to eliminate chronic pain after one treatment. Prior to the DAT, I would have treated Patient #9501 with ice, massage, and electrotherapy, because I did not know any other options for treatment. I would have known that these treatments would not immediately change her pain, but I would have hoped that a placebo effect or rest would improve her condition. Within one semester of being in the DAT program, I added one of the most effective interventions I had ever seen to my practice and was amazed by the results. The effects were also instrumental in improving my confidence in using the MC on future patients.

Due to my initial excitement over the results of Patient #9501's treatment, I overlooked some of my mistakes in my initial assessment and my analysis of outcome measures. Although I completed the SFMA top tier during Patient 9501's initial evaluation, I did not complete any of the breakouts. The SFMA top tier assessment includes 10 fundamental movement patterns which are evaluated for pain and dysfunction according to predetermined criteria (Cook, 2010). The SFMA breakouts offer a hierarchy to assist with the dissection of dysfunctional movement patterns in order to determine the specific source of the dysfunction (Cook, 2010). At the time of evaluation and treatment, I felt that if the MC was successful in eliminating pain, then I did not need to do any further exploration to determine Patient #9501's source of dysfunction. As time progressed, however, the patient continued to come back in to the clinic for the same injury. Because I did not complete the SFMA breakouts, I did not know if her pain was returning because I did not address the source of the problem, or if it was because she continued to perform the aggravating motion in dance class. The valuable lesson that I learned from this case was to incorporate the SFMA breakouts on patients with chronic pain so that I could ensure that I was addressing the true cause of their pain.

Another learning moment in this patient case came from my use of the DPA Scale. Although I was eliminating Patient #9501's pain after each treatment, her DPA Scale scores did not reflect this apparent improvement (Chart 3.1). Since there was no decrease in her DPA Scale scores, it did not appear as though I had made progress on her primary issue. Due to my failure to look for meaning in her responses on the DPA Scale, I did not address her high scores in the well-being section. As a result, I discovered the importance of determining the overall effects of treatment on pain, disability, and function. Following my experiences with Patient #9501 and other patients during the Fall I semester, eliminating pain was no longer the only goal, because there were now other outcomes to measure as well.

While this first patient experience demonstrated my ability to collect outcomes and apply new interventions, it in no way signified competence in these skills. As I stated earlier, I should have completed the SFMA assessment to identify the region of the body contributing to her Achilles tendon pain. If I had located the source of her problem during the initial evaluation, I might have been able to prevent her pain from returning. Proper analysis of the DPA Scale also would have revealed that I was not making progress on her primary issue. Regardless, Patient #9501 still experienced positive outcomes and a minimal clinically importance difference (MCID) in pain scores on the NRS after every treatment and during the first two consecutive visits (Chart 3.2). The MCID for the NRS is a decrease of 2 points or 30% (Farrar et al., 2001). Additionally, I began to expect positive changes and was able to track my effectiveness with each treatment, which was a stark difference from my previous method of practice.

The practical experience I obtained as I experimented with several different interventions during the Fall I semester was priceless. I learned that chronic pain could be eliminated instantly, and this concept completely changed my expectations. Prior to the DAT program, I believed that this type of outcome was possible, but I did not know how to achieve it with every patient. Suddenly, I was not only given this ability to heal my patients, but I believed I would be able to do so every time. I quickly realized my naivety when some patients did not improve as expected. When I look back, I realize that I used a "shotgun" approach to treatment during the Fall I semester: I believed that if I tried enough treatments, eventually one of them would be successful. Although I had become familiar with many treatments over the course of the semester, my knowledge regarding their applications and the theories behind their effectiveness needed time to catch up to my clinical skills. To be able to apply the technique was only one component of being a successful clinician. The other component was being able to explain when and why I used these techniques.

Spring I, 2014

The change in my outcomes documentation criteria and the addition of new measurement tools during the Spring I semester resulted in data that was clear to understand. The first addition was the Patient-Specific Functional Scale (PSFS), which allows each patient to choose three to five activities or movements that he or she cannot do at what is considered a normal level. The patient then rates each activity on a scale of 0 (cannot perform) to 10 (can perform normally at pre-injury level). An increase in 2 points represents an MCID (Nicholas, Hefford, & Tumilty, 2012; Young, Cleland, Michener, & Brown, 2010). The PSFS was a valuable addition to my data collection, because I was able to add quantifiable movements and activities to measure patient progress with treatment.

In addition to adding the PSFS to my data collection during the Spring I semester, I also administered the Global Rating of Change (GRC) scale and Modified Oswestry Low Back Pain Disability Questionnaire (OSW). The GRC scale is designed to measure a patient's improvement over time with end ranges at -5 (very much worse) and 5 (completely recovered). On the 11-point scale, the MCID is an increase in 2 points (Kamper & Mackay, 2009). Initially, I struggled with the appropriate timing of the GRC scale, since patients were required to compare their then-current condition to their status prior to treatment. I found that patients often did not remember how they felt prior to treatment, or their perception of their current status changed so significantly that they did not recognize the amount of improvement achieved. As a result, I modified the GRC slightly to provide patients with a reminder of their previous injury status. During the initial administration of the GRC, the patients listed descriptive terms to provide helpful cues about their status prior to receiving treatment. The adjustment that I made to this measure became extremely valuable to me as the patients' perceptions changed over time. I believe that I was able to obtain a more accurate GRC score because patients were able to compare their current status to one at a previous visit. My experiences with the GRC warrant further inquiry to determine if the modified GRC should be conducted instead of the traditional method of administration.

Since my dissertation focus is on LBP, I decided, during the Spring I semester, to add the OSW as an outcome measure. The OSW is one of the most common self-report questionnaires for LBP, and I knew I needed to gain proficiency with this measure. The questionnaire consists of 10 different items that pertain to LBP and a patient's ability to perform activities of daily living. Each question is scored from 0 to 5, with higher numbers corresponding to greater disability. The MCID is a decrease of 6 points or 12% (Fritz & Irrgang, 2001). The questionnaire provides insight on each patient's function as well as information about pain management and positions of comfort. I administered the OSW to six patients, and all but one scored under 20% on the initial exam, which indicated minimal disability. I believe these results demonstrated my patients' abilities to tolerate their LBP and still function in normal activities of daily life. In the majority of cases, they reported higher scores on sitting and minimal to no disability in other areas. The questionnaire was helpful in that it assisted me with identifying which areas caused the most problems, and it helped me to determine how my treatment improved the patient's pain and disability in those areas.

Another meaningful change in my clinical practice and patient outcomes occurred in the Spring I semester with the addition of the MyoKinesthetic™ (MYK) System posture screen. I initially learned how to perform the posture screen in the MYK System certification class that I completed at the end of Fall I. The MYK System is a global approach to assessment and treatment that focuses on compensations in the nervous system that are displayed by postural abnormalities (Uriarte, 2014). My previous clinical experience with the MYK System established this intervention as very effective in treating a variety of musculoskeletal conditions. Additional information about the MYK System can be found in Appendix A.

The MYK posture screen was beneficial to my clinical practice because it provided another means to classify my patients, similar to the classification achieved through the SFMA top tier. The main difference between the two was that the MYK System also offered a matching treatment based on what was uncovered in the posture assessment. In contrast, the SFMA offered treatment in the form of exercises. Based on my experiences in the DAT program, strengthening was rarely the solution to an “apparent” muscle weakness. Many times muscles appeared weak because of altered signal transmission from the central nervous system (CNS) or because the muscles were not at an optimal length to produce strength. The MYK System treatment, however, was designed to impact the CNS in a manner that would restore normal neural input and output.

As a result of my previous success with the MYK System, I was excited to increase my accuracy in selecting a patient’s treatment by adding the posture screen to my evaluation. The following patient examples demonstrate my successful application of the MYK posture screen as a classification tool. Both patients were treated with a matching MYK treatment, based on the findings in their posture assessment.

The first patient (#9527) complained of chronic LBP lasting approximately four years, with an unknown mechanism of injury. The patient had received several chiropractic treatments since her initial onset of pain, but the pain relief only lasted for one day following each treatment. During my initial evaluation, Patient #9527 was classified as having minimal disability (OSW = 14%), and she reported 25 on the DPA Scale and 6 on the NRS. Her MYK postural analysis revealed a dysfunction at the L5 nerve root level. The patient was treated a total of 7 times over 15 days, resulting in full resolution of pain and function. Other positive outcomes are recorded in Table 3.2.

The second patient (#9529) complained of chronic LBP lasting approximately two years, during which time he completed physical therapy without receiving a permanent resolution of pain. Eight months prior to my initial examination, the patient, who had disc bulges at L3-4, L4-5, and L5-S1 that were confirmed through magnetic resonance imaging (MRI), underwent a surgical procedure that severed the sensory nerve roots in an attempt to relieve his chronic back pain. The patient reported pain relief for two months following the surgical procedure, but pain eventually returned to pre-surgery levels. Patient #9529 was classified as having minimal disability (OSW = 10%), and he reported 13 on the DPA Scale and 3 on the NRS. His initial evaluation and MYK postural analysis revealed a dysfunction at the L4 and L5 nerve root levels. The patient was treated a total of 10 times over 21 days, resulting in full resolution of pain and function. Progression of these positive findings is presented in Table 3.3. The results from this case study also translated into a two-part manuscript that was submitted for publication with the International Journal of Athletic Therapy and Training (IJATT) in October, 2014 (Brody, Baker, Nasypany, & May, 2014a, 2014b) (See Appendices A and B for complete copies of the manuscripts).

Table 3.2. Patient #9527 Outcomes with MYK – LBP

	Day 1		Day 7		Day 15 - DIS		Day 38
Measurement	**Pre-MYK**	**Post-MYK**	**Pre-MYK**	**Post-MYK**	**Pre-MYK**	**Post-MYK**	**Follow-up**
NRS (standing)	6	3*	2*	0*	0	0	0^
DPA	25	NT	6*	NT	0*	NT	0^
PSFS	4.3	NT	9*	NT	10*	NT	10^
GRC	NT	NT	4	NT	5	NT	5
OSW	14%	NT	NT	NT	0%*	NT	0%
FFD (cm)	-11.5	NT	-16	-16.5	-17	-17	-19
MMST (flexion)	5.5cm	NT	5.5cm	6cm	7cm	7cm	6.5cm
MMST (ext)	2cm	NT	3cm	4cm	2.5cm	2.5cm	3cm
Prone Instability Test	(+) at L4	NT	(-)	NT	(+) at L4	NT	NT
Thigh Thrust	(+) L	NT	(-)	NT	(-)	NT	NT
Key: *Denotes weekly MCID; ^Denotes MCID from initial visit to discharge/follow-up; FFD - Fingertip-to-floor distance; MMST - Modified-modified Schober test; NT – Not tested; DIS - Discharge							

Table 3.3. Patient #9529 Outcomes with MYK – LBP

	Day 1		Day 8		Day 15		Day 21		Day 29
Measurement	**Pre-MYK**	**Post-MYK**	**Pre-MYK**	**Post-MYK**	**Pre-MYK**	**Post-MYK**	**Pre-MYK**	**Post-MYK**	**DIS**
NRS (standing)	3	0*	0	0	0	0	0	0	0^
DPA	13	NT	5*	NT	4	NT	NT	NT	1^
PSFS	3	NT	6*	NT	8*	NT	9.5	NT	10^
GRC	NT	NT	3	NT	3.5	NT	4.5	NT	5^
OSW	10%	NT	NT	NT	6%	NT	NT	NT	2%
FFD (cm)	-12	-13.5	-5	-8.5	-6	-9	-10.5	-16.5	-7
MMST (flexion)	8.5cm	8.5cm	7.5cm	7.5cm	7cm	7cm	7cm	7cm	7cm
MMST (ext)	3cm	3cm	2cm	2cm	3cm	3.5cm	3cm	3.5cm	3cm
Slump Test	(+) B	NT	(-)	NT	(-)	NT	NT	NT	(-)
Key: *Denotes weekly MCID; ^Denotes MCID from initial visit to discharge/follow-up; FFD - Fingertip-to-floor distance; MMST - Modified-modified Schober test; NT – Not tested; DIS - Discharge									

The positive results demonstrated by these patients provided preliminary evidence for the efficacy of the MYK System as a Treatment-based Classification (TBC) system, and as a successful treatment for the condition of chronic LBP. The original TBC system for LBP was developed in an attempt to improve patient outcomes by classifying patients into subgroups according to the findings in their physical examination and the results of outcome measures (Delitto, Erhard, & Bowling, 1995). The posture screen appeared to be precise in determining the correct treatment level under the MYK System; therefore, it seemed as though the MYK System could accurately place patients into subgroups with a matching treatment intervention. I was very eager to collect more data to validate this finding. I was also encouraged by the positive outcomes demonstrated by my LBP patients. Although I used the MYK System treatment prior to the DAT program, I did not regularly select an accurate treatment level because I did not know how to utilize the posture screen. I now realize that this was one of the reasons that I did not experience consistently positive results with this intervention prior to my enrollment in the DAT program.

In addition to my success with LBP patients, the Spring I semester also resulted in noticeable differences in my data collecting procedures. When I reflected on patient outcomes, I realized that I was able to achieve MCIDs on the DPA Scale, NRS, and Patient-Specific Functional Scale (PSFS) in most patients by the second treatment (Charts 3.3-3.5). I believe that these improvements were a result of a greater understanding of each outcome measure, which was demonstrated by their increased use, appropriate administration, and documented results. I also improved my consistency in measuring disease-oriented outcomes, such as AROM and orthopedic special tests. When I reflected on the data collected during the Spring I semester, the most obvious omission proved to be long-term follow-up examinations.

I realized, at the conclusion of the semester, that this information was vital to my data if I wanted to provide evidence for long-term efficacy of interventions.

While improvements in data outcome collection can be seen in both the LBP case series and my global outcomes, I was also encouraged by developments in my clinical skills. As I began to focus more on applying one intervention rather than using a “shotgun” approach, I discovered when and why each intervention was effective. The sacrifice I made in applying only one intervention was that I allowed some patients to leave the clinic without achieving a full resolution of pain. Frequently, however, the individual conditions of those patients who left the clinic while still experiencing pain improved between treatments, which demonstrated that some interventions have latent effects or that there were other psychogenic factors that contributed to healing. Regardless, I was encouraged by this opportunity to explore each technique further and to track my outcomes without interference from other treatments. I believe this was an important discovery in my quest toward advancing my manual therapy skills, as evidenced by this WordPress blog post (formal critical reflection as a component of the DAT curriculum), dated April 11, 2014:

> *How many times do you combine different techniques to achieve optimal outcomes with your patients? I have thought a lot about this recently as I try to collect some pilot data for my research. For me, I was combining treatments 100% of the time to try to get each patient to a 0. The problem with this is not really knowing which treatment provided the best benefit. Once patients feel better, they are more reluctant to be treated with anything less than they received the first time. With a few patients, I have focused on just one intervention and tracked their progress. Surprisingly, I was able to get their pain to a 0 by the second treatment. Normally, I would've been too impatient for these results and added other interventions during the first visit. Now I wonder, is this always necessary? Maybe we need to be more patient and confident in our tools to see the true benefit. How can we really assess the value of each technique if we do not allow it time to demonstrate its effectiveness? Should a tool always provide immediate relief, or can there be gradual progress? Will patients respond to the change better if it is gradual as opposed to going from a painful condition to pain-free in minutes? These are just some of the thoughts that go through my mind as I reflect on each patient's treatment and outcomes. I'm curious to hear your ideas....*

Fall II, 2014

Although the majority of patients included in my global outcomes during the Fall II semester were patients in my action research study on LBP, I was encouraged by the positive results in 100% of the documented cases (Table 3.1). I defined positive results as a current NRS score ≤ 1, a GRC score > 2, and MCIDs on the majority of other outcome measures (i.e., DPA Scale, PSFS, and OSW) on a patient's final visit in the clinic. A neutral result was defined as little to no change (< MCIDs) in most or all outcome measures when compared to the initial examination. When I reflected on my global outcomes from the Fall II semester, I noticed that I obtained significant improvements in all outcome measures, as evidenced by the results I obtained from several paired samples *t*-tests. A statistically significant decrease was recorded on the DPA Scale from the pre-intervention measure (28.36 ± 14.28) to the week two measure (14.21 ± 12.42, $t(13) = 5.00$, $p < 0.01$, two-tailed). The mean decrease in DPA Scale scores was 14.14 with a 95% CI ranging from 8.04 to 20.25. A statistically significant decrease was also recorded on the NRS from the pre-intervention measure (3.14 ± 2.25) to the post-intervention measure (0.71 ± 1.49, $t(13) = 4.11$, $p < 0.01$, two-tailed). The mean decrease in NRS scores was 2.43 with a 95% CI ranging from 1.15 to 3.70. A statistically significant increase was obtained on the PSFS from the pre-intervention measure (5.11 ± 1.64) to the week two measure (8.09 ± 1.41, $t(11) = -5.23$, $p < 0.01$, two-tailed). The mean increase in PSFS scores was -2.98 with a 95% CI ranging from -4.24 to -1.73. A statistically significant decrease was also obtained on the OSW from the pre-intervention measure (22.44 ± 12.99) to the week two measure (8.22 ± 6.74, $t(8) = 3.48$, $p < 0.05$, two-tailed). The mean decrease in OSW scores was 14.22 with a 95% CI ranging from 4.79 to 23.65. All improvements exceeded MCIDs for each outcome measure.

Another important indication of the progress I made in my data collection during the Fall II semester was a perceptible change in my understanding of the information I gathered. Focusing on one injury and comparing identical outcome measures made it easier to organize the data and find comparable cases. As such, I discovered a theme in some of the LBP data, which is made evident in a WordPress blog post that I wrote on September 19, 2014:

> *Through my LBP data collection, I found some interesting information that I thought was an anomaly in one patient until it occurred in a second patient. Both patients had imaging done and were given similar diagnoses: lumbar disk herniations. Patient #1 had disk herniations at L3-4, L4-5, and L5-S1. Patient #2 had one herniation at L5-S1. Pain was chronic in both cases, and one had radiating symptoms. Throughout the treatments, I noticed that thoracolumbar flexion decreased as pain decreased. Patient #2 also experienced decreased lateral flexion as symptoms improved (this was not measured in Patient #1). Flexion was measured using the fingertip-to-floor distance (FFD) and lateral flexion was measured using the fingertip-to-thigh distance (FTD). The changes in AROM were as follows:*
> ***Patient #1:***
> *Initial Exam: FFD = 8cm (from the floor on a 20cm step)*
> *Discharge: FFD = 15cm *decrease in 7cm*
> ***Patient #2:***
> *Initial Exam: FFD = 5cm   FTD = 21cm (R), 20.5cm (L)*
> *After 4 Tx: FFD = 8cm   FTD = 13cm (R), 11.5cm (L)*
> **decrease in 3cm (FFD), 8cm (FTD-R), 9cm (FTD-L)*
> *I found it very interesting that as both patients became pain-free, their ROM decreased and remained at that measurement. I have not seen this occur in every patient, but these were very similar cases. My theory behind the decrease is that the individualized hypermobility may have contributed to the disk injury and subsequent pain or vice versa. With treatment, we were able to restore proper muscular function, which led to increased lumbar stabilization and protection during movement. I believe that the decreased ROM, although within normal limits, was necessary for them to achieve pain-free movement. I have not done a follow-up SFMA on Patient #2 yet, but Patient #1 did have improved motion despite the decreased flexion. Is it possible, with certain injuries, that a decrease in ROM is essential to establish pain-free movement?*

In addition to recognizing the connection between the resolution of LBP and decreased AROM, I also noted an interesting finding in one LBP patient's GRC scores: All of my LBP patients reported lower scores at their one-month follow-up visits than they had at the initial examination; however, one patient (#9535) reported feeling almost unchanged

(GRC = 1) from his condition prior to treatment. Over the past three semesters, this was not my only case where patient-perceived progress contradicted the results of patient-oriented and disease-oriented evidence, but it was the only one that contained consistent measures to document the data. Many patients fail to quantify their improvements for a variety of reasons, such as changes in expectations and an inability to recall pain-free periods of time. Therefore, it is beneficial for the clinician to utilize multiple outcome measures to quantify progress made with treatment. Sometimes positive evidence is all that is required to change a patient's perspective and offer hope toward complete healing. Although this was not the case with Patient #9535, I am excited to provide future patients with more concrete verification of their improvements. A detailed explanation of a useful procedure that aids in the psychological component of rehabilitation can be found in the study by Jihong Park and Alan Nasypany (2012).

My collection of outcomes from the Fall II semester also included reliability data on both the MYK posture screen and SFMA top tier assessment. While collecting this reliability data, I realized that proper posture did not always correlate to functional movement patterns. I knew that asymmetrical posture would cause dysfunctional movement; therefore, I believed that a balanced posture should produce more functional movement. One patient included in this study had minimal posture imbalances, very dysfunctional movement patterns, and no injuries or pain. The results of this patient case demonstrated that the MYK posture screen might be more predictive of injury than the SFMA or the Functional Movement Screen (FMS), and worthy of future research. The following WordPress blog post, dated September 26, 2014, provides a critical examination of both the SFMA and MYK System while further revealing my growth as a reflective practitioner:

> *For the past couple weeks I have been collecting data for the MYK posture and injury prediction study. Hopefully I will have some good reliability information to disseminate by the end of the semester on the MYK posture screen and SFMA top tier. In the meantime, I wanted to share an interesting case that I evaluated this week. I completed the MYK posture screen on a cross country patient, who had the fewest asymmetries of anyone I have assessed. In the upper body, he had 2 imbalances (one in the neck and one in the hand). In the lower body, he also had 2 imbalances (one in the knee and one in the foot). Then came the SFMA.....completely dysfunctional! His only functional movements were cervical extension and single-leg stance on the left side. The other patterns were not even close to being functional (not very objective, but his dysfunctions were obvious). Interestingly, he has never been injured and has been running for many years. Although the SFMA is intended for painful conditions, I do not think he would have performed well on the FMS either. That being said, is it only a matter of time until he develops an injury or has he learned to be a master compensator? Are these functional movement patterns suggested by Cook really necessary in everyone? Although this is only one example in the many screens I have performed, it did make me consider the possibility of functional movement being more individualized. Maybe it is unrealistic to generalize the movement criteria for everyone, and each person has their tipping point for injury. Movement for thought......*

The biggest difference when I compared the Fall II semester to the previous two semesters was the consistent improvement in all outcome measures during Fall II (Charts 3.3-3.5). The statistical analysis of global outcomes, which I had not been capable of conducting in the previous semesters, provided further evidence of my development as a scholarly practitioner. As I had during the Spring I semester, I minimized the number of interventions I used during each patient visit. Although the duration of each of my treatments was shorter, I achieved better results than I had during in the Fall I semester (Table 3.1). My improved patient outcomes were due, in large part, to my increased competency and confidence in the interventions, as well as better classification of my patients. Having developed an increased understanding of each paradigm, I identified common themes in my outcomes. I also set a priority, for the Fall II semester, of focusing on and improving my assessment skills, since good evaluation skills translate into greater success in selecting the proper interventions. My discovery of the MYK System and TMR as global assessments with matching treatment interventions secured these as my evaluation tools of choice. I found both systems to be more efficient and direct in identifying the source of pain and providing an appropriate treatment than interventions that focused solely on pain location.

The positive outcomes seen with the MYK System this semester provided me with further verification of this technique as a powerful manual therapy intervention. Although I had experienced success with the MYK System in the past, I had not been able to justify my favorable opinion of the technique through the use of any kind of documentation until this year. Additionally, the required reflections and critical analysis of the MYK System that I performed this semester allowed me to obtain a much deeper understanding of the supporting theory while increasing my accuracy when classifying patients within this paradigm. More importantly, I was no longer acting as robot clinician. Instead of mimicking others, I was developing reasoning behind my use of each intervention and providing clinical evidence for my decisions.

A Priori Research Design

Collecting outcomes and understanding how to translate that information into valuable data for research purposes was one of my greatest challenges at the beginning of the DAT program. My defining "aha" moment regarding research finally came during the Spring I semester, when I developed *a priori* research designs. The addition of *a priori* designs was tremendously helpful in improving data collection. Through this method, I identified inclusion and exclusion criteria, necessary data, and time frames for outcome measure administration. The *a priori* research design also provided me with many of the answers about conducting research and analyzing results that I had been seeking. Additionally, since I am naturally a very organized person, the *a priori* concept was easy for me to implement into my practice.

The only challenging component was deciding what data would be helpful with each condition.

My first attempt at an *a priori* investigation was a case series for the evaluation and treatment of meniscal lesions. I chose this topic after doing a class presentation on the Mulligan Concept, and based on my success with the “Squeeze” technique in the clinic. I was fascinated by the potential of this treatment, because conservative options are limited for the management of meniscal injuries.

Following the premise of an *a priori* research design, I set my inclusion criteria as the following: joint line knee pain, positive findings on one or more orthopedic special tests for meniscal injuries (i.e., McMurray, Apley’s, and Thessaly Test), a history of catching or locking, and pain with knee flexion or extension. Three patients with suspected meniscal lesions were evaluated in the clinic, and two of them met the inclusion criteria for this case series.

Patient #9525 presented with left knee medial and lateral joint line pain, which had been constant for two-and-a-half months. The specific mechanism of injury could not be identified, but the pain began after playing in a soccer game. Initial examination findings for both patients are highlighted in Appendix D. Patient #9525 was treated with the “Squeeze” technique and immediately reported full resolution of pain with walking and knee flexion, and a decrease in pain from an 8 to a 2 on the NRS in knee extension.

Patient #9526 presented with right knee medial joint line pain, which had been constant for three months. The injury was sustained when the patient slipped on ice, forcing her knee into a valgus position. Patient #9526 was also treated with the “Squeeze” technique and experienced full resolution of pain in all motions following one treatment. Only two treatments were performed on both patients, which resulted in MCIDs in pain (NRS) and function (PSFS) in addition to normalization of AROM and special tests. All outcomes are provided in further detail in Appendix D.

The results of this case series further signified my growth as a clinician and researcher. Additionally, I was able to properly classify and apply the appropriate treatment to both patients. Prior to the DAT program, I did not have a treatment for meniscal injuries and often advised my patients to have surgery, because research currently supports surgical treatment of meniscal tears (Boyd & Myers, 2003; Herrlin, Hållander, Wange, Weidenhielm, & Werner, 2007; Rathleff et al., 2013). The addition of the “Squeeze” technique to my practice and the rapid and favorable results with these two patients were defining moments for me in the DAT program. The outcomes generated provided evidence of my success as a clinician and also resulted in the creation of two manuscripts that were submitted for publication with the IJATT in September, 2014 (Brody, Baker, Nasypany, & Seegmiller, 2014a, 2014b) (See Appendices C and D for complete copies of the manuscripts).

My experience conducting my first *a priori* research study, while incredibly positive, also contained errors in my methods and data collection. For example, I failed to identify a predetermined time between treatment sessions. Consequently, Patient #9526 had 14 days between treatments, whereas Patient #9525 had 6 days between treatments. Patient #9526 also did not return for a discharge visit and did not respond to emails to obtain long-term data. Additionally, I did not give Patient #9525 a DPA Scale during his second visit, because I thought he would require more treatments. The key concept I took away from this experience was the necessity of defining timelines for each outcome measure and treatment session. I should have also ensured that patients were scheduled for appointments regardless of their progress, so I did not miss opportunities to conduct discharge or follow-up examinations. While I was satisfied with the information collected in this case series, I was determined to correct my mistakes for future *a priori* investigations.

Another successful example of my ability to apply an *a priori* design to action research was that of my study on the MYK System and LBP. For this case series, I modified the methods from my pilot study to include a larger sample size, and I collected all outcomes once per week, at discharge, and at a one-month follow-up visit. All outcome measures remained the same, with the exception of the Modified-modified Schober Test, which was replaced with the Fingertip-to-thigh test because I wanted to obtain a measure for thoracolumbar lateral flexion. In order to establish reliability of the MYK posture screen, I also collected data that compared my results to those of a novice practitioner and an expert.

I was fortunate to obtain all nine of my participants within a matter of a few weeks, which helped me to become more proficient in my evaluations and in MYK treatment application while still affording me sufficient time to conduct a one-month follow-up visit. Inclusion criteria remained the same as what was stated in the pilot study: The patient's chief complaint had to be LBP with or without radiating symptoms, and the patient needed to be 18 years of age or older. Due to the general nature of the inclusion criteria, I was not forced to exclude any patients who reported to the clinic for treatment from this study. Of the nine patients included in this study, there were a variety of TBC subgroups and a combination of acute, subacute, and chronic cases. Symptom duration prior to treatment ranged from 1 day to 12 years, and the mean total MYK treatments provided was 12.11.

I was able to measure the effectiveness of the MYK System through several different patient-oriented and disease-oriented outcomes, and statistically significant improvements were made in all outcome measures (Charts 3.6-3.9). Patient #9543 was the only participant who did not experience significant changes in his DPA Scale score, but his initial score of 4 was extremely low and well within the healthy normative data for the DPA Scale (0-34). Immediate and lasting changes were recorded at each measurement interval, and all improvements were maintained at the one-month follow-up assessment. More detail pertaining to patient demographics and results can be found in Chapter 5 and Appendix E.

Chart 3.6. LBP Participants' DPA Scale Results with MYK Treatment

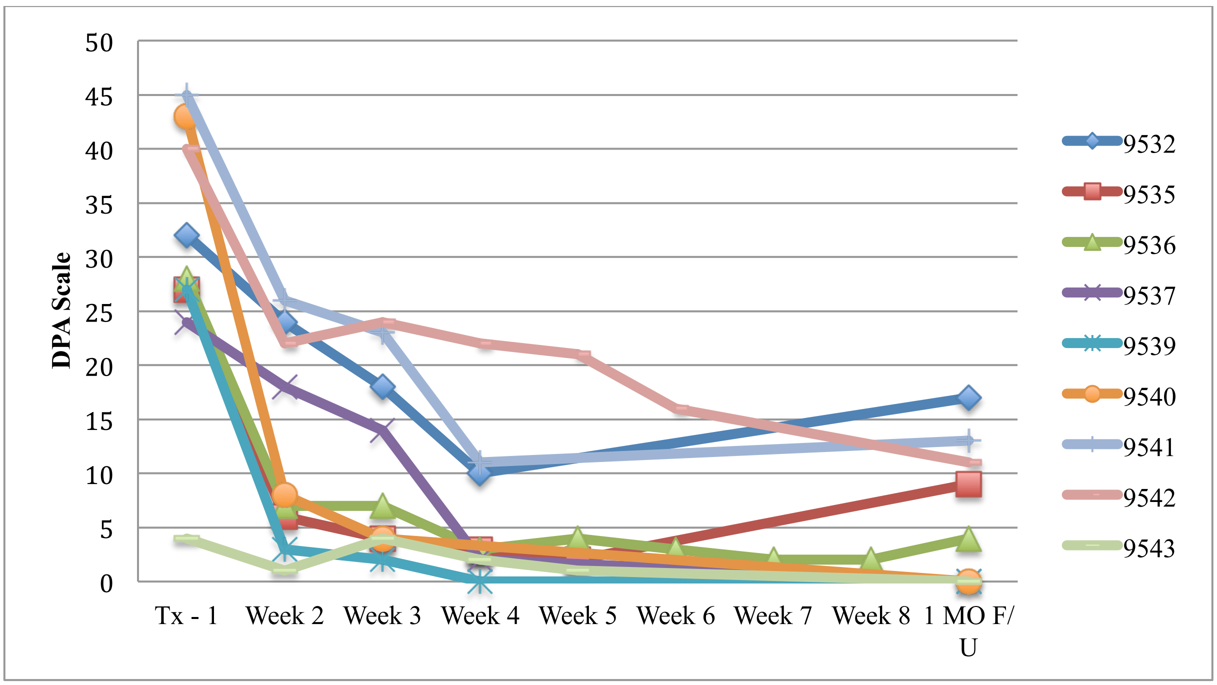


Chart 3.7. LBP Participants' NRS Total Score Results with MYK Treatment

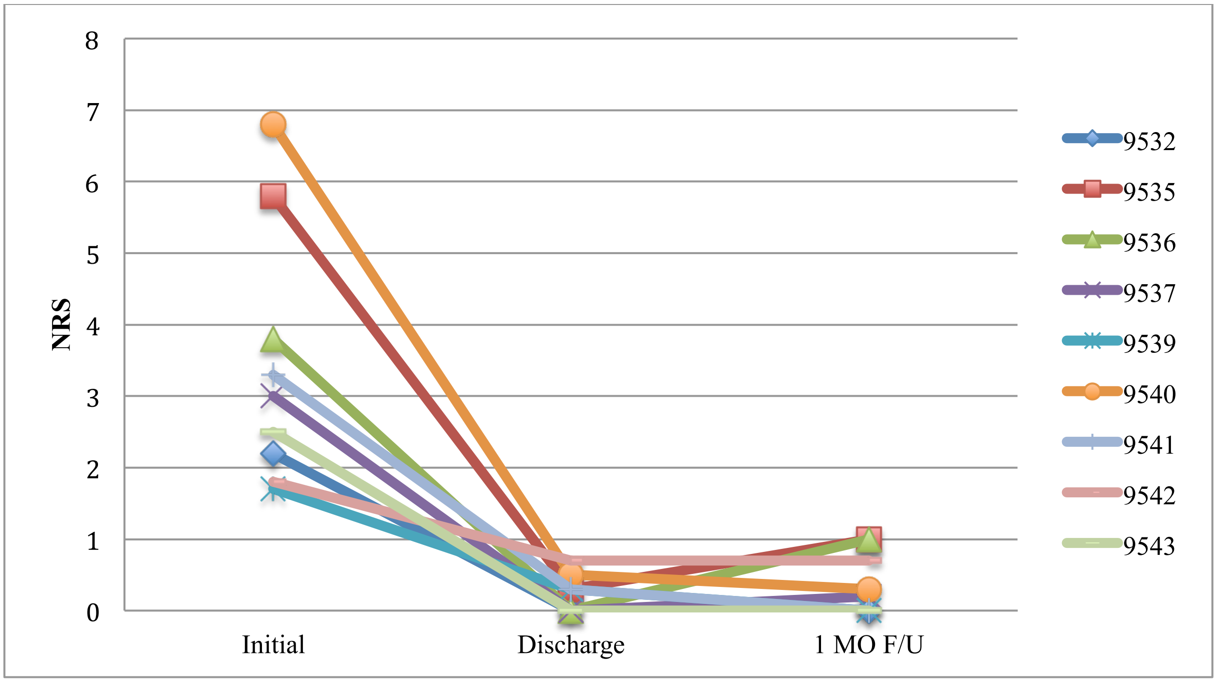


Chart 3.8. LBP Participants' PSFS Results with MYK Treatment

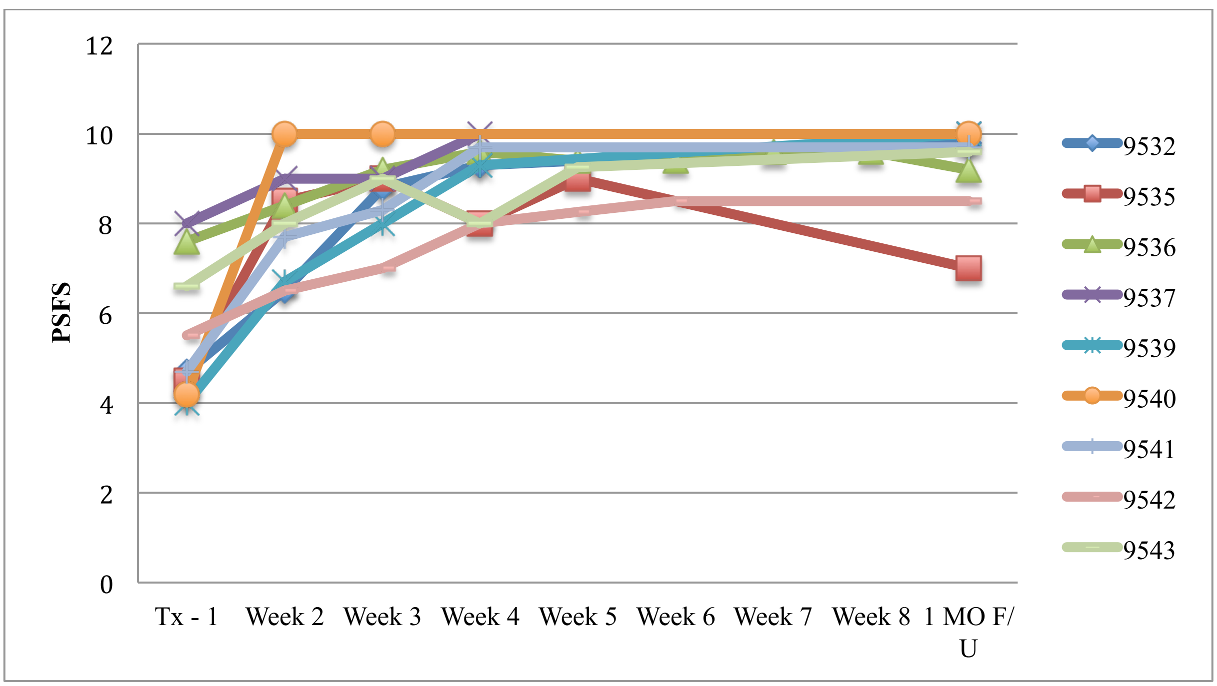
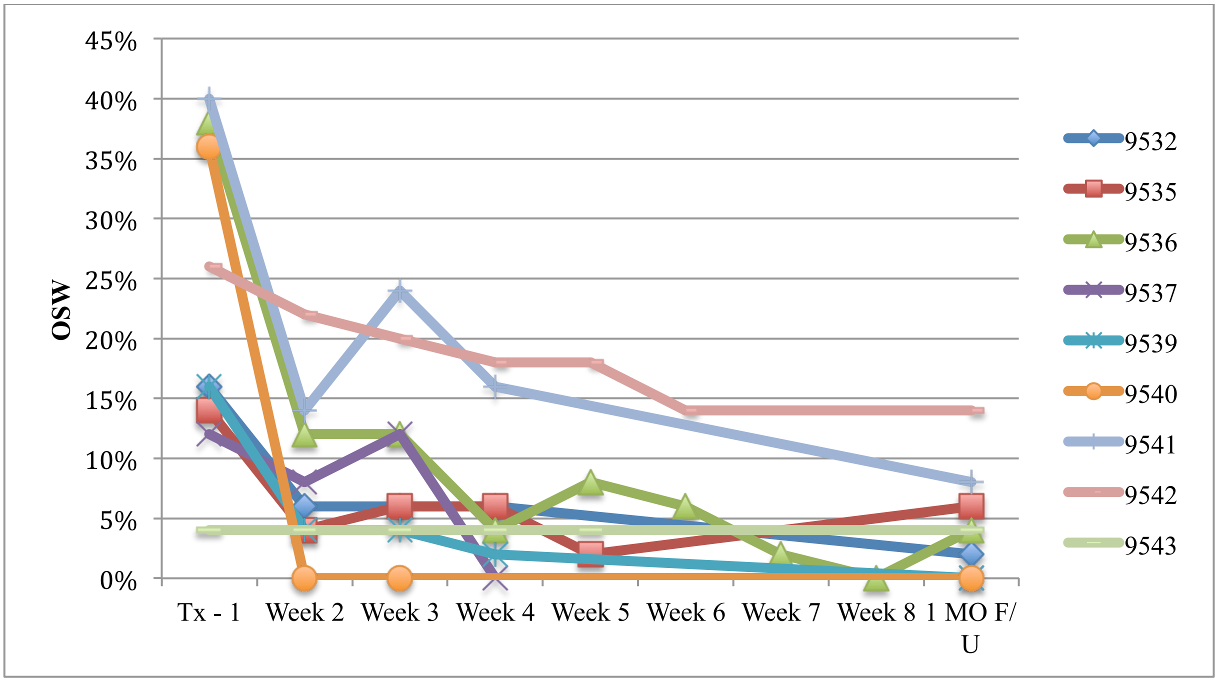


Chart 3.9. LBP Participants' OSW Results with MYK Treatment



Through my action research methodology on LBP, I was able to answer the research questions posed in my dissertation proposal and have a positive impact on the patients included in my study. Once I analyzed the data using inferential statistics, I was amazed at the significance of the findings on all outcome measures. I knew I was making positive changes in my patients' pain, disability levels, and functional statuses, but the statistical data provided tangible information that could be compared to other LBP studies.

Another advantage of this action research study was my ability to become much more confident in my application of the MYK System. In order to become experts in specific areas, clinicians need to limit their focus; therefore, I appreciated the opportunity to become more advanced in my knowledge and use of the MYK System. The experience also reinforced my belief that in order to develop proficiency with an intervention, I need to spend time treating patients solely within that paradigm.

Designing *a priori* studies made data collection more seamless, because I classified specific subsets of patients to *include*—which eliminated random information. I enjoyed having a greater purpose for my data collection as well as knowing that I could gather meaning from the outcomes. I was also surprised by some of the conclusions I drew once I had evaluated all of the data, such as the statistically significant improvements I obtained with all outcome measures in the LBP case series. Most importantly, I was finally obtaining patient outcomes that demonstrated the effective application of PBE within my practice.

Final Reflection and Impact of Residency

The clinical residency experience has been more rewarding than I envisioned it would be a year-and-a-half ago. The challenges I have overcome and the abundance of knowledge and skills that I have obtained have defined me as a clinician and have served as a platform for my growth. Although I had very little experience outside of a collegiate, athletic setting, I quickly became comfortable working in a clinic with a more heterogeneous patient population. Prior to the DAT program, I did not believe that I had the clinical skills to treat chronic conditions in elderly patients. Much to my satisfaction, my clinical residency experience has given me more confidence in my ability to treat all populations. However, continued practice and a quest for knowledge are necessary if I am to become even more competent.

While it would be impossible to list all of the information I learned while in the DAT program, improving my evaluation skills and learning the theories supporting different treatment paradigms were some of the most valuable components of my journey toward advanced practice. Previous to my enrollment, my patient assessments were focused on identifying a pathoanatomic site of pain under a biomechanical model of treatment. As a result, I rarely located the source of the injury, but often focused instead on treating compensations in the body. The use of classification systems and the practice of adjusting treatment based on patient response were ideas that were invaluable to me. As a result of my transformation as a clinician in the DAT program, I began to rely less on special tests that identified specific problematic tissues, and I became more concerned with global movements and posture imbalances. Treating the source and not site of pain became my goal with each patient. Although this now seems like common sense, it was a clear shift in my clinical reasoning, which I believe resulted in more positive outcomes.

One area that I hope to continue to explore in more depth is the psychogenic component of injury and pain. Although there are existing theories on pain, such as the gate control and pain neuromatrix, scientists are unable to offer evidence explaining how the brain works to produce the sensation of pain in all patient cases. One theory that was developed in an effort to explain chronic conditions was that of a psychogenic cause (Sarno, 1999). The theory proposes that the brain, in its complexity, is able to transform unconscious emotions and feelings into physical manifestations. The development of physical manifestations is reasoned to arise out of an unacceptability of emotions, such as anger and rage, becoming part of conscious behavior; therefore, the brain provides a distraction by causing pain. Simply put, the brain prevents certain emotions from reaching the surface of consciousness by employing the autonomic nervous system to restrict blood flow to specific muscles, tendons, or nerves. Decreased blood flow results in a decrease in oxygen to the tissue, which causes pain in what is termed “tension myositis syndrome” or TMS (Sarno, 1999). Postural muscles in the back, neck, and shoulder are often the targets in the diversion process. According to this theory, pain cannot be abolished until the emotion is addressed. Many patients with LBP are assumed to fall into this category of TMS, yet I was able to achieve positive results with a manual therapy intervention, although we are continuing to collect data on the long-term effects of the treatments. According to Sarno's theory, if the psychogenic source of a patient's pain is not addressed with the MYK treatment, then the patient's condition will return, in time. For this reason, it is vital to understand the various causes of pain and to be able to offer treatments that address those causes. Since our understanding of the brain is constantly evolving, I anticipate that more theories will come into existence; therefore, my path toward advanced practice will be a continuous one.

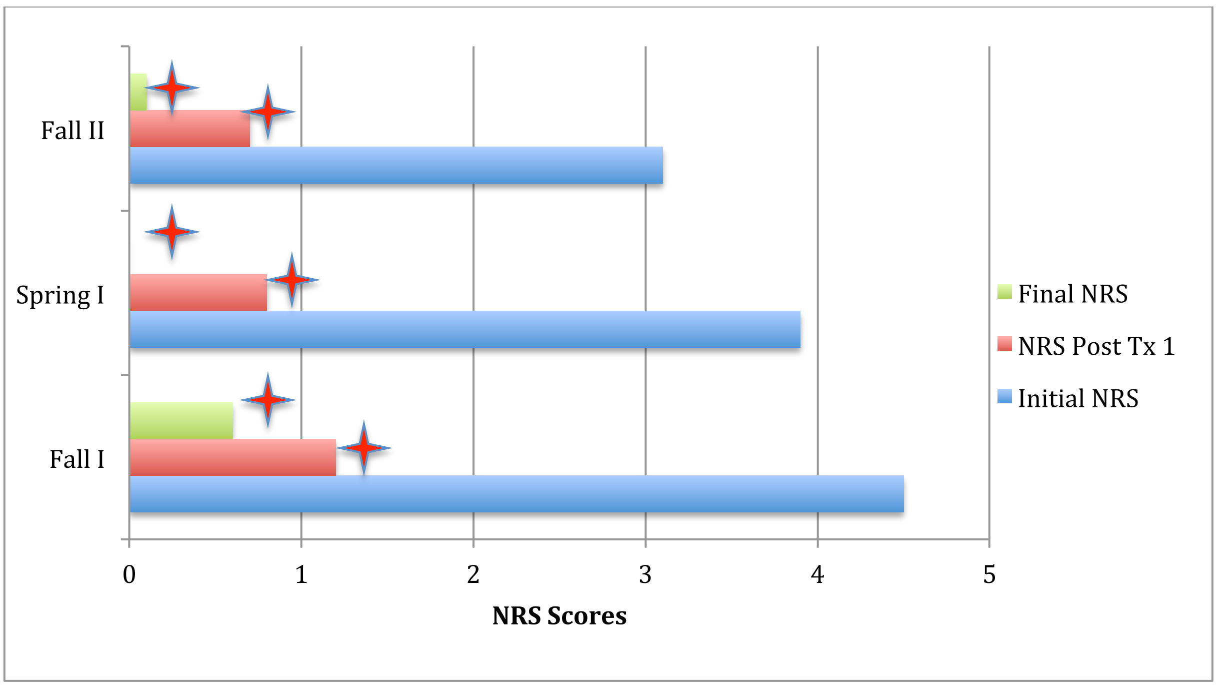
The DAT program has also helped me to enjoy being a part of the change in clinical practice that is necessary in our profession if we are to establish our role as scholarly practitioners. The stereotype of "water boys" or "first responders" has not benefited athletic training. We must embrace the concepts of evidence-based scholarly practice if we hope to align ourselves with other healthcare professions. I believe we can, as athletic trainers, maintain our unique status in the medical field, while also establishing validity in patient care through the use of outcomes and through contributions to the latest research. Through the work I have completed in the DAT program, I not only know that it is possible to conduct a meaningful study in an athletic training clinic, but I am comfortable with the methods required to do this. I believe that this confidence has been demonstrated through the various case studies and case series I have completed over the past three semesters. I displayed growth in this process by continually improving my methods of data collection, analysis, and results dissemination. My final action research project is evidence of scholarly practice; but more importantly, it has served to set me on a firm course along the path toward advanced practice. I will not revert back to my prior clinical ways, and I will continue to seek methods of bringing a collaborative and informed approach to patient care. The DAT program has provided the foundation for the knowledge, skills, and motivation necessary for this pursuit. With renewed passion, I am excited for my future as a clinician and for my opportunity to have a greater impact on the health and well-being of my patients.

Table 3.1. Global Patient Outcomes Summary (Fall I, Spring I, and Fall II)

Pt. ID	# of Tx	Type	Location c/c	Initial NRS	Intervention(s)	Outcome
Fall I - 2013						
9501	3	Chronic	LE – Lower Leg	3	Mulligan, PRT	Positive
9502	4	Chronic	TMJ	2	PRRT, Mulligan, MYK	Positive
9503	1	Acute	LE - Hamstring	3	Mulligan, PRT	Positive
9504	6	Chronic	LE – Hip	3	MYK, PRT, PRRT, Mulligan	Positive
9505	2	Acute	UE – Shoulder	3	Mulligan	Positive
9506	5	Acute	LE – Hip	3	MYK, Mulligan, PRT	Neutral
9507	5	Acute	Lumbar Spine	8	MYK, Mulligan	Neutral
9508	3	Acute	LE - Foot	9	Mulligan	Positive
9509	2	Acute	LE – Great Toe	4	Mulligan	Positive
9510	2	Acute	LE – Ankle	9	Mulligan	Positive
9511	15	Chronic	UE – Shoulder	5	EFT, AAT, PRRT, MYK, PRT, Mulligan	Positive
9512	1	Chronic	LE – Knee	5	Mulligan	Positive
9513	3	Chronic	Thoracic Spine	3	TRA, PRRT, PRT, Mulligan	Positive
9514	2	Acute	Lumbar Spine	4	MYK	Positive
9515	5	Chronic	Brain	0	EFT, MYK	Neutral
9516	2	Chronic	Lumbar Spine	8	MYK, RNT, TMR	Positive
Spring I - 2014						
9518	2	Acute	UE - Shoulder	3	Mulligan, PRRT, TMR	Positive
9519	20	Chronic	Lumbar Spine	8	MYK, Mulligan, PRRT, AAT, PRT	Positive
9520	3	Chronic	UE – Shoulder	0	MYK, Mulligan, PRRT	Positive
9521	5	Chronic	LE - Foot	4	MYK, Mulligan, PRRT, EC	Neutral
9522	3	Chronic	LE - Ankle	4	Mulligan	Positive
9523	3	Chronic	Lumbar Spine	3	MYK	Positive
9524	1	Acute	LE - Foot	3	Mulligan	Positive
9525	2	Chronic	LE - Knee	3	Mulligan	Positive
9526	2	Chronic	LE – Knee	8	Mulligan	Positive
9527	7	Chronic	Lumbar Spine	6	MYK	Positive
9528	10	Acute	Lumbar Spine	2	MYK	Positive
9529	10	Chronic	Lumbar Spine	3	MYK	Positive
Fall II - 2014						
9530	2	Chronic	Thoracic Spine	5	Mulligan	Positive
9531	2	Acute	LE – Ankle	6	Mulligan	Positive
9532	9	Chronic	Lumbar Spine	0	MYK	Positive
9533	10	Chronic	Head	14	MYK	Positive
9534	2	Chronic	Thoracic Spine	2	TMR	Positive
9535	15	Chronic	Lumbar Spine	6	MYK	Positive
9536	25	Chronic	Lumbar Spine	2	MYK	Positive

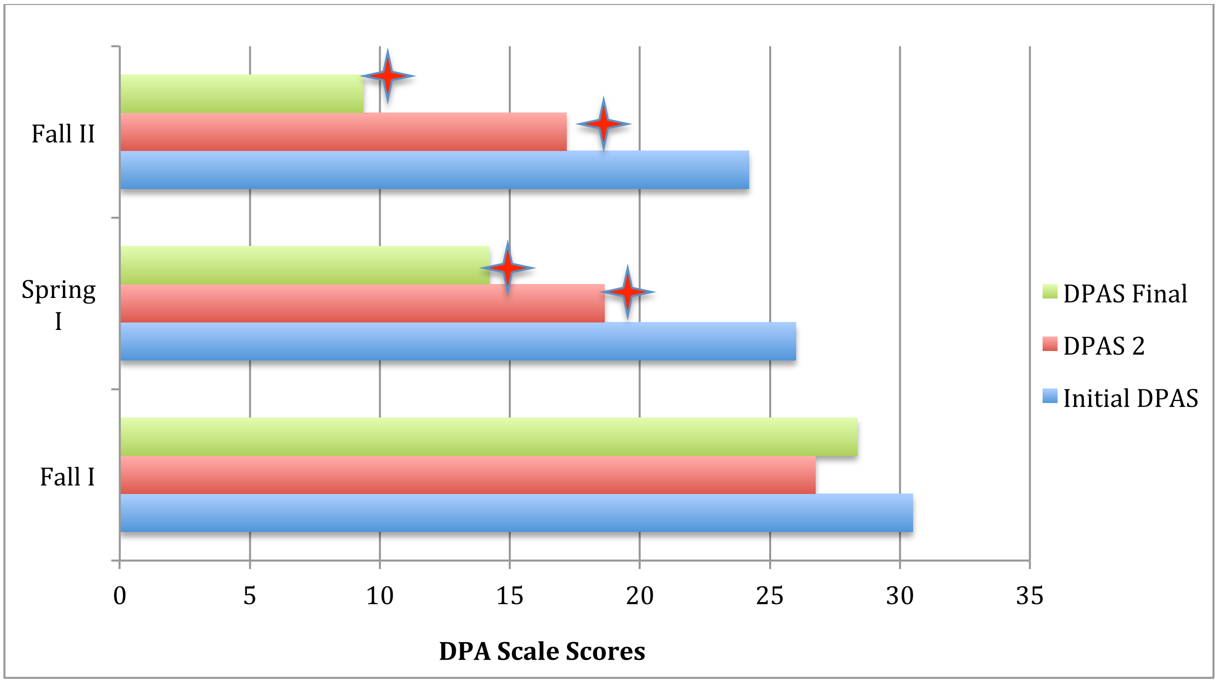
9537	8	Acute	Lumbar Spine	3	MYK	Positive
9538	2	Acute	LE – Calf	3	Mulligan, PRT	Positive
9539	7	Acute	Lumbar Spine	1	MYK	Positive
9540	5	Acute	Lumbar Spine	7	MYK	Positive
9541	8	Chronic	Lumbar Spine	2	MYK	Positive
9542	18	Chronic	Lumbar Spine	1.5	MYK	Positive
9543	15	Chronic	Lumbar Spine	1	MYK	Positive
Key: Tx – Treatment; c/c – Chief complaint; LE – Lower extremity; UE – Upper extremity; TMJ – Temporomandibular joint; EFT – Emotional Freedom Technique; AAT – Associative Awareness Technique; TRA – Thoracic Ring Approach; EC – Emotion Code; RNT – Reactive Neuromuscular Training						

Chart 3.3 Mean NRS Scores – Fall I, Spring I, Fall II



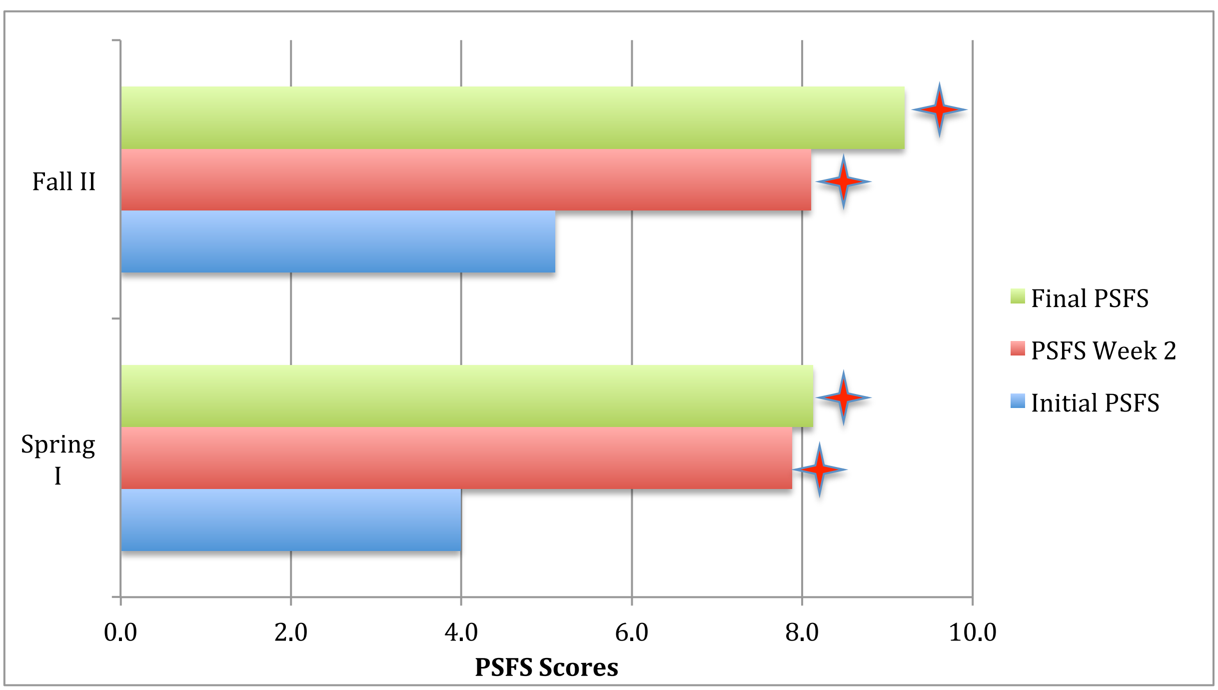
Denotes MCID from Initial Score on NRS

Chart 3.4 Mean DPA Scale Scores – Fall I, Spring I, Fall II



Denotes MCID from Initial Score on DPA Scale

Chart 3.5 Mean PSFS Scores – Fall I, Spring I, Fall II



Denotes MCID from Initial Score on PSFS

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CHAPTER 4

LITERATURE REVIEW

Low Back Pain

In the United States, nearly half of all patients seen in outpatient physical therapy clinics suffer from low back pain (LBP) (Cleland, Fritz, & Childs, 2007). Researchers have estimated that in industrialized countries, LBP has a lifetime prevalence of over 70% (Apeldoorn et al., 2010; Browder, Childs, Cleland, & Fritz, 2007). Although disabling, LBP is one of the most common and poorly understood conditions in healthcare today. A lack of understanding of the source of LBP results in a vague diagnosis of non-specific LBP in approximately 80% of patients who report to a primary care physician with complaints of back pain (Childs, Fritz, Flynn, Irrgang, & Johnson, 2004; Cleland et al., 2007; Fritz, Childs, & Flynn, 2005; Kent, Keating, & Leboeuf-yde, 2010). A non-specific LBP diagnosis is detrimental to the treatment process, as evidenced by the lack of optimal patient outcomes (Childs et al., 2004; Cleland et al., 2007). Among those patients whose LBP does, in fact, resolve with treatment, 90% are subject to recurrence (Delitto, Erhard, & Bowling, 1995). The loss of work productivity coupled with the use of medical resources results in healthcare costs ranging from $84.1 billion to $624.8 billion in the United States alone (Gore, Tai, Sadosky, Leslie, & Stacey, 2012). Low success rates with pain management translate to job absenteeism, decreased productivity, increased obesity, a steady rise in healthcare costs, and many psychosocial effects. A thorough understanding of the evaluation and classification of LBP is essential in creating homogenous subgroups of patients who respond favorably to properly selected interventions.

Low back pain is defined as pain occurring between the 12th rib and the inferior folds of the gluteals, with or without radiating leg pain (Chevan & Clapis, 2013; Machado, Maher, Herbert, Clare, & McAuley, 2010). A gold standard measurement for LBP diagnosis does not exist, so clinicians are forced to rely on evaluations and imaging that usually cannot identify the exact cause of pain. Using advanced imaging, the anatomic source of LBP can be identified in about 70% of cases (Laslett, McDonald, Tropp, Aprill, & Oberg, 2005). In a study done to compare clinical examination with advanced imaging, Laslett et al. (2005) reported an overall agreement between the two methods of evaluation ranging from 32% to 57%. Most LBP has no known etiology, but it may be subdivided into different classifications in order to redefine a patient's condition.

Two schools of thought exist in the subdivision of LBP: nominalist and essentialist. A nominalist defines LBP by its symptom profile (e.g., acute LBP lasting two weeks), whereas an essentialist recognizes the underlying pathophysiology (Fairbank et al., 2011). When focusing on the pathophysiology, there is a tendency for pathologic conditions to occur simultaneously, making it difficult to locate a target area for treatment. Additionally, LBP usually has multiple causes, which reduces the efficacy of interventions aimed solely at treating the tissue source of pain (Fairbank et al., 2011).

Numerous causes for LBP exist, such as nerve root irritation, spinal stenosis, fractures, hip joint pathology, neoplasm, and vascular disorders. According to Laslett et al. (2005), the most frequent sources of LBP are facet-joint dysfunction, intervertebral disc problems, and sacroiliac joint pathology. Within the spine, there may be multiple structures confined to one small area that are innervated by the same nerves. Damage to these nerves makes it extremely difficult to isolate the exact cause of pain.

The structure of the vertebrae, strength of the ligaments and fascia, and resiliency of the intervertebral discs and joint capsules all provide stability in the spine. The ligaments act, primarily, as checkreins during flexion and extension of the spine, in that they increase tension at end ranges. The intervertebral discs have, according to Schuenke, Schulte, and Schumacher (2010), “no ligamentous reinforcement, especially laterally (predisposing to lateral disc herniation)” (p. 95). Over time, the discs undergo regressive changes and actually become thinner. A portion of a disc’s nucleus pulposus may protrude through the weakened outer tissue and compress nerve roots and vessels. One of the most prevalent causes of radiculopathy is disc herniation (Talebi, Taghipour-Darzi, & Norouzi-Fashkhami, 2010). Disc degeneration also leads to changes in the bone as stability decreases, since osteophytes can form and create ankylosis of the facet joints.

The muscles of the abdomen, spine, and pelvis also act to stabilize the vertebrae and to move the trunk and pelvis. Muscle imbalances can cause faulty posture, which can lead to other chronic conditions in the spine. The pelvic girdle also plays a key role in lumbopelvic stability and movement. Comprised of 11 joints, the pelvic girdle distributes forces from the lower extremity to the spine. If any of the 11 joints do not function properly, it can result in LBP. In approximately 30% of patients with LBP, the source is sacroiliac joint dysfunction (Laslett, Oberg, Aprill, & McDonald, 2005). Dysfunction in this area can result from leg-length discrepancies or hypo- or hypermobility of the sacrum.

Classification of Low Back Pain

Currently, patients have many treatment options for LBP; but since some research supports the use of the most commonly used treatments while other research refutes their efficacy (Beurskens et al., 1997; Borman, Keskin, & Bodur, 2003; Fritz, Delitto, & Erhard, 2003), the fact that there are many options available has not made an impact in improving patient outcomes (Cleland et al., 2007). Some of the non-surgical treatment possibilities discussed in published research include massage therapy, manipulation, direction-specific exercises, traction, and mobilization, as well as the stretching, strengthening, and stabilization of trunk musculature. However, due to the heterogeneous nature of this condition, an intervention may be successful with one patient and ineffective with another. Despite the variety of treatment choices, the optimal treatment remains unknown.

Recent research is focused on analyzing classification algorithms in an effort to identify the most beneficial system for the individual patient. According to Stanton, Hancock, Apeldoorn, Wand, and Fritz (2013), "The treatment-based classification algorithm was developed to help clinicians match patients with acute low back pain to the most appropriate intervention" (p. 346). The purpose of the treatment-based classification (TBC) system is to identify clinical presentations that are likely to respond to treatment instead of identifying a specific anatomic source or pathology. Since LBP patients represent a heterogeneous group, the TBC system includes a method to divide patients into subgroups based on their history and the information gleaned from a thorough evaluation. Classification is based on a patient's history, clinical presentation, and physical examination (Apeldoorn et al., 2012). Although clinical evaluations have shifted toward placing patients in specific subgroups, classification systems have not demonstrated significant improvements in the management of LBP (Henry et al., 2014; Petersen et al., 2003; Stanton et al., 2011). The classification system may not be the problem, however; limited use of additional therapies may be hindering the process.

Delitto et al. (1995) developed one of the first TBC systems for patients with acute LBP. The purpose of this system was to match a patient's treatment with their LBP classification, which was based on an examination and specific algorithm for subgroup placement. In Delitto's model, three main treatment classifications existed: mobilization, extension movement, and traction. In 2006, Fritz and colleagues revised the TBC system to reflect evidence published on the classification criteria. The updated TBC algorithm separated patients into one of four treatment categories: manipulation, stabilization, specific exercise, or traction (Fritz, Brennan, Clifford, Hunter, & Thackeray, 2006). Due to a lack of evidence supporting the efficacy of traction for LBP, this category is not included in all recent classification systems (Cleland et al., 2007). Research on the updated TBC system developed by Delitto demonstrated moderate to good inter-rater reliability, regardless of the clinician's training and experience (Fritz et al., 2006; Stanton et al., 2011). When isolated to acute or subacute LBP, research has also supported the discriminant validity of the TBC system (George & Delitto, 2005).

In a study done to evaluate Delitto's classification system, researchers discovered that patients identified by individual subgroups were mutually exclusive in approximately 50% of the cases that were conducted. Of the remaining 50%, patients met criteria for more than one subgroup or did not meet criteria for any subgroup (Apeldoorn et al., 2012; Stanton et al., 2011). In this same study, the most common groups that overlapped were the exercise and manipulation groups. Many reasons may exist for this overlap. The classification categories may not have been exhaustive and exclusive, and patients who met the criteria for two categories might have benefitted from receiving both treatments instead of just one. The participants who did not fall into any subgroup were usually less disabled by LBP and had a longer duration of symptoms (Stanton et al., 2013).

An ideal system should also include a limited number of subgroups to minimize clinician error and increase competency in assigning patients to a specific classification (Fairbank et al., 2011). Each patient must fit into a subgroup if selection of a matching intervention is desired. Further research is needed to explore these issues.

The question of whether or not classifying patients with LBP is effective in the treatment process remains. Several studies demonstrated short-term improvements in pain and disability scores when patients were treated according to their specific subgroups (Brennan et al., 2006; Cleland et al., 2007; Fritz et al., 2003; Slater et al., 2012; Widerstrom, Olofson, & Arvidsson, 2007). Most of these studies included small sample sizes and excluded patients with chronic LBP. In larger randomized controlled trials (RCT), Delitto's TBC system did not produce more favorable results than did traditional physical therapy in patients with subacute or chronic LBP (Apeldoorn et al., 2012; Henry et al., 2014). While both groups of patients (TBC system and physical therapy) reported a reduction in pain and disability, the differences between groups were not significant.

Perhaps a better use of a classification system would be to differentiate between patients requiring surgery and those that would benefit from non-surgical options. Ultimately, a classification system should be easy to use, reliable, and all-inclusive, and it should accurately direct treatment interventions. More extensive research is needed in this area, however, in order to improve the classification model and offer more treatment options.

Treatment-Based Classification System Interventions

Despite the abundance of research, it remains unclear if manual therapy is effective, since positive changes in a patient's status could be attributed to a placebo effect or the natural healing of damaged structures. Numerous non-surgical interventions for LBP have been utilized by osteopaths, physical therapists, chiropractors, athletic trainers, and other healthcare professionals, with varying levels of success. Based on published research, it appears that the efficacy of different treatments contributes to much of the confusion surrounding the diagnosis of LBP. Manual therapy treatments such as massage, manipulation, and mobilization have not been consistently effective (Beurskens et al., 1997). The question that research attempts to answer is whether this is due to the actual treatment or to the improper classification of the patient. The latter may be the case, since most of the manual therapy treatments demonstrate positive outcomes in certain patient populations. The interventions considered in this review are manipulation, the McKenzie Method, stabilization, traction, and the MyoKinesthetic™ System.

Manipulation

Manipulation is one of the few interventions for LBP that is supported by evidence (Fritz, Whitman, Flynn, Wainner, & Childs, 2004). The technique is commonly used in LBP patients with acute symptoms, and it produces positive results when patients meet predefined criteria. Flynn et al. (2002) developed a clinical prediction rule (CPR) to classify patients within a manipulation subgroup. Five criteria were reported to predict favorable outcomes: a symptom duration of less than 16 days, the absence of symptoms distal to the knee, a Fear Avoidance Belief Questionnaire Work Subscale (FABQW) of less than 19, the existence of one or more hypermobile segments in the lumbar spine, and the presence of greater than 35 degrees of internal rotation in one or both hips (Childs et al., 2004). According to this CPR, the presence of at least four of the five factors maximized the likelihood—by more than 92%— that a patient would benefit from manipulation. Patients with two or less factors were likely to show improvement with manipulation only 9% of the time (Childs et al., 2004). The results of this study clearly demonstrated the importance of matching a treatment intervention to a patient's classification status. In a later study, Fritz et al. (2005) discovered that the presence of only two of the variables predicted success with manipulation therapy. In order to allow a more pragmatic approach to patient classification, the researchers in this study sought to eliminate the FABQW, the assessment of lumbar hypermobility, and the hip range of motion variable. A short duration of symptoms and the absence of symptoms distal to the knee had an accuracy of 83.7% when compared to the original CPR involving five criteria (Fritz et al., 2005).

One reason for some of the conflicting evidence surrounding manipulation may be the inconsistency in the treatment application among clinicians. The term *manipulation* can refer to both thrust and non-thrust procedures, with great variability between the two methods. Cleland et al. (2009) conducted an RCT to determine the efficacy of the original CPR in multiple settings and with the use of different forms of manipulation. The study, which compared two thrust maneuvers with a non-thrust manipulation, found significant differences in outcomes between the contrasting methods. The spine thrust and side-lying thrust manipulation achieved 86.5% and 81.6% success rates, respectively, at four weeks on the Oswestry Disability Questionnaire (OSW). The non-thrust group demonstrated a success rate of only 18.9% on the OSW at four weeks (Cleland et al., 2009). Based on these results, the authors concluded that the CPR could only be utilized with forms of thrust manipulation treatment.

Osteopathic manipulative treatment (OMT) is another form of manipulation. Chronic LBP is the most common reason patients see osteopaths, with the most prevalent symptom being pain in the lumbar spine (Licciardone et al., 2003). While osteopathic medicine has been shown to be successful, in some cases, in treating LBP, the results have not been consistent, because the patients were not placed in a homogenous group. In a study by Licciardone et al. (2003), OMT was not more effective than sham manipulation in improving patient outcomes. Another study, conducted ten years later, demonstrated short-term success in treating chronic LBP with its use of ultrasound therapy combined with OMT (Licciardone, Minotti, Gatchel, Kearns, & Singh, 2013). More research is needed on the variations of manipulative therapy in order to assess their long-term effects on LBP. Many of the trials conducted by researchers utilized a heterogeneous sample of LBP patients, when it would have been preferable to attempt an *a priori* identification of the subgroups that were most likely to respond to manipulation, instead.

McKenzie Method

Direction-specific lumbar exercises are another form of treatment for LBP within the TBC system. The McKenzie method, which is also known as mechanical diagnosis and therapy (MDT), was developed in 1981 and is based on the assumption that LBP can be extinguished through the use of particular exercises that are performed in a single, preferred direction (Guild, 2012). As a TBC system, MDT has demonstrated good reliability with trained and experienced clinicians (Fairbank et al., 2011). Mechanical diagnosis and therapy includes a strict evaluation format that classifies symptoms into three syndromes, which are derangement, dysfunction, and postural syndrome (Garcia et al., 2013). Many clinicians avoid using the strict MDT assessment, preferring to use the intervention component in isolation, instead (May & Donelson, 2008). Use of the direction-specific exercises without a thorough MDT evaluation compromises the integrity of the technique.

Several studies have demonstrated an excellent prognosis for patients who, through MDT evaluation, have been categorized with centralization (May & Donelson, 2008; Werneke & Hart, 2001). Centralization occurs when pain is abolished or moves from the periphery to the midline or spine as a result of position or movement (Chevan & Clapis, 2013; Werneke, Hart, & Cook, 1999). A recent RCT compared the Back School and MDT in 148 patients with chronic LBP. The Back School method attempts to manage LBP and prevent the recurrence of symptoms through the utilization of exercises that are aimed at improving flexibility, mobility, and strength (Garcia et al., 2013). Both the Back School and MDT groups exhibited a reduction in pain intensity and disability at one-month and six-month follow-ups. When compared with the Back School group, the MDT group demonstrated greater improvements in disability, but not in pain intensity (Garcia et al., 2013).

Several other studies also demonstrated the effectiveness of MDT compared to manual therapies such as manipulation and stabilization (Browder et al., 2007; May & Donelson, 2008; Petersen et al., 2011). However, one comparison of the MDT classification with an unclassified control group did not reveal any significant difference in pain reduction among patients (Fairbank et al., 2011). Other studies provided contrasting results (Machado et al., 2010; Petersen, Kryger, Ekdahl, Olsen, & Jacobsen, 2002). In an RCT on patients with acute LBP, MDT exercises were not significantly more effective on pain, disability, function, global effect, or the risk of developing additional symptoms than was first-line care (Machado et al., 2010). The length of time in which a patient suffers from LBP also appears to have an effect on the success of MDT. As with other research into LBP treatments, it is difficult to determine from these studies which information provides applicable evidence for clinicians. Inconsistencies in outcomes are one reason for the rising costs in healthcare associated with

LBP and for the prevalence of its occurrence. The lack of clinically meaningful outcomes in acute patients may suggest that most patients with acute LBP may spontaneously heal without the use of interventions (Machado et al., 2010).

Stabilization

Lumbar exercises have increased in popularity in the conservative management of LBP and are the treatment of choice for patients placed in the stabilization classification within Delitto's TBC system. Instability can be the result of excessive motion or a loss of muscular control. The stabilization subgroup was created to provide exercises for patients that exhibit certain signs and symptoms of instability (Cleland et al., 2007). In the revised version of Delitto's TBC system, stabilization replaced the immobilization subgroup. The original classification was based on the need for motion restriction in hypermobile patients. Patients were graded by their degree of disability and assigned stabilization exercises or corsets and braces (Delitto et al., 1995). Since radiographic imaging is not always conclusive in diagnosing lumbar segmental instability (LSI), researchers developed a CPR to be used in the clinical setting (Hicks, Fritz, Delitto, & McGill, 2005). The primary predictor of success when using this CPR was the presence of three or more of the following variables: age over 40 years, a positive prone instability test, aberrant lumbar movements, and an average straight leg raise greater than 91 degrees (Hicks et al., 2005).

Many studies have been conducted to examine the effectiveness of stabilization exercises for LBP patients, but the results have been inconsistent (Cairns, Foster, & Wright, 2006; Koumantakis, Watson, & Oldham, 2005). Patients that are not properly placed into the stabilization category do not respond better to treatment than patients receiving other manual therapy interventions (Cairns et al., 2006). The effectiveness of stabilization exercises depends largely on proper classification, yet the CPR has not been validated in the research (Rabin, Shashua, Pizem, Dickstein, & Dar, 2014). In a study done by Rabin et al. (2014) to assess the validity of the original CPR, the researchers discovered that a modified version of the CPR produced a better predictive validity, but this finding was discovered in post hoc testing and requires more research. The modified CPR included two (aberrant movement and a positive prone instability test) of the original four items (Rabin et al., 2014).

Regardless of the type of treatment intervention used on a patient, an acute LBP episode generally resolves within two to four weeks; but the recurrence rates are extremely high, at 60% to 86% (Hides, Jull, & Richardson, 2001). In the study by Hides et al. (2001), recurrence rates in participants who completed specific exercises for the multifidus and transversus abdominis muscles were much lower than a control group: 30% compared to 84%, respectively. Specific exercises in certain populations may result in positive long-term outcomes.

Traction

Traction, which relieves spinal pressure through decompression, was first popularized by Cyriax as a treatment for LBP patients with disc herniations (Fritz, Thackeray, Childs, & Brennan, 2010). Traction is often combined with other interventions, such as massage, heat application, and electrotherapy; however, there is a lack of clinical evidence to support the use of traction as an intervention for patients with LBP (Cai, Pua, & Lim, 2009; Fritz et al., 2010; Chevan & Clapis, 2013) . Indeed, the small amount of available evidence indicates that the mechanical effects of traction appear to have more short-term than long-term benefits (Beurskens et al., 1997).

In spite of the lack of convincing evidence, the original TBC system developed by Delitto contained a traction subgroup. In addition, Cai et al. (2009) developed a CPR for patients likely to benefit from traction therapy. Cai and cohorts determined that the four predictors for whether or not a patient would respond positively to traction were the following: a FABQW of less than 21, the absence of neurological deficit, an age over 30 years, and a non-manual employment status (Cai et al., 2009). The presence of all four predictors increased the probability of a successful mechanical traction intervention to 69%. Other clinicians support the presence of nerve root compression as the main indicator for the use of traction in LBP patients (Chevan & Clapis, 2013).

Many of the studies done on mechanical traction either contained flaws in the procedures or applied the technique to a heterogeneous LBP population. Researchers who conducted these studies reported that traction was no more effective than a placebo or sham treatment (Beurskens et al., 1997; Cleland et al., 2007; Guild, 2012). Fritz et al. (2007) found that many of the studies on traction used mixed groups instead of a homogeneous sample likely to benefit from the intervention. Beurskens et al. (1997) did not find any significant differences in pain, disability, or global change between traction and a sham treatment at five weeks, twelve weeks, and six months. Patients in the traction group also received more additional forms of therapy between follow up visits than those who received the sham treatment (Beurskens et al., 1997). In a meta-analysis of 25 trials, Guild (2012) reported that traction, whether continuous or intermittent, was equally as, or less effective than, a placebo. Another study compared the use of traction with standard physical therapy and did not find the addition of traction more beneficial than physical therapy alone (Borman et al., 2003). The commonalities in all of these traction studies were the use of a heterogeneous group of LBP patients and the combining of therapies. Both made it difficult for researchers to identify the reason for improvement in LBP among patients.

In contrast to these findings, some studies have demonstrated positive outcomes with traction. A relatively new traction system, the vertebral axial decompression (VAX-D), was studied in patients with LBP who possessed degenerative or herniated intervertebral discs as evidenced by imaging. The study by Beattie, Nelson, Michener, Cammarata, and Donley (2008) did not classify patients and included mostly chronic cases of LBP, but the findings indicated that patients obtained favorable outcomes with this new traction device. Improvements in pain and disability were discovered at discharge and at 30 and 180 days post-discharge (Beattie et al., 2008). Diab and Moustafa (2013) examined the benefits of lumbar extension traction and discovered significant positive effects on lordotic curvature, but not on pain or disability, when compared to a control group. The conflicting results suggest that there may be a specific subgroup of patients that will respond positively to traction.

The MyoKinesthetic™ System

Another TBC system is the MyoKinesthetic™ (MYK) System, which contains a global assessment that is focused on classifying the body's primary dysfunctions. The concept was developed by Dr. Michael Uriarte through experimentation in his clinical practice and serves as a means to balance the nervous system by treating muscles rather than by applying the common chiropractic philosophy of treating bony positional faults with manipulation (Uriarte, 2014). The technique was first introduced in 1998 and lacks independent research.

The MYK System is a unique paradigm, because its purpose is to evaluate and treat posture imbalances as a method to restore allostasis. The theoretical underpinnings of the paradigm are that standing, static posture underlies all movement patterns; therefore, if posture is not symmetrical, movement will be dysfunctional (Van Dillen, Sahrmann, & Wagner, 2005). Posture imbalances may result from changes in the central nervous system (CNS) as it works to achieve pain-free motion by responding to afferent feedback from the muscles (Shacklock, 1999a; Wyke, 1972). If an unbalanced posture exists, an underlying cause must be present, and the body must compensate before initiating any movements.

The MyoKinesthetic™ System Clinical Assessment

A clinician who uses the MYK System is guided by a specific evaluation process that matches a patient's posture imbalances and symptoms to a corresponding nerve root level (e.g., C3, L4, S2) (Uriarte, 2014). The MYK System assessment includes a thorough posture analysis, as well as: identification of peripheral neuropathy and pain, evaluation of weak movements through manual muscle testing, and inclusion of diagnosed pathological conditions. The patient is in a standing position for the majority of the MYK System posture analysis, which allows the clinician to observe the patient's posture from head to toe and document any imbalances. Hip, leg, foot, and toe postural exams are done in a standing, seated, and prone position. Each imbalance identified and documented in the evaluation is correlated to one or more nerve root levels on the posture chart. At the end of the assessment, the nerve root levels are totaled to determine the nerve pathway that contains the highest number of imbalances. The nerve root level identified in the assessment is presumed to be the cause of pain and dysfunction (Uriarte, 2014).

Within the MYK System postural analysis, clinicians are also provided a dichotomous key to aid in the determination of the appropriate treatment level. The key may be necessary if the clinician discovers that two or more nerve root levels have an equal number of posture imbalances. In cases where the patient's evaluation leads to two nerve root levels (e.g., L4 and

L5), the clinician utilizes other assessment components, such as positive dermatomal, myotomal, or peripheral nerve findings, to select the appropriate treatment level. Each positive finding within the evaluation can be correlated to a single nerve root level, which provides a means for discriminating between treatments. Treating the incorrect nerve root level will not result in an increase in symptoms, and often provides some relief, but it usually does not resolve the entire presentation (symptomology and function). The detailed evaluation included in the MYK System is theorized to allow the clinician to treat the cause of pain and not just the site of pain (Uriarte, 2014).

The MyoKinesthetic™ System Treatment

The primary goal of the MYK System is to balance posture by treating muscles bilaterally along a specific nerve pathway (e.g., C5, L5, S1), thereby producing changes in the nervous system (Uriarte, 2014). Pain and dysfunction can disrupt the transmission of signals traveling between the CNS and the muscles, resulting in muscle inhibition or facilitation. The MYK System includes stimulation of several ascending sensory tracts (anterior or lateral spinothalamic, and anterior and posterior spinocerebellar) to improve communication between the CNS and all of the muscles innervated by one nerve root. The spinothalamic tracts are stimulated by touch, and the spinocerebellar tracts are stimulated with movement (Uriarte, 2014). The CNS operates by receiving input from the tissues and environmental stimuli through these ascending tracts, and it produces a response to regulate the musculoskeletal system (Shacklock, 1999a). For example, repeated movements and tactile stimulation of a body part can change the brain's perception of that body part (Shacklock, 1999a). According to theory, the MYK System treatment is used to force information up to the brain along several different routes, causing the CNS to respond by sending signals back to the body, thus expediting allostasis (Uriarte, 2014). Although the intervention only includes muscles innervated by one nerve root, other muscles are affected when the CNS reacts to the treatment. It is hypothesized that as the nervous system communication (efferent and afferent) normalizes, it allows all of the muscles to function properly (Uriarte, 2014). The normalizing of neural input and output along the total nerve root pathway may produce changes in the musculature innervated by that level. As in other RI models, such as myofascial release and Total Motion Release, this muscular normalization may decrease compensation in adjacent and remote areas, resulting in decreased pain or in positive and observable changes in postural balancing and range of motion.

The MYK System treatment combines active and passive movement with tactile stimulation of each muscle that is innervated by one nerve root. Tactile stimulation can be performed with deep or soft pressure anywhere on the muscle, as long as the proper combination of muscles receives stimulation. By treating all of the muscles in a single nerve pathway, it is theorized that the treatment stimulates every mechanoreceptor along that pathway. Stimulation of multiple mechanoreceptors is speculated to be more effective than the stimulation of a single mechanoreceptor (Uriarte, 2014), and it results in decreased nociceptor firing and muscle relaxation (Noordzij et al., 2000; Wyke, 1972; Zoppi, Voegelin, Signorini, & Zamponi, 1991). Since muscle and fascia contain mechanoreceptors, both can be affected by the treatment. Researchers have also shown that forms of proprioceptive input that are similar to MYK treatment have demonstrated changes in the brain’s perception of and reaction to pain (Shacklock, 1999a).

Because the CNS functions bilaterally and its neural components are responsible for the cross-education of muscle strength and motor skills, all movements and tactile stimulation in the MYK System treatment are performed bilaterally (Farthing et al., 2011; Kim, Cha, & Fell, 2011; Lee, Gandevia, & Carroll, 2009; Lee, Hinder, Gandevia, & Carroll, 2010). As a result of the bilateral treatment, there is an increase in the transfer of information from the muscle on one side of the body to the other. The MYK System treatment is continuous, and the clinician moves from one body area to the next until all muscles have been treated. All movements within the treatment parameters should be pain-free, and the treatment can be performed daily. The only known contraindication to treatment is moving beyond the patient's range of motion. Analogous to other manual therapy interventions, the MYK System can directly impact the autonomic nervous system and may influence all levels of the healing process (Shacklock, 1999a, 1999b). Research studies on the MYK System are needed in order to determine the efficacy of this intervention for LBP.

Summary and Future Research

Based on the information provided in this review of literature, it can be concluded that treatment interventions for LBP have not consistently improved patient outcomes. The shift toward patient-centered evidence has resulted in numerous studies on the effectiveness of various treatments for LBP. The abundance of research focused on LBP demonstrates the heterogeneous nature of this condition. Although TBC systems were developed to match patients with an appropriate intervention, they have not been substantially more successful than unmatched treatments. Individuals suffering from LBP deserve a better understanding of their condition and a means to control their pain and level of disability.

Healthcare practitioners utilize many methods to examine patients with LBP; yet, in about 50% of cases, they fail to place patients into one classification or subgroup in the Delitto TBC system. There are numerous non-surgical treatments available to those who suffer from LBP, but their success rates will not improve until the cause of LBP is better understood. The classification system needs refining: It must be inclusive of all the varying levels of LBP among patients. The examination of why certain treatments fail should also become a critical part of the evaluation process. Successful patient outcomes in the area of LBP will significantly reduce healthcare costs and lessen the spread of this frustrating epidemic. As indicated by this review, the TBC system must be more thoroughly researched, and additional treatment interventions must be incorporated. Future research is also needed on the MYK System in order to provide evidence of its short- and long-term effects on LBP. Specifically, investigating the use of the MYK System as a treatment intervention within the Delitto TBC system will offer further evidence of its applicability with specific subgroups of LBP patients. The development of an *a priori* research design to assess the effects of MYK treatment on pain, disability, and active range of motion in LBP patients is needed. Once completed, this action research project may provide other clinicians with beneficial information for the management of LBP, and it may offer relief to those patients who have not experienced improved outcomes with the use of other interventions.

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CHAPTER 5

APPLIED CLINICAL RESEARCH

Analysis of Patient Outcomes Using the MyoKinesthetic™ System in a Treatment-Based Classification System for Low Back Pain

Submitted to the Journal of Manual and Manipulative Therapy

Abstract

Objectives: Research conducted on the treatment of low back pain (LBP) has not resulted in either the identification of a gold standard diagnostic method or a demonstrated, consistent improvement in patient outcomes. The purpose of this case series was to explore the effects of the MyoKinesthetic™ (MYK) System on a heterogeneous population of patients with LBP.

Methods: Nine participants (mean age 31.11 years) with a primary complaint of LBP were evaluated and included. The initial assessment contained the following components: patient history, palpation, range of motion testing, lower quarter neurologic screening, Selective Functional Movement Assessment (SFMA) top tier, MYK System posture screen, orthopedic special tests, and baseline data for pain intensity, disability, and function. All participants were treated with the MYK System.

Results: A repeated measures analysis of variance revealed statistically significant and clinically meaningful improvements in pain, disability, function, and posture from the initial evaluation to discharge and from the initial evaluation to a one-month follow-up ($p < 0.01$).

Discussion: All results of this case series provided evidence of the effectiveness of the MYK System as a treatment-based classification (TBC) system and intervention for patients with acute, subacute, and chronic LBP.

Keywords: Low back pain; MyoKinesthetic™ System; Treatment-based classification system

Introduction

Low back pain (LBP) is a widespread and costly healthcare epidemic. Over 1,000 randomized controlled trials (RCTs) of various interventions utilized for the management of LBP have been conducted, but the evidence from these trials remains contradictory and inconclusive (Apeldoorn et al., 2010; Childs, Fritz, Flynn, Irrgang, & Johnson, 2004; Cleland, Fritz, & Childs, 2007). The lack of a gold standard for LBP diagnosis further complicates the problem. Advanced imaging detects many abnormalities in both asymptomatic and symptomatic individuals, which indicates that pathoanatomic structures may not be responsible for symptoms (Chou, Qaseem, Owens, & Shekelle, 2011). Radiographic imaging also cannot account for the psychogenic causes that may be the source of chronic LBP in many individuals (Sarno, 1999). Due to a complicated etiology, approximately 85% of LBP patients receive a vague diagnosis of nonspecific LBP (Apeldoorn et al., 2010; Cleland et al., 2007; Fritz, Childs, & Flynn, 2005; Kent, Keating, & Leboeuf-yde, 2010; Waddell, 2005; Widerstrom, Olofson, & Arvidsson, 2007).

Many LBP studies lack favorable outcomes due to a heterogeneous population of nonspecific LBP patients and the focus on one intervention benefiting everyone (Cleland et al., 2007). In an effort to rectify this problem, attempts were made to place LBP patients into homogeneous subgroups, based on the patients' responses to selected interventions. Most of these classification systems were based on the clinicians' intuition and clinical experience and the patients' biomedical characteristics (Apeldoorn et al., 2010).

One classification system that has demonstrated potential for improving patient outcomes is the treatment-based classification (TBC) system developed by Delitto, Erhard, and Bowling (1995). The purpose of Delitto's TBC system was to identify patients who were most likely to respond to one of the following interventions: manipulation, stabilization, specific exercise, or traction (Delitto et al., 1995). Within this system, classification into the treatment subgroups was based upon a combination of the findings derived from the patients' histories, physical examinations, and clinical presentations (Delitto et al., 1995). Patients with acute LBP who were properly matched to treatment within the TBC system demonstrated greater improvements in disability and pain levels than patients who received unmatched treatments (Brennan et al., 2006; Fritz, Delitto, & Erhard, 2003).

The clinical usefulness of Delitto's TBC system is still under investigation, and researchers continue to implement changes to make it more inclusive of all LBP patients (Apeldoorn et al., 2010; Brennan et al., 2006; Cleland et al., 2007; Fritz, Delitto, & Erhard, 2003; Slater et al., 2012; Stanton et al., 2011). Although acute LBP patients have experienced positive outcomes from the use of the TBC system, those who suffer from chronic conditions, which the TBC system was not designed for, have met with limited success (Apeldoorn et al., 2012; Henry et al., 2014).

The MyoKinesthetic™ (MYK) System is a TBC system used for a variety of musculoskeletal conditions, including acute and chronic LBP. Developed and introduced by Dr. Michael Uriarte in 1998, the MYK System is a relatively new paradigm focused on balancing the nervous system by correcting posture abnormalities (Uriarte, 2014). Researchers have hypothesized that posture imbalances are the result of changes in the central nervous system (CNS) as it responds to afferent feedback from the body (Shacklock, 1999). The developed posture asymmetries are considered to be compensations that the CNS established in an effort to achieve pain-free, yet dysfunctional, movement (Van Dillen, Sahrmann, & Wagner, 2005). In this compensatory state, posture imbalances would result in restricted joint motion and decreased mechanoreceptor firing (Uriarte, 2014).

A clinician using the MYK System classifies patients based on their postural abnormalities, presence of peripheral neuropathy, and muscle weakness. The MYK System includes a comprehensive global evaluation process, with the primary component being a full-body posture screen (Fig. 5.1). Each posture imbalance is correlated with one or more nerve root levels, and upon completion, the levels are totaled to determine the nerve pathway with the most imbalances (e.g., L4, C5, S1). The selected nerve root level is presumed to be the source of pain and dysfunction. The assessment process is theorized to provide the clinician with a classification, rather than an anatomical diagnosis, through which to treat the patients' causes of pain, resolve their symptoms, and restore allostasis (Uriarte, 2014).

Treatment within the MYK System is focused on stimulating the CNS through a unique manual therapy approach. All muscles associated with the selected nerve root are treated bilaterally with active and passive movement, and sensory stimulation. Bilateral treatment is essential, since it mirrors the function of the CNS and allows for the cross-education of strength and motor skills (Farthing et al., 2011; Kim, Cha, & Fell, 2011; Lee, Gandevia, & Carroll, 2009; Lee, Hinder, Gandevia, & Carroll, 2010). The combination of tactile stimulation and movement stimulates mechanoreceptors of the selected nerve root pathway, resulting in decreased nociceptor firing and in muscle relaxation (Noordzij et al., 2000; Zoppi, Voegelin, Signorini, & Zamponi, 1991). Since pain and dysfunction can alter signal transmission from the CNS, the MYK treatment is used to improve communication between the CNS and muscles (Uriarte, 2014). The MYK treatment is theorized to increase afferent stimulation along a specific nerve root pathway, resulting in the generation of efferent feedback, which causes normalization of neural input and output, allowing muscles to function properly (Uriarte, 2014). Improved CNS function is observed through postural balancing and the resolution of signs and symptoms.

Although it was introduced in 1998, the MYK System lacks independent research. In a case study on chronic LBP, the use of the MYK System resulted in significant improvements in pain, disability, and function in a patient with multiple disc herniations (confirmed through magnetic resonance imaging, or MRI) (Brody, Baker, Nasypany, & May, 2014). Numerous studies have been conducted to assess the effectiveness of a variety of manual therapy interventions for LBP, but only one has targeted the MYK System. Therefore, the purpose of this study was to assess the effects of the MYK System on LBP. Additionally, patients were placed into the Delitto et al. (1995) TBC system to determine the effects of MYK treatment on different subgroups.

Methods

Participants

A convenience sample of patients who reported to a university athletic training clinic for evaluation and treatment were screened for inclusion in the study. Inclusion criteria was defined as: (1) age over 18 years and (2) chief complaint of LBP, with or without radiating leg pain. Patients were excluded if they were in their third trimester of pregnancy, exhibited signs of serious infection, or received steroid injections up to one month prior to the initial evaluation. Additionally, patients were to be removed from this study and offered an alternate treatment if a 50% reduction in pain on the Numeric Rating Scale (NRS) was not reported after four successive MYK treatments. Between September 2014 and October 2014, nine consecutive patients (four females, five males) were evaluated in the clinic, and all met the inclusion criteria for the study (Table 5.1 and Appendix E). Informed consent was obtained from all participants, and the University of Idaho Institutional Review Board approved the research protocol.

Outcome Measures

Outcome measurements were obtained at the initial evaluation, weekly appointments, discharge, and one-month follow-up visits. The primary outcomes were pain (NRS), disability (DPA Scale and OSW), function (PSFS), active range of motion (FFD and FTD), posture (MYK System), and global efficacy of treatment (GRC Scale). A description of each outcome measure is listed in Table 5.2.

The MYK System posture assessment was used to identify imbalances in the neck, thorax, shoulders, scapula, lumbar spine, hips, and the extremities. Each posture imbalance was correlated to specific nerve root levels (Fig. 5.1). The number of posture asymmetries was totaled to determine the appropriate nerve pathway for treatment (Uriarte, 2014). Prior to the study, the researcher conducted inter- and intra-rater reliability testing (kappa coefficient, % agreement) on the MYK System posture screen. The primary researcher, a certified MYK practitioner, demonstrated almost perfect agreement with an expert practitioner on both the upper body (.903 [95% CI, .719-1.087, $p < .001$], 93.3%) and lower body posture assessment (.882 [95% CI, .659-1.105, $p < .001$], 93.3%). In two separate trials to establish intra-rater reliability, there was substantial agreement between the trials on both the upper body (.792 [95% CI, .533-1.051, $p < .001$], 93.3%) and lower body posture screen (.766 [95% CI, .490-1.042, $p < .001$], 86.7%).

Procedures

All initial examinations, follow-up visits, and treatments were completed by the same researcher, who was a certified MYK practitioner. The initial evaluation included patient history, palpation, range of motion testing, lower-quarter neurologic screening, Selective Functional Movement Assessment (SFMA) top tier, MYK System posture screen, orthopedic special tests (Appendix F), and baseline data for the NRS, DPA Scale, OSW, and PSFS. Additionally, all participants were evaluated and placed into subgroups using the TBC system algorithm (Fig. 5.2) (Stanton et al., 2011). All NRS scores were recorded pre- and post-treatment, while all other measures were recorded weekly, at discharge, and at the one-month follow-up visit. Discharge criteria were set as follows: NRS scores (current pain levels) ≤ 1, DPA Scale < 23, OSW < 20%, and balanced MYK postures maintained between visits.

The MYK treatment was performed daily (if patient availability allowed), and all movements were pain-free. Treatment times varied from 5 to 20 minutes, depending on the nerve root level being treated. The combination of muscles treated varied between nerve root levels. An additional description of the technique is illustrated in Figures 5.3 and 5.4. All nine patients were treated with only the MYK System and no patient had to be removed from participation.

Statistical analyses

All data was analyzed using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA). One-way repeated measures analysis of variance tests were conducted to evaluate the effect of MYK treatment on the NRS, DPA Scale, PSFS, OSW, MYK posture, FFD, and FTD across time. Mean differences from the initial visit scores and 95% confidence intervals (CIs) were calculated for the NRS, DPA Scale, PSFS, OSW, and MYK posture for discharge and a 1-

month follow-up. Significant changes were further analyzed with Bonferroni *post hoc* testing. Prior to data analysis, normality of distribution was assessed and the confidence level was set at $p < 0.05$. Effect size differences were computed with eta squared (η^2). A small effect size is $\eta^2 = 0.01$; medium effect size is $\eta^2 = 0.06$; large effect size is $\eta^2 = 0.15$ (Vincent & Weir, 2012).

Results

The participants' mean age was 31.11 years (*SD* = 16.04). The majority of patients reported chronic LBP (*n* = 6), with an average symptom duration of 6 years (*SD* = 4.52). The remaining patients reported subacute or acute LBP (*n* = 3), with an average symptom duration of 8.67 days (*SD* = 10.79). The mean number of MYK treatments administered was 12.11 (*SD* = 6.25), and the mean number of days until discharge was 28.67 (*SD* = 9.38). At the discharge visit, 100% of the participants reported complete resolution of their pain. At the 1-month follow-up visit, 89% of the participants remained pain-free.

Numeric Rating Scale

The MYK System resulted in statistically significant improvements in pain over time [$F(1.101, 8.804) = 29.659$, $p < 0.001$, $\eta^2 = 0.788$, Power = 0.999] (Table 5.3). The mean changes in NRS scores from initial visit to discharge (*M* = 3.2, 95% CI [1.44, 4.96], $p = 0.002$), and from initial visit to 1-month follow-up (*M* = 3.08, 95% CI [1.42, 4.74], $p = 0.002$), were significant. The change in NRS scores from discharge visit to 1-month follow-up (*M* = 0.12, 95% CI [-0.33, 0.57], $p = 1.00$) was not significant and indicated improvements were maintained at follow-up examination. Effect size reduction in pain was high, at 0.79, which demonstrated that 79% of the variance in pain scores could be explained by MYK treatment.

The mean change in NRS scores from initial exam to discharge exam exceeded the minimal clinically important difference (MCID) value on the NRS (Farrar, Young, LaMoreaux, Werth, & Poole, 2001). Of greater clinical relevance, 100% of patients reported an NRS score that exceeded the MCID value after 1 week of treatment. Additionally, 89% of the patients achieved an MCID on the NRS (current pain) following the first treatment.

Disablement in the Physically Active Scale

Statistically significant improvements were recorded for DPA Scale scores over time [$F(2, 14) = 87.763$, $p < 0.001$, $\eta^2 = 0.926$, Power = 1.00] (Table 5.3). The mean changes in DPA Scale scores from initial visit to discharge ($M = 27.38$, 95% CI [20.69, 34.06], $p < 0.001$), and from initial visit to 1-month follow-up ($M = 26.50$, 95% CI [16.92, 36.09], $p < 0.001$), were significant. The change in DPA Scale scores from discharge visit to 1-month follow-up ($M = 0.88$, 95% CI [-4.16, 5.91], $p = 1.00$) was not significant and indicated the improvements were maintained at follow-up examination. The large effect size of 0.93 indicated that MYK treatment could be used to explain 93% of the variance in DPA Scale scores.

The mean change in DPA Scale scores from initial exam to discharge exam exceeded the MCID value on the DPA Scale (Vela & Denegar, 2010). At both exams, the lower boundary of the 95% CI demonstrated a reduction of more than 9 points, providing further evidence of clinically important change (Vela & Denegar, 2010). Additionally, 89% of patients reported a DPA Scale score that exceeded the MCID value after 1 week of treatment. The initial DPA Scale score in this study ($M = 33.25$) was higher than reported normal baseline values for this outcomes measure ($M = 27.27$); however, the patients in this study achieved much lower scores at discharge (*M* = 5.88) than the reported normal values for persistent injuries at 6 weeks (*M* = 18.91) (Vela & Denegar, 2010).

Patient-Specific Functional Scale

The MYK treatment also produced statistically significant improvements in PSFS scores over time [$F(2, 16) = 46.660$, $p < 0.001$, $\eta^2 = 0.854$, Power = 1.00] (Table 5.3). The mean changes in PSFS scores from initial visit to discharge (*M* = 3.87, 95% CI [2.40, 5.35], $p < 0.001$), and from initial visit to 1-month follow-up (*M* = 3.79, 95% CI [2.07, 5.48], $p < 0.001$), were significant. The change in PSFS scores from discharge visit to 1-month follow-up (*M* = 0.09, 95% CI [-0.70, 0.89], $p = 1.00$) was not significant and indicated the improvements were maintained at follow-up examination. Effect size reduction in pain was high, at 0.85, which demonstrated that 85% of the variance in PSFS scores could be explained by MYK treatment.

The mean change in PSFS scores from initial exam to discharge exam exceeded the MCID value on the PSFS (Nicholas, Hefford, & Tumilty, 2012; Young, Cleland, Michener, & Brown, 2010). After 1 week of treatment, 44% of patients reported a PSFS score that exceeded the MCID value. At discharge, 89% of patients reported a score of 9 or higher, with 10 representing the highest score possible. At the 1-month follow-up, 78% of patients reported a score of 9 or higher.

Modified Oswestry LBP Disability Questionnaire

Statistically significant improvements were recorded for OSW scores over time [$F(1.147, 9.173) = 15.128$, $p = 0.003$, $\eta^2 = 0.654$, Power = 0.969] (Table 5.3). The mean changes in OSW scores from initial visit to discharge (*M* = 17.56, 95% CI [4.89, 30.22], $p = 0.009$), and from initial visit to 1-month follow-up (*M* = 17.60, 95% CI [3.73, 31.47], $p =$

0.015), were significant. The change in OSW scores from discharge visit to 1-month follow-up (*M* = 0.04, 95% CI [-4.27, 4.36], $p = 1.00$) was not significant and indicated the improvements were maintained at follow-up examination. The large effect size of 0.65 indicated that MYK treatment could be used to explain 65% of the variance in DPA Scale scores.

The mean change in OSW scores from initial exam to discharge exam exceeded the MCID value on the OSW (Fritz & Irrgang, 2001). Additionally, 44% of patients reported an OSW score that exceeded the MCID value after 1 week of treatment. The mean OSW score at initial exam indicated "moderate disability," which was later reduced to "minimal to no disability" at both discharge visit and 1-month follow-up for 100% of the patients.

MyoKinesthetic Posture Assessment

The MYK treatment also produced statistically significant improvements in posture over time [$F(1.191, 9.524) = 39.626$, $p < 0.001$, $\eta^2 = 0.832$, Power = 1.00] (Table 5.3). The mean changes in the total number of posture asymmetries from initial visit to discharge (*M* = 4.33, 95% CI [3.33, 5.34], $p < 0.001$), and from initial visit to 1-month follow-up (*M* = 3.44, 95% CI [1.37, 5.52], $p = 0.003$), were significant. The change in the total number of posture asymmetries from discharge visit to 1-month follow-up (*M* = 0.89, 95% CI [-0.48, 2.26], $p = 0.259$) was not significant and indicated the improvements were maintained at follow-up examination. Effect size reduction in posture imbalances was high, at 0.83, which demonstrated that 83% of the variance in posture could be explained by MYK treatment.

Active Range of Motion

The MYK treatment did not produce statistically significant changes in thoracolumbar flexion over time [$F(2,16) = 0.716$, $p = 0.504$, $\eta^2 = 0.082$, Power = 0.150] (Table 5.3). The mean changes in FFD scores from initial visit to discharge (*M* = 0.89, 95% CI [-4.20, 5.98], $p = 1.00$), and from initial visit to 1-month follow-up (*M* = 0.94, 95% CI [-5.70, 3.81], $p = 1.00$), were not significant.

The MYK treatment also did not produce statistically significant changes in thoracolumbar right lateral flexion over time [$F(2, 16) = 0.412$, $p = 0.669$, $\eta^2 = 0.049$, Power = 0.105] (Table 5.3). The mean changes in FTD-R scores from initial visit to discharge (*M* = 1.06, 95% CI [-4.41, 6.52], $p = 1.00$), and from initial visit to 1-month follow-up (*M* = 1.33, 95% CI [-3.03, 5.69], $p = 1.00$), were not significant.

The MYK treatment did not produce statistically significant changes in thoracolumbar left lateral flexion over time [$F(1.215, 9.717) = 1.148$, $p = 0.324$, $\eta^2 = 0.125$, Power = 0.171] (Table 5.3). The mean changes in FTD-L scores from initial visit to discharge (*M* = 1.72, 95% CI [-3.56, 7.01], $p = 1.00$), and from initial visit to 1-month follow-up (*M* = 1.72, 95% CI [-1.75, 5.20], $p = 0.520$), were not significant. Medium effect sizes were reported for all AROM tests (FFD = 0.08, FTD-L = 0.12, FTD-R = 0.05), which demonstrated that 5 to 12% of the variance in AROM measurements could be explained by MYK treatment.

Treatment-Based Classification System

Due to the small sample size of subgroups within the TBC system, inferential statistics were not conducted to compare the effects of MYK treatment on each TBC subgroup. However, based on the mean change scores across all outcome measures, there did not appear to be a significant difference between the TBC subgroups (Table 5.4).

Discussion

In this case series, LBP patients reported statistically significant and clinically meaningful improvements in pain, disability, and function at discharge and at a one-month follow-up. Although the MYK System did not produce significant changes in AROM, it should be noted that FTD measurements were within normal ranges prior to treatment (Norkin & White, 2009). Additionally, the mean value for FFD at the initial exam exceeded the normal range by 14.33 cm, indicating hypermobility in thoracolumbar flexion in this patient population (Norkin & White, 2009). Despite minimal changes in AROM, the MYK System did result in statistically significant improvements in posture, as measured by the MYK posture screen. In this study, a broad scope of outcomes was included, because in the assessment of LBP treatments, no one, fixed outcome is considered ideal; rather, the use of a battery of outcome measures is suggested (Cook et al., 2013). The consistent improvement in all outcome measures in this study provides evidence of the effectiveness of the MYK System on multiple dimensions of LBP.

Despite the heterogeneous nature of the patient population included in this study, classification and treatment within the MYK System produced greater decreases in NRS scores than those documented in other TBC studies (Apeldoorn et al., 2012; Henry et al., 2014; Machado, Maher, Herbert, Clare, & McAuley, 2010). Apeldoorn et al. (2012) reported a mean baseline score of 6.06 on the NRS, which was only lowered to 4.04 following 8 weeks of treatment with Delitto's TBC system. Our mean NRS scores, in comparison, were 3.43 at baseline and 0.23 at discharge, and were achieved within 1 month for most patients. Additionally, 100% of the participants in our study reported NRS scores less than 1 at discharge and 1-month follow-up, which was lower than the mean NRS score of 3.14 reported at 26 weeks in the study by Apeldoorn et al. (2012).

Additionally, the results of this study indicate better outcomes on the OSW and GRC when compared to other similar studies (Costa et al., 2009; Hicks, Fritz, Delitto, & McGill, 2005; Macedo et al., 2012; Miyamoto, Costa, Galvanin, & Cabral, 2012). In a study examining the effects of stabilization exercises on patients with LBP, Hicks et al. (2005) reported 33% of participants achieved a 50% or greater improvement on the OSW over a period of 8 weeks. Our study, in contrast, included a minimum 50% improvement in OSW scores in 67% of patients in the first week of treatment and in 78% of patients at discharge. In addition, the patients in our study reported being almost completely recovered on the GRC at discharge and 1-month follow-up. The mean GRC scores at discharge and 1-month follow-up of 4.4 and 4.1, respectively, were higher than the GRC scores (M = 1.3, 2.0, and 3.2) that were reported in other studies on LBP treatment (Costa et al., 2009; Macedo et al., 2012; Miyamoto et al., 2012).

In comparison to other studies using the PSFS, the patients in our study reported higher PSFS scores following one month of treatment (Aasa, Berglund, Michaelson, & Aasa, 2015; Costa et al., 2009; Macedo et al., 2012; Miyamoto et al., 2012). In a study examining the effects of motor control exercises on LBP, Aasa et al. (2015) reported a mean PSFS baseline score of 3.8, and a 2-month follow-up score of 7.8. Similarly, Macedo et al. (2012) reported a baseline PSFS score of 3.7 and a 2-month follow-up score of 5.9 in patients treated with motor control exercises. In our study, patients reported a higher baseline PSFS score (M = 5.5) and a higher score at the 1-month follow-up (M = 9.3). More importantly, our patients' scores were also close to the maximum score of 10, which indicated that the patients had returned to almost normal, pre-injury function at discharge and 1-month follow-up exams.

Although Delitto's TBC system was developed to improve patient outcomes, only 50% of patients can be placed into one subgroup (Stanton et al., 2011). The remaining 50% either do not fit into any subgroup or can be placed into several subgroups (Stanton et al., 2011). Our findings are similar, as 44% of our patients could not be placed into any of the subgroups within Delitto's TBC system. These patients would be less likely to receive a classification-based treatment in the TBC model; but within the MYK System, all of these patients appeared to receive a properly matched treatment.

With the variety of interventions available for patients with LBP, consistent selection of effective treatment is difficult (Cleland et al., 2007). The value of any TBC system is predicated upon its ability to produce more consistent outcomes (Brennan et al., 2006). The results of this preliminary study provide evidence that the MYK System was effective in reducing pain and disability and in improving function and posture in patients with LBP. Although the intention of this study was not to investigate the effects among TBC subgroups, the use of the MYK System did appear to benefit each patient classification equally. Additionally, patients with acute LBP required fewer treatments ($M = 6.7$ in 3 weeks) than the average 4-week treatment protocols found in other studies (Brennan et al., 2006; Machado, De Souza, Ferreira, & Ferreira, 2006). The patients with chronic LBP also required fewer treatments ($M = 14.8$) than the average number of treatments (35.7) found in other studies (Cook et al., 2013). The rapid and lasting improvements offer evidence that the MYK System compares favorably to other TBC options.

A number of limitations, however, were present in this study. First, due to the sample size, it was difficult to compare the effects of the MYK treatment between each TBC subgroup. Additionally, bias may have been introduced, since the patient and primary researcher were not blinded to the procedure or outcomes. The lack of a control or comparison group also limited the researcher's ability to verify that all changes were the result of MYK treatment. Further studies are needed, with independent researchers, to confirm the benefits experienced in this case series compared to the benefits experienced with other interventions. Although there were positive findings with MYK treatment at one-month follow-up, subsequent studies should be conducted to investigate the long-term benefits of this treatment.

Conclusion

In this case series, the use of the MYK System resulted in significantly improved pain, disability, function, and posture in patients with LBP. The patients did not require additional treatment following discharge, and all improvements were maintained at a one-month follow-up. Based on the results in this study, the MYK System may be an appropriate TBC system for all patients with LBP, but further research is required to substantiate these findings.

Table 5.1 Participants' demographic details (n = 9)

Patient	Age/ Gender	Symptom location	Symptom duration	Injury mechanism	TBC	MYK Tx	Txs
1	30/F	Right lumbar, hip	9 years	Gradual onset	Traction	L4	9
2	30/M	Bilateral lumbar	12 years	Weight lifting/sudden	None	S1	15
3	24/M	Central lumbar	9 years	Fall/trauma	None	L4 & C8	24
4	50/F	Bilateral lumbar, right hip	3 weeks	Running/sudden	None	L5	8
5	19/M	Left lumbar	1 day	Weight lifting/sudden	Manipulation	L4	7
6	19/F	Right lumbar, posterior thigh	4 days	Running/sudden	Specific exercise	L5	5
7	65/M	Bilateral lumbar	2 years	Gradual onset	None	L3	8
8	20/F	Right lumbar, SIJ	2 years	Weight lifting/sudden	Specific exercise	L5 & S1	18
9	22/M	Central lumbar	2 years	MVA/trauma	Specific exercise	L5 & C5	15

Key: TBC – treatment-based classification subgroup; MYK Tx – nerve root level used for treatment; Txs – number of treatments; SIJ – sacroiliac joint; MVA – motor vehicle accident

Table 5.2 Description of Outcome Measures

Outcome measure	Construct	Description
Numeric Rating Scale (NRS) (Childs, Piva, & Fritz, 2005; Farrar et al., 2001; Williamson & Hoggart, 2005)	Pain intensity	The NRS is an 11-point scale, with 0 representing no pain and 10 indicating extreme pain. The NRS scores were recorded before and after each treatment. The NRS total (an average of the current, best, and worst score) was used for reporting. The minimal clinically important difference (MCID) was a decrease of 2 points or 30%. When compared to other pain rating scales, the NRS was valid, reliable, and more sensitive than the verbal rating scale.
Disablement in the Physically Active (DPA) Scale (Vela & Denegar, 2010)	Disability	The DPA Scale is a 16-item questionnaire related to the following items: impairment, functional limitation, disability, and quality of life. Each statement was rated by the patient on a scale of 1 (no problem) to 5 (severe), with a maximum score of 64 and minimum score of 0. The MCID was a decrease of 9 points for acute injuries and 6 points for chronic injuries. The DPA Scale has been shown to be valid, reliable, and responsive.
Modified Oswestry LBP Disability Questionnaire (OSW) (Fairbank, Davies, Couper, & O'Brien, 1980; Fritz & Irrgang, 2001)	Disability	The OSW is a 10-item questionnaire related to normal activities of daily living. Each question was scored from 0 to 5, with higher numbers corresponding to greater disability. The MCID was a decrease of 6 points or 12%. The OSW has been shown to be valid and reliable, and it demonstrated higher levels of test-retest reliability when compared to the Quebec Back Pain Disability Scale.
Patient-Specific Functional Scale (PSFS) (Fairbairn et al., 2012; Nicholas et al., 2012; Young et al., 2010)	Function	Participants selected 3 to 5 activities that they could not perform at a normal level. Each activity was rated on a scale of 0 (could not perform) to 10 (could perform normally at pre-injury levels). The scores were then averaged to determine the final score, with an MCID represented by a decrease in 2 points. The PSFS has been found to be reliable, valid, and responsive in various patient populations.
Fingertip-to-floor distance (FFD) (Norkin & White,	Thoracolumbar active range of	The FFD was measured with the patient standing on a 20 cm-high step with the feet

2009)	motion (AROM)	together. The patient was instructed to bend forward, and the distance from the third fingertip to the floor was measured in centimeters. An average of 3 readings was recorded. Normal values for the FFD have been identified as 0.1 to 2.2 cm, with participants standing on the floor.
Fingertip-to-thigh distance (FTD) (Norkin & White, 2009)	Thoracolumbar AROM	The FTD was measured with the patient standing with his or her back against a wall with feet shoulder width apart. An initial mark was made where the patient's third fingertip rested on the lateral thigh. The patient was instructed to laterally flex as far as possible while keeping his or her back and shoulders against the wall. A final mark was made where the third fingertip moved down the thigh. The distance was measured between both marks and recorded in centimeters. An average of 3 readings was recorded. Normal values for the FTD have been identified as 19.1 to 21.6 cm.
MYK System posture screen (Uriarte, 2014)	Posture	Each participant's posture was assessed using the MYK posture screen, which correlated each imbalance with a specific nerve root. The number of posture asymmetries was totaled to determine the nerve root level for treatment.
Global Rating of Change (GRC) scale (Kamper & Mackay, 2009)	Global efficacy of treatment	The GRC is an 11-point scale, with end ranges at -5 (very much worse) and 5 (completely recovered). Participants assessed their improvement over time in order to determine the effects of MYK treatment on their chief complaint. The GRC demonstrated high reliability and validity scores, and the MCID was an increase in 2 points.

Table 5.3 Overall mean ± SD and effect size differences at discharge and one-month follow-up (*n* = 9)

Outcome measures	Initial examination	At discharge	At one-month F/U	η^2	*p*-value
NRS (Total)	3.43 ± 1.78	0.23 ± 0.25*	0.36 ± 0.43^	0.79	0.000
DPA Scale	33.25 ± 8.21	5.88 ± 5.72*	6.75 ± 6.67^	0.93	0.000
PSFS	5.53 ± 1.50	9.41 ± 0.48*	9.31 ± 0.99^	0.85	0.000
OSW	22.44 ± 12.99	4.89 ± 6.09*	4.84 ± 4.96^	0.65	0.003
MYK	7.44 ± 1.42	3.11 ± 0.78	4.00 ± 1.22	0.83	0.000
FFD (cm)	14.22 ± 9.23	13.33 ± 8.60	15.17 ± 7.22	0.08	0.504
FTD (cm) L	20.44 ± 3.80	18.72 ± 6.12	18.72 ± 4.93	0.13	0.324
FTD (cm) R	20.33 ± 3.19	19.28 ± 5.57	19.00 ± 5.00	0.05	0.669

Key: F/U – follow-up; * - MCID – day 1 to discharge; ^ - MCID – day 1 to F/U; MYK - # of posture imbalances
NRS = Numeric Rating Scale; MCID = 2 points or 30%
DPA Scale = Disablement in the Physically Active Scale; MCID = 6 points for chronic, 9 points for acute
PSFS = Patient-Specific Functional Scale; MCID = 2 points
OSW = Modified Oswestry Low Back Pain Disability Questionnaire; MCID = 12%
FFD = Fingertip-to-floor Distance; no MCID; normal ranges 0.1 – 2.2 cm from the floor without a step
FTD = Fingertip-to-thigh Distance; no MCID; normal ranges 19.1 – 21.6 cm

Table 5.4 Mean scores comparing TBC subgroups (*n* = 9)

TBC	Time	NRS (*M*Δ)	DPA Scale (*M*Δ)	PSFS (*M*Δ)	OSW (*M*Δ)
Traction (*n* = 1)	Initial	2.2	32	4.7	16%
	Discharge	0 (2.2)	10 (22)	9.3 (4.6)	6% (10%)
	1 month	0 (2.2)	17 (15)	9.8 (5.1)	2% (14%)
No Subgroup (*n* = 4)	Initial	4.0	31	6.2	26%
	Discharge	0.2 (3.8)	4.3 (26.7)	9.6 (3.4)	4.5% (21.5%)
	1 month	0.6 (3.4)	6.5 (24.5)	9 (2.8)	4.5% (21.5%)
Manipulation (*n* = 1)	Initial	1.7	27	4	16%
	Discharge	0.3 (1.4)	0 (27)	9.3 (5.3)	2% (14%)
	1 month	0 (1.7)	0 (27)	10 (6)	0% (16%)
Specific Exercise (*n* = 3)	Initial	3.7	29	5.4	22%
	Discharge	0.4 (3.3)	7 (22)	9.3 (3.9)	6% (16%)
	1 month	0.3 (3.4)	3.7 (25.3)	9.4 (4)	6% (16%)

Key: *M*Δ - mean change from initial visit

HEAD	
Extension	____(C1-C3)
Flexion	____ (C1-T1)
Rotation	____ (C1-T1)
Lateral flexion	____ (C1-T1)
SCAPULA	
Elevated	____ (C3,C4)
Depressed	____ (C3-C5)
Protracted(AB)	____ (C3-C5)
Retracted (ADD)	____ (C5-C8)
Upward rotated	____ (C3-C8)
Downward rotated	____ (C3-C7)
SHOULDER	
Flexed	____ (C5-C8)
Extended	____ (C5-C8)
Depressed(AB)	____ (C5-C8)
Elevated (ADD)	____ (C5-C6)
Medial rotated	____ (C5-C6)
Lateral rotated	____ (C5-C8)
ELBOW	
Flexed	____ (C7-C8)
Extended	____(C5-C7)
FOREARM	
Supinated	____ (C6-T1)
Pronated	____ (C5-C6)
WRIST	
Flexed	____ (C6-C8)
Extended	____ (C6-T1)
Radial deviated	____ (C7-C8)
Ulnar deviated	____ (C6-C7)
THUMB	
Flexed	____ (C7-T1)
Extended	____ (C6-T1)
Abducted	____ (C8-T1)
Adducted	____ (C6-T1)
FINGER	
Flexed	____ (C6-T1)
Extended	____ (C7-T1)
Abducted	____ (C8-T1)
Adducted	____ (C8-T1)

		LUMBAR SPINE
(L1-L5)	____	Flexed
(L1-L2)	____	Extended
(L1,L2)	____	Lateral Flexion
(L1-L5)	____	Rotation
		HIP
(L5,S1)	____	Ant Rot (flex)
(L1,2,3,4,5)	____	Post Rot (Ext)
(L2,L3)	____	Downslip (AB)
(L4,L5)	____	Upslip (ADD)
(L2,3,4,5,S1)	____	Lateral Rotated
(L5,S1)	____	Medial Rotated
		KNEE
(L3,L4)	____	Flexed
(S1)	____	Extended
(L2,L3,S1)	____	Externally Rot
(S1)	____	Internally Rot
		ANKLE
(L4)	____	Plantar Flexed
(S1,S2)	____	Dorsiflexed
(L4)	____	Everted
(L4)	____	Pronated
(L5,S1)	____	Inverted
(L5,S1)	____	Supinated
		BIG TOE
(L5)	____	Flexion
(S1,S2)	____	Extension
(S1,S2)	____	Hal Varus/AB
(L5,S1)	____	Hal Valgus/ADD
		TOES
(L5)	____	Flexed
(S1,S2)	____	Extended

Figure 5.1 MYK Posture Chart

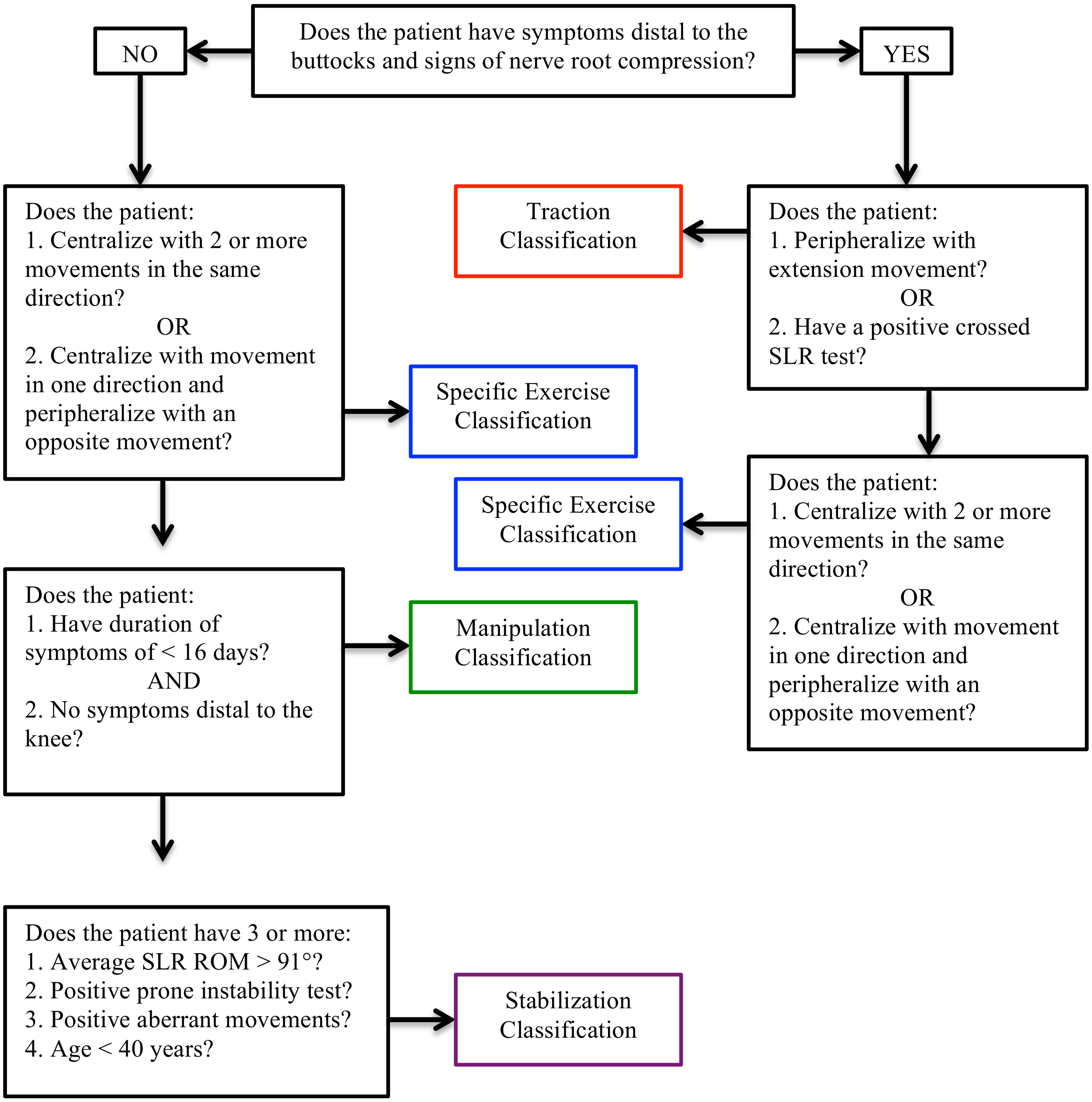

Figure 5.2 TBC System Algorithm

Figure 5.3 The starting and ending position for MYK passive treatment of the psoas major and psoas minor muscles. The clinician applies tactile stimulation medial to the anterior superior iliac spine while passively moving the hip into extension.

Figure 5.4 The starting and ending position for MYK active treatment of the psoas major and psoas minor muscles. The clinician applies tactile stimulation medial to the anterior superior iliac spine while the patient actively contracts the gluteus maximus.

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APPENDIX A

THE MYOKINESTHETIC™ SYSTEM, PART 1: A CLINICAL ASSESSMENT AND MATCHING TREATMENT INTERVENTION

Forthcoming in the International Journal of Athletic Therapy and Training

Key Points

- The MyoKinesthetic™ System is a relatively new form of manual therapy used to identify posture asymmetries that result in pain and dysfunction.
- The uniqueness of the MyoKinesthetic™ System lies in the ability to match treatment to dysfunction identified in the global assessment.
- The MyoKinesthetic™ System can be used to treat a variety of musculoskeletal conditions.

In sports medicine, clinicians and authors have emphasized the need to shift from an isolated evaluation of a painful structure to an assessment of multiple regions of the body.[1,2] The purpose of this new approach is to identify painful areas, as well as areas of dysfunction that may be the cause, or contributing factor, to the patient's pain. In short, the site of pain may simply serve as a warning for other, more significant complications in the body.[3-5] In chronic pain cases, it is common for the site of pain to be a structure that is overworked in response to other areas in the body not functioning properly.[6,7] As a result, clinicians are challenged with finding efficient ways to look beyond the site of pain to determine the source of a patient's complaint or dysfunction.

Utilization of comprehensive (i.e., global) evaluation models, such as the Regional Interdependence (RI) approach, has aided clinicians in the identification of other contributing factors affecting pain and dysfunction.[1] The MyoKinesthetic™ (MYK) System is another global model, which contains a broad assessment focused on classifying the body's primary dysfunctions. The MYK System evaluation is used to detect compensations within the nervous system that are displayed by postural abnormalities and result in physical impairment. The concept was developed by Dr. Michael Uriarte as a means to balance the nervous system by treating the muscles versus applying the common chiropractic philosophy of treating bony positional faults with manipulation.[8] Dr. Uriarte developed the theory of the MYK System through experimentation in his clinical practice. The technique was first introduced in 1998,[8] and has not been researched; therefore, all current evidence is anecdotal in nature.

The MYK System is a unique paradigm because the purpose is to evaluate and treat posture imbalances as a method to restore allostasis. The theoretical underpinnings of the paradigm are that standing, static posture underlies all movement patterns; therefore, if posture is not symmetrical, movement will be dysfunctional.[9] Posture imbalances may result from changes in the central nervous system (CNS) as it responds to afferent feedback from the muscles to achieve pain-free motion.[10] If an unbalanced posture exists, an underlying cause must be present, and the body must compensate before one initiates any movements.

The following brief example is used to translate the MYK System theory of a CNS-caused compensation to a mock patient presentation. In this example, if a patient experiences a fall, this can result in one or more bony positional faults. As that person returns to a standing posture, afferent nerves send signals back to the brain alerting it about the subluxations, while the CNS has sent messages through efferent nerves to the surrounding muscles to contract or relax. The result of CNS response may be observed through postural asymmetries, such as a rotated head, elevated scapula, or internally rotated hip.[8] The postural asymmetries may also result in restricted joint motion and subsequent decreased mechanoreceptor firing.[8] The development of these compensations indicates the presence of a causative factor; and, it could be argued under the RI model that treating the postural imbalances through an intervention that stimulates the CNS is necessary to address the root cause of a patient's dysfunction and pain.

In addition to postural asymmetries, Dr. Uriarte has included numerous pathological conditions that can be treated with the MYK System, such as headaches, medial epicondylalgia, sciatica, patellofemoral pain, plantar fasciitis, and achilles tendinopathy.[8] Indications for treatment include posture imbalances, limited range of motion, pain, peripheral neuropathy, and muscle weakness. The only known contraindications to the MYK System treatment are moving beyond the patient's range of motion, open wounds, infections, bleeding disorders, fractures, or any other contraindication associated with massage. Treatment time varies (5 to 20 minutes) based on the nerve root level being treated. The purpose of this article is to provide an overview of the MYK System clinical assessment and treatment technique.

MyoKinesthetic™ System Clinical Assessment

A clinician using the MYK System is guided by a specific evaluation process that matches a patient's posture imbalances and symptoms to a corresponding nerve root level (e.g., C3, L4, S2), which is used for treatment.[8] The MYK System assessment includes a thorough posture analysis, as well as: identification of peripheral neuropathy and pain, evaluation of weak movements through manual muscle testing, and inclusion of diagnosed pathological conditions. The MYK System posture analysis is completed with the patient in a standing position for the majority of the assessment. The patient's posture is observed from head to toe and each imbalance is documented on a chart (Figure 1). Hip, leg, foot, and toe postural exams are performed in a standing, seated, and prone position. Each imbalance identified in the evaluation is correlated to one or more nerve root levels on the posture chart. At the end of the assessment, the nerve root levels are totaled to determine the nerve pathway that contains the highest number of imbalances, and is presumably the cause of pain and dysfunction.[8]

Within the MYK System postural analysis, clinicians are also provided a dichotomous key to aid in the determination of the appropriate treatment level. The key may be necessary if the clinician discovers that two or more nerve root levels have an equal number of posture imbalances. In cases where the patient's evaluation leads to two nerve root levels (i.e., L4 and L5), the clinician utilizes the other assessment components such as positive dermatomal, myotomal, or peripheral nerve findings to select the appropriate treatment level. Each positive finding within the evaluation can be correlated to a single nerve root level to provide a means for discriminating between treatments. Treating the incorrect nerve root level will not result in an increase in symptoms, and often provides some relief but usually does not resolve the entire presentation (symptomology and function). The detailed evaluation included in the MYK System is theorized to allow the clinician to treat the cause of pain and not just the site of pain.[8]

MYK System Treatment Technique

The primary goal of the MYK System is to balance posture by treating muscles bilaterally along a specific nerve pathway (e.g., C5, L5, S1), thereby producing changes in the nervous system.[8] Pain and dysfunction can disrupt the transmission of signals traveling between the CNS and the muscles, resulting in muscle inhibition or facilitation. The MYK System is theorized to stimulate several ascending sensory tracts (anterior or lateral spinothalamic, and anterior and posterior spinocerebellar) to improve communication from the CNS to all of the muscles innervated by one nerve root. The spinothalamic tracts are stimulated by touch, and the spinocerebellar tracts are stimulated with movement.[8] The CNS operates by receiving input from the tissues and environmental stimuli through these ascending tracts, and produces a response to regulate the musculoskeletal system.[11] For example, repeated movements and tactile stimulation can change the brain's perception of that body part.[11] By forcing information up to the brain along several different routes in a MYK System treatment, it is theorized that the CNS responds by sending signals back to the body to expedite allostasis.[8] Although the intervention only includes muscles innervated by one nerve root, other muscles are affected when the CNS reacts to the treatment. It is hypothesized that as the nervous system communication (efferent and afferent) normalizes, it allows all of the muscles to function properly.[8] The normalizing of neural input and output along the total nerve root pathway may produce changes in the musculature innervated by that level. Additionally, this muscular normalization may decrease compensation in adjacent and remote areas as in other RI models (e.g. myofascial release, Total Motion Release). Many of these changes can be evidenced by observed changes in postural balancing, increased range of motion, and decreased pain.

The MYK System treatment combines active and passive movement with tactile stimulation of each muscle innervated by one nerve root (Figures 2 and 3). Tactile stimulation can be performed with deep or soft pressure anywhere on the muscle, as long as the proper combination of muscles receives stimulation. By treating all of the muscles in a single nerve pathway, it is theorized that the treatment stimulates every mechanoreceptor along that pathway. Stimulation of multiple mechanoreceptors is speculated to be more effective than stimulating a single mechanoreceptor,[8] and results in decreased nociceptor firing and muscle relaxation.[12,13] Since muscle and fascia contain mechanoreceptors, both can be affected by the treatment. Researchers have also shown that forms of proprioceptive input, similar to MYK treatment, demonstrated changes in the brain's perception of and reaction to pain.[10]

The MYK System treatment is always completed bilaterally as the CNS functions bilaterally, and neural components are responsible for the cross-education of muscle strength and motor skills.[14-17] For these reasons, all movements and tactile stimulation are performed bilaterally to increase the transfer of information from the muscle on one side of the body to the other. The treatment is continuous, and the clinician moves from one body area to the next until all muscles have been treated. All movements within the treatment parameters should be pain-free and the treatment can be performed daily. Analogous to other manual therapy interventions, the MYK System can directly impact the autonomic nervous system and may influence all levels of the healing process.[10]

Summary

Similar to other global methods, the MYK System assesses the entire body to address compensations that have led to pain and dysfunction. As clinicians search for the most effective strategies to evaluate and treat pain, the MYK System may be a valuable addition to their practice. An advantage of the MYK System is the ability to match a treatment to identified dysfunction and asymmetry revealed in the evaluation; however, research is needed to determine if the MYK System is effective in treating musculoskeletal conditions. In Part 2, we present an *a priori* case study used to assess the effectiveness of the MYK System to treat non-specific chronic low back pain.

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HEAD

Extension	____	(C1-C3)
Flexion	____	(C1-T1)
Rotation	____	(C1-T1)
Lateral flexion	____	(C1-T1)

SCAPULA

Elevated	____	(C3,4)
Depressed	____	(C3-C5)
Protracted(AB)	____	(C3-C5)
Retracted (ADD)	____	(C5-C8)
Upward rotated	____	(C3-C8)
Downward rotated	____	(C3-C7)

SHOULDER

Flexed	____	(C5-C8)
Extended	____	(C5-C8)
Depressed(AB)	____	(C5-C8)
Elevated (ADD)	____	(C5-C6)
Medial rotated	____	(C5-C6)
Lateral rotated	____	(C5-C8)

ELBOW

Flexed	____	(C7-C8)
Extended	____	(C5-C7)

FOREARM

Supinated	____	(C6-T1)
Pronated	____	(C5-C6)

WRIST

Flexed	____	(C6-C8)
Extended	____	(C6-T1)
Radial deviated	____	(C7-C8)
Ulnar deviated	____	(C6-C7)

THUMB

Flexed	____	(C7-T1)
Extended	____	(C6-T1)
Abducted	____	(C8-T1)
Adducted	____	(C6-T1)

FINGER

Flexed	____	(C6-T1)
Extended	____	(C7-T1)
Abducted	____	(C8-T1)
Adducted	____	(C8-T1)

LUMBAR SPINE

(L1-L5)	____	Flexed
(L1-L2)	____	Extended
(L1,L2)	____	Lateral Flexion
(L1-L5)	____	Rotation

HIP

(L5,S1)	____	Ant Rot (flex)
(L1,2,3,4,5)	____	Post Rot (Ext)
(L2,L3)	____	Downslip (AB)
(L4,L5)	____	Upslip (ADD)
(L2,3,4,5,S1)	____	lateral Rotated
(L5,S1)	____	Medial Rotated

KNEE

(L3,L4)	____	Flexed
(S1)	____	Extended
(L2,L3,S1)	____	Externally Rot
(S1)	____	Internally Rot

ANKLE

(L4)	____	Planter Flexed
(S1,S2)	____	Dorsiflexed
(L4)	____	Everted
(L4)	____	Pronated
(L5,S1)	____	Inverted
(L5,S1)	____	Supinated

BIG TOE

(L5)	____	Flexion
(S1,S2)	____	Extension
(S1,S2)	____	Hall Varus/AB
(L5,S1)	____	Hal Valgus/ADD

TOES

(L5)	____	Flexed
(S1,S2)	____	Extended

Figure 1. MYK Posture Chart

Figure 2. The starting and ending position for MYK passive treatment of the gluteus medius and minimus muscles. The clinician applies tactile stimulation between the greater trochanter and iliac crest while passively moving the hip into adduction.

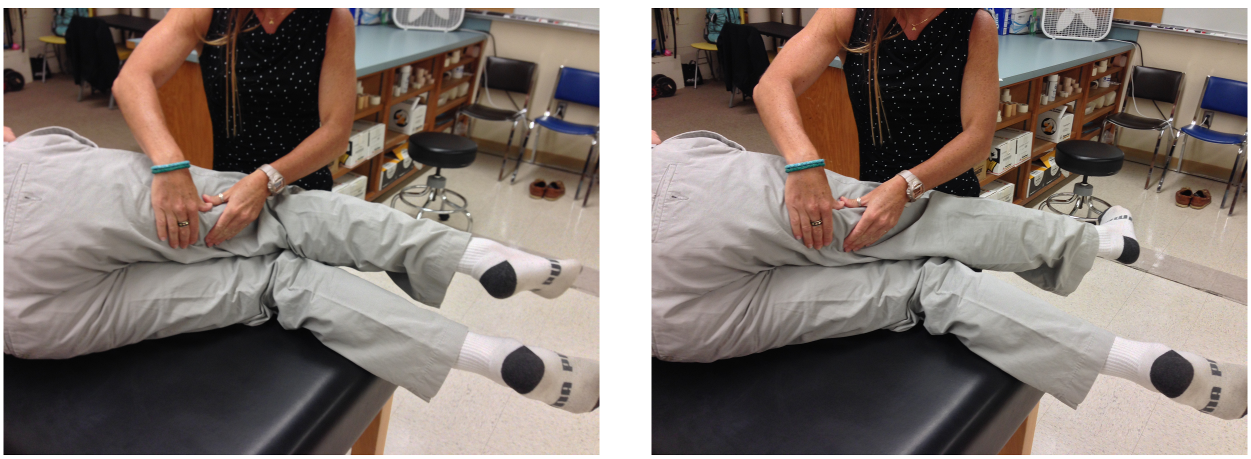

Figure 3. The starting and ending position for MYK active treatment of the hamstring muscles. The clinician applies tactile stimulation to the hamstrings while the patient actively contracts the quadriceps.

APPENDIX B

TREATMENT OF CHRONIC LOW BACK PAIN USING THE MYOKINESTHETIC™ SYSTEM: PART 2

Under consideration with the International Journal of Athletic Therapy and Training

Key Points

- The MyoKinesthetic™ System evaluation complements the standard clinical examination.
- The MyoKinesthetic™ System can produce clinically significant improvements in pain and function in patients with chronic low back pain.
- The MyoKinesthetic™ System treatment can balance posture asymmetries.

Low back pain (LBP), acute and chronic, is one of the most common disabling and poorly understood conditions in healthcare today. Researchers estimate that LBP in industrialized countries will have a lifetime prevalence of over 70% and it will account for substantial healthcare costs and personal distress.[1-3] In addition, chronic LBP that resolves with treatment is subject to a 90% recurrence rate.[4] A lack of understanding of the source of LBP results in a vague diagnosis of non-specific low back pain in 85 to 95% of patients who report to a primary care physician with complaints of back pain.[5] Non-specific LBP is an ambiguous term assigned to patients when an anatomic source or pathology cannot be identified, and the use of this diagnostic classification does not lead to effective treatment.[6-8]

Although considerable research has been conducted on different treatment methods for LBP, a majority of the findings conflict with one another. The results of over 1000 studies on management of LBP are inconclusive in offering support for one or more techniques.[9] Due to the complex nature of LBP, treatment based solely on pain presentation is not always effective.[10] Treatment-based classification (TBC) systems are utilized in an attempt to improve patient outcomes by placing patients into subgroups according to specific patterns of signs and symptoms. Delitto et al.[4] developed one of the first TBC systems for patients with acute LBP. The purpose of this system was to match a patient's treatment with their LBP classification, which was based on an examination and specific algorithm for decision-making. The success of the Delitto et al.[4] TBC system is still under investigation, but support exists for improving LBP patient outcomes through the use of this system.[7-9,11-13]

The interventions utilized in the Delitto et al.[4] TBC system for LBP are manipulation, specific exercise, traction, and stabilization. The MyoKinesthetic™ (MYK) System is another TBC system, but it currently has not been studied to determine its effectiveness for treating patients with non-specific LBP. The MYK System guides a clinician through a comprehensive approach to the evaluation and treatment of musculoskeletal injuries. Treatment strategies are designed to affect the nervous system in a specific way by treating a precise combination of muscles.[14] Within the MYK System, a clinician utilizes an evaluation of the patient's posture as well as identification of symptoms and muscle weakness to determine the appropriate nerve pathway treatment. The MYK treatment combines active and passive movement with tactile stimulation of each muscle innervated by one nerve root. The MYK System utilizes several ascending tracts (anterior or lateral spinothalamic, and anterior and posterior spinocerebellar) to improve communication from the CNS to all of the muscles innervated by one nerve root. The spinothalamic tracts are stimulated by touch, and the spinocerebellar tracts are stimulated with movement.[14] The CNS operates by receiving input from the tissues and environmental stimuli through these ascending tracts, and produces a response to regulate the musculoskeletal system.[15] The primary goal of the MYK System is to balance posture by treating muscles bilaterally along a specific nerve pathway, thereby producing changes in the nervous system.[14]

The purpose of this case report was to assess the effectiveness of the MYK System as a treatment for LBP. Additionally, the Stanton et al.[13] algorithm was used to place this patient into the Delitto et al.[4] TBC system to determine if MYK treatment could be included as an intervention within one of the subgroups. We documented the outcomes of a single patient who was diagnosed with multiple disc herniations and treated with the MYK System.

Case Report

History

The patient, an otherwise healthy 22-year-old male, presented with LBP of approximately two years duration without previous history of LBP prior to this onset. Pain was isolated to the lumbar spine and along the quadratus lumborum bilaterally. The onset of symptoms initially occurred when the patient attempted to stand from a seated position on a boat. Prior to this event, the patient had completed a half Ironman competition and heavy weightlifting workout in the days preceding the initial onset of pain, but did not report any discomfort or pain with these events. When the symptoms arose, the patient experienced severe muscle spasms, which caused him to seek treatment in the emergency department. Initial treatment consisted of medication and physical therapy. The patient completed physical therapy treatments for two years, with minimal relief in symptoms. Massage and heat provided the greatest relief, but the positive effects only lasted a couple hours. Magnetic Resonance Imaging (MRI) and x-rays, completed about 10 months post-injury, revealed mild disc herniations at L3-4, L4-5, and L5-S1. Diagnostic imaging did not reveal any signs of inflammation or compression of his nerve roots and there was no evidence of spondylolysis, spondylolisthesis, or degenerative changes.

Due to a lack of progress with physical therapy treatment, the patient decided to undergo a rhizotomy (a surgical procedure designed to relieve chronic back pain by severing the sensory nerve roots[16]) one year and four months following the initial injury. The patient reported pain relief for two months following the procedure, but pain eventually returned to levels equal to pre-surgery status. The patient continued physical therapy treatments and denied taking any medications for pain. At eight months post-surgery, the patient reported to our clinic for another opinion.

Examination

During the initial exam, the patient's chief complaint was centralized, constant LBP. The examination did not reveal any swelling or deformity, but the patient was tender to palpation over the following areas: bilateral quadratus lumborum and piriformis, right gluteus medius and popliteus, and left ischial tuberosity. The patient reported the greatest amount of pain during sitting (5 out of 10), no pain at rest (0 out of 10), and current pain with standing (3 out of 10) using the Numeric Rating Scale (NRS). Disability was measured using the Disablement in the Physically Active (DPA) scale and Modified Oswestry LBP Disability Questionnaire (modified OSW). The patient reported a 13 on the DPA scale, which is scored from 0 (no disability) to 64 (maximum disability).[17] His modified OSW was 10%, which indicated minimal disability.[18] The patient chose sitting as his limited activity on the Patient-Specific Functional Scale (PSFS), and rated it a 3 out of a possible 10. Activities are rated on the PSFS on a scale of 0 (cannot perform) to 10 (can perform normally at pre-injury level).[19]

All active range of motion (AROM) measurements were obtained by averaging three readings. The same clinician completed all examination and follow-up assessment components. Thoracolumbar flexion and lumbar flexion and extension were measured using the following procedures:

- Fingertip-to-floor distance (FFD): Patient stands on a 20cm-high step with feet together and is instructed to bend forward. The distance from the third fingertip to the floor is measured in centimeters and recorded as a negative value if the patient's hands extend beyond the step.[20]
- Modified-modified Schober Test (MMST): Patient standing with feet together, while a mark is placed over the sacral spine between the posterior superior iliac spine (PSIS) and 15cm above the original mark. The distance is measure between the two marks at the end of AROM in flexion and extension.[20]

During the initial evaluation, the patient achieved -12cm on the FFD (i.e., 12cm beyond the top of the step closer to the floor). He also displayed 8.5cm of flexion and 3cm of extension on the MMST. The patient reported pain-free AROM and PROM, and demonstrated dysfunctional and non-painful cervical, upper extremity, squat, multi-segmental flexion and extension movement patterns on the Selective Functional Movement Assessment (SFMA). During the movement assessment, the patient did not demonstrate any aberrant movements. The MYK System posture screen revealed eight lower body imbalances, with the majority of asymmetries at the L4 and L5 nerve root levels. Based on the posture assessment and symptoms, the patient was diagnosed with an L5 imbalance in the MYK System. His lower quarter screen for dermatomes, reflexes and myotomes was unremarkable. The patient had a positive Slump test, with pain radiating bilaterally down both legs with cervical flexion.

The patient tested negative on the prone instability, Valsalva, Crossed Straight Leg Raise, sacroiliac distraction and compression, thigh thrust, and sacral thrust tests. According to the Stanton et al.[13] algorithm (Figure 1), the patient could not be placed into one of the TBC subgroups because he did not have any symptoms distal to the buttocks or aberrant movements, did not centralize or peripheralize with flexion or extension, did not test positive on the prone instability test, and did have chronic pain.

Treatment & Outcomes Collection

The patient received an MYK L5 treatment following the initial assessment. Each MYK treatment includes tactile stimulation and active and passive movement of every muscle innervated by the selected nerve root level. Tactile stimulation can be performed with deep or soft pressure anywhere on the muscle, as long as the proper combination of muscles innervated by the appropriate nerve root receives stimulation. The MYK System treatment is always completed bilaterally as the CNS functions bilaterally, and neural components are responsible for the cross-education of muscle strength and motor skills.[21-24] For these reasons, all movements and tactile stimulation are performed bilaterally to increase the transfer of information from the muscle on one side of the body to the other. All movements within the treatment parameters should be pain-free and the treatment can be performed daily.

The following measurements were recorded pre- and post-MYK treatment: FFD, MMST, NRS (standing), and MYK posture imbalances. The DPA scale, PSFS, and Global Rating of Change (GRC) scores were obtained once per week prior to treatment. The modified OSW score was recorded once every two weeks prior to treatment. The patient did not receive any additional treatment (i.e., massage, heat), and denied taking any medications. The patient did not alter his normal activity levels during the course of treatment. Discharge criteria were set to when NRS scores remained at 0, the PSFS score was reported an 8 or higher, the GRC score was reported a 4 or higher, and balanced MYK postures were maintained between visits.

Results

Following the initial L5 treatment, the patient demonstrated a minimal clinically important difference (MCID) on the NRS[25] (Table 1). The patient also exhibited MCIDs on the DPA scale[17] and PSFS[19] on the first follow-up measurements with these tools at the one-week mark (Table 1; Figure 2). The patient was treated twice during the first week, and based on changes in the posture assessment and symptoms, the treatment was shifted to target the L4 nerve root level; therefore, the patient received MYK L4 treatments during the third and fourth weeks.

After 7 treatments in 14 days, the patient had full resolution of pain. The patient's Slump test normalized by the fourth visit, and he was discharged after 10 treatments. Total treatment time during each visit was 15 minutes. At discharge, the patient reported a 0 on the NRS, 1 on the DPA scale, 10 on the PSFS, 2% on the modified OSW, and 5 on the GRC (11-point scale) (Table 1). On his MYK posture assessment, three of the eight lower extremity imbalances normalized with treatment. The patient also demonstrated functional multi-segmental flexion and extension movement patterns on the SFMA.

Discussion

Significant improvements in pain, disability, and function in this patient suggest that the MYK System was an effective treatment for this case of LBP and may be effective in other similar cases of chronic LBP. The results of this case report demonstrated MCIDs for the NRS, DPA scale, and PSFS after three treatments (Table 1). The intervention also resulted in normalization of the Slump test and achievement of functional movement patterns on the SFMA. As the patient's symptomology and function improved, there was a corresponding decrease in total range of motion on the FFD (Table 1). The patient's thoracolumbar flexion was within normal limits[20] at discharge, suggesting that the patient identified a new movement pattern that was more balanced between mobility and stability.

Clinicians currently have many treatment options for treating patients with LBP, but support for effective treatment of LBP is limited.[9] Research can be found to substantiate or refute the use of the most popular treatments for LBP.[7,26,27] Based on the evidence currently available, several investigators have suggested using a classification system for LBP will produce more favorable patient outcomes. One potential problem with classification-based systems is the possibility of a patient not fitting into a subgroup classification or being classified into a subgroup (e.g., "other") that does not match the patient to a treatment strategy. Stanton et al.[13] discovered that patients identified by individual subgroups were mutually exclusive in approximately 50% of the cases. In the remaining 50%, patients met criteria for more than one subgroup or did not meet criteria for any subgroup.[13] Patients that do meet any criteria, as was the case with this patient, are less likely to receive a treatment that is matched to their condition.

The shift toward patient-centered evidence has resulted in numerous studies on the effectiveness of various treatments for LBP. Surgical procedures for LBP are facing scrutiny from health care reformers as a result of their high costs and low levels of effectiveness.[28] Typical management of disc herniations includes spinal steroid injections, muscle relaxants and other medications, physical therapy, and bracing.[28] Nearly one third of patients with lumbar disc herniations seek surgery after approximately six months of unsuccessful non-surgical treatments.[28] In this case study, the patient had already experienced failed surgical and conservative treatment, and then experienced outcomes that far exceeded the lengthy outcomes seen in other conservatively managed cases. Additionally, the patient only required 10 total treatments over 21 days, with each treatment lasting 15 minutes. In contrast to some interventions, each MYK treatment was pain-free and the patient was able to maintain his active lifestyle without any restrictions. The rapid and lasting changes provide preliminary evidence that the MYK System may be more effective than traditional physical therapy strategies in certain cases.

As with all research, there must be some caution with generalizing these outcomes to all patients. First, the lack of additional patients or a control group limits broad conclusions about the effectiveness of the MYK System in all cases of LBP. Additionally, the patient and clinician recording the outcomes were not blinded to the changes, which may introduce bias. Additional research on the MYK System is needed to determine its effectiveness in treating other subgroups of LBP patients and to confirm that the benefit experienced with this treatment exceeds the amount associated with other treatment strategies. Although our findings demonstrated positive short-term outcomes with the MYK System, future research is needed to establish long-term effects of the treatment.

Conclusion

The results of this case study demonstrated that the MYK System was associated with clinically significant improvements in pain and function in a patient with multiple lumbar disc herniations. Reduction in pain and disability allowed the patient to progress from sitting for less than 10 minutes to sitting for an unlimited amount of time without any pain or discomfort. Although our findings indicated that the MYK System was an effective treatment for chronic LBP, future research is needed on a larger sample to determine its efficacy compared to other manual therapy interventions.

Table 1. Patient Outcomes with MYK Treatment

	Day 1		Day 8		Day 15		Day 21 - Discharge		Day 29
Measurement	**Pre-MYK**	**Post-MYK**	**Pre-MYK**	**Post-MYK**	**Pre-MYK**	**Post-MYK**	**Pre-MYK**	**Post-MYK**	**Follow-up**
NRS (standing)	3	0*	0	0	0	0	0	0	0
DPA	13	NT	5*	NT	4	NT	NT	NT	1
PSFS – sitting	3	NT	6*	NT	8*	NT	9.5	NT	10
GRC	NT	NT	3	NT	3.5	NT	4.5	NT	5
Modified Oswestry	10%	NT	NT	NT	6%	NT	NT	NT	2%
FFD (cm)	-12	-13.5	-5	-8.5	-6	-9	-10.5	-16.5	-7
MMST (flexion)	8.5cm	8.5cm	7.5cm	7.5cm	7cm	7cm	7cm	7cm	7cm
MMST (extension)	3cm	3cm	2cm	2cm	3cm	3.5cm	3cm	3.5cm	3cm
Slump Test	(+) B with cervical flex	NT	(-)	NT	(-)	NT	NT	NT	(-)
Key: NT – not tested; *Denotes MCID PSFS – 0 = unable to perform, 10 = able to perform at a normal level									

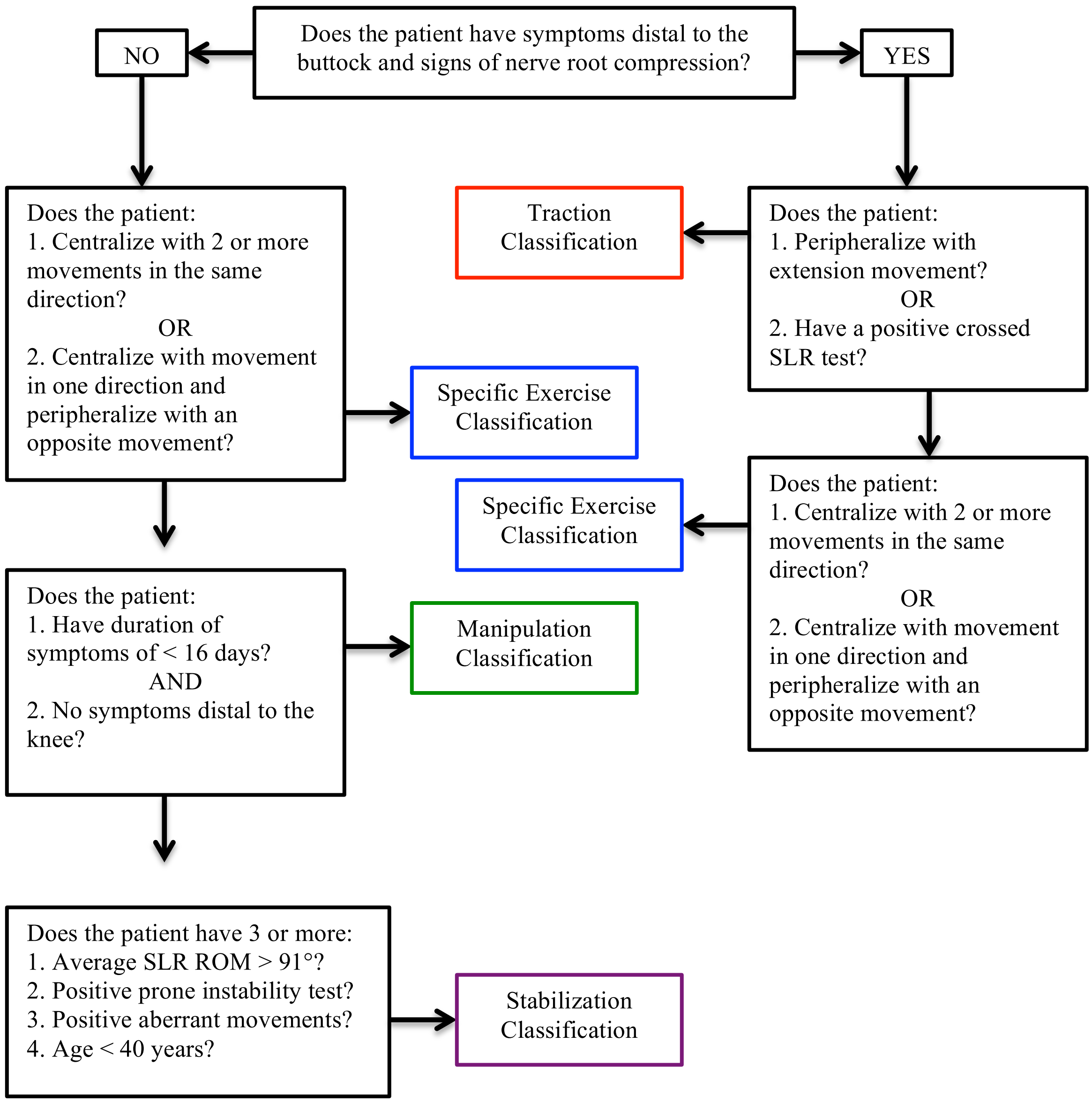

Figure 1. TBC System Algorithm

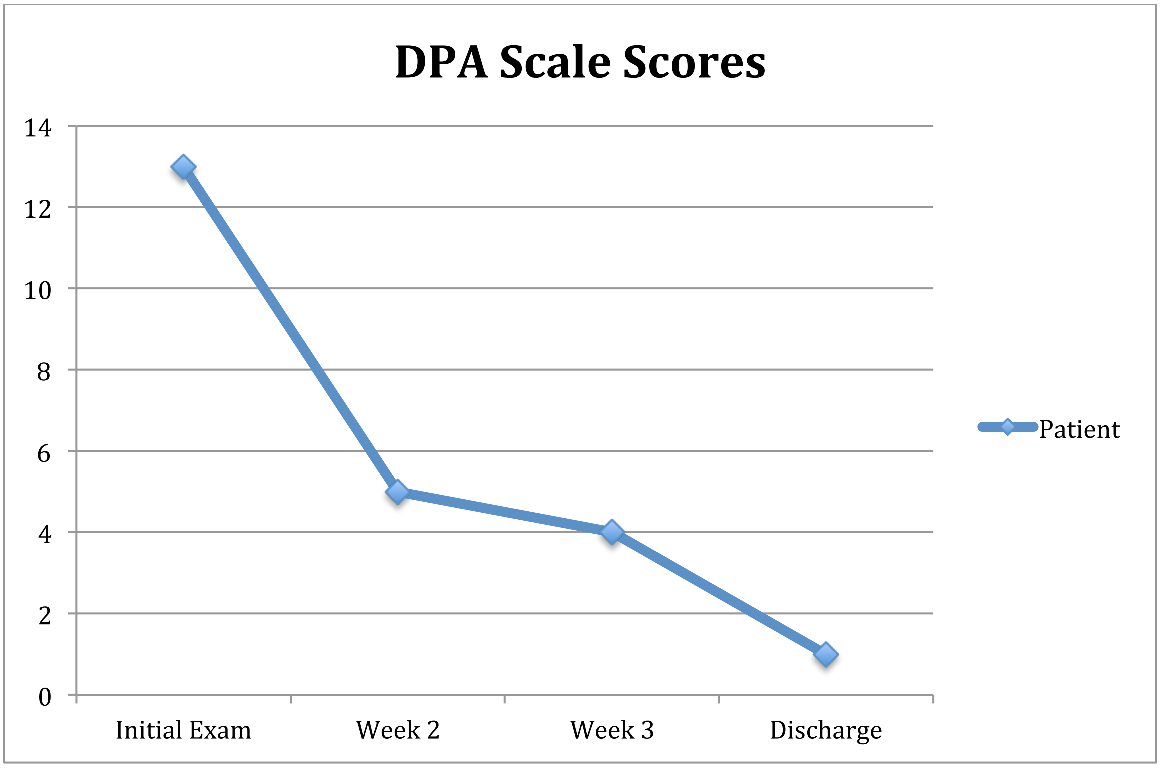

Figure 2. Changes in the DPA Scale

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APPENDIX C

MENISCAL LESIONS: THE EVIDENCE FOR THE PHYSICAL EXAMINATION AND CONSERVATIVE TREATMENT

Forthcoming in the International Journal of Athletic Therapy and Training

Key Points

- A thorough physical examination can be as accurate as an MRI in diagnosing meniscal tears.
- Evaluation of conservative options for treating symptomatic meniscal lesions is limited in the literature.
- Surgical treatment of meniscal lesions leads to premature joint degeneration.

Many studies to date have focused on the common diagnostic method of magnetic resonance imaging (MRI) for identification of meniscal tears. Additionally, much of the research has been centered on the outcomes following arthroscopic surgery for the management of this injury. Therefore, the purpose of this paper was to provide information concerning alternative assessment methods for meniscal injuries and to discuss the results of conservative options for treatment.

The menisci of the knee are two fibrocartilaginous discs which increase the contact surface area between the femur and tibia, and distribute the load evenly across articulating surfaces.[1] Once thought to be functionless, the menisci are now known to serve an integral part in shock absorption, load bearing, and stabilization of the knee.[2] Injuries to the menisci can occur in a variety of populations as a result of trauma or degeneration, and result in knee dysfunction and instability. The avascular nature of nearly two thirds of the meniscal tissue significantly impedes natural healing.[3] The medial meniscus is injured more often than the lateral meniscus, partially due to its capsular attachments.[2,4] Acute injuries to the menisci often occur from twisting motions on a partially flexed knee during weight-bearing, or in combination with other ligament sprains. Despite the common association with physical activity and meniscal injuries, only one third of meniscal tears are sports-related.[4] Meniscal lesions represent a common diagnosis as evidenced by MRI, which detected tears in 35% of people over the age of 50.[5] In younger populations, 64% of meniscal tears are sports-related, indicating that degenerative changes may not be a factor in the majority of lesions in patients under the age of 30.[4] Acute meniscal tears are often observed in conjunction with injuries to the anterior cruciate ligament (ACL). In 72% of cases, patients with recent ACL ruptures had a concomitant tear of the meniscus.[6] Despite their high prevalence of detection with an MRI, a large percentage of meniscal tears remain asymptomatic in older populations.[5,7,8]

Assessment of Meniscal Injuries

Injury to the meniscus can result in a variety of symptoms depending on the mechanism. The most common patient-reported symptoms of an acute meniscal lesion are pain, swelling, giving way, and locking or catching of the joint.[9,10] Arthroscopic assessment is the definitive diagnostic technique for identifying the location and severity of meniscal tears.[3] The most common advanced diagnostic method for assessing a meniscal lesion is the MRI, which has a reported diagnostic accuracy of 88%, a sensitivity of 96%, and a specificity of 76%.[6,9,11,12]

Despite the reliance on MRIs for diagnosis, a detailed physical examination and patient history can be just as accurate and result in selection of the appropriate treatment. McDermott[9] reported that a clinical assessment including patient's history, physical exam, and appropriate special tests can produce a diagnostic accuracy of 90%. A combination of reliable tests has been indicated to be more predictive than any single test that is pathognomonic of meniscal injuries. Lowery et al.[13] found that a history of joint catching or locking, pain with terminal passive knee flexion, pain with terminal passive extension, pain or clicking with McMurray's test, and joint line tenderness had a positive predictive value of 92.3% for diagnosing a meniscal tear. If all 5 symptoms were found during a clinical exam, the prediction rules resulted in a specificity of 99% and a sensitivity of 11% for predicting a meniscal tear. The presence of 4 (96%) or 3 (90%) of these patient characteristics still produced good specificity, while only resulting in a moderate increase in sensitivity (17% with 4 findings and 31% with 3 findings).[13]

The most common clinical tests used to identify a meniscal lesion are Apley's grind test, McMurray's test, and the Thessaly test.[10] McMurray's test is the most widely used, but only represents positive findings in 58% of patients with meniscal lesions.[14] In isolation, the Thessaly test had the highest diagnostic accuracy (94% to 96%) when performed in 20° of knee flexion.[14] Joint line tenderness also had a high diagnostic accuracy rate (81% to 89%), whereas McMurray's and Apley's compression tests had inferior rates (78% to 84% and 75% to 82%, respectively).[14] In a meta-analysis, Scholten et al.[15] reported high variability in sensitivity (20% – 66%) and specificity (57% – 98%) ratings for McMurray's test, while Apley's test produced more consistent specificity values (89%).[15] Despite the heterogeneous ratings of McMurray's and Apley's tests, several studies reported high diagnostic accuracy (>88%) when these tests were included in a battery of tests.[9,13,16]

Treatment Options for Meniscal Lesions

The ability to identify meniscal lesions without an MRI reduces health care costs and results in fewer unnecessary surgical interventions. When used without clinical findings, MRIs would inappropriately direct patients to surgery in 35% of the cases.[17] In addition to a reduction in surgeries, treatment of meniscal tears has changed considerably in the last 40 years with an increased appreciation for the importance of this structure.[9] In the past, treatment of meniscal tears primarily consisted of total meniscectomies, which increased degenerative changes in the knee.[3,6,11] Due to the critical function of the menisci and increased incidence of osteoarthritis, treatment changed to more conservative measures to protect the meniscus. The rationale for surgical repair (e.g., meniscectomy) or conservative treatment is dependent upon the severity of the tear.[3] The current goal of many surgical techniques is to maintain intact fibrocartilaginous tissue.[3,10] Surgical options for the preservation of meniscal tears include partial meniscectomies or repair techniques, depending on the severity and location of the tear.[3] Despite less invasive surgical options, long-term results for partial meniscectomies are associated with premature degeneration.[3] Activity levels after a meniscectomy can also greatly increase the risk of developing degenerative changes. McDermott[6] reported that 89% of athletes exhibited evidence of degeneration 14.5 years after isolated meniscectomy surgery.[6] In contrast, meniscal repairs have demonstrated a success rate of 69% to 79% at 10 years.[3,6,11]

While meniscus repair allows for greater preservation of the meniscus than a meniscectomy, it can have up to a 20% failure rate and significantly worse outcomes in older populations.[11] In addition to this, 58% of MRI-verified meniscal tears have the potential to become asymptomatic, indicating that surgery may not be the best option for these patients.[20] The standard rehabilitation protocol for meniscal repairs does not allow a return to regular physical activity prior to 12 weeks.[9,11] The lengthy recovery period for meniscal repairs is a stark contrast to the quick return to normal activity levels after partial meniscectomies.

Patients can expect to have full recovery in approximately six weeks, with potential for more rapid recoveries in some cases, following surgery.[9] Due to its shorter rehabilitation period and positive outcomes, partial meniscectomy is the preferred surgical choice for meniscal tears.[1,20]

Nonoperative therapy is an alternate treatment for meniscal tears, and has demonstrated similar effectiveness when compared to surgical options.[9] Katz el al.[5] performed a randomized controlled trial (RCT) and did not find a significant difference in functional improvement between surgical and non-surgical patients at a six-month follow-up. Yim et al.[8] reported no significant difference in pain relief, function, or increased satisfaction of patients in a two-year follow-up study comparing the effects of meniscectomies to nonoperative treatment. Non-surgical options for meniscus tears typically include physical therapy protocols to address inflammation, strength, proprioception, and range of motion. Although nonoperative management has not demonstrated more successful outcomes than meniscectomies or repairs, it does produce significant improvements in pain and function.[7,18-20] Important considerations in choosing surgical or non-surgical treatment are success rate, length of rehabilitation, and the time it takes to determine patient improvement with conservative care. In some cases, patients chose surgery after experiencing limited progress with conservative treatments. Katz et al.[5] reported that patients that completed physical therapy had a 35% rate of crossover to surgery at one-year follow-ups, meaning that 35% discontinued physical therapy within six months and opted for surgery.

Conclusion

Although much of the research supports arthroscopic treatment as the primary option for meniscal lesions,[20] several investigators have demonstrated the effectiveness of conservative management in treating meniscal tears.[7,8,18-20] A primary reason for choosing conservative care over a partial meniscectomy is the increased risk of developing osteoarthritis following surgery.[3,9] Meniscal lesions that are minimally symptomatic and do not cause significant dysfunction are initially treated with physical therapy (i.e., range of motion, strength, balance, and proprioception).[9] When compared to partial meniscectomies, patients assigned to physical therapy respond similarly at 6-month and two-year follow-ups.[5,8,20] The commonalities seen in patient outcomes between surgical and non-surgical treatment suggest that conservative management may produce the least risk with similar benefits in pain and function. Patients that do not respond to conservative treatment (30% - 42%) generally choose arthroscopic surgery after six months.[5,20] Many of the studies documented in the literature focus on the rehabilitation performed following surgery, rather than examining non-surgical options. Additionally, the majority of research on conservative management is conducted on an older patient population with degenerative tears, and very little has been done on young, active patients with acute tears. Despite preliminary evidence of the effectiveness of non-surgical treatments, more research needs to be conducted to provide clinicians with interventions aimed at improving the symptomology of meniscal injuries.

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APPENDIX D

TREATMENT OF MENISCAL LESIONS USING THE MULLIGAN "SQUEEZE" TECHNIQUE: A CASE SERIES

Under consideration with the International Journal of Athletic Therapy and Training

Key Points

- The Mulligan "Squeeze" technique can be a viable alternative to surgical treatment of meniscal lesions.
- The "Squeeze" technique is indicated in patients with knee joint line pain and limited range of motion.
- The "Squeeze" technique can produce clinically significant improvements in pain and range of motion in patients with apparent meniscal injuries.

Meniscal lesions, which can occur in patients of any age, are a common cause of knee pain and dysfunction.[1-3] Two primary mechanisms account for injuries to the menisci: degeneration and acute trauma occurring from a twisting motion during weight-bearing.[4] Surgical treatment options for this injury consist of meniscal repairs and partial meniscectomies, with a patient preference for the latter due to its shorter rehabilitation period combined with positive outcomes.[5,6] Although much of the research supports arthroscopic treatment as the primary option for meniscal lesions,[7] several investigators have demonstrated similar effectiveness with conservative management.[6-10] A primary reason for choosing non-surgical treatment options over a partial meniscectomy is the increased risk of developing osteoarthritis following surgery.[1,11] Conservative care generally includes physical therapy protocols to address pain, inflammation, range of motion, strength, and proprioception.[11]

Very few manual therapy techniques are indicated in the management of meniscal lesions, with strengthening and range of motion exercises being the most common in the literature. The Mulligan Concept is a therapeutic intervention which combines an accessory mobilization with active and passive movements.[12] The Mulligan Concept utilizes mobilizations with movement (MWMs) to restore joint memory to move in a pain-free range of motion.[12] The technique was developed by Brian Mulligan as a result of his influences from therapists such as Cyriax, Kaltenborne, Maitland, and McKenzie.[13] Although there is limited research on MWMs, most studies have demonstrated positive outcomes on range of motion and pain when compared to placebos or control groups.[14]

The Mulligan "Squeeze" Technique

Based on his clinical experiences, Brian Mulligan developed the "Squeeze" technique for treatment of acute and chronic meniscal tears. The treatment is indicated in patients with symptoms of a meniscal lesion, such as medial or lateral joint line tenderness and painful knee flexion and/or extension.[12] The "Squeeze" technique is a MWM that can be applied in both non weight-bearing (NWB) and weight-bearing (WB) positions depending on the motion that elicits pain. An area of tenderness must first be established by palpating both the medial and lateral joint lines. The medial border of the clinician's thumb is placed over the tender area and is reinforced by the other thumb (Figure 1). The patient actively flexes the knee while in a supine, partially WB (Figure 2), or WB position. The clinician squeezes centrally as the joint space opens during flexion. Once the patient reaches end-range flexion, overpressure can be applied while the squeeze is maintained. The technique can be applied a maximum of 30 times (three sets of 10 repetitions) if pain is reduced and range of motion improves. Motion and pain should be assessed after the first set, and the technique is only repeated if immediate improvements are made. If pain only occurs in extension, the same technique can be applied in extension but with the patient in a supine position. The "Squeeze" technique is generally uncomfortable due to the pressure applied to a tender joint line, but should be well tolerated by the patient.[12]

Given the frequency of meniscal injuries, limited options for manual therapy, and failure to demonstrate superior results with surgery, it is important to study patient outcomes when applying conservative treatments to suspected meniscal lesions. To our knowledge, no other research has been conducted on the "Squeeze" technique. The purpose of this *a priori* investigation was to assess the effectiveness of the "Squeeze" technique in the treatment of consecutive patients who met the inclusion criteria for a clinical diagnosis of a meniscal lesion.

Case Descriptions

Physical Exam

Both patient histories are presented in Table 1. The patients were otherwise healthy college students who complained of joint line knee pain and restricted range of motion compared to the uninvolved side. Inclusion criteria were: joint line knee pain, positive findings on one or more orthopedic special tests for meniscal injuries (i.e., McMurray, Apley's, and Thessaly Test), a history of catching or locking, and pain with knee flexion or extension. Exclusionary criteria included: an absence of joint line pain, an absence of pain during knee flexion and extension, negative findings on all three meniscal special tests, presence of a suspected anterior cruciate ligament injury, and increased pain during application of the intervention.

During a 3-month period, 3 patients reported to our clinic with suspected meniscal pathology. After physical examination, 2 of these patients met the initial inclusion criteria, while one was excluded because the patient did not exhibit at least 3 of the required clinical findings during the exam. As tests and clinical prediction rules with high specificities are useful to rule in pathology,[15] the patients that met the criteria were determined to be likely to have suffered a meniscal lesion. The patients also tested negative for other significant knee trauma or chronic pathologies (e.g., ligament rupture, fracture, tendinopathy). Based on the clinical findings and patient histories, the two included patients were diagnosed with a medial meniscal tear.

Outcome Measures

Disease-oriented evidence (DOE) was collected in the form of baseline measurements for active range of motion (AROM) in knee flexion and extension; patient-oriented evidence (POE) was collected from the DPA scale, PSFS, and pain scores on the NRS during knee flexion, extension, and walking. All goniometric measurements were recorded by the same clinician, and represented an average of three readings. Active ROM and NRS scores were obtained during the initial examination and pre- and post-treatment. The DPA scale and PSFS scores were recorded during the initial examination for both patients. Due to a lack of compliance for follow-up treatments, the DPA scale was recorded at discharge for Patient #1 and prior to the final treatment for Patient #2. The PSFS score was obtained before and after the first treatment for both patients, at discharge for Patient #1, and prior to the second treatment for Patient #2.The Disablement in the Physically Active (DPA) scale is a subjective measurement of the following items: impairment, functional limitation, disability, and quality of life. Each statement is rated by the patient on a scale of 1(no problem) to 5 (severe), with the total score ranging from 0 to 64. A decrease in 9 points for acute injuries and 6 points for chronic injuries represents minimal clinically important differences (MCIDs).[16] The Patient-Specific Functional Scale (PSFS) allows each patient to choose three to five activities or movements that he or she cannot do at a normal level. The patient then rates each activity on a scale of 0 (cannot perform) to 10 (can perform normally at pre-injury level). An increase in 2 points represents an MCID.[17,18] The numerical rating scale (NRS) allows the patient to rate their pain on a scale of 0 (no pain) to 10 (worst pain imaginable), and the MCID is a decrease in 2 points or 30%.[19] All instruments have demonstrated validity and reliability.[16,18-20]

Intervention

All Mulligan "Squeeze" treatments were administered by the same clinician, who received training from a certified Mulligan practitioner. Each treatment session included three sets of 10 repetitions of the "Squeeze" technique applied to the medial joint line. During the first treatment, the technique was applied in a partial weight-bearing (PWB) position with the patient's foot on a chair (Figure 2). The clinician performed the MWM by applying pressure over the medial joint line as the patient lunged forward. During the second visit, neither patient experienced pain with PWB lunges, but both did have pain with knee flexion in a loaded position. Due to the change in reported symptoms, the "Squeeze" technique was applied during a squat at the second visit.

Results

Following the first treatment, both patients reported an MCID on the NRS and PSFS (Tables 2 and 3).[18,19] Both patients received two treatments and reported pains scores on the NRS of 0 on the final visit. Each patient achieved AROM measurements for flexion and extension equal to the uninvolved side after two treatments.

Patient #1 reported a full resolution of pain with walking and knee flexion following the first treatment (Figures 3 and 4). His pain was also reduced in knee extension from an 8 to a 2 on the NRS (Figure 5). Active knee flexion (146°) and extension (0°) were equal bilaterally. On the PSFS, the patient reported an 8 for knee extension and 10 for squatting (Table 2). The PSFS score for running could not be obtained until the patient had time to perform activity and assess his function, which was done at discharge. All range of motion improvements were maintained at the second visit and Patient #1 still reported a resolution of pain with walking. No additional treatments were needed, and all improvements were maintained three weeks following the initial assessment (Table 2). Patient #1 also had negative McMurray's, Thessaly, and Apley's tests at discharge. The patient reported a higher DPA scale score (3 points) at discharge due to an increase in stress and frustration from school and social activities. Despite this variance, both scores were well below normal ranges for healthy, uninjured participants.[16]

Patient #2 experienced a full resolution of pain in flexion, extension and walking following the first treatment (Figures 3-5). Active range of motion improved from 136° to 147° in flexion and 0° to -3° in extension (Table 3). The patient's PSFS scores indicated an MCID increase in all three activities (Table 3). Some improvements were maintained at the second visit, and the patient exhibited equal AROM and complete resolution in pain following the second application of the "Squeeze" technique (Table 3). The patient tested negative for McMurray's, Thessaly, and Apley's tests. The DPA scale score also demonstrated an MCID decrease of 15 points.[16] The patient was contacted several times via email, but did not reply or return for subsequent treatments, therefore a complete discharge evaluation was not completed.

Long-term follow-up results were obtained from Patient #1 at 21 weeks post-discharge. Patient #1 denied needing or receiving any additional treatments. He reported pain scores on the NRS of 0 with walking, knee flexion, and knee extension. The patient also maintained improvements in function with PSFS scores of 10 with knee extension and post-activity, and 9 with squatting. Patient #2 could not be reached to assess long-term results despite multiple efforts to contact the patient for follow-up.

Discussion

The results of this case series demonstrated MCIDs in pain and function after the application of the "Squeeze" technique on two patients classified with an apparent meniscal lesion (Tables 2 and 3). Our immediate changes in range of motion and pain may be a result of a repositioning of the meniscus within the joint.[12] Only two treatments were performed on both patients, which resulted in normalization of AROM measurements and special tests following the second treatment. The second DPA scale score also exceeded MCID values for Patient #2.

The rapid changes in baseline measures suggest that the "Squeeze" technique may be more effective initially than traditional physical therapy. The immediate results seen in our study far exceeded the average time of 12 weeks to six months to achieve outcomes in other conservatively managed cases.[7,8] Although the majority of research favors surgical treatment for meniscal lesions, conservative management has produced equally beneficial results.[6-10] Important considerations in choosing surgical or non-surgical treatment are success rate, length of rehabilitation, and the time it takes to determine patient improvement with conservative care. The Mulligan "Squeeze" technique addresses some of these issues because it produces an instant result if it is indicated for the patient.

Several limitations were present in this study. First, the small number of participants and lack of a control group makes generalization of the results challenging. Second, the patients did not adhere to a standard treatment schedule, which influenced consistency of outcome measures. Patient #1 had six days between treatments, whereas Patient #2 had 14 days between treatments. The difference in time between interventions may have affected the outcomes. Although our findings demonstrated positive short- and long-term outcomes with the “Squeeze” technique, future research is needed on a larger sample size to establish treatment effectiveness, and offer comparison to other non-surgical techniques.

Conclusion

The results of this case series demonstrated that the Mulligan “Squeeze” technique was associated with clinically significant improvements in pain and function in patients with apparent meniscal lesions. In addition to this, both patients exhibited negative findings on McMurray’s, Apley’s, and Thessaly tests after two treatments. Our study provides clinicians with evidence to support the use of the “Squeeze” technique from an evaluative and rehabilitative component to determine if it is an appropriate conservative management option for their patient who presents with a suspected meniscal injury. Although our findings indicated that the “Squeeze” technique was effective, future research is needed on a larger sample to determine the efficacy compared to other interventions and to assess if the outcomes are maintained on arthroscopic or MRI confirmed meniscal tears.

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Captions

Table 1: Summary of Initial Clinical Examination

Patient	Sex	Physical Exam	DPA	PSFS
1	M	Presented with left side medial and lateral joint line knee pain, which began after playing soccer. Pain and "clicking" has been constant for approximately two and a half months. Reported swelling and decreased range of motion at the time of injury. Patient did not see a physician and initially treated the injury with ice and rest. Observation of the knee and related structures was unremarkable. Patient was tender to palpation (TTP) over the medial joint line. Stated pain was an 8 during active knee extension, 3 with active knee flexion, and 1 with walking using the NRS. Goniometric measurements of active knee flexion revealed 143° of flexion on the left side and 146° on the right side. Knee extension was 2° on the left side and 0° on the right side. All manual muscle tests (MMT) were equal bilaterally. The patient also had a positive (elicited pain) McMurray's and Thessaly test at 5° and 20°; Apley's Compression, Lachman, Anterior Drawer, Valgus, and Varus tests were negative.	10	7 – knee ext 5 – squatting 4 – post running
2	F	Patient presented with right side medial joint line knee pain lasting approximately three months. Injury was sustained when the patient slipped on ice and her knee was forced into a valgus position. Reported hearing a "pop" and experiencing "achy" pain at the time of injury. Patient did not see a physician and initially treated the injury with ice and rest. Observation of the knee and related structures was unremarkable. Patient was TTP over the medial joint line. Stated pain was an 8 with active knee flexion, extension, and walking using the NRS. Goniometric measurements of active knee flexion revealed 136° of flexion on the right side and 150° on the left side. Knee extension was 0° on the right side and -2° on the left side. Quadriceps MMT was 4/5 on the right side; all other MMTs were equal bilaterally. The patient also had an antalgic gait and positive (elicited pain) McMurray's test, Thessaly test at 20°, and Apley's Compression test. Lachman, Anterior Drawer, Valgus, and Varus tests were negative.	40	4 – walking 2 – stairs 0 - squatting

Table 2. Patient 1 Outcomes with "Squeeze" Technique – Left Knee

	Day 1		Day 7		Day 21
Measurement	**Pre-Squeeze**	**Post-Squeeze**	**Pre-Squeeze**	**Post-Squeeze**	**Discharge**
AROM - Flexion	R=146° L=143°	L=146°	R=145° L=145°	L=146°	R=146° L=146°
AROM – Ext.	R=0° L=2°	L=0°	R=0° L=1°	L=(-)1°	R=1° L=1°
McMurray's (NRS)	(+)pain, IR	NT	(+)pain (2)	(+)pain (1*)	(-)
Apley's	(-)	NT	(-)	NT	(-)
Thessaly's	(+) at 5° & 20°	NT	(-)	NT	(-)
NRS (walking)	1	0*	0	0	0
NRS (flexion)	3	0*	2	0*	0
NRS (ext)	8	2*	2	1*	0*
DPA scale	10	NT	NT	NT	13
PSFS: Ext/squat/post running	(7/5/4)	(8/10*/NT)	NT	NT	(9/9/8*)
Key: NT – not tested; *Denotes MCID PSFS – 0 = unable to perform, 10 = able to perform at a normal level					

Table 3. Patient 2 Outcomes with "Squeeze" Technique – Right Knee

	Day 1		Day 15	
Measurement	**Pre-Squeeze**	**Post-Squeeze**	**Pre-Squeeze**	**Post-Squeeze**
AROM - Flexion	L=150° R=136°	R=147°	R=150° L=150°	R=152°
AROM – Ext.	L=(-)2° R=0°	L=(-)3°	R=0° L=(-)2°	R=(-)2°
McMurray's (NRS)	(+)pain (9)	(-)	(-)	NT
Apley's (NRS)	(+)pain (9)	(-)	(-)	NT
Thessaly's (NRS)	(+) at 5° & 20° (7)	(+) at 20° (1*)	(-)	NT
NRS (walking)	8	0*	3	0*
NRS (flexion)	8	0*	4	0*
NRS (ext)	8	0*	0	0
DPA scale	40	NT	25*	NT
PSFS: Walking/stairs/ squatting	(4/2/0)	(10*/4*/7*)	(10/8*/9*)	NT
Key: NT – not tested; *Denotes MCID PSFS – 0 = unable to perform, 10 = able to perform at a normal level				

Figure 1. "Squeeze" Technique in NWB position over medial joint line

Figure 2. "Squeeze" technique in WB position over medial joint line

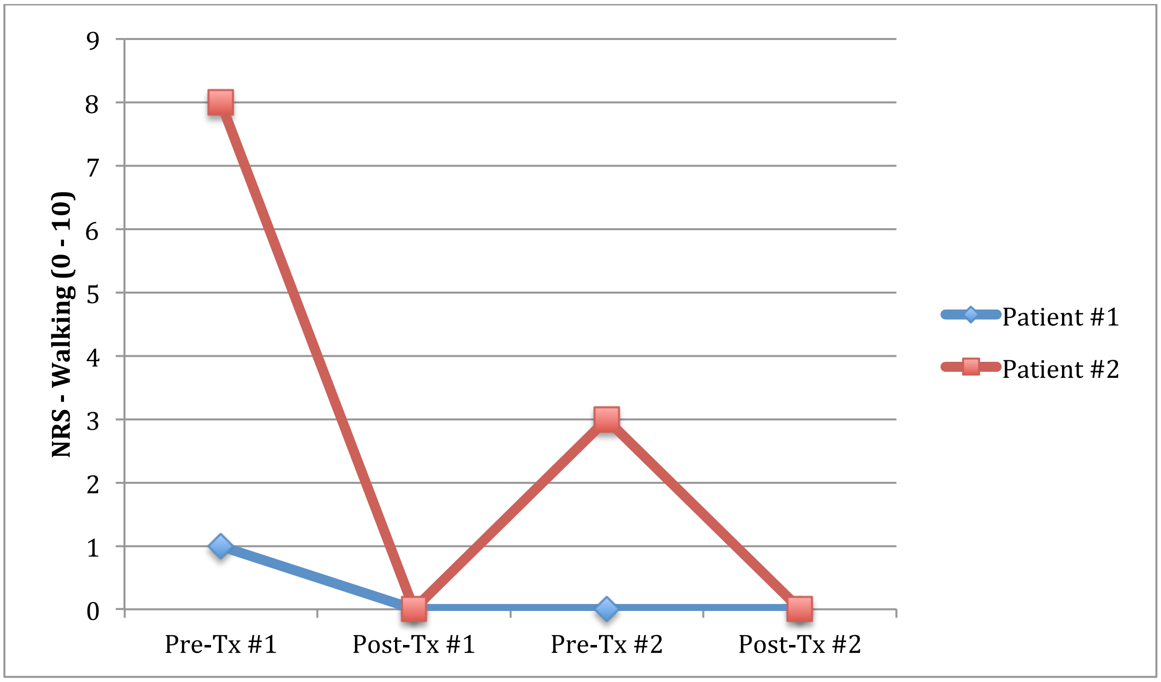

Figure 3. Changes in numeric rating scale (NRS) during walking

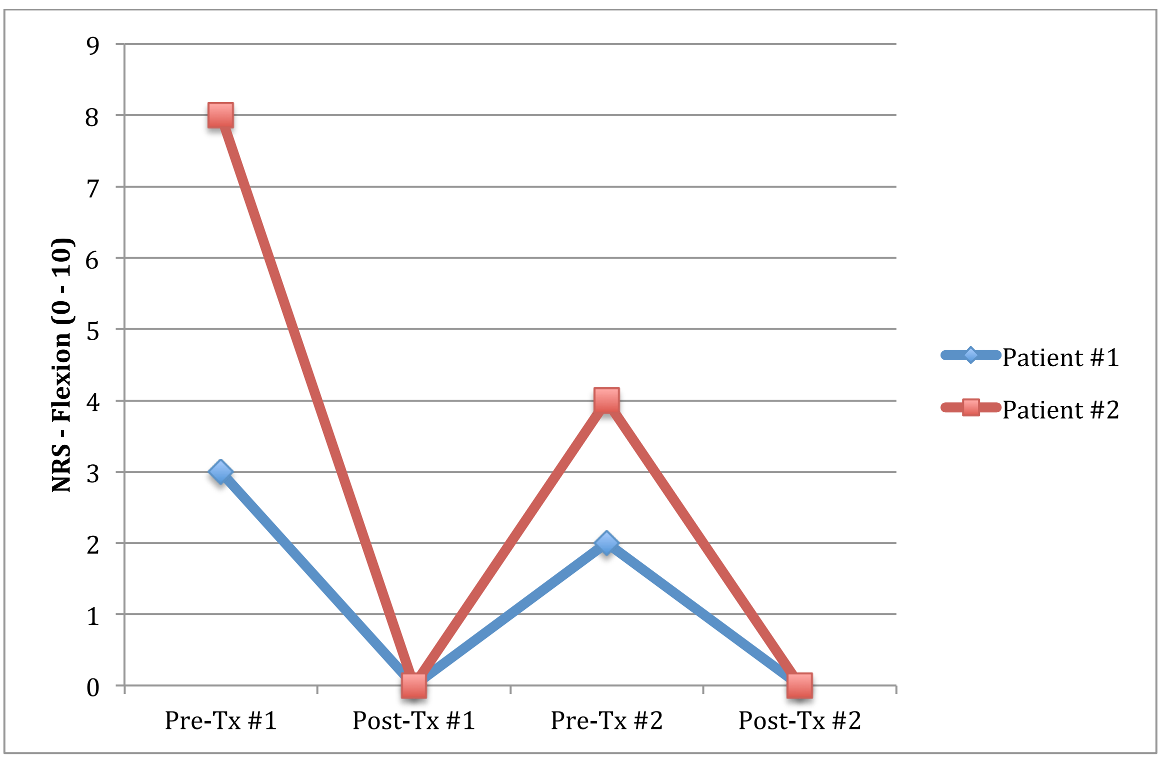

Figure 4. Changes in numeric rating scale (NRS) during knee flexion

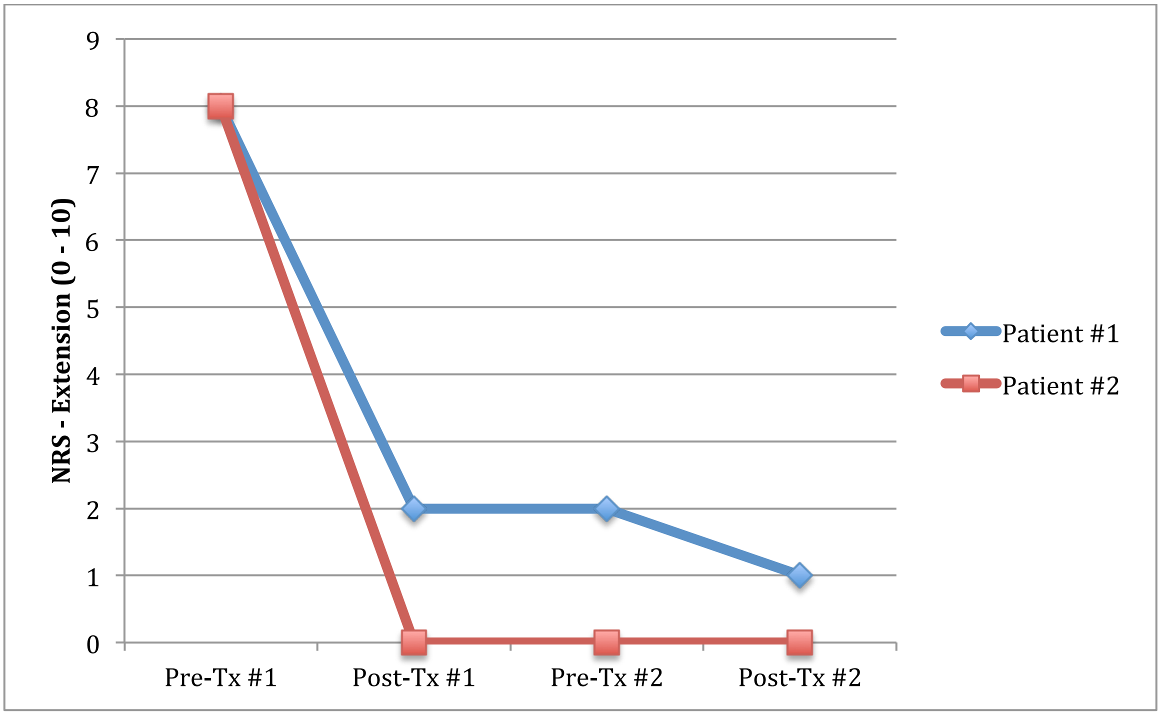

Figure 5. Changes in numeric rating scale (NRS) during knee extension

APPENDIX E

LOW BACK PAIN PARTICIPANTS' DEMOGRAPHIC INFORMATION

Case #1 – Patient #9532

Patient Characteristics

A 30-year-old female presented with an 11-month history of low back pain (LBP) and right anterolateral hip pain with an unknown mechanism of injury. She was in good health and very physically active, but experienced pain with prolonged sitting. Her first onset of LBP began approximately nine years prior to her evaluation in our clinic. She was diagnosed with a herniated disc at L5-S1 at the initial time of injury. She completed physical therapy for a month-and-a-half and experienced 70% reduction in pain, but the symptoms returned eight months after completing physical therapy. Since the initial onset nine years ago, she has experienced intermittent episodes of LBP but has not attempted physical therapy treatment since her initial diagnosis. The patient denied taking any medication for her LBP. During the initial evaluation in our clinic, the patient reported 32 on the Disablement in the Physically Active (DPA) Scale, 4.7 on the Patient-Specific Functional Scale (PSFS), 16% on the Modified Oswestry LBP Disability Questionnaire (OSW), and 2.2 on the Numeric Rating Scale (NRS) total (average of current, best, and worst) (Table E.1).

Examination and Clinical Impression

The patient demonstrated normal active range of motion (AROM), but experienced pain in her right hip during trunk extension. Her fingertip-to-floor (FFD) and fingertip-to-thigh (FTD) tests were within normal ranges (5cm and 20.5[L]/21[R]cm). On the Selective Functional Movement Assessment (SFMA) top tier, the patient performed functional non-painful (FN) movements in cervical flexion and extension and the single-leg stance bilaterally. All other movements were dysfunctional non-painful (DN) with the exception of multi-segmental extension, which was dysfunctional painful (DP). Her lower quarter neurologic screen revealed paresthesia in the right great toe during the L1/L2 myotome test. During palpation, tender points were found on the right quadratus lumborum, gluteus medius, sacroiliac joint, piriformis, tensor fasciae latae, psoas major, and iliacus. Her MyoKinesthetic™ (MYK) posture screen revealed a postural imbalance at the L4 and S1 nerve root levels, with 8 total imbalances. She tested positive on the Quadrant test on the right side and for pelvic girdle dysfunction. Based on her symptoms distal to the knee and peripheralization with extension, the patient was placed into the traction subgroup within the treatment-based classification (TBC) system.

Intervention and Outcome

The patient was treated with MYK L4 a total of 9 times over 21 days. She had full resolution of LBP following one treatment. Her pelvic girdle motion normalized by the first follow-up conducted one week after her initial evaluation, and her Quadrant test normalized by the second-week follow-up. She was discharged after 21 days with a DPA Scale score of 10, PSFS score of 9.3, OSW score of 6%, GRC score of 3.5, and NRS score of 0. Her total number of imbalances on the MYK posture screen decreased from 8 to 3. Although her AROM was within normal limits and pain-free, her FFD and FTD tests demonstrated decreased movement (12cm and 8[L]/10.5[R]cm). On the SFMA, the patient's multi-segmental flexion improved from DN to FN. The patient did not require any further treatments and all improvements were maintained at the one-month follow-up. She reported a 17 on the DPA Scale, 9.8 on the PSFS, 2% on the OSW, 5 on the GRC, and 0 on the NRS. Her total number of imbalances on the MYK posture screen remained at 3, and her FFD and

FTD test results were similar to discharge (14cm and 11[L]/10[R]cm). Her SFMA results were unchanged from discharge. The patient also tested negative on the Quadrant test, but demonstrated dysfunctional pelvic girdle motion.

Case #2 – Patient #9535

Patient Characteristics

A 30-year-old male presented with a 12-year history of LBP following an injury he sustained while weight lifting. He was in good health and very physically active, but experienced pain with exercise and transitioning from sitting to standing. He never consulted a physician or received treatment for his LBP. Since the initial onset 12 years ago, he has experienced intermittent episodes of extreme LBP, which lasts for approximately two weeks and is resolved with rest and ice. The patient denied taking any medication for his LBP. During the initial evaluation in our clinic, the patient reported 27 on the DPA Scale, 4.5 on the PSFS, 14% on the OSW, and 5.8 on the NRS (Table E.2).

Examination and Clinical Impression

The patient demonstrated limited AROM in trunk flexion and extension. His FFD test was below normal ranges (35cm), and the FTD tests were within normal ranges (22[L]/22[R]cm). On the SFMA top tier, the patient performed FN movements in cervical flexion and the single-leg stance on the left side. All other movements were DN with the exception of multi-segmental flexion and extension and the overhead squat, which were DP. His lower quarter neurologic screen revealed hyporeflexive patellar tendons bilaterally and weakness of the S2 myotome on the right side. During palpation, tender points were found on the erector spinae muscles bilaterally and the spinous processes of L4 and L5. His MYK posture screen revealed a postural imbalance at the L4 and S1 nerve root levels, with 10 total imbalances. He tested positive on the Slump test bilaterally, the Thigh Thrust test on the left side, and the Sacral Thrust test. The patient could not be placed into any of the TBC system subgroups because he did not display symptoms distal to the buttocks, his pain did not centralize or peripheralize, he had chronic pain, his straight leg raise (SLR) was less than 91°, he tested negative on the Prone Instability test, and he did not have aberrant movements.

Intervention and Outcome

The patient was treated with MYK S1 a total of 15 times over 36 days. He had immediate reduction in pain following one treatment. His Slump test and Thigh Thrust test normalized by the first follow-up conducted one week after his initial evaluation, and his Sacral Thrust test normalized by the second-week follow-up. He was discharged after 36 days with a DPA Scale score of 2, PSFS score of 9, OSW score of 2%, GRC score of 4, and NRS score of 0.3. His total number of posture imbalances on the MYK posture screen decreased from 10 to 5. He also demonstrated improvements in AROM (FFD = 31cm and FTD = 8[L]/10.5[R]cm). On the SFMA, the patient's multi-segmental extension and overhead squat improved from DP to DN. His cervical extension and rotation also improved from DN to FN. The patient did not require any further treatments and most improvements were maintained at the one-month follow-up. He reported a 9 on the DPA Scale, 7 on the PSFS, 6% on the OSW, 1 on the GRC, and 1 on the NRS. His total number of posture imbalances on the MYK posture screen was 4, and his FFD test results were similar to discharge (32cm). The patient's FTD test results were similar to the initial evaluation (22[L]/21[R]cm). His SFMA results were similar to discharge, with the exception of multi-segmental extension, which returned to DP. The patient also tested negative on the Slump test and Thigh Thrust test, but tested positive on the Sacral Thrust test.

Case #3 – Patient #9536

Patient Characteristics

A 24-year-old male presented with a 9-year history of LBP following a fall on his back while playing basketball. He was in good health and physically active, but experienced pain with exercise and sitting for prolonged periods. The patient sought treatment from a chiropractor and physical therapist after the initial injury, but pain relief did not last longer than a day with each treatment. Since the initial onset nine years ago, he has experienced constant LBP. The patient denied taking any medication for his LBP. During the initial evaluation in our clinic, the patient reported 28 on the DPA Scale, 7.6 on the PSFS, 38% on the OSW, and 3.8 on the NRS (Table E.3).

Examination and Clinical Impression

The patient demonstrated normal AROM, but experienced pain in his lumbar spine during trunk extension. His FFD and FTD tests were within normal ranges (13cm and 23[L]/23.5[R]cm). On the SFMA top tier, the patient performed FN movements in cervical flexion and multi-segmental rotation on the right side. All other movements were DN with the exception of cervical flexion, multi-segmental extension, and the overhead squat, which were DP. His lower quarter neurologic screen revealed decreased sensation over the L5 dermatomal pattern. During palpation, tender points were found on the erector spinae muscles bilaterally and the spinous processes of L4 and L5. His MYK posture screen revealed a postural imbalance at the L4 nerve root level, with 7 total imbalances. He tested positive on the Quadrant test on the left side, Slump test bilaterally, FABER test bilaterally, the Prone Instability test, and for pelvic girdle dysfunction. The patient could not be placed into any of the TBC system subgroups because he did not display symptoms distal to the buttocks, his pain did not centralize or peripheralize, he had chronic pain, his SLR was less than 91°, and he did not have aberrant movements.

Intervention and Outcome

The patient was treated with MYK L4 initially, followed by a combination of L4 and C8 for a total of 24 treatments over 45 days. His pain was reduced after one treatment, but it was not completely resolved until the fourth week of treatment. His Slump test and pelvic girdle motion normalized by the second follow-up conducted two weeks after his initial evaluation. The patient's Quadrant test normalized by the fourth week, and his Prone Instability test normalized by the one-month follow-up. He was discharged after 45 days with a DPA Scale score of 2, PSFS score of 9.6, OSW score of 0%, GRC score of 5, and NRS score of 0. His total number of posture imbalances on the MYK posture screen decreased from 7 to 3. Although his AROM was within normal limits and pain-free, his FTD tests demonstrated decreased movement (15[L]/14[R]cm). His FFD test was slightly improved from the initial evaluation (11cm). On the SFMA, the patient's cervical extension, multi-segmental extension, and overhead squat improved from DP to DN. His multi-segmental flexion and multi-segmental rotation to the left also improved from DN to FN. The patient did not require any further treatments and all improvements were maintained at the one-month follow-up. He reported a 4 on the DPA Scale, 9.2 on the PSFS, 4% on the OSW, 4 on the GRC, and 1 on the NRS. His total number of posture imbalances on the MYK posture screen was 6, and his FFD test results were similar to discharge (12cm). The patient's FTD measurements increased from discharge (18[L]/22[R]cm). His SFMA results were similar to discharge. The patient also tested negative on the Quadrant test, Slump test, Prone Instability test, and for pelvic girdle dysfunction.

Case #4 – Patient #9537

Patient Characteristics

A 50-year-old female presented with a 3-week history of LBP. She was in good health and physically active, but experienced pain with running and prolonged sitting. Her first onset of LBP occurred six years prior to this incident, but she has not experienced any pain since that injury resolved. The patient denied taking any medication for her LBP. During the initial evaluation in our clinic, the patient reported 24 on the DPA Scale, 8 on the PSFS, 12% on the OSW, and 3 on the NRS (Table E.4).

Examination and Clinical Impression

The patient demonstrated limited AROM in trunk extension, and experienced pain in her lumbar spine during trunk rotation to the left. Her FFD and FTD tests were within normal ranges (8cm and 20[L]/21.5[R]cm). On the SFMA top tier, all movements were DN, with the exception of multi-segmental rotation to the left, which was DP. Her lower quarter neurologic screen revealed weakness of the L5 myotomes bilaterally and the S2 myotome on the right side. During palpation, tender points were found on the spinous processes of L4 and L5. Her MYK posture screen revealed a postural imbalance at the L5 nerve root level, with 8 total imbalances. She tested positive on FABER test bilaterally, the Prone Instability test, and for pelvic girdle dysfunction. The patient could not be placed into any of the TBC subgroups because her symptoms were not distal to the buttocks, her pain did not centralize or peripheralize, she experienced pain for greater than 16 days, she was older than 40 years of age, and she did not demonstrate aberrant movements.

Intervention and Outcome

The patient was treated with MYK L5 a total of 8 times over 28 days. She had immediate resolution of LBP following one treatment. Her FABER test normalized by the first follow-up conducted one week after her initial evaluation, and her pelvic girdle motion normalized by the third-week follow-up. She was discharged after 28 days with a DPA Scale score of 2, PSFS score of 10, OSW score of 0%, GRC score of 5, and NRS score of 0. Her total number of posture imbalances on the MYK posture screen decreased from 8 to 3. Her AROM was within normal limits and pain-free, and her FFD and FTD test results were similar to the initial evaluation (10cm and 20[L]/20.5[R]cm). On the SFMA, the patient's cervical extension, upper extremity patterns, and single-leg stance bilaterally improved from DN to FN. Additionally, her multi-segmental rotation to the left improved from DP to DN. The patient did not require any further treatments and all improvements were maintained at the one-month follow-up. She reported a 0 on the DPA Scale, 10 on the PSFS, 0% on the OSW, 5 on the GRC, and 0.2 on the NRS. Her total number of posture imbalances on the MYK posture screen remained at 3, and her FTD test results were balanced and similar to discharge (19[L]/19[R]cm). Her FFD test results increased from discharge (16cm). Her SFMA results were unchanged from discharge. The patient also tested negative on FABER test and for pelvic girdle dysfunction.

Case #5 – Patient #9539

Patient Characteristics

A 19-year-old male presented with acute LBP following weight lifting. He was in good health and very physically active, but experienced pain with trunk flexion. Symptoms had been present for one day at the time of the initial examination. The patient had no prior history of LBP. The patient denied taking any medication for his LBP. During the initial evaluation in our clinic, the patient reported 27 on the DPA Scale, 4 on the PSFS, 16% on the OSW, and 1.7 on the NRS (Table E.5).

Examination and Clinical Impression

The patient demonstrated limited AROM in trunk flexion and extension. His FFD and FTD tests were within normal ranges (17cm and 24[L]/22[R]cm). On the SFMA top tier, the patient performed FN movement in cervical flexion. All other movements were DN with the exception of multi-segmental flexion and the overhead squat, which were DP. His lower quarter neurologic screen was unremarkable. During palpation, tender points were found on the left gluteus medius and psoas major. His MYK posture screen revealed a postural imbalance at the L4 nerve root level, with 9 total imbalances. He tested positive on the Quadrant test on the left side, the Slump test bilaterally, the Passive SLR test bilaterally, the Thigh Thrust test on the left side, FABER test on the right side, and for pelvic girdle dysfunction. The patient was placed into the manipulation TBC subgroup as a result of his acute symptoms, lack of radiating pain, and lack of centralization or peripheralization.

Intervention and Outcome

The patient was treated with MYK L4 a total of 7 times over 22 days. He had immediate reduction in pain following one treatment. His Slump test, Passive SLR test, Thigh Thrust test, FABER test, and pelvic girdle motion normalized by the first follow-up conducted one week after his initial evaluation. His Quadrant test normalized by the second-week follow-up. He was discharged after 22 days with a DPA Scale score of 0, PSFS score of 9.3, OSW score of 2%, GRC score of 4.5, and NRS score of 0.3. His total number of posture imbalances on the MYK posture screen decreased from 9 to 3. He also demonstrated improvements in the FFD test (14cm), but the FTD test remained similar to the initial exam (23[L]/25[R]cm). On the SFMA, the patient's multi-segmental flexion and overhead squat improved from DP to DN. The patient did not require any further treatments and all improvements were maintained at the one-month follow-up. He reported a 0 on the DPA Scale, 10 on the PSFS, 0% on the OSW, 5 on the GRC, and 0 on the NRS. His total number of posture imbalances on the MYK posture screen was 4, and his FFD and FTD test results were similar to discharge (13cm and 25[L]/25[R]cm). His SFMA results did not change from discharge. The patient also tested negative on all special tests.

Case #6 – Patient #9540

Patient Characteristics

A 19-year-old female presented with acute LBP and radiating anterior thigh pain on the right side following running in a rugby game. She was in good health and physically active, but she experienced constant pain since the onset of injury. Symptoms had been present for four days at the time of the initial examination. The patient had a prior history of LBP, which occurred four years before the current incident. She was treated by a chiropractor after her initial LBP episode, and her pain relief lasted for two months. She has experienced intermittent episodes of LBP since the initial injury four years ago. The patient denied taking any medication for her LBP. During the initial evaluation in our clinic, the patient reported 43 on the DPA Scale, 4.2 on the PSFS, 36% on the OSW, and 6.8 on the NRS (Table E.6).

Examination and Clinical Impression

The patient demonstrated limited and painful AROM in trunk extension. Her FFD test was within normal ranges (13cm), but her FTD test was below normal ranges (16.5[L]/15[R]cm). On the SFMA top tier, the patient performed FN movements in the upper extremity pattern 1, multi-segmental flexion, and the single-leg stance on the left side. All other movements were DN with the exception of multi-segmental extension, multi-segmental rotation on the right side, and the single-leg stance on the right side, which were DP. Her lower quarter neurologic screen revealed diminished sensation over the L2 dermatomal pattern. During palpation, tender points were found on the right sacroiliac joint (SIJ) and piriformis. Her MYK posture screen revealed a postural imbalance at the L5 and S1 nerve root levels, with 7 total imbalances. She tested positive on the Quadrant test on the right side, the Valsalva test, the Slump test bilaterally, the Thigh Thrust test bilaterally, the SIJ Compression test, FABER test bilaterally, Gaenslen's test bilaterally, the SIJ Distraction test, and the Sacral Thrust test. The patient was placed into the specific exercise TBC subgroup as a result of her acute radiating symptoms distal to the buttocks, and centralization with flexion.

Intervention and Outcome

The patient was treated with MYK L5 a total of 5 times over 16 days. She had immediate elimination of pain following one treatment. Her Valsalva test, SIJ Compression test, FABER test, and Gaenslen's test normalized by the first follow-up conducted one week after her initial evaluation. Her Slump test, Thigh Thrust test, and SIJ Distraction test normalized by the second-week follow-up. She was discharged after 16 days with a DPA Scale score of 4, PSFS score of 10, OSW score of 0%, GRC score of 4.5, and NRS score of 0.5. Her total number of posture imbalances on the MYK posture screen decreased from 7 to 3. She also demonstrated improvements in the FFD test (11cm), but the FTD test remained similar to the initial exam (16[L]/16[R]cm). On the SFMA, the patient's multi-segmental rotation improved from DP to DN. Her single-leg stance on the right side also improved from DP to FN, and cervical flexion improved from DN to FN. The patient did not require any further treatments and all improvements were maintained at the one-month follow-up. She reported a 0 on the DPA Scale, 10 on the PSFS, 0% on the OSW, 4.5 on the GRC, and 0.3 on the NRS. Her total number of posture imbalances on the MYK posture screen was 3, and her FFD and FTD test results were similar to discharge (10cm and 17.5[L]/19[R]cm). Her SFMA results did not change from discharge. The patient also tested negative on all special tests.

Case #7 – Patient #9541

Patient Characteristics

A 65-year-old male presented with a 2-year history of LBP with an unknown mechanism of injury. He was in good health, but experienced pain with trunk rotation and standing. He received chiropractic treatment and a steroid injection at the initial onset of injury, which eliminated his pain for six weeks. The pain has been constant since it returned following the injection. The patient reported taking Aleve three times a day for his LBP. During the initial evaluation in our clinic, the patient reported 45 on the DPA Scale, 4.7 on the PSFS, 40% on the OSW, and 3.3 on the NRS (Table E.7).

Examination and Clinical Impression

The patient demonstrated limited AROM in trunk extension. His FFD test was within normal ranges (16cm), and the FTD test was below normal ranges (14[L]/17[R]cm). On the SFMA top tier, the patient performed FN movement in cervical flexion, and all other movements were DN. His lower quarter neurologic screen revealed decreased sensation on the L2 and L3 dermatomal patterns, weakness of the L5 myotome. During palpation, tender points were found on the right gluteus medius and adductor longus, and left psoas major. His MYK posture screen revealed a postural imbalance at the L3 and L4 nerve root levels, with 6 total imbalances. He tested positive on the Slump test on the right side, FABER test bilaterally, Gaenslen's test on the right side, and on the Sacral Thrust test. The patient could not be placed into any of the TBC system subgroups because he did not display symptoms distal to the buttocks, his pain did not centralize or peripheralize, he had chronic pain, his SLR was less than 91°, he tested negative on the Prone Instability test, and he did not have aberrant movements.

Intervention and Outcome

The patient was treated with MYK L3 a total of 8 times over 22 days. He had immediate reduction in pain following one treatment. His Gaenslen's test and Sacral Thrust test normalized by the first follow-up conducted one week after his initial evaluation, and FABER test normalized by the second-week follow-up. He was discharged after 22 days with a DPA Scale score of 11, PSFS score of 9.7, OSW score of 16%, GRC score of 5, and NRS score of 0.3. His total number of imbalances on the MYK posture screen decreased from 6 to 3. He demonstrated decreased AROM on the FFD test (22cm), but the FTD test remained similar to the initial examination (15[L]/16[R]cm). On the SFMA, the patient did not improve from the initial assessment. The patient did not require any further treatments and all improvements were maintained at the one-month follow-up. He reported a 13 on the DPA Scale, 9.7 on the PSFS, 8% on the OSW, 4 on the GRC, and 0 on the NRS. His total number of posture imbalances on the MYK posture screen was 4, and his FFD test results improved from discharge (17.5cm). The patient's FTD measurements were balanced, but returned to initial evaluation scores (14[L]/14[R]cm). His SFMA results were similar to discharge. The patient also tested negative on the Slump test, FABER test, Gaenslen's test, and the Sacral Thrust test.

Case #8 – Patient #9542

Patient Characteristics

A 20-year-old female presented with a 2-year history of LBP with radiating posterior thigh pain bilaterally following a weight lifting incident. She was in good health and physically active, but experienced pain with prolonged sitting and exercise. She was diagnosed with a herniated disc at L4-L5 and L5-S1 at the initial onset of pain. She has received treatment from a chiropractor and athletic trainer for the last two years, but has not experienced pain relief for more than a couple hours. The patient denied taking any medication for her LBP. During the initial evaluation in our clinic, the patient reported 40 on the DPA Scale, 5.5 on the PSFS, 26% on the OSW, and 1.8 on the NRS (Table E.8).

Examination and Clinical Impression

The patient demonstrated normal AROM, but experienced pain in her lumbar spine during trunk extension. Her FFD and FTD tests exceeded normal ranges (4cm and 26[L]/24[R]cm). On the SFMA top tier, the patient performed FN movements in cervical extension, upper extremity pattern 1 on the left side, upper extremity pattern 2 on the right side, multi-segmental flexion, and the single-leg stance bilaterally. All other movements were DN with the exception of cervical flexion, multi-segmental extension, and multi-segmental rotation, which were DP. Her overhead squat was functional painful (FP). The patient's lower quarter neurologic screen revealed weakness of the L1 and L2 myotomes on the right side, and weakness of the S2 myotomes bilaterally. During palpation, tender points were found on the right erector spinae muscles, gluteus medius, sacroiliac joint, and piriformis. Her MYK posture screen revealed a postural imbalance at the L5 nerve root level, with 6 total imbalances. She tested positive on the Quadrant test bilaterally, Slump Test bilaterally, Prone

Instability test, Sacral Thrust test, and for pelvic girdle dysfunction. The patient was placed into the specific exercise TBC subgroup as a result of her radiating symptoms distal to the buttocks, centralization with flexion, and negative results on the Crossed SLR test.

Intervention and Outcome

The patient was treated with MYK L5 initially, followed by S1 for a total of 18 treatments over 37 days. She had immediate reduction in LBP following one treatment and full resolution of pain after four weeks. Her Slump test and pelvic girdle motion normalized by the second-week follow-up, and her Prone Instability test and Sacral Thrust test normalized by the third-week follow-up. She was discharged after 37 days with a DPA Scale score of 16, PSFS score of 8.5, OSW score of 14%, GRC score of 4, and NRS score of 0.7. Her total number of imbalances on the MYK posture screen decreased from 6 to 3. Her AROM was within normal limits, but she experienced pain in trunk extension. Her FFD and FTD tests remained similar to the initial evaluation and exceeded normal ranges (1cm and 26.5[L]/24.5[R]cm). On the SFMA, the patient's cervical flexion and multi-segmental rotation improved from DP to FN, and her overhead squat improved from FP to FN. The patient did not require any further treatments and most improvements were maintained at the one-month follow-up. She reported an 11 on the DPA Scale, 8.5 on the PSFS, 14% on the OSW, 4 on the GRC, and 0.7 on the NRS. Her total number of posture imbalances on the MYK posture screen increased to 6, and her FFD test results increased from discharge (6cm). Her FTD test results remained similar to both discharge and the initial evaluation (26[L]/25[R]cm). Her SFMA results were unchanged from discharge. The patient also tested negative on the Slump test, Prone Instability test, Sacral Thrust test, and for pelvic girdle dysfunction.

Case #9 – Patient #9543

Patient Characteristics

A 22-year-old male presented with a 2-year history of LBP and radiating lateral lower leg pain on the right side following an injury he sustained in a motor vehicle accident. He was in good health and very physically active, but experienced pain with exercise and standing. He received chiropractic treatments but did not have complete relief of pain. Since the initial onset 2 years ago, he has experienced constant LBP. The patient denied taking any medication for his LBP. During the initial evaluation in our clinic, the patient reported 4 on the DPA Scale, 6.6 on the PSFS, 4% on the OSW, and 2.5 on the NRS (Table E.9).

Examination and Clinical Impression

The patient demonstrated limited and painful AROM in trunk extension. His FFD test was within normal ranges (17cm), and the FTD tests were slightly below normal ranges (18[L]/17[R]cm). On the SFMA top tier, the patient performed DN movements in all patterns with the exception of multi-segmental extension, which was DP. His lower quarter neurologic screen revealed a hyporeflexive patellar tendon on the left side. During palpation, one tender point was found on the L4 spinous process. His MYK posture screen revealed a postural imbalance at the L5 nerve root level, with 6 total imbalances. He tested positive on the Quadrant test bilaterally, the Slump test bilaterally, Gaenslen’s test on the left side, and the Prone Instability test. The patient was placed into the specific exercise TBC subgroup as a result of his radiating symptoms distal to the buttocks, centralization with flexion, and negative results on the Crossed SLR test.

Intervention and Outcome

The patient was treated with MYK L5 initially, followed by C5 for a total of 15 treatments over 31 days. He had immediate reduction in pain following one treatment, and complete resolution of pain after three weeks. His Quadrant test and Gaenslen's test normalized by the first follow-up conducted one week after his initial evaluation. His Slump test and Prone Instability test normalized at discharge. He was discharged after 31 days with a DPA Scale score of 1, PSFS score of 9.25, OSW score of 4%, GRC score of 4, and NRS score of 0. His total number of posture imbalances on the MYK screen decreased from 6 to 2. He also demonstrated improvements in AROM (FFD = 8cm and FTD = 18[L]/20[R]cm). On the SFMA, the patient's single-leg stance bilaterally improved from DN to FN. The patient did not require any further treatments and most improvements were maintained at the one-month follow-up. He reported a 0 on the DPA Scale, 9.6 on the PSFS, 4% on the OSW, 4.5 on the GRC, and 0 on the NRS. His total number of posture imbalances on the MYK posture screen was 3. The patient's FFD and FTD test results decreased from discharge (16cm and 16[L]/16[R]cm). His SFMA results were similar to discharge, with the exception of the single-leg stance, which returned to DN. The patient also tested negative on the Quadrant test, Slump test, Gaenslen's test, and Prone Instability test.

Table E.1. Patient #9532, Chronic LBP (L5 disc herniation) – Traction Subgroup

	Day 1	Week 2	Week 3	Week 4 - Discharge	1 Month Follow-up
Measurement					
NRS (current) P/P	0/0	0/0	0/0	0/0	0
NRS (best)	0	0	0	0	0
NRS (worst)	6.5	0*	0	0	0^
NRS (total)	2.2	0*	0	0	0^
DPA scale	32	24*	18*	10*	17^
PSFS	4.7	6.5	8.8*	9.3	9.8^
OSW	16%	6%	6%	6%	2%^
GRC	NT	NT	NT	3.5	5
FFD	5cm	8cm	11cm	12cm	14cm
FTD (cm) L/R	20.5/21	11.5/13	8/13	8/10.5	11/10
MYK Posture (#)	L4/S1 (8)	S1 (10)	S1 (4)	C5 (3)	L5/S1 (3)
Quadrant Test	(+) R	(+) R	(-)	(-)	(-)
PG Motion	(+)	(+)	(-)	(-)	(+)

Key: * = MCID - weekly, ^ = MCID – day 1 to follow-up, NT = Not tested, P/P = Pre/Post MYK, L/R = Left/Right, B = Bilateral, # = number of lower body posture imbalances, PG = pelvic girdle
NRS = Numeric Rating Scale; MCID = 2 points or 30%
DPA Scale = Disablement in the Physically Active Scale; MCID = 6 points for chronic, 9 points for acute
PSFS = Patient-Specific Functional Scale; MCID = 2 points
OSW = Modified Oswestry LBP Disability Questionnaire; MCID = 12%
FFD = Fingertip-to-floor distance measured on 20cm high step; no MCID; normal ranges 0.1cm – 2.2cm from the floor without a step
FTD = Fingertip-to-thigh distance; no MCID; normal ranges 19.1cm – 21.6cm

Table E.2. Patient #9535, Chronic LBP – No Subgroup

	Day 1	Week 2	Week 3	Week 4	Week 5 - Discharge	1 Month Follow-up
Measurement						
NRS (current) P/P	6/0*	2/2	1*/0.5*	1/1	0*/0	0^
NRS (best)	3	0*	0	0	0	0^
NRS (worst)	8.5	2*	2	2	1*	3^
NRS (total)	5.8	1.3*	1	1	0.3*	1^
DPA scale	27	6*	4	3	2	9^
PSFS	4.5	8.5*	9	8	9	7^
OSW	14%	4%	6%	6%	2%	6%
GRC	NT	NT	NT	NT	4	1
FFD	35cm	36cm	33cm	28cm	31cm	32cm
FTD (cm) L/R	22/22	22.5/22	24/23	26/25.5	27/27	22/21
MYK Posture (#)	L4/S1 (10)	L4 (7)	S1 (6)	L4/S1 (6)	S1 (5)	L4 (4)
Slump Test	(+) B	(-)	(-)	(-)	(-)	(-)
Thigh Thrust	(+) L	(-)	(-)	(-)	(-)	(-)
Sacral Thrust	(+)	(+)	(-)	(-)	(-)	(+)

Key: * = MCID - weekly, ^ = MCID – day 1 to follow-up, NT = Not tested, P/P = Pre/Post MYK, L/R = Left/Right, B = Bilateral, # = number of lower body posture imbalances, PG = pelvic girdle
NRS = Numeric Rating Scale; MCID = 2 points or 30%
DPA Scale = Disablement in the Physically Active Scale; MCID = 6 points for chronic, 9 points for acute
PSFS = Patient-Specific Functional Scale; MCID = 2 points
OSW = Modified Oswestry LBP Disability Questionnaire; MCID = 12%
FFD = Fingertip-to-floor distance measured on 20cm high step; no MCID; normal ranges 0.1cm – 2.2cm from the floor without a step
FTD = Fingertip-to-thigh distance; no MCID; normal ranges 19.1cm – 21.6cm

Table E.3. Patient #9536, Chronic LBP – No Subgroup

	Day 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8 DIS	1 Month F/U
Measurement									
NRS (current) P/P	2/1*	2/1*	0*/0*	0/0	1/0	0*/0	0/0	0/0	0^
NRS (best)	1.5	0*	0	0	0	0	0	0	0^
NRS (worst)	8	3*	1*	0*	2	0*	0	0	3^
NRS (total)	3.8	1.7*	0.3*	0*	1	0*	0	0	1^
DPA scale	28	7*	7	3	4	3	2	2	4^
PSFS	7.6	8.4	9.2	9.6	9.4	9.4	9.6	9.6	9.2
OSW	38%	12%*	12%	4%	8%	6%	2%	0%	4%^
GRC	NT	NT	NT	NT	NT	NT	NT	5	4
FFD (cm)	13	13	10	11	16	16	12	11	12
FTD (cm) L/R	23/23.5	19/20	18.5/18	11.5/17.5	15/14	16.5/17.5	15/17	15/14	18/22
MYK Posture (#)	L4 (7)	L4 (6)	L5/S1 (3)	C7/L4 (5)	L4 (7)	L4-S1 (4)	S1 (3)	C5/ C6 (3)	L2/L3/S1 (6)
Quadrant Test	(+) L	(+) B	(+) L	(+) L	(-)	(-)	(-)	(-)	(-)
Slump Test	(+) B	(+) B	(-)	(-)	(-)	(-)	(-)	(-)	(-)
FABER Test	(+) B	(+) B	(+) R	(+) R	(+) R	(+) R	(+) R	(+) R	(+) B
PI Test	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(-)
PG Motion	(+)	(+)	(-)	(-)	(-)	(-)	(-)	(-)	(-)

Key: * = MCID - weekly, ^ = MCID – day 1 to follow-up, NT = Not tested, Wk = Week, DIS = discharge, F/U = follow-up P/P = Pre/Post MYK, L/R = Left/Right, B = Bilateral, # = number of lower body posture imbalances, PG = pelvic girdle, PI = Prone Instability
NRS = Numeric Rating Scale; MCID = 2 points or 30%
DPA Scale = Disablement in the Physically Active Scale; MCID = 6 points for chronic, 9 points for acute
PSFS = Patient-Specific Functional Scale; MCID = 2 points
OSW = Modified Oswestry LBP Disability Questionnaire; MCID = 12%
FFD = Fingertip-to-floor distance measured on 20cm high step; no MCID; normal ranges 0.1cm – 2.2cm from the floor without a step
FTD = Fingertip-to-thigh distance; no MCID; normal ranges 19.1cm – 21.6cm

Table E.4. Patient #9537, Subacute LBP – No Subgroup

	Day 1	Week 2	Week 3	Week 4 - Discharge	1 Month Follow-up
Measurement					
NRS (current) P/P	3/0*	1/0*	0/0	0/0	0^
NRS (best)	2	0*	0	0	0^
NRS (worst)	4	1*	0*	0	0.5^
NRS (total)	3	0.7*	0*	0	0.2^
DPA scale	24	18*	14	2*	0^
PSFS	8	9	9	10	10^
OSW	12%	8%	12%	0%*	0%^
GRC	NT	NT	NT	5	5
FFD	8cm	13cm	16cm	10cm	16cm
FTD (cm) L/R	20/21.5	17.5/18.5	17.5/19	20/20.5	19/19
MYK Posture (#)	L5 (8)	C5 (3)	S1 (2)	S1 (3)	S1 (3)
FABER Test	(+) B	(-)	(-)	(-)	(-)
Prone Instability Test	(+)	(+)	(+)	(+)	(+)
PG Motion	(+)	(+)	(+)	(-)	(-)

Key: * = MCID - weekly, ^ = MCID – day 1 to follow-up, NT = Not tested, P/P = Pre/Post MYK, L/R = Left/Right, B = Bilateral, # = number of lower body posture imbalances, PG = pelvic girdle
NRS = Numeric Rating Scale; MCID = 2 points or 30%
DPA Scale = Disablement in the Physically Active Scale; MCID = 6 points for chronic, 9 points for acute
PSFS = Patient-Specific Functional Scale; MCID = 2 points
OSW = Modified Oswestry LBP Disability Questionnaire; MCID = 12%
FFD = Fingertip-to-floor distance measured on 20cm high step; no MCID; normal ranges 0.1cm – 2.2cm from the floor without a step
FTD = Fingertip-to-thigh distance; no MCID; normal ranges 19.1cm – 21.6cm

Table E.5. Patient #9539, Acute LBP – Manipulation Subgroup

	Day 1	Week 2	Week 3	Week 4 - Discharge	1 Month Follow-up
Measurement					
NRS (current) P/P	1/0*	0/0	1/0*	0/0	0^
NRS (best)	0	0	0	0	0
NRS (worst)	4	0*	3	1*	0^
NRS (total)	1.7	0*	1.3	0.3*	0^
DPA scale	27	3*	2	0	0^
PSFS	4	6.7*	8	9.3	10^
OSW	16%	4%*	4%	2%	0%^
GRC	NT	NT	NT	4.5	5
FFD	17cm	13cm	14cm	14cm	13cm
FTD (cm) L/R	24/22	23.5/23	25/25	23/25	25/25
MYK Posture (#)	L4 (9)	L4/S1 (6)	L4 (10)	L4 (3)	L4/S1 (4)
Quadrant Test	(+)	(+) L	(-)	(-)	(-)
Slump Test	(+)	(-)	(-)	(-)	(-)
Passive SLR	(+) B	(-)	(-)	(-)	(-)
Thigh Thrust Test	(+) L	(-)	(-)	(-)	(-)
FABER Test	(+) R	(-)	(-)	(-)	(-)
PG Motion	(+)	(-)	(-)	(-)	(-)

Key: * = MCID - weekly, ^ = MCID – day 1 to follow-up, NT = Not tested, P/P = Pre/Post MYK, L/R = Left/Right, B = Bilateral, # = number of lower body posture imbalances, PG = pelvic girdle
NRS = Numeric Rating Scale; MCID = 2 points or 30%
DPA Scale = Disablement in the Physically Active Scale; MCID = 6 points for chronic, 9 points for acute
PSFS = Patient-Specific Functional Scale; MCID = 2 points
OSW = Modified Oswestry LBP Disability Questionnaire; MCID = 12%
FFD = Fingertip-to-floor distance measured on 20cm high step; no MCID; normal ranges 0.1cm – 2.2cm from the floor without a step
FTD = Fingertip-to-thigh distance; no MCID; normal ranges 19.1cm – 21.6cm

Table E.6. Patient #9540, Acute LBP – Specific Exercise Subgroup

	Day 1	Week 2	Week 3 - Discharge	1 Month Follow-up
Measurement				
NRS (current) P/P	7/0*	1/0*	0.5/0*	0^
NRS (best)	4.5	0*	0	0^
NRS (worst)	9	2.5*	0.5*	1^
NRS (total)	6.8	1.2*	0.5*	0.3^
DPA scale	43	8*	4	0^
PSFS	4.2	10*	10	10^
OSW	36%	0%*	0%	0%^
GRC	NT	NT	4.5	4.5
FFD	13cm	10cm	11cm	10cm
FTD (cm) L/R	16.5/15	13.5/16	16/16	17.5/19
MYK Posture (#)	L5/S1 (7)	L5 (7)	S1 (3)	L5/S1 (3)
Quadrant Test	(+) R	(+) R	(+) R	(+) L
Valsalva Test	(+)	(-)	(-)	(-)
Slump Test	(+) B	(+) B	(-)	(-)
Thigh Thrust Test	(+) B	(+) R	(-)	(-)
SIJ Compression	(+)	(-)	(-)	(-)
FABER Test	(+) B	(-)	(-)	(-)
Gaenslen's Test	(+) B	(-)	(-)	(-)
SIJ Distraction	(+)	(+)	(-)	(-)
Sacral Thrust	(+)	(+)	(+)	(-)

Key: * = MCID - weekly, ^ = MCID – day 1 to follow-up, NT = Not tested, P/P = Pre/Post MYK, L/R = Left/Right, B = Bilateral, # = number of lower body posture imbalances, PG = pelvic girdle
NRS = Numeric Rating Scale; MCID = 2 points or 30%
DPA Scale = Disablement in the Physically Active Scale; MCID = 6 points for chronic, 9 points for acute
PSFS = Patient-Specific Functional Scale; MCID = 2 points
OSW = Modified Oswestry LBP Disability Questionnaire; MCID = 12%
FFD = Fingertip-to-floor distance measured on 20cm high step; no MCID; normal ranges 0.1cm – 2.2cm from the floor without a step
FTD = Fingertip-to-thigh distance; no MCID; normal ranges 19.1cm – 21.6cm

Table E.7. Patient #9541, Chronic LBP – No Subgroup

	Day 1	Week 2	Week 3	Week 4 - Discharge	1 Month Follow-up
Measurement					
NRS (current) P/P	2/0*	0/0	0/0	0/0	0^
NRS (best)	0	0	0	0	0
NRS (worst)	8	0*	2.5	1*	0^
NRS (total)	3.3	0*	0.8	0.3*	0^
DPA scale	45	26*	23	11*	13^
PSFS	4.7	7.7*	8.3	9.7	9.7^
OSW	40%	14%*	24%	16%	8%^
GRC	NT	NT	NT	5	4
FFD	16cm	19cm	24cm	22cm	17.5cm
FTD (cm) L/R	14/17	15/16.5	13/14.5	15/16	14/14
MYK Posture (#)	L3/L4 (6)	S1 (9)	L4 (7)	L4 (3)	L3/L4 (4)
Slump Test	(+) R	(+) R	(+) R	(-)	(-)
FABER Test	(+) B	(+) L	(-)	(-)	(-)
Gaenslen's Test	(+) R	(-)	(-)	(-)	(-)
Sacral Thrust	(+)	(-)	(-)	(-)	(-)

Key: * = MCID - weekly, ^ = MCID – day 1 to follow-up, NT = Not tested, P/P = Pre/Post MYK, L/R = Left/Right, B = Bilateral, # = number of lower body posture imbalances, PG = pelvic girdle
NRS = Numeric Rating Scale; MCID = 2 points or 30%
DPA Scale = Disablement in the Physically Active Scale; MCID = 6 points for chronic, 9 points for acute
PSFS = Patient-Specific Functional Scale; MCID = 2 points
OSW = Modified Oswestry LBP Disability Questionnaire; MCID = 12%
FFD = Fingertip-to-floor distance measured on 20cm high step; no MCID; normal ranges 0.1cm – 2.2cm from the floor without a step
FTD = Fingertip-to-thigh distance; no MCID; normal ranges 19.1cm – 21.6cm

Table E.8. Patient #9542, Chronic LBP (L4-S1 disc herniations) – Specific Exercise Subgroup

	Day 1	Week 2	Week 3	Week 4	Week 5	Week 6 - Discharge	1 Month Follow-up
Measurement							
NRS (current) P/P	1.5/0*	1/0*	1/0*	1/0*	0/0	0/0	1^
NRS (best)	0	0	0	0	0	0	0
NRS (worst)	4	2*	2	1*	1	2	1^
NRS (total)	1.8	1*	1	0.7*	0.3*	0.7	0.7^
DPA scale	40	22*	24	22	21	16	11^
PSFS	5.5	6.5	7	8	8.25	8.5	8.5^
OSW	26%	22%	20%	18%	18%	14%	14%^
GRC	NT	NT	NT	NT	NT	4	4
FFD	4cm	4cm	2cm	1cm	1.5cm	1cm	6cm
FTD (cm) L/R	26/24	24/23	28/26	25.5/23.5	25/24	26.5/24.5	26/25
MYK Posture (#)	L5 (6)	L4-S1 (5)	S1 (6)	S1 (3)	S1 (4)	S1 (3)	S1 (6)
Quadrant Test	(+) B	(+) B	(+) B	(+) B	(+) R	(+) B	(+) R
Slump Test	(+) B	(+) B	(-)	(-)	(-)	(-)	(-)
Prone Instability Test	(+)	(+)	(+)	(-)	(-)	(-)	(-)
Sacral Thrust	(+)	(+)	(+)	(-)	(-)	(-)	(-)
PG Motion	(+)	(+)	(-)	(-)	(-)	(-)	(-)

Key: * = MCID - weekly, ^ = MCID – day 1 to follow-up, NT = Not tested, P/P = Pre/Post MYK, L/R = Left/Right, B = Bilateral, # = number of lower body posture imbalances, PG = pelvic girdle
NRS = Numeric Rating Scale; MCID = 2 points or 30%
DPA Scale = Disablement in the Physically Active Scale; MCID = 6 points for chronic, 9 points for acute
PSFS = Patient-Specific Functional Scale; MCID = 2 points
OSW = Modified Oswestry LBP Disability Questionnaire; MCID = 12%
FFD = Fingertip-to-floor distance measured on 20cm high step; no MCID; normal ranges 0.1cm – 2.2cm from the floor without a step
FTD = Fingertip-to-thigh distance; no MCID; normal ranges 19.1cm – 21.6cm

Table E.9. Patient #9543, Chronic LBP – Specific Exercise Subgroup

	Day 1	Week 2	Week 3	Week 4	Week 5 - Discharge	1 Month Follow-up
Measurement						
NRS (current) P/P	1/0*	0/0	2/0*	0/0	0/0	0^
NRS (best)	0	0	0	0	0	0
NRS (worst)	6.5	0*	2	0*	0	0^
NRS (total)	2.5	0*	1.3	0*	0	0^
DPA scale	4	1	4	2	1	0
PSFS	6.6	8	9	8	9.25	9.6^
OSW	4%	4%	4%	4%	4%	4%
GRC	NT	NT	NT	NT	4	4.5
FFD	17cm	12cm	9cm	12cm	8cm	16cm
FTD (cm) L/R	18/17	20/22	18.5/16.5	17.5/21	18/20	16/16
MYK Posture (#)	L5 (6)	L5 (5)	C5 (3)	C5 (2)	C5 (2)	C5 (3)
Quadrant Test	(+) B	(-)	(-)	(-)	(-)	(-)
Slump Test	(+) B	(+) R	(+) R	(+) R	(-)	(-)
Gaenslen's Test	(+) L	(-)	(-)	(-)	(-)	(-)
Prone Instability Test	(+)	(+)	(+)	(+)	(-)	(-)

Key: * = MCID - weekly, ^ = MCID – day 1 to follow-up, NT = Not tested, P/P = Pre/Post MYK, L/R = Left/Right, B = Bilateral, # = number of lower body posture imbalances, PG = pelvic girdle
NRS = Numeric Rating Scale; MCID = 2 points or 30%
DPA Scale = Disablement in the Physically Active Scale; MCID = 6 points for chronic, 9 points for acute
PSFS = Patient-Specific Functional Scale; MCID = 2 points
OSW = Modified Oswestry LBP Disability Questionnaire; MCID = 12%
FFD = Fingertip-to-floor distance measured on 20cm high step; no MCID; normal ranges 0.1cm – 2.2cm from the floor without a step
FTD = Fingertip-to-thigh distance; no MCID; normal ranges 19.1cm – 21.6cm

APPENDIX F

ORTHOPEDIC SPECIAL TESTS FOR THE LUMBAR SPINE AND PELVIC GIRDLE

1. Prone Instability Test: The patient lies prone with his or her legs over the edge of the plinth and feet on the floor. The clinician applies a posterior-anterior (PA) force to each lumbar spinous process and reports any provocation of pain. The patient lifts both legs off the floor and PA compression is applied again to the painful lumbar spinous process. The test is positive for lumbar instability if pain is present in the resting position, but subsides in the second position. (Cleland, Fritz, & Childs, 2007; Hicks, Fritz, Delitto, & Mishock, 2003; Ravenna, Hoffman, Van Dillen, & Dillen, 2011).
2. Crossed Straight Leg Raise (SLR) Test: With the patient supine, passively flex the uninvolved hip with the knee in extension. A positive test occurs when the patient reports pain on the involved side at 40° or less of hip flexion on the uninvolved side. The Crossed SLR test has been shown to be specific for diagnosing disc pathology (Fritz et al., 2007).
3. Passive Straight Leg Raise (PSLR) Test: With the patient supine, passively flex the hip keeping the knee extended and repeat on the other side. The clinician reports the angle of hip flexion at pain onset. If the PSLR produces symptoms unilaterally or bilaterally at less than 50°, then the leg is lowered to reduce pain followed by ankle dorsiflexion, hip medial rotation, and neck flexion. If symptoms are reproduced with one of those motions the test is positive for nerve root tension (Rebain, Baxter, & Mcdonough, 2002).
4. Valsalva Test: The patient is seated and takes a deep breath, followed by holding the breath while bearing down. The test increases intrathecal pressure similar to a cough or sneeze. The test is positive if spinal or radicular pain is present (Starkey, Brown, & Ryan, 2010, p. 487).

5. Slump Test: The patient is sitting with his or her legs over the end of the plinth. (1) The patient rounds his or her shoulders and slumps forward while keeping a neutral cervical spine. (2) The patient performs cervical spine flexion, which is held by the clinician. (3) The patient actively extends his or her knee. (4) The patient actively dorsiflexes his or her ankle. (5) The sequence is repeated on opposite side. The test is positive if sciatic pain or other neurologic symptoms occur (Starkey et al., 2010, p. 492).
6. SI Joint Distraction/Compression Test: With the patient side lying, the clinician applies a medial force on the iliac crest causing sacroiliac joint (SIJ) distraction. With the patient supine, the clinician applies a posterolateral force through the ASIS bilaterally causing SIJ compression. The test is positive if pain is produced in the SIJ (Lee, 2011, p. 222).
7. Thigh Thrust: The patient is supine with the hip and knee flexed. Placing the opposite hand on anterior superior iliac spine (ASIS) to stabilize the pelvis, the clinician applies a posterior force through the femur. The test is positive if pain is produced in the gluteal area on the ipsilateral side (Lee, 2011, p. 223).
8. Sacral Thrust: With the patient prone, the clinician applies a PA force to the sacrum and maintains the force for five seconds. The test is positive if pain occurs (Lee, 2011, p. 223).
9. FABER Test: With the patient supine, the examiner brings the hip into flexion, abduction, and external rotation with the knee flexed so the heel is resting on the contralateral knee. The examiner stabilizes the contralateral ASIS and applies a downward pressure to the flexed knee. If pain is reproduced in the buttock or groin below L5, the test is considered positive (Arab, Abdollahi, Joghataei, Golafshani, & Kazemnejad, 2009).
10. Gaenslen's Test: The patient is supine with the affected leg partially off the plinth. On the unaffected side the patient pulls the knee to the chest. The clinician applies downward

pressure to the affected side, forcing the hip into hyperextension. Pain in the SIJ is considered a positive test (Ozgocmen, Bozgeyik, Kalcik, & Yildirim, 2008).

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APPENDIX G

PROTOCOL APPROVAL FROM INSTITUTIONAL REVIEW BOARD FROM THE UNIVERSITY OF IDAHO

University *of* Idaho

Office of Research Assurances Institutional Review Board

To: Alan Nasypany

From: Traci Craig, Ph.D., Chair, University of Idaho Institutional Review Board University Research Office Moscow, ID 83844-3010

Date: 4/15/2014 6:15:43 PM

Title: Effectiveness of the MyoKinesthetic System in the low back pain treatment-based classification system

Project: 14-154

Approved: April 15, 2014

Renewal: April 14, 2015

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 April 14, 2015.

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.

Traci Craig, Ph.D.

University of Idaho Institutional Review Board: IRB00000843, FWA00005639